THE CHARACTERISTICS OF THE FINANCIAL SYSTEM OF DEVELOPING COUNTRIES: A STUDY OF THE THAI STOCK MARKET

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The Characteristics of the Financial System of Developing Countries:
A Study of the Thai Stock Market

by

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Statement

This thesis contains no material that has been accepted for the award of another degree, diploma or award at any University or other educational institution. To the best of my knowledge and belief, it contains no material previously published or written by another person or persons, except where due reference has been made.

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Abstract

This is an econometric study of development finance with an emphasis on empirical investigation of the financial market. Applying econometric methods to investigate empirical characteristics of the financial market and its components such as the stock market is an important area of study in finance, for academic, policy formulation and investment planning purposes.

There are substantial differences in the operation and characteristics of financial markets in developed and developing countries in terms of efficiency, stability, and the effectiveness in promoting economic development. There are different views about the performance and characteristics of the financial markets in both developed and developing economies. One view stresses the possibility for efficient operation of the market leading to efficient allocation of resources while the other highlights the real life evidence of market failure, weak-form EMH, market inefficiency, and existence of speculation, bubbles, anomalies, etc. This thesis undertakes an empirical study of the characteristics of a developing Asian financial market as a case study by applying the methods of financial econometrics to investigate whether and how these characteristics correspond with these views. Emphasis is placed on understanding those special characteristics of the financial system of developing countries which can cause financial market failures, and the existence of market imperfections such as asymmetric information, adverse selection and moral hazard.

The stock market plays a major role in a developing economy's financial system. While focusing on Thailand as a case study, this thesis provides both the researcher in quantitative financial economics and the stock market investor, with an understanding of the financial issues of a developing economy's stock market such as market efficiency, valuation, predictability, speculative bubbles, anomalies and volatilities.

Many contemporary techniques, approaches and models are used in this study and include simple multivariate regression, run test, ACF model, multi-factor model, exponential smoothing, Holt Winter's model, ARIMA, TSMM, Duration

Dependence Test, Weibull Hazard, time-series regression model with dummy variable, and GARCH type models. They are developed in order to examine the financial econometric issues of the Thai stock market. Data for the period of 1975 to 2001 was collected and used to undertake these econometric modeling exercises.

All the characteristics of the Stock Exchange of Thailand analysed in terms of market index prices and returns revealed evidence of inefficiency in the market (substantial empirical evidence supports the rejection of the hypothesis of the process being white noise in both the short-term and long-term analysis). The notion of existing market inefficiency is supported by the presence of rational bubbles, anomalies and volatility. Anomalies in the stock market (in the form of Monday and January effects) are evident during 1992-2001. The existence of speculative bubbles in the stock market was confirmed by the test models. In addition, volatility in the stock price was high in 1992, 1993, and the second and fourth years after the Thai financial crisis. High volatility in stock prices and returns was also found in January, February and December. Empirical estimation of stock valuation models reveals that many economic factors are the determinants of the value of Thai stock such as the interest rate, bonds yield, foreign exchange rates, price earning ratio, market capitalization, and the consumer price index.

The findings of this study provide justification for governments in developing countries adopting financial policies designed to evolve a developed, efficient financial market. Suggestions for further study in this area and directions for future research are included.

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Chapter 1

INTRODUCTION

1.1 Introduction

There has been a rapid growth in empirical studies of the characteristics of the financial system including the stock market. Many financial concepts, theories, econometric methods and models have been developed to undertake these studies for both developed and developing countries. However, the concepts, principles and models in finance are often derived from, and related to the special economic, institutional, and structural characteristics of developed economies. Therefore, the use of these financial theories and models in explaining the economic realities of nations should also be derived for and applied to developing countries. Myrdal (1981, p. 24) states the case against the uncritical application of traditional economic concepts and theories to developing and undeveloped nations as:

> *Economic theorists, more than any other social scientists, have long been disposed to arrive at general propositions and then postulate them as valid for every time, place and culture. There is a tendency in contemporary economic theory to follow this path to the extreme ... when theories and concepts designed to fit the special conditions of the Western world – and thus containing the implicit assumptions about social reality by which this fitting was accomplished are used in the study of underdeveloped countries, where they do not fit, the consequences are serious.*

This argument for using caution in the application of financial concepts, issues and models to developing countries is echoed in studies of the financial system and markets in developing countries by Fry (1995), McKinnon (1973, 1976), Shaw

(1973), Stigliz (1993), and Mishkin (1976), among others. They have argued that the financial markets in developing countries are different from those of developed countries in terms of market characteristics and operations. They are underdeveloped, fragile, unstable, inefficient, fragmented, imperfect and even non-existent in some sectors.

Currently, there are very few comprehensive analyses of the empirical characteristics of financial systems and issues in developing countries using a wide range of financial econometric methods. This thesis provides a critical study on the application of quantitative financial econometric methods to the investigation of the financial system of a developing economy and its specific issues such as market efficiency, valuation, predictability, speculative bubbles, anomalies and volatilities. Using the methods of financial econometrics, it undertakes an investigation of the empirical characteristics of the Thai financial system with a focus on the Thai stock market.

1.2 The Thai Financial System and the Stock Market

The financial sector plays a very crucial role in the Thai economy. For the past decades, many have viewed Thailand's economy as an "economic miracle". Thailand achieved and sustained high rates of economic growth, recording one of the highest average growth rates in the region. During the liberalization and globalization of the financial system, which took place between 1991 and 1993, foreign investors believed Thailand was lucrative investment destination. The Thai economy responded by opening up to the international economy with the removal of barriers to the inflow of foreign capital and investment. After the Asian financial and economic crisis in 1996, the Thai economy shifted dramatically from a high growth to a sharp decline in economic activity.

Undoubtedly, the stock market plays a major role in the Thai financial system. Massive investment in Thailand's stock market during 1992-1994 shifted the stock market index up from around 800 points to 1600 points. It is believed that stock market performance underlies the growth of the Thai economy, because its economic characteristics have a profound influence on the allocation of capital resources. However, it was the Asian economic crisis that spelt the end of the Thai economic miracle and the announcement of the devaluation of the Thai bath which followed greatly impacted upon the Thai stock market. By the end of 1997, the stock market index was down to just 370 points.

It is important to have an understanding of the stock market and other financial markets in Thailand to formulate effective economic and financial policies that foster Thailand's economic development. It is also essential to study Thailand's pre- and post-crisis stock market by utilizing quantitative financial econometric approaches that provide an in-depth understanding of the impact of the crisis on various aspects of the Thai stock market such as efficiency, valuation, predictability, speculative bubbles, anomalies and volatility and their possible effect on the economy's slowdown.

1.3 Financial System and Issues

The major set of issues and the characteristics of the financial system, which are commonly investigated in the existing literature include the efficiency of the market, valuation, predictability, volatility, bubbles, and speculative behaviour. Most of the studies on the above issues are based on a developed financial system. A developed financial system is characterised by "the efficiency and stability" of its payment system and derivatives (Hunt and Terry 2002).

According to Fry (1995), there are four major differences in the financial systems of developed and developing countries. First, financial markets in most developing countries are oligopolistic. Second, although detailed financial regulations exist in all nations, financial regulations are enforced less consistently and less effectively in the developing countries, and may effectively appear quite different in practice. Third, in most developing countries, deposits are converted into tangible assets as inflation hedges, whereas in developed countries' national saving rates may be unaffected by deposit rate saving. Finally, developing countries experience more of the driving forces of financial innovations, reforms and policy recommendations of the IMF and the World Bank than developed countries do.

Since the 1980s, there has been tremendous growth in financial markets on a global scale. The stock market is accepted as an important unit in financial systems and its performance is one of the determinants of the path of a national economy. Financial time-series analysis of the stock market index has therefore become a major area of financial research over the past decades.

The first step in financial economic research is to identify the characteristics of an ideal financial system conducive to efficient resource allocation, stability of the economy and rapid economic development, which provides socially acceptable financial outcomes. The next step is to test the underlying empirical characteristics of the financial system of a particular economy by using various quantitative methods including financial econometric methods.

Empirical research of the stock market using time-series analysis began as early as the 1930s with papers by Cowles (1933) and Working (1934). Cowles investigated the predictability of future price changes by market analysts and financial services, while Working focused on the characteristic of random changes in stock prices and commodities.

Kendall (1953) found little evidence that past changes in weekly series could be used in predicting financial prices. This finding underlines the basic concept of the efficient market hypothesis (EMH), where the stock prices should always fully reflect all relevant information and hence, no arbitrage opportunities exist. Therefore, the fundamental value under the expected discounted present value of future cash flow and dividends should always underline the expected value of the stock, i.e. as:

$$v_o = \sum_{n=1}^{\infty} \frac{(CF_n + D_n)}{(1+k)^n}$$

According to Kendall (1953), in addition to the EMH, prices cannot be predicted from past changes in a time-series of historical prices. Therefore, successive price changes should be independent. Samuelson (1965) modeled this property of prices as the random walk:

$$Y_t = Y_{t-1} + \varepsilon_t$$

This proposition reflects the evidence of the efficient market hypothesis. One way the random walk model can be tested is by examining the autocorrelation properties of price changes such as the Autocorrelation and Partial-Autocorrelation Functions. This approach has been developed by Box and Jenkins (1976) as the Autoregressive Integrated Moving Average (ARIMA) model.

Other approaches such as the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT) are conceptual cornerstones of modern capital market theory and stock valuations. Sharpe and Cooper (1972) and Black, Jensen and Scholes (1972) have provided evidence on the stability of betas and found that the relationship between strategy and return whilst not perfect, is a close one. According to Cuthbertson (1996), APT provides the baseline models of equilibrium asset returns.

There have been extensive studies such as Fama (1965), Cross (1973) and French (1980), which document long-term anomalies in the stock market that seem to contradict the efficient market hypothesis. In the late 1980s, West (1987) also found evidence of rational bubbles in stock prices and returns.

Recently, the study of the stock market has attracted growing attention by academics especially volatility modelling. The study of volatility in the stock market is important for portfolio management in developing countries where the financial system is different from those in developed countries since high volatility could mean greater uncertainty.

1.4 Characteristics of the Stock Market in Developing Countries

A considerable number of recent studies have discussed efficiency issues of stock markets in emerging economies. Takagi (2002), Stiglitz (1993) and Allen and Gale (1990) have discussions on market imperfections and failures in developing economies where asymmetric information, moral hazard and adverse selection are likely to be found, especially in the stock market.

According to Binswanger (1999), in emerging economies, particularly in most developing countries, financial liberalisation and reform caused a relaxation of the aggregate financial constraint. This relaxation allowed more money to flow into financial markets where it contributed to the emergence of speculative bubbles. But speculative bubbles themselves may be understood as a response to operative real and demand constraints. Consequently, the co-evolution between the real and financial sectors in the economy becomes more complex as speculative bubbles also influence the level of real economic activity. Characteristics of stock markets in developing countries with a high degree of speculation are:

- trading of highly standarized, homogenous, storable products with low transaction costs;
- frequent trading activities (sequential trading); and
- uncertainty in the direction and size of future price movements, which gives rise to divergent expectations of future price movements among market participants.

Despite strong evidence that the stock market is highly efficient, there have been scores of studies that have documented long-term historical anomalies in the stock market that seem to contradict the efficient market hypothesis. Among these are the studies of Fama (1965), Cross (1973), French (1980), Abraham and Ikenberry (1994), and Al-Loughani and Chappel (2001). Anomalies have been confirmed to exist in international markets and are particularly persuasive. These anomalies, which are not consistent with the existing EMH, concern the relationship between stock returns and variables, such as firm size and earnings-to-price ratios, and seasonal effects, such as January and turn-of-the-month.

There are a number of empirical studies on the Thai stock market. In Sukhamongkhon's dissertation (1994), a model is developed to test the long-run relationship between microeconomic factors on the Stock Exchange of Thailand (SET) by using the Arbitrage Pricing Theory (APT) model. Nuntajindawat (1995) provides the theoretical study and background of market efficiency for the SET, and Kiranand (1999) uses empirical studies to investigate Asian stock markets integration. Some recent publications on the Thai stock market are the studies of Wongbangpo and Sharma (2002), which investigate the role of select macroeconomic variables among five Asian countries, and Nasseh and Strauss (2000), which use a cointegration approach to identify the relationship between stock prices and domestic and international macroeconomic activity.

1.5 Financial Econometric Methods and Models

To study the characteristics of the financial system and stock market issues, a wide range of financial econometric methods are used (Moosa 2003a; Mills 1999; Campbell, Lo and Mackinlay 1997; Cuthbertson 1996). These methods include descriptive statistics such as mean, median, standard deviation, skewness and kurtosis. Other econometric methods include the ordinary least squares method and its extensions, the maximum likelihood method, the unit root test and the linear and non-linear volatility modelling process. Univariate time series econometrics models such as the moving average, exponential smoothing, Holt Winters and autoregressive integrated moving average model, are also used in the study. Applications of these methods provide useful information about the empirical characteristics of the financial system and stock market.

1.6 Limitations of Existing Literature

There are several limitations in the existing literature on the Thai stock market and the Thai financial system. They can be summarised as follows.

1. There is no previous econometric study of the Thai stock market that covers a comprehensive set of economic issues. Most of the literature investigates

separate issues in finance, while this thesis provides an econometric investigation into most of the key issues such as EMH, valuation, forecasting, rational bubbles, anomalies, and volatility.

2. In the existing literature, the valuation models are based on the concept of market equilibrium and the existence of a perfect market. In an economy like the Thai economy, these conditions do not exist and this thesis develops a suitable alternative approach for valuation.
3. The previous studies use only a small number of variables to estimate the long-run relationship of stock prices or returns which results in ineffective and inaccurate stock valuation and forecasting.
4. The models in some of the literature are not up to date and have been criticized in recent studies for using the unit root test in determining the level of rational bubbles. They have also been criticized for using discounted cash flow and CAPM in stock valuation. This thesis uses contemporary econometrics and financial models in all relevant issues.

1.7 Motivation and Objectives of the Study

The major objective of this thesis is to undertake an econometric study of the complete and comprehensive set of issues of a typical developing economy, especially the Thai stock market, to acquire a clear understanding of its empirical and behavioural characteristics as a part of the Thai financial system. As with most research on the stock market, the behaviour of the Thai stock markets at a macro level is expressed by returns on an index calculated for the period from May 1975 to December 2001.

This thesis develops a number of quantitative financial economic and econometric models in order to test market efficiency, stock valuation and return predictability, anomalies and volatility. There is no previous empirical study of the Thai stock market that covers these issues with a variety of contemporary quantitative financial economic and econometric models.

The objectives of this study are as follows.

1. To develop a comprehensive set of appropriate financial econometrics methodology and models to study various issues of the Thai stock market.
2. To develop new models and/or use the latest available models and approaches to test various issues and hypotheses about the Thai financial system and markets to investigate their characteristics.
3. To state briefly the policy and investment strategy implications of the findings of this study.

