THE EFFICIENT MARKET HYPOTHESIS REVISITED: SOME EVIDENCE FROM THE ISTANBUL STOCK EXCHANGE

A thesis submitted for the degree of Doctor of Philosophy

by

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DECLARATION

ABSTRACT

This thesis seeks to address three important issues relating to the efficient functioning of the Istanbul Stock Exchange. In particular the thesis seeks to answer the following questions :

1. What makes markets informationally efficient or inefficient?

2. Has increased stock market volatility had an impact on the equity risk premium and the cost of equity capital to firms? and

3. How is it possible to reconcile the view that markets are weak form efficient and yet technical analysis is a pervasive activity in such markets?

Unlike previous studies, this thesis seeks to examine the issue of efficiency when institutional features specific to the market under investigation are taken into account. Specifically, the thesis adopts a testing methodology which enables us to recognize possible non-linear behaviour, thin trading and institutional changes in testing market efficiency. The results from this investigation show that informationally efficient markets are brought about by improving liquidity, ensuring that investors have access to high quality and reliable information and minimising the institutional restrictions on trading. In addition, the results suggest that emerging markets may initially be characterised as inefficient but over time, with the right regulatory framework, will develop into efficient and effective markets.

The second important issue to be examined in this thesis concerns the impact of regulatory changes on market volatility and the cost of equity capital to firms. It is not sufficient to simply examine whether volatility has increased following a financial market innovation such as changes in regulation. Rather, it is necessary to investigate why volatility has changed, if it has changed, and the impact of such a change on the equity risk premium and the cost of equity capital to firms. Only then can inferences be drawn about the desirability or otherwise of innovations which bring about increases in volatility. Surprisingly, these issues have not been addressed in the literature. The evidence presented here suggests that the innovations which have taken place in the ISE have increased volatility, but also improved the pricing efficiency of the market and reduced the cost of equity capital to firms.

Finally, the thesis tries to identify the conditions under which weak-form efficiency is consistent with technical analysis. It is shown that this paradox can be explained if adjustments to information are not immediate, such that market statistics, in particular statistics on trading volume contain information not impounded in current prices. In this context technical analysis on volume can be viewed as part of the process by which traders learn about fundamentals. Therefore, the thesis investigates the issue whether studying the joint dynamics of stock prices and trading volume can be used to predict weakly efficient stock prices.

In summary, the findings of this thesis will be of interest to international investors, stock market regulators, firms raising funds from stock markets and participants in emerging capital markets in general. The implication of the results presented here is that informational efficient emerging markets are brought about by improving liquidity, ensuring that investors have access to high quality and reliable information and minimising the institutional restrictions on trading. In addition, the evolution in the regulatory framework of, and knowledge and awareness of investors in, emerging markets may mean that they will initially be characterised by inefficiency, but over time will develop into informational efficient and effectively functioning markets which allocate resources efficiently. In addition, the results of this thesis have important implications, for emerging markets in general, in identifying the regulatory framework that will achieve efficient pricing and a reduction in the cost of equity capital to firms operating in the economy.

I. INTRODUCTION

The past fifteen years have witnessed spectacular growth in both the size and relative importance of emerging equity markets in developing countries. High economic growth, the pursuit of liberalisation policies within these countries and trends towards financial markets globalisation provided the environment in which equity markets could thrive. In addition, Western equity fund managers were attracted to these markets by the potentially high rates of returns offered and the desire to pursue international diversification. As these capital markets have developed considerable attention has been given to the question of whether they function efficiently. This thesis seeks to address three important issues relating to the efficient functioning of emerging capital markets. In particular the thesis seeks to answer the following questions:

1. What makes markets informationally efficient or inefficient?

2. Has increased stock market volatility had an impact on the equity risk premium and the cost of equity capital to firms? and

3. How is it possible to reconcile the view that markets are weak form efficient and yet technical analysis is a pervasive activity in such markets?

The issue of efficiency is of great significance to both foreign investors and the allocation of scarce resources within these countries. The question of whether these markets price securities efficiently is ultimately an empirical issue and it is this which has attracted most attention in the literature. However, if the evidence on efficiency/inefficiency is to be reliable it is essential that the methodology adopted in statistical tests takes account of the institutional features and trading conditions of the market under investigation. Only then can we address the more important issue of what makes markets informationally efficient or inefficient. An understanding of this issue will help to determine the appropriate regulatory framework for the establishment of efficiently functioning equity markets.

The issue of efficiency in emerging markets has been widely investigated in recent years. Research has focused on either the conventional form of efficiency (Fama, 1970) or on examining the question of whether anomalies exist. Overall results are mixed. For example, Barnes (1986) reports the Kuala Lumpur stock market to be inefficient, Butler and Malaikah (1992) find evidence of inefficiency in the Saudi Arabian stock market, but not in the Kuwait market and Panas (1990) concluded that market efficiency could not be rejected for Greece. Fama (1991) has questioned the validity of some of the results demonstrating market inefficiency by arguing that 'With many clever researchers, on both sides of the efficiency fence, rummaging for forecasting variables, we are sure to find instances of "reliable" return predictability that are in fact spurious.... evidence of predictability should always be met with a healthy dose of scepticism...' (1991, pp.1585-1586). It is possible, in the spirit of Fama, that the positive evidence in favour of efficiency is also questionable: it is difficult to believe that the Nairobi stock market is efficient (see, Dickinson and

Muragu (1994)) when there is evidence that some of the most developed markets in the world are characterised by inefficiency (see, for example, DeBondt and Thaler (1985, 1987), Lo and MacKinlay (1988) and Conrad and Kaul (1988)). Thus, both the positive and negative evidence on efficiency in emerging markets may reflect the methodology adopted for testing and the time period under investigation, rather than giving a true picture of the state of the market. The conventional tests of efficiency have been developed for testing markets which are characterised by high levels of liquidity, sophisticated investors with access to high quality and reliable information and few institutional impediments. On the other hand, emerging markets are typically characterised by low liquidity, thin trading, possibly less well informed investors with access to unreliable information and considerable volatility.

Furthermore, efficiency implicitly assumes that investors are rational, where rationality implies risk aversion, unbiased forecasts and instantaneous responses to information. Such rationality leads to prices responding linearly to new information. However, emerging markets, especially during the early years of trading, may be characterised by investors who do not have these attributes. In particular, investors may not always be risk averse, sometimes they may be risk loving or risk neutral if by taking risk they believe they can minimise their losses. In addition, investors may place too much faith in their own forecasts introducing bias into their actions. Similarly, investors do not always respond instantaneously to information. They may delay their response to see how others behave because they do not have the resources to fully analyse the information or because the information is not reliable. As a result prices may respond in a non-linear fashion.

Failure to take into account the institutional features of these equity markets may lead to statistical illusions regarding efficiency or inefficiency. With reference to evidence in favour of efficiency, this is perhaps the outcome of using linear models for testing efficiency in markets characterised by inherent non-linearities. If the generating process is non-linear and a linear model is used to test for efficiency, then the hypothesis of no predictability may be wrongly accepted. This is because non-linear systems such as 'chaotic' ones look very similar to a random walk. If however, the system is non-linear, the series may be predictable. Conventional tests of efficiency, such as the ones used in chapter 4 of the thesis (for example, autocorrelation tests, runs tests, spectral analysis and frequency tests) are not capable of capturing non-linearities and therefore, inferences drawn from such tests may be inappropriate. Similarly, if markets are inefficient prices do not fully incorporate information. However, as Grossman and Stiglitz (1980) have argued, why should investors not use something of value? Perhaps, the reason why inefficiencies are observed is due to the fact that information is not free or is not reliable, investors are not able to process information, the market is illiquid leading to infrequent trading or there are restrictions on trading. Thus, while evidence that, for example, prices do not follow a random walk suggests that the market is inefficient, thin trading and illiquidity may mean that trades cannot be carried out at the prices shown in the data. This feature of the market must, therefore, be recognised in empirical tests. In addition, emerging markets by their very nature change rapidly through time. The dismantling of barriers to the flow of capital both within the country and from external sources will cause changes in the institutional and regulatory environments which will impact on both the informational and allocational efficiency of the market. It is therefore necessary to examine the evolution of these markets, rather than simply taking a snapshot of the market at a particular point in time. By examining markets in this way it is possible to identify the impact of regulatory changes on the efficient functioning of the market. This allows clear policy implications to be reached regarding the appropriate regulatory framework for newly developing equity markets.

This thesis seeks to examine the issue of efficiency when institutional features specific to the market under investigation are taken into account. Specifically, the thesis adopts a testing methodology which enables us to recognize possible non-linear behaviour, thin trading and institutional changes in testing market efficiency.

The second important issue to be examined in this thesis concerns the impact of regulatory changes on market volatility and the cost of equity capital of firms. There is a widespread belief that financial market volatility has increased during the 1980s and 1990s. Changes in volatility following financial market innovation have important implications for investors and policy-makers. Traditionally, increased volatility has been viewed as an undesirable consequence of destabilizing forces such as speculative activity, noise trading or feedback trading. However, greater volatility resulting from an innovation may simply reflect the actual variability of information regarding fundamental values. Hence, increased asset volatility need not be undesirable, rather it may be the result of improvements in the functioning of markets. The question of whether increased volatility following financial market innovation is the result of the more rapid impounding of information or the result of destabilizing forces is essentially an empirical issue. However, even if increased volatility is the result of improvements in informational efficiency, it may still lead to an increase in the equity risk premium and, hence, the cost of equity capital. For example, French, Schwert and Stambaugh (1987) present evidence of a direct relationship between expected risk premiums and volatility. Thus, if investors perceive increased volatility as being the result of an increase in the riskiness of the market they may direct their funds towards less risky investments, raising the cost of equity to firms and leading to a misallocation of resources. Furthermore, small and new firms may be most adversely affected as investors concentrate their investments in established large firms which are perceived to be less risky. In the light of this, it is not sufficient to simply examine whether volatility has increased following a financial market innovation. Rather, it is necessary to investigate why volatility has changed, if it has changed, and the impact of such a change on the equity risk premium and the cost of equity capital to firms. Only then can inferences be drawn about the desirability or otherwise of innovations which bring about increases in volatility. Surprisingly, these issues have not been addressed in the literature.

An important determinant of financial innovation and, hence, volatility is changes in the regulatory framework within which the market operates. The regulatory framework will partly determine the number and quality of investors in the market, the quality of investment analysis and the quantity and reliability of information flowing to the market. In turn, these factors will impact on volatility, pricing efficiency and the equity risk premium. Emerging markets provide a rich source of information by which the issues discussed above can be investigated. By their very nature, emerging markets tend to be characterised by major changes in the early years of operation. For example, as the market develops the flow of capital may be freed up, the requirements on firms to disclose information may change and the reliability of information flowing to the market may be improved by more strict auditing requirements. All such changes are likely to impact on volatility, efficiency and the cost of equity capital.

The thesis addresses the following three important issues:

* have changes in the regulatory framework had an impact on the level of stock price volatility?
* if there has been a change, is this due to information being impounded into prices more rapidly or is it the result of destabilizing forces?
* how have any changes in volatility impacted on the equity risk premium and what are the implications of such changes for the cost of equity capital to firms?

Finally, the thesis tries to identify the conditions under which weak-form efficiency is consistent with technical analysis. It is shown that this paradox can be explained if adjustments to information are not immediate, such that market statistics, in particular statistics on trading volume contain information not impounded in current prices. In this context technical analysis on volume can be viewed as part of the process by which traders learn about fundamentals. Therefore, the thesis investigates the issue whether studying the joint dynamics of stock prices and trading volume can be used to predict weakly efficient stock prices.

The market chosen for investigation in the thesis is the Istanbul Stock Exchange (ISE). This market has undergone considerable regulatory changes since the inception of trading in 1986. The developments and regulatory changes which have taken place in the ISE provide a valuable opportunity to examine the above mentioned issues. The results of this investigation have important implications not only for the regulation of the ISE, but also help in identifying the regulatory framework for any emerging market which wishes to achieve efficient pricing and a reduction in the cost of equity capital to firms operating in the economy.

The thesis proceeds as follows: Chapter 2, provides an overview of the Turkish economy and the Istanbul Stock Exchange. This is intended to provide the background against which the stock exchange has developed. The development of capital markets crucially depend on the stage of economic development of the country, otherwise capital markets will become speculative casinos and will lead to the missallocation of scarce resources within the economy. The chapter shows that the economic environment of Turkey at the time the ISE was developed was, conducive to the successful development and subsequent growth of the stock exchange.

Chapter 3 sketches the development of the efficient market theory, by reviewing the principal contributors. The idea was formalised by Roberts (1959) and Fama (1965). The chapter shows that the efficient market theory despite its restrictive assumptions successfully opened stock markets to economic thought and altered both the way we think about, and our respect for, financial markets.

Chapter 4 is the first empirical chapter of the thesis and investigates the efficiency of the ISE using the conventional tests used in previous literature. Most of these techniques are primarily intended to test whether financial markets are efficient or not. While they do not address the more important question of what makes financial markets efficient and why should markets be inefficient, they provide a benchmark against which the results of chapter 5 can be evaluated. The chapter shows that the market could be classified as inefficient.

Chapter 5 develops and uses a methodology for testing market efficiency which directly recognises that emerging markets are characterised by low liquidity, thin trading, possibly less well informed investors with access to unreliable information and considerable volatility. Furthermore, the chapter examines the impact of the market maturing and regulatory changes on the trading behaviour and efficiency of the market. The results show that, unlike the findings in chapter 4 using conventional tests, in its early years of development the exchange was characterised by thin trading, nonlinear behaviour and inefficient pricing. However, changes in the regulatory structure from 1989 encouraged participation in the market, improved the quality of information available and led to the more rapid impounding of information into prices.

Chapter 6 examines the impact of the regulatory changes on level of stock market volatility, the equity risk premium and the cost of capital to the firms. The chapter demonstrates that increased volatility may be undesirable if it increases the cost of capital to firms. The evidence presented here suggest that the innovations which have taken place in the ISE have increased volatility, but also improved the pricing efficiency of the market and reduced the cost of equity capital to firms. These findings reinforced the results of chapter 5.

Finally, chapter 7 identifies the conditions under which stock markets could be classified as weak form efficient and yet technical analysis is a pervasive activity. The chapter shows that if prices are not fully revealing then technical analysis on prices in conjunction with volume will aid traders to infer information about fundamentals. Therefore, technical analysts could contribute to the efficient pricing of stocks and hence any actions on the part of the regulators in reducing their activities will have a negative impact on the efficient functioning of capital markets.

II. THE ROLE OF CAPITAL MARKETS, THE TURKISH ECONOMY AND THE ISTANBUL STOCK EXCHANGE

2.1. INTRODUCTION

The chapter provides a brief discussion on the role of capital markets in contributing to economic development, an overview of the Turkish economy and the Istanbul Stock Exchange (ISE). In particular, after reviewing some aspects of capital market development and their contribution to economic development, the general economic trends of the Turkish economy are analyzed over the period 1988-1993, (the period of investigation cover by the thesis) and the regulatory framework and structure of the ISE is explained. The rationale for this, is to enable the investigation of the efficiency and effectiveness of the ISE to be placed within the general developments of the economy, given that the fundamental role of capital markets is to facilitate the transfer of funds between lenders (savers) and borrowers (business enterprises). The price of lending is set in the capital markets and the accuracy of this pricing process is essential if scarce capital resources are to be used most efficiently. Moreover, the development of capital markets crucially depend on the stage of economic development of the country, otherwise capital markets will become considerably speculative and lead to misallocation of scarce resources within the economy.

The concept of efficiency is based on the notion that capital markets are fair and competitive, therefore the regulatory structure and trading rules could be very crucial to the efficient and effective functioning of these markets. Institutional restrictions could affect the pricing of securities and hence the allocation of capital resources. The chapter proceeds as follows: Section (2.2), provides a brief discussion on the role of capital markets in emerging economies. This is followed by section (2.3), which provides an overview of the Turkish economy. Section (2.4) explains the structure and organisation of the ISE. Finally, section (2.5) concludes the chapter.

2.2. THE ROLE OF CAPITAL MARKETS

Purpose of Capital Market Development

A necessary if not sufficient condition for a rapid economic growth of a nation is the development of an efficient capital market where savings by individuals flow efficiently into investment by suppliers of real productive capital. Economic pioneers such as Goldsmith (1969), Shaw (1973), McKinnon (1973), and Patrick (1966) emphasise the importance of the link between the capital market development and the economic growth of a nation.

Capital markets play an important role in economic development because they directly affect two of the major development goals of developing countries, namely, the mobilization of savings and the channelling of investments into productive enterprises. Thus the main reasons for developing capital markets are to attract an increased volume of medium and long term savings into the financial system by offering investors a variety of financial institutions and investment opportunities, and to improve efficiency in the allocation of financial resources by allowing a broad spectrum of entrepreneurs an opportunity to obtain financing for their projects. Therefore, capital markets are mechanisms for mobilizing and channelling funds which are received from surplus units and are allocated among deficit units.

Recently the stock market has been the focus of intense and professional research in finance. Research activity in this area and the amount of attention directed at the stock market has surpassed that devoted to any other area of finance. This attention at the stock market lies in the important economic functions the stock market is supposed to perform within the economy. These functions include: Firstly, the provision or offer of guidance to corporate management, especially with respect to information on the current cost of capital which is so important in determining the level of investment which is appropriate for the firm to undertake. Secondly, the possibility of long term investments to be financed by funds provided by individuals, who wish to make the funds available for only a very limited period or who wish to withdraw them at will without necessarily having to wait until the liquidation of the firm or the maturity of the financial instruments which they hold. Thus, the market imparts a measure of liquidity to long term investment that permits their instruments to be sold. Thirdly, the stock market is often said to play critical role in the efficient allocation of the economy's capital resources, so that the more profitable and efficient a firm is, the greater the amount of resources that it uses or invests. Capital markets help to allocate resources efficiently by directing savings flow to the best investment returns for a given level of risk.

It is this last function of the stock market, that of efficient allocation of resources, which is of primary interest to us in this thesis. Since as Salameh (1986) suggested, "although stock markets are important mechanisms for the mobilization of resources, it is necessary to know more about their relationship to economic stability if their benefits for development are to be realised". The stock exchange interacts with the economy in such a way that any developments in the economy are reflected in stock prices which in return affect financial markets which further affect the economy.

Structure of Capital Markets

Capital markets are that part of the financial system which deals in medium and long term credits which may take the form of loans or cover the issuance of stocks and bonds. On the other hand, money markets lend and borrow at short and medium terms and these operations are carried out by commercial banks and other financial intermediaries. It could therefore be said that capital markets provide long term funds which can be used to make capital investments, whereas money markets provide short term funds for meeting fluctuating needs and must be paid relatively quickly. Capital markets are divided into two segments: the securities markets and the non-securities markets. Securities markets provide medium and long term equity and debt funds in negotiable form which are issued by corporations and governments, or through financial institutions such as investment and merchant banks and venture capital firms, directly to individual and institutional investors and are then traded among different holders. Non securities markets provide non-negotiable medium and long term debt funds through financial institutions such as commercial banks, development banks and contractual savings institutions which mobilize savings and then lend those mobilized funds directly to business, industry and other users of funds.

Table 2.1

Organization of Capital Markets

		Securities Markets	Non-Securities
Instruments		Equity (shares & stocks)	Loans
		Equity equivalents	Mortgages
		Convertible bonds or	Leases
		debentures	Sale & lease back
		debt securities (bonds or debentures)	
Institutions	Development banks	Primary Markets	Secondary
	Specialized banks		
	Commercial banks	Corporate government	OTC
	Savings banks	issues	Stock
	Insurance Companies	investment merchant	Exchange
	Pension & Employee	banks	Brokers
	provident funds	Brokers-dealers	dealers
	Lending companies		Clearance
		Securities-	settlement
		Regulatory bodies	Transfer
		Debenture trustees	agents and mutual funds

The above table shows how capital markets are composed. Although each institution plays an important role in the capital market, it should be stressed that a well established system of organized securities exchanges should provide investors with (1) market places for securities already outstanding, (2) availability of market liquidity, and (3) orderly market price fluctuations.

For a long time it was believed by governments and institutions that it was not worth setting up a stock market in developing countries because the costs would overweight the economic benefits. However, in recent years economists have focused attention on capital markets and particularly on the securities markets and stock exchanges in order to find the ways and means of financing economic development. There are, however, difficulties in creating securities markets in developing countries:

A. **The demand for stocks depends on several factors, some of which are following :**

1. **Individual demand :** The first factor is the number of financially sophisticated individuals with enough money to purchase shares. In their early stages stock markets cater to as few as 10,000 shareholders, of whom only several hundred may be active traders. Also remittances from workers abroad can play a significant role in the demand for shares, where non resident workers and overseas resident represent a potentially important source of demand for securities investment.

2. **Institutional demand :** In many emerging markets, demand from insurance companies, pension funds, and mutual funds is negligible; in some countries their presence plays an important role. Private parties and government authorities interested in the development of a stock market are often not sufficiently aware of the potential importance of institutional investment whose active participation is critically important because they represent a potentially large source of stable investible funds. Without them, there is a great risk of

a market dominated by individual speculators.

3. **Investment alternatives :** Individual as well as institutional investors are more attracted to shares in comparison with other investment alternatives. In determining how and where to invest their money, rational investors look at risk, liquidity, overall return and tax treatment.

B. Factors behind the supply of stocks :

A greater constraint on the development of an active equity market is not having enough stock issues to trade adequately more than the number of investors. Too few stocks may at first deter investors from entering the market at all. Later, when trading is active, too many people may be chasing to few stocks, thus adding to price volatility. The lack of float is another potential problem frequently encountered in developing stock markets. Before a stock market can start, at least 20 companies, each with a float of about 25 percent of their capital, should be available for trading. Active emerging markets now have 300 or more listed stocks, of which at least 25-50 are actively traded on a daily basis. The factors influencing the supply of securities are:

1. Size : What determines the number of sizeable corporations which are likely to be available for listing their shares on the stock exchange are the size of the economy, its level of development and growth rate and its free enterprise orientation.

2. **Attitude :** Equally important is the attitude of existing owners regarding dilution of the ownership and control of their firms. This attitude usually depends on whether the companies are still managed by the original owners or whether professional managers have been brought in. In the latter case, existing shareholders are more likely to be willing to list their companies on a stock exchange and sell some of their shares, especially if they can make an attractive profit.

3. **Need :** The need for a sizeable amount of additional capital is a major factor inducing companies to go public. Such a need exists when the company is growing so rapidly that internally generated cash flow or the owner's resources are outstripped by the capital requirements of major expansion.

4. **Interest rate policies :** Entrepreneurs find it advantageous to borrow rather than to issue shares to the general public when interest rates are generally held below inflation levels for sustained periods or loans with a large subsidy element are easily available.

5. **Legislation :** In many countries, under outdated company laws, the prices at which shares can be sold to the public are determined by government authorities on the basis of par or book value and rights issues must be offered first to existing shareholders.

6. **Government participation :** In some countries, governments dominate the

ownership of major enterprises, which means that they may be in a position to increase substantially the supply of stocks available from trading by directing their interest in public sector corporations which are profitable and professionally managed.

C. **Factors limiting the development of securities markets :**

1. **Limited supply of corporate securities :** Fundamentally the limited supply of private securities in underdeveloped countries is related to the small size and limited investment horizons of many local businesses. It will inevitably take time for such firms to reach the point of raising funds through public shares and debentures issues, thus providing the necessary augmentation of the supply of private paper. In some countries it might be desirable for development banks, etc. to raise funds by issuing shares and debentures publicly. It is therefore argued that the whole machinery of public companies, issuing shares and bonds which are traded on the stock exchange, is inappropriate to underdeveloped countries, where there is likely to be, for some time, a preponderance of firms which are too small to approach the public capital market and depend upon self finance or institutional finance for expansion.

2. **Limited demand for securities :** There are a number of reasons for expecting the demand for securities to be limited in an under developed economy:

1. Individual savings accrue in the main to unsophisticated people, who are financially inexperienced and have conservative attitudes towards money.

2. Share ownership by individuals tends to be confined to those with high incomes who may spread their risks through diverse portfolios.

3. The generally underdeveloped financial system means that there is little or institutional demand for securities.

4. Price uncertainty reinforces the traditional preference for money over financial assets which fluctuate in value.

5. Investment in securities is extremely risky and in the nature of a race course gamble, as accurate information is scarce, the costs of obtaining it are inordinately high and market regulation is limited.

D. **Other factors behind the creation of securities markets in less developed countries :**

1. **Political and economic environment :** Investors are very sensitive to political uncertainty. The level of political development is a critical detriment in influencing the supply of securities. In countries which are in domestic turmoil engaged in major border conflicts there is little interest in establishing a stock

market and investing in shares. If a market exists, trading activity and prices are usually in decline.

Political disruption in economic activity is almost always affected, because companies postpone investments and scale down their growth projection. A major reason for the lack of activity of securities markets in many developing countries are unfavourable or unstable macro economic policies such as, high inflation, negative real interest rates, frequent devaluations, and discriminatory tax treatment of shares. Frequent devaluations and negative real interest rates at home tempt investors to invest abroad.

2. **Tax policies and other inducements :** an essential feature for the establishment and development of an equity market is an flexible and positive government attitude. Companies may not want to go public because they fear that tax authorities could catch them more easily at tax evasion, a widespread practice among privately held companies in many countries. Tax incentives are designed to counter such fears and to provide a positive inducement for companies to go public or for owners to sell (supply incentives) and for investors to buy shares (demand incentives).

2.3. THE TURKISH ECONOMY

Following the establishment of Turkey in 1923, the country followed a state controlled economic policy. The foundations of industry in Turkey were laid during that period. After the Second World War, measures toward liberalization were adopted and Turkey began opening to the West. Since January 1980, the Turkish economy has been in the midst of a prolonged process of economic reform and liberalization, based on a model of economic growth driven by exports. Import barriers have been lowered thus improving productivity levels through enhanced competition. On the other hand, exports have boomed, tourism has surged, and foreign exchange reserves have risen so far as to ensure the convertibility of the Turkish lira.

Table (2.2) provides figures for the GNP and growth rates for the Turkish economy on a yearly basis from 1988 to 1993. As can be seen from the table the average economic growth between 1988 and 1993, was 4.8%, a level considerably higher than the OECD average for the same period.

Table 2.2

GNP AND GROWTH RATES IN TURKEY YEARLY BASIS

(TRILLION TL)

	1988	1989	1990	1991	1992	1993
GNP* TrillionTL	134	230	397	634	1,104	1,909
GNP#	77	77	85	85	90	97
GRWR* %	72.1	78.3	72.4	59.7	74	72.9
GRWR# %	1.4	1.6	9.4	0.4	6.4	7.3
GNP Per Capita* MillionTL	-	4,2	7,1	11,1	18,8	31,9
GNP Per Capita# MillionTL	-	1,4	1,5	1,5	1,5	1,6
Per Capita* GRWR %	-	74.5	68.7	56.3	70.3	69.2
Per Capita# GRWR %	-	0.6	7.0	1.8	4.1	5.0
Per Capita# Thousand $	-	2.0	2,7	2,6	2,7	2,9
SECTOR SHARE IN GNP*						
AGR.	17.0	16.4	18.0	15.6	16.5	13.1
IDUST.	26.8	26.6	25.0	25.8	29.9	32.4
SERVICE	56.2	57.0	57.0	58.6	53.6	54.5

GRWR: Growth rate
*: Current prices
#: In 1987 constant prices
(Source: Istanbul Chamber of Commerce)

Turkey, which historically had exploited its comparative advantage in the labour intensive industries of agriculture and textiles, was now developing an efficient manufactured goods industry. Throughout the latter half of the 1980s, public sector fixed investment formerly at the vanguard of Turkish economic development, declined in the face of surging private sector investment. Overall, private sector was 54.4% in 1992, 57.1% in 1993 as a proportion of total investment in Turkey.

Over the period 1988 to 1993, however, the purchasing power of money has been declining due to increases in the rate of inflation as shown below in Table (2.3),

Table 2.3

CONSUMER PRICE INDEX

1987	1988	1989	1990	1991	1992	1993
23.4	38.4	62.53	100.00	166.10	282.25	468.83

INFLATION RATE BY YEAR

1987	1988	1989	1990	1991	1992	1993
23.4	38.4	62.53	100.00	166.10	282.25	468.83

(Source: Istanbul Chamber of Commerce)

A further look at export figures reveals the reason behind the growth rates in the Turkish economy over the period. In 1980, exports of manufactured goods amounted $1 billion; by 1990, this had increased by ten-fold to $10.2 billion. While obviously emphasizing the growth of its manufactured food sector, Turkey, self-sufficient in its food production, has not ignored its more traditional strengths in agriculture. Agricultural exports increased from $1.7 billion in 1980 to $2.4 billion in 1990.

Table 2.4

EXPORTS BY MAIN SECTORS AND % SHARE'S IN TOTAL

MILLION $

EXPORTS=100%

Year	Total	Agriculture	%	Mine	%	Industry	%
1988	11,662	2,341	20.1	377	3.2	8,944	76.7
1989	11,625	2,126	18.3	413	3.6	9,086	78.2
1990	12,959	2,388	18.4	331	2.6	10,240	79.0
1991	13,593	2,726	20.1	286	2.1	10,581	77.8
1992	14,715	2,259	15.4	264	1.8	12,192	82.9
1993	15,344	2,381	15.5	238	1.6	12,725	82.9

(Source: Istanbul Chamber of Industry)

Total income from exports increased from $11,662 to $15,344 million over the period under investigation. Income from the agricultural sector averaged 19.23% between 1988-1991 but this figure decline to 15.5% in 1993 which indicates the reduction on this sector's contribution to exports. Income from Mining also decreased from 3.2% to 1.6%. However, industrial exports increased from 76.7% to 82.9% and this shows the increasing importance of this sector in the growth of the economy.

Table 2.5

IMPORTS BY MAIN GOODS GROUPS AND % SHARE'S IN TOTAL

MILLION $

Year	Total	Investment	%	Consume	%	Raw Metr.	%
1988	14,335	3,989	27.8	1,110	7.7	9,236	64.4
1989	15,792	3,845	24.3	1,389	8.8	10,558	66.9
1990	22,302	5,928	26.6	2,885	12.9	13,489	60.5
1991	21,047	6,051	27.7	2,911	13.8	12,085	57.4
1991	22,872	6,772	29.6	2,972	13.0	13,128	57.4
1993	29,429	9,566	32.5	4,116	14.0	15,747	53.5

(Source: Istanbul Chamber of Industry)

Total imports seem to have increased over the years from $14,335 million in 1988 to $29,429 million in 1993. Import for investment have also increased over the same period from 27.8% to 32.5%. Import for consumer goods seem to have double over the same period. But raw materials' seems to have been decreasing from 64.4% to 53.5% in this period.

Export and import ties with the OECD countries have been consistently on the rise throughout the 1980s. The combining of the EC trading groups will no doubt increase trade opportunities especially as Turkey is on schedule to achieve customs union with both blocks by 1996.

Table 2.6

EXPORT AND IMPORT BY COUNTRIES GROUPS AND % SHARE'S IN

TOTAL

MILLION $

EXPORT=100%

IMPORTS=100%

Year	Total	OECD	%	Islamic	%	Others	%
EXPORT							
1988	11,662	6,707	57.5	3,525	30.2	1,430	12.3
1989	11,625	7,175	61.7	2,870	24.7	1,580	13.6
1990	12,959	8,810	68.0	2,490	19.2	1,659	12.8
1991	13,593	8,856	65.2	2,666	19.6	2,071	15.2
1992	14,715	9,346	63.5	2,775	18.9	2,594	17.6
1993	15,344	9,065	59.1	2,704	17.6	3,575	23.3
IMPORT							
1988	14,335	9,238	64.4	2,926	20.4	2,171	15.1
1989	15,792	9,912	62.8	2,921	18.5	2,959	18.7
1990	22,302	14,225	63.8	3,855	17.3	4,222	18.9
1991	21,047	14,071	66.9	3,175	15.1	3,801	18.1
1992	22,872	15,422	67.4	3,414	14.9	4,036	17.6
1993	29,429	19,975	67.9	3,518	12.0	5,936	20.2

(Source:Istanbul Chamber of Industry)

It seems over the six year period, exports and imports to and from OECD countries have increased while exports to be Islamic countries seem to have declined.

Table 2.7

TOURISM INFLOWS AND OUTFLOWS

(BILLION $)

Year	Inflows	Outflows	Net Income
1988	2,355	358	1,997
1989	2,556	565	1,991
1990	3,308	520	2,788
1991	2,654	592	2,062
1992	3,639	776	2,863
1993	3,959	934	3,025

(Source:Istanbul Chamber of Commerce)

Another important sources of revenue for the Turkish economy has been tourism. Revenues from tourism almost doubled between 1988 and 1993.

Table 2.8

WORKERS REMITTANCE'S INFLOWS AND OUTFLOWS BY YEAR

(TEN BILLION $)

	1988	1989	1990	1991	1992	1993
ANNUAL TOTAL	1,865	3,138	3,325	2,901	3,074	2,963
ANNUAL CHANGE(%)	(11.3)	68.3	6.0	(12.8)	6.0	(3.6)

(*) provisional
(Source: Istanbul Chamber of Commerce)

Worker remittances represent another substantial source of foreign currency inflow to Turkey. Coming predominantly from workers in Germany. Combined, tourism revenues and worker remittances have provided enough of cash cushion to give Turkey a comfortable current account surplus of $5,988 billion in 1993.

Inflow of international capital is another important factor contributing to economic development. In 1981, international investment comprised $338 million, while in 1992 the figure increased to $913 million. The liberalization programme adopted by the government in the early 1980s along with the deregulation programme followed since, render foreign investors the same rights, privileges and incentives granted to Turkish enterprises. In addition with the opening of the Istanbul Stock Exchange to international investors in 1989, international capital has found another outlet through which to invest in Turkey's future.

Table 2.9

FOREIGN DIRECT INVESTMENT PERMITS BY YEARS

(MILLION $)

YEAR	ANNUAL VALUE	CUMULATIVE VALUE	INFLOWS	OUTFLOWS	NET
1988	821	3,279	387	33	354
1989	1,512	4,791	738	75	663
1990	1,861	6,652	789	76	713
1991	1,967	8,619	910	127	783
1992	1,820	10,439	912	133	779
1993	2,271	12,710	797	175	622

FOREIGN DIRECT INVESTMENT PERMITS BY SECTORS

(MILLION $)

Sectors	1991 Annual		1992 Annual		1993 Annual	
	A	B	A	B	A	B
Agriculture	18	22.4	23	36	30	31.2
Mining	21	39.8	18	19	13	11.8
Manufacture	378	1,095.5	431	1,273.9	427	1,726.6
Services	523	809.6	609	492.2	650	501.7
TOTAL	940	1,967.3	1,081	1,821.1	1,120	2,271.3

(Source:Istanbul Chamber of Commerce)

The manufacturing sector seems to have attracted more investment from foreign investors. Again reflecting the importance of this sector to the economy. The second largest sector in terms of attracting foreign investment is services, which includes tourism, banking, investment financing among others.

Table 2.10

FOREIGN DIRECT INVESTMENT PERMITS BY COUNTRIES

(MILLION $)

Countries	1991 Annual		1992 Annual		1993 Annual	
	A	B	A	B	A	B
OECD	656	1,774.3	763	1,612.8	774	2,042.8
Islamic	108	122.9	102	127.1	108	78.7
Other	176	70.1	216	80.1	238	149.9
Total	940	1,967.3	1,081	1,820	1,120	2,271.3

(A):Number of permits
(B):Amount of capital
(Source: Istanbul Chamber of Commerce)

Again above table shows the importance of trading relations between Turkey and OECD countries. Investment from OECD countries to Turkey represent almost 90% of total foreign direct investment.

As the Turkish economy looks forward to the 21st century, one could state that its full potential has yet to be reached. Every year, new industries enter the export arena while foreign investment continues to increase.

2.4. TURKISH CAPITAL MARKETS AND THE ISTANBUL STOCK EXCHANGE: STRUCTURE, PERFORMANCE AND REGULATION

Even though securities trading in Turkey has been seen as early as the 17th century, it was carried out in the form of unorganized markets.The concept and operations of an organized securities market in Turkey have its roots which back to Crimean War in the middle of the 19th century. The first securities market was established immediately after the Crimean War (1866) under the name "Imperial Securities Exchange" when the Ottoman Sultan issued sovereign bonds to finance the war campaign. Although it emerged as one of the leading financial centres in Europe, the market fell victim to a succession of wars. After the Turkish Republic was proclaimed in 1923, a new attempt was made to launch a stock exchange. However, this effort was averted by the Depression. After the Depression, as the pace of change in political environment gained momentum throughout the world, the number of joint stock companies rose sharply.