Both time-series univariate modeling and multivariate methods are developed to accomplish these objectives.

1.8 Contributions of this Research

The contributions of this research are the following.

1. This is the first study to consider the relevance and appropriateness of using financial econometric fundamentals, concepts, and models in the empirical analysis of a developing economy especially in the Thai financial system.
2. Empirical studies and analyses of the characteristics of the Thai stock market such as market efficiency, rational speculative bubbles, anomalies and volatility, are addressed in this thesis.
3. This is probably the first comprehensive research to develop a valuation model, especially for a developing economy, which addresses capital investment decisions and analyses the relationships between the stock price and macro, micro and international economic factors. This model overcomes the limitations of traditional valuation methods.

1.9 Methodologies and Sources of Data

1.9.1 Methodologies

In order to analyse empirical characteristics of the stock market, the application of financial econometric methods is essential. A wide range of financial econometric methods is carefully chosen ensuring that these methods are appropriate to the developing economy, and various issues of the Thai stock market are investigated. Most of the methodology and models described below have not previously been applied for studying the Thai financial and stock market. Methodologies adopted in this thesis to investigate various issues can be summarised as follow:

1. Descriptive statistics such as mean, median, standard deviation, skewness and kurtosis, are used to provide a general understanding of the statistical characteristics of the Thai stock market.
2. A nonparametric run test and autocorrelation function model are developed to test market efficient hypothesis.
3. A new stock valuation model, called the Thai Stock Multi-Factor Model (TSMM), is developed to overcome the existing limitations. Prior to the use of TSMM, a unit root test is employed to ensure the accuracy of the model by using augmented Dickey Fuller, augmented Engle Granger (for error correction model) and cointegration methods. Regression methods are used also to estimate the valuation model.
4. In forecasting techniques, a number of models are developed in order to project the next 50-month period forecast. These models are single exponential smoothing, double exponential smoothing, Holt Winter's model, ARIMA, and TSMM.
5. In detecting rational bubbles anomalies, two recent models of duration dependent testing, the Duration Dependent Test or Log Logistics (McQueen and Thorley 1994) and Weibull Hazard (Mudholkar et al. 1996) are used.
6. General time-series regression models are used to identify seasonal anomalies. The day of the week effect and January effect have been tested.
7. A new approach to identify volatility has been developed by using the autoregressive Heteroscedasticity process. Two linear GARCH and three non-linear GARCH models have been used in order to identify the volatility of the stock market at a particular time period.

1.9.2 Sources of Data and Computer Programs

Monthly data for closing SET index levels from the establishment of SET in 1975 until 2001 is used in this study. Daily data has been gathered during 1992 to 2001. The choice of time period corresponds to the pre- and post-crisis period (duration of 5 years for each period). These stock price indexes are obtained from Stock Exchange of Thailand CD-ROMs and SET Data Service Department; and the economic factors are gathered from the Bank of Thailand, United Nations (Research Department), and International Monetary Fund (International Financial Statistics CD-ROM). A number of statistical software packages such as Microsoft Excel, MiniTab and Stata have been used in this thesis.

1.10 Structure of the Thesis

Chapter 2 describes Thailand's financial system and stock market. It provides an introduction, and the motivation for the study. It overviews the financial system in Thailand which consists of five markets: a) the financial market, b) the money and capital market, c) the financial future market, d) the gold and commodities market, and e) the stock market. Later in the chapter, the Thai economic situation is also reviewed to give a broad understanding of the position Thailand took prior to and after the crisis.

Chapter 3 analyses the Stock Exchange of Thailand. It starts with the basic concept of returns and descriptive statistics of the SET index prices from the establishment of the market until December 2001. Later in the chapter, linear and non-linear forecasting techniques are applied to investigate the movements of stock price. These techniques are moving average, single exponential smoothing, double exponential smoothing, Holt Winter's model, and ARIMA.

Chapter 4 reviews the concept of the efficient market hypothesis where stock prices should always fully reflect the information available and price changes should be independent. The non-parametric run test and autocorrelation function model are used to identify the autocorrelation of the stock price.

Chapter 5 introduces a new valuation model called Thai Stock Multi-Factor Model (TSMM). This model overcomes the limitations of existing models such as the DCF, CAPM and APT. This model allows other macroeconomic factors in each market, previously discussed in Chapter 2, to have some influence on the stock price and hence reflects the long-run relationship between the stock price and these factors.

Chapter 6 uses the latest models to detect the rational speculative bubbles of the Thai stock market. McQueen and Thoreley's (1994) Duration Dependence Test and Mudholkar et al.'s (1996) Weibull Hazard Test are applied to identify the presence of bubbles. The chapter describes why these models are considered superior to the traditional unit-root test.

Chapter 7 uses time-series methods with dummy variables to find the existence of seasonal daily and monthly anomalies such as the day of the week effect and January effect. An analysis of the causes of anomalies is also provided.

Chapter 8 employs the Autoregressive Conditionally Heteroscedasticity (ARCH) and Generalized ARCH (GARCH) models to capture the volatility of the Thai stock market. A new approach is developed to identify the volatility of the stock price on various seasonal factors, which uses five GARCH models with 27 seasonal variables. This approach has not been previously undertaken. The five GARCH type models such as GARCH(1,1), EGARCH(1,1), GARCH-M(1,1), GJR-GARCH(1,1) and PGARCH(1,1) have been used in comparison and confirm the level of volatility for the stock market index.

Chapter 9 concludes with the major findings and suggests areas for further study. Policy implications of the results and findings along with the limitations of the thesis are also given in this chapter.

Chapter 2

THE THAI FINANCIAL SYSTEM: CHARACTERISTICS OF THE EMERGING THAI STOCK MARKET

2.1 Introduction

This chapter focuses on the Thai financial system. However, details regarding to the development patterns and characteristics of the financial system in East Asian economies are discussed in Masuyama, Vandenbrink and Yue (1999) and Rodan, Hewison and Robison (2001).

The financial system in Thailand started to improve from about 1987 onwards when exports grew rapidly at the rate of 20 per cent per annum and real GDP grew at double-digit rates for many consecutive years. Following financial liberalization in 1990, Thailand's economy was one of the fastest growing in the world and was considered an economic miracle. The economy recorded an average growth rate in excess of seven percent with a moderate inflation rate and stable exchange rate due to a high savings rate and a tradition of conservative monetary and fiscal policy. The financial system has been in the public focus since the announcement of a currency devaluation and since changing its exchange system from a fixed to a managed floatation system in 1997. This chapter overviews the development of the Thai financial system.

2.2 Financial Markets

Thailand's organized financial markets are made up of eight major types of financial institutions: (a) commercial banks; (b) finance, securities, and credit companies; (c) specialized banks; (d) development finance corporations; (e) the stock exchange; (f) insurance companies; (g) saving cooperatives; and (h) a variety of mortgage institutions. Commercial banks dominated most of the financial assets in terms of total assets, credit extended and savings mobilized, followed by finance companies. In 1990, commercial banks accounted for 71 per cent of the financial assets in the country (Warr 1996). After a comprehensive financial reform plan was introduced in 1990, there was significant growth in the financial market, particularly in the banking system. The reform focused on the development of financial deregulation and liberalization, the improvement of supervision and examination of financial institutions, and development of financial instruments, services and the payments system. Again, a second financial development plan was introduced in 1993, which focused on the establishment of the Bangkok International Banking Facilities (BIBF) along with the development of savings mobilization, extension of financial services to rural areas and the development of Bangkok as a financial center (Masuyama et al. 1999; Lewis 1998).

According to the Bank of Thailand (2000a), the Thai government established a number of specialized financial institutions for development purposes. These included the Government Saving Bank, the Government Housing Bank, the Bank for Agriculture and Agricultural Cooperatives, the Industrial Finance Corporation of Thailand, the Small Industry Credit Guarantee Corporation, the Small Industry

Finance Corporation, and the Export-Import Bank of Thailand (EXIM Bank). The structure of the financial institution in Thailand is shown in Appendix 1. Table 2.1 lists financial institutions in Thailand ranked by asset (1997) where commercial banks dominate as the top asset holders followed by finance and securities companies.

Table 2.1: Financial Institutions in Thailand Ranked by Asset, 1997

Financial Institution	Assets*
Commercial Banks	7279365
Finance and Securities Companies	1616948
Government Housing	310195
Government Savings Bank	280933
Saving Cooperatives	276230
Bank for Agriculture and Agricultural	236432
Industrial Finance Corp. of Thailand	217499
Life Insurance Companies	173243
Mutual Fund	102462
Credit Foncier Companies	74161
Export – Import Bank of Thailand	61377
Agricultural Cooperatives	38790
Securities Companies	32423
Pawnshops	16900
Small Industry Finance Corporation	1765
Small Industry Credit Guarantee Corporation	580

*Unit: Million bath.

Source: Bank of Thailand 2000b

2.2.1 The Central Bank and Commercial Bank

The Central Bank

The Central Bank or the Bank of Thailand was established in 1939 and was originally called Thai National Banking Bureau under the supervision of the Ministry of Finance. However, in 1942 the Bureau changed its name to the Central Bank as per the Bank of Thailand Act.

There are two main reasons for having a central bank. The first is that the central bank could be seen as the last resort to prevent systematic financial crises. The second is that there is a need for the government to have its reserve policies, which often are in form of a standard unit of account such as the gold reserve (Mctaggart et al. 1996). The role of the Thai Central Bank was to: (a) formulate monetary policy to maintain monetary stability; (b) supervise financial institutions to ensure that they are secure and supportive of economic development; (c) act as banker and recommend economic policy to the government; (d) act as banker to financial institutions; (e) manage the international reserves; and (f) print and issue bank notes (Bank of Thailand 2002b).

The Central Bank attempts to influence the economy by using monetary policy to control money supply and interest rates. A change in monetary policy setting can also have an effect on the exchange rate; a tightening of monetary policy leads to an appreciation in the exchange rate.

The Commercial Banks

During 1990s commercial banks dominated the majority of all financial activities and absorbed roughly three-quarters of all deposits placed with financial institutions.

From 1972 to 1986, the commercial banks total assets increased by around 19.5 percent annually. After financial liberalization in 1988 and until 1994, the average annual growth rate was as high as 22.85 per cent with the total assets of the banking system increasing more than twelvefold.

The ownership of commercial banks in Thailand was characterised by a high degree of concentration and dominated by sixteen families. However, the concentration of ownership was reduced after the crisis in 1997 when the fifteen banks reduced to twelve, five of which were bought by foreign institutions (Asia Week 2000; Masuyama et al. 1999; Lewis 1998; Warr 1996). Table 2.2 shows the performance of the top ten Thai commercial banks compared to the rest of the world in term of total assets.

Table 2.2: Top 10 Commercial Banks in Thailand Compared to the Rest of the World, 1999

	Institution	HQ	Assets ($US Mil)	Profits ($US Mil)	Ranks in World Top 500
1	Bangkok Bank	Bangkok	31,495	-1,594.6	74
2	Krung Thai Bank	Bangkok	26,458	-2,451.3	85
3	Thai Farmer Bank	Bangkok	19,539	-1,253.2	112
4	Siam Commercial Bank	Bangkok	18,445	-947.5	118
5	Bank of Ayudhya	Bangkok	11,901	-585.6	160
6	Thai Military Bank	Bangkok	8,929	-309.8	183
7	Siam Cty Bank	Bangkok	7,187	-204.3	206
8	Bank Thai	Bangkok	6,291	-512.3	229
9	Bangkok Metropolitan Bank	Bangkok	4,298	-159.6	279
10	Bank of Asia	Bangkok	4,183	-299.0	284

Source: Asia Week 2000.

2.2.2 Money and Capital Markets

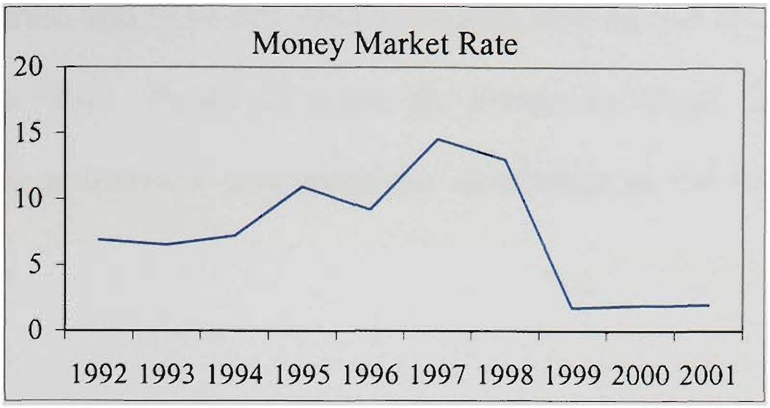
On the basis of the original maturity length of the financial instruments traded, financial markets can be divided into two general types: money markets and capital markets. The money market is the market for short-term funds (usually one year or less) and includes instruments such as treasury bills, banker's acceptances, and commercial paper, while the capital market is the market for securities of long-term funds (usually more than one year to maturity) and instruments such as bonds, notes, and stocks. The money market rate is usually calculated as:

$$mr_t = \left(\frac{d_t}{1 - (d_t / 365)} \right) \left(\frac{365}{M} \right)$$

where, *mr* is the money market rate, *d* is the discount and *M* is the days to maturity. The Thai money market rate for the period 1992-2001 is shown in Figure 2.1.

Although Thailand's financial system growth rate is high compared to other countries and is considered one of the South East Asia financial centers, some of its financial markets are not yet well developed. Some commentators have highlighted that the lack of government securities and regulations undermines the efficiency of the financial market (Masuyama et al. 1999). Apart from an inter-bank market, which may be considered a mature market, many financial areas are still developing. The level of money market rates could impact investment in the stock market where investors will have more choices among stock market returns and money market instruments.

Figure 2.1: Money Market Rate, 1992-2001



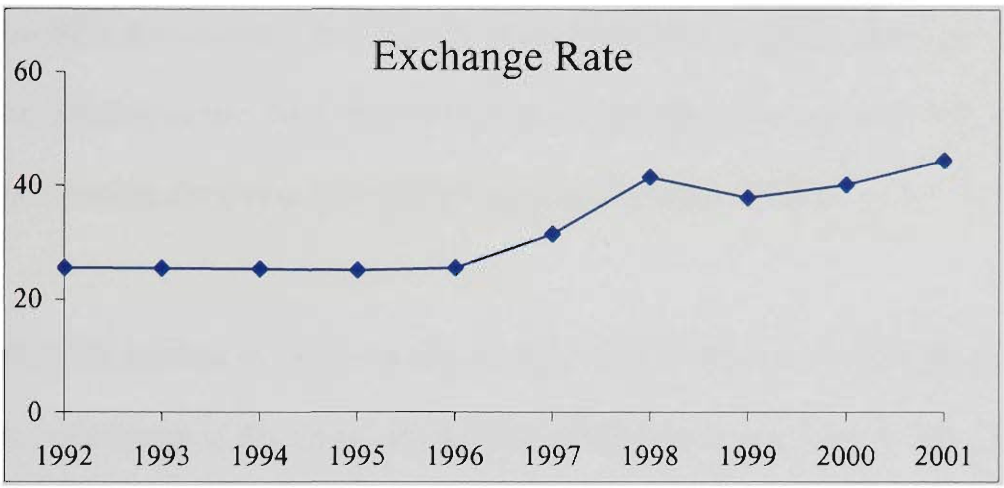
Source: International Monetary Fund, International Financial Statistics 2002.