Imperial Securities Exchange created also a medium for European investors who were seeking higher returns in the vast Ottoman markets. Following the proclamation of the Turkish Republic, on the ruins of the Ottoman Empire, a new law was enacted in 1929 to reorganize the fledgling capital markets under the new name of "Istanbul Securities and Foreign Exchange Bourse." In short time, the bourse became very active and contributed substantially to the funding requirements of new enterprises across the country. Nevertheless, its success was clouded by a string of events including the 1929 Depression and the impending Second World War abroad which taken their toll in the embryonic business world in Turkey. An unfortunate decision to move it to the commercially inactive capital city of Ankara during the war years, coupled by poor communications, further exacerbated the problems of the capital markets. During the industrial drive of the subsequent decades, there was a continuous increase in the number and size of joint stock companies, which began to open up their equity capital to the public. Those mature shares faced a strong and growing demand from mostly individual investors and some institutional investors. While the stock exchange existed as a legal entity, the secondary market developed at a faster pace in parallel to an over the counter market.

From 1940 to 1990, bank debt was the premier source of finance for Turkish companies most of which operated high leverage at low or negative real interest rates. This became too risky after 1980 following rises in inflation, interest rates, and change in government policy which introduced significant real interest rates on loans with making high leverage a risky proposition for most institutions. Additionally, increasingly sophisticated Turkish savers changed the direction of savings, with greater investment in securities. During this time, trading was carried out through unorganised markets, mostly in Istanbul.

The early phase of the 1980's saw a marked improvement in the Turkish Capital Markets, both in regard to the legislative framework and the institutions required to set the stage for sound capital movements. In 1981, the "Capital Market Law" was enacted. One year later, the major regulatory body responsible for the supervision and regulation of the Turkish Securities Markets, the Capital Market Board based in

Ankara, was established. A new Decree-Law was issued by Council of Ministers in October 1983, to define the establishment and activities as well as the operation principles and arrangement for the supervision of securities exchanges as warranted by the Capital Market Board (CMB). The purpose of the Decree-Law was to secure and provide for the transparent, coherent and prudent operation of the securities exchanges for the objective of transacting securities in a medium of confidence and stability and to lay the foundations for the securities exchanges to assume an effective role in the capital markets by arranging for their establishment, management, administration and operation principles and eventual supervision.

The regulations concerning operational procedures were approved in subsequent extraordinary meetings of the General Assembly and the Istanbul Stock Exchange was formally inaugurated at the end of 1985, commencing operations in 1986.

Further impetus was given in August 1989 when trading conditions for international investors were improved significantly; free repatriation of dividends, initial investment and capital gains were allowed, and taxes on capital gains were suspended. There is no tax on dividends.

The growth of the newly established stock has been very impressive. The daily average value of trade in shares increased from $0.45 million in 1988 to $3.03 million in 1989, $23.70 million in 1990, $34.42 million in 1991, $34.13 million in 1992 and over $88.50 million by the end of the 1993. In the same time, daily average volume of trading has been increasing. From 13,000 in 1986 it increased to 934,000 in 1989 and 143,289,000 in 1993.

As shown in the following table, the growth number of traded companies, number of companies traded on the Istanbul Stock Exchange, total trading values and volume over the same period ;

Table 2.11

OVERALL PROFILE OF ISE

Years	No. of Com. Traded on The ISE	Total Trading VALUE ($ Million)	Total Trading VOLUME ('000)
1986	80	13	3.273
1987	82	118	14.731
1988	79	115	31.679
1989	76	773	238.056
1990	110	5.854	1.537.387
1991	134	8.502	4.531.153
1992	145	8.567	10.285.263
1993	160	21.771	35.249.007

(Source:Istanbul Stock Exchange)

Naturally, there was a lag between the opening of the Istanbul Stock Exchange and the commencement of effective operations. As shown previous table (2.11), while trading values boomed in 1987, the world stock market crash in October 1987 and high interest rates had a negative impact on operations until 1989 when extremely low valuations and high dividend yields encouraged an increase in stock market activity. While annual trading volume increased in 1990, the number of companies traded surged form 76 to 160 in 1993, indicating a fast development of the Exchange.

Other important developments included the ending of doubled taxation of corporate income in 1985, the abolition of withholding tax on dividends in 1986 and changes in tax laws making mutual funds viable investment vehicles in 1987. Further recent changes have awarded tax advantages to institutions investing in equities. Short selling is abolished in 1992. Virtually all shares traded on the Istanbul Stock Exchange are common stock, with the majority of those traded being in bearer form.

More deregulation was introduced; enabling the issuance of new instruments and taking measures against insider trading with the passing of the new Capital Markets Law by the Parliament in 1992.

The Capital Market Board

The Capital Market Board, founded in 1982, is the supervisory and regulatory authority. Its actions to date have included introducing and expanding accounting principles for listed companies that are more in line with international accounting standards than those used for the purposes of tax declarations to the Ministry of Finance; the institution of trading practices; and the general overseeing of all types of activity pertaining to securities. The mission of the Board is to create an ever more efficient system within which securities markets may operate and to safeguard the interest of investors who channel their savings into these markets. The head of the Capital Market Board and its members are appointed by the government.

The Istanbul Stock Exchange is a self-regulated, professional public organization and is governed by an Executive Council composed of the Chairman and four elected members who each represent a different group of intermediary institutions. The Chairman is appointed by the Government for five years. The Chairman and the employees of the Exchange cannot perform any other duties. The Chairman also acts as the Chief Executive Officer and is responsible for acting as an intermediary between the members and authorities. The Istanbul Stock Exchange is accountable to two governing bodies, the Under secretariat of Treasury and the Capital Market Board. Administrative matters are controlled by the Under-secretariat of Treasury. The General Assembly is the decision making body of the Istanbul Stock Exchange. Its decisions are subject to approval by the Capital Market Board (CMB). All accounts of the Istanbul Stock Exchange are audited by two internal auditors appointed by the General Assembly and also by the CMB.

Members comprise banks and brokerage houses. The banks are divided into two categories: development and industrial banks and commercial banks including foreign banks established in Turkey. Members have to obtain a licence from the Capital Market Board to operate in the capital markets. With the Capital Market Law amendments, the Exchange has the authority to control admission to the trading floor and permission to trade in the Bonds and Bills Market.

The number of trading members of the Exchange has risen from 47 in 1986 to 176 at the end of 1993. These 176 members are 112 brokerage houses, 53 commercial banks and 11 investment banks. Security trades are concluded in cash payment. Both domestic and international securities traded on the Exchange are in Turkish Lira.

There is one main market and a market for unlisted securities at the Istanbul Stock Exchange. 160 stocks are traded on the trading floor on a continuous auction system. The unlisted market, on the other hand, hosts trading in stocks which do not meet all the requirements of full listing on the Exchange. The purpose of this market is to give companies and institutions the opportunity to trade in an organized Exchange and the possibility of upgrading to the Main Market.

The Istanbul Stock Exchange reviews the performance of stocks every six months and is authorized to review stocks for various reasons. At present, there are no foreign companies traded on the Istanbul Stock Exchange. However, local subsidiaries of international firms are traded.

To meet a growing demand from small investors, the Exchange initiated an odd-lot, off-Exchange trading in pre-determined stocks by designated members. Designated members are required to quote two way prices and accept buy and sell orders up to a predetermined level. Settlement is done on cash basis (same day value).

The Istanbul Stock Exchange is currently housed in a building in the old financial centre of Istanbul. There are two sessions; the first (for odd lots) is between (7.15) am. and (8.00) am. (GMT); the second is between (8.30) am. and (10.30) am. (GMT), Monday to Friday.

The Bound Market is located in the same premises and has longer trading hours from (8.00) am. to (3.00) pm. GMT., Monday to Friday. Authorized dealer from approved intermediaries transact business on a screen based system. At present, only the best bids and offers are displayed blind on the screen for securities falling due at and given date but, upon phoning the Exchange other bids and offers can be learned. For same day value transactions, settlement in cash can take place until noon or by bank transfer until (2.00) pm. Only future value transactions (of up to one week) may take place between (2.00) pm. and (5.00) pm. Settlement is through exchange of securities for cash or bank account transfers.

Companies with securities to be listed on the Exchange are required to submit a written registration form that contains basic information about its financial position, assets and liabilities, profit and loss statements and the right attached to the securities. The Executive Council is entitled to seek further information in case of ambiguities and if necessary, additional markets for the securities not listed on the Istanbul Stock Exchange. Additionally, the Executive Council may terminate the markets of companies or delist the securities of companies if the securities of such companies are not traded for a period of more than three months.

Corporations have to apply with a written registration form concerning the financial position of the concerned security. In general, a company must have a minimum paid-in capital of TL 500 million of which 15% must have been offered to the public and should have at least 100 shareholders. Furthermore, a company needs to have three-year-end financial statements and should be profitable for the last two years. In addition, these requirements mainly apply to industrial corporations, banks, remain under the supervision of the Central Bank and the relevant Minister of State may waive any and all of the conditions for state-owned companies. Listing fees consist of the admission and extension fees. The admission fee is paid within seven days following the acceptance notice to listing. Whereas the extension fee is paid annually as long as the securities remain on the Exchange while it is not require for the first year.

By the approval of the Executive Council, of the securities unlisted on the Exchange, the ones satisfying the qualifications specified in the circular of the Executive Council are transacted. Later on, if a security loses such qualifications, it is discharged from the market by the decision of the same authority. Admissions and transactions fees for the unlisted securities are not fixed and are subsequently published in the Exchange Bulletin.

Subject to the permission of the Executive Council, the following special transactions are conducted on the Istanbul Stock Exchange.

In the case of the desire of a member to sell or buy a quantity higher than the predetermined size, firstly the Chairman is informed about the transaction. Once the Chairman is informed either prior to the session or during the session. One organises one or more special sessions to enable the execution of such securities. Information on the said special sessions as to the number of securities and the location is announced on the Exchange Bulletin.

Official Auctions take place on the request of enforcement officers and other government departments. The limit to session are determined on the account of the securities' qualifications and their transactions volumes. At the end of the predetermined period for the transactions, the unsold securities are return to the concerned authority. Delivery of the securities and payment of revenues are conducted by the Exchange after deducting all the fees related to the transaction of such securities.

Transactions are supervised by the Exchange experts. "Multiple Price" method is employed in trading securities which are conducted according to a continuous auction method in which the ask and bid orders are entered on the boards assigned to each stock where a transaction is concluded by matching ask and bid orders under the following priority rules.

The matching of ask and bid orders in the markets can only be executed within the price limits determined by the Exchange Administration. Prices formed during a session cannot exceed (+ -) 5 percent of the base price. Price limits are fixed at 10 percent for special orders and registered shares. The base price is the weighed average price on the preceding trading day. In the cases of dividend payment and bonus issues, the base price is determined by the Exchange. The method determining the base price is ascertained by the Executive Council and publicized in the Exchange Bulletin.

The bids and offers are written on boards and the counterpart, by crossing off the relevant bid or offer, completes the trade. All trading slips are entered into the computer by the Stock Exchange employees, and confirmation of trading is issued later that same day. Settlement is by physical exchange of documents for payment and occurs on the next business day.

Ask and bid orders are submitted to the Exchange members for trading in securities. In principle, such orders are given in a written form. However, Exchange members may accept direct verbal orders, telephone calls or requests through other communication means. A customer may either determine the price or may assign this task to the member. Prices are fixed according to the "limited" or "free price" option. Limited price is the price that the buyer or seller wishes to receive on a specific day. The Istanbul Stock Exchange member is bound to seek this price on the market during the session. The "free price" option is giving the authority to the members to sell and buy at the most suitable price. The customer is ready to accept the price negotiated by the member. Exchange members may require a partial or full collateral or payment concerning the value of the order.

A transaction is realized when one party checks out, using felt-tipped markers, the corresponding price of the other party. This party who closes the deal initiates the trade execution process by filling out three copies of the trade agreement form and time-stamps it. The Exchange, during the day, distributes to each member a transaction book that shows every trade on every stock by each member. Following the distribution of the book, the members can ask for correction within a time limit. Real-time prices are fed to the systems of local and international information vendors. Members are liable to each other and to the Exchange for the implications of their transactions.

With the permission of the Executive Council, block trade of securities, official auctions, sales of securities pertaining to the primary market operations which are subject to special transactions are conducted by the Exchange experts under the framework of the said Regulations.

Shares are traded in lots, each lot representing 1,000 shares.

Orders For Odd Lots : An order issued for a number of shares less than a unit of transaction.

Special Orders : Orders valued at market value at the daily base level of the issuing day. The market value of the special order must not be below TL 2 billion. Special orders may only be traded as an entirety and not partially. Preferred shares are entered as special orders.

Market Order : Buy or sell securities at the price.

Limit Order : Buy or sell securities provided if a specified price is met.

Types of Stocks

Ordinary Shares : Shares representing equal ownership in a corporation embodying such rights as the receipts of dividends, subscription to bonus and rights issues and the liquidation of assets, including voting rights. Almost all shares quoted on the Istanbul Stock Exchange belong to this category. Most of the stocks traded on the Istanbul Stock Exchange are bearer type. Registered stocks may be traded also as bearer stocks in case the issuing company accepts the "blank endorsement" of its registered shares.

Preferred (preferences) Shares : Preferred shares carry preferential rights as to voting rights or dividends in contrast to ordinary shares.

Founders' Shares : The owner has special benefits in case of distribution of profits.

The Istanbul Stock Exchange Indices

The Istanbul Stock Exchange (ISE) has been computing and publishing a stock price index (the ISE Index) as a comprehensive measure of the market's performance since its introduction in January 1986. The ISE was weighted average of stocks based on the weighted total market value of a large number of companies. The Istanbul Stock Exchange Composite Index is weighted by the proportion of the product of the company's number of stocks, multiplied by the market price of the stocks offered to the public.

Thus, any price change in stocks of companies with a large market value and widely held by the public will have a greater impact on the Istanbul Stock Exchange Composite Index than price changes occurring in smaller companies. 75 companies are included in the ISE Composite Index. Selection criteria are the proportion of equity actually held by the public, trade value, number of shares traded, number of contracts and market value. About 93 percent of the total market value is covered by the Index. The continuity of the index is secured by adjustments to capital increases. The 75 companies represented in the ISE Composite Index are divided into two groups according to their nature. 59 companies are included in the "Industrial Index" representing 63 percent of the total market value. The "Financial Index", comprising 16 banks and holding companies as well as insurance companies, represents 37 percent of the market value. All indices are computed on the basis of the closing prices as well as on the basis of weighted average prices. The list of the companies on which the index is based is reviewed every six months. The ISE Composite Index and the "Financial Index" and the "Industrials Index" are displayed on Reuters and Telerate pages.

The Istanbul Stock Exchange charges members a fee in the form of a commission by their representatives for their intermediary actions in security trading. Commission fee will amount to 0.75 percent of the traded value times two percent.

For transactions made through the Exchange, at the end of each month, a fee is changed that will amount to 0.25 percent of the buy or sale value times two percent. On transactions executed over the counter, an amount of 0.25 percent of the traded value times three percent will be charged at the end of each week.

Commissions on security transactions are negotiable, but may not exceed 1%. There is a small turnover tax. Custody fees are generally around 0.75% of corporate actions.

The Exchange disseminates both market and corporate information to its members and to the investing public. At present, traded companies submit half-year externally audited balance sheet and income statement data to the Exchange, in addition, to unaudited first and third quarter results. Such information is transmitted without delay to the vendors and published in various forms by the Exchange. Quotations including real-time stock trade information, indices, various market news about companies, and current events, historical indices, P/E ratios, market value, most active members and stocks and statistical records are entered on the Reuters and Telerate screens.

The Istanbul Stock Exchange puts out several publications both in Turkish and English, as Daily Bulletin in Turkish, incorporating the last day's closing, high-low and closing prices, number and volume of shares traded, the weighted average price and the median traded price. The Bulletin also features aggregate results of "off-exchange" odd-lot transactions. Such information is rounded up in weekly and monthly bulletins. Monthly Bulletin is also printed in English. In addition to these bulletins, the Istanbul Stock Exchange also issues semi-annual, quarterly and annual reports, Yearbook of Companies in Turkish and English.

Other sources of information include the Capital Market Board with its regular publications, the companies themselves as and when they publish information required by the Board or the Exchange and intermediaries, which have significantly bolstered their research capabilities over the past 6 years.

Investor Protection

All transactions on the Istanbul Stock Exchange are under the strict control of the Istanbul Stock Exchange management supported at times by the functions of the Disciplinary and Arbitration Committees. To prevent unjustified and potentially detrimental price fluctuations, the Istanbul Stock Exchange has authority to suspend trading in any security for a specific time.

All other regular arrangements designed for the protection of the investor are also applicable. In addition, the Istanbul Stock Exchange *itself, its members, and virtually* all securities transacted on the Istanbul Stock Exchange have been insured against fraud, theft, damage and loss. The coverage involves all of the conceivable risks associated with operating a cohesive and sound stock market. Another innovation devised purposefully to enhance confidence in the market will enable traded companies to have their stock certificates be printed abroad, equipped with a wide variety of "security printing" features.

Investments

There are no restrictions on foreign portfolio investors. Foreigners can freely invest in Turkish securities and repatriate the proceeds. However, all investments in securities and the repatriation of the sale proceeds inclusive of capital gains have to be done through banks and special finance institutions. Banks and brokerage houses are required to provide the Treasury with quarterly reports and information concerning investment from abroad.

Legislative Changes and Reform

On 13th May 1992, amendments to the Capital Market Law (CML) took effect after publication in the Official Gazette. The new changes aim to create new capital market instruments, channel savings into the securities sector as well as boost investor confidence, particularly in the stock market by making insider trading a criminal offense and improving transparency. Under the new Law, banks' shares traded on the Istanbul Stock Exchange are required to conform with the Capital Market Law which were previously subject to the Banking Law. Banks' monopoly to set up mutual funds was abolished. The amendments eliminate differences in dividend payments between existing shares and new shares issued against capital increases.

Taxation

Dividends are exempt from withholding tax. On the other hand, the interest earned on private corporate debentures is subject to tax withholding at the rate of 10.5%. For foreign-national corporate entities and real persons, this withholding constitutes the entire tax burden on interest income.

The interest income earned by foreign individuals on treasury bills, government bonds and revenue-sharing instruments is not taxed in Turkey. The gains resulting from the appreciation of foreign currency exchange rates in the case of government revenue-sharing instruments that are foreign currency indexed are also tax-exempt.

Until December 31st 1999, the capital gains that private individuals secure from the disposal (through a bank or brokerage house) of securities that they own are not taxable. Similarly, in the case of securities that private individuals purchase through the Stock Exchange and those that they retain in their portfolios for at least one year (regardless of where or how they may have acquired them), the capital gains that they secure from the disposal of such instruments are also tax-exempt.

The capital gains that corporations secure in Turkey from the disposal of Treasury bills, Government bonds and Revenue-Sharing Instruments are exempt from the corporation tax.

Disclosure

While corporate disclosure requirements are not quite as sophisticated as those in most markets, they are exemplary by the standards of emerging markets. The mid-year and annual financial statements have to be reviewed and audited by independent auditors. Quarterly reporting has been expanded to give greater details on companies' performance. Accounting norms are much in line with GAAP, expect in certain cases where the treatment of income and expenses are similar to the cash basis used for Turkish tax purposes rather than the accrual basis.

Investments are stated at cost; plant and equipment are revalued at the end of each financial year in line with the revaluation coefficient announcement by the government. Companies are free to capitalise or expense financing costs occurred after the investment period. Both normal and accelerated depreciation may be used. Provisions for retirement and severance pay are set aside in line with the regulations but are not allowable for taxes.

2.5. CONCLUSION

The objective of this chapter was to the place the main theme of the thesis, namely the efficiency of the Istanbul Stock Exchange within a more general context. This is because capital markets play an important role in the economic development as they directly affect the mobilization of savings and the channelling of investments into productive enterprises. In other words, capital markets play a critical role in the efficient allocation of the economy's resources, so that the more profitable and efficient a firm is, the greater the amount of resources that it attracts and invests.

The Istanbul Stock Exchange (ISE) was developed at a time when the Turkish economy went through a process of economic reform and liberalization. This process lowered import barriers and promoted growth. As a result the growth rate of the economy between 1988 and 1993 averaged 4.8 percent, a level considerably higher than the OECD average for the period. Therefore, the economic environment was conducive to the development of the exchange and its subsequent expansion.

Capital markets will contribute to economic growth and the efficient allocation of resources if they function effectively, in other words, if capital markets price stocks efficiently. However, the efficient functioning of an exchange crucially depends on its regulatory structure and trading rules. The ISE went through considerable regulatory changes from its inception. A priori, these changes encourage participation and have led to a considerable increase in the volume of trading. The important questions are whether such changes had an impact on the efficiency of the market, the volatility and the equity market risk premium. These questions among others are the subject matter of the subsequent chapters of this thesis.

III. THE EFFICIENT MARKET THEORY AND DEVELOPMENTS

3.1. INTRODUCTION

The objective of the chapter is to sketch the developments of the efficient market theory, the subject matter of this thesis, by reviewing the principal contributions. The nature and extent of our knowledge of stock market efficiency is examined. The development of the concept of efficiency is traced from Roberts (1959) and Fama (1965) onward. The concept of an efficient stock market has stimulated both insight and controversy since Fama (1965) introduced it to the financial economics literature and it commonly describes the relationship between information and security prices. The chapter proceeds as follows: Section (3.2) provides a brief background against which the idea of efficient markets emerged. This is followed by section (3.3) which traces the early use of the term efficiency. Section (3.4) compares and contrasts Fama's models with alternative definitions and identifies some of the limitations of the theory of Efficient Market Hypothesis. Finally, section (3.5) summarizes the chapter.

3.2. BACKGROUND AGAINST WHICH THE IDEA EMERGED

Before the theory of efficient markets was developed, the areas of finance and economics had little to offer on the behaviour of stock prices. The stock market was generally explained as exhibiting little economic order whatsoever (see, Ball and Brown (1968)). In the empirical literature the relationship between prices and information was simply a statistical one with no economic insights or explanation. For example Bachelier (1900), Working (1934), Kendall (1953), Cootner (1962), Osborne (1962), Granger and Morgenstern (1963) and Fama (1965), among others, suggested that successive stock price changes are approximately independent: that prices behave like random walks. Thus in the absence of an economic explanation the behaviour of stock prices and returns was described using a statistical language.

The connection of random walk models with the economics of competitive markets began with Roberts (1959, p.7) who provisionally reasoned:

> "...there is a plausible rationale [for the random walk model]. "If the stock market behaved like a mechanically imperfect roulette wheel, people would notice the imperfections and by acting on them, remove them. This rationale is appealing, if for no other reason than its value as counterweight to the popular view of stock market "irrationality", but it is obviously incomplete."

Stock price behaviour which was not shown as being describable in terms of economic theory, however Roberts' reasoning provided a foundation for doing so. From this point onwards statistical dependence in security returns began to be interpreted as indicating unexploited economic rents and thus being inconsistent with rational investor behaviour in competitive markets. Later on this interpretation of evidence became known as "market inefficiency".

3.3. EARLY USE OF THE TERM EFFICIENCY

The term " market efficiency " was first used in the context of securities markets by Fama (1965, p.4), who defined it as :

> " a market where there are large numbers of rational, profit-maximizers actively competing with each other trying to predict future market values of individual securities, and where important current information is almost freely available to all participants. "

In an efficient market, on average, competition among investors will ensure the full effect of new information about the intrinsic value of securities will instantaneously be impounded in actual prices.

An important aspect in this definition was the term information. Around the same time, Samuelson (1965) and Mandelbrot (1966) have provided an economic formalization to Roberts'(1959) reasoning, proving that under stationarity conditions successive price changes in competitive markets are independent.

The early empirical literature was increasingly conducted under the belief that it was researching the inferences of competitive equilibrium in stock markets, in the context of information use. However, it did so without using formal models of the type of equilibrium which can be seen in the data by researchers. For instance, the Ball and Brown (1968) study of public earnings announcements bore no direct correspondence with the Mandelbrot and Samuelson random walk models. However, the first attempt to a formal model of public information came with Fama (1970).

By extending the information set beyond past prices to include publicly-available information such as stock splits or earnings FFJR (Fama, Fisher, Jensen and Roll) pioneered an ingenious research design. Publicly-available information is formally defined as information freely available to all investors. Transactions costs are being ignored in the economic models being developed. A testable inference of such models is that, if there is zero cost in reproducing public information then expected gains from public information would also be zero. Security prices therefore should adjust to information at the first trade after it becomes publicly available. Hence, at the time of the announcement, abnormal returns should be encountered completely by the owners of securities.

In contrast, competitive markets allowed investors to gain from producing private information which is not publicly available. Analyses of whether competitive returns are earned from private information production would be hard to discharge, because they would require among other things, estimates of the cost of information production. Hence the early empirical literature of market efficiency, focused only on public information whose cost of production is known to be approximately zero. It is in this spirit that early researchers sought to demonstrate that the stock market can be described in terms of simple economic models of competition. Thus this model of competitive market behaviour opened up a legitimate area of economic research.

3.4. FAMA'S MODELS AND ALTERNATIVE DEFINITIONS OF EFFICIENCY

Fama (1970) continued the process of formalizing the concept of "efficiency" in economic terms. He stated that "to a large extent the empirical work in this area preceded the development of the theory", and then he defined an efficient market as one "in which prices always 'fully reflect' available information" and argued that the sufficient conditions for efficiency to obtain are: "there are no transactions costs in trading securities, all available information is costlessly available to all market participants, and all agree on the implications of current information for the current price and distributions of future prices of each security".

Fama's attention was to formalize the "fully reflect" notion in terms closer to those of equilibrium pricing theory. He was showing that a market is called "efficient" if investors who possess information nevertheless earn only a competitive expected return from investing: that is, the information does not alter their expected returns.

This part is the basis of his definition, equating securities' conditional (on the information set) and unconditional expected returns. The unconditional expected part of return, that would be earned without possessing information, is not directly observable. Its proxy typically has been the "market model", which researchers have associated, however loosely, with the CAPM. The market model residual or prediction error is the difference between the observed return, which by sample construction is conditional on the information set being studied, and the model's proxy for the "correct" return. The efficient market prediction then is that the sample average post announcement residual is zero. The research therefore, can be interpreted as comparing observed returns, which by sample construction are conditional on announced information, with some economically "correct" value, using the market model to provide the empirical proxy for "correct" returns.

Crediting Harry Roberts, Fama distinguished three nested information sets: past prices, publicly-available information, and all information including private information. Then, accordingly he distinguished between the "weak", "semi-strong" and "strong" forms of efficiency. While this was the first recognition that efficiency must be defined with respect to a particular information set, it unfortunately was couched in terms of statistical rather than economic properties of information. Especially, the distinctions were not explicitly based on costs of producing information, which are necessary for the economics of competitive markets to predict different returns to public and private information. The statistically based classification scheme possibly distracted attention away from the important issue of the costs of obtaining and processing information and thus from the fundamental economics involved. This demonstrates that the theory of efficient markets had not yet shed its statistical origins.

Fama's (1970) modelling seems to have served the purpose of early empirical researchers well. They took it for granted that this was a precise enough statement of what they were looking for in the data which it also stimulated a definitional debate that continued for almost two decades. The modelling and even the concept of "efficiency" began to attract criticism, possible fuelled by;

1. The emergence of information economics as an important field, populated by researchers placing more emphasis on logical coherence than did the "empiricists",
2. The logical scrutiny of the "efficiency" construct that arose naturally from researchers seeking explanations for the early empirical anomalies; and
3. Reactions to Fama's (1970) review. In historical sequence, Rubinstein (1975), Beja (1976), LeRoy (1976), Fama (1976), Grossman (1976), Jensen (1978), Grossman and Stiglitz (1980), Beaver (1981), Jordan (1983) and Latham (1986), among others, contributed to the debate.

LeRoy criticized Fama's definition on the grounds that it was empty/tautological, because it allowed any feasible set of return distributions to be consistent with "efficiency". The quality of conditional and unconditional expected returns is logically feasible in a market that gets them both wrong. However, it could be argued that this criticism missed the spirit of Fama's original definition, in which the unconditional expected return seemed intended to represent its "correct" equilibrium value. However, LeRoy's criticism did demonstrate that the definition could be tightened. Fama (1976) responded with a revised definition explicitly requiring that "the market correctly uses all available information" and thus the joint distribution of future prices established by the market is identical to the "correct" distribution implied by all available information at the time. This definition requires empirical researchers to state or imply something about the "correct" distribution of future prices, that is, to test efficiency joint with an hypothesis about market equilibrium, the CAPM having been the prevalent example. However, it is hard to explain how empirical research under any definition of market "efficiency" could do otherwise. Most subsequent empirical work in the area adopted Fama's revised definition of market efficiency.

Around the same time a sequence of related papers gave tighter specification to the equilibrium being contemplated in market "efficiency". For example, Rubinstein (1975) provided alternative definitions and their properties. Sharpe suggested a development of one of these to Beja (1976) and this in turn was refined by Beaver (1981) as:

> "market efficiency with respect to an information item means that prices act as if everyone knows that information". More formally, Beaver (1981) stated:

A securities market is efficient with respect to a signal if and only if the configuration of security prices $\{P_{jt}\}$ is the same as it would be in an otherwise identical economy (i.e. with an identical configuration of preferences and endowments) expect that every individual receives the same signal.

Beaver also provided a more comprehensive definition of efficiency, defined with respect to the system that produces the observed signal and therefore, with respect to the set of all feasible signals. He termed it "information system efficiency", as distinct from "signal efficiency".

Latham (1986) explained that is logically feasible for a piece of information to cause offsetting revisions in individual investors' portfolios, without any net effect on excess demand and hence, on prices. For instance, information feasibly could cause two investors to make precisely offsetting buy and sell decisions. He thus, described efficiency relative to some information set "if revealing it to all agents would change neither equilibrium prices nor portfolios." The advantage of this definition is its potential for linking with the theory and empirical studies on trading volume, investor heterogeneity, information production and the microstructure of the trading mechanism.

The notion of efficiency could also be seen in the works of Grossman (1976), Grossman and Stiglitz (1980) and Jordan (1983), among others, who sought an "efficiency" construct that is compatible with incentives to produce information. Grossman and Stiglitz (1980) observed that, under Fama's (1970) definition in which "at any time prices fully reflect all available information", there is no incentive for any individual to produce information. They suggested a reformulation of efficiency as a noisy rational expectations equilibrium, with supply-induced noise interfering with the inference of information from prices. Prices then cannot fulfil Fama's "fully reflect all information" criterion: without noise, no information is produced, due to lack of incentive; and with noise, prices cannot fully reflect information. Their model says that Fama's definition cannot possible describe any real or hypothetical market.

While clearly there is no incentive to incur costs in reproducing information that already is freely and publicly available, there do remain incentives to produce private information in a competitive world. For instance, consider the relation between reported earnings and prices. It is clear from Ball and Brown (1968) that there are gains from obtaining private information on earnings before the market does-that is, before it becomes publicly available. Security analysts hence, incur costs in forecasting earnings or in obtaining information that subsequently will be reflected in earnings. However, such information cannot be fully reflected in security prices and remain privately valuable, which highlights the inadequacy of Fama's (1970) original definition that Grossman and Stiglitz observed.

The problem in part is due to Fama's (1970) statistically based classification of information sets. If the subdivisions had been based on the cost of production of information which could be zero in the case of the so-called "weak" and "semi-strong" forms of the efficient market hypothesis and positive in the so-called "strong"form, then the subsequent confusion might not have arisen. Whereas, Fama referred to prices reflecting all available information, the fundamental competitive economics predicts only that prices reflect all publicly available information. Grossman and Stiglitz' argument, therefore, points out once more the inadequacy of Fama's (1970) original definition, which they cited, though in fairness to Fama it should be noted that his (1976) revision by then was free of these problems.

In addition, the Grossman-Stiglitz framework does not captured many institutional mechanisms, to solve the incentive problem for producing information that is to be placed in the public domain. First, firms voluntarily contract to produce and disclose information to the public, including stockholders. Watts and Zimmerman (1983) displayed that such undertakings have been included in corporate charters, and therefore, have been part of companies's contracts with their shareholders, for six centuries. Ball (1989) shows that companies have motivation to voluntarily produce and disclose information to the factor market including actual and potential shareholders, creditors, managers and employees and the product market, which includes, actual and potential consumers, as a contracting efficient solution. This amounts to public disclosure, the incentive being contracting cost minimization by the firm. Secondly, stock exchange listing requirements, which are a contract between listed firms and the exchange and hence, also are part of listed companies's contracts with shareholders and others, typically require companies to disclose important information to the market as a whole (i.e.the public). Presumably, stock exchanges have motivation to enact these requirements and listed companies have incentives to comply. Thirdly, directors have fiduciary responsibilities to shareholders that encompass a broad range of disclosure provisions, and these are enforced by the courts to form part of the contract between companies and shareholders. There appear to be no first-order "free rider" incentive problems under any of these institutional solutions:

1. Provided the market is efficient as in Fama (1976), the response of the companies's own stock price to the publicly disclosed information will be captured entirely by its existing shareholders, since all post disclosure buyers will pay a fully reflecting price, and

2. Existing shareholders incur the per-share costs of the information production and disclosure.

Similarly, propositions hold for contracting costs. Fourthly, statutory disclosure laws and regulations, which are superimposed on the above mentioned voluntary disclosure mechanisms, require companies to produce and disclose information (Foster, 1981).

The Grossman-Stiglitz model captured none of this institutional details. Thus, it allows no role for institutions or institutional practices, and then, investors are assumed to behave independently, making individual information production decisions. Information is disclosed to the public indirectly and with noise, through their trading. These important institutional solutions to the disclosure incentive problem has been omitted in this model. In reality, public disclosure occurs under sophisticated institutional arrangements and is consistent with both Fama's (1976) revised definition of efficiency and the underlying concept of a competitive securities market.

Nonetheless, the fundamental limitation of efficiency have been highlighted in this literature: namely its reliance on a pure exchange theory, completely silent of how information is produced, acquired and processed by companies, analysts and investors. In this regard, the efficient markets's theory echoes the tendency to ignore supply in finance theory.

The theory of efficient markets has also ignored another potentially important aspect, namely, the cost to investors of acquiring and processing information. Information costs are neither new to economists nor inconsistent with competitive markets, for example, see, Coase (1937), Hayek (1945), Simon (1955,1957) and Stigler (1961). Nevertheless, information acquisition and processing costs have received scant attention in the theory and empirical research on stock market efficiency, even though, the subject of the theory is the market reaction to information.

The initial event studies considered only publicly available information which is widely disseminated in the financial press, on the wire services, to analysts and to other investors. Fama, Fisher, Jensen and Roll (1969) investigated stock splits and Ball and Brown (1968) studied earnings. The cost to individual investors of acquiring public domain information was assumed to be negligible. The information also was assumed to be simple to use, with negligible processing cost. If there are competitive returns to negligible information costs which expressed as a percentage of market value, of the firm or of a typical share holding in the firm, then they will have a negligible effect on expected returns and will be lost in the noise of exogenous price variability.

The estimated abnormal returns will be overstated, in research designs which simulate trading strategies with substantial information acquisition and processing costs, the direction of the bias is consistent with the anomalies evidence, but little more can be said without knowing more about either theory or evidence about the magnitude of information processing and acquisition costs and their effects on gross (pre-cost) expected returns. Information costs determine gross expected returns with investor heterogeneity, however, it does not seem so clear. Do lower information cost investors earn infra-marginal returns?.

Another definition of the theory is its mechanical characterization of markets as machines driven by objective information engines. Investors beliefs play no role, information is a homogenous commodity. Publicly-available information is not processed in different ways by different investors and therefore it has identical implications for all.