2.2.3 Foreign Exchange Market

Ho (1991) states that the existence of a well-developed foreign exchange market is a major element in determining the importance of a country as a financial center. An efficient foreign exchange market would attract foreign banks to engage in exchange transactions and at the same time strengthen the link between domestic and foreign financial markets.

The foreign exchange market in Thailand grew significantly after the liberalization of foreign exchange controls and the setting up of the Bangkok International Banking Facilities (BIBFs) in the early 1990s. Most of the transactions are now under the structure of Thai baht per US dollar that takes place in the inter bank market and the exchange rate can be calculated from the spot transactions and forward exchange contract. At the present time, the process of a spot transaction usually takes place instantly by either a direct telephone contact or indirectly through the Reuters dealing system, where the confirmations are printed out instantly and automatically (EMEAP 2002). A forward exchange contract is a transaction in which a specified quantity of a stated foreign currency is bought or sold at the rate of exchange fixed at the time of making the contract, and to be delivered at a future time agreed upon when making the contract (Ho 1991). Figure 2.2 shows the average exchange rate during 1992-2001. The Thai government announced the devaluation of the Thai baht in July 1997.

Figure 2.2: Average Exchange Rate (Thai baht per US dollar), 1992-2001



Source: International Monetary Fund, International Financial Statistics 2002.

According to CSES (1998), devaluation of the Thai currency had an immediate contractionary impact on the domestic demand in Thailand as it exacerbated the external debt burden of banks and other financial institutions, and aggravated the debt burden of many companies which led to a reduction in their investment spending.

2.2.4 The Stock Market: General Characteristics

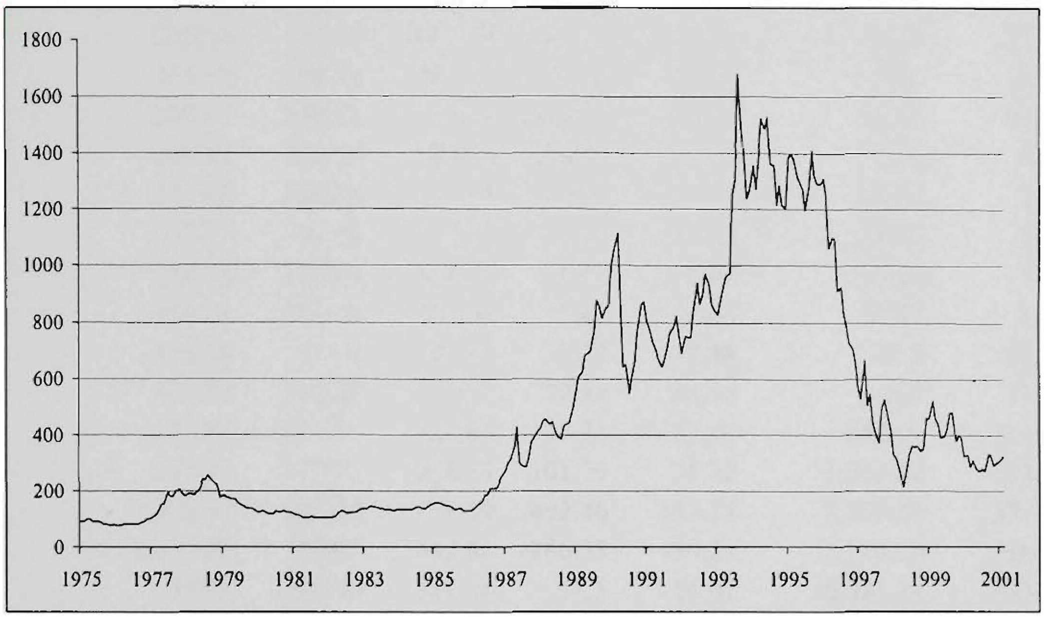
A stock market is an elaborate structure designed to bring together buyers and sellers of securities. The performance of the stock market can determine the national economy, since it provides information that facilitates effective decisions in production activities and has a profound influence on the allocation of capital resources.

The Stock Exchange of Thailand (SET) was established on 30th April 1975. There were fourteen listed companies on the market at the time. Subsequently, the number of securities listed on the market increased to 384 companies by 31st May 2002. The role of the SET is to provide facilities for trading of listed securities and undertaking businesses relating to the stock market such as a clearing house, securities depository center and securities registrar (Stock Exchange of Thailand 2002b).

Although stock trading activities began in the stock exchange of Thailand in May 1975, the transaction of the stock market has greatly increased from 1980s onward. There was a minor boom in the stock market during 1977 to 1979 as industrial development turned to the stock market for temporary investment. A capital gains tax of ten per cent was introduced on profits from stock trading in May 1978 which removed some of the arbitrage opportunities in the Thai stock market and hence reduced fluctuation in stock prices. In April 1981, the corporate tax rate was lowered by five per cent for companies listed on the stock exchange.

The major boom in the stock market occurred during 1987 to 1994 following financial liberalization and the reforms introduced by the government in February 1987. The boom continued and reached the highest SET index of 1,753.73 points in 1994. The Asian economic crisis and the subsequent devaluation of the Thai currency in 1997 caused a significant loss in the SET index of over seventy per cent to 342.56 points in December 2001. The movement of stock prices during the period 1975 to 2001 is shown in Table 2.3 and Figure 2.3.

Figure 2.3: Movement of The SET Index, 1975-2001



Source: Stock Exchange of Thailand 2002a.

As at 30th June 2001 the SET Index comprised some 379 stocks from all sectors of the market. The SET Index reflects the aggregate market value of all the covered stocks. Figure 2.3 shows a monthly chart for the SET going back to the opening of the market in 1975 to the end of 2001. Table 2.3 is calculated from the regional indices available at the time.

Table 2.3 shows the movements of the SET Index from 1975 to 2001. There was a major boom in the stock market during the period 1987-1995. In this period, the SET Index rose 4.49 times reaching 1682.85 points by the end of 1993. Stock prices then fell dramatically by 70 per cent by the end of 1997 as consequences of the Asian economic crisis and devaluation of the baht.

Table 2.3: SET Index of Stock Prices, 1975-2001

End of Year	High	Low	Close	Chg	% Chg	Volume (mil shares)	Value (mil baht)
1975	100.11	84.07	84.07	84.07		2.83	547.32
1976	83.95	76.43	82.69	-1.38	-1.64	5	971.6
1977	205.08	82.48	181.58	98.89	119.59	96.87	26,226.10
1978	266.19	180.79	257.73	76.15	41.94	173.65	54,412.10
1979	259.81	146.11	149.4	-108.33	-42.03	92.58	21,139.50
1980	148.23	113.33	124.67	-24.73	-16.55	57.06	6,386.50
1981	129.03	103.19	106.62	-18.05	-14.48	28.24	2,206.10
1982	138.77	102.03	123.5	16.88	15.83	58.99	5,537.61
1983	148.36	122.88	134.47	10.97	8.88	63.43	7,393.30
1984	144.83	128.69	142.29	7.82	5.82	74.17	8,802.00
1985	158.08	132.76	134.95	-7.34	-5.16	72.5	11,091.56
1986	207.98	127.26	207.2	72.25	53.54	142.9	23,376.82
1987	472.86	203.14	284.94	77.74	37.52	883.04	115,637.83
1988	471.45	287.71	386.73	101.79	35.72	1,562.82	152,653.51
1989	879.19	391.23	879.19	492.46	127.34	3,253.64	377,037.72
1990	1,143.78	544.3	612.86	-266.33	-30.29	8,244.36	626,307.92
1991	908.9	582.48	711.36	98.5	16.07	10,425.34	793,068.01
1992	963.03	667.84	893.42	182.06	25.59	27,848.09	1,860,070.52
1993	1,682.85	818.84	1,682.85	789.43	88.36	32,544.84	2,201,148.18
1994	1,753.73	1,196.59	1,360.09	-322.76	-19.18	23,051.91	2,113,860.65
1995	1,472.04	1,135.69	1,280.81	-79.28	-5.83	20,874.18	1,534,899.91
1996	1,415.04	816.79	831.57	-449.24	-35.07	19,359.12	1,303,143.75
1997	858.97	357.13	372.69	-458.88	-55.18	29,902.35	929,597.70
1998	558.92	313.04	318.16	-54.53	-14.63	18,643.65	335,061.65
1999	545.91	313.65	481.92	126.11	35.44	96,322.94	1,609,787.16
2000	498.46	250.6	269.19	-212.73	-44.14	60,502.56	923,696.83
2001	342.56	265.22	303.85	34.66	12.88	180,317.53	1,577,757.97

Source: Stock Exchange of Thailand 2000a.

During the pre-crisis period of 1987 to 1996, a number of favourable factors were responsible for the major boom in the stock market. These factors were financial liberalization and reforms, the remarkably consistent performance of the Thai economy, the significant growth rate and profits in most listed companies, the inflows of foreign capital, and the high performance of the banking sector.

On the other hand, one of the major factors contributing to the sharp decline in stock prices after 1997 was the Asian economic crisis. Many have argued that the causes of the crisis could be summarized as the loss of competitive ability especially the slowdown in exports, over investment in the property sector, and lack of effective regulation and policies for the Thai financial system (Dixon 1999; Mishkin 1999).

2.3 Recent Issues and Characteristics of the Thai Financial System and the Stock Market

2.3.1 Financial Liberalization

Financial liberalization in Thailand was first introduced in 1990 along with national economic policies aimed at liberalization and deregulation. Throughout the liberalization period – the first phase in 1990-1992 and the second phase in 1993 with the establishment of new banking facilities to serve as international financial intermediates – the Thai government implemented credit allocation, interest rate liberalization, loan portfolio, business lines, market entry including entry by foreign institutions, and development and reform of the securities markets (Masuyama et al. 1999). The key actions taken by the Thai government in liberalizing its financial system were interest rate liberalization, exchange control deregulation and the establishment of the Bangkok International Banking Facilities (BIBF). Williamson and Mahar (1998) believe that liberalization has been an important contributory factor to the boom and crash cycles in emerging economies.

2.3.2 Economic Crisis

Economic and financial crisis, market instability and high volatility in the stock market have become a worldwide phenomena in recent years. In early 1997, macroeconomic conditions had seriously deteriorated in most Asian countries. The crisis affected trade, investment and financial linkages, increasing risk premiums between many developing countries, especially Asian countries, and the rest of the world. Thailand was the first to experience the effects of the crisis (CSES 1998; Mishkin 1997).

The Thai government was forced to implement a devaluation policy, moving from a fixed to a managed float currency system in July 1997. Many finance companies, 56 out of 91, closed down in December 1997. The crisis caused sudden and unprecedented collapse in asset prices, corporate and financial fragility, and a drastic economic slowdown in East Asian markets. In just over 12 months, the region's stock markets shrunk by as much as 85% in US dollars. At the same time, East Asian currencies depreciated sharply beyond the levels needed to maintain export competitiveness, while the credit rating of government bonds fell from AA+ to CC- and unemployment jumped 370 per cent in 1998 compared to 1997 (IMF 2002; International Financial Risk Institute 2001; Bank of Thailand 2000c; Leightner 1999).

2.3.3 Focus on Foreign Capital Flows

Foreign capital has played an important role in developing economies. It has filled the gap when domestic savings were insufficient to finance the country's investment activities. Foreign capital flows have the components of direct foreign investment, portfolio investments, foreign loans and short-term foreign loans. Notwithstanding the availability of domestic savings, Thailand's economy also depended relatively heavily on foreign investment in order to secure its high rates of growth. The composition of foreign capital has changed over time as dependence on official sources gradually declined and foreign direct investment became the main source of foreign capital. Table 2.4 shows the net foreign capital inflows to Thailand.

Many developing countries implemented financial liberalization and globalization to attract international capital flows. However, in most cases the capital flows went into financial and portfolio investments rather than real investments and consumptions (Siamwalla et al. 1999; Akrasanee et al. 1993).

Table 2.4: Net Capital Inflows to Thailand's Economy (US$ millions), 1980-1997

	1980	1985	1990	1995	1996	1997
Official transfer	141	119	187	42	30	14
Direct investment	187	159	2404	1169	1455	2354
Portfolio investment	96	141	457	3485	4351	4451
Other long-term capital	1824	1326	793	3718	5935	2625
Other short-term capital	-64	227	4489	2310	2460	-9306
Deposit money banks	N/A	-533	1603	11239	5003	-5340
Net errors and omissions	-180	113	1182	-1479	-2985	235

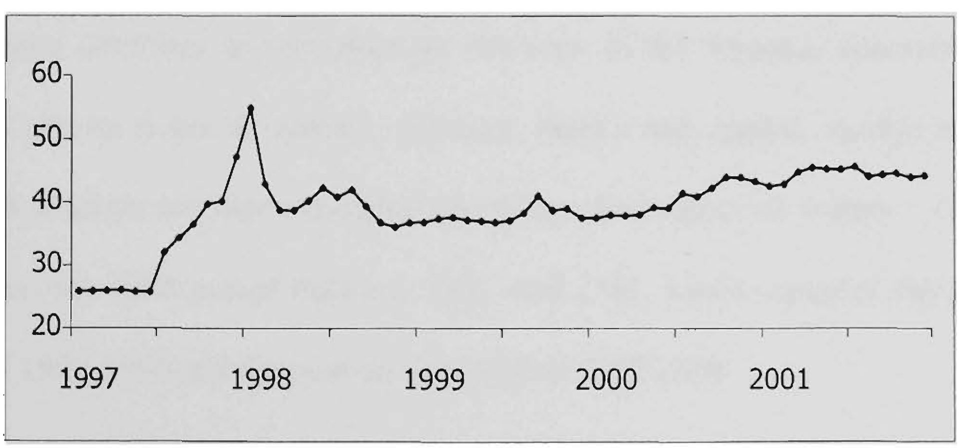
Source: Masuyama et al. 1999, p. 9.

2.3.4 Unstable Exchange Rate in an Open Economy

Exchange rates are important for macroeconomic policy in an open economy for a number of reasons. The exchange rate is used as a mechanism of monetary and fiscal policies, affecting real income and domestic price levels. It can be viewed as a filter to the external shocks that could affect the domestic economy. Finally, the short-run dynamics of an exchange rate adjustment is used in formulating and implementing aggregate demand policies (Grabbe 1996; Gay and Kolb 1984).

After the devaluation of the Thai baht against international currency in 1997, the Thai exchange rate had fluctuated severely immediately after the announcement of the devaluation policy and consequently created uncertainty and discouraged international trade and investments. Figure 2.4 shows the price volatility in the exchange rate between 1997 and 2001.

Figure 2.4: Exchange Rate during 1997-2001 (Thai baht per US dollar)



Source: International Monetary Fund, International Financial Statistics 2002.

2.3.5 Market Imperfection

The sudden crisis in Thailand revealed the shortcomings of traditional open economy models, which assume efficient global financial markets. Financial market imperfection could be seen as asymmetric information, adverse selection, moral hazard and incomplete markets. Information asymmetry can severely restrict financial market transactions. Adverse selection would create inequality or inefficiency in the exchanges on the market caused by information asymmetry between the two parties. Moral hazard is the risk resulting from misleading information about a company's assets, liabilities, or credit capacity, or by an incentive to take unusual risks in a desperate attempt to earn a profit before the contract settles. These imperfections harm long-term development and account for many characteristics of the recent crisis (Dixon 1999).

2.4 Conclusions

This chapter describes and provides an overview of the financial characteristics of Thailand and its financial system. Finance, money and capital, foreign exchange, and stock markets are major components of the Thai financial system. This study focuses on the time period between 1992 and 2001 which includes the pre-crisis period of 1992-1996 and the post-crisis period of 1997-2001.

The ordinance of the financial system in 1996-1997 is a clear example of the result of the Asian economic crisis. Although many government policies such as devaluation and financial intervention took place immediately after the crisis, the Thai economy is still recovering. This situation affects the behaviour of investors and, ultimately, market prices. The Thai stock market performance is still very poor, measured by the closing index at the end of 2001 at around 300 index points compared to the end of 1999 and 2000 at around 540 and 500 points respectively.

The following chapter applies some univariate time series models on the SET index and market returns to highlight financial market characteristics.

Chapter 3

DESCRIPTIVE STATISTICS AND GENERAL CHARACTERISTICS OF THE STOCK MARKET

3.1 Introduction

A stock market index is a tool for measuring the performance of an entire stock market or group of related stocks. It plays an important role in finance, as it is often associated with particular stock exchanges or industries, which is used in many finance and econometric applications and models (Gourieroux and Jasiak 2001).

It is stated in Section 1.3 that there is a large number of financial econometric methods, which can be applied to investigate issues in the theory of financial and stock markets. In this chapter, 1) descriptive statistics such as mean, median, standard deviation, skewness and kurtosis; and 2) univariate time series econometric models such as the moving average, exponential smoothing, Holt Winters and Autoregressive Integrated Moving Average (ARIMA) models are applied to investigate the empirical characteristics of the Thai stock market. Formal tests will also be undertaken to identify which is the best model to describe the time series behaviour of the Thai stock market.

3.2 Descriptive Statistics

Stock market returns are calculated from the monthly index performance of the Stock Exchange of Thailand. The SET Index is intended to provide investors with a general idea about the stock price movements in the Thai stock market and is computed by comparing the current total market value of the issued shares of the constituent stocks with their corresponding value on the base day as:

$$I_t = \frac{\sum MC_t}{\sum MC_{t-1}} \times 100$$

where I is the index at date t, and MC is the market capitalization of constituent stocks at dates t, and base day $t-1$.

Geometric average return is used in the notation of general continuously compounded multi-period returns. Campbell et al. (1997) give two reasons for focusing on returns rather than on prices. First, for the average investor, financial markets may be considered close to perfectly competitive, so that the size of the investment does not affect price changes. Therefore, since the investment is "constant-returns-to-scale", the return is a complete and scale free summary of the investment opportunity. In addition, for theoretical and empirical reasons, returns have more attractive statistical properties than prices, such as stationarity and ergodicity. In particular, the dynamic general-equilibrium model often yields nonstationary prices, but stationary returns.

Stock market returns are gathered assuming that stock prices and returns follow a geometrical random walk. Denoted by I_t is the price of the closing index at time (day/month) t and ln is the logarithm neperiano. We assume that the model's variable α is a constant with a zero mean and is a normal random variable. The simple net return, R_t, on the asset between dates $t-1$ and t, is defined as:

$$R_t = \ln\left(\frac{I_t}{I_{t-1}}\right) \times 100 = \alpha + u$$

For univariate statistics, mean, median, standard deviation, skewness, and kurtosis are computed in order to determine the central tendency, dispersion and shape of frequency distributions of the return on the stock exchange of Thailand. Mean μ is calculated by the following formula:

$$\mu = \frac{\sum R}{n}$$

where $\sum R$ refers to the sum of all the observation returns, and n refer to the number of observations in the population. The median could be seen as:

$$Median = L + \frac{n/2 - F}{fm} c$$

where L is lower limit of the median class, F is sum of the frequencies up to but not including the median class, fm is frequency of median class, and c is width of the class interval.

The monthly and daily stock volatility of the stocks trading on the SET could be estimated from the stock returns (simple net return) of the Stock Exchange of Thailand composite portfolio from January 1992 through December 2001. The estimates from January 1975 through December 2001 use monthly returns on the SET composite portfolio. The estimator of the variance σ^2 of the yearly return is the sum of the squared monthly returns (after subtracting the average monthly return). It is important to note that it is possible to estimate the monthly variance by finding the daily returns on the selected composite portfolio.

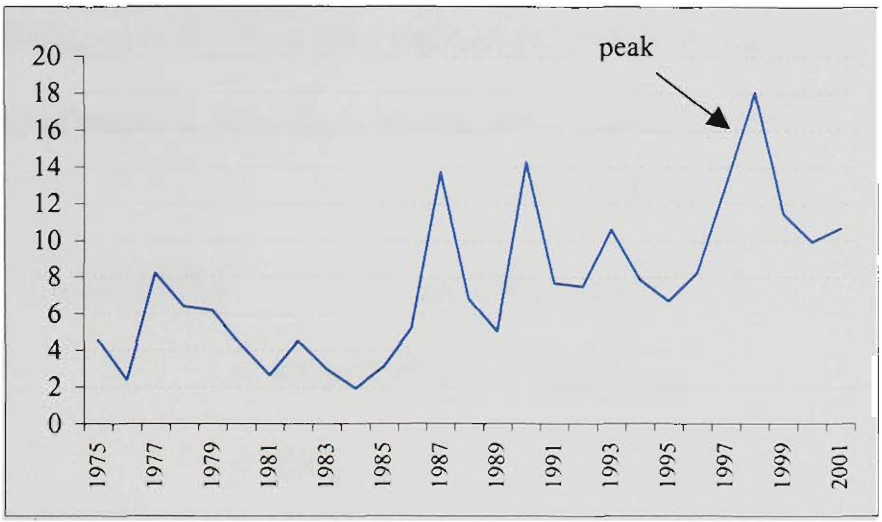
Standard deviation σ is calculated by the following formula:

$$\sigma = \sqrt{\frac{\sum R_{it} - \mu)^2}{N_t}}$$

where there are N_t monthly or daily returns R_{it} in month t. Using nonoverlapping samples of monthly data to estimate the yearly variance creates an estimation error that is uncorrelated through time.

Figure 3.1 plots the estimated standard deviations from monthly returns between May 1975 to December 2001. Volatility estimations are much higher following October 1997 to December 1999 (marked by the arrow). High volatility fluctuation is present in the period when Thailand experienced the economic crisis and the crash in the Thai stock market. The overall volatility of the individual stocks had increased substantially immediately after the crisis.

Figure 3.1: Volatility of the Stock Market Index, 1975-2001



Source: Author's estimate.

The market risk premium is a broad measure that considers the stock markets as a whole. However, not all companies are equally risky. Investors would demand more return for making an investment in a risky venture than in a company that has stable and predictable earnings. The beta coefficient is an adjustment to the market risk premium based upon the risk perception of the company. Therefore, if a company is perceived to be no more or no less risky than the stock market as a whole, its beta coefficient would be 1. Similarly, firms more risky than the average will have a beta coefficient greater than 1 and companies with less risk will have a beta coefficient value of less than one. The beta coefficient is an individual risk measure for a given firm, identifying how responsive the stock's return is relative to movements in the entire stock market (Lie, Brooks and Faff 2000). Beta is estimated by:

$$R_i = \alpha_i + \beta_i\, (SET)_m + \varepsilon_i$$

By deriving the covariance between the returns on stock i and the market index, we are able to identify the systematic and non-systematic risk. By definition, the firm-specific or non-systematic component is independent of the systematic component, that is, $Cov(SET_m, \varepsilon_i) = 0$. From this relationship, it follows that the covariance of the excess rate of return on security i with that of the market index is:

$$
\begin{aligned}
Cov(R_i, SET_m) &= Cov(\beta_i\, SET_m + \varepsilon_i\, SET_m) \\
&= \beta_I\, Cov\,(SET_m) + Cov(\varepsilon_i\, SET_m) \\
&= \beta_i \sigma_m^2
\end{aligned}
$$

Note that it is possible to drop α_i from the covariance terms because α_i is a constant and thus has zero covariance with all variables. Because $Cov(R_i, SET_m) = \beta_i \sigma_m^2$, the sensitivity coefficient, β_i, in equation $R_i = \alpha_i + \beta_i\,(SET)_m + \varepsilon_i$, is the slope of the regression line representing the index model, equals:

$$
\beta_i = \frac{Cov(R_i, SET_m)}{\sigma_m^2}
$$

The market model beta coefficient turns out to be the same beta as that of the Capital Asset Pricing Model (CAPM) for a well-specified and observable market index. We can test the beta of individual stock to see whether that particular stock has a greater risk. However, the beta is not modeled here for the individual stock.

Skewness and kurtosis can be defined as:

$$
Skewness = \frac{3(\mu - med)}{\sigma} = \frac{\sum f(R-\mu)^3}{\sigma^3}
$$

$$Kurtosis = \frac{\sum f(R-\mu)^4}{\sigma^4}$$

In this chapter, the monthly market index was observed from May 1975 to December 2001. The time interval of 1992 to 1996 has been regarded as the boom in the Thai financial and stock market followed by a tumultuous period of economic crisis from 1997 to 2001. We hypothesize that the statistical characteristics are different in each time interval: whereas the pre-crisis results would produce more positive returns, the post-crisis period is hypothesized to produce negative returns with higher standard deviation. Thus, the comparison between the periods of May 1975 to December 2001 (referred to as *Overall* period), January 1992 to December 1996 (referred to as *Pre-Crisis* period), and January 1997 to December 2001 (referred to as *Post-Crisis* period) is shown in Table 3.1.

Table 3.1 presents a number of descriptive statistics calculated for the monthly return series of the SET closing index over the period 1975 to 2001. In particular, the return over the whole ten-year period starting from 1992 to 2001 is the focus of the analysis of the effect of the economic crisis (pre-crisis and post-crisis effects). The mean, median, standard deviation, skewness and kurtosis were estimated and are reported in tables 3.1 and 3.2.

Table 3.1: Descriptive Statistics for Monthly Return on the SET Index

Period	Observations	Mean	Median	Standard Deviation	Skewness	Kurtosis
1975-2001 (Overall)	320	0.3815	0.2231	8.8641	-0.2197	2.3113
1992-1996 (Pre-Crisis)	60	0.2602	0.0019	8.5283	0.5426	1.1602
1997-2001 (Post-Crisis)	60	-1.6780	-2.1431	12.9072	0.3222	-0.0586
1992	12	1.8990	2.8589	7.2041	-0.2121	2.2764
1993	12	5.2766	3.7574	10.1528	1.1599	0.7747
1994	12	-1.7745	-1.3858	7.5528	0.1006	-1.4915
1995	12	-0.5005	-1.2123	6.4481	0.7773	2.2531
1996	12	-3.5994	-1.3811	7.9116	-0.5269	-0.1699
1997	12	-6.6881	-6.8083	12.4969	0.8473	1.9644
1998	12	-0.3863	-2.1297	17.2904	0.3491	-1.1387
1999	12	2.5282	1.7722	10.9680	0.6248	0.4093
2000	12	-4.8530	-2.2471	9.5303	-0.7489	-0.2242
2001	12	1.0093	1.6694	10.2452	-0.0371	0.5100
1992-2001	120	-0.7089	-0.8735	10.9819	0.2793	0.5092

Source: Author's estimate.

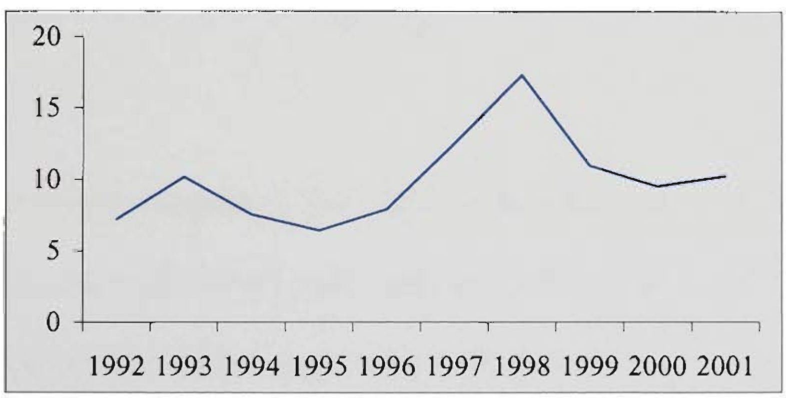
Table 3.2: Descriptive Statistics for Daily Return on the SET Index

Period	Mean	Median	Standard Deviation	Skewness	Kurtosis
1992-1996 (Pre-Crisis)	0.0127	0.0151	1.4489	-0.1920	4.9080
1997-2001 (Post-Crisis)	-0.0820	-0.2174	2.2383	0.6318	2.7615
1992	0.0923	0.0826	1.6157	0.0058	9.0352
1993	0.2042	0.1424	1.1882	0.5779	1.1866
1994	0.0006	0.0704	1.6676	-0.6639	3.0638
1995	-0.0111	-0.1245	1.2615	0.3288	1.4969
1996	-0.2047	-0.1589	1.3551	-0.3649	2.7480
1997	-0.3121	-0.4524	2.2737	0.7017	1.4035
1998	-0.0190	-0.0880	1.8891	0.4559	4.0141
1999	0.1238	-0.0338	2.1975	1.0905	3.1830
2000	-0.2358	-0.2462	1.8965	-0.2398	4.0205
2001	0.0494	-0.0317	1.6612	-0.3562	2.8353
1992-2001	-0.0347	-0.0802	1.8863	0.4537	4.0283

Source: Author's estimate.

The monthly return during the overall period is higher than the pre-crisis and post-crisis period. The stock exchange performed best over the period of financial liberalisation in 1988 to 1996. The significant effect of the Asian economic crisis results in negative returns in the subsequent years with the highest risk level, measured by standard deviation, in 1997 and 1998 of 12% and 17% respectively. A higher degree of risk in the exchange market could also be interpreted as a higher degree of speculation over the stocks and consequently producing greater volatility in the market as shown in Figure 3.2.

Figure 3.2: Volatility of the Stock Market Index Measured by Standard Deviation, 1992-2001



Source: Author's estimate.