The early work of efficient markets model avoided such issues as heterogeneity of investors. While restrictive in its assumptions, the mechanical homogeneous information model allowed powerful insights into price behaviour that had not hitherto been feasible. Its early success was due in part to the wealth of research opportunities afforded by the abundant information available for correlating with stock prices. Nonetheless, Hayek (1945) analysed the role of markets when information is decentralized i.e. legally held by individuals, and challenged the mechanistic efficiency model as a way of characterizing a competitive stock market. This analysis was the forerunner to a now burgeoning literature dealing with heterogeneity of investor information and beliefs. Many empirical studies have been done by many researchers such as, Beaver's (1968) work on trading volume at earnings announcements, and Grossman's and Stiglitz's (1976) work on noise-trading models. The incremental contribution of these models to empirical work largely remains unseen.

The early work on stock market efficiency was carried out under the economic tradition of assuming that competitive markets act as if they are costless to operate. In response of this, Jensen (1978, p.96) offered an alternative definition of market efficiency in terms of transaction costs as follows:

> " A market is efficient with respect to an information set if it is not possible to make economic profits by trading on the basis of that information set." By economic profits, we mean the risk adjusted returns net of all costs. (emphasis added)

A similar definition is implied when authors fail to reject efficiency in the presence of significant post-announcement abnormal returns, on the grounds they are less than transactions costs.

An attractive feature of this approach is that it explicitly introduces the economics of the market trading mechanism. The approach also appears to offer a solution to how large an anomaly one can tolerate before rejecting efficiency as an hypothesis.

Despite its attractive features, the transactions cost approach has several shortcomings. First, it begs the central question of the magnitude of transactions costs that the researcher will tolerate while still calling a market efficiency. To illustrate, observe that in the limit, under this definitions, there could be no feasible inefficient market in a world of infinite transactions costs because no trading rules could generate positive after-cost profit. This seems absurd: surely we want to describe no market with infinite transactions costs as efficient. Under this definition, the likelihood that a given set of prices and events will lead to researchers describing the market as efficient increases with the level of transactions costs. Institution and the logic of competitive price theory suggest the opposite.

Second, transactions costs cannot predict the sign or the magnitude of average abnormal returns calculated from transacted prices. Transactions costs can inhibit trading and therefore, delay the response of prices to announcements, which can generate short term abnormal returns, bounded by the magnitude of transactions costs, which take the sign of the information in the announcement. However, conditional on post announcement trade taking place, there can be no predicted price bias in an efficient market. Transactions costs of x% then might allow price errors of ± x% to remain, independent of the sign of the information, but they cannot explain a systematic bias of that magnitude. Since most event studies and related efficiency tests study abnormal return averages, transaction costs are not obviously relevant to interpreting their results.

Third, describing efficiency in terms of transactions costs can produce as many definitions as there are investors, because transactions costs vary across investors. At one extreme, brokers or specialists typically face small costs. At the other extreme, one can imagine many classes of people who face large transactions costs whose transactions costs are to be used in judging the market to be efficient. A possible solution might be to state efficiency in terms of the lowest cost trader. The reasoning here is that in equilibrium all investors must satisfy their own marginal conditions, and then, lower cost traders will continue trading on smaller price errors, after higher cost traders have ceased trading, so only price errors in the order of the lowest transactions costs should remain. But this approach can degenerate into ignoring transactions costs entirely. First, some specialists and institutional investors face transactions costs that are very low, relative to statistically detectable effects on abnormal returns, perhaps in the order of one tenth of one percent. Second, investors transact for reasons other than exploiting price errors, e.g.individuals investing/disinvesting for future/present consumption, or institutions doing so on their behalf. For such investors, the marginal cost of also incorporating information into their transaction decisions can be zero or negligible. Hence, describing efficiency in terms of the global-minimum cost of transacting does not give a clear alternative to ignoring costs at the outset.

All factors considered, the case appears weak for the looser definition of efficiency, in which transactions costs play a role. Nonetheless, the accurate role of transactions costs in the theory of market efficiency remains an unsettled issue.

A closely related, but distinguishable, issue is the effect of market microstructure, which is the market mechanism for determining transactions prices on the relevance to researchers of recorded prices. Like transactions costs, trading-mechanism effects present the researcher with a dilemma. Trading mechanisms certainly are not costlessly to operate, so transacted prices are unlikely to be completely independent of institutional arrangements. This seems particularly likely for small capitalization and low price stocks, and low turn over stocks and stock exchanges. In contrast with transactions costs, it seems unreasonable to interpret price behaviour induced by the trading mechanism as indicating market inefficiency, because recorded prices are not those at which the simulated trading strategies could have been executed at the close of trading. Keim's (1989) trading mechanism explanation for the "turn of the year" effect is consistent with this view. Yet taking this view to its limit leads to seemingly-unreasonable conclusions here also, such as efficiency being an increasing function of bid-ask spreads, other things remaining equal. The precise role of trading mechanism/market microstructure effects in the theory of market efficiency once again is not apparent.

It is difficult to find any evidence that the term efficiency was carefully selected, by researchers, from among alternatives at the outset. It seems to have "just caught on". The term is curiously appropriate, for reasons discussed below.

First, when the term arose it offered a convenient juxtaposition with the then commonly-held view [see, Roberts (1959, quoted above)] that share price behaviour was neither systematic nor capable of orderly economic description (certainly not using words like rational). The terms efficiency suggested the opposite.

Second, the term dovetailed nicely with its traditional use in statistics, connoting the property of minimum-variance. If prices adjust instantaneously to all public information, then at any point in time there will be no future price reaction to it. Thus, of all feasible prices, those established in such a market offer the minimum-variance distribution of future returns, conditional on public information. In contrast, an inefficient market at any point in time need not have completed its price reaction to public information (it might have over or under reacted) and hence there would be a component of future price variation that is a response to old information. Present prices then would not be minimum-variance, or efficient, with respect to public information.

Third, the term suggested a linkage with the broader economic concept of efficiency. Fama (1970, p.383) introduced his influential literature review by drawing this link. For example, if firms optimal investment (and reinvestment) decisions depend on the prices at which security claims to their existing investments sell, then market errors in pricing securities could lead to sub-optimal resource allocation decisions. While informational efficiency is not sufficient for allocative efficiency, the linkage provided intuitive appeal.

Finally, in adopting the term efficient, as an alternative to Samuelson's (1965) earlier use of the generic term competitive market, FFRJ gave empirical researchers temporary respite from the full baggage of the theory of competitive markets.

3.5. CONCLUSION

The idea germinated in Roberts (1959) and Fama (1965), that the actions of competing maximizing investors explain the random walks observed in stock prices, quickly grew into the theory of efficient markets. The theory characterizes a market as being in competitive equilibrium with respect to some set of information. Public-domain information occupied a central role, primarily because it simplified the theory's predictions about expected returns from using information (zero, consistent with public information's private cost) and because it fit best with the early theory's assumption of objective information. Thus, the concept of efficiency can be seen as a restrictive model of competitive price behaviour, particularly adapted to researching the flow of public information to be market, with attendant strengths and weaknesses. Various versions of the model formulate the competitive equilibrium in terms of properties of either: (1) prices; (2) prices and portfolios; (3) traded prices, allowing for market microstructure effects; or (4) trading rule profitability, after deducting trading costs. Like all theories, market efficiency is an attempt to abstract and describe salient features of reality, so it inevitably characterizes securities markets in an imperfect fashion. In spite of its restrictive assumptions concerning processing costs and the nature of investors' beliefs, the work on the theory of efficient markets successfully opened stock markets to economic thought. This notion of efficiency will be the subject of investigation in the subsequent chapters of the thesis.

IV. CONVENTIONAL TESTS OF WEAK FORM EFFICIENCY : THE RANDOM WALK TESTS OF ISTANBUL STOCK EXCHANGE

4.1. INTRODUCTION

The past fifteen years have witnessed spectacular growth in both the size and relative importance of emerging equity markets in developing countries. High economic growth, the pursuit of liberalisation policies within these countries and trends towards financial markets globalisation provided the environment in which equity markets could thrive. In addition, Western equity fund managers were attracted to these markets by the potentially high rates of returns offered and the desire to pursue international diversification. As these capital markets have developed considerable attention has been given to the question of whether they function efficiently. The issue of efficiency is of great significance to both foreign investors and the allocation of scarce resources within these countries. The question of whether these markets price securities efficiently is ultimately an empirical issue and it is this which has attracted most attention in the literature.

The issue of efficiency in emerging markets has been widely investigated in recent years. Research has focused on either the conventional form of efficiency (Fama, 1970) or on examining the question of whether anomalies exist. Overall results are mixed. For example, Barnes (1986) reports the Kuala Lumpur stock market to be inefficient, Butler and Malaikah (1992) find evidence of inefficiency in the Saudi

Arabian stock market, but not in the Kuwaiti market and Panas (1990) concluded that market efficiency could not be rejected for Greece.

As mentioned in the previous chapter, tests of efficient market hypothesis have become synonymous with tests of the random walk hypothesis. The random walk hypothesis is a statement that price changes are in some way random and so prices wander ('walk') in an entirely unpredictable way. Consequently, forecasts based on today's price cannot be improved by also ensuring the information in previous prices. There are many ways to phrase the random walk hypothesis in statistical terms. A number of definitions have been published. In every case the best forecast of tomorrow's price requires today's price but not previous prices. Bachelier (1900) in a most remarkable thesis implied that price changes have independent and normal distributions. Fama (1965) removed the assumption of normal distributions. The hypothesis is then that price changes are independent and have identical distributions. Granger and Morgenstern (1970, pp.71-3) do not require the price changes to be identically distributed. The random walk hypothesis is defined by constant expected price changes and zero correlation between the price changes for any pair of different days.

This chapter using data from the ISE seeks to examine the issue of efficiency adopting the conventional tests used in previous literature. This is intended to act as a benchmark for the next chapter and to enable comparisons with other studies. The chapter proceeds as follows: Section (4.2) describes the methodology and tests used in the chapter. This is followed by section (4.3) where the data used is explained and the empirical results are presented. The main findings of the chapter are summarized in section (4.4).

4.2. METHODOLOGY

Empirical tests of the random walk hypothesis have been published for nearly all the world's financial markets. The earlier studies include important investigations by Working (1934), Kendall (1953), and Fama (1965). Working showed that several series of commodity futures prices strongly resembled an artificial series obtained by simulating a random walk. Kendall, after analysing wheat prices, cotton prices and share indices, concluded that investors ought to assume that prices followed random walks. Fama studied the prices of all 30 stocks in the Dow Jones Industrial Average index in considerable detail. His results show that US stock prices either follow random walks or something very similar.

Fama's paper rightly had a significant impact on academic research. After (1965), many researchers assumed that prices followed random walks and then sought answers to other questions about optimal investment decisions. Tests of the random walk hypothesis continued to be done with conclusions that tended to agree with Fama's.

According to Fama (1965) the random walk hypothesis involves two separate hypotheses:

1. Successive price returns are independent; and
2. The returns series conform to some specified type of probability distribution

Several random walk test statistics have been used in previous studies to test the first part of the above mentioned hypothesis. The most popular techniques used are the following:

1. Autocorrelation tests
2. Spectral Analysis Tests
3. Runs tests

With respect to the second part of the random walk hypothesis traditionally researchers have tested the following hypotheses:

H_0: The returns are characterized by the normal distribution

H_1: The returns are not generated from a normal distribution

These hypotheses are examined through basic tests of normality. These tests of normality are based on the sample skewness and sample kurtosis.

4.2.1. AUTOCORRELATION COEFFICIENT TESTS

The correlation between two random variables obtained from stationary process is called the autocorrelation. The random walk hypothesis implies zero autocorrelation among returns. The autocorrelation coefficient (r_k) gives a measure of the relationship between the value of a random variable in time t and its value (k) periods earlier. The population autocorrelation coefficient (R_k) is estimated using the sample serial correlation coefficient (r_k).

For the variable (U_t), (=log P_{t+1} - log P_t), the serial correlation coefficient for lag (k) is the correlation between pairs of terms (k) units apart, viz

$$r_k = \frac{Cov(U_t, U_{t-k})}{\sigma(U_t)\,\sigma(U_{t-1})} \qquad (4.1)$$

which can be approximated by

$$r_k \approx \frac{Cov(U_t, U_{t-k})}{Var(U_t)} \qquad (4.2)$$

where (U_k) is a log price relative,

t=1,2,...,n

k=1,2,...,(n-1) or in more analytical terms.

$$r_k = \frac{\frac{1}{n-k}[U_t-\frac{1}{n-k}\sum_1^{n-k}U_t][U_{t+k}-\frac{1}{n-k}\sum_1^{n-k}U_{t+k}]}{[\frac{1}{n-k}\sum_1^{n-k}(U_t-\frac{1}{n-k}\sum_1^{n-k}U_t)^2\frac{1}{n-k}\sum_1^{n-k}(U_{t+k}-\frac{1}{n-k}\sum_1^{n-k}U_{t+k})^2]} \quad (4.3)$$

In practice and also for theoretical convenience it makes sense for simplicity to modify these definitions to some extent. Instead of measuring the first (n-k)U's about their mean, we may measure about the mean of the whole set of observations; and similarly for the values at the end. Hence, writing

$$(\bar{U})$$

for

$$\sum_1^n \frac{U_t}{n},$$

we might put as follows (Kendall and Stuart, 1976).

$$r_k = \frac{\frac{n}{n-k}\sum_1^{n-k}(U_t-\bar{U})(U_{t+k}-\bar{U})}{\sum_1^n(U_t-\bar{U})^2}. \quad (4.4)$$

Hegarman and Richmond (1973) suggested an approach as the following estimate of the slope coefficient in the regression model for large samples,

$$U_t=\alpha+\beta_{U_{t+k}}+E_t. \quad (4.5)$$

In this model, (β) is the effect of the return from (t-k-1) to (t-k) on the return from (t-k) to (t-k+1). (α) is the average continuously compounded monthly return on the security if (β) is zero, which is implied by serial independence. If the distribution of (U_t) has finite variance, then for large samples, the standard error of (r_k) may be computed as

$$\sigma \approx \sigma(r_k) = \sqrt{\frac{1}{n-k}} \tag{4.6}$$

(Fama (1965), Cooper (1982), Wong and Kwong (1984)). We will test whether (r_k) is significantly different from zero, by comparing (r_k) with the statistic $|2\sigma|$. If $|r_k| \leq 2|\sigma|$, then (r_k) is not significantly different from zero. If (r_k)$>2|\sigma|$, then it is significantly different from zero, which means that there exists a linear dependence among (U_t), (U_{t-k}).

4.2.2. SPECTRAL ANALYSIS TESTS

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 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 decomposes a time series into a number of components, each associated with a frequency or period. The frequency of variation is the reciprocal of the period. Frequency indicates the number of cycles per unit of time, and the period describes the length of the time required for one complete cycle.

This section examines the transformation of changes in the log of share prices which defines the correspondence in the log of share prices which defines the correspondence between the time domain and the frequency domain. This allows to pinpoint any cyclical or seasonal patterns and to measure their relative importance in a way which the simple statistical methods of time series analysis cannot.

This spectral decomposition of a time series yields a spectral density function and measures the relative importance of each of the frequency bands in terms of its contribution to the overall variance of the time series. Essentially, spectral analysis is an examination of the variance of a time series with respect to frequency components

(Leuthold, 1972).

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 comprise autocorrelation results (Taylor, 1986).

Spectral analysis can be noted as two special types of spectra. If the spectrum is flat, indicating that every component is present to an equal amount, the series is merely a sequence of uncorrelated readings, a so-called 'purely random or white noise series'. That means, if the random walk model is in fact true, then:

$$X_t = \log P_t + 1 - \log P_t, \quad (4.7)$$

where (P_t) is the closing price series in time (t), the model suggested that (X_t) has mean zero and is uncorrelated with (X_{t+k}), all $k \neq 0$. The (X_t) series is called white noise. If the spectrum has a clear peak at some frequency, this results in a 'cycle' appearing in the series. In practice, estimated spectra are rarely of either of these shapes, rather being very high at zero and very low frequencies (long periods) and consistently failing in value as frequency increases, expect for possible peaks at the seasonal frequencies ('typical spectral shape').

Spectral analysis has been used in testing necessary conditions for market efficiency, in the context of commodity markets, future markets, securities markets, money markets, and foreign exchange market. The subject is to decide if the estimated spectrum departs from a population spectrum which is a constant independent of frequency or price always follow a random walk.

Prior studies on share prices have been carried out by Granger and Mongenstern (1963, 1970), Praetz (1973, 1979), Cooper (1982), and Hevas (1984). Bond prices have been studied by Granger and Rees (1968). Also Larson (1964), Roll (1972), Leuthold (1972), Dusak (1973), and Cargill and Rauser (1975) have studied on the commodity or future prices. The main references on applied spectral analysis in social science are those by Harvey (1975), and Praetz (1979). The Fourier transformation which expresses $f_x(w)$ in terms of the $\tau_x(k)$ and w, ie.,

$$f_x(w) = \frac{1}{2\pi} \sum_{k=-\infty}^{\infty} \tau_x(k) \exp(-iwk), \qquad -\pi \leq w \leq \pi \qquad (4.8)$$

where (w) is frequency measured in radians per unit time, $f_x(w)$ is a continuous function of (w) called the theorical power spectrum and (i) is the square root of (-1), and $\tau_x(k)$ is the covariance between (X_t) and (X_{t+k}).

Since we are dealing with a real process, the autocovariance function will be symmetric about (k=0), and likewise the power spectrum will be symmetric about (w=0). Expression (1) can, thus be expressed as

$$f_x(w) = \frac{1}{2\pi}[\sigma_{x^2}+2\sum_{k=1}^{\infty}\tau_x(k)\cos wk], \qquad 0 \le w \le \pi \quad (4.9)$$

Estimation of the spectrum corresponding to a theorical $f(w)$ often uses a finite set of values, denoted (w_j), j=0,1,...,m, as it is imposable to estimate overall values of (w), $(0 \leq w \leq \pi)$. A very commonly used set of values is an equation spaced set (Praetz 1979) defined by $(w_j = j\pi/m)$. For the size of (m), conventional wisdom suggests $(m \approx n/5)$ to (n/6), where (n) data points are available. Therefore spectral estimates are of the form,

$$f(w_j) = \frac{1}{2\pi}[\mu . C(0) + 2\sum_{k=1}^{m} \mu_k C(k) \cos w_{jk}] \quad (4.10)$$

where,

$$C(k) = \frac{\sum_{t=1}^{n-k}(X_t-\overline{X})(X_{t+k}-\overline{X})}{(n-k)} \quad (4.11)$$

ie. : C(k) is the autocovariance coefficient of order (k).

μ_k : a set of weighting coefficients.

m : an arbitrary integer to be chosen by the user representing the maximum lag.

w_j : a set of real numbers with $|w_j| \leq \pi$

(j=0,1,2,...,m).

If an appropriate set of weights is not used, the estimates $f(w_j)$ are not consistent estimates of $f(w)$. Therefore weights μ_k are used for consistent estimates of $f(w)$. There are several weights functions used, and the commonly used set of windows are the 2nd Tukey-Hanning weights and the 2nd Parzen weights (Jenkins 1961).

1. The 1st Bartlett weights $\mu_k = 1$.

2. The 2nd Bartlett weights $\mu_k = 1-k/m$.

3. The 1st Tukey-Hanning weights

   $\mu_k = 1-2a+2a \cos\pi\, k/m$ (a=0.23 suggested)

4. The 2nd Tukey-Hanning weighs

   $\mu_k = 1/2\ (1 + \cos \pi k/m\ ), \qquad |k|<m$

   $\quad = 0, \qquad |k|\geq m$

5. The 1st Parzen weights $\mu_k = 1-k^2 / m^2$

6. The 2nd Parzen weights

   $\mu_k = 1-6k^2\ (1-|k|/m)/m^2 \qquad 0\leq|k|\leq m/2$

   $\quad = 2\ (1-k/m\ ) \qquad m/2\leq|k|<m$

   $\quad = 0 \qquad |k|\geq m$

7. Daniell μ_k = Sin kh/kh (k=0,1,...,n)

After having obtained the spectral estimates, the next step is to examine whether or not they represent a significant deviation from a white noise time series. It has been shown that for a sequence of uncorrelated normal variances, the periodogram is proportional to a Chi-square variate with two degrees of freedom, Praetz (1979). Spectral estimates will be asymptotically Chi-squared with equivalent degrees of freedom (EDF) a function of the weights (μ_k) used. More specifically, for the 2nd Tukey-Hanning weight and for the 2nd Parzen weight, they are,

$$EDF = 2\frac{2}{3}\frac{n}{m} \tag{4.12}$$

for the 2nd Tukey-Hanning weights

$$EDF = 3.7\frac{n}{m} \tag{4.13}$$

for the 2nd Parzen weights.

The significance of the spectral ordinates, therefore, can be estimated by getting confidence interval at a level (α) of significance. The confidence intervals used are of the form (Howrey (1968), Praetz (1979), Gottman (1981), Hevas (1984)).

$$1-\alpha = P\{f(w_j)\,V_1 \leq f(w_j) \leq f(w_j)\,V_2\} \tag{4.14}$$

or

$$PX^2_{EDF,\frac{\alpha}{2}} \leq \frac{EDF.fW_j}{f(W_j)} \leq X^2_{EDF,\frac{\alpha}{2}} \tag{4.15}$$

where

$$V_1 = \frac{X^2_{EDF,1-\frac{\alpha}{2}}}{EDF} \tag{4.16}$$

is the lower limit, and

$$V_2 = \frac{X^2_{EDF,\frac{\alpha}{2}}}{EDF} \tag{4.17}$$

is the upper limit.

As the flat spectrum can be simplified to ($f(w) = \sigma^2/2\pi$) for all (w) by the equation (4.9), actual spectral estimates are compared whether they deviate from the flat spectrum. In this case, (σ^2) can be replaced by the sample variances (Praetz, 1979). Thus, the actual test is to consider the number of estimates that lie outside the confidence interval and compare them with the expected number of observations to lie out of the confidence intervals. Praetz (1979) has shown that for a 95% spectral confidence limits (α=0.05), the expected value is (s), the number of estimated spectral ordinates, is given by

$$E(s) = 0.05(m+1) \tag{4.18}$$

The only problem with this approach is to judge whether the difference, s-E(s), presents a serious deviation from a white noise or not. Any answer on this relays explicitly on the researcher's personal judgment (Hevas, 1984).

The hypothesis under this test is as follows:

H_0: The spectral density is constant.

H_1: The spectral density is not constant.

4.2.3. RUNS TESTS

A 'Run' is defined as a sequence of price changes of the same sign. There are three different kinds of price change which are positive (+), negative (-) and zero (0). As a result, there are three kind of runs. The number of runs over any given period is the number of sign changes plus one. The larger is the positive serial dependence in price changes, the smaller will be the expected number of runs. The expected number of runs (m) is compared with the actual number of runs (R) and the standardised normalised variable (k) tests the statistical significance of (R-m):

$$k = \frac{R + \frac{1}{2} - m}{\sigma_m} \qquad (4.19)$$

$$m = \frac{N(N+1) - \sum_{i=1}^{3} n_i^2}{N} \qquad (4.20)$$

m : the expected number of runs in the series,

N : the total number of price changes or differences (U_t),

n_i : the number of price changes of each sort ((i=1) for positive changes, (i=2) for negative changes, (i=3) for no changes).

The standard error of (m) is

$$\sigma_m = \frac{\sum_{i=1}^{3} n_i^2 \{\sum_{j=i}^{3} n_i^2 + N(N+1)\} - 2N\sum_{i=1}^{3} n_i^3 - N^3}{N^2(N-1)} \qquad (4.21)$$

The computation of (m) is based on two assumptions: that the sample proportions of positive, negative and zero price changes are good estimates of the population proportions and that successive price changes are independent (Wong and Kwong, 1984).

For large (N), the sampling distribution of (m) is approximately normal. Because the distribution of (k) is N(0,1), then the critical value of (k) at the 5% level of significance is $\pm|1.96|$. Wherever $k \geq |1.96|$, then the sign movement in the same direction. In such cases, the random walk hypothesis is rejected, otherwise it is accepted.

The runs tests are used to test the following hypothesis:

H_0: The successive price returns of a company's shares on the ISE are random.

H_1: The successive price returns of a company's shares on the ISE are not random.

The hypotheses are designed to test randomness of successive price returns.

4.2.4. DISTRIBUTION OF SHARE PRICES

Considerable interest has been generated in the nature of the distribution of returns of equity shares, especially, because of the effect it may have on tests of efficiency. The aim is to determine whether successive rates of return for the Istanbul Stock Exchange are characterised by a Normal distribution. An important attribute of normal distribution is that a known proportion of observations fall within a given number of standard deviations from the mean. This chapter investigates the following question:

Are returns on shares on the ISE characterised by the normal distribution? To answer this question the following hypotheses are tested:

H_0: The returns on shares on the ISE are characterised by the normal distribution.

H_1: The returns on shares on the ISE are not characterised by the normal distribution.

These hypotheses are tested using the following tests:

Skewness Coefficients

Skewness statistics are used to assess the symmetry of distributions. The skewness coefficient is defined by the following equation:

$$b = \frac{1}{n-1}\Sigma_{t=1}^{n}(x_t-\overline{x})^3/s^3 \ , \qquad (4.22)$$

where

$$\overline{x} = \frac{1}{n}\Sigma_{t=1}^{n} x_t \ , \qquad (4.23)$$

and

$$s^2 = \frac{1}{n-1}\Sigma_{t=1}^{n}(x_t-\overline{x})^2 \ , \qquad (4.24)$$

If the distribution of a return series is symmetric about its mean, as in the case of normal distribution then the skewness coefficient should be close to zero.

Kurtosis

The sample kurtosis is defined as follows:

$$k = \frac{1}{n-1}\Sigma_{t=1}^{n}(x^{t}-\overline{x})^{4}/s^{4}. \qquad (4.25)$$

Normal distributions have kurtosis equal to (3). High values of (k) are caused by more observations several standard deviations away from the mean than predicted by normal distributions.

4.3. DATA AND EMPIRICAL RESULTS

4.3.1. DATA

In this chapter we use data on all companies traded on the ISE from 1988 to 1993. The sample for individual companies is subdivided into 5 groups. The first group includes all companies listed on the ISE during 1988 and trading between 1988-1993. This group consist of 48 companies; the second group includes companies trading between 1989-1993 and consists of 4 companies; the third group includes all companies listed in 1990 and were trading until 1993. This group consists of 42 companies; the forth group of companies used in this investigation consists of 21 companies were listed on the ISE during 1991 and were trading until 1993; the final group includes all companies listed during 1992 and were trading until 1993. The total number of companies in this group is 13. The rationale for this division of the companies is to investigate whether regulatory and other institutional changes had an impact on the efficient pricing of these securities and whether the length of trading impacts on the pricing of securities. In other words, we try to investigate if there is a learning curve for the market and investors in pricing risky assets. All of the investigations are carried out using daily closing prices, supplied by the ISE.

4.3.2. THE EMPIRICAL RESULTS

A. DESCRIPTIVE STATISTICS

Table (4.1A) provides the mean, standard deviation, skewness and kurtosis coefficients for the returns series for all sub-samples under investigation. For almost all companies the coefficients of skewness and kurtosis suggest significant departures from normality for the returns series. However, further investigation suggested that most departures from normality were due to a few outliers.

Table 4.1

SAMPLE PERIOD I

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
1	-0.5E-3	0.057	-8.254*	152.731*
2	-0.7E-3	0.054	-2.366*	24.824*
3	0.5E-3	0.058	-6.831*	88.867*
4	-0.2E-3	0.073	-13.843*	306.477*
5	0.2E-3	0.054	-5.004*	63.074*
6	0.1E-3	0.055	-5.310*	67.670*
7	0.1E-3	0.059	-5.538*	73.792*
8	0.1E-3	0.056	-4.128*	49.502*
9	-0.2E-3	0.046	-0.141	0.787*
10	-0.6E-3	0.069	-9.768*	169.954*
11	0.6E-3	0.054	-4.497*	64.503*
12	0.002	0.073	-15.797*	389.931*
13	-0.3E-3	0.064	-5.274*	76.511*
14	0.2E-3	0.073	-15.582*	403.378*
15	0.001	0.054	-4.046*	58.102*
16	-0.5E-3	0.062	-2.848*	37.379*
17	0.003	0.058	-2.747*	28.355*
18	0.6E-3	0.050	-5.290*	81.124*
19	0.8E-3	0.057	-6.813*	110.452*
20	0.001	0.052	-4.223*	48.558*
21	-0.001	0.049	-2.431*	20.919*
22	-0.7E-3	0.059	-7.155*	151.166*
23	0.1E-3	0.063	-4.024*	50.724*
24	0.002	0.048	-1.272*	10.378*
25	0.001	0.0062	-8.162*	147.781*

TABLE 4.1

Sample period I

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
26	-0.3E-3	0.059	-2.998*	39.496*
27	0.6E-3	0.068	-10.077*	190.497*
28	0.001	0.055	-2.994*	43.475*
29	-0.002	0.058	-4.100*	62.818*
30	0.7E-3	0.061	-12.713*	298.716*
31	-0.002	0.061	-6.710*	129.139*
32	-0.001	0.063	-5.807*	72.513*
33	0.2E-3	0.055	-3.627*	46.353*
34	-0.2E-3	0.062	-6.420*	86.571*
35	0.7E-4	0.071	-15.611*	429.890*
36	0.001	0.066	-12.979*	321.514*
37	-0.3E-3	0.055	-3.356*	37.169*
38	-0.003	0.077	-6.265*	82.203*
39	-0.002	0.066	-7.309*	105.116*
40	0.002	0.058	-0.470	2.640
41	-0.002	0.068	-1.490*	20.884*
42	-0.001	0.058	-3.402*	38.445*
43	0.002	0.051	-1.468*	14.824*
44	0.4E-3	0.052	-3.656*	39.907*
45	0.861	0.057	-3.784*	44.524*
46	0.5E-4	0.060	-6.206*	118.259*
47	-0.4E-3	0.061	-5.953*	77.917*
48	7.918	0.973	0.310	-1.369*

Notes: * denotes statistically significant at the 5% level.[1]

TABLE 4.1

Sample period II

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
1	0.002	0.075	-9.549*	154.798*
2	0.002	0.055	-1.514*	13.596*
3	0.9E-3	0.051	-0.375	2.221
4	0.002	0.052	-1.722*	15.532*

TABLE 4.1

Sample period III

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
1	0.9E-3	0.047	-0.804	7.467*
2	-0.9E-3	0.045	-2.578*	26.888*
3	0.001	0.048	-0.805	7.450*
4	0.9E-3	0.053	-2.692*	36.924*
5	-0.6E-3	0.066	-7.351*	97.830*
6	-0.5E-3	0.071	-4.993*	69.456*
7	-0.001	0.047	-2.402*	18.086*
8	-0.001	0.074	-10.225*	185.935*
9	-0.004	0.067	-4.746*	65.216*
10	-0.001	0.065	-8.368*	127.000*
11	0.2E-3	0.070	-7.975*	143.600*
12	0.9E-4	0.067	-7.661*	108.248*
13	-0.9E-3	0.058	-6.263*	72.760*
14	-0.9E-3	0.068	-6.084*	83.754*

TABLE 4.1

Sample period III

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
15	-0.3E-3	0.056	-2.687*	180.713*
16	0.001	0.049	-0.680	4.940*
17	-0.003	0.074	-5.174*	56.075*
18	-0.1E-3	0.058	-3.556*	42.191*
19	0.003	0.043	-0.047	1.596*
20	-0.002	0.078	-11.586*	229.174*
21	-0.9E-3	0.094	-15.811*	340.816*
22	-0.001	0.062	-3.637*	40.427*
23	0.3E-3	0.060	-4.327*	46.497*
24	-0.001	0.049	-0.028	1.515*
25	-0.001	0.054	-1.608*	16.915*
26	-0.3E-3	0.057	-0.176	0.869*
27	-0.002	0.067	-3.385*	37.380*
28	-0.002	0.053	-2.097*	37.380*
29	-0.001	0.051	-0.981	15.884*
30	0.001	0.051	0.124	10.417*
31	0.6E-3	0.058	-0.138	0.427*
32	-0.7E-3	0.070	-5.571*	0.336*
33	-0.5E-3	0.049	-1.934*	71.590*
34	-0.004	0.093	-14.682*	14.758*
35	-0.002	0.068	-2.573*	326.933*
36	-0.002	0.071	-10.028*	27.354*
37	0.2E-3	0.057	-1.495*	194.019*
38	0.001	0.054	-3.662*	13.866*
39	-0.1E-3	0.049	-2.839*	26.492*
40	-0.001	0.070	-6.072*	95.661*

TABLE 4.1

Sample period III

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
41	-0.002	0.053	-2.083*	25.763*
42	0.E-3	0.049	-0.795	7.582*

TABLE 4.1

Sample period IV

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
1	-0.005	0.157	-21.805*	536.828*
2	-0.004	0.148	-18.185*	454.077*
3	-0.001	0.074	-8.561*	116.090*
4	0.1E-3	0.058	-2.808*	31.522*
5	0.001	0.069	-6.203*	82.552*
6	-0.001	0.067	-4.410*	41.687*
7	0.004	0.055	-8.449*	153.581*
8	-0.003	0.124	-17.311*	367.020*
9	0.003	0.050	-1.616*	16.779*
10	0.003	0.035	0.097	3.436
11	-0.003	0.065	-5.185*	61.882*
12	0.002	0.051	-0.068	0.811*
13	-0.8E-3	0.045	-3.742*	40.248*
14	0.002	0.062	-5.320*	71.877*
15	0.003	0.057	-1.566*	13.471*
16	-0.6E-4	0.065	-6.425*	77.916*

TABLE 4.1

Sample period IV

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
17	0.8E-3	0.051	0.009	0.654*
18	-0.001	0.065	-5.884*	75.911*
19	-0.002	0.057	-2.704*	26.122*
20	0.004	0.044	0.282	0.789*
21	-0.001	0.062	-1.044*	16.012*

TABLE 4.1

Sample period V

DESCRIPTIVE STATISTICS FOR STOCK RETURNS

No	Mean	Std. dev	Skewness	Kurtosis -3
1	-0.002	0.058	-2.894*	27.910*
2	0.4E-3	0.042	0.084	0.810*
3	0.010.	0.033	1.520*	4.025*
4	0.002	0.050	-3.101 *	28.818*
5	0.002	0.048	0.072	0.357*
6	0.004	0.059	-6.026*	73.193*
7	0.003	0.048	-3.522*	39.598*
8	-0.001	0.073	-5.198*	48.955*
9	0.9E-3	0.040	-0.323	2.478
10	0.004	0.075	-4.121*	37.533*
11	0.7E-3	0.069	-9.490*	127.627*
12	0.002	0.041	-2.043*	27.210*
13	0.006	0.092	-7.371*	81.884*

B. AUTOCORRELATION COEFFICIENT TESTS

Table (4.2) provides estimates of the autocorrelation coefficients for individual stock log prices for periods 1, 2, 3, 4, 5. All autocorrelation coefficients are statistically significant at the 5% level of significance, suggesting that the series are not stationary. This implies that the mean values of the series change frequently as time progresses. This makes statistical analysis very difficult.