The stock market during the post-crisis period was very volatile, measured by standard deviation, especially in 1997-1998 when there was high fluctuation in stock returns. The monthly returns data shows a positive skewness for both periods. The shape of kurtosis for both periods is platykurtic. The kurtosis of no more than 5.00 for both monthly and daily SET returns suggests that the unconditional distribution of volatility is nearly a normal distribution. This means that the periods of relatively modest change are interspersed with lower-than-predicted changes, especially in both pre- and post-crisis periods. Considering monthly and daily returns (Table 3.1 and pre- and post-crisis periods. Considering monthly and daily returns (Table 3.1 and Table 3.2), the basic characteristics of these descriptive statistics are very similar. However, the monthly returns and risk are much higher than those in the daily data to the extent that the mean and standard deviation have a large range.

In addition, details of the market capitalization (Mkt Cap), price to earning ratio (P/E), price to book value (P/BV), dividend yield and geometric return for the stock exchange of Thailand are reported in Appendix 2. P/E ratio for the stock is the ratio of the stock's price to the stock's annual earnings:

$$\text{P/E} = \frac{P}{E}$$

P/E ratio can represent a measure of the market sentiment regarding a stock. Stocks which have great expectations but small earnings can have P/E of 30 or more, while solid but uninspiring companies may have P/Es below 10. In general, some investors wishing to invest in growth stocks usually avoid companies with a P/E above 20. Similarly, the Dividend Yield (DY) is the ratio of the annual dividend per share to the stock price.

3.3 Univariate Time Series Modelling

The stock market indexes are often collected in the form of non-stationary series. These series wander widely, rarely return to an earlier value and are also called random walk (Abelson and Joyeux 2000). Time series analysis is the set of statistical methodologies that is appropriate to analyse these data series. It is a model that identifies the regularity patterns present in the data to forecast future observations. Campbell, Lo and MacKinlay (1997) comment that one of the earliest and most enduring questions of financial econometrics is whether financial asset prices are forecastable. Efficient market hypothesis provides the view that stock prices cannot be predicted because they stagger up and down over time, which is often described as a random walk, $Y_t = Y_{t-1} + \varepsilon_t$; with random up and down prices called the martingale property (or drift), $Y_t = Y_{t-1} + \alpha + \varepsilon_t$.

Since a pure time series model does not include explanatory variables, these forecasts of future observations are simply extrapolations of the observed series at the end of the sample. In this section, we consider a single variable in the stock market index analysis which is called a *univariate time series model.*

A univariate time series model for y_t is formulated in terms of past values of y_t and/or its position in relation to time. Time series of economic data display many different characteristics and one easy way of starting the analysis of a series is to display the data by means of a time plot in which the series of interest is graphed against time. The basic characteristics of univariate time series are trends (long-run movements of the series), seasonalities (see also Chapter 7), and cycles.

The trend is specified as a deterministic function of time which is usually denoted as a random walk model with drift and can be formulated as follows:

$$y_t = \alpha + \beta t + \varepsilon_t$$

where ε_t is the error term that may be correlated. The variable t is constructed artificially as a seasonal variable (trend) that takes the value of 1 in the first period of the sample, 2 in the second period and so on.

A time series with seasonality can be easily modelled as a deterministic function of time by including in the regression model a set of n seasonal dummies:

$$D_{it} = \begin{cases} 1 & t \in season(i) \\ 0 & otherwise \end{cases} \quad i=1,2,\ldots,n$$

where n is the number of seasons in a year, thus, n=4 if we have quarterly data, n=12 if we have monthly data, and so forth. A linear regression model for a time series with a linear trend and seasonal behaviour can be formulated as follows:

$$y_t = \alpha + \beta t + \sum_{i=1}^{n} \gamma_i D_{it} + \varepsilon_t$$

where γ_i are the seasonal coefficients constrained to sum zero.

A linear regression model is simple and could be easily estimated by least squares. Trends and seasonalities estimated by these models are represented by a deterministic function of time which holds at all points throughout the sample.

The alternatives to these models are the Exponential Smoothing Modelling and Holt Winters' Model. These models fit trends and seasonalities placing more weight on the more recent observations. In addition, these methods allow the components to change slowly within the sample and the most recent estimations of these components are extrapolated into the future in forecasting. These models are easy to implement and can be quite effective. Finally, modelling time series with a trend and/or seasonal behaviour within the ARIMA framework is a popular approach to forecast stock market index returns.

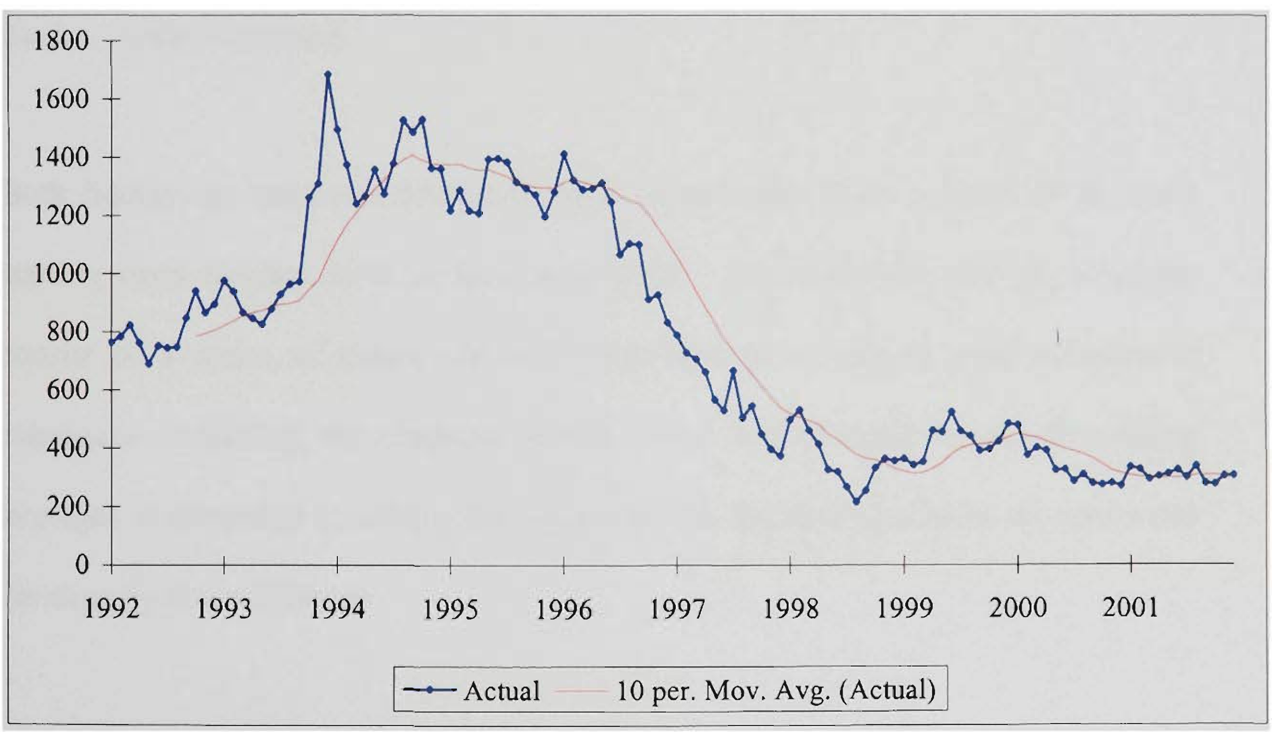
However, if we are dealing with two or more variables in the stock market analysis, a *multivariate time series* model is applied which will be discussed in Chapter 5. This technique is based on the relationship between one dependent variable and one or more independent variables. This technique involves more sophisticated forecasting models. This category of time series modelling technique is called *causal technique* where the model is called a multi-factor model. The model generated in this thesis is called the Thai Stock Market Multi-Factor Model (TSMM, see Chapter 5).

This section provides an understanding of time series analysis, models, smoothing and forecasting techniques. By doing so, we use historical data for stock prices to forecast future prices. Monthly data for the stock market index and returns during January 1992 to December 2001 were used in the analysis. The discussed time series techniques are moving average, exponential smoothing, Holt Winters' model, and ARIMA. Moving average is used as smoothing technique and trading rules. Exponential, Holt Winters and ARIMA are used as forecasting techniques.

3.3.1 Moving Average

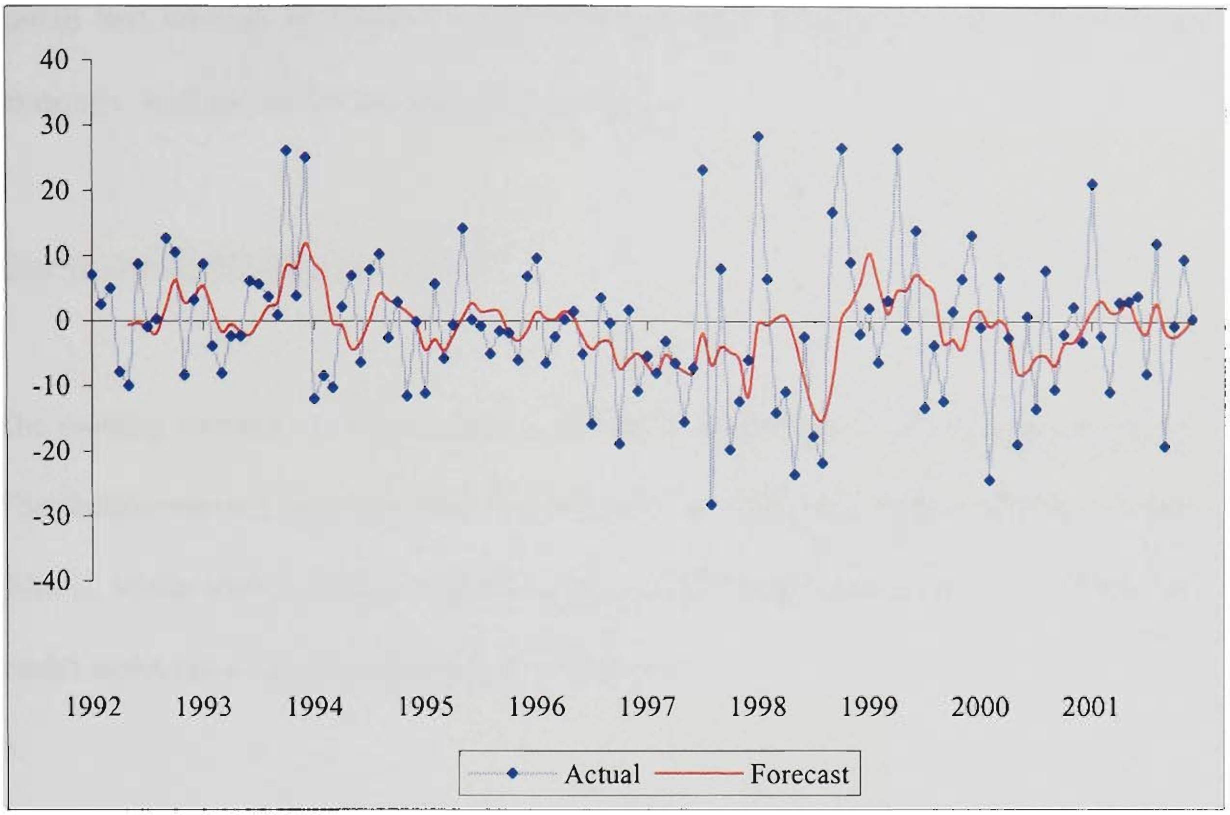
A moving average of ten months is used on the SET index to determine the medium-term trends, to smooth the time series and to develop a new trading rule. The method of moving average is highly subjective and dependent on the length of the period (*L*) selected for constructing the averages. The methods of moving averages are well established, are considered reliable, and are simple to understand and to calculate (Temby 1998). Figure 3.3 shows the moving average of 10 consecutive months on SET index, while figure 3.4 shows the moving average on the SET returns.

Figure 3.3: Single Moving Average on Monthly SET Index, 1992-2001



Source: Author's estimate.

Figure 3.4: Single Moving Average on the Monthly Stock Returns, 1992-2001



Source: Author's estimate.

Both figures are computed ten-month moving averages from a series of 10 years starting from January 1992 to December 2001. The ten-month moving averages consist of a series of means obtained over time by averaging over consecutive sequences containing ten observed values. The first of these ten-month moving averages is computed by adding the values for the first ten months in the series and dividing by ten as follows:

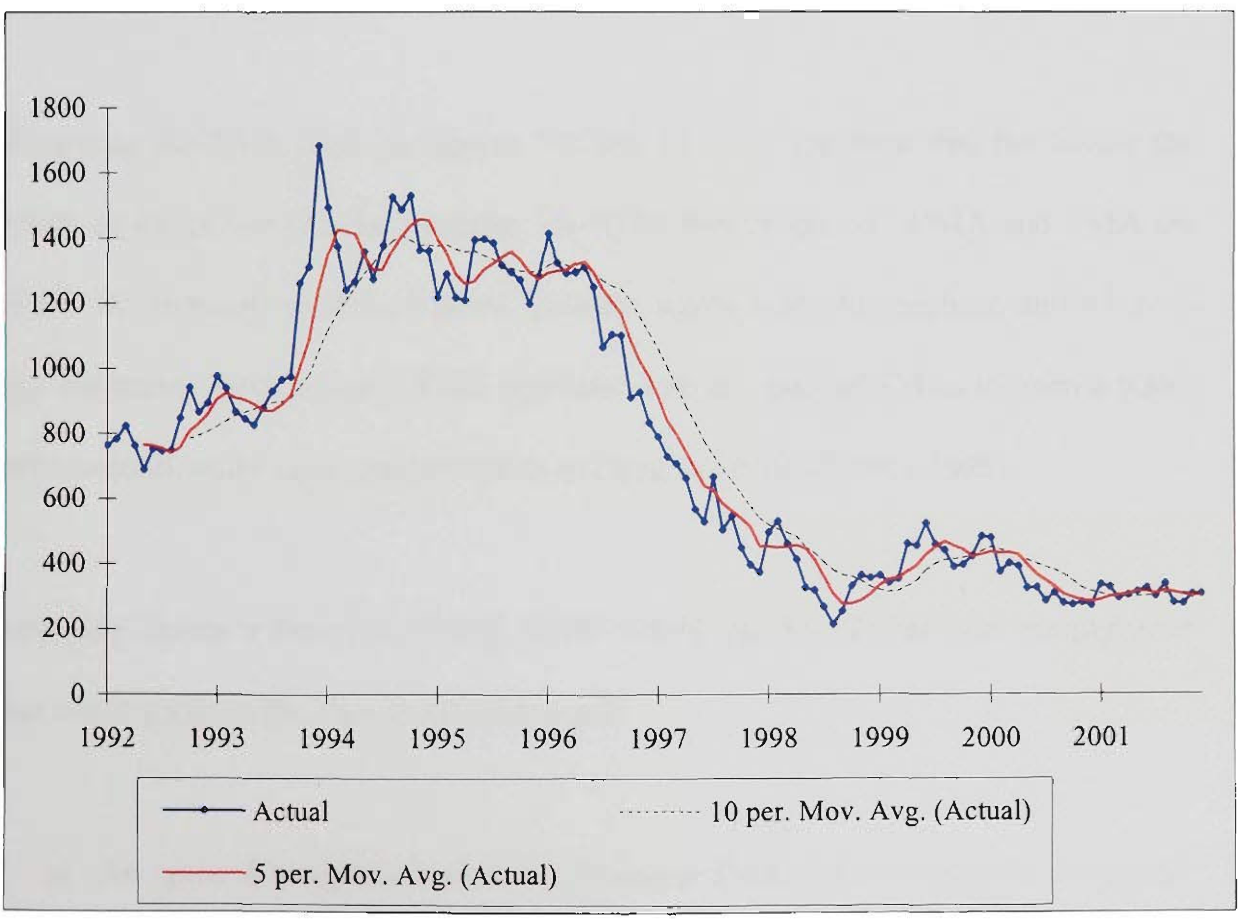
$$Mov(10) = \frac{\sum_{t=1}^{10} M_t}{10}$$

The second of these ten-month moving averages is computed by adding the values of month two through to eleven in the series and then dividing by ten. The process continues until the last of the moving averages.

Double and Triple Moving Average

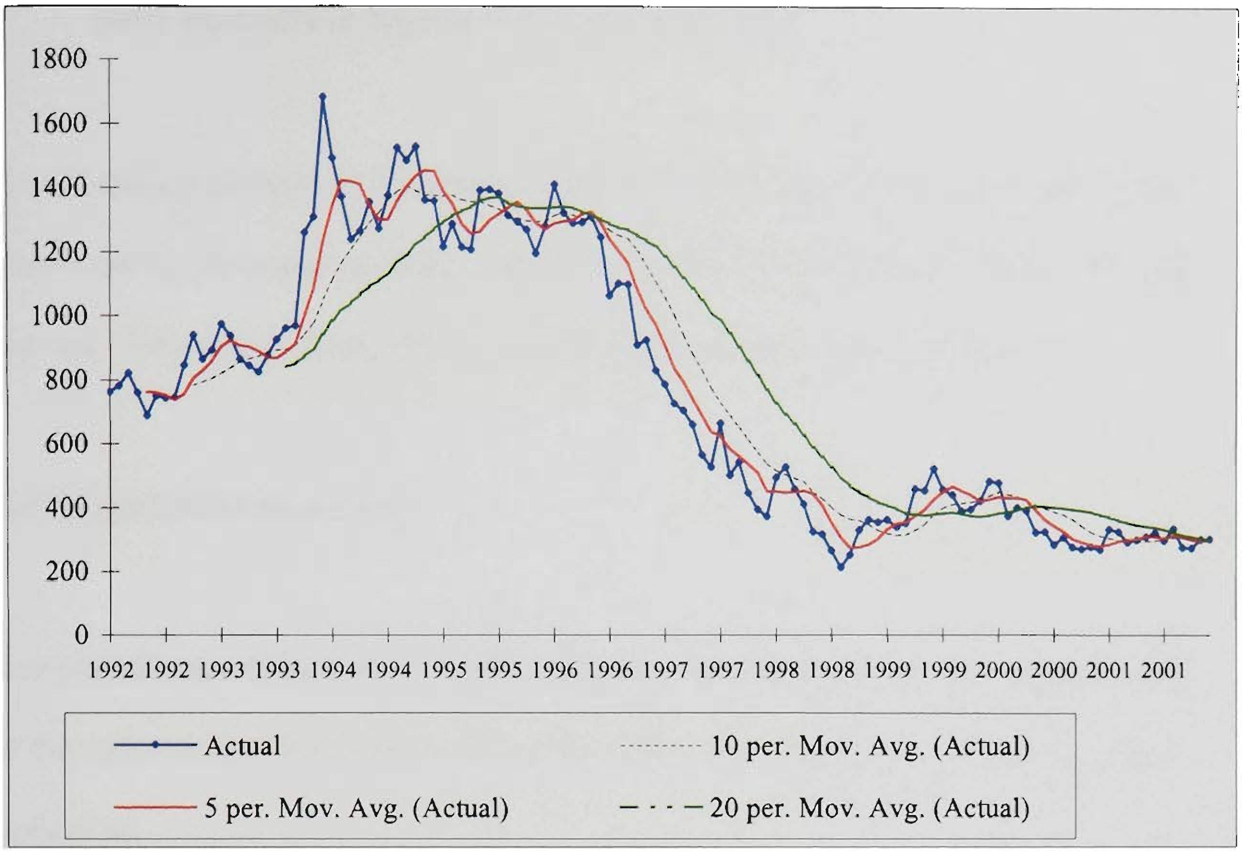
The moving average concept can be extended to double and triple moving averages. The double moving average (DMA) comprises an additional single moving average (SMA), while triple moving average (TMA) adds two additional SMAs. TMA is a useful *technical analysis* technique for investors.

Figure 3.5: Double Moving Average on the Monthly SET Index, 1992-2001



Source: Author's estimate.

Figure 3.6: Triple Moving Average on the Monthly SET Index, 1992-2001.



Source: Author's estimate.

Observing the SMA lines in figures 3.5 and 3.6, it is apparent that the longer the length of the period (L) the smoother the SMA line produced. DMA and TMA are useful for investors as these models give the signal when to purchase and when to quit the trade. Basically, the TMA indicator uses one pair of SMAs to open a trade, and a second, more agile, pair of SMAs to close the trade (Temby 1998).

Applying Temby's theory of "Basic TMA" (1998, pp. 55-58), the new trading rules that could apply to the Thai stock market are:

a) An uptrend is signaled when the 5-month SMA crosses above the 10-month SMA. This happened in January 1993 to January 1995 and January 1999 to July 2000.

b) A downtrend is signaled when the 5-month SMA crosses below the 10-month SMA especially in January 1995 and January 1999.

As a statistical measure of the market between 1992 to 2001, 56% of the SET index was below its 20 months moving average and 52% was below its 10 months moving average. However in 1996, 1997 and 1998, these numbers were around 89%.

3.3.2 Exponential Smoothing

Exponential smoothing uses only past values of a time series to forecast future values of the same series. It is a form of moving average of time series forecasting, and is defined as:

$$F_{t+1} = \alpha y_t + (1-\alpha)F_t$$

where F_t is the forecast for period or time t, y_t is the actual value of the present time period, and α is the exponential smoothing constant.

With exponential smoothing, the forecast value at any time is a weighted average of all the available previous values which decline geometrically over time. If this process uses more than one period of time, the forecast F_t will be:

$$F_t = \alpha y_{t-1} + (1-\alpha)F_{t-1}$$

Substituting F_t into the preceding equation for F_{t+1}, we get:

$$F_{t+1} = \alpha y_t + (1-\alpha)[\alpha y_{t-1} + (1-\alpha)F_{t-1}]$$

$$= \alpha y_t + \alpha(1-\alpha)[\alpha y_{t-2} + (1-\alpha)^2 F_{t-1}]$$

However, $F_{t-1} = \alpha y_{t-2} + (1-\alpha)F_{t-2}$

Then we substitute this expression for F_{t-1} into the preceding equation for F_{t+1} and repeat to F_{t+n}, to get:

$$F_{t+1} = [\alpha y_t + \alpha(1-\alpha)][y_{t-1} + (1-\alpha)^2 F_{t-1}]$$

$$F_{t+2} = [\alpha y_t + \alpha(1-\alpha)]\{y_{t-1} + (1-\alpha)^2[\alpha y_{t-2} + (1-\alpha)F_{t-2}]\}$$

$$F_{t+3} = [\alpha y_t + \alpha(1-\alpha)]\{y_{t-1} + \alpha(1-\alpha)^2[y_{t-2} + (1-\alpha)^3 F_{t-2}]\}$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$F_{t+n} = [\alpha y_t + \alpha(1-\alpha)]\{y_{t-1} + \alpha(1-\alpha)^2[y_{t-2} + (1-\alpha)^n F_{t-2}]\}$$

Usually, the weight value α is determined by the forecaster, Table 3.3 shows the values of α, $(1-\alpha)$, $(1-\alpha)^2$, $(1-\alpha)^3$, and $\alpha\,(1-\alpha)^3$, which is the weight value on the actual value for three previous periods.

Table 3.3: Selected Weights

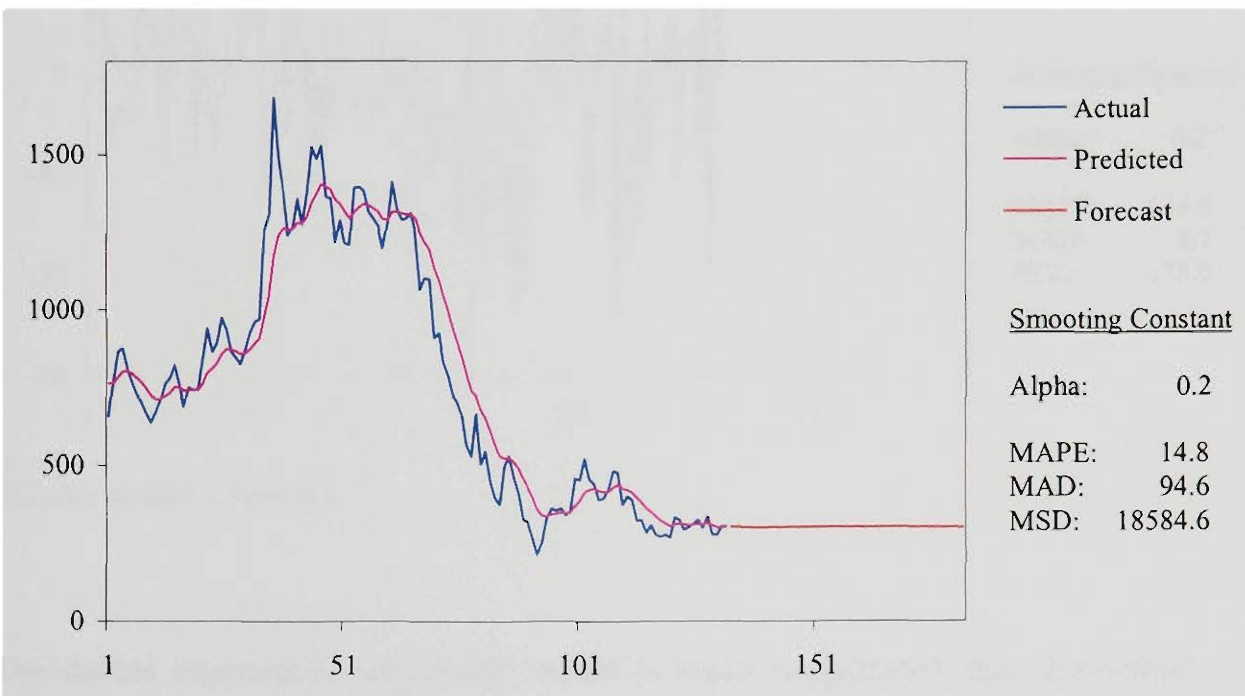
α	$1-\alpha$	$(1-\alpha)^2$	$(1-\alpha)^3$	$\alpha\,(1-\alpha)^3$
0.2	0.8	0.64	0.512	0.1024
0.5	0.5	0.25	0.125	0.0625
0.8	0.2	0.04	0.008	0.0064

Source: Author's estimate.

According to Black and Eldreadge (2002), the value of α determines the impact level that the error has on the new forecast. If α is small, there will be less impact on the new forecast. On the other hand, if α is equal to 1.0, the new forecast is likely to be the same as the last actual value.

In choosing α, we selected an α value close to 0 if the series has a great deal of random variation, while we selected an α value close to 1 if the forecast values depend strongly on recent changes in the actual values.

Figure 3.7: Single Exponential Smoothing of the SET Index (α = 0.2, 0.5 and 0.8)

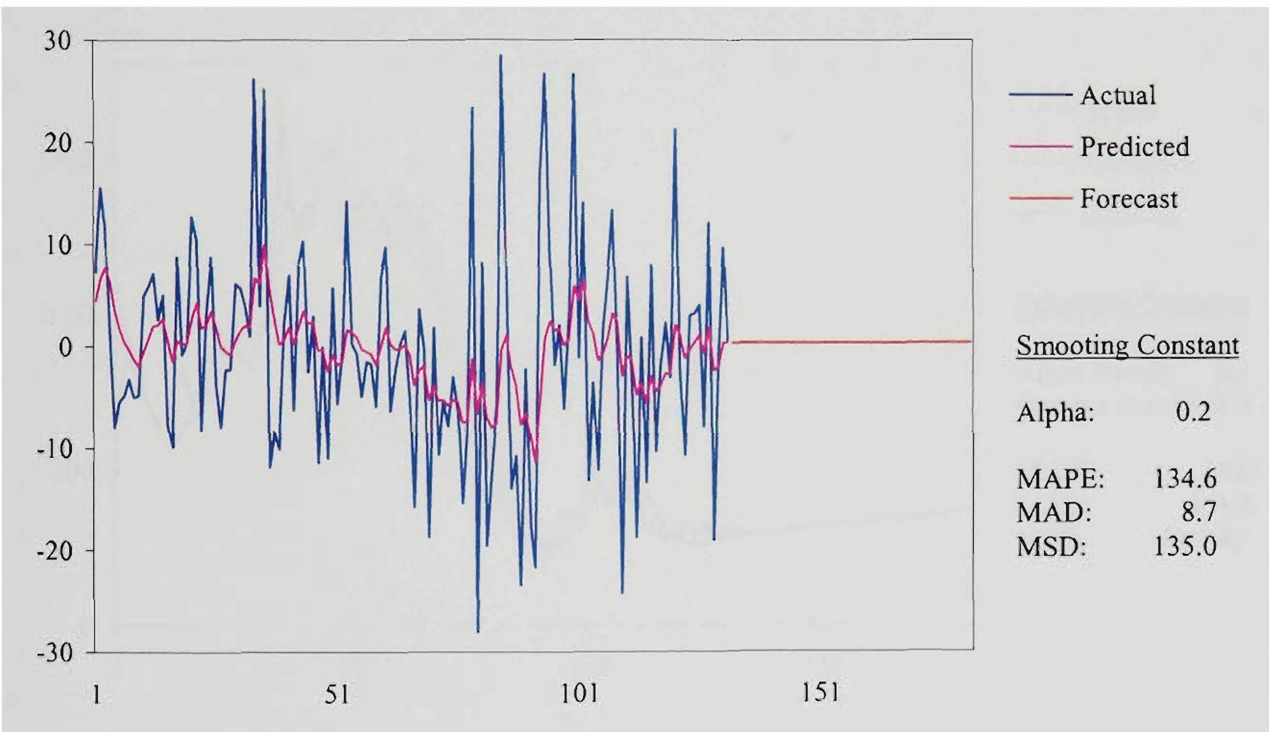


Source: Author's estimate.