TABLE 4.2

Sample period I

Autocorrelation Coefficients For Individual Stock Log Prices

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	1372	0.995*	0.990*	0.985*	0.980*	0.975*
2	1372	0.997*	0.994*	0.991*	0.988*	0.985*
3	1501	0.995*	0.990*	0.985*	0.980*	0.975*
4	1501	0.996*	0.992*	0.987*	0.983*	0.979*
5	1501	0.994*	0.988*	0.982*	0.976*	0.969*
6	1501	0.994*	0.987*	0.979*	0.972*	0.964*
7	1501	0.994*	0.987*	0.981*	0.974*	0.967*
8	1501	0.992*	0.984*	0.977*	0.970*	0.963*
9	1372	0.991*	0.981*	0.971*	0.960*	0.950*
10	1501	0.998*	0.996*	0.994*	0.991*	0.989*
11	1501	0.994*	0.986*	0.980*	0.974*	0.967*
12	1501	0.997*	0.994*	0.991*	0.988*	0.985*
13	1372	0.995*	0.990*	0.985*	0.980*	0.975*
14	1501	0.996*	0.992*	0.988*	0.984*	0.980*

TABLE 4.2

Sample period I

Autocorrelation Coefficients For Individual Stock Log Prices

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
15	1292	0.992*	0.983*	0.975*	0.967*	0.960*
16	754	0.994*	0.989*	0.983*	0.978*	0.972*
17	965	0.985*	0.968*	0.952*	0.935*	0.917*
18	1501	0.996*	0.991*	0.987*	0.982*	0.978*
19	1501	0.997*	0.993*	0.990*	0.986*	0.982*
20	1501	0.998*	0.996*	0.993*	0.991*	0.989*
21	1372	0.994*	0.987*	0.981*	0.975*	0.969*
22	1372	0.998*	0.995*	0.992*	0.990*	0.987*
23	1372	0.991*	0.981*	0.971*	0.960*	0.949*
24	1501	0.996*	0.992*	0.989*	0.985*	0.981*
25	1375	0.995*	0.989*	0.983*	0.977*	0.971*
26	1372	0.994*	0.987*	0.980*	0.974*	0.967*
27	1501	0.998*	0.996*	0.994*	0.993*	0.990*
28	1372	0.995*	0.990*	0.985*	0.980*	0.975*
29	1316	0.997*	0.993*	0.989*	0.985*	0.981*
30	1501	0.997*	0.995*	0.992*	0.989*	0.987*
31	1372	0.996*	0.991*	0.987*	0.983*	0.978*
32	1372	0.997*	0.993*	0.989*	0.986*	0.982*
33	1501	0.994*	0.988*	0.982*	0.976*	0.970*
34	1372	0.992*	0.983*	0.974*	0.966*	0.958*
35	1372	0.996*	0.993*	0.989*	0.985*	0.980*
36	1501	0.997*	0.994*	0.990*	0.987*	0.984*
37	1372	0.997*	0.995*	0.992*	0.990*	0.987*
38	1372	0.997*	0.994*	0.991*	0.987*	0.984*
39	1372	0.996*	0.992*	0.989*	0.985*	0.982*
40	1371	0.987*	0.973*	0.958*	0.944*	0.930*

TABLE 4.2

Sample period I

Autocorrelation Coefficients For Individual Stock Log Prices

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
41	1372	0.995*	0.990*	0.984*	0.979*	0.974*
42	1368	0.997*	0.994*	0.991*	0.988*	0.985*
43	1501	0.998*	0.995*	0.993*	0.991*	0.988*
44	1501	0.996*	0.990*	0.986*	0.980*	0.975*
45	1501	0.995*	0.990*	0.986*	0.981*	0.975*
46	1372	0.998*	0.996*	0.994*	0.991*	0.989*
47	1051	0.995*	0.989*	0.983*	0.977*	0.972*
48	1051	0.997*	0.993*	0.989*	0.985*	0.981*

TABLE 4.2

Sample period II

Autocorrelation Coefficients For Individual Stock Log Prices

No	No Obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	1114	0.994*	0.987*	0.980*	0.972*	0.964*
2	985	0.987*	0.973*	0.958*	0.943*	0.927*
3	980	0.996*	0.992*	0.987*	0.983*	0.978*
4	1114	0.997*	0.993*	0.989*	0.986*	0.982*

TABLE 4.2

Sample period III

Autocorrelation Coefficients For Individual Stock Log Prices

No	No Obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	883	0.993*	0.986*	0.979*	0.973*	0.967*
2	726	0.994*	0.989*	0.984*	0.979*	0.974*
3	877	0.992*	0.985*	0.978*	0.972*	0.965*
4	851	0.984*	0.967*	0.949*	0.931*	0.912*
5	880	0.993*	0.986*	0.980*	0.973*	0.967*
6	754	0.982*	0.963*	0.943*	0.922*	0.902*
7	737	0.997*	0.993*	0.990*	0.987*	0.983*
8	863	0.996*	0.992*	0.988*	0.984*	0.981*
9	754	0.992*	0.985*	0.978*	0.971*	0.964*
10	873	0.996*	0.991*	0.986*	0.981*	0.975*
11	754	0.994*	0.988*	0.983*	0.977*	0.971*
12	883	0.994*	0.988*	0.981*	0.975*	0.968*
13	754	0.990*	0.981*	0.973*	0.965*	0.957*
14	754	0.990*	0.979*	0.969*	0.959*	0.949*
15	754	0.992*	0.982*	0.972*	0.964*	0.954*
16	754	0.978*	0.957*	0.937*	0.917*	0.899*
17	753	0.996*	0.991*	0.987*	0.982*	0.980*
18	722	0.992*	0.984*	0.977*	0.969*	0.962*
19	790	0.995*	0.989*	0.983*	0.978*	0.972*
20	685	0.981*	0.960*	0.941*	0.922*	0.902*
21	773	0.993*	0.986*	0.979*	0.971*	0.963*
22	754	0.989*	0.979*	0.969*	0.959*	0.949*
23	783	0.990*	0.981*	0.972*	0.963*	0.954*
24	754	0.992*	0.985*	0.978*	0.973*	0.967*

TABLE 4.2

Sample period III

Autocorrelation Coefficients For Individual Stock Log Prices

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
25	754	0.993*	0.986*	0.979*	0.973*	0.967*
26	754	0.981*	0.964*	0.949*	0.933*	0.918*
27	669	0.992*	0.983*	0.975*	0.966*	0.958*
28	754	0.993*	0.985*	0.978*	0.971*	0.963*
29	739	0.995*	0.990*	0.985*	0.980*	0.974*
30	754	0.975*	0.951*	0.929*	0.904*	0.876*
31	754	0.988*	0.976*	0.964*	0.952*	0.942*
32	754	0.990*	0.979*	0.967*	0.956*	0.945*
33	754	0.990*	0.982*	0.974*	0.967*	0.960*
34	753	0.998*	0.995*	0.993*	0.991*	0.988*
35	754	0.993*	0.985*	0.976*	0.967*	0.958*
36	754	0.973*	0.945*	0.918*	0.892*	0.868*
37	821	0.992*	0.984*	0.976*	0.968*	0.961*
38	883	0.994*	0.989*	0.984*	0.979*	0.974*
39	785	0.991*	0.982*	0.974*	0.967*	0.957*
40	637	0.980*	0.961*	0.941*	0.920*	0.899*
41	871	0.996*	0.991*	0.987*	0.982*	0.978*
42	754	0.992*	0.984*	0.977*	0.969*	0.962*

TABLE 4.2

Sample period IV

Autocorrelation Coefficients For Individual Stock Log Prices

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	709	0.995*	0.988*	0.982*	0.977*	0.971*
2	709	0.996*	0.990*	0.985*	0.980*	0.975*
3	556	0.993*	0.984*	0.975*	0.967*	0.958*
4	586	0.985*	0.967*	0.948*	0.927*	0.907*
5	524	0.994*	0.986*	0.979*	0.971*	0.964*
6	483	0.990*	0.981*	0.971*	0.960*	0.949*
7	705	0.993*	0.986*	0.979*	0.973*	0.966*
8	657	0.987*	0.975*	0.965*	0.955*	0.945*
9	646	0.991*	0.980*	0.970*	0.960*	0.950*
10	439	0.987*	0.973*	0.959*	0.944*	0.929*
11	549	0.991*	0.981*	0.971*	0.962*	0.952*
12	504	0.986*	0.972*	0.960*	0.949*	0.937*
13	571	0.986*	0.972*	0.960*	0.949*	0.939*
14	627	0.995*	0.989*	0.982*	0.976*	0.969*
15	646	0.989*	0.977*	0.964*	0.952*	0.940*
16	642	0.991*	0.983*	0.974*	0.966*	0.956*
17	456	0.969*	0.945*	0.915*	0.886*	0.857*
18	543	0.991*	0.981*	0.972*	0.962*	0.953*
19	612	0.994*	0.987*	0.980*	0.973*	0.966*
20	542	0.991*	0.982*	0.974*	0.966*	0.958*
21	607	0.987*	0.974*	0.960*	0.948*	0.936*

TABLE 4.2

Sample period V

Autocorrelation Coefficients For Individual Stock Log Prices

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	323	0.978*	0.952*	0.928*	0.906*	0.885*
2	351	0.984*	0.967*	0.949*	0.931*	0.910*
3	142	0.982*	0.964*	0.945*	0.925*	0.905*
4	222	0.953*	0.906*	0.866*	0.826*	0.785*
5	212	0.961*	0.916*	0.878*	0.837*	0.797*
6	290	0.985*	0.970*	0.954*	0.939*	0.924*
7	292	0.952*	0.903*	0.860*	0.818*	0.771*
8	330	0.964*	0.928*	0.893*	0.861*	0.835*
9	296	0.951*	0.900*	0.858*	0.807*	0.749*
10	197	0.943*	0.871*	0.789*	0.709*	0.635*
11	262	0.984*	0.963*	0.944*	0.925*	0.905*
12	497	0.991*	0.983*	0.973*	0.963*	0.952*
13	196	0.949*	0.908*	0.871*	0.836*	0.806*

Given the non-stationarity of the stock log price series, autocorrelation coefficients are estimated for all individual stock return series for periods 1, 2, 3, 4, 5. The results are presented in table (4.3). As can be seen from the table, for 25 out of 48 stocks in period 1, for 4 out of 4 stocks in period 2, for 8 out of 42 in period 3, for 8 out of 21 companies in period 4, and for 3 out of 13 companies in period 5, the autocorrelation coefficients are significant at the 5% level of significance for lag one. This could be interpreted as evidence against the random walk hypothesis and hence market efficiency for companies in period 1 and 2. On the other hand most companies in period 3, 4 and 5 could be considered to be efficiently priced.

TABLE 4.3

Sample period I

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	1371	0.030	-0.038	-0.040	0.019	0.037
2	1371	0.004	-0.011	0.016	-0.048	0.013
3	1500	0.046	0.002	0.016	-0.020	0.003
4	1500	0.059*	-0.017	0.005	-0.007	0.020
5	1500	0.078*	-0.023	0.030	0.042	0.035
6	1500	0.116*	0.008	-0.008	-0.004	-0.034
7	1500	0.057*	-0.006	0.006	-0.001	0.018
8	1500	0.058*	-0.039	-0.041	-0.021	-0.017
9	1371	0.053*	0.012	-0.017	0.042	0.021
10	1500	0.010	-0.029	0.021	0.016	-0.001
11	1500	0.110*	-0.058*	-0.058*	0.016	-0.017
12	1500	0.018	-0.001	0.2E-3	-0.004	0.026
13	1371	0.051	0.009	-0.014	-0.042	0.005
14	1500	0.031	-0.022	0.023	0.017	0.025
15	1291	0.050	-0.014	-0.046	-0.021	-0.003
16	753	0.021	-0.009	0.016	0.013	0.031
17	964	0.098*	0.014	0.037	0.089*	0.033
18	1500	0.039	-0.037	-0.016	0.025	0.015
19	1500	0.073*	-0.004	0.002	0.030	0.021
20	1500	0.071*	-0.003	0.024	0.016	-0.018
21	1371	0.044	-0.023	-0.7E-3	-0.018	0.009
22	1371	0.086*	-0.030	-0.030	0.033	-0.031
23	1371	0.069*	0.019	0.040	-0.002	0.008
24	1500	0.094*	-0.007	-0.008	-0.002	0.025

TABLE 4.3

Sample period I

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
25	1374	0.067*	-0.002	0.012	0.029	0.002
26	1371	0.071*	-0.016	-0.030	0.016	-0.008
27	1499	0.054*	-0.007	0.013	0.035	0.011
28	1371	0.085*	-0.008	-0.010	-0.009	-0.006
29	1315	0.092*	0.027	0.030	0.003	-0.015
30	1500	0.007	-0.029	-0.027	0.043	0.027
31	1371	0.042	-0.023	0.002	0.014	0.009
32	1371	0.041	-0.003	-0.028	0.013	-0.018
33	1500	0.047	-0.032	-0.038	-0.008	-0.007
34	1371	0.037	0.004	-0.021	-0.001	0.021
35	1366	-0.001	0.036	0.034	0.061*	0.027
36	1500	0.052*	0.027	0.032	0.002	-0.003
37	1371	0.021	-0.007	-0.021	-0.038	0.072*
38	803	0.057	-0.013	0.034	0.032	-0.002
39	1371	0.026	0.004	-0.059*	-0.012	-0.028
40	751	0.174*	0.067	-0.008	-0.005	-0.049
41	673	0.057	0.031	-0.039	-0.031	-0.070
42	1367	0.088*	0.017	0.016	-0.053	-0.019
43	1500	0.148*	0.036	0.3E-3	-0.004	-0.058*
44	1500	0.087*	-0.021	0.027	0.048	0.029
45	1500	0.040	-0.016	0.007	0.048	-0.016
46	1371	0.097*	0.005	0.006	0.025	0.027
47	1500	0.042	-0.013	-0.032	-0.007	-0.021
48	1132	0.164*	0.083*	0.012	-0.005	-0.021

TABLE 4.3

Sample period II

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	1113	0.135*	0.038	0.025	0.019	0.009
2	984	0.084*	0.023	0.022	0.060	0.008
3	979	0.073*	0.013	0.031	0.007	-0.019
4	1113	0.093*	0.008	-0.010	0.025	0.040

TABLE 4.3

Sample period III

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	882	-0.025	-0.063	0.040	-0.018	0.006
2	725	-0.058	-0.071	-0.045	0.027	0.031
3	876	-0.026	-0.062	0.040	-0.016	0.007
4	850	0.104*	0.011	0.022	0.011	-0.003
5	879	0.030	-0.030	0.005	-0.051	-0.002
6	753	0.055	0.018	-0.007	0.012	-0.004
7	736	0.051	0.003	0.006	0.061	-0.003
8	862	0.059	0.002	0.001	-0.029	-0.001
9	753	-0.009	-0.024	-0.020	0.040	0.029
10	872	0.136*	0.019	0.010	0.020	-0.030
11	753	-0.002	0.025	-0.029	0.036	0.027
12	882	0.031	0.021	0.033	-0.044	-0.002
13	753	-0.062	-0.068	-0.024	0.022	0.029
14	753	0.067	-0.017	-0.009	0.002	0.009

TABLE 4.3

Sample period III

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
15	753	0.057	-0.020	-0.010	0.020	-0.045
16	753	-0.057	-0.035	-0.035	0.005	-0.024
17	752	0.068	0.007	-0.009	0.011	-0.030
18	721	0.046	-0.089*	0.6E-3	0.003	0.067
19	789	0.038	0.045	-0.1E-3	0.024	0.018
20	684	0.065	-0.018	-0.003	0.030	-0.051
21	772	0.028	-0.026	0.033	0.034	0.043
22	753	-0.072*	-0.011	-0.024	0.046	0.022
23	782	0.021	-0.011	-0.028	0.036	0.048
24	753	-0.058	-0.046	-0.200*	0.008	0.024
25	753	-0.035	-0.041	-0.067	0.020	0.014
26	753	-0.056	-0.060	-0.022	-0.069	-0.026
27	668	-0.017	0.025	-0.032	0.001	0.033
28	753	0.056	0.028	-0.065	0.022	-0.008
29	738	0.021	0.024	0.005	0.050	-0.111*
30	753	-0.023	-0.055	0.045	0.054	0.043
31	753	0.048	-0.019	-0.074*	-0.095*	-0.032
32	753	0.120*	0.018	-0.032	-0.048	-0.003
33	753	-0.144*	0.007	-0.018	-0.050	0.020
34	752	0.075*	0.041	0.028	-0.027	-0.019
35	753	0.133*	0.101*	0.019	0.034	0.004
36	753	0.032	-0.028	-0.006	-0.052	0.019
37	820	-0.022	-0.011	-0.008	-0.031	-0.044
38	882	0.023	-0.050	0.004	0.012	-0.028
39	784	-0.008	-0.2E-3	-0.028	0.045	0.021
40	636	-0.022	-0.018	-0.034	0.002	-0.007

TABLE 4.3

Sample period III

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
41	870	0.122*	0.059	-0.033	0.014	-0.041
42	753	-0.021	-0.002	-0.023	0.071	0.7E-3

TABLE 4.3

Sample period IV

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	708	0.027	-0.020	-0.042	-0.002	-0.036
2	708	-0.024	-0.002	-0.030	-0.002	-0.021
3	555	0.107*	0.031	-0.006	-0.009	-0.014
4	585	0.145*	0.080	0.025	-0.007	0.004
5	523	0.110*	0.037	-0.002	-0.010	-0.026
6	482	-0.004	0.110*	0.037	0.071	-0.045
7	704	0.013	-0.013	-0.073	0.007	-0.027
8	656	-0.044	-0.057	-0.021	-0.043	-0.060
9	645	0.121*	0.025	0.014	0.020	0.021
10	438	0.132*	0.045	0.115*	0.057	-0.045
11	548	0.064	-0.071	0.029	-0.018	-0.014
12	503	0.020	-0.088*	0.028	0.110*	-0.005
13	570	-0.017	-0.113*	-0.059	-0.004	-0.014
14	626	0.141*	0.078	0.008	-0.019	-0.026
15	643	0.080*	0.032	-0.022	0.009	0.040
16	641	0.032	-0.048	0.030	0.058	0.009

TABLE 4.3

Sample period IV

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
16	641	0.032	-0.048	0.030	0.058	0.009
17	455	-0.148*	0.123*	-0.051	0.032	-0.086
18	542	-0.020	0.055	-0.048	0.024	0.098*
19	611	0.066	0.034	0.030	-0.016	-0.015
20	541	0.058	0.065	0.053	0.007	-0.026
21	606	-0.003	0.013	-0.030	-0.069	-0.039

TABLE 4.3

Sample period V

Autocorrelation Coefficients For Individual Stock Returns

No	No obs	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
1	322	0.108	-0.060	-0.030	-0.048	-0.5E-3
2	350	0.094	0.037	-0.074	0.061	0.095
3	142	-0.036	0.068	0.117	0.003	0.116
4	221	-0.016	-0.114	0.054	0.051	-0.005
5	211	0.194*	0.002	0.1E-3	-0.056	-0.041
6	289	0.051	-0.019	0.059	-0.030	-0.052
7	291	-0.070	-0.107	0.065	0.048	0.082
8	329	-0.016	0.011	-0.030	-0.075	-0.059
9	295	-0.002	-0.109	0.112	-0.002	0.005
10	196	0.233*	0.171*	0.018	-0.039	-0.012
11	261	0.122*	-0.007	-0.045	0.002	-0.031
12	496	0.036	0.091*	0.138*	0.024	0.051
13	195	0.083	-0.8E-3	-0.006	-0.056	0.006

C. SPECTRAL ANALYSIS

Spectral analysis is an alternative to studying autocorrelations. It is particularly appropriate when cycles in returns are the preferred alternative to random behaviour. The null hypothesis is that the spectral density is constant and thus returns follow a random walk process and are not predictable. Table (4.4) presents the spectral Zero frequency and Weex Cycle tests.

Table 4.4

Sample period I

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
1	1.939*	1.816
2	2.221*	-0.310
3	0.641	-0.123
4	2.036*	0.051
5	1.302	0.104
6	-0.370	-0.031
7	0.992	-1.036
8	0.403	0.349
9	1.145	-0.861
10	0.216	0.044
11	1.182	-0.320
12	-0.361	-0.775
13	1.646	1.447
14	0.853	-0.109
15	0.247	0.570

Table 4.4

Sample period I

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
16	-0.245	0.011
17	0.249	-0.626
18	2.360*	1.416
19	0.703	-0.295
20	1.051	-0.768
21	0.227	-0.081
22	0.849	0.649
23	0.965	-1.160
24	2.649*	1.477
25	2.639*	-1.054
26	1.154	0.338
27	1.694	-0.063
28	0.902	1.379
29	0.018	-0.208
30	1.893*	1.221
31	0.820	1.327
32	-0.825	-1.368
33	0.087	-0.591
34	0.098	-0.509
35	1.100	0.447
36	0.470	-0.348
37	0.529	-0.126
38	-0.093	0.020
39	-1.693	0.000
40	-0.385	-0.158
41	-0.236	-0.171

Table 4.4

Sample period I

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
42	-0.371	-0.037
43	-0.874	-0.409
44	1.611	0.836
45	1.806	1.625
46	1.402	0.452
47	1.829	-0.325
48	1.541	-1.743

Table 4.4

Sample period II

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
1	1.110	0.107
2	0.224	0.442
3	1.031	-0.676
4	3.449*	0.167

Table 4.4

Sample period III

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
1	0.104	-1.741
2	-1.194	-0.105
3	-0.713	0.398
4	1.792	-0.498
5	-0.268	-0.106
6	0.187	-0.511
7	-0.028	-0.469
8	0.162	-0.668
9	1.513	-1.038
10	0.753	0.823
11	2.152*	1.787
12	0.497	0.573
13	-1.308	-0.551
14	0.145	-0.030
15	0.163	0.202
16	-0.514	-0.618
17	0.002	-0.213
18	-0.023	0.685
19	-0.191	0.179
20	-0.157	0.089
21	0.236	1.108
22	1.619	-0.640
23	0.280	-0.634
24	-0.254	-0.138
25	0.941	-0.751
26	-1.317	0.121

Table 4.4

Sample period III

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
27	-0.705	1.483
28	0.696	0.351
29	0.263	-0.720
30	0.414	-1.503
31	-0.115	-0.179
32	-0.834	0.545
33	0.589	0.220
34	0.766	-0.505
35	0.523	-0.989
36	-0.769	-0.039
37	1.738	-0.237
38	1.165	-0.512
39	0.026	-1.173
40	0.000	-0.121
41	2.538*	-0.803
42	0.727	-1.069

Table 4.4

Sample period IV

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
1	-0.560	0.290
2	-0.502	-0.211
3	-0.398	0.259
4	0.504	-0.696
5	1.544	0.533
6	0.486	-0.128
7	-0.603	0.587
8	-0.735	0.014
9	0.950	0.802
10	2.087*	-1.131
11	-0.622	-0.116
12	2.054*	0.058
13	0.655	0.391
14	1.288	-0.721
15	0.660	1.053
16	0.097	0.926
17	-1.452	-1.562
18	-0.538	0.512
19	1.817	-1.212
20	0.223	0.095
21	-0.456	-0.958

Table 4.4

Sample period V

SPECTRAL TEST STATISTICS

NO	ZERO FREQUENCY	WEEX CYCLE
1	-1.014	-0.819
2	1.399	-0.575
3	2.036*	-1.116
4	-0.727	-0.401
5	2.617*	-0.474
6	-0.409	-0.621
7	-0.506	0.931
8	-0.902	-1.193
9	-0.568	0.024
10	-0.441	-1.227
11	0.533	0.278
12	2.447*	0.420
13	0.287	-0.765

For most of the companies in all periods under investigation both Zero Frequency and Weex Cycle tests indicate acceptance of the null hypothesis at the 5% level of significance. The evidence then suggests that the density function is constant and the random walk hypothesis is accepted. These results seem to contradict the earlier finding, based on autocorrelations, that most companies in periods 1, 2 and 3 are statistically independent and thus inefficient. Perhaps such contradictory results reflect the power of these test statistics.

D. RUNS TESTS

As returns have a non-normal distribution non-parametric tests of random walk could be more appropriate. The only non-parametric statistic to date is the total number of runs. The null hypothesis here is that the series under investigation are generated by a strict white noise process. The rejection of the null hypothesis would imply dependence in returns and hence predictability and inefficiency. Table (4.5) presents the results from the run test for all companies under investigation.

Table 4.5

Sample period I

RUN TEST

NO	RUNS OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
1	835.0	872.1	17.2	-2.15
2	820.0	906.9	17.4	-5.01
3	913.0	956.5	18.0	-2.41
4	901.0	979.7	18.1	-4.34
5	909.0	963.2	18.1	-3.00
6	867.0	938.5	18.0	-3.96
7	892.0	952.8	18.0	-3.37
8	867.0	949.7	18.0	-4.59
9	814.0	915.0	17.4	-5.79
10	917.0	989.1	18.2	-3.97
11	889.0	963.7	18.1	-4.14
12	903.0	975.9	18.1	-4.04
13	835.0	908.2	17.4	-4.21

Table 4.5

Sample period I

RUN TEST

NO	RUNS OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
14	847.0	955.5	18.0	-6.01
15	762.0	813.1	16.7	-3.06
16	514.0	795.8	15.7	-17.96
17	683.0	909.0	17.4	-13.01
18	922.0	995.3	18.2	-4.03
19	896.0	961.7	18.0	-3.64
20	916.0	971.3	18.1	-3.06
21	820.0	856.4	17.2	-2.11
22	781.0	890.9	17.3	-6.36
23	785.0	913.1	17.4	-7.35
24	860.0	951.0	18.0	-5.05
25	792.0	879.9	17.3	-5.09
26	809.0	907.7	17.4	-5.68
27	850.0	984.0	18.1	-7.39
28	753.0	911.1	17.4	-9.09
29	773.0	866.9	17.0	-5.53
30	875.0	957.7	18.0	-4.58
31	826.0	903.6	17.4	-4.47
32	830.0	892.9	17.3	-3.64
33	889.0	981.1	18.1	-5.08
34	831.0	902.7	17.3	-4.13
35	679.0	901.6	17.3	-12.88
36	850.0	987.2	18.1	-7.57
37	857.0	904.7	17.4	-2.75
38	647.0	875.5	16.9	-13.50
39	646.0	901.3	17.3	-14.78

Table 4.5

Sample period I

RUN TEST

NO	RUNS OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
40	634.0	858.0	16.7	-13.43
41	566.0	805.7	15.8	-15.13
42	726.0	906.1	17.3	-10.38
43	876.0	971.0	18.1	-5.25
44	892.0	949.9	18.0	-3.21
45	933.0	982.4	18.1	-2.73
46	801.0	892.2	17.3	-5.27
47	882.0	978.9	18.1	-5.35
48	773.0	998.3	18.2	-12.37

Notes: * denotes statistically insignificant at the 5% level.

Table 4.5

Sample period II

RUN TEST

NO	RUNS OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
1	622.0	718.4	15.5	-6.20
2	570.0	624.6	14.6	-3.74
3	574.0	652.6	14.7	-5.34
4	669.0	723.3	15.6	-3.48

See notes on Table (4.5) Sample Period I.

Table 4.5

Sample period III

RUN TEST

No	OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
1	565.0	571.7	13.9	-0.48*
2	434.0	478.5	12.6	-3.54
3	536.0	575.9	13.8	-2.88
4	503.0	540.9	13.6	-2.80
5	517.0	570.8	13.8	-3.89
6	422.0	502.1	12.9	-6.21
7	434.0	472.5	12.4	-3.10
8	516.0	545.9	13.7	-2,19
9	474.0	499.4	12.9	-1.97
10	481.0	543.8	13.7	-4.58
11	466.0	481.0	12.8	-1.18*
12	496.0	588.5	14.0	-6.62
13	478.0	501.0	12.9	-1.78*
14	427.0	496.2	12.8	-.539
15	360.0	471.5	12.4	-9.03
16	491.0	500.7	12.9	-0.75*
17	421.0	466.1	12.7	-3.54
18	430.0	479.1	12.6	-3.90
19	487.0	512.6	13.1	-1.95*
20	394.0	435.0	12.2	-3.38
21	462.0	484.9	12.9	-1.77*
22	488.0	497.6	12.9	-0.75*
23	470.0	486.4	13.0	-1.26*
24	440.0	499.9	12.9	-4.66
25	464.0	502.1	12.9	-2.96
26	470.0	502.8	12.9	-2.54

Table 4.5

Sample period III

RUN TEST

No	OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
27	424.0	444.0	12.1	-1.65*
28	443.0	487.7	12.8	-3.50
29	422.0	490.3	12.7	-5.35
30	466.0	502.8	12.9	-2.85
31	435.0	501.7	12.9	-5.18
32	411.0	495.8	12.8	-6.63
33	425.0	484.5	12.6	-4.72
34	431.0	494.4	12.8	-4.95
35	418.0	500.3	12.9	-6.39
36	470.0	489.6	12.8	-1.53
37	504.0	547.7	13.5	-3.24
38	532.0	580.4	13.9	-3.48
39	493.0	517.4	13.1	-1.86
40	406.0	424.2	11.8	-1.54*
41	500.0	570.0	13.8	-5.08
42	460.0	502.1	12.9	-3.27

See notes on Table (4.5) Sample Period I.

Table 4.5

Sample period IV

RUN TEST

NO	RUNS OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
1	441.0	456.7	12.4	-1.27*
2	422.0	451.4	12.3	-2.39
3	205.0	350.0	10.6	-13.63
4	299.0	377.6	11.1	-7.07
5	198.0	324.4	10.2	-12.40
6	192.0	252.6	8.5	-7.13
7	421.0	459.4	12.3	-3.11
8	292.0	410.5	11.5	-10.30
9	356.0	399.7	11.8	-3.70
10	202.0	254.0	8.9	-5.85
11	328.0	350.6	10.9	-2.08
12	300.0	332.2	10.5	-3.07
13	334.0	362.9	10.9	-2.66
14	361.0	388.4	11.6	-2.35
15	365.0	402.2	11.8	-3.15
16	396.0	407.6	11.8	-0.98*
17	300.0	299.7	9.9	0.03*
18	346.0	360.1	10.9	-1.29*
19	272.0	362.0	10.6	-8.47
20	305.0	361.6	10.9	-5.18
21	389.0	404.6	11.6	-1.35*

See notes on Table (4.5) Sample Period I.

Table 4.5

Sample period V

RUN TEST

NO	RUNS OBSERVED	RUNS EXPECTED	STANDARD DEVIATION	RUNS TEST STATISTIC
1	193.0	208.6	8.3	-1.87*
2	208.0	218.4	8.7	-1.21*
3	63.0	65.6	4.6	-0.58*
4	142.0	145.0	6.9	-0.44*
5	111.0	141.5	6.8	-4.49
6	185.0	182.8	7.9	0.27*
7	184.0	194.7	8.0	-1.33*
8	200.0	219.1	8.5	-2.25
9	194.0	193.4	7.9	0.08*
10	104.0	130.8	6.5	-4.10
11	162.0	168.2	7.5	-0.82*
12	311.0	331.1	10.5	-1.92*
13	85.0	105.4	5.7	-3.61

See notes on Table (4.5) Sample Period I.

As can be seen from the above tables, for most companies in periods 1, 2, 3 and 4 the null hypothesis is rejected at the 5% level of significance, suggesting that returns are not generated from a strict white noise process. This implies that returns are dependent and predictable and hence inefficiently priced. The negative sign for all run test coefficients implies positive dependence. On the other hand for most companies in period 5 the null hypothesis is accepted.

4.4. CONCLUSION

Whether capital markets are informationally efficient is ultimately an empirical question. The issue of efficiency in emerging markets has been widely investigated in recent years, with mixed results. Most previous studies examined the issue of efficiency using conventional tests. This chapter seeks to examine whether companies listed on the ISE are weak-form efficient using some of the conventional tests that appeared in the literature.

All results, presented in the chapter, taken together seem to suggest that companies listed on the ISE are not efficiently priced in the weak-form. This apparent inefficiency could obviously lead to misallocation of resources. However as mentioned in the introduction of the thesis most of these conventional tests could be misleading since there are not capable of capturing the institutional and investor behaviour found in emerging markets. These issues are the subject matter of the next chapter.

ENDNOTES

[1] For the rest of the thesis a * denotes statistically significant at the 5% level unless otherwise stated.

V. MARKET EFFICIENCY, THIN TRADING AND NON-LINEAR BEHAVIOUR

5.1. INTRODUCTION

The previous chapter has, using conventional tests for efficiency, shown that the ISE could be classified as inefficient. However, if the evidence on efficiency/inefficiency is to be reliable it is essential that the methodology adopted in statistical tests takes account of the institutional features and trading conditions of the market under investigation. Only then can we address the more important issue of what makes markets informationally efficient or inefficient. An understanding of this issue will help to determine the appropriate regulatory framework for the establishment of efficiently functioning equity markets.

In this chapter using data from the Istanbul Stock Exchange we seek to examine the issue of efficiency when institutional features specific to the market under investigation are taken into account. Specifically, we adopt a testing methodology which enables us to recognise the possible presence of non-linear behaviour and correct for the effects of thin trading. In addition, by investigating efficiency on a yearly basis we are able to examine the impact of the market maturing and regulatory changes on the trading behaviour and efficiency of the market. The chapter is organised as follows. The next section examines some fundamental aspects of efficiency and emerging market behaviour and outlines the methodology adopted in this chapter. Section (5.3) discusses the major features of the Istanbul Stock Exchange (ISE) and its evolution over time. In section (5.4) the data and results are presented. This is followed by a conclusion and summary.

5.2. ISSUES OF MARKET EFFICIENCY, THIN TRADING AND NON-LINEAR BEHAVIOUR

The issue of market efficiency is often investigated by examining whether prices in equity markets exhibit patterns which allow future prices to be predicted and, thus, abnormal profits to be achieved. For a market to be efficient no such patterns should exist and prices should follow a random walk, or the less restrictive martingale process. Implicit in these specifications of an efficient price series is the assumption that investors are rational. Rationality implies firstly that investors are risk averse, secondly, that they are unbiased in their forecast and thirdly they respond instantaneously to new information. These three assumptions lead to a linear relationship which is used to test market efficiency. If these assumptions are not valid and if the return generating process is non-linear and a linear model is used to test efficiency then the hypothesis of independence of successive price changes may wrongly be accepted. This can arise because non-linear systems such as chaotic systems exhibit similar patterns to a random walk process. If however, the system is non-linear the series may be predictable.

There are several reasons why non-linearities may be observed in financial markets. First, the characteristics of the market microstructure may lead to non-linearities because of difficulties in carrying out arbitrage transactions. For example, differing microstructures between stock markets and derivative markets may give rise to non-linear dependence. Stoll and Whaley (1990) show that price discovery takes place in futures markets and then the information is carried to the stock market through the process of arbitrage. Delays in transacting the stock market leg of the arbitrage means that the immediate response in the mispricing would only be partial, reflecting the change in the futures price alone. This may induce further arbitrage activity and could actually result in overshooting of the arbitrage bounds. Furthermore, short sales restrictions in stock markets may lead to delays in executing arbitrage transactions, this in turn may cause non-linear behaviour.

Second, non-linearities may be explained in terms of non-linear feedback mechanisms in price movements. When the price of an asset gets too high self-regulating forces usually drive the price down. If the feedback mechanism is non-linear then the correction will not always be proportional to the amount by which the price deviates from the asset's real value. Consider, for example, the logistic map whereby a series evolves according to the following function:

$$X_t = aX_{t-1}(1 - X_{t-1}) = aX_{t-1} - aX_{t-1}^2 \tag{5.1}$$

This function maps the value at time (t-1) into the value at time (t). The second term in the equation is a negative non-linear feedback term which competes with the linear term in stabilising the series. It has the kind of features one might expect in self-regulatory markets. For example, whenever the price of an asset deviates from its fundamental value then market forces will drive the price back to its equilibrium level. If the corrective measure taken by the market is not proportional to the original deviation then the feedback mechanism is said to be non-linear. It is not unreasonable to expect such non-linear corrections in financial markets. Such effects could be explained by the market psychology, where investors and markets over-react to bad news and under-react to good news (see, for example, DeBondt and Thaler (1985,1987) and DaCosta (1994)). There are many participants in financial markets with many complex sets of human relationships, motivations and reactions. It would be a miracle if these complexities always averaged out to give an aggregate linear feedback.

Third, non-linearities could arise because of the presence of market imperfections such as transactions costs. Although information arrives randomly to the market, market participants respond to such information with a lag, due to transactions costs. In other words, market participants do not trade every time news comes to the market. Rather they trade whenever it is economically profitable leading to clustering of price changes. Fourth, when announcements of important factors are made less often than the frequency of observations non-linearities may be observed. For example, monthly money supply announcements will cause non-linearities in daily and weekly series, but not in quarterly series.

A fifth reason relates to the fact that, as mentioned above, capital market theory is based on the notion of rational investors. It is assumed that investors are risk averse, unbiased when they set their subjective probabilities and they always react to information as it is received. The implication is that the data generating process is linear. In practice however, investors may well be risk lovers when taking a gamble to minimise their losses. Moreover they may have too much faith in their own forecasts, thus introducing bias into their subjective probabilities. In addition, they may not react to information instantaneously but delay their response until other investors reveal their preferences. The above points not only question the rationality of the individual investor but of the market as a whole since the market is an aggregation of individuals. Therefore, linear models may not be adequate in explaining the market behaviour.

The existence of non-linearities is supported empirically in mature markets. For example, Savit (1988) suggests that asset returns may not follow a stochastic process. Rather they might be generated by deterministic chaos in which case the forecasting error grows exponentially so that the process appears stochastic. Scheinkman and LeBaron (1989) find some support for the hypothesis that stock returns follow a non-linear dynamic system. Similarly, in an extensive study on the stock, bond and currency markets Peters (1991) presents evidence of non-linearities.

Given that non-linearities have been observed in highly liquid developed markets it may be expected that they will also be observed in emerging markets characterised by continuous change. One of the most important aspects of change in emerging markets relates to the regulatory framework which impacts on the functioning of markets through factors such as restrictions on short sales, trading conditions, information disclosures by companies and listing requirements. In addition, emerging markets are typically characterised by thin trading, wide spreads, possibly unreliable information, over reaction and uninformed investors, higher transactions costs and insider trading. It, therefore, is reasonable to expect that conventional tests of market efficiency based on the linear model (for example, autocorrelation, runs tests, frequency distribution and spectral analysis) may wrongly lead to the acceptance or rejection of the null hypothesis. The logistic map with an error term, or a similar specification, may therefore provide a useful approximation for testing for efficiency, since it allows for non-linearities, but if the non-linear term is found to be insignificant the model collapses to the random walk.

In testing for efficiency in emerging markets it is not sufficient to recognise the possible presence of non-linearities, it is also necessary to take account of the thin trading which typically characterises these markets. Thin trading introduces serial correlation. Therefore observed dependence is not necessarily evidence of predictability, but rather may be a statistical illusion brought about by thin trading. Failure to recognise this makes inferences drawn from tests unreliable. A final issue in relation to testing efficiency in emerging markets relates to the fact that these markets are characterised by continuous change in the regulatory structure. Given that the regulatory framework may impact on the efficiency of markets it is necessary to examine efficiency at different stages of development to reflect changes in regulations. To summarise, tests of market efficiency must take account of the characteristics of the market under investigation. For emerging markets this requires the recognition that there may be non-linearities, thin trading and a changing regulatory framework. It is only by directly incorporating these issues into tests of efficiency in emerging markets that we can address the more important issue of identifying the forces which lead to markets being efficient or inefficient.

5.3. METHODOLOGY

This chapter investigates the efficiency of the Istanbul Stock Exchange (ISE) using equation (5.1) (the logistic map) as the basis for investigation to take account of the possibility of their being non-linearities in the price series. The main purpose of using this approach is not to determine the precise nature of any non-linearities, but rather to ascertain whether any non-linearities exist. The following equation is estimated:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_n R_{t-1}^n + \varepsilon_t \qquad (5.2)$$

where (R_t) is the return at time (t), calculated as the difference of log prices and (n=2,3). For the efficient markets hypothesis to hold we would expect ($\alpha_0=\alpha_1=\alpha_n=0$) and ($\varepsilon_t$) is a white noise process.

As mentioned above, emerging markets are characterised by thin trading. Thin (or infrequent) trading occurs when stocks do not trade at every consecutive interval. A number of studies have investigated the impact of thin trading and discussed its consequences (see, for example, Fisher (1966), Dimson (1979), Cohen et al (1978, 1979), Lo and MacKinlay (1990), Stoll and Whaley (1990) and Miller, Muthuswamy and Whaley (1994)). Infrequently traded shares can affect the results of empirical studies on efficiency by introducing serious bias into the results of the empirical work.

The major source of bias is that prices recorded at the end of a time period have a tendency to represent an outcome of a transaction which occurred earlier in, or prior to, the period in question. Thus, thin trading induces autocorrelation in the time series of returns for a series which would otherwise exhibit serial independence. The methodology adopted here to deal with this problem is that proposed by Miller et al (1994). This methodology basically suggests that to remove the impact of thin trading a moving average model (MA) that reflects the number of non-trading days should be estimated and then returns be adjusted accordingly. However, given the difficulties in identifying the non-trading days, Miller et al have shown that it is equivalent to estimate an AR(1) model from which the non-trading adjustment can be obtained[1]. Specifically, this model involves estimating the following equation:

$$R_t = a_1 + a_2 R_{t-1} + e_t \qquad (5.3)$$

Using the residuals from the regression adjusted returns are estimated as follows:

$$R_t^{adj} = \frac{e_t}{(1 - a_2)} \qquad (5.4)$$

Where (R_t^{adj}) is the return at time (t), adjusted for thin trading.

The above model assumes that the non-trading adjustment required to correct returns is constant throughout the period. While this may be a realistic assumption for highly liquid developed markets, for emerging markets it is more likely that the required adjustment will vary through time. Therefore, in this chapter equation (5.3) is estimated recursively. In testing for efficiency equation (5.2) is estimated using corrected returns calculated recursively from equation (5.4). In addition to testing for efficiency over the period 1988-1993, tests are also carried out on a yearly basis to examine the impact of the regulatory changes which took place over this period.

5.4. THE ISTANBUL STOCK EXCHANGE

As mentioned in chapter 2, The Istanbul Stock Exchange (ISE) in its current form was formally inaugurated in late 1985, commencing operations in 1986. Major changes in the regulatory structure have taken place on a frequent basis since that date. Specifically, in 1989 trading conditions for international investors were improved significantly; free repatriation of dividends, investment capital and capital gains were allowed and taxes on capital gains and dividends were suspended. In addition, a regulation was passed which came into effect in 1990, requiring listed companies to have their financial statements audited by members of the Association of Accountants and Auditors. The impact of these changes contributed to the increase in the percentage of domestic savings being invested in the stock exchange from 3% in 1990 to 13% in 1991.

Further deregulation was introduced in 1992, which enabled the issuance of new instruments and took measures against insider trading. In addition, short sales restrictions were abolished in 1992 and a computerised system of trading was introduced. The Capital Market Law which came into effect in May 1992 sought to create new capital market instruments, channel savings into the security sector and boost investor confidence by making insider trading a criminal offence and improving transparency. Further changes expanded the role of quarterly reporting in order to give greater detail on companies' performance.

During the period of these changes and in subsequent years the volume of trading on the ISE increased substantially as shown in table (5.1). In addition, the table shows the mean and standard deviation of returns on the ISE Composite Index. The index, the composition of which is reviewed every six months, consists of the 75 most highly traded companies. These companies account for 93% of the total market value.

TABLE 5.1

YEARLY STATISTICS FOR ISE INDEX LEVEL 1988-1993

YEAR	VOLUME OF TRADING	MEAN VALUE OF INDEX	STANDARD DEVIATION OF INDEX
1988	7,031	530	131
1989	5,777	904	501
1990	4,888	4,017	713
1991	1.66E+7	3,715	705
1992	3.75E+7	3,991	389
1993	9.09E+7	10,571	457

(Source: Istanbul Stock Exchange)

As can be seen from table (5.1) the mean level of the index rose from 530 in 1988 to 4,017 in 1990 (a 659% increase) and to 10,571 in 1993 (1,898% higher than in 1988). This gives some indication of the magnitude of the performance of the exchange. The standard deviation, which may be taken as a measure of volatility and riskiness of the market, increased from 1988 to 1990 and then declined. The perceived riskiness of the market appears to have declined since 1991. Table (5.1) also demonstrates the spectacular increase which has taken place in the volume of trading between 1988 and 1993. However, while the volume of trade increased almost sixfold between 1988 and 1990, there was an almost eighteen fold increase in volume between 1990 and 1993. Further evidence of the maturing of the market is provided by the fact that the number of trading members of the exchange rose from 47 in 1986 to 176 by the end of 1993.

The prima facia evidence from table (5.1) suggests that the changes in regulation and liberalisation of the market increased interest in the equity market and, by making information more reliable, helped bring about a reduction in the perceived riskiness of the market. However, the crucial question from the point of view of resource allocation is whether these changes have affected the efficient functioning of the market. It is this issue which will now be addressed.

5.5. DATA AND EMPIRICAL RESULTS

5.5.1. DATA

In this chapter we use data on all companies traded on the ISE from 1988 to 1993 and the ISE Composite Index for the period 1988 to 1993. The sample for individual companies is subdivided into 5 groups. The first group includes all companies listed on the ISE during 1988 and trading between 1988-1993. This group consist of 48 companies; the second group includes companies trading between 1989-1993 and consists of 4 companies; the third group includes all companies listed in 1990 and were trading until 1993. This group consists of 42 companies; the forth group of companies used in this investigation includes all companies listed on the ISE during 1991 and were trading until 1993 and consists 21 companies; the final group includes all companies listed during 1992 and were trading until 1993. The total number of companies in this group is 13. The rationale for this division of the companies is to investigate whether regulatory and other institutional changes had an impact on the efficient pricing of these securities and whether the length of trading impacts on the pricing of securities. In other words, we trying to investigate if there is a learning curve for the market and investors in pricing risky assets. The second part of the empirical section of the chapter focuses on the stock market Index for the following reasons: first, the index represents more than 90% of the value of trade on the ISE; second, if inefficiency is found in the index then it would be possible to form a portfolio which replicates the index and trade profitably on this; third, given the composition of the index it will be possible to identify the impact of regulatory changes on the market as a whole, something which may not be possible when individual company analysis is used. All of the investigations are carried out using daily closing prices, supplied by the ISE.

5.5.2. EMPIRICAL RESULTS

A. COMPANY ANALYSIS

TABLE 5.2A

Sample period I

RANDOM WALK TEST WITHOUT NON-LINEARITIES FOR UNADJUSTED RETURNS

$$R_{it} = \alpha_{i0} + \sum_{j=1}^{5} \alpha_{ij} R_{it-j} + \varepsilon_{it}$$

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.001 (1.27)	0.120* (5.22)	0.781	2.351	0.898
2	0.001 (0.84)	0.024 (1.03)	0.132	0.764	1.500
3	0.003* (3.30)	0.047* (2.76)	1.068	0.960	1.778
4	0.002* (2.11)	0.051* (3.34)	9.751*	11.732*	0.874
5	0.002 (1.91)	0.071* (3.57)	0.061	0.006	1.514
6	0.002* (2.12)	0.098* (5.37)	6.173*	6.879*	2.042
7	0.002* (2.19)	0.049* (2.58)	17.053*	18.448*	1.805
8	0.002 (1.93)	0.052* (2.56)	11.465*	10.583*	1.736

Table 5.2a

Sample period I

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
9	0.1E-3 (0.09)	0.069* (2.61)	3.256	3.391	2.581
10	0.002* (2.07)	0.020 (1.20)	6.271*	7.378*	1.377
11	0.002 (1.89)	0.095* (4.52)	0.781	2.351	0.898
12	0.004* (4.19)	0.058* (2.50)	0.132	0.764	1.500
13	0.001 (1.06)	0.043* (2.02)	0.040	0.049	1.117
14	0.003* (2.46)	0.147* (7.04)	8.321*	7.209*	0.908
15	0.002 (1.91)	0.059* (2.54)	13.313*	10.977*	0.908
16	0.3E-3 (0.14)	0.028 (0.87)	12.672*	14.977*	0.547
17	0.003* (2.13)	0.074* (2.67)	11.551*	11.733*	0.941
18	0.002* (2.36)	0.021 (1.03)	1.318	0.373	1.088
19	0.004* (3.87)	0.002 (0.09)	18.045*	14.314*	1.390
20	0.003* (3.07)	0.071* (3.59)	8.439*	6.582*	2.113
21	0.001 (0.98)	0.048* (2.17)	13.456*	13.737*	2.648
22	0.4E-3 (0.35)	0.074* (3.56)	11.222*	14.151*	0.625
23	0.002 (1.39)	0.081* (3.74)	2.072	5.932*	1.623

Table 5.2a

Sample period I

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
24	0.003*	0.085*	2.733	5.426*	1.529
	(2.64)	(3.61)			
25	0.003*	0.088*	3.625	2.327	1.073
	(2.80)	(4.73)			
26	0.9E-3	0.097*	9.529*	17.393*	0.994
	(0.69)	(3.84)			
27	0.003*	0.094*	33.613*	36.157*	1.009
	(2.97)	(4.74)			
28	0.003*	0.093*	0.621	0.213	0.797
	(2.17)	(3.97)			
29	0.9E-4	0.123*	1.322	2.169	1.461
	(0.08)	(5.70)			
30	0.003*	0.126*	2.923	2.214	0.713
	(2.65)	(5.90)			
31	0.5E-3	0.039	3.786	3.174	0.846
	(0.39)	(1.87)			
32	0.002	0.055*	12.766*	11.032*	1.975
	(1.32)	(2.86)			
33	0.002	0.056*	5.826[c]	6.807*	1.712
	(1.58)	(2.75)			
34	0.002*	0.035	5.190*	2.898	1.649
	(2.13)	(1.84)			
35	0.002	0.019	16.723*	0.151	0.398
	(1.68)	(1.09)			
36	0.004*	0.054*	6.256*	1.992	0.652
	(3.19)	(3.22)			
37	0.002	0.006	10.614*	2.102	1.503
	(1.29)	(0.28)			

Table 5.2a

Sample period I

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
38	0.3E-3 (0.18)	0.052* (2.07)	2.541	1.591	1.129
39	0.001 (1.05)	0.028 (1.52)	31.357*	31.385*	1.330
40	0.002 (1.08)	0.187* (5.50)	0.052	8.150*	1.161
41	-0.9E-3 (0.44)	0.069* (2.24)	0.146	0.301	1.913
42	0.9E-3 (0.76)	0.094* (4.29)	8.011*	10.856*	1.596
43	0.003* (2.23)	0.139* (6.00)	2.351	8.798*	1.020
44	0.002* (2.15)	0.086* (4.26)	3.685	3.513	2.148
45	0.003* (2.37)	0.067* (3.26)	2.840	3.242	2.230
46	0.002 (1.43)	0.010* (4.86)	15.407*	15.653*	0.978
47	0.002* (2.15)	0.038* (2.05)	4.138*	8.085*	1.878
48	0.003* (2.07)	0.188* (6.78)	0.002	2.960	1.163

Table 5.2a

Sample period II

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.005*	0.120*	19.226*	24.100*	1.108
	(3.69)	(6.63)			
2	0.002	0.084*	3.813	9.048*	0.794
	(1.52)	(2.87)			
3	0.002	0.079*	2.470	10.175*	2.836
	(1.40)	(2.64)			
4	0.003*	0.099*	1.261	3.158	1.768
	(2.24)	(3.57)			

Table 5.2a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.002	-0.013	2.492	3.934*	0.950
	(1.13)	(-0.42)			
2	0.2E-3	-0.039	0.770	1.071	0.553
	(0.14)	(-1.23)			
3	0.002	0.009	1.958	4.183*	1.902
	(1.39)	(0.30)			
4	0.002	0.135*	0.018	0.227	0.610
	(1.01)	(4.53)			
5	0.003*	0.025	6.525*	3.853*	1.249
	(2.49)	(1.18)			
6	0.002	0.060*	2.944	9.164*	0.966
	(1.05)	(2.16)			
7	0.001	0.049	1.266	4.806*	1.192
	(0.91)	(1.64)			

Table 5.2a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
8	0.002 (1.25)	0.072* (3.36)	9.733*	14.237*	0.832
9	-0.8E-3 (-0.45)	0.002 (0.06)	0.193	0.070	0.777
10	0.002 (1.06)	0.097* (4.43)	13.477*	9.548*	0.907
11	0.003 (1.33)	-0.006 (-0.22)	0.064	0.046	0.567
12	0.003* (2.16)	0.039 (1.77)	3.724	4.969*	0.987
13	0.002 (1.37)	-0.045 (-1.85)	0.053	0.103	1.060
14	0.002 (1.18)	0.076* (2.90)	7.216*	7.160*	0.937
15	0.002 (0.85)	0.070* (2.27)	0.853	2.722	0.606
16	0.003 (1.79)	-0.061 (-1.82)	0.121	3.053	1.925
17	0.001 (0.66)	0.067* (2.81)	11.734*	9.378*	1.708
18	0.002 (1.32)	0.048 (1.58)	3.930*	0.465	0.751
19	0.003* (1.97)	0.042 (1.22)	4.709*	11.301*	0.720
20	0.8E-3 (0.43)	0.063* (2.60)	5.293*	7.333*	0.498
21	0.004* (2.31)	0.029 (1.78)	3.635	3.139	0.575
22	0.6E-3 (0.31)	-0.068* (-2.28)	0.099	0.082	0.815

Table 5.2a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
23	0.003*	-0.017	7.454*	1.935	1.170
	(2.13)	(-0.61)			
24	-0.002	-0.043	0.354	5.820*	0.921
	(-0.98)	(-1.22)			
25	-0.8E-3	-0.033	3.657	4.338*	0.661
	(-0.47)	(-0.99)			
26	0.5E-3	-0.051	0.613	3.244	1.118
	(0.22)	(-1.42)			
27	-0.001	0.006	2.269	0.333	0.963
	(-0.67)	(0.18)			
28	-0.2E-3	0.053	0.334	0.007	1.914
	(-0.01)	(1.74)			
29	-0.3E-3	0.024	0.852	0.225	0.561
	(-0.18)	(0.70)			
30	0.001	-0.023	0.186	8.228*	1.022
	(0.75)	(-0.64)			
31	0.8E-3	0.052	6.127*	0.593	0.691
	(0.39)	(1.45)			
32	0.002	0.105*	9.790*	12.339*	0.842
	(0.89)	(3.87)			
33	0.001	-0.176*	0.266	1.283	0.980
	(0.90)	(-5.71)			
34	-0.002	0.046*	0.026	0.271	0.575
	(0.89)	(2.22)			
35	-0.7E-3	0.175*	0.044	1.723	0.981
	(-0.03)	(5.53)			
36	0.7E-3	-0.008	3.939*	5.911*	0.460
	(0.39)	(-0.31)			
37	0.002	-0.018	0.427	0.016	1.421
	(1.06)	(-0.60)			

Table 5.2a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
38	0.003* (2.19)	0.010 (0.36)	0.678	0.611	1.213
39	0.002 (1.18)	0.018 (0.60)	0.115	1.162	1.084
40	0.2E-3 (0.11)	-0.026 (-0.83)	3.465	4.929*	0.427
41	-0.6E-3 (-0.36)	0.127* (4.22)	0.623	1.270	0.619
42	0.001 (0.63)	-0.031 (-0.91)	0.089	1.604	0.561

Table 5.2a

Sample Period IV

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.002 (1.28)	0.018 (1.85)	4.467*	0.043	0.448
2	0.1E-3 (0.06)	-0.022 (-1.86)	4.089*	0.890	0.427
3	0.003 (1.69)	0.156* (5.53)	26.163*	33.786*	0.370
4	0.002 (0.73)	0.151* (4.24)	2.065	7.131*	0.348
5	0.006* (2.67)	0.102* (3.44)	11.195*	15.150*	0.512
6	0.004 (1.75)	0.028 (0.86)	2.443	4.514*	0.761

Table 5.2a

Sample Period IV

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
7	0.006* (3.91)	-0.026 (-0.94)	4.623*	5.956*	0.340
8	0.002 (1.10)	-0.019 (-1.34)	8.005*	2.784	0.338
9	0.004* (2.11)	0.120* (3.35)	4.413*	4.560*	0.431
10	0.003 (1.60)	0.129* (2.71)	0.361	4.629*	20.040*
11	-0.1E-3 (-0.07)	0.051 (1.70)	1.501	0.515	0.895
12	0.002 (0.87)	0.012 (0.28)	5.561*	0.015	0.594
13	0.001 (0.74)	-0.082* (-2.19)	2.045	8.773*	0.426
14	0.004 (1.10)	0.096* (3.17)	6.378*	3.751	0.615
15	0.004* (2.18)	0.094* (2.66)	8.197*	9.643*	0.929
16	0.003 (1.89)	0.036 (1.38)	1.228	0.595	1.135
17	0.7E-3 (0.32)	-0.150* (-3.21)	0.015	1.140	47.205*
18	0.002 (1.08)	-0.035 (-1.63)	4.429*	2.822	0.669
19	0.1E-3 (0.09)	0.099* (2.92)	4.889*	14.791*	0.676
20	0.004 (1.93)	0.070 (1.64)	0.060	12.254*	0.624
21	-0.3E-3 (-0.16)	0.002 (0.06)	0.380	2.478	1.193

Table 5.2a

Sample period V

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.4E-3 (0.17)	0.107* (2.17)	0.747	0.377	0.467
2	0.8E-3 (0.42)	0.136* (2.63)	3.659	0.001	1.098
3	0.009* (3.33)	0.042 (0.53)	0.056	0.045	0.488
4	0.003 (1.10)	0.007 (0.14)	0.636	7.848*	0.617
5	0.002 (0.70)	0.221* (3.26)	0.790	4.190*	0.008
6	0.005* (2.31)	0.079* (1.99)	1.041	1.023	0.512
7	0.004* (2.20)	-0.133* (-3.22)	2.134	5.481*	0.470
8	0.004 (1.43)	0.135* (3.31)	1.989	4.954*	1.005
9	0.004* (2.02)	0.132* (2.74)	0.283	6.180*	3.082
10	0.006 (1.65)	0.120* (2.80)	0.018	2.771	0.441
11	0.004 (1.87)	0.052 (1.58)	15.416*	10.929*	0.348
12	0.003 (1.62)	0.014 (0.36)	3.900*	0.053	0.390
13	0.006 (1.50)	0.143* (2.06)	3.801	1.900	0.319

Notes: Figures in parentheses are t statistics.

* denotes significance at the 5% level.

[1] denotes a test for serial correlation;

[2] denotes a test for; a linear functional form and

[3] denotes a test for heteroscedasticity .

[1 2 & 3] are distributed $\chi^2(.)$ under the null hypothesis.

Table 5.2b

Sample period I

RANDOM WALK TEST WITH NON-LINEARITIES FOR ADJUSTED RETURNS

$$R_{it} = \alpha_{i0} + \sum_{j=1}^{5} \alpha_{ij} R_{it-j} + \alpha_{i6} R_{it-1}^{2} + \alpha_{i7} R_{it-1}^{3} + \varepsilon_{it}$$

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.001 (1.23)	0.132* (4.98)	0.143 (0.95)	0.022	3.366	0.893
2	0.8E-3 (0.65)	0.034 (1.32)	0.082 (0.87)	0.668	0.5E-4	0.486
3	0.003* (2.73)	0.066* (2.66)	0.191 (1.04)	0.004	0.069	1.769
4	0.002 (1.63)	0.116* (4.68)	0.065* (3.36)	0.123	0.286	0.877
5	0.002 (1.41)	0.067* (2.52)	0.279 (0.56)	1.796	5.723*	1.500
6	0.002 (1.69)	0.137* (5.81)	0.133* (2.61)	1.145	0.075	2.052
7	0.002 (1.54)	0.117* (4.74)	0.206* (4.31)	0.432	0.302	1.774
8	0.002 (1.35)	0.099* (3.97)	0.200* (3.25)	0.141	0.046	1.716
9	0.2E-3 (0.21)	-0.013 (-0.33)	10.113* (2.71)	0.3E-3	0.103	2.539
10	0.002 (1.76)	0.069* (2.83)	0.073* (2.71)	0.253	0.612	1.371
11	0.002 (1.46)	0.133* (5.27)	0.153* (2.71)	2.315	2.718	1.098

Table 5.2b

Sample period I

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
12	0.004*	0.087*	0.275*	0.009	0.651	0.808
	(3.56)	(3.52)	(3.72)			
13	-0.2E-3	0.031	0.646*	1.593	0.754	1.097
	(-0.14)	(1.16)	(2.50)			
14	0.002	0.190*	0.184*	0.036	0.094	0.651
	(1.93)	(7.74)	(3.32)			
15	0.002	0.109*	0.232*	1.449	1.241	0.887
	(1.31)	(4.04)	(3.59)			
16	-0.001	0.091*	0.354*	0.455	0.048	0.593
	(-0.53)	(2.57)	(3.90)			
17	0.003	0.137*	0.402*	3.801	0.853	0.902
	(1.17)	(4.35)	(4.10)			
18	0.001	0.007	0.717*	3.955*	1.868	1.063
	(1.12)	(0.28)	(2.77)			
19	0.002	0.141*	0.475*	0.615	4.220*	1.447
	(1.84)	(5.88)	(3.13)			
20	0.001	0.101*	0.924*	0.533	0.249	2.006
	(1.22)	(4.15)	(4.32)			
21	0.1E-3	0.097	0.408*	1.295	0.691	2.565
	(0.14)	(0.10)	(3.71)			
22	-0.001	0.119*	0.621*	0.679	0.202	0.644
	(-0.84)	(4.68)	(3.02)			
23	0.001	0.118*	0.141*	3.012	6.082*	1.564
	(0.96)	(4.51)	(2.51)			
24	0.002	0.105*	0.345*	0.143	0.006	1.472
	(1.80)	(4.20)	(2.33)			
25	0.002	0.112*	0.381*	0.593	1.226	1.067
	(1.93)	(4.64)	(2.29)			
26	-0.8E-3	0.128*	0.612*	0.686	0.054	1.006
	(-0.59)	(4.86)	(4.19)			

Table 5.2b

Sample period I

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
27	0.002*	0.182*	0.275*	3.437	1.194	1.176
	(2.19)	(7.59)	(6.16)			
28	0.003*	0.098*	0.032	0.758	8.186*	0.788
	(2.05)	(3.77)	(0.46)			
29	0.7E-3	0.138*	-0.061	0.529	4.402*	1.445
	(0.06)	(5.27)	(-0.97)			
30	0.002*	0.148*	0.137*	0.138	0.961	0.711
	(2.31)	(6.28)	(6.13)			
31	0.2E-3	0.066*	0.065	1.193	19.757*	0.840
	(0.23)	(2.56)	(1.77)			
32	0.001	0.114*	0.159*	1.463	2.018	2.004
	(0.86)	(4.36)	(3.32)			
33	0.001	0.086*	0.151*	0.364	0.204	1.705
	(1.15)	(3.62)	(2.43)			
34	0.002	0.065*	0.076	3.542	15.853*	1.635
	(1.87)	(2.50)	(1.70)			
35	0.002	0.104*	0.077*	0.035	0.111	0.389
	(1.37)	(3.96)	(4.30)			
36	0.002*	0.098*	0.472*	0.042	6.258*	0.633
	(2.06)	(3.96)	(3.58)			
37	0.7E-3	0.057*	0.270*	0.188	1.223	1.466
	(0.62)	(2.16)	(3.57)			
38	0.9E-4	0.082*	0.061	0.799	6.101*	1.137
	(0.05)	(2.36)	(1.26)			
39	0.5E-3	0.130*	0.211*	0.059	0.039	1.285
	(0.45)	(5.09)	(5.65)			
40	-0.6E-3	0.209*	0.787*	3.484	4.436*	1.199
	(-0.30)	(6.04)	(2.84)			
41	-0.8E-3	0.074*	0.023	0.038	0.604	1.907
	(-0.38)	(2.26)	(0.23)			

Table 5.2b

Sample period I

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
42	0.1E-3	0.145*	0.254*	0.633	2.605	1.586
	(0.13)	(5.61)	(3.66)			
43	0.002	0.163*	0.329*	2.296	3.535	1.076
	(1.43)	(6.61)	(2.77)			
44	0.002	0.112*	0.135	0.353	0.639	2.120
	(1.76)	(4.57)	(1.87)			
45	0.001	0.082*	0.598*	0.018	0.506	2.170
	(1.03)	(3.27)	(2.36)			
46	-0.5E-4	0.167*	0.692*	2.000	0.956	1.037
	(-0.04)	(6.57)	(3.42)			
47	0.002	0.085*	0.128*	1.611	3.711	1.872
	(1.74)	(3.42)	(2.84)			
48	-0.4E-3	0.136*	1.445*	0.069	0.009	1.148
	(-0.25)	(4.13)	(3.67)			

Table 5.2b

Sample period II

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.004*	0.225*	0.145*	0.043	5.403*	1.148
	(2.92)	(8.09)	(4.93)			
2	0.001	0.118*	0.440*	2.360	3.515	0.791
	(0.64)	(3.79)	(3.79)			
3	0.1E-3	0.114*	0.702	3.637	0.614	2.378
	(0.11)	(2.83)	(1.73)			
4	0.002	0.114*	0.233	1.177	5.507*	1.717
	(1.69)	(3.99)	(1.77)			

Table 5.2b

Sample period III

No	α_0	α_1	α_n	$\chi^2(1)$[1]	$\chi^2(1)$[2]	$\chi^2(1)$[3]
1	0.003 (1.23)	0.026 (0.80)	0.465* (2.12)	0.579	0.639	0.937
2	-0.7E-3 (-0.49)	-0.065 (-1.66)	1.711 (1.64)	0.586	1.166	0.535
3	0.001 (0.67)	0.025 (0.79)	0.436* (2.04)	0.026	0.301	1.893
4	0.001 (0.91)	0.141* (4.30)	0.047 (0.47)	1.013	2.277	0.600
5	0.002 (1.47)	0.091* (2.85)	0.527* (3.10)	0.142	4.614*	1.187
6	-0.3E-3 (-0.17)	0.116* (3.43)	0.735* (2.55)	9.081*	0.588	0.814
7	-0.7E-3 (-0.49)	0.064 (1.68)	2.717* (2.24)	0.901	3.481	1.119
8	0.001 (0.91)	0.163* (5.08)	0.119* (3.79)	0.615	0.030	0.861
9	-0.9E-3 (-0.48)	0.008 (0.24)	0.021 (0.32)	0.125	0.040	0.775
10	-0.1E-3 (-0.07)	0.175* (5.44)	0.719* (3.20)	1.930	0.032	0.872
11	0.003 (1.34)	-0.011 (-0.31)	-0.009 (-0.21)	0.067	0.335	0.587
12	0.002 (1.33)	0.094* (2.92)	0.417* (2.19)	0.283	0.608	0.968
13	0.1E-3 (0.07)	-0.070 (-1.92)	1.192* (2.76)	1.406	1.079	1.047
14	0.002 (0.82)	0.137* (3.95)	0.147* (2.67)	0.429	2.118	0.913
15	0.8E-3 (0.51)	0.988* (2.79)	0.188 (1.64)	2.592	2.603	0.602

Table 5.2b

Sample period III

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
16	0.003	-0.092*	0.753*	0.339	0.185	1.889
	(0.74)	(-2.16)	(1.89)			
17	0.3E-3	0.140*	0.183*	2.722	0.291	1.744
	(0.22)	(4.16)	(3.06)			
18	0.002	0.093*	0.218*	0.042	6.141*	0.761
	(0.89)	(2.61)	(2.37)			
19	0.001	0.093*	1.004*	0.373	0.526	0.802
	(0.58)	(1.98)	(2.09)			
20	0.4E-3	0.141*	0.085*	0.015	0.569	0.482
	(0.22)	(3.76)	(2.71)			
21	0.003	0.086*	0.252*	0.104	0.440	0.482
	(1.74)	(2.49)	(2.21)			
22	0.6E-3	-0.065	-0.018	0.149	2.522	0.579
	(0.31)	(-1.78)	(-0.14)			
23	0.002	0.037	0.204*	2.258	0.815	0.817
	(1.62)	(1.06)	(2.47)			
24	-0.005*	-0.040	1.349*	5.963*	7.720*	1.158
	(-2.55)	(-1.15)	(3.56)			
25	-0.002	-0.004	0.315*	0.108	0.006	0.693
	(-0.93)	(-0.11)	(2.08)			
26	0.5E-3	-0.074	1.800	0.160	4.359*	1.127
	(0.25)	(-1.41)	(0.60)			
27	-0.001	-0.006	-0.052	6.308*	0.044	0.963
	(-0.57)	(-0.17)	(-0.57)			
28	-0.4E-3	0.068	0.131	0.795	0.032	1.904
	(-0.21)	(1.93)	(0.84)			
29	-0.9E-3	0.019	-0.089	1.294	0.450	0.561
	(-0.05)	(0.54)	(-0.44)			
30	-0.002	0.035	1.323*	2.222	0.068	1.302
	(-0.86)	(0.58)	(2.88)			

Table 5.2b

Sample period III

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
31	0.5E-3	0.168*	-2.413*	2.463	2.075	0.661
	(0.25)	(2.71)	(-2.29)			
32	0.7E-3	0.187*	0.209*	0.020	1.140	0.851
	(0.38)	(5.26)	(3.53)			
33	-0.4E-3	-0.178*	0.913*	0.313	0.131	0.945
	(-0.21)	(-4.84)	(2.15)			
34	-0.004	0.051	0.681	0.783	0.290	0.562
	(-1.68)	(1.40)	(1.81)			
35	-0.004	0.171*	1.226*	0.288	0.530	1.008
	(-1.73)	(4.70)	(2.94)			
36	0.3E-3	0.055	0.087*	2.159	1.803	0.455
	(0.19)	(1.53)	(2.43)			
37	0.7E-3	-0.037	0.442	2.564	0.012	1.389
	(0.35)	(-1.05)	(1.29)			
38	0.001	-0.027	0.986*	1.066	3.209	1.151
	(0.86)	(-0.81)	(2.84)			
39	-0.5E-3	-0.002	1.329*	4.815*	0.050	1.062
	(-0.31)	(-0.06)	(2.50)			
40	-0.004	-0.8E-4	1.368*	0.105	0.2E-3	0.414
	(-1.60)	(-0.02)	(2.94)			
41	-0.001	0.150*	0.206	1.015	2.684	0.629
	(-0.69)	(4.58)	(1.77)			
42	-0.001	-0.077	1.111*	0.253	2.393	0.549
	(-0.64)	(-1.93)	(2.36)			

Table 5.2b

Sample period IV

No	α_0	α_l	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.002 (1.22)	0.072* (2.31)	0.016 (1.83)	1.128	0.060	0.453
2	0.2E-4 (0.01)	-0.004 (-0.17)	0.007 (0.94)	2.843	3.011	0.427
3	0.002 (1.00)	0.322* (8.24)	0.297* (6.00)	0.167	0.878	0.569
4	0.001 (0.62)	0.200* (4.84)	-0.432* (-2.31)	4.366*	2.856	0.378
5	0.002 (1.00)	0.208* (5.28)	0.979* (3.20)	4.077*	4.999*	0.487
6	0.003 (1.50)	0.063 (1.44)	0.116 (1.19)	0.572	4.629*	0.747
7	0.006* (3.60)	0.035 (0.95)	0.134* (2.46)	0.308	0.952	0.338
8	0.002 (0.93)	0.065 (1.97)	0.039* (2.81)	0.556	0.495	0.336
9	0.003 (1.47)	0.148* (3.89)	0.381* (2.14)	0.640	0.186	0.424
10	0.002 (1.18)	0.124* (2.59)	0.477 (0.81)	1.273	6.234*	16.503*
11	-0.1E-3 (-0.01)	0.068 (1.73)	-0.058 (-0.66)	1.279	0.273	0.889
12	0.002 (0.83)	0.081 (1.01)	-7.000 (-1.02)	4.877*	0.949	0.614
13	0.9E-3 (0.66)	-0.077 (-1.90)	0.066 (0.31)	5.422*	9.099*	0.430
14	0.003 (1.55)	0.154* (4.01)	0.174* (2.44)	0.758	0.468	0.610
15	0.003 (1.21)	0.138* (3.65)	0.532* (3.12)	0.003	3.327	0.908

Table 5.2b

Sample period IV

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
16	0.003	0.075*	0.095	0.146	0.465	1.142
	(1.63)	(2.02)	(1.48)			
17	-0.004	-0.155*	1.848*	0.971	1.811	0.134
	(-1.60)	(-3.33)	(3.31)			
18	0.003	-0.108*	-0.188*	0.212	2.637	0.674
	(1.44)	(-2.69)	(-2.72)			
19	-0.005*	0.145*	2.298*	2.867	0.549	0.660
	(-2.48)	(3.67)	(5.72)			
20	-0.2E-3	0.028	2.034*	0.046	0.081	0.487
	(-0.09)	(0.64)	(3.52)			
21	-0.8E-3	0.007*	0.138	0.008	10.795*	1.195
	(-0.39)	(2.00)	(1.02)			

Table 5.2b

Sample period V

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.1E-3	0.119*	0.106	1.879	0.183	0.458a
	(0.05)	(2.15)	(0.61)			
2	0.9E-3	0.136*	-0.026	3.665	1.863	1.104
	(0.38)	(2.63)	(-0.04)			
3	0.009*	0.078	-0.420	0.066	0.009	0.495
	(3.32)	(0.41)	(-0.21)			
4	0.004	-0.093	-0.625*	4.162*	0.063	0.607
	(1.71)	(-1.49)	(-2.81)			
5	0.008	0.083	0.024	1.333	2.097	0.302
	(1.75)	(1.20)	(0.03)			

Table 5.2b

Sample period V

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
6	0.006*	0.041	-0.109	0.111	0.088	0.515
	(2.48)	(0.74)	(-1.00)			
7	0.003	-0.062	0.414*	1.528	2.296	0.566
	(1.61)	(-1.26)	(2.65)			
8	-0.005	0.107	3.387*	0.164	0.226	0.816
	(-1.49)	(1.94)	(4.77)			
9	0.003	-0.051	21.347*	5.266*	4.788*	2.764
	(1.59)	(-0.63)	(2.73)			
10	0.006	0.196*	0.014	0.021	2.729	0.445
	(1.65)	(2.73)	(0.07)			
11	0.003	0.217*	0.251*	6.585*	1.374	0.381
	(1.27)	(3.68)	(3.34)			
12	0.001	0.062	0.595*	0.595	0.195	0.358
	(0.90)	(1.55)	(3.28)			
13	0.003	0.119	0.990	2.379	0.988	0.485
	(0.71)	(1.66)	(1.31)			

Tables (5.2a) and (5.2b) show the results of the random walk test carried out for all companies trading on the ISE between 1988 and 1993 using equation (5.2) for returns unadjusted for thin trading. Table (5.2a) presents results excluding the non-linear term, while table (5.2b) presents results when the non-linear term has been included. Coefficient (α_1) in table (5.2a) is statistically significant at the 5% level, for 87 companies out of a total of 128 companies in the whole sample, returns are predictable. This implies that overall the market is inefficient. Furthermore, the diagnostic tests show that the hypothesis that the error term is a white noise process is rejected for most of the companies. What is interesting from this set of results is that the proportion of companies that are efficiently priced seems to have increased from 1988 to 1993. The individual groups' results are as follows:

Sample	inefficient companies	total number of companies in the group
Sample 1	40 (83%)	48
Sample 2	4 (100%)	4
Sample 3	20 (47%)	42
Sample 4	14 (66%)	21
Sample 5	9 (69%)	13

Thus, while 83% of the companies listed in 1988 where inefficient only 47% of the companies listed in 1990 deemed to be inefficient. Therefore, it is quite possible that the changes in regulation had a positive impact on the pricing of these securities.