Figure 3.7 shows the forecast of the next 50 months on the SET index data, 1992-2001, and the results are shown in Appendix 3 for α = 0.2. The weight value of 0.2, 0.5 and 0.8 is used, however the results indicate a close match between actual and predicted values as in Figure 3.7 and Figure 3.8.

Single exponential smoothing projects the forecast of the next 50 periods of the stock market index and returns simply by imitating the last period outcome. Because of this it is limitated in that its forecast lags behind the actual data and has no ability to adjust for any trend or seasonality. A model that can accommodate trends is required.

Figure 3.8: Single Exponential Smoothing of the SET Index Returns (α = 0.2)



Source: Author's estimate.

The double exponential smoothing[1] model is more complicated than the simple exponential smoothing model because it includes trend components that may be present in the data. Double exponential smoothing is defined as:

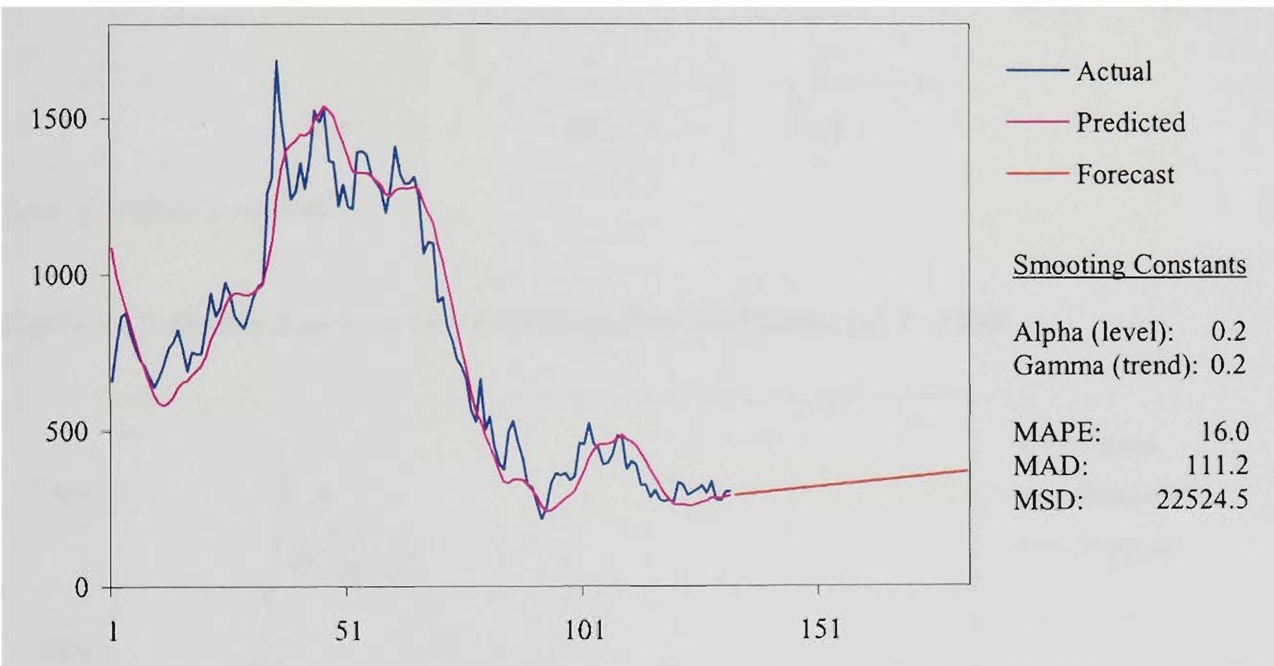
$$F_t = [\alpha y_{t-1} + (1-\alpha)F_{t-1}] + \{\beta[\alpha y_{t-1} + (1-\alpha)F_{t-1}][\alpha y_{t-2} + (1-\alpha)F_{t-2}]\} + (1-\beta)T_{t-1}$$

[1] Sometimes called trend adjusted exponential smoothing.

where $T_t = \beta[\alpha y_{t-1} + (1-\alpha)F_{t-1}][\alpha y_{t-2} + (1-\alpha)F_{t-2}] + (1-\beta)T_{t-1}$.

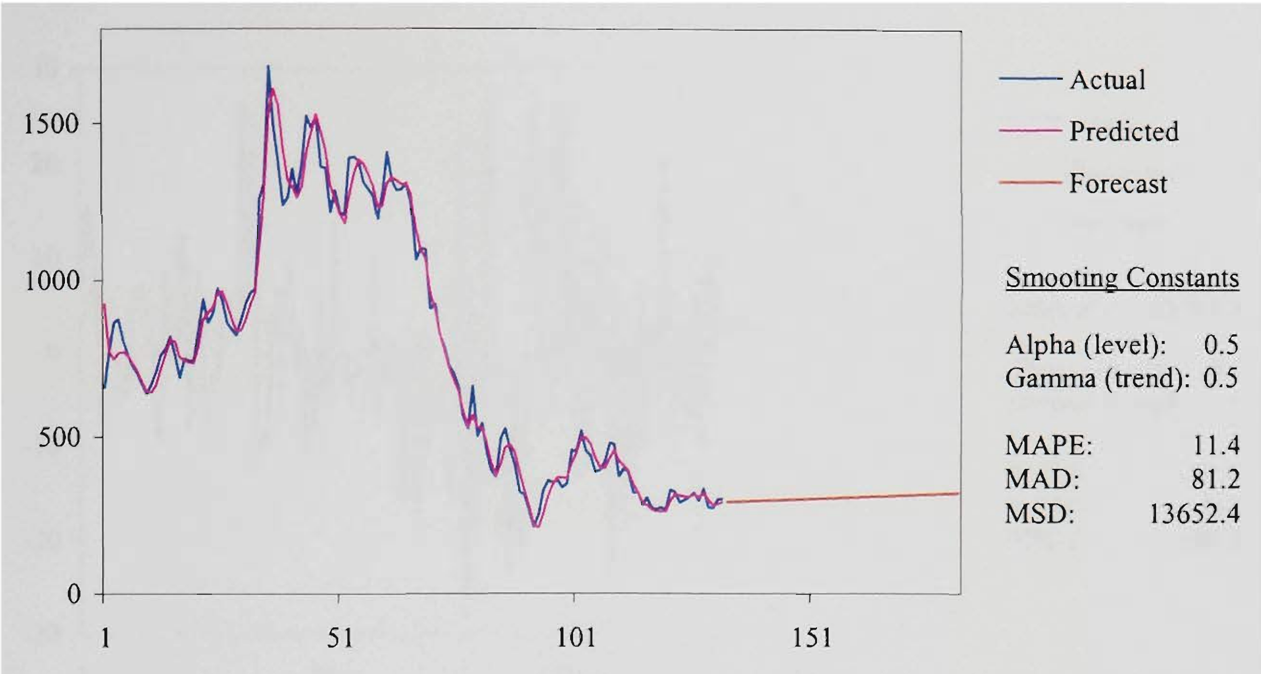
Figures 3.9, 3.10 and 3.11 present the forecast for the next 50 months on the SET index data and figures 3.12, 3.13 and 3.14 forecast for the next 50 months on the returns on SET (when $\alpha = 0.2$, 0.5, and 0.8 respectively). The SET index and returns during 1992-2001 are examined, and the results are shown in Appendix 3.

Figure 3.9: Double Exponential Smoothing of the SET Index (α, T = 0.2)



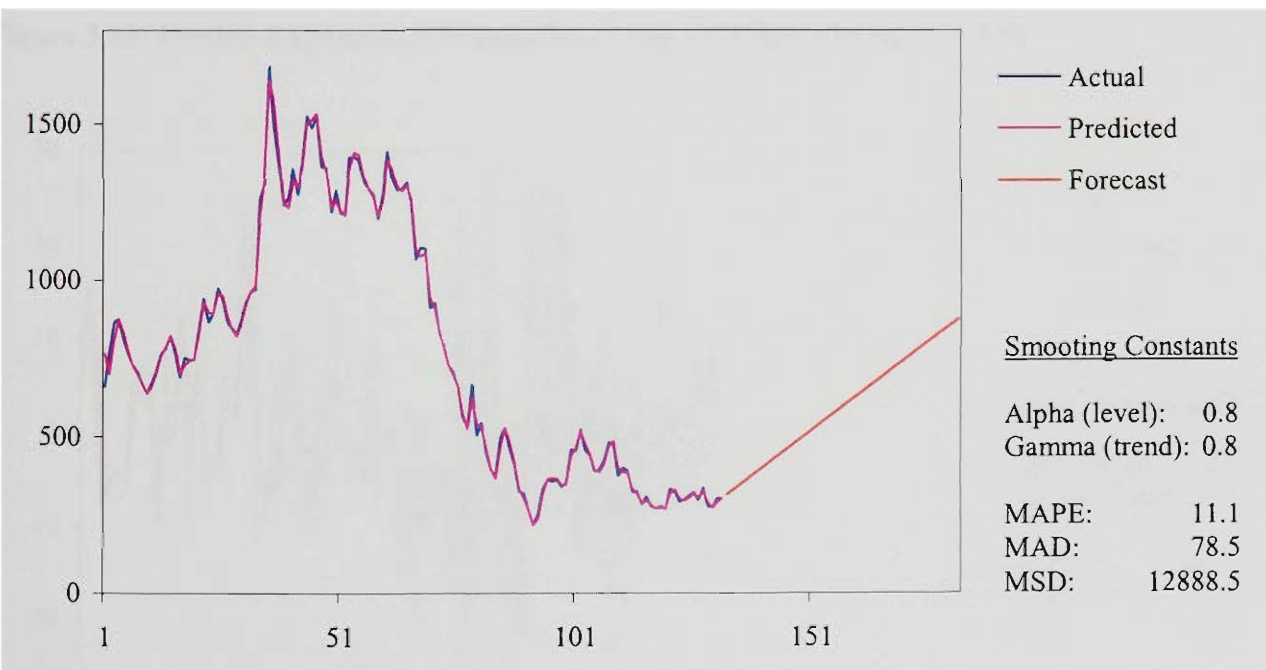
Source: Author's estimate.

Figure 3.10: Double Exponential Smoothing of the SET Index (α, T = 0.5)



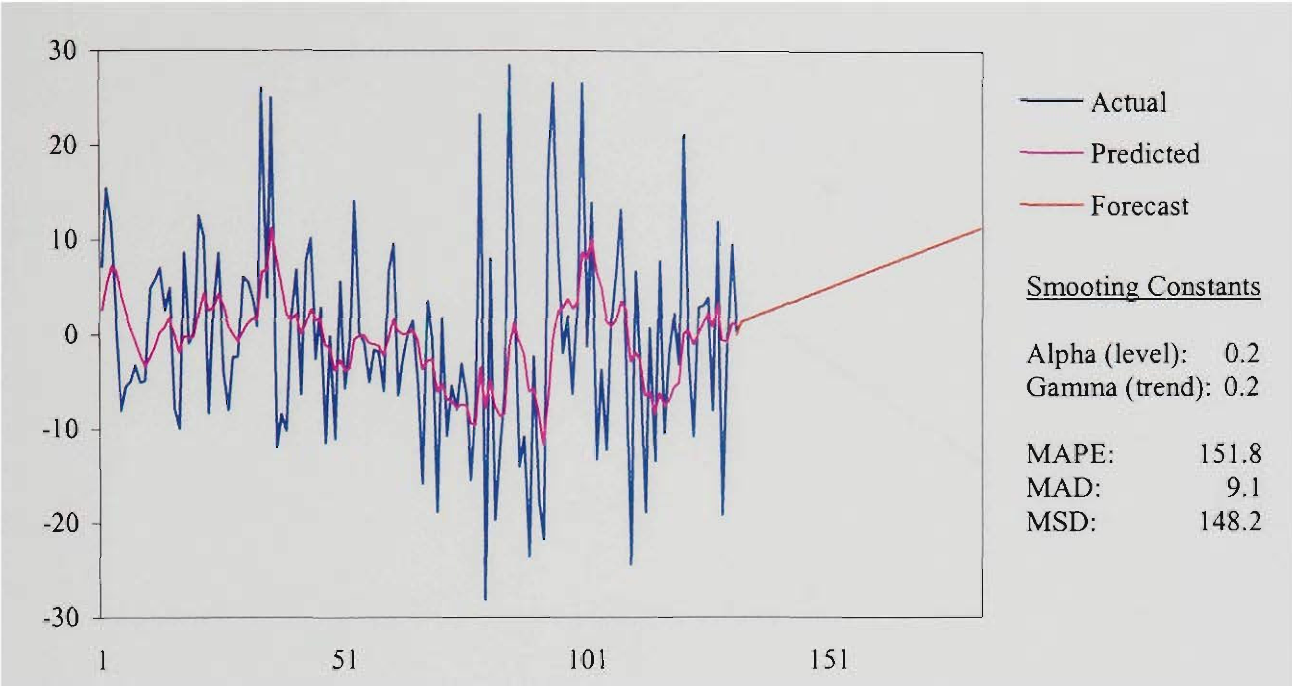
Source: Author's estimate.

Figure 3.11: Double Exponential Smoothing of the SET Index (α, T = 0.8)



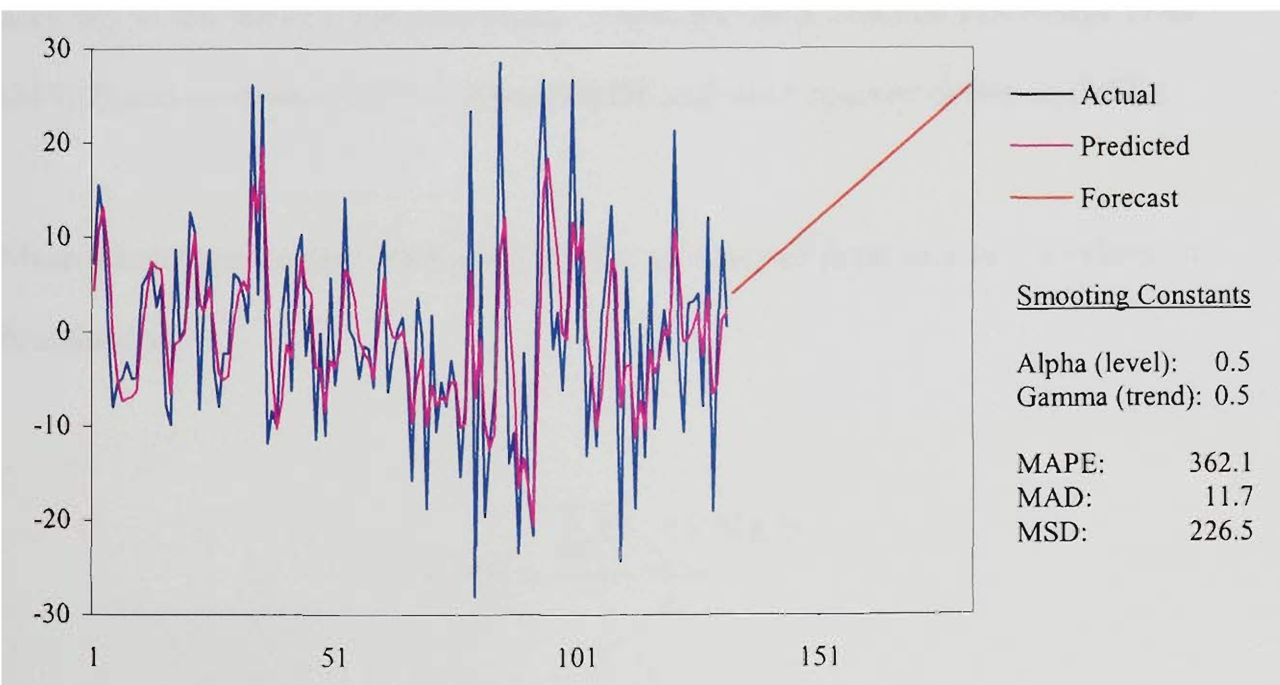
Source: Author's estimate.