Table (5.2b) shows that the introduction of a non-linear term leads to the error term having white noise properties for almost all companies (for 85% of the companies) in all sample periods. However, either coefficient (α_l) or (α_n) or both are statistically significant for most companies.

Sample	inefficient companies	total number of companies in the group
Sample 1	47 (98%)	48
Sample 2	4 (100%)	4
Sample 3	20 (47%)	42
Sample 4	14 (66%)	21
Sample 5	9 (69%)	13

The evidence presented here again imply predictability and inefficiency.

TABLE 5.3a

Sample period I

RANDOM WALK TEST WITHOUT NON-LINEARITIES FOR UNADJUSTED RETURNS

$$R_{it} = \alpha_{i0} + \sum_{j=1}^{5} \alpha_{ij} R_{it-j} + \alpha_{i6} R_{it-1}^{2} + \alpha_{i7} R_{it-1}^{3} + \varepsilon_{it}$$

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.044* (3.04)	-0.044* (-2.33)	0.544	0.015	0.756
2	0.002* (2.40)	0.029 (0.14)	0.025	0.225	1.507
3	0.004* (3.50)	0.038 (1.02)	1.559	1.850	1.689
4	0.005* (4.51)	-0.028* (-2.38)	12.360*	20.398*	0.590
5	0.004* (3.60)	0.011 (0.20)	0.922	2.506	1.460
6	0.002* (2.30)	-0.128 (-1.38)	10.513*	7.862*	2.095
7	0.004* (3.44)	-0.035 (-1.92)	20.583*	20.941*	1.480
8	0.004* (3.39)	-0.039* (-1.98)	16.214*	20.737*	1.570
9	0.003* (3.20)	0.104 (1.10)	1.975	2.959	2.903
10	0.002* (2.40)	0.181* (3.62)	5.552*	5.951*	1.374
11	0.004* (3.16)	-0.075* (-3.70)	9.204*	10.373*	1.134
12	0.002* (2.04)	0.009 (0.64)	10.146*	0.935	0.829

Table 5.3a

Sample period I

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
13	0.004 (1.95)	0.297* (5.39)	0.002	0.035	1.080
14	0.002 (1.96)	0.013* (6.23)	9.042*	4.258*	0.590
15	0.003* (2.49)	0.039[a] (1.68)	7.167*	2.227	0.945
16	0.002 (1.00)	0.725* (2.43)	7.335*	9.971*	0.474
17	-0.001 (-0.55)	-0.053 (-1.94)	11.548*	4.585*	1.101
18	0.004* (4.32)	-0.016 (-0.78)	1.302	0.E-3	1.127
19	0.004* (2.05)	0.106* (3.02)	18.045*	14.314*	1.389
20	0.004* (4.10)	0.053 (0.64)	10.863*	15.773*	1.834
21	0.003* (2.61)	0.025 (1.11)	9.749*	2.076	2.618
22	0.001 (1.40)	0.144 (0.94)	5.689*	5.343*	0.614
23	0.004* (2.51)	0.017 (0.79)	1.865	0.056	1.541
24	0.003* (2.80)	0.089* (2.08)	3.424	5.579*	1.584
25	0.003* (2.21)	0.053* (2.80)	3.159	3.321	0.959
26	0.003* (2.50)	0.395* (2.69)	5.786*	12.642*	0.909
27	0.004* (2.05)	0.139 (1.96)	45.529*	36.451*	1.176

Table 5.3a

Sample period I

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
28	0.003	0.167	2.401	0.520	0.949
	(1.55)	(0.89)			
29	0.003	0.311	3.267	2.720	1.655
	(1.40)	(1.81)			
30	0.003*	0.069*	0.855	0.222	0.642
	(2.53)	(3.16)			
31	0.004*	-0.048*	7.076*	2.361	0.754
	(2.60)	(-2.40)			
32	0.003*	0.312	12.430*	11.520*	0.002
	(3.20)	(0.43)			
33	0.003*	0.041*	7.065*	3.141	2.062
	(2.54)	(2.05)			
34	0.004*	-0.067*	5.822*	5.782*	1.220
	(3.07)	(-3.66)			
35	0.002	-0.013	19.998*	0.018	0.402
	(1.86)	(-0.79)			
36	0.002*	0.253*	9.394[8]	3.353	0.652
	(2.30)	(3.05)			
37	0.003*	-0.023	14.288*	1.031	1.599
	(2.22)	(-1.05)			
38	0.004*	0.528	0.216	0.012	1.057
	(3.70)	(1.87)			
39	0.003*	0.178*	27.378*	26.981*	1.454
	(3.00)	(1.98)			
40	0.002*	0.467*	0.327	5.148*	1.504
	(2.30)	(3.00)			
41	0.002	0.361	0.281	0.857	1.974
	(1.00)	(1.11)			
42	0.002	0.041	4.132*	2.329	1.694
	(1.54)	(1.85)			

Table 5.3a

Sample period I

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
43	0.003*	0.031	4.163*	3.918*	1.093
	(2.50)	(1.33)			
44	0.004*	0.015	6.639*	6.850*	1.852
	(3.50)	(0.47)			
45	0.004*	0.065*	2.088	1.890	2.355
	(3.31)	(3.14)			
46	0.003*	-0.033	17.348*	17.984*	0.928
	(2.48)	(-1.64)			
47	0.002*	0.038*	4.138*	8.085*	1.878
	(2.15)	(2.05)			
48	0.001	0.107*	0.006	3.587	1.255
	(0.82)	(3.80)			

Table 5.3a

Sample period II

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.E-3	-0.084*	9.605*	10.165*	1.299
	(0.34)	(-4.64)			
2	-0.E-3	-0.065*	3.641	6.233*	0.872
	(-0.22)	(-2.24)			
3	0.E-4	-0.146*	9.748*	12.320*	2.726
	(0.02)	(-5.03)			
4	-0.E-4	-0.070*	1.820	0.809	1.858
	(-0.03)	(-2.68)			

Table 5.3a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.003* (2.04)	0.010 (0.31)	3.739	1.105	0.934
2	0.032* (2.53)	0.076* (2.27)	0.043	1.621	0.577
3	0.003* (2.22)	0.032 (1.06)	2.216	4.804*	1.821
4	0.003 (1.79)	0.008 (0.25)	0.239	0.005	0.631
5	0.003 (1.83)	-0.019 (-0.91)	6.054*	2.468	1.192
6	0.005* (1.99)	-0.071 (-1.58)	1.147	4.778*	0.672
7	0.003* (2.11)	-0.032 (-1.03)	2.585	5.066*	1.102
8	0.E-3 (0.05)	-0.039* (-2.06)	4.408*	9.671[8]	0.404
9	0.007* (3.64)	0.042 (1.42)	0.E-3	0.003	0.772
10	0.004* (2.32)	-0.062* (-8.90)	9.752*	0.952	0.455
11	0.005* (2.63)	0.004 (0.16)	0.180	0.187	0.564
12	0.005* (3.19)	0.020 (0.88)	2.706	3.490	1.076
13	0.004* (2.79)	0.020 (0.82)	0.141	0.034	1.043
14	0.007* (3.81)	0.026 (1.02)	8.921*	10.318*	0.830
15	0.003 (1.81)	0.008 (0.26)	2.388	4.910*	0.587

Table 5.3a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
16	0.003* (2.27)	0.064 (1.95)	0.020	0.153	1.953
17	0.001 (0.68)	-0.037 (-1.51)	9.875*	7.457*	1.827
18	0.006* (3.20)	0.036 (1.20)	2.938	1.683	0.716
19	0.002 (1.24)	0.025 (0.70)	0.082	2.650	0.601
20	0.003 (1.48)	-0.045 (-1.85)	2.600	4.771*	0.500
21	0.005* (2.94)	0.182 (1.06)	2.868	3.490	0.570
22	0.005* (2.52)	-0.030 (-1.00)	0.233	0.E-3	0.784
23	0.004* (2.56)	-0.069* (-2.60)	10.527*	0.732	1.031
24	0.002 (1.16)	-0.021 (-0.58)	0.184	2.452	0.949
25	0.005* (2.84)	-0.042 (-1.27)	2.529	3.328	0.637
26	0.003 (1.68)	0.036 (1.02)	0.191	2.123	1.441
27	0.006* (2.98)	-0.008 (-0.28)	0.274	0.381	0.811
28	0.004* (2.54)	0.041 (1.63)	3.269	7.993*	0.906
29	0.002 (0.95)	0.039 (1.12)	0.065	0.378	0.674
30	0.003 (1.52)	0.048 (1.30)	3.096	7.092*	50.683*

Table 5.3a

Sample period III

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
31	0.002 (1.00)	0.032 (0.87)	0.278	0.803	0.816
32	0.005* (2.21)	-0.056* (-2.05)	9.726*	9.116*	0.838
33	0.004* (3.42)	-0.009 (0.27)	1.253	2.149	1.015
34	-0.E-3 (-0.09)	-0.097* (-5.88)	0.771	0.011	0.516
35	0.004 (1.56)	0.105* (3.17)	2.347	0.023	1.218
36	0.004 (1.94)	-0.064* (-2.60)	2.671	4.578*	0.466
37	0.006* (3.24)	0.024 (0.75)	0.161	0.258	1.701
38	0.005* (3.07)	-0.032 (-1.17)	0.924	0.789	1.277
39	0.004* (2.85)	0.040 (1.34)	0.565	0.288	1.052
40	0.006* (2.63)	0.033 (0.80)	1.743	8.720*	0.775
41	0.004* (2.24)	-0.006 (-0.20)	0.380	2.051	0.618
42	0.004* (2.22)	-0.013 (-0.36)	0.095	1.541	0.599

Table 5.3a

Sample period IV

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.010* (6.71)	-0.042* (-6.31)	9.296*	8.463*	0.428
2	0.E-3 (0.06)	-0.022 (-1.86)	4.089*	0.890	0.427
3	0.004 (1.86)	-0.043 (-1.66)	17.240*	15.199*	0.523
4	0.006* (2.27)	-0.088* (-3.63)	3.523	4.138*	0.385
5	0.012* (4.99)	-0.056 (-1.89)	11.926*	9.811*	0.386
6	0.008* (4.03)	0.105* (3.23)	1.662	3.670	0.700
7	0.002 (1.33)	-0.096* (-4.33)	6.782*	5.358*	0.281
8	0.004* (2.19)	0.032* (2.02)	0.117	1.358	0.326
9	0.004* (2.07)	0.003 (0.10)	5.672*	5.375*	0.507
10	0.003 (1.68)	0.073 (1.58)	0.646	5.460*	0.168
11	0.006* (2.97)	-0.068* (-2.43)	2.597	1.683	0.966
12	0.007* (2.99)	0.012 (0.26)	4.753*	0.374	0.513
13	0.004* (2.95)	-0.093* (-2.54)	1.452	9.468*	0.493
14	0.008* (3.66)	-0.036 (-1.28)	3.730	0.511	0.590
15	0.003 (1.10)	-0.014 (-0.41)	12.083*	8.749*	0.880

Table 5.3a

Sample period IV

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
16	0.007*	-0.004	2.204	0.970	1.171
	(4.12)	(-0.17)			
17	0.E-3	-0.004	7.249*	0.004	0.030
	(0.06)	(-0.08)			
18	0.006*	-0.122*	0.127	0.313	0.831
	(3.05)	(-3.30)			
19	0.004	0.028	4.475*	9.161*	0.673
	(1.74)	(0.82)			
20	-0.002	-0.041	4.084*	6.813*	1.452
	(-1.18)	(-0.99)			
21	0.005*	0.064	0.496	4.559*	1.202
	(2.42)	(1.84)			

Table 5.3a

Sample period V

No	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.004 (1.32)	0.032 (0.67)	0.170	0.014	0.382
2	0.008* (3.46)	-0.118* (-2.49)	1.387	2.976	2.746
3	0.005* (2.12)	0.158* (2.00)	3.842*	2.308	0.077
4	0.006* (2.35)	0.087 (1.61)	3.082	8.890*	0.632
5	0.008* (2.05)	0.083 (1.21)	1.082	0.001	0.304
6	-0.001 (-0.57)	0.049 (1.23)	0.975	1.854	0.593
7	0.006* (3.41)	-0.034 (-0.84)	1.709	2.359	0.431
8	0.015* (4.91)	-0.077 (-0.37)	1.098	1.973	0.882
9	0.005* (2.73)	0.219* (4.79)	0.506	6.879*	2.653
10	-0.033 (-0.66)	-0.183* (-3.03)	0.311	0.355	0.546
11	0.005 (1.84)	0.019* (9.15)	4.587*	1.953	0.362
12	0.004* (2.16)	-0.059 (-1.66)	7.183*	0.256	0.392
13	0.E-3 (0.18)	0.125 (1.78)	4.757*	0.138	0.141

Table 5.3b

Sample period I

RANDOM WALK TEST WITH NON-LINEARITIES FOR ADJUSTED

RETURNS

$$R_{it} = \alpha_{i0} + \sum_{j=1}^{5} \alpha_{ij} R_{it-j} + \alpha_{i6} R_{it-1}^{2} + \alpha_{i7} R_{it-1}^{3} + \varepsilon_{it}$$

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.003* (2.77)	0.079* (3.00)	0.087 (0.99)	0.103	0.286	0.751
2	0.003* (1.99)	-0.099 (-0.35)	-0.022 (-0.14)	0.011	0.695	1.507
3	0.003* (3.07)	0.008 (0.33)	0.055 (1.35)	0.035	0.163	1.690
4	0.005* (4.07)	0.062* (2.69)	0.040* (4.53)	0.135	1.632	0.593
5	0.004* (2.76)	0.7E-3 (0.03)	0.007 (0.03)	5.903*	4.724*	1.452
6	0.003* (2.16)	0.047 (1.95)	-0.408* (-1.98)	1.815	0.352	2.115
7	0.002 (1.73)	0.050* (2.04)	0.598* (4.38)	2.109	0.070	1.454
8	0.003[8] (2.69)	0.020 (0.82)	0.176* (3.92)	0.421	3.136	1.569
9	0.004* (2.79)	-0.084* (-2.03)	5.271 (1.62)	0.147	1.592	2.838
10	0.002 (1.81)	0.065* (2.63)	0.066* (2.44)	0.047	1.206	1.368
11	0.004* (2.93)	-0.021 (-0.86)	0.143* (3.78)	0.118	1.122	1.368
12	0.001 (1.36)	0.076* (3.08)	0.283* (4.03)	0.047	0.762	0.825

Table 5.3b

Sample period I

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
13	0.004*	-0.026	0.332	2.132	1.185	1.061
	(2.43)	(-0.99)	(1.54)			
14	0.002	0.174*	0.180*	0.009	1.344	0.595
	(1.46)	(7.04)	(3.28)			
15	0.003*	0.076*	0.170*	0.749	0.547	0.921
	(2.01)	(2.81)	(2.64)			
16	0.003	0.022	0.250*	0.017	0.8E-3	0.501
	(1.43)	(0.62)	(3.17)			
17	-0.002	0.020	0.326*	0.651	4.956*	1.212
	(-1.13)	(0.64)	(4.06)			
18	0.001	0.007	0.717*	3.955*	1.868	1.063
	(1.12)	(0.28)	(2.77)			
19	0.004*	0.060*	0.127*	3.519	2.153	1.389
	(3.32)	(2.55)	(3.78)			
20	0.004*	0.063*	0.181*	0.096	1.692	1.843
	(3.19)	(2.59)	(4.00)			
21	0.002	0.067*	0.368*	0.489	0.531	2.524
	(1.71)	(2.61)	(3.29)			
22	0.001	0.039	0.053*	0.803	2.551	0.622
	(0.88)	(1.51)	(3.53)			
23	0.003*	0.045	-0.111*	0.342	0.104	1.509
	(2.36)	(1.71)	(-1.85)			
24	0.002	0.020	0.313*	0.036	2.085	1.522
	(1.62)	(0.79)	(2.36)			
25	0.002*	0.084*	0.057	0.388	1.934	0.948
	(1.99)	(3.28)	(1.79)			
26	0.002	0.064*	0.472*	0.778	0.165	0.898
	(1.29)	(2.43)	(3.56)			
27	0.002*	0.107*	0.475*	1.117	2.528	1.334
	(2.01)	(4.58)	(4.67)			

Table 5.3b

Sample period I

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
28	0.001	0.028	0.681*	3.532	3.600	0.914
	(0.91)	(1.06)	(2.50)			
29	0.003*	-0.025	-0.055	1.805	0.711	1.661
	(2.14)	(-0.94)	(-1.31)			
30	0.002*	0.082*	0.097*	0.003	0.067	0.638
	(2.30)	(3.44)	(4.67)			
31	0.003*	-0.009	0.071*	1.896	2.978	0.777
	(2.27)	(-0.37)	(2.52)			
32	0.003*	0.087*	0.156*	0.764	0.645	1.986
	(2.10)	(3.35)	(3.40)			
33	0.002*	0.067*	0.131*	2.323	0.006	2.050
	(2.11)	(2.85)	(2.10)			
34	0.004*	-0.033	-0.042	2.871	1.857	1.290
	(2.98)	(-1.41)	(-1.93)			
35	0.1E-3	0.048	0.866*	14.031*	2.383	0.382
	(0.09)	(1.84)	(3.02)			
36	0.001	0.050*	0.437*	0.503	3.347	0.636
	(0.85)	(2.02)	(3.79)			
37	0.002	0.035	0.269*	1.211	0.736	1.608
	(1.46)	(1.33)	(3.97)			
38	0.004*	0.033	0.005	1.104	3.082	1.056
	(2.07)	(0.97)	(0.11)			
39	0.002	0.095*	0.189*	0.3E-3	1.111	1.413
	(1.64)	(3.62)	(5.15)			
40	0.7E-3	0.053	0.549*	2.142	1.500	1.513
	(0.28)	(1.49)	(2.26)			
41	0.003	0.005	-0.038	0.222	0.772	1.974
	(1.15)	(0.14)	(-0.27)			
42	0.001	0.083*	0.196*	1.511	0.1E-3	1.673
	(0.98)	(3.18)	(3.07)			

Table 5.3b

Sample period I

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
43	0.002	0.059*	0.297*	1.879	4.280*	1.064
	(1.69)	(2.34)	(2.99)			
44	0.003*	0.022	0.149*	1.687	0.036	2.042
	(2.45)	(0.92)	(2.80)			
45	0.002	0.071*	0.612*	0.500	0.624	2.290
	(1.83)	(2.76)	(2.20)			
46	0.001	0.042	0.567*	1.573	1.193	0.952
	(0.96)	(1.65)	(3.34)			
47	0.004*	0.051*	-0.061	0.783	0.695	1.911
	(3.71)	(2.02)	(-0.85)			
48	-0.002	0.072*	1.061*	0.211	0.056	1.265
	(-0.93)	(2.23)	(3.15)			

Table 5.3b

Sample period II

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.9E-4	-0.016	0.076*	0.273	7.129*	1.266
	(0.06)	(-0.55)	(3.18)			
2	-0.002	-0.033	0.312*	0.537	0.273	0.923
	(-0.85)	(-1.02)	(2.50)			
3	-0.002	-0.082*	0.403	1.991	2.822	4.290*
	(-0.74)	(-2.31)	(1.90)			
4	-0.7E-3	-0.059	0.125	0.792	0.150	1.878
	(-0.41)	(-1.93)	(0.49)			

Table 5.3b

Sample period III

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.002	0.026	0.465*	0.579	0.639	0.937
	(1.26)	(0.80)	(2.11)			
2	0.003*	0.049	1.163	2.581	2.221	0.612
	(2.63)	(1.27)	(1.44)			
3	0.002	0.048	0.466*	0.018	0.254	1.802
	(1.41)	(1.54)	(2.18)			
4	0.003	0.001	0.050	0.102	1.199	0.632
	(1.81)	(0.03)	(0.39)			
5	0.001	0.042	0.453*	1.234	4.246*	1.158
	(0.96)	(1.30)	(2.84)			
6	0.004	-0.035	-0.056	0.309	1.454	0.681
	(1.89)	(-1.01)	(-1.85)			
7	0.001	0.002	1.219*	3.258	0.192	1.035
	(0.66)	(0.05)	(2.59)			
8	0.002	0.084*	0.078*	1.326	1.056	0.671
	(0.87)	(2.57)	(4.29)			
9	0.007*	0.041	-0.004	0.035	1.329	0.773
	(3.57)	(1.18)	(-0.05)			
10	0.003	0.004	0.173*	3.407	1.880	0.449
	(1.80)	(0.13)	(2.97)			
11	0.005*	0.014	0.102*	0.167	0.573	0.563
	(2.58)	(0.37)	(1.99)			
12	0.004*	0.066*	0.102	0.038	0.655	1.066
	(2.80)	(2.04)	(1.97)			
13	0.003	-0.020	0.956*	1.487	0.014	1.027
	(1.70)	(-0.54)	(2.03)			
14	0.006*	0.102*	0.139*	0.067	0.227	0.802
	(3.20)	(2.95)	(3.22)			
15	0.003	0.047	0.214*	3.220	0.241	0.589
	(1.34)	(1.33)	(2.21)			

Table 5.3b

Sample period III

No	α_0	α_l	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
16	0.002	0.034	0.984*	0.397	0.053	1.863
	(1.02)	(0.78)	(2.14)			
17	-0.001	0.021	0.701*	1.346	0.005	1.749
	(-0.66)	(0.61)	(3.84)			
18	0.005*	0.076*	-0.247*	0.016	3.656	0.722
	(3.03)	(2.11)	(-1.99)			
19	0.002	0.084	-0.985	0.996	1.438	0.606
	(1.30)	(1.66)	(-1.83)			
20	0.003	0.022	0.058*	1.019	0.271	0.500
	(1.24)	(0.57)	(2.18)			
21	0.004*	0.045	0.201	1.435	3.237	0.622
	(2.61)	(1.34)	(1.78)			
22	0.005*	-0.035	0.031	1.216	0.313	0.782
	(2.52)	(-0.94)	(0.21)			
23	0.002	-0.004	0.679*	0.208	0.025	1.060
	(1.25)	(-0.10)	(2.58)			
24	0.002	-0.035	1.595*	1.808	2.768	0.816
	(1.17)	(-0.71)	(4.15)			
25	0.004*	-0.019	0.268	0.122	0.001	0.660
	(2.27)	(-0.55)	(1.82)			
26	0.003	0.046	-0.830	0.249	2.009	1.444
	(1.64)	(0.88)	(-2.50)			
27	0.006*	0.005	0.038	2.197	0.866	0.810
	(2.81)	(0.15)	(0.61)			
28	0.004*	0.003	0.114*	0.567	0.015	0.940
	(2.32)	(0.09)	(2.83)			
29	0.002	0.037	-0.041*	0.438	0.616	0.700
	(0.97)	(1.02)	(-2.01)			
30	-0.3E-3	0.030	1.340*	0.017	1.213	3.738
	(-0.16)	(0.81)	(2.67)			

Table 5.3b

Sample period III

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
31	0.002	0.144*	-0.396*	2.853	0.447	0.809
	(0.89)	(2.46)	(-2.15)			
32	0.004	0.016	0.148*	1.981	0.437	0.855
	(1.66)	(0.45)	(3.03)			
33	0.003	-0.008	1.193*	0.425	1.030	0.938
	(1.91)	(-0.22)	(2.39)			
34	-0.002	-0.115*	0.373	2.163	0.457	0.514
	(-0.65)	(-3.12)	(1.25)			
35	-0.6E-3	0.064	1.053*	0.015	0.168	1.262
	(-0.22)	(1.68)	(2.80)			
36	0.003	-0.014	-0.038	0.213	1.616	0.474
	(1.81)	(-0.39)	(-1.87)			
37	0.004*	-0.009	1.552	3.252	0.410	1.664
	(2.33)	(0.26)	(1.74)			
38	0.003	-0.073*	1.638*	1.256	2.691	1.239
	(1.78)	(2.15)	(2.89)			
39	0.002	0.008	3.607*	0.474	0.910	0.980
	(0.96)	(0.19)	(2.73)			
40	0.002	0.005	1.442*	1.675	0.041	0.382
	(0.76)	(0.13)	(2.96)			
41	0.004	0.013	0.141	1.253	0.585	0.613
	(1.88)	(0.39)	(1.43)			
42	0.002	-0.065	3.793*	0.419	1.448	0.577
	(0.87)	(-1.57)	(2.46)			

Table 5.3b

Sample period IV

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.009* (6.09)	0.045 (1.49)	0.016* (2.96)	1.369	0.028	0.437
2	0.008* (4.49)	0.072* (1.98)	0.024* (2.21)	0.005	0.021	0.420
3	0.004 (1.53)	0.070 (1.91)	-0.261* (-4.47)	2.123	0.221	0.553
4	0.005* (2.08)	-0.022 (-0.53)	-0.026 (-1.93)	0.283	2.262	0.394
5	0.011* (4.68)	0.036 (0.92)	0.150* (3.30)	2.897	1.369	0.525
6	0.008* (3.66)	0.133* (3.09)	0.107 (0.98)	0.442	4.711*	0.673
7	0.5E-4 (0.03)	-0.044 (-1.18)	1.154* (2.79)	2.725	2.596	0.358
8	0.004* (2.18)	0.033 (1.06)	-0.2E-8 (-0.04)	0.208	1.884	0.325
9	0.003 (1.44)	0.039 (1.01)	0.333* (2.32)	1.432	0.416	0.512
10	0.003* (1.69)	0.007 (0.07)	14.973 (1.28)	0.959	5.785*	17.066
11	0.006* (2.84)	-0.039 (-1.05)	-0.063 (-1.18)	1.357	1.078	0.973
12	0.007* (2.96)	0.098 (1.26)	-8.839 (-1.35)	3.063	1.520	0.417
13	0.004* (2.90)	-0.094* (-2.20)	0.010 (0.20)	4.817*	10.978*	0.493
14	0.007* (3.10)	0.009 (0.20)	0.107* (2.30)	2.978	0.152	0.641
15	0.8E-3 (0.40)	0.033 (0.90)	0.397* (3.00)	2.403	0.104	0.601

Table 5.3b

Sample period IV

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
16	0.006*	0.029	0.306	0.224	0.9E-4	1.159
	(3.30)	(0.81)	(1.20)			
17	0.4E-4	-0.111	16.423	0.991	2.652	3.160
	(0.02)	(-1.11)	(1.21)			
18	0.005*	-0.093*	0.078*	5.310*	7.780*	0.857
	(2.42)	(-2.34)	(2.47)			
19	0.003	0.075	-0.512*	0.506	0.114	0.664
	(1.56)	(1.84)	(-2.03)			
20	-0.002	0.042	-8.896	0.326	1.818	1.497
	(-1.10)	(0.65)	(-1.67)			
21	0.005*	0.065	0.035	0.422	7.995*	1.203
	(2.28)	(1.85)	(0.24)			

Table 5.3b

Sample period V

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1	0.004	0.035	0.020	1.404	0.211	0.380
	(1.25)	(0.64)	(0.12)			
2	0.4E-3	0.034	0.170	2.068	0.739	0.840
	(0.20)	(0.37)	(0.23)			
3	0.004	0.085	1.712	1.581	4.165*	0.420
	(1.60)	(0.93)	(1.51)			
4	0.008*	-0.011	-0.834*	0.481	0.207	0.703
	(3.13)	(-0.18)	(-2.10)			
5	0.008*	-0.064	12.125	0.227	2.609	0.339
	(2.17)	(-0.53)	(1.48)			
6	0.8E-3	0.046	-1.113	0.365	1.645	0.595
	(0.31)	(0.74)	(-1.75)			

Table 5.3b

Sample period V

No	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
7	0.005*	0.028	0.313	0.788	0.532	0.436
	(2.82)	(0.55)	(1.10)			
8	0.014*	-0.002	0.101	1.168	2.055	0.887
	(4.31)	(-0.03)	(1.10)			
9	0.004*	0.054	19.590*	1.024	4.707*	2.155
	(2.46)	(0.69)	(2.60)			
10	-0.004	-0.187*	0.105	0.230	0.065	0.552
	(-0.74)	(-3.03)	(0.34)			
11	0.004	0.095	-0.004	3.744	0.7E-3	0.382
	(1.63)	(1.74)	(-1.39)			
12	0.002	0.009	0.489*	0.427	0.104	0.415
	(1.41)	(0.22)	(3.69)			
13	-0.7E-3	0.126	0.481	4.076*	0.023	0.227
	(-0.18)	(1.79)	(0.68)			

Notes: See notes on table (5.2a)

Tables (5.3a) and (5.3b) show the results for returns corrected for the impact of thin trading. The adjustment to returns to take account of thin trading appears to have removed the apparent predictability for most of the companies shown in table (5.2a). Specifically, 60% of the companies under investigation seem to be efficiently priced as compared to 32% in table (5.2a). This set of results seems to point out that the length of trading is an important factor that contributes to the efficient pricing of securities. Almost 65% of the companies trading for more than 2 years seem to be efficient. Furthermore, most diagnostic tests seem to allow acceptance of the hypothesis that the residuals follow a white noise process. Hence, the results suggest that the random walk model is accepted and the market on average is informationally efficient.

Sample	inefficient companies	total number of companies in the group
Sample 1	19 (40%)	48
Sample 2	4 (100%)	4
Sample 3	10 (24%)	42
Sample 4	12 (57%)	21
Sample 5	7 (54%)	13

However, the inclusion of a non-linear term as shown in table (5.3b) leads to a rather different conclusion. With the introduction of non-linearities for almost 70% of all companies the hypothesis of no predictability is rejected at the 5% level, while the error term seems to appear white noise. As mentioned before if the underlying process generating returns comes from a non-linear system which looks like a random walk then the use of a linear model may wrongly lead to the acceptance or rejection of the hypothesis. Again the results seem to indicate that companies listed after the changes in regulation are more likely to be efficient. However, to examine this issue further the same investigation is carried out for the market index.

Sample	inefficient companies	total number of companies in the group
Sample 1	40 (83%)	48
Sample 2	4 (100%)	4
Sample 3	30 (71%)	42
Sample 4	12 (57%)	21
Sample 5	4 (31%)	13

B. MARKET INDEX ANALYSIS

TABLE 5.4a

RANDOM WALK MODEL WITHOUT NON-LINEARITIES FOR

UNCORRECTED RETURNS FOR THE ISE INDEX

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \varepsilon_t$$

α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
0.002* (2.91)	0.261* (10.39)	8.338*	0.034	0.072

TABLE 5.4b

RANDOM WALK MODEL WITH NON-LINEARITIES FOR UNCORRECTED

RETURNS FOR THE ISE INDEX

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_n R_{t-1}^n + \varepsilon_t$$

α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
0.002* (2.88)	0.367* (9.70)	-28.717* (-3.74)	0.6E-4	0.373	0.939

Notes: See notes on table (5.2a)

Tables (5.4a) and (5.4b) show the results of the random walk test carried out for the period 1988 to 1993 using equation (5.2) for market returns unadjusted for thin trading. Table (5.4a) presents results excluding the non-linear term, while table (5.4b) presents results when the non-linear term has been included. Coefficient (α_1) in table (5.4a) is statistically significant at the 5% level which implies predictability in returns, and thus inefficiency. Furthermore, the diagnostic tests show that the hypothesis that the error term is a white noise process is rejected. Specifically, the series is found to be serially correlated.[2]

Table (5.4b) shows that the introduction of a non-linear term leads to the error term having white noise properties. However, both coefficients (α_1) and (α_n) are statistically significant[3]. This again implies predictability and inefficiency.

TABLE 5.5a

RANDOM WALK MODELS WITHOUT NON-LINEARITIES FOR

CORRECTED RETURNS

$$R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \varepsilon_t$$

α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
0.002 (1.67)	-0.9E-4 (-0.004)	5.771*	2.277	1.455

TABLE 5.5b

RANDOM WALK MODELS WITH NON-LINEARITIES FOR CORRECTED RETURNS

$$R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \alpha_n R_{t-1}^{n(adj)} + \varepsilon_t$$

α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
0.002 (1.69)	0.105* (2.97)	-14.309* (-4.15)	0.722	2.247	1.035

Notes: (See table 5.2a)

Tables (5.5a) and (5.5b) show the results for returns corrected for the impact of thin trading.The adjustment to returns to take account of thin trading appears to have removed the apparent predictability shown in table (5.5a). Furthermore, all the diagnostic tests allow acceptance of the hypothesis that the residuals follow a white noise process[4]. Hence, the results suggest that the random walk model is accepted and the market is informationally efficient. However, the inclusion of a non-linear term as shown in table (5.5b) leads to a very different conclusion. In particular, with the introduction of a non-linear component both coefficients (α_1) and (α_n) are statistically significant, while the error term is still white noise. This seems to indicate predictability and inefficiency. As mentioned in section (5.1) if the underlying process generating returns comes from a non-linear system which looks like a random walk then the use of a linear model may wrongly lead to the acceptance or rejection of the hypothesis.

TABLE 5.6a

RANDOM WALK TEST ON A YEARLY BASIS WITHOUT NON-LINEARITIES FOR UNADJUSTED RETURNS

$$R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \varepsilon_t$$

YEAR	α_0	α_1	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1988	-0.001 (-0.58)	0.076 (1.20)	1.904	2.169	0.148
1989	0.007* (2.91)	0.110 (1.77)	3.724	17.043*	7.938*
1990	-0.002 (-0.61)	0.024 (0.38)	0.462	0.310	0.858
1991	-0.8E-3 (-0.28)	-0.099 (-1.60)	0.051	0.491	1.511
1992	-0.002 (-1.01)	-0.095 (-1.58)	0.360	0.305	0.008
1993	0.006* (2.78)	-0.111 (-1.73)	0.187	0.417	0.012

Notes: Table (5.2a)

Table (5.6a) shows the results on a yearly basis in the absence of non-linearities. The results shows that the coefficient (α_1) is insignificantly different from zero at the 5% level for all years, with most diagnostic tests indicating the error term is a white noise process. Thus there appears to be no predictability and the market appears to be efficient for all years. However, the introduction of non-linearities produces a very interesting set of results as shown in table (5.6b). In particular, the inclusion of a non-linear term makes coefficient (α_1) statistically significant for 1988, 1989 and 1990, with the non-linear term being significant for 1988 and 1990. However, for 1991 onwards we observe no predictability. Hence, it appears that the regulatory and institutional changes have brought about more volume of trading, more and better quality information and more and perhaps better informed investors. The result is that the market became efficient. Pre-1991 poor quality information, institutional restrictions on trading and possibly less well informed investors appear to have resulted in non-linear behaviour and inefficiency.

TABLE 5.6b

RANDOM WALK TEST ON A YEARLY BASIS WITH NON-LINEARITIES FOR ADJUSTED RETURNS

$$R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \alpha_n R_{t-1}^{n(adj)} + \varepsilon_t$$

YEAR	α_0	α_1	α_n	$\chi^2(1)^1$	$\chi^2(1)^2$	$\chi^2(1)^3$
1988	-0.6E-3 (-0.34)	0.425* (4.45)	-0.997* (-4.77)	0.801	0.075	0.360
1989	0.006* (2.45)	0.207* (2.05)	-15.975 (-1.39)	1.492	0.046	0.001
1990	-0.002 (-0.66)	0.183* (2.01)	1.195* (2.39)	0.017	0.404	0.309
1991	-0.7E-3 (-0.25)	-0.084 (-0.82)	-1.904 (-0.19)	0.094	0.488	1.202
1992	-0.003 (-1.21)	-0.083 (-1.29)	0.615 (0.57)	0.027	1.737	0.740
1993	0.007* (3.05)	-0.066 (-0.85)	-1.331 (-1.37)	0.063	0.376	0.050

Notes: See table (5.2a).

The main message from these results is that equity markets in general, and emerging markets in particular, become informationally efficient when the right institutional and regulatory framework is in place. Thus providing a regulatory framework which encourages participation in the market, removes institutional restrictions and ensures that high quality and reliable information is provided leads to markets being efficient.

5.5. CONCLUSION

This chapter investigates the issue of efficiency for Istanbul Stock Market. However, unlike most previous studies on emerging markets the chapter recognises the importance of taking into account the institutional features of the market when examining pricing efficiency. In particular, it recognises that the market may be characterised by non-linear behaviour, thin trading and market evolution through time. Conventional tests of market efficiency such as autocorrelation tests, spectral analysis and run tests are incapable of taking account of these features and as such may lead to inappropriate conclusions being reached about the efficiency or otherwise of an emerging market. In this chapter, we use an augmented logistic map model to test for efficiency, which collapses to the random walk model if the non-linear terms are found to be statistically insignificant. In addition, returns are adjusted for thin trading as suggested by Miller et al (1994) and the chapter demonstrates the potential impact of thin trading on tests of market efficiency. More importantly, however, efficiency is analysed on a yearly basis so that it is possible to determine how the evolution of the market, including changes in the regulatory framework and the ability of investors to evaluate information, impacts on the efficiency of the market. Through this investigation we are able to shed light on the important question of why markets are inefficient and what factors lead them to become efficient.

Using data from the Istanbul Stock Exchange from 1988 to 1993 the results show that up to 1990 the market was inefficient, but the inefficiency manifested itself through non-linear behaviour. It is likely that the non-linear behaviour is the result of the features of the market at this time. In particular, information was not reliable as companies did not have to audit their financial statements leading to a lag in information being impounded into prices; there were restrictions on the repatriation of capital which may have deterred foreign participation, thus, contributing to illiquidity and low volume of trading; and there were no restrictions on insider trading which will impact on the confidence and perceived riskiness of the market. The ISE went through a period of very considerable liberalisation and regulatory change from late 1989 to 1992 which directly addressed these shortcomings. The result of these changes improved participation considerably, increased the volume of trading and improved the reliability and timeliness of information. Unsurprisingly, the results show that from 1991 onwards the market is not characterised by predictability and is therefore informationally efficient. The implication of the research reported in this chapter is that informationally efficient emerging markets are brought about by improving liquidity, ensuring that investors have access to high quality and reliable information and minimising the institutional restrictions on trading. In addition, the evolution in the regulatory framework of, and knowledge and awareness of investors in, emerging markets may mean that they will initially be characterised by inefficiency, but over time will develop into efficient and effectively functioning markets which allocate resources efficiently.

ENDNOTES

[1] As Miller et al argue the effects of thin trading are more complex than is captured by this simple model. However, our objective is not to develop a model which precisely captures the impact of thin trading, but to recognise and take account of the problem in our empirical analysis.

[2] Standard errors for the coefficients in the table (5.2a) were obtained using the Newey-West heteroscedasticity and autocorrelation estimates of the variance-covariance matrix.

[3] Tests were carried out to determine whether the findings of non-linearities were the result of changes in volatility. A GARCH model was fitted to the data. However, the results were unaffected by this specification. As a further test to verify this finding, the residuals estimated from a GARCH process were regressed against non-linear components. This showed that the non-linear terms were significant which further suggests that the non-linearities were not due to volatility changes. The results are available on request.

[4] Serial correlation is significant at 10% level of significance.

VI. STOCK MARKET VOLATILITY, REGULATORY CHANGES AND COMPANY COST OF CAPITAL

6.1. INTRODUCTION

The previous chapter has shown that regulatory changes led to a faster impounding of information into prices. However, as Ross (1989) has shown an increase in the rate of impounding of information will lead to an increase in the level of stock market volatility, assuming there are no arbitrage opportunities. There is a widespread belief that increased volatility is undesirable. This view stems from the belief that increased volatility is the result of destabilising forces. However, even if increased volatility is the result of improvements in informational efficiency, it may still lead to an increase in the equity risk premium and, hence, the cost of capital to firms.

In this chapter, we address the following three important issues using data from the Istanbul Stock Exchange (ISE):

* have changes in the regulatory framework had an impact on the level of stock price volatility?,
* if there has been a change, is this due to information being

impounded into prices more rapidly or is it the result of destabilizing forces?,

* how have any changes in volatility impacted on the equity risk premium and what are the implications of such changes for the cost of equity capital to firms?.

As mentioned in previous chapters the ISE has undergone considerable regulatory change since the inception of trading in 1986. The developments and regulatory changes which have taken place in the ISE provide a valuable opportunity to examine the impact of such innovations on price volatility, the equity risk premium and company betas. The rest of the chapter is organised as follows. The next section discusses more fully theoretical considerations in relation to volatility, regulatory change and the cost of equity. Section (6.3) sets out the empirical design adopted in this chapter. Empirical results are presented and discussed in section (6.4) and section (6.5) provides a summary and concluding remarks.

6.2. ISSUES MARKET VOLATILITY, REGULATION AND THE COST OF CAPITAL

The view that volatility is undesirable is associated with the notion that speculators have a destabilizing impact on prices. Discussion of this issue dates back at least to the work of John Stuart Mill (1871) who argued that 'contrary to common opinion' the activities of speculators lead to fluctuations in prices being less extreme than they otherwise would be:

> " [T]he tendency of this operation [by speculators] is to equalise price, or at least to moderate its inequalities...Speculators, therefore, have a highly useful office in the economy of society" (Mill, 1871, pp.276-277).

While Mill is arguing that speculators do not destabilize prices, implicit in his comments is the view that volatility is undesirable. This general view that greater volatility is undesirable is also to be found in other discussions of the impact of speculators, even when there is disagreement about the issue of whether speculation stabilizes or destabilizes prices (see, for example, Marshall (1923), Kaldor (1960) and Friedman (1953)). This view of volatility as undesirable stems from a failure to recognise the relationship between information and volatility. For example, Marshall (1923) argued that it was in the interests of speculators to be well informed and that in pursuing their own interest they would bring good quality information to the market. However, rather than making a link between information and volatility Marshall argues in relation to speculators in futures that:

> " Their influence certainly tends to lessen the amplitude of price variations from place to place and from year to year." (Marshall, 1923, p.262).

Within the efficient markets literature there is a clear positive relationship between the arrival of good quality information and price volatility. In an efficient market prices respond in a rapid and unbiased manner to the arrival of new information. Thus, if the flow of information increases in an efficient market, then price movements will be more frequent and prices will be seen to be more volatile. This issue is addressed at the theoretical level by Ross (1989).

Ross assumes that an arbitrage free economy exists and proceeds to provide a condition under which the no arbitrage situation will be sustained. Firstly, he assumes that asset prices are a martingale which can be represented by the following differential equation

$$\frac{dp}{p} = \mu_p dt + \sigma_p dz_p \qquad (6.1)$$

where (p) is the asset price with mean (μ_p), standard deviation (σ_p) and z~N(0,1). Further, by assuming that prices are determined by a pricing standard, (q), as in an asset pricing framework for example, Ross (1989, p.5, theorem 1) demonstrates that expected returns will satisfy the following security market line expression

$$\mu - r = -cov(p,q) \tag{6.2}$$

where (r) is the risk free rate of interest. Ross also assumes that information evolves according to

$$\frac{ds}{s} = \mu_s dt + \sigma_s dz_s \tag{6.3}$$

By imposing a terminal condition that at some future point in time, call this (T), the asset price will be such that p(T) = s(T), the following pricing relationship holds

$$p(t) = se^{[\mu_s - r + cov(q,s)(T-t)]} \tag{6.4}$$

from which Ross derives the following differential equation

$$\frac{dp}{p} = \frac{ds}{s} - [\mu_s - r + cov(q,s)]dt \tag{6.5}$$

Substituting (6.1) and (6.3) into (6.5) yields

$$\mu_p dt + \sigma_p dz_p = [r - cov(q,s)]dt + \sigma_s dz_s \tag{6.6}$$

Using (6.2) in (6.6) and rearranging, we obtain

$$\sigma_p dz_p = \sigma_s dz_s \tag{6.7}$$

and therefore (Ross (1989, p.8, theorem 2))

$$\sigma_p = \sigma_s \tag{6.8}$$

(6.8) is Ross's condition for no arbitrage, and implies that the variance of price change will be equal to the rate (or variance) of information flow. The implication of this is that the volatility of the asset price will increase as the rate of information flow increases. If this is not the case, arbitrage opportunities will be available. Thus, any action which increases the flow of information, such as more stringent stock exchange disclosure requirements, should lead to an increase in the volatility of prices.

In addition, if information becomes more reliable (for example, due to more rigorous auditing requirements) then prices may become more volatile and news may have less persistence. If information is unreliable some investors may not respond instantaneously to news but rather they may delay their response until the information can be verified. Similarly, if investors are uncertain about the reliability of an item of news they may base their investment decisions on the activities of other investors who are perceived to have access to more reliable information. As such, news will have a more persistent effect than if all investors have faith in the news and respond to it instantaneously. Hence, regulatory changes which make information more reliable may be expected to increase price volatility, but reduce the persistence of news. By examining and comparing volatility and persistence in periods before and after regulatory changes, the impact of those changes on the efficient functioning of the market can be examined.

Even if increased volatility is the result of improvements in informational efficiency, it may still lead to increases in the equity risk premium and, hence, the cost of equity capital since investors may perceive any increased volatility resulting from regulatory changes as an increase in the riskiness of the market. Alternatively, regulatory change may lead to a reduction in uncertainty concerning the company, since more information may be available, information may be more reliable and there may be an increase in informed investors who have confidence in the functioning of the market. This reduction in uncertainty may manifest itself through a decrease in the equity risk premium. In order to fully understand the impact of regulatory change on the operation of financial markets and the real economy, it is necessary to examine the effect on the cost of equity capital as well as the effect on volatility and persistence. In this chapter we examine these issues within the context of an emerging market which has been characterised by considerable regulatory change since it commenced trading in 1986. The analysis of the ISE provides an experimental framework which allows investigation of the impact of regulation on these issues of central concern to both financial markets and the real economy. In this way important policy advice for the regulation of financial markets can be obtained.

6.3. METHODOLOGY

The empirical analysis seeks to examine the impact of market wide regulatory changes on three aspects. First, we wish to determine whether volatility has changed with changes in regulation. Second, if there has been a change, is this due to the more rapid impounding of information or is it the result of destabilizing forces? Third, we wish to determine the effect of regulatory changes on individual firms' cost of equity capital. In order to undertake this investigation data is required on the return on the market and the returns for individual firms. Emerging markets, as mentioned in chapter 5, are typically characterised by thin and nonsynchronous trading. For this reason, the returns series used in this chapter are corrected for thin trading using the methodology outlined in chapter 5.

6.3.1. MEASURING THE IMPACT OF REGULATION ON AGGREGATE STOCK MARKET VOLATILITY

In examining the impact of regulatory change on stock market volatility this chapter is concerned not only with the question of whether volatility has changed post-regulation, but also if it has changed, why has it changed? As such it is necessary to employ a technique which allows examination of the time varying nature of volatility. A natural way to capture the time varying nature is to model volatility as a GARCH process (Engle (1982), Bollerslev (1986), Engle and Bollerslev (1986)). The GARCH technique models the conditional volatility for lag lengths of order (p) and (q) as follows[1]

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i u_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \tag{6.9}$$

To address the first issue, we augment the conditional variance equation with a dummy variable, (D_r), taking the value of zero pre-regulatory change and one post-regulatory change. Thus equation (6.9) becomes:

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i u_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} + \gamma D_r \tag{6.10}$$

If the coefficient (γ) is statistically significant then changes in regulation have had an impact on price volatility. To address the second issue, the period under investigation is partitioned into two sub-periods relating to before and after major regulatory changes. GARCH models of the form (6.9) are estimated for both sub-periods, thereby allowing a comparison of the nature of volatility before and after regulatory change.

The advantage of the GARCH specification is that it allows for the separation of the effect of "new" news and "old" news. To illustrate, assume that the order of the GARCH model is (1,1) then (α_1) represents the impact of last period's news and (β_1) measures past periods' conditional variance (termed persistence). In terms of our empirical analysis, changes in the GARCH coefficients following regulatory reforms will indicate the effect of innovation on the volatility of the stock market and importantly will allow determination of whether changes in volatility result from an improved flow of information or from noise and feedback trading.

6.3.2. MEASURING THE IMPACT OF REGULATION ON THE COST OF CAPITAL

While the role of information is important for an effectively functioning stock market the real test of the imposition of regulation on the stock market is the effect this has on a firm's cost of equity capital. This constitutes the third part of our investigation. In order to examine the effect of changes in volatility brought about by regulatory reforms on the cost of equity capital, individual firm betas are examined using the traditional market model which relates a firm's measure of systematic risk to a market wide measure of risk

$$R_{it}^{*} = \gamma_0 + \beta_i R_{mt}^{*} + v_{it} \quad (6.11)$$

where (R_{it}^{*}) is the return on the ith stock, (R_{mt}^{*}) is the return on the market index, (γ_0) is a constant, (β_i) is the measure of systematic risk for the ith stock and (v_{it}) is a firm specific error term which measures unsystematic risk. The above equation is augmented with an interactive dummy variable as follows:

$$R_{it}^{*} = \gamma_0 + \beta_i R_{mt}^{*} + \rho_i(\delta \times R_{mt}^{*}) + e_{it} \quad (6.12)$$

where (δ_t) is a dummy variable which takes the value of zero before regulatory reforms and one after; and (ρ_i) measures the impact of regulatory change on the systematic risk of firm (i). If changes in regulation have reduced uncertainty and led to a lower required rate of return by investors and ultimately a lower cost of equity capital for the firm then (ρ_i) will be less than zero. Conversely, if regulatory change has an adverse impact on the risk of the firm then (ρ_i) will be greater than zero. The intermediate case is when regulatory changes have no effect on the firm's beta, in this case (ρ_i) will be equal to (0).

However, changes in firm betas do not necessarily fully capture the impact of regulatory changes on the cost of equity capital. It is quite possible that the above technique for measuring the effect of regulatory change can be distorted by changes in the overall market risk premium. In this case, the analysis of betas and (ρ) will make inferences regarding the equity cost of capital misleading. For example, assume that the beta falls but simultaneously the equity risk premium increases, the firm may not experience a fall in the cost of equity capital since the combined effect could well be different from the effect of the fall in the beta. Similarly, it is possible that the beta remains the same while there is a fall in the equity risk premium and a resultant fall in the cost of equity capital. Such a pattern would not be picked up by the analysis of beta alone. Therefore, in addition to examining the impact on individual firm betas, the effect of regulatory change on the equity market risk premium is investigated.

In this study we adopt the technique proposed by McElroy et al (1985) for estimating the equity market risk premium. This technique involves joint estimation of the betas and risk premium[2]. McElroy et al (1985) show that the pricing restrictions imposed by factor asset pricing models such as the CAPM and the APT can be written as a non-linear equation

$$R_{it} - R_f = \lambda\beta_i + \beta_i f_t + u_{it} \qquad (6.13)$$

where (R_{it}) is the return on asset (i) in time (t), (R_f) is the risk free rate, (β_i) is the sensitivity of asset (i) to the factor (f_t), (λ) is the risk premium associated with factor

(f_t) and (e_{it}) is a firm specific error term. In terms of the CAPM, (f_t) is replaced by the excess return on the market portfolio. By stacking the equations for each firm together a system of non-linear seemingly unrelated regressions (NLSUR) is obtained and under certain regularity conditions (see, McElroy et al (1985)) the estimates of the parameters exist. Using this framework we obtain estimates of the equity market risk premium prior to, and post, regulatory change.

6.4. DATA AND EMPIRICAL RESULTS

6.4.1. DATA

The data used in this chapter consists of daily closing prices for 23 companies listed on the ISE from January 1988 to December 1993. This represents the sample of companies whose stocks were traded continuously on the ISE throughout this period. The ISE Composite Index proxies for the market portfolio.

6.4.2. EMPIRICAL RESULTS

The maximum likelihood estimates for the conditional volatility, using a GARCH (1,1), of the Turkish stock index are reported in table (6.1). Panel A reports results for the whole period with a dummy variable to assess the impact of regulatory changes on the conditional volatility. The results indicate that regulatory changes have led to an increase in the conditional volatility.

TABLE 6.1

GARCH Models of Stock Market Volatility :

Whole Sample with my (Panel A), Pre-Regulatory Change (Panel B)[a],

Post-Regulatory Change (Panel C)[b]

Panel A

$$h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1} + \gamma d_{91}$$

Variable	Estimate	. Standard Error	T-Stat
α_0	0.0005	0.0000	6.39
α_1	0.3004	0.0310	9.67
β_1	0.6479	0.0261	24.8
γ	0.00004	0.00001	63.53

Panel B

$$h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}$$

Variable	Estimate	. Standard Error	T-Stat
α_0	0.0017	0.0000	32.4
α_1	0.0052	0.0023	2.23
β_1	1.0096	0.0022	47.7

Panel C

$$h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}$$

Variable	Estimate	. Standard Error	T-Stat
α_0	0.0000	0.0000	2.79
α_1	0.1150	0.0234	4.91
β_1	0.8316	0.0352	23.6

Notes: [a] The pre-regulatory change period dates from January 1988 to December 1990 which gives a sample size of 755 daily observations.

[b] The post-regulatory change period dates from January 1991 to December 1993 which gives a sample size of 741 daily observations.

The question that arises is to what extent is this increase in volatility due to information being impounded more quickly into prices or is it the result of destabilizing forces? In order to address this question we split the sample into two periods, one relating to pre- and the other to post-regulatory changes. GARCH models are then estimated for the two sub-periods thereby allowing a comparison of the nature of volatility before and after regulatory changes. Panel B reports the results for pre-regulatory changes and panel C reports the results for post-regulatory changes. These results provide strong evidence regarding the impact of changes in regulation on volatility. Panel B shows that before the onset of regulatory changes the GARCH coefficients are integrated ($\alpha_1+\beta_1 = 1$) indicating that a shock to the variance is permanent. Furthermore, the news coefficient (α_1) is very small indicating that volatility is driven more by old news than new news. However, post regulation the results panel C are markedly different, the coefficients are no longer integrated and the news coefficient has increased by a significant amount. This shows that conditional volatility is of a substantially different nature in the two periods. In particular, conditional volatility post-regulatory change is driven much more by news than past information and the persistence of "old" news. Overall, this part of the investigation strongly suggests that changes in regulation which required companies to have their financial statements audited by members of the Association of Accountants and Auditors have led to an increase in the quality of information which has impacted on volatility through reducing persistence and increasing the impact of news. While the volatility of the ISE appears to be driven more by news after the regulatory changes, the important question is to what extent has this increase in information had an impact on the cost of equity capital and hence the real economy?

To examine this issue we begin by estimating the extended market model given in equation (6.12). The results are reported in table (6.2) for our sample of 23 Turkish stocks. For sixteen of the firms regulatory change has a negative impact on the beta coefficient, out of which fourteen are statistically significant. Of the remaining seven firms, for only three is there a statistically significant positive impact on the firm's beta.

Table 6.2

Estimates of Individual Firm Betas and Effect of Regulatory Change on Beta

$$R_{it}^{*} = \gamma_{0} + \beta_{i} R_{mt}^{*} + \rho_{i} (\delta \times R_{mt}^{*}) + e_{it}$$

Firm No.	β_i	T-Stat	ρ_i	T-Stat
1.	0.9346	28.085	-0.1298	-2.901
2.	0.9607	23.709	-0.1795	-3.310
3.	0.9311	24.083	-0.1850	-3.538
4.	0.9811	27.986	-0.1578	-3.333
5.	0.9266	22.592	-0.0752	-1.370
6.	0.9987	22.781	-0.2671	-4.531
7.	0.7768	14.185	0.0438	0.5935
8.	1.1255	25.408	-0.3183	-5.372
9.	0.8429	23.082	-0.1669	-3.412
10.	0.9322	25.702	-0.1270	-2.595
11.	0.7277	20.062	-0.0127	-0.261
12.	0.9670	27.692	-0.1088	-2.356
13.	0.9130	26.224	-0.0791	-1.699
14.	0.9759	24.763	-0.0153	-0.288
15.	0.6769	16.066	0.2501	4.433
16.	0.8887	25.842	-0.1280	-2.756
17.	0.6940	17.115	0.0827	1.512
18.	0.8960	22.615	-0.0911	-1.716
19.	0.6779	13.949	0.1944	2.959
20.	0.9425	24.837	-0.0718	-1.409
21.	0.7312	16.795	0.0393	0.674
22.	0.8279	20.370	0.0741	1.359
23.	0.3066	8.984	0.1629	3.528

Overall, assuming that the equity market risk premium is constant before and after the regulatory change, innovations brought about by changes in regulation seem to have reduced the firms equity beta and hence the cost of equity capital. Interestingly, the companies which experience a decrease in the value of beta were those with the highest betas, whereas companies with a low beta value were characterized by an increase in beta following changes in regulation. This would seem to suggest that as information has increased and become more reliable and the volume of trading has increased[3] there has been a re-evaluation of the riskiness of individual companies. In the absence of reliable information it is reasonable to expect investors to allocate their funds in what they perceive to be "safe" assets. Conversely, investors require higher rates of return for investments in companies which provide little reliable information and hence are perceived to be more risky than they actually are. Thus, the absence of reliable and verifiable information leads to an inefficient allocation of resources in the economy. However, as investors become better informed about the financial and operating positions of the companies they more accurately perceive the riskiness of the companies and hence reallocate their funds accordingly. To summarize thus far, regulatory changes between 1989 and 1991 have led to an increase in stock market volatility which is a result of the faster impounding of information in prices. This in turn has changed investors' perceptions of individual firms' risk levels, with an overall reduction in the perceived level of risk. Hence there has been a reallocation of investment funds.

However, as noted earlier, examining the beta coefficients independently of the equity market risk premium is not sufficient to infer that the required rate of return of investors and hence the cost of equity capital has fallen. To examine whether the equity market risk premium has changed post-1991 we estimate (6.7) using actual returns adjusted for thin trading[4]. The data on adjusted returns for the twenty three stocks are stacked into a system and the coefficients in (6.7) are estimated using NLSUR. The results are reported in table (6.3). Panel A reports the equity market risk premium pre-regulatory change and Panel B post-regulatory change. These results confirm the broad findings of the effect of regulatory change on betas.

Table 6.3

NLSUR Estimates of the Equity Market Risk Premium :
(Panel A) Pre-Regulatory Change, (Panel B) Post-Regulatory Change

$$R_{it} - R_f = \lambda\beta_i + \beta_i f_t + u_{it}$$

Panel A

	Coefficient	Standard Error	T-Stat
Risk Prem.	0.00158	0.00083	1.91
Panel B			
Risk Prem.	0.00100	0.00051	1.98

The equity market risk premium is a third lower post-regulatory change than pre-regulatory change. This coupled with the reduction in betas clearly indicates that changes in regulation in the Turkish stock market has reduced the required rate of return of investors and hence, the cost of equity capital to firms. Even for those few firms which experienced a rise in beta, the extent of the fall in the equity market risk premium is greater than the rise in beta and hence the overall effect is a fall in the required rate of return.

6.5. CONCLUSION

Traditionally, innovations which bring about increases in stock market volatility are seen as undesirable. This view stems from the belief that volatility is a result of destabilizing forces such as noise and feedback trading and speculative forces which can lead to large swings of prices away from fundamental values. This higher volatility, it is believed, will result in an increase in the equity market risk premium and hence a higher cost of equity capital. Ultimately, this can provide a set of market prices that allocates resources in the economy in a sub-optimal way. While this issue is important for all economies, it is of particular significance to developing economies.

In this chapter, we address three issues relating to the impact of changes in stock market regulation. First, have changes in regulation impacted on the level of stock market volatility? Second, if so, is this the result of destabilizing forces or the improvement of the impounding of information on prices? Third, what are the implications of this for the changes in the cost of equity capital? Using data from the ISE we find that changes in the regulatory framework which result in more reliable information, increased participation, and higher volume of trading lead to an increase in stock market volatility. However, far from being undesirable, the increased volatility is the result of more rapid impounding of information. In addition, the availability of more reliable information has led investors to reassess the riskiness of individual firms and hence the rate of return required from holding these assets. Furthermore, the period post-regulatory change is associated with a lower equity market risk premium. In conclusion, it is demonstrated that measures which improve the confidence of investors in the stock market lead to a more informationally efficient market and an improvement in the allocation of resources in the economy.

ENDNOTES

[1] Most empirical studies have found that a GARCH (1,1) specification adequately captures the conditional volatility (see, inter alia, Bollerslev et al (1992)). The GARCH (1,1) model has the advantage of providing straightforward interpretation of the news and persistence coefficients.

[2] The traditional technique for estimating the equity market risk premium is that proposed by Fama and MacBeth (1973). Typically, researchers using this technique from portfolios to overcome the errors in variables problem inherent in the methodology (see, Blume and Friend (1973)). In our case, however, data limitations prevent us from adopting this approach.

[3] The volume of trade has increased from 7,031 lots in (1988) to 16.6 million in (1991) and further increased to 90 million in (1993). In addition, the number of trading members of the exchange rose from 47 in (1986) to 176 by the end of (1993).

[4] Ideally, we would estimate (6.7) in excess *return form*. However, there is no adequate and reliable data for Turkish interest rates over our sample period. Since the use of excess returns involves subtracting the risk free rate from both the individual stock and the market in (6.7) the only difference in using actual returns rather than excess returns is that the estimated coefficients will be larger in the case of actual returns. Furthermore, this part of our analysis is merely illustrative and not definitive. We are simply trying to establish the overall effect of changes in regulation on the equity market risk premium, that is, has it fallen or risen post-regulatory change.

VII. TECHNICAL ANALYSIS, TRADING VOLUME AND MARKET EFFICIENCY

7.1. INTRODUCTION

In spite of the fact that there is a widespread belief that stock markets are weak-form efficient and the evidence presented in chapter 5, technical analysis is a pervasive activity in such markets. In this chapter, we examine the extent to which this apparent paradox can be explained by expanding the assumed information set used by analysts to include the past sequence of volume in addition to the past sequence of prices. Using data from the Istanbul Stock Exchange the chapter demonstrates that for a number of companies in the sample returns appear to conform to the weak-form version of the efficient markets hypothesis. However, when returns are conditioned on past levels of volume, current returns on over half of these companies exhibit predictability. This is particularly true for companies which have low trading volumes.

As mentioned before in the thesis, Fama (1970, 1976) defines a market as being weak-form efficient if current prices fully reflect the information contained in past prices. The implication of this level of efficiency is that technical analysis of past stock prices has no value. In contrast, technical analysts base their activities on the belief that information contained in past prices is not fully incorporated in the current price. Such analysts believe that by examining the history of prices information can be gleaned on future price movements. In spite of the fact that there is a widespread belief that stock markets are weak-form efficient, technical analysis is a pervasive activity in such markets. This apparent paradoxical situation can be explained if adjustments to information are not immediate, such that market statistics, in particular statistics on trading volume, contain information not impounded in current prices. In such a situation the analysis of past price and volume data will provide information on future price movements. This will be especially true if, as suggested by Blume, Easley and O'Hara (1994), volume provides information about the quality of traders' information which cannot be obtained from price statistics. In this context, technical analysis can be viewed as part of the process by which traders learn about fundamentals. Thus, traders use data on volume to update their beliefs, with the results that volume statistics not only describe the market but also affect the market.

In a world characterised by investors who are homogeneously informed, technical analysis has no value (see, Brown and Jennings, 1989). However, Blume, Easley and O'Hara (1994) demonstrate that if investors have differing signals, technical analysis of price and volume will be worthwhile and will be of most value for less widely followed stocks. Thus, while current prices may be efficient in the sense that they contain all information implied by past prices, the use of non-price information in conjunction with past prices may enable traders to predict future price movements. This chapter investigates the issue of whether studying the joint dynamics of stock prices and trading volume can be used to predict future price movements more successfully than simply examining the unvaried dynamics of stock prices. This analysis is undertaken using data from an emerging market which is characterised by thin trading and differentially informed investors. The rest of the chapter is organised as follows. Section (7.2) briefly discusses some of the issues on market efficiency, volume and technical analysis. The data, methodology and results are presented in section (7.3) and section (7.4) provides a conclusion.

7.2. ISSUES IN VOLUME OF TRADING, MARKET EFFICIENCY AND TECHNICAL ANALYSIS

To recoup from earlier chapters, Fama (1976) defines capital markets as being efficient when the joint distribution of prices $f_m(P_{1t},.....P_{nt} \mid \Omega_{m,t-1})$ given the information set used by the market in the determination of security prices at time (t-1), is the same as the joint distribution of prices that would be obtained if all relevant information available at time (t-1) were utilised, $f(P_{1t}....P_{nt} \mid \Omega_{t-1})$. This is expressed mathematically as:

$$f_m(P_{1t},...,P_{nt}|\Omega_{m,t-1}) = f(P_{1t},...,P_{nt}|\Omega_{t-1}) \qquad (7.1)$$

The weak-form version of market efficiency defines (Ω_{t-1}) as being the previous history of prices. A market which is weak-form efficient will have incorporated all information contained in the historical sequence of prices into current prices and thus technical analysis of past prices provides no new information and consequently has no value.

However, technical analysis on other market variables, such as trading volume, which not only describe but also affect the market may be of value, even in a market which is weak-form efficient. This will be true in markets where equilibrium prices are not fully revealing and traders have differential information sets. In a situation where prices are not fully revealing for all market participants, some traders will not be able to use market prices to distinguish between news and noise. In contrast, if these (relatively uninformed) traders observe both prices and volume then they may be able to distinguish between the two types of signals coming to the market. Consider, for example, a situation where there are two groups of market participants: informed and uninformed. For the informed trader prices are fully revealing about the fundamental value of the asset. Thus technical analysis is not required by this group of traders. The uninformed market participants are unable to distinguish between noise and news on the basis of market prices. However, by observing the volume of trade which is taking place they gain insight into the fundamental value placed on assets by the informed traders. The key role which volume plays is that it enables the uninformed market participants to determine the quality of the information flowing to the market, i.e. is the information news or noise? Thus, volume increases the precision of the signal flowing to the uninformed participants[1].

Furthermore, the value of an asset can never be known with certainty, even to informed investors, because of the common error term. The lack of perfect revelation in current market statistics means that all traders face a learning problem in determining the underlying value of an asset. Since news arrives in every period, investigation of the sequence of prices and volume may provide information to traders, including those who are informed. Therefore, technical analysis of prices in conjunction with volume may be of value.

It is reasonable to assume that technical analysis of price and volume will be of most value for stocks for which there is relatively little information. Such stocks are associated with firms for which there is greater uncertainty about their future prospects and the quality of information is less precise. In addition, the information which is available may well be private information and the only way for the majority of investors to infer this information is by examining both prices and volume.

We begin our analysis by examining the role of volume and trade information in the standard rational expectations framework typically employed to investigate how market clearing prices reflect underlying information, and how agents, in turn, learn from prices.

In the standard approach (see, Grossman and Stiglitz, 1980) and following Blume, Easley and O'Hara (1994) a collection of agents, indexed by (i) = 1,...,I, trade a risky asset and a riskless asset in a single market. Both Brown and Jennings and Grundy and McNichols consider the limit case where the number of agents I is infinite. In this standard model, trades may occur at time (1) and at time (2). Here we consider only time (1) and so do not include time indices. At the end of trading, the riskless asset pays a known dividend of (1) and the risky asset pays a liquidating dividend given by the random variable (ψ). Traders begin with identical beliefs about the pay off (ψ) which are presented by a normal distribution N (ψ_o, $1/\rho_o$).

$$U(w_i) = -\exp[\ -w_i] \tag{7.2}$$

where (w_o) is agent (i)'s terminal wealth (we have fixed the coefficient of absolute risk aversion at one). Final period wealth depends on the agents' trading decisions and the assets' pay offs, and so can be written as ($w_o = d_i\ \psi + n_i$), where (d_i) is agent (i)'s demand for the risky asset and (n_i) is the number of units of the riskless asset that have a price normalized to one.

Before the start of period 1, and shown by Blume, Easley and O'Hara (1994) , each trader receives an endowment of (n_o) units of the riskless asset. Each trader also receives a private signal, (y_i), on the value of the risky asset which is given by

$$y_i = \psi + e_i \tag{7.3}$$

where the distribution of each (e_i) is $N(0,1/\rho)$. Because the signals' errors are assumed normally distributed with finite variances and are independent across traders, it follows that the average signal

$$\bar{y}=\sum_{i=1}^{I} y_i/I,$$

converges to (ψ) with probability 1 as the number of traders grows large.

In the Brown and Jennings framework, there is an exogenous supply of the random asset given by the random variable (X), with per capita supply X/I, denoted (x). As is the case with all random variables in the model, (x) is normally distributed and is independent of any private signals. Equilibrium, according to Blume, Easley and O'Hara (1994), requires that

$$x = \sum_{i=1}^{I} d_i/I$$

or simply that per capita demand equal per capita supply.

In rational expectations models of the form considered here, equilibrium involves a set of price and demand functions that satisfy the following properties. First, given their information sets (H^i) agents conjecture the equilibrium price function. Based on these price functions and an observation of the equilibrium price, traders determine their demands for the risky asset. In an equilibrium, these price conjectures will be correct and per capita demand will equal per capita supply.

According to Blume, Easley and O'Hara (1994), to construct such an equilibrium, suppose that each trader conjectures that the price of the risky asset, (p), is a linear function of aggregate information

$$(\bar{y})$$

and per capita supply (x):

$$p = \alpha\psi_o + \beta\bar{y} - yx \qquad (7.5)$$

Then, the posterior distribution of (ψ) given H^i = (y_i, p) is normal with mean (E) [ψ\H^i]. Trader (i)'s demand is then

$$d_i = \frac{E[\psi|H^i]-p}{Var[\psi|H^i]}. \qquad (7.6)$$

Using the equilibrium condition (7.4), Brown and Jennings then solve for the equilibrium price. They show that it is linear as conjectured and that the coefficient on (x) is not zero. Thus, prices are not revealing. This allows Brown and Jennings to demonstrate how a sequence of prices could provide information that a single price observation could not, and thus provides a role for technical analysis.

Now suppose that contemporaneous volume data is publicly available. Volume is typical defined as the number of shares of the risky asset that are traded. Since every trade involves a buyer and seller, volume could be calculated by simply adding up all buy orders or all sell orders. An equivalent approach in a Walrasian equilibrium is to sum the absolute value of traders' demands and divide by two.

If traders do know volume in the Brown and Jennings framework, then the role for technical analysis dissipates. What causes this to happen is that, if traders use the information conveyed by volume and their trading behaviour, there is a revealing equilibrium. Consequently, with all information revealed to traders, there is no benefit to considering the sequence of prices. To see why this occurs, suppose we let traders condition on per capita volume and the direction of their own trade (i.e., either a buy or sell). Their information set is now H' = (p, y_i, V, J) where (J) is an indicator variable denoting whether the trader buys or sells, and (per capita) volume is defined by

$$V = \frac{1}{2I}(\sum_{i=1}^{I} |d_i| + |X|).$$

Further, let traders conjecture that the equilibrium price function is given by (7.5) and that price and volume together will be revealing. In this case, each trader's demand function is given by

$$d_i = (\psi_o \rho_o + \bar{y} I \rho) - P(\rho_o + I\rho) \qquad (7.7.)$$

and the price function is given by

$$p = (\psi_o \rho_o + \bar{y} I \rho - \chi)/(\rho_o + I\rho). \qquad (7.8)$$

To show that these equations describe an equilibrium, we need to show that the traders' conjectures are correct and that the market clears. First, note that in a revealing equilibrium, every trader will demand the same amount of the risky asset, i.e., ($d_i = d_j = d$) for all (i) and (j). So per capita volume will be

$$\frac{1}{2}(|d| + |\chi|).$$

Now market clearing yields (d=-x), so (V=|x|). Thus, each trader infers that (x=-V) if he is a buyer, i.e., (d_i>0), or (x=V) if he is a seller, i.e., (d^i<0). using the inferred value for (x) and the market price, (p), each traders inverts the price equation (7.8) to solve for

$(\bar{Y})$. Given by knowledge of

$\bar{y}$,

the optimal demand for any trader is given by (7.7). It is easy to check that the price given by (7.8) clears the market when demands are given by (7.7). Thus, traders have equal demands and their conjectures are correct. Once you know volume, therefore, you can infer the underlying supply uncertainty, prices are revealing, and technical analysis has no role.

Interestingly, the opposite conclusion arises from the Grundy-McNichols approach: volume is devoid of any useful information whatever. The reason for this lies in the uncertainty structure of their model. Unlike the random aggregate supply feature of the Brown and Jennings model, Grundy and McNichols introduce uncertainty by assuming that each of the I traders in the market receives a random endowment of the risky asset. These endowments, (x_i), are assumed independently and identically normally distributed *with mean* (μ_x) *and variance* ($\sigma^2_x I$). *In this model, some traders* receive negative quantities of the risky asset, some receive positive quantities, and trade presumably arises in part to rebalance portfolios.

To ensure that individual traders' endowments carry no information about per capita supply (x), Grundy and McNichols consider only the limit economy. In this economy, the variance of (x) is infinite and the Law of Large Numbers cannot be applied. Note that this assumption of the limit economy (infinite traders) is fundamental to their approach. If we consider the finite economy, then there is a finite variance and endowments must provide some information. Each trader also receives a private signal ($y_i = \psi + w + \varepsilon_i$) where ($\psi$) is the per unit pay off from the risky asset, (w) is a common error, and (ε_i) is an idiosyncratic error.

If we examine per capita volume in the limit economy we find the distracting feature that it is infinite. In particular, per capita trading volume is

$$\frac{1}{2}\lim_{I\to\infty}\frac{1}{I}\sum_{i=1}^{I} |d_i-\chi_i| \tag{7.9}$$

where (d_i) is trader (i)'s equilibrium demand and (x_i) is his endowment. Asymptotically, (d_i) and (x_i) are uncorrelated, but (x_i) has infinite variance. Thus, per capita volume is infinite and it provides no information about the value of the asset.

The fundamental difficulty is the underlying supply structure. Whether supply is introduced by an exogenous random supply or by random endowments, if volume reveals anything it reveals the supply. Consequently, if we allow traders to condition on contemporaneous volume, it is essentially allowing them to remove the "noise" in the pricing equation. With prices then depending only on private signals, the only known equilibrium is one in which price reveals the underlying information.

In this context, volume provides no useful information about any fundamental relating to the asset but rather is exogenously determined. It seems more reasonable to believe that the volume statistic should capture some endogenous aspect of the trading process not necessarily incorporated in prices. In particular, since volume arises from individual demands, it may be the case that volume reflects aspects of the information structure that traders might wish to know.

But a second difficulty arises in investing this role. This is the problem created by conditioning on contemporaneous information. Even if volume has some meaningful economic role, when traders use the information conveyed by contemporaneous volume, the only revealing equilibrium is the anomalous one in which volume actually has no information. To see why this is so, consider a Grossman-Stiglitz-style model without the modelling device of random endowments or random supply. Suppose that traders have common preferences and endowments and receive pay off-relevant signals. Now, suppose that there exists a revealing rational expectations equilibrium with conditioning on price and volume. In this equilibrium, traders have common information and they all choose the same trade. But the only such trade that is consistent with market clearing is no trade, and so regardless of the signals, volume is zero and carries no information. Alternatively, there could be nonrevealing equilibria in which traders condition on price and volume. However, as volume is a sum of absolute values it cannot be normally distributed. So although such an equilibrium might exist there seems to be no hope of constructing it, and hence no hope of using a contemporaneous data approach to study volume.

One way to avoid these difficulties and following Blume, Easley and O'Hara (1994) is to allow traders to condition on all information up to but not including the market statistic resulting from their desired trade. This approach, first suggested by Hellwig (1982), avoids the simultaneity problem noted above while retaining the ability to learn from market information. Blume and Easley (1984) use this approach to examine the information content of past market prices.

This approach, like the approach of conditioning on contemporaneous data, is an abstraction. Blume, Easley and O'Hara (1994) offer two justifications for it. First, traders who submit market orders do not know the price at which their order will execute until after the trade occurs. Even traders who use limit orders cannot condition their quantity perfectly on price unless they use incredibly and unrealistically complex orders. But unless traders know the price at which they will trade, and use the information the price contains in selecting their trade, the usual rational expectations approach is not valid. Hence, actual market settings are not consistent with contemporaneous conditioning requirements, but are compatible with the conditioning requirement considered by the authors. Second, asset markets such as the New York Stock Exchange are never in a Walrasian equilibrium: The market is a dynamic process in which continual adjustments occur. The fiction of a Walrasian equilibrium is itself an approximation to workings of the market. Whether this oversimplified description is best constructed with conditioning on past or contemporaneous data depends on how well each model serves its intended purpose.

Conditioning on predetermined rather than contemporaneous information has another advantage. If traders can condition on contemporaneous price information, they can also condition on the information contained in their own net trade. If we include his own net trade in each individual's information set the conventional equilibrium remains as an equilibrium. But there are others as well. Jordan (1983) has shown that with these information sets there always exists a revealing equilibrium. Furthermore, the revealing equilibrium is in a sense more natural as it is robust to the model specification (i.e., exponential utilities and normal distributions) whereas the conventional equilibrium is not robust. Analyses with conditioning on contemporaneous information thus finesse a delicate equilibrium selection problem which does not arise when traders use past information.

The Informational Content of Volume

Blume, Easley and O'Hara (1994) considered a repeated asset market in which agents can trade a risk-free and a risky asset. All trading takes place between the agents they we modeled; there is no exogenous supply of any asset. Each agent maximizes a negative exponential utility function of the form defined in equation (7.2). Using, Blume, Easley and O'Hara (1994) notation the asset's eventual value is given by the random variable (ψ), where (ψ) is normally distributed with mean (ψ_0) and variance ($1/\rho_0$). All traders initially have $N(\psi_0, 1/\rho_0)$ as their (common) prior on asset value. We make the usual assumption that all random variables in the model are independent.

Their interest is in the market statistics that arise in a competitive economy with a large number of traders. They developed these statistics by analysing a market with (N) traders and providing results as ($N \rightarrow \infty$). They refer to results obtained by taking the limit as the number of traders grows large as results for the large economy. Because traders are risk averse, movements in the price elicit portfolio rebalancing trades. In addition, trade may also occur in response to new information on the asset's true value. Each trader in their economy receives an informative signal in every period. They then divide the traders into two groups, with ($N_I = \mu N$) traders in group 1 and ($N_u = (1-\mu)N$) in group 2. The traders in each group receive signals from a common distribution, but there are different distributions for the two groups. Formally, each informed trader (i) in group 1, (i) = 1,..., N_I receives a signal at date (t) of

$$y_t^i = \psi + w_t + e_t^i$$

where (w_t) is a common error term distributed $N(0,1/\rho_w)$. The

$$e_t^i$$

represents and idiosyncratic error which is distributed $N(0,1/\rho^1{}_w)$. Similarly, trader (i) in group 2, (i) = N_I + 1,...,N, receives signal

$$y_t^i = \psi + w_t$$

where each $\varepsilon^i_t \sim N(0,1/\rho^2)$. They keep ($\rho^2$) fixed (and known) to reduce the complexity of the presentation.

The precision of group 1's signals (the $\rho^1{}_t$) are random variables. All parameters other that the ($\rho^1{}_t$)'s are known to all traders, but each ($\rho^1{}_t$) is known only to traders in group 1. This randomness in precision means that the "quality" of signals varies over time. Consequently, the underlying information structure is complex, in that both the level and quality of signals are unknown.

Each trader begins with zero endowment of the risky asset and some exogenous endowment, (N_0), of the riskless asset. For simplicity, they set the price of the riskless asset at one. As the utility function is negative exponential and the asset's eventual pay off has a normal distribution, it is well known that trader's demands for the risky asset will be independent of his wealth. They are interested in the Walrasian equilibrium price and volume of the risky asset. To calculate these equilibrium statistics, they need only find traders' demands for the risky asset and find the price that clears the market (i.e., makes excess demand zero).

To make it easier to write asset demands, they note assumed that for traders in group 1 each signal (y^i_t) is distributed N(ψ, $1/\rho^{s1}_t$) where $\rho^{s1}_t = \rho_w \rho^1_t / (\rho_w + \rho^1_t)$ (DeGroot 1970). Similarly, for traders in group 2 each (y^i_t) is distributed N(ψ, $1/\rho^{s2}$) where $\rho^{s2} = \rho_w \rho^2 / (\rho_w + \rho^2)$. Conditional on ($w_t$), each ($y^i_t$) is distributed N($\theta_t$, $1/\rho^1_t$) for traders in group 1 and N(θ_t, $1/\rho^2$) for traders in group 2, where ($\theta_t = \psi + w_t$). So by the Law of Large Numbers, the mean signal in each group,

$$\bar{y}^1_t \quad \text{and}$$

$$\bar{y}^2_t,$$

converges almost surely to (θ_t) as ($N \to \infty$). In the large economy, the mean signal is almost surely equal to the value plus the common error.

Initially, they consider a two-period version of the model, and then extended their results to the multi-period version. Following Brown and Jennings, they assumed that traders have myopic, or naive, demands so that each trader chooses his demand to maximize expected utility on a period by period basis. Denoting the price of the risky asset by (ρ_1), the first period demand for the risky asset for each trader (i) in group 1 is given by

$$\rho_o(\psi_o - p_1) + \rho_1^{s1}(y_1^i - p_1) \qquad \text{Group I} \quad \text{and by (7.10)}$$

$$\rho_o(\psi_o - p_1) + \rho^{s2}(y_1^i - p_1) \qquad \text{Group II} \qquad (7.11)$$

for each trader (i) in group 2. The equilibrium first-period price for an economy with (N) traders is then given by

$$p_1 = \frac{\rho_o \psi_o + \mu \rho_1^{s1} \bar{y}_1^1 + (1-\mu)\rho^{s2} \bar{y}_1^2}{\rho_o + \mu \rho_1^{s1} + (1-\mu)\rho^{s2}} \qquad (7.12)$$

By the Law of Large Numbers they show that in the large economy,

$$p_1 = \frac{\rho_o \psi_o + (\mu \rho_1^{s1} + (1-\mu)\rho^{s2})\theta_1}{\rho_o + \mu \rho_1^{s} + (1-\mu)\rho^{s2}}. \qquad (7.13)$$

An important property of this equilibrium price is that it is not revealing. Because traders in group 2 do not know ($\rho^s{}_1$) they cannot infer the signal (θ_1) from the equilibrium price. Hence, while prices reflect the aggregated value of the underlying signals, these traders do not have enough information to discern what this value is. The conditional distribution of (θ_1) given price is not normal, so any multi-period analysis with conditioning on price alone would be quite complex.

Traders in group 1, however, do know ($\rho^{s1}{}_1$) and (ρ^{s2}), so observing the equilibrium price tells them (θ_1), which is everything that can be known about the underlying asset.

Because traders in group 2 cannot recover (θ_1) from price alone, there is a reason for them to look at volume. The first period volume can be found by summing the absolute values of demands at price (p_1) and dividing by 2. As it will be easier to consider per capita volume, they defined this as

$$V_1 = \frac{1}{2}\frac{1}{N}\left(\sum_{i=1}^{Nt} \left|\rho_o(\psi_o - p_1) + \rho_1^{s1}(y_1^i - p_1)\right| + \sum_{i=N_I+1}^{N} \left|\rho_o(\psi_o - p_1) + \rho^{s2}(y_1^i - p_1)\right|\right) \tag{7.14}$$

Inspection of the volume definition in equation (7.14) reveals an immediate problem in analysing the properties of this market statistic. Because volume is based on absolute values of the demands defined in equations (7.10) and (7.11) its distribution is complicated. Unfortunately, while demands involve normally distributed random variables, volume per se cannot be normally distributed. Consequently, if we are to understand the market information conveyed by the volume statistic we must find a way to describe its statistical properties. Their proposition (1) provides this characterization of the volume statistic.

PROPOSITION (1): In the large economy, given (θ_1), per capita volume, (V_1), is given by

$$\frac{\mu}{2}[2\frac{\rho_1^{s1}}{(\rho_1^1)^{1/2}}\ \phi(\frac{\delta^1(\rho_1^1)^{1/2}}{\rho_1^{s1}})+\delta^1(\Phi(\frac{\delta^1(\rho_1^1)^{1/2}}{\rho_1^{s1}}) - \Phi(\frac{-\delta^1(\rho_1^1)^{1/2}}{\rho_1^{s1}}))]$$

$$+ \frac{(1-\mu)}{2}\ [\ 2\frac{\rho^{s2}}{(\rho^2)^{1/2}}\ \Phi\ (\frac{\delta^2(\rho^2)^{1/2}}{\rho^{s2}})$$

$$+ \delta^2(\Phi(\frac{\delta^2(\rho^2)^{1/2}}{\rho^{s2}}) - \Phi(\frac{-\delta^2(\rho^2)^{1/2}}{\rho^{s2}}))]$$

where (ϕ) is the standard normal density, (Φ) is the standard normal cumulative distribution function and

$$\delta^i = \rho_o\ (\psi_o - p_1) + \rho^{si}{}_1\ (\theta_1 - p_1), \qquad (i=1,2).$$

From Proposition (1) and equation (7.13), they stated the market statistics for price and volume in period 1. The question of interest is what information do these market statistics provide? Give that price alone is not revealing, traders cannot infer the noisy signal value (θ_1) from just the market price. However, if traders observe both the price and the volume, then potentially the volume information can provide sufficient additional information about (θ_1).

To determined the value of looking at volume, they argued, it is necessary to separate out the information generated by prices from that generated by volume. From the volume equation it is apparent that the volume statistic includes both (θ_1) and ($\rho^1{}_1$). Using the equilibrium price equation they show that

$$\theta_1 - p_1 = \frac{\rho_0(p_1 - \psi_0)}{(\mu \rho_1^{s1} + (1-\mu)\rho^{s2})}. \qquad (7.15)$$

Substituting for (θ_1) allowed them to write the volume statistic as

$$\frac{\mu}{2}\Big[\frac{\rho^{s1}}{(\rho_1^1)^1/2}\phi\Big(\frac{\hat{\delta}_1^1(\rho_1^1)^1/2}{\rho_1^{s1}}\Big) + \hat{\delta}_1^1\Big(\phi\Big(\frac{\hat{\delta}_1^1(\rho_1^1)^1/2}{\rho_1^{s1}}\Big) - \phi\Big(\frac{-\hat{\delta}_1^1(\rho_1^1)^1/2}{\rho_1^{s1}}\Big)\Big)\Big]$$

$$+ \frac{(1-\mu)}{2}\Big[\ 2\ \frac{\rho^{s2}}{(\rho^2)^{1/2}}\ \Phi\ \Big(\frac{\hat{\delta}_1^2(\rho^2)^{1/2}}{\rho^{s2}}\Big)$$

$$+ \delta_1^2(\Phi(\frac{\delta_1^2(\rho^2)^{1/2}}{\rho^{s2}}) - \Phi(\frac{-\delta_1^2(\rho^2)^{1/2}}{\rho^{s2}}))] \qquad (7.16)$$

where

$$\hat{\delta}_1^j = \rho_0(p_1 - \psi_0)(\frac{\rho_{1_{sj}}}{\mu\rho_1^{s1} + (1-\mu)\rho^{s2}} - 1), \qquad \text{for } j=1,2.$$

Using this expression for volume, they then investigated how volume is related to the underlying parameters in the market. They shown that given price volume conveys information about signal quality, ($\rho^1{}_1$), which can then be used in the price equation to make an inference about (θ_l).

Calculation shows that ($\rho^1{}_1$) $\in$ (ρ^2, ρ_w), then volume is increasing the precision of group 1's signal. To explain why this relationship occurs, and how traders use it, they focused on the simple case where (ρ^2=0) and ($\rho^1{}_1$>0). As a first property they shown that given a price (p_1), on volume is given by

$$\frac{\partial V_1}{\partial \rho_1^1} = \frac{\mu}{2}\phi(\hat{\delta}_1\frac{(\rho_w+\rho_1^1)}{\rho_w(\rho_1^1)^1/2})(\frac{\rho_w}{(\rho_1^1)^1/2})\frac{(\rho_w-\rho_1^1)}{(\rho_w+\rho_1^1)^1/2}. \qquad (7.17)$$

Thus, for any price, (p_1), per capita volume is increasing the precision, ($\rho^1{}_1$>ρ_w).

Given this role for volume, it now becomes apparent why observing price and volume together is more informative than observing price alone. A trader observing only a high price is unable to determine whether the price is high because of a high average signal (the θ_l) or an average signal with a high quality (ρ^1_l). In fact, he is left with a curve of (θ_l, ρ^1_l) that are consistent with the price. Volume picks up the quality of the signal in a way different from price.

The role of volume as a signal of the precision of beliefs means that the volume statistic provides information to the market that is not conveyed by price. Moreover, this information is related to information about the asset value and not to exogenous liquidity or supply shocks. This role for volume is remarkably similar to that claimed by proponents of technical analysis. For example, Pricing (1991) explains that "Most indicators [of market movements] are a statistical deviation from price data. Since volume indicators are totally independent of price, they offer a more objective view of the quality of the price trend." Thus, a trader watching only prices cannot learn as much as a trader watching both prices and volume and so faces an necessary penalty if he ignores the volume statistic.

PROPOSITION (2) : If $\rho^1_l \in (\rho^2, \rho_w)$then in the large economy (ρ^1_l, θ_l) is revealed by(p_l, V_l).

The proposition demonstrates that under our assumptions market statistics are revealing. Of course, the value of the asset is not known to anyone with certainty because of the common error term, and so it cannot be revealed by these market statistics. Nonetheless, by observing volume in conjunction with price traders can infer all the information available in the market. However, since traders do not know the true asset value (the ψ) it is not the case that the price and the volume reveal complete information. This lack of perfect revelation means that all traders face a learning problem in determining the value of the underlying asset. Since new signals arrive every period, it may be that the sequence of price and volume statistics provides information to all market participants. If this is the case, then technical analysis of past market statistics can be valuable. In the next section we begin our investigation of this role of technical analysis by extending our model to a multi-period setting.

7.3. DATA, METHODOLOGY AND EMPIRICAL RESULTS

7.3.1. DATA AND METHODOLOGY

This chapter uses daily closing prices for 63 stocks traded on the Istanbul Stock Exchange (ISE) in the period January 1988 to December 1993. As mentioned in previous chapters, it is well known that emerging markets are characterised by thin trading, therefore the price series used in this chapter is corrected for thin or infrequent trading using the Miller Muthuswamy and Whaley (1994) methodology outlined in chapter 5.

To investigate the issues identified in the previous section the following methodology is used. We begin by defining the return on asset (i) in time period (t) as (R_{it}) and assume that the return generating process is given by

$$R_{it} = f[\; R_{it-1} | \Omega_{it-1}] \qquad (7.18)$$

where (Ω_{it-1}) is the information set which contains the complete history of the sequence of returns observed up to and including time period (t-1). It is possible to write (7.18) as:

$$R_{it} = f[R_{it-1} \,|\, R_{it-2} .. R_{it-n}] \quad (7.19)$$

From this returns generating process we can obtain an empirically testable proposition relating to the weak-form of the EMH:

$$R_{it} = \alpha_0 + \sum_{j=1}^{n} \alpha_j R_{it-j} + \varepsilon_{it} \tag{7.20}$$

for weak-form efficiency to be accepted we require that (α_j=0) and that (ε_{it}) is a white noise process. A less restrictive version of efficiency is provided by the martingale process which places no distributional assumptions on (ε_{it}). In the initial stage of the investigation, equation (7.20) is estimated for all companies in the sample. For all those companies where we can not reject the hypothesis of weak-form efficiency, we extend the information set in (7.18) to include the sequence of volume:

$$R_{it} = f[\ R_{it-1} \mid V_{it-1} \ldots V_{it-n}, R_{it-2} \ldots R_{it-n}\ ] \tag{7.21}$$

If technical analysis on volume is useful in predicting weakly efficient returns, then conditioning past returns on past volume should reveal that when the information set is extended returns are predictable. In order to test the proposition that conditioning past returns on volume may lead to predictability in the returns series we estimate equation (7.20) using instrumental variables, where the instruments are those in (7.21).

7.3.2. EMPIRICAL RESULTS

Equation (7.20) was estimated for the 63 companies in our sample. For 40 of these companies we could not accept the null hypothesis of weak-form efficiency. Technical analysis of past prices would appear to be useful in predicting current prices for these companies. However, for the remaining 23 companies, where we accept the null of weak-form efficiency, an analysis solely of the history of prices is of no value. The results for these 23 companies are reported in table (7.1).[2]

Table 7.1

TECHNICAL ANALYSIS OF RETURNS

$$R_{it} = \alpha_0 + \alpha_1 R_{it-1} + \varepsilon_{it}$$

Company No.	α_0	α_1
1	0.0026	-0.0113
	(1.30)[b]	(0.47)
2	0.0036*	-0.0159
	(3.60)	(1.45)
3	0.0024	0.0199
	(1.20)	(1.66)
4	0.0036*	-0.0271
	(3.60)	(1.51)
5	0.0023*	-0.0078
	(2.30)	(0.39)
6	0.0044*	-0.0301
	(2.20)	(0.10)
7	0.0043*	-0.0391
	(2.15)	(0.55)
8	0.0049*	-0.0246
	(2.45)	(0.45)
9	0.0036*	-0.0321
	(3.60)	(0.51)
10	0.0020*	-0.0063
	(2.00)	(0.49)
11	0.0036*	0.0398
	(3.60)	(1.21)
12	0.0033*	0.0272
	(3.30)	(1.51)
13	0.0043*	0.0016
	(2.15)	(0.09)

Table 7.1

TECHNICAL ANALYSIS OF RETURNS

Company No.	α_0	α_1
14	0.0042*	0.0007
	(4.20)	(0.02)
15	0.0015	-0.0103
	(1.50)	(0.37)
16	0.0042*	0.0308
	(2.10)	(0.73)
17	0.0030*	-0.0004
	(3.00)	(0.01)
18	0.0030*	-0.0018
	(3.00)	(0.07)
19	0.0033	0.0260
	(1.65)	(1.37)
20	0.0032	0.0356
	(1.07)	(0.69)
21	0.0027	-0.0006
	(1.35)	(0.02)
22	0.0033	-0.0418
	(1.10)	(1.39)
23	0.0035*	-0.0181
	(3.50)	(0.45)

Notes: * Denotes Statistically Significant at the 5% level.

[a] Denotes a Mean Volume more than 50% below the Sample Average Volume and returns are predictable.

[b] Standard Errors are based on Newey-West Variance-covariance Matrix.

However, as discussed in the previous section, technical analysis of prices in conjunction with volume may be of value even in a weakly efficient market. To investigate whether this is the case, equation (7.20) is estimated for the 23 companies using instrumental variables[3].

Table 7.2

TECHNICAL ANALYSIS OF RETURNS CONDITIONED ON THE PAST

SEQUENCE OF VOLUME AND RETURNS

$$R_{it} = \alpha_0 + \alpha_1 R_{it-1} + \varepsilon_{it}$$

$$instruments : R_{it-2} \ldots R_{it-5} , V_{it-1} \ldots V_{it-5}$$

Company No.	α_0	α_1	Mean Volume
1	0.0024*	0.0285	41,692
	(2.40)[b]	(0.15)	
2	0.0035*	0.0378	588,204
	(3.50)	(1.02)	
3	0.0024*	0.1808*	736,910
	(2.40)	(3.62)	
4	0.0036*	0.0107	190,960
	(3.60)	(0.21)	
5	0.0023	-0.1281	939,508
	(2.30)	(1.38)	
6	0.0020	0.7252*	21,593[a]
	(1.00)	(2.43)	
7	0.0041*	0.1389*	553,286
	(2.05)	(1.96)	
8	0.0039*	0.2965*	79,719[a]
	(1.95)	(5.39)	
9	0.0032*	0.1038	89,026
	(3.20)	(1.10)	
10	0.0023*	0.2534*	59,535[a]
	(1.15)	(3.05)	
11	0.0025*	0.3953*	321,634
	(2.50)	(2.69)	
12	0.0032*	0.3121*	90,156[a]
	(3.20)	(0.43)	

Table 7.2

TECHNICAL ANALYSIS OF RETURNS CONDITIONED ON THE PAST

SEQUENCE OF VOLUME AND RETURNS

Company No.	α_0	α_1	Mean Volume
13	0.0041*	0.1056*	228,499
	(2.05)	(3.02)	
14	0.0041*	0.0526	127,356
	(4.10)	(0.64)	
15	0.0014	0.1435	104,253
	(1.40)	(0.94)	
16	0.0037*	0.5281*	54,914[a]
	(3.70)	(1.87)	
17	0.0030*	0.1784*	40,995[a]
	(3.00)	(1.98)	
18	0.0028*	0.0893*	289,843
	(2.80)	(2.08)	
19	0.0031*	0.1671	11,805
	(1.55)	(0.89)	
20	0.0023*	0.4674*	6,777[a]
	(2.30)	(3.00)	
21	0.0020	0.3614	9,226
	(1.00)	(1.11)	
22	0.0028*	0.3113*	53,723[a]
	(1.40)	(1.81)	
23	0.0035*	0.0146	105,193
	(3.50)	(0.47)	

Notes: * Denotes Statistically Significant at the 5% level.

[a] Denotes a Mean Volume more than 50% below the Sample Average Volume and returns are predictable.

[b] Standard Errors are based on Newey-West Variance-covariance Matrix.

The results from this are reported in table (7.2). In contrast to the results in table (7.1), when returns are conditioned on the past sequence of volume and returns, there is considerable evidence of predictability for just over half of the returns series. Therefore, volume, in conjunction with prices, would appear to have a useful role in terms of stock return predictability and consequently technical analysis will be of value.

The final column of table (7.2) reports mean volume for the 23 companies. Interestingly, predictability is more apparent (two-thirds of the cases) when the mean trading volume is more than 50% below the sample average. As explained above, the role of volume takes on increasing importance for companies which have a very low level of volume. This could be rationalised by the fact that there is relatively little information about these companies and hence greater uncertainty about their future prospects. Therefore, prices will not reflect all information regarding the company. Investors may use volume to improve the precision of the information relating to the fundamentals of these companies. Overall, it appears that volume has a useful role in predicting returns and this is particularly true for firms with low volume. Therefore, traders who undertake technical analysis on prices alone cannot and will not learn as much about the future pattern of returns as those who actively use volume in conjunction with returns.

7.4. CONCLUSION

In this chapter, following the arguments of Blume, Easley and O'Hara (1994), we have argued that technical analysis which incorporates data on volume as well as returns may provide evidence of return predictability that technical analysis on returns alone will not. The rationale for this is based on the premise that volume contains information regarding the quality and arrival of information which is not contained in prices.

Using daily closing price data on individual companies from the ISE, the chapter investigates the extent to which past volume, in conjunction with past returns, can predict returns from seemingly efficient prices. The results reveal that technical analysis on volume can aid the prediction of returns which can not be predicted by the analysis of past returns in isolation. This is particularly the case for stocks which have a low level of trading volume. The results presented here suggest that any assessment of the value of technical analysis must take account of the fact that market prices are not fully revealing. Volume has a useful role to play that is not captured in the past sequence of prices.

ENDNOTES

[1] The role of volume in aiding uninformed traders' understanding of the quality of information is discussed by Blume, Easley and O'Hara (1994).

[2] The results for the remaining companies for which efficiency could not be accepted are available on request.

[3] Augmented Dickey-Fuller tests were carried out on the volume series in order to ensure stationarity in the variables used in the analysis. In all cases the volume series were found to be stationary. These results are available on request.

VIII. CONCLUSIONS

This chapter briefly reviews the issues, methodologies used in this thesis and summarizes the results of the analysis. The specific results for issues considered are emphasised initially; comparisons are made with the existing literature. Policy implications of the results follow that discussion. Possible extensions of the present analysis are pointed out.

The thesis presents empirical evidence dealing with:

* The efficiency of the ISE using conventional tests;

* The efficiency of the ISE using a methodology that directly incorporates possible nonlinear behaviour, thin trading and institutional changes. These are typical features of emerging markets;

* The impact of regulatory changes undertaken by the ISE on the level of market volatility, the equity risk premium and the cost of capital to firms; and

* The conditions under which technical analysis is consistent with weakly efficient prices.

The rationale for investigating the above mentioned issues stems from the fact that capital markets play an important role in the economic development as they directly affect the mobilization of savings and the channelling of investments into productive enterprises. In other words, capital markets play a critical role in the efficient allocation of an economy's scarce resources. However, capital markets will contribute to economic development only if they function efficiently. The important question is what makes capital markets function efficiently. The answer to such a question has important policy implications not only for the Istanbul Stock Exchange but for emerging markets in general. The general conclusion from the thesis is that measures which improve: the confidence of investors in the stock market, the liquidity of the market, the quality and reliability of information and trading conditions by removing institutional restrictions on trading, lead to a more informational efficient market and an improvement in the allocation of resources in the economy.

As shown in chapter 2, the ISE was developed at a time when the Turkish economy went through a process of economic reform and liberalization. This process promoted economic growth and an economic environment conducive to the successful development of the stock exchange. The ISE went through considerable regulatory changes since its inception. The important question is to what extent such changes had an impact of the functioning of the ISE. This question was the subject matter of chapters 4, 5, 6 and 7.

In chapter 3, it is shown that the issue of efficiency in emerging markets has been widely investigated in recent years. Using conventional tests, such as autocorrelation tests, spectral analysis tests and run tests, the overall results are mixed.

The results presented in the chapter 4 seem to suggest that companies listed on the ISE are not efficiently priced. However, if the evidence on efficiency is to be reliable it is essential that the methodology adopted in statistical tests takes account of the institutional features and trading conditions of the market under investigation. The conventional tests of efficiency have been developed for testing markets which are characterised by high levels of liquidity, sophisticated investors with access to high quality and reliable information and few institutional impediments. Emerging markets, on the other hand, are typically characterised by low liquidity, thin trading, possibly less well informed investors with access to unreliable information and considerable volatility. Therefore, it is not all clear that the evidence of inefficiency presented in this chapter along with similar evidence from other studies, reflect genuine inefficiencies or a statistical illusion. In particular, while the evidence presented suggest that prices do not follow a random walk, thin trading and illiquidity may mean that trades cannot be carried out at the prices shown in data and therefore such observed inefficiencies cannot be exploited.

Chapter 5 seeks to re-examine the issue of efficiency when institutional features specific to the market under investigation are taken into account. In particular, unlike most previous studies on emerging markets the chapter recognises the importance of taking into account the institutional features of the market when examining pricing efficiency. The chapter recognises that the market may be characterised by non-linear behaviour, thin trading and market evolution through time. This study uses an augmented logistic map model to test for efficiency. In addition, returns are adjusted for thin trading. More importantly, however, efficiency is analysed on a year to year basis so that it is possible to determine how the evolution of the market impacts on the efficiency of the market. This investigation sheds light on the important question of why markets are inefficient and what factors lead them to become efficient. The results show that up to 1990 the market was inefficient, but inefficiency manifested itself through non-linear behaviour. However, from 1991 onwards the market became efficient. This change was brought about by measures taken by the exchange which led to improved liquidity, better quality of information and more educated investors along with the abolition of institutional restrictions on trading. The implications of this research is that the evolution in the regulatory framework of, and knowledge and awareness of investors in, emerging markets may mean that they will initially be characterised by inefficiency, but over time will develop into efficient and effectively functioning markets which allocate resources efficiently.

Chapters 4 and 5 have shown that regulatory changes of the ISE have brought about more volume of trading, more and better quality information, more educated investors and increased foreign participation. As a result of such changes the market became informational efficient. However, as Ross (1989) has shown an increase in the flow of information will lead to an increase in stock market volatility, in an arbitrage free world. The results of chapter 5 confirmed that regulatory changes increased the flow of information to the market and this led to a faster impounding of news into prices. Using Ross's argument, the increase in information flow should also have an impact on stock market volatility. However, even if increased volatility is the result of improvements in informational efficiency, it may still lead to an increase in the equity risk premium and, hence, higher level of individual firm's risk. Therefore, chapter 6 addressed three issues relating to the impact of changes in stock market regulation. In particular, the chapter firstly, examined whether changes in regulation impacted on the level of market volatility. Secondly, if there has been a change, is this due to information being impounded into prices more rapidly or is it the result of destabilising forces? (the answer to this question will also validate the findings of chapter 6). And thirdly, how have and changes in volatility impacted on the equity risk premium and the systematic risk of individual firms? Only by addressing these issues can inferences be drawn about the desirability or otherwise of innovations, such as changes in regulation, which bring about increases in volatility. The chapter has shown that changes in the regulatory framework led to an increased in stock market volatility. However, far from being undesirable, the increased volatility is the result of more rapid impounding of information. This in turn has changed investors' perceptions of individual firms' risk levels, with an overall reduction in the perceived level of risk. Hence there has been a reallocation of investment funds. Furthermore, the period post-regulatory change is associated with lower equity market risk premium and thus more efficient allocation of resources in the economy.

Having shown that regulatory changes of the ISE have led to more stock market volatility but to an informational efficient market and better allocation of resources, chapter 7, tried to identify the conditions under which weak-form efficiency can be reconciled with the activities of technical analysts. Theoretically it has been shown (see Blume, Easley and O'Hara (1994) that technical analysis on prices in conjunction with volume can aid the prediction of returns, if market prices are not fully revealing. This is based on the premise that volume contains information regarding the quality and arrival of information which is not contained in prices. The results presented in the chapter reveal that technical analysis on volume can aid the prediction of returns which cannot be predicted by the analysis of past returns in isolation. This finding suggest that technical analysts have a useful role to play even in markets which are characterised as informational efficient in the weak-form. Hence regulators need not worry about the activities of such traders.

The findings of this thesis will be of interest to international investors, stock market regulators, firms raising funds from stock markets and participants in emerging capital markets in general. The implication of the results presented in this thesis is that informational efficient emerging markets are brought about by improving liquidity, ensuring that investors have access to high quality and reliable information and minimising the institutional restrictions on trading. In addition, the evolution in the regulatory framework of, and knowledge and awareness of investors in, emerging markets may mean that they will initially be characterised by inefficiency, but over time will develop into informational efficient and effectively functioning markets which allocate resources efficiently. In addition, the results of this thesis have important implications, for emerging markets in general, in identifying the regulatory framework that will achieve efficient pricing and a reduction in the cost of equity capital to firms operating in the economy.

The research presented in this thesis could be extended in a number of ways. Firstly, it will be interesting to revisit all evidence of efficiency on emerging markets using the methodology adopted in the thesis. Secondly, the impact of financial innovation could be investigated using the methodology adopted in chapter 6 of the thesis. Finally, the evidence presented in chapter 7 could be confirmed by similar studies not only in emerging markets but also in well developed stock markets.

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