Figure 3.12: Double Exponential Smoothing of the SET Returns (α, T = 0.2)



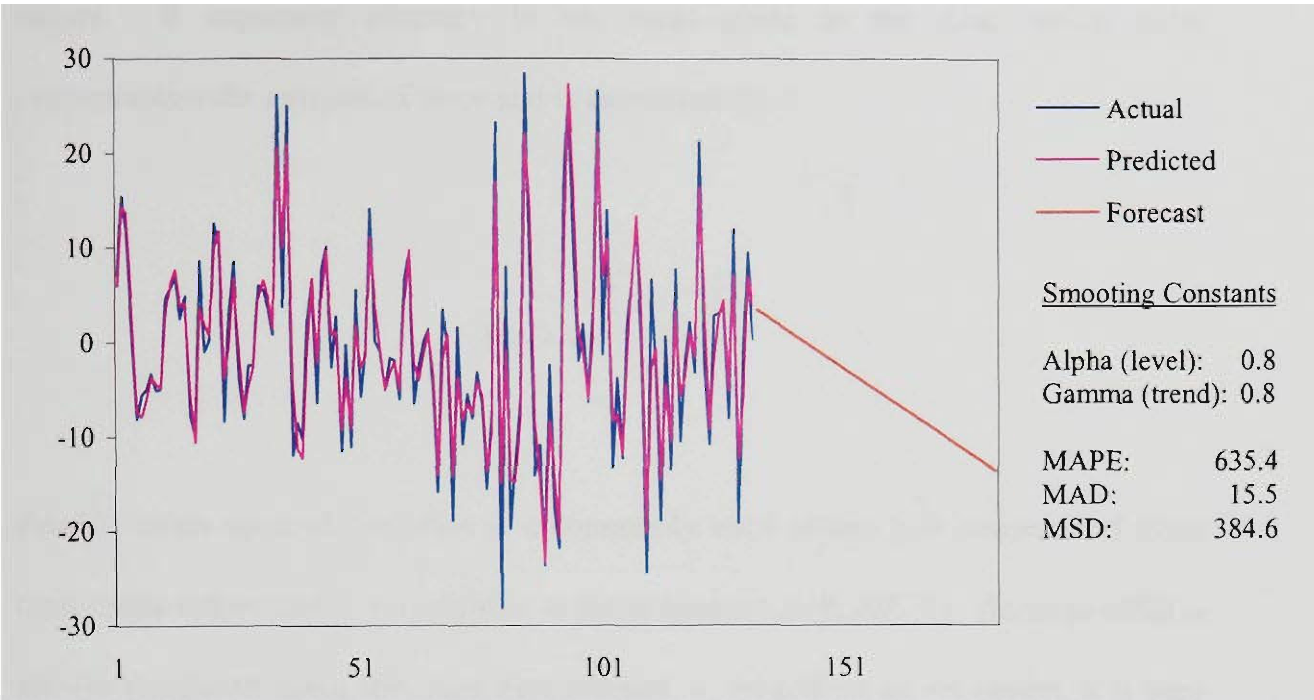
Source: Author's estimate.

Figure 3.13: Double Exponential Smoothing of the SET Returns (α, T = 0.5)



Source: Author's estimate.

Figure 3.14: Double Exponential Smoothing of the SET Returns (α, T = 0.8)



Source: Author's estimate.

Several techniques are used as the assessment measures in evaluating the forecast accuracy of the above fitted time series. These are *mean absolute percentage error* (MAPE) and *mean absolute deviation* (MAD), and *mean squared deviation* (MSD).

Mean absolute percentage error measures the accuracy of fitted time series values. It is defined as:

$$MAPE = \frac{\sum_{t=1}^{n} \left|(y_t - \hat{y}_t)/y_t\right|}{n}$$

where $y_t \neq 0$, y_t = the actual value, $\hat{y}_t$ = the forecast value, and n equals the number of forecasts.

Mean absolute deviation is also used to measure the accuracy of fitted time series values. It expresses accuracy in the same units as the data, which helps conceptualize the amount of error and is expressed as:

$$MAD = \frac{\sum_{t=1}^{n} |y_t - \hat{y}_t|}{n}$$

Finally, mean squared deviation is a commonly used measure of accuracy of fitted time series values and is very similar to mean squared error (MSE). Because MSD is always computed using the same denominator, n, regardless of the model, it is very useful and effective to compare MSD values across models. On the other hand, MSE is computed with different degrees of freedom for different models which make it harder to compare MSE values across models and will not be used here. MSD is defined as:

$$MSD = \frac{\sum_{t=1}^{n} (y_t - \hat{y}_t)^2}{n}$$

Table 3.4: Summary of the Forecasting Assessment Measures Results

	MAPE	MAD	MSD
Single Exponential (α = 0.2)			
SET Index	14.8	94.6	18584.6
SET Returns	134.6	8.7	135.0
Double Exponential			
SET Index (α, T = 0.2)	16.0	111.2	22524.5
SET Index (α, T = 0.5)	11.4	81.2	13652.4
SET Index (α, T = 0.8)	11.1	78.5	12888.5
SET Returns (α, T = 0.2)	151.8	9.1	148.2
SET Returns (α, T = 0.5)	362.1	11.7	226.5
SET Returns (α, T = 0.8)	635.4	15.5	384.6

Source: Author's estimate.

Comparing MAPE, MAD, and MSD across all models, we found that it is better to use a smoothing constant value α and trends T that are close to 1 to forecast the SET index for the future periods, as this minimizes the value of MAPE, MAD and MSD. On the other hand, as shown in Table 3.4, when the smoothing and trends level values are close to 0, the value of these forecasting assessment measures is minimized.

3.3.3 Holt Winters' Multiplicative Method

Winters (1960) proposes forecasting techniques for seasonal time series which are additive seasonality (additive Holt Winters method) and multiplicative seasonality (multiplicative Holt Winters method). The additive Holt Winters method does not depend on the current level of the time series and can simply be added to or subtracted from a forecast that depends only on level and trend. On the other hand, the multiplicative Holt Winters shows that the effect of seasonal influences increases with an increase in the level of the time series. It is important to note that while the multiplicative Holt Winters method provides reasonable point forecasts, it is very difficult to justify the choice of prediction intervals because no underlying statistical model on which to base the variance of the forecast error has been found (Koehler and Snyder 1999).

Assuming that the initial conditions and the parameters are the same, the Holt Winters method adds a third smoothing constant and smoothed seasonal indices to the double exponential smoothing model. This method uses weights to smooth the trend that is similar to single and double exponential smoothing.

The Holt Winters method uses the following four equations:

a) seasonal smoothed values (*S*):

$$S_t = \alpha X_t + (1-\alpha)(S_{t-1} + T_{t-1})$$

b) trend (*T*):

$$T_t = \beta(E_t - E_{t-1}) + (1-\beta)T_{t-1}$$

c) forecast (*F*):

$$F_{t+1} = S_t + T_t$$

d) for *f* periods:

$$F_{t+f} = S_t + fT_t$$

Applying the multiplicative property to the model, the new Holt Winters Exponential Smoothing Model requires the following equations:

a) level (*L*):

$$L_t = \alpha\left(\frac{y_t}{S_{t-s}}\right) + (1-\alpha)(L_{t-1} + T_{t-1})$$

b) trend:

$$T_t = \beta(L_t - L_{t-1}) + (1 - \beta)T_{t-1}$$

c) seasonal smoothed values:

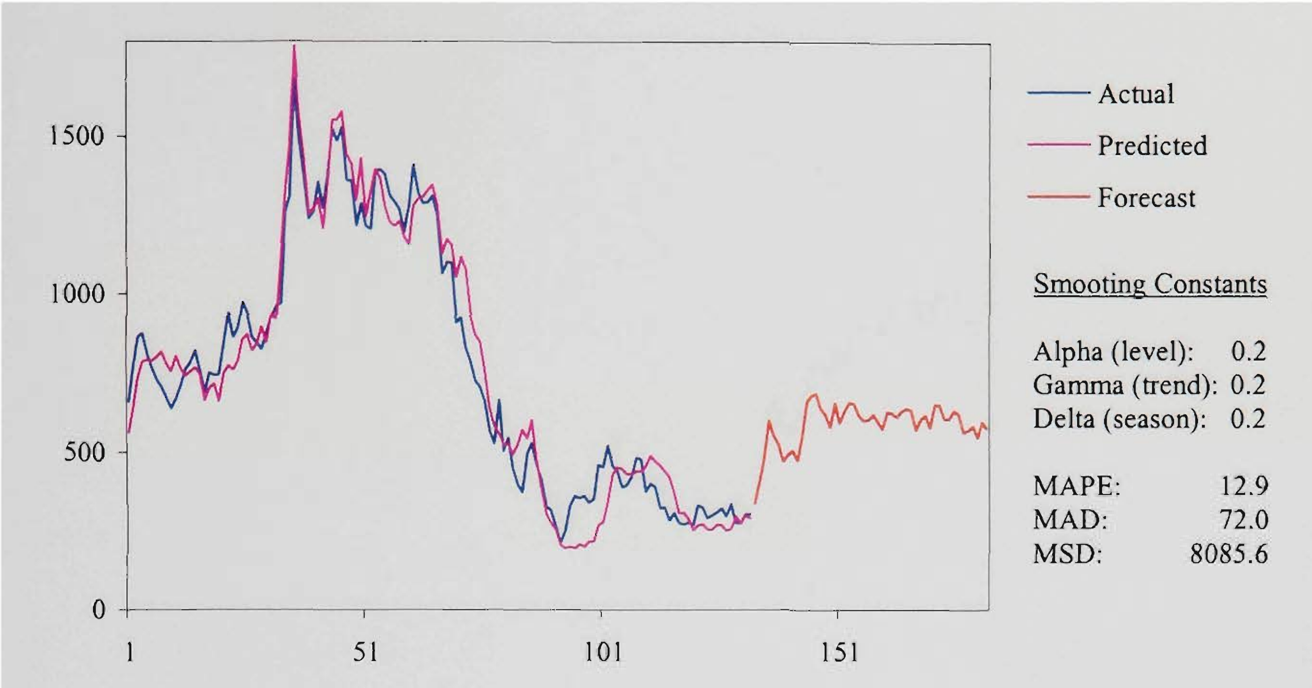
$$S_t = \gamma\left(\frac{y_t}{L_t}\right) + (1 - \gamma)S_{t-s}$$

d) forecast:

$$F_{t+f} = (L_t + T_{t+f})S_{t-s+f}$$

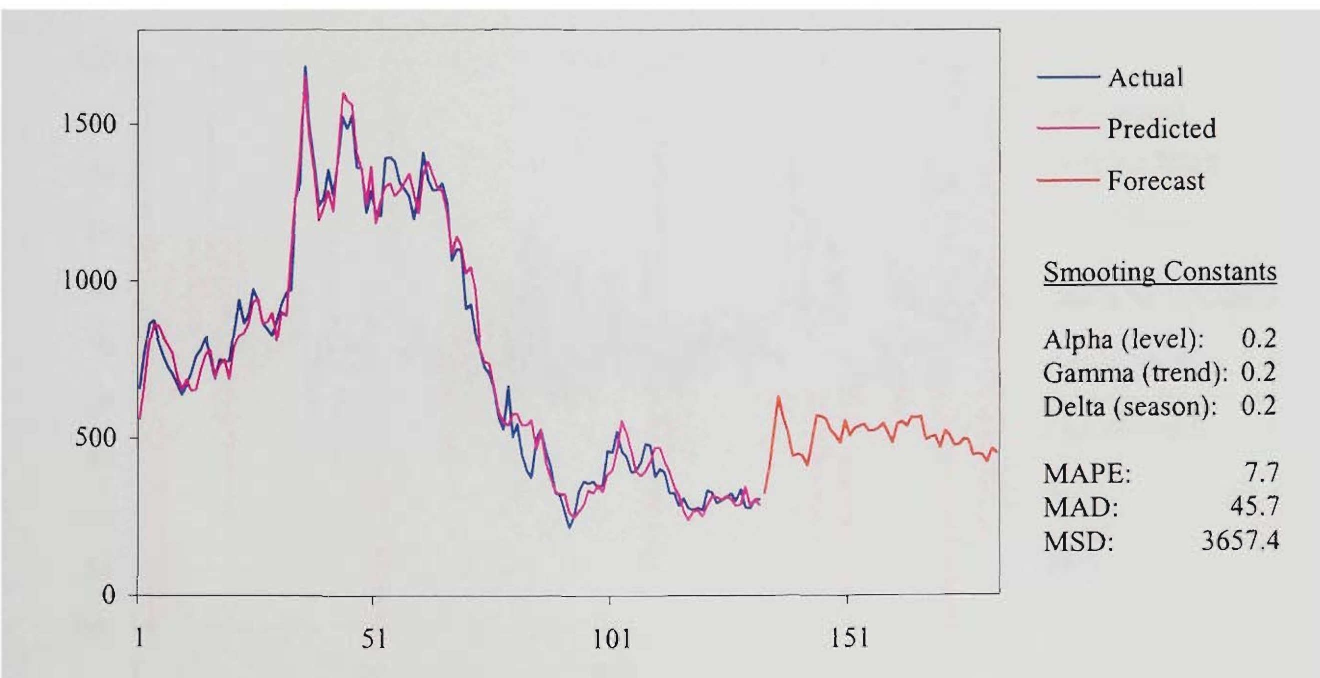
Now we complete the Holt Winters multiplicative model; the forecasts of the SET index for the next 50 periods are presented in figures 3.15, 3.16 and 3.17, and the returns on SET are shown in figures 3.18, 3.19 and 3.20 for various weightings (see Appendix 3).

Figure 3.15: Holt Winters Model of the SET Index Price (*L, T, S* = 0.2)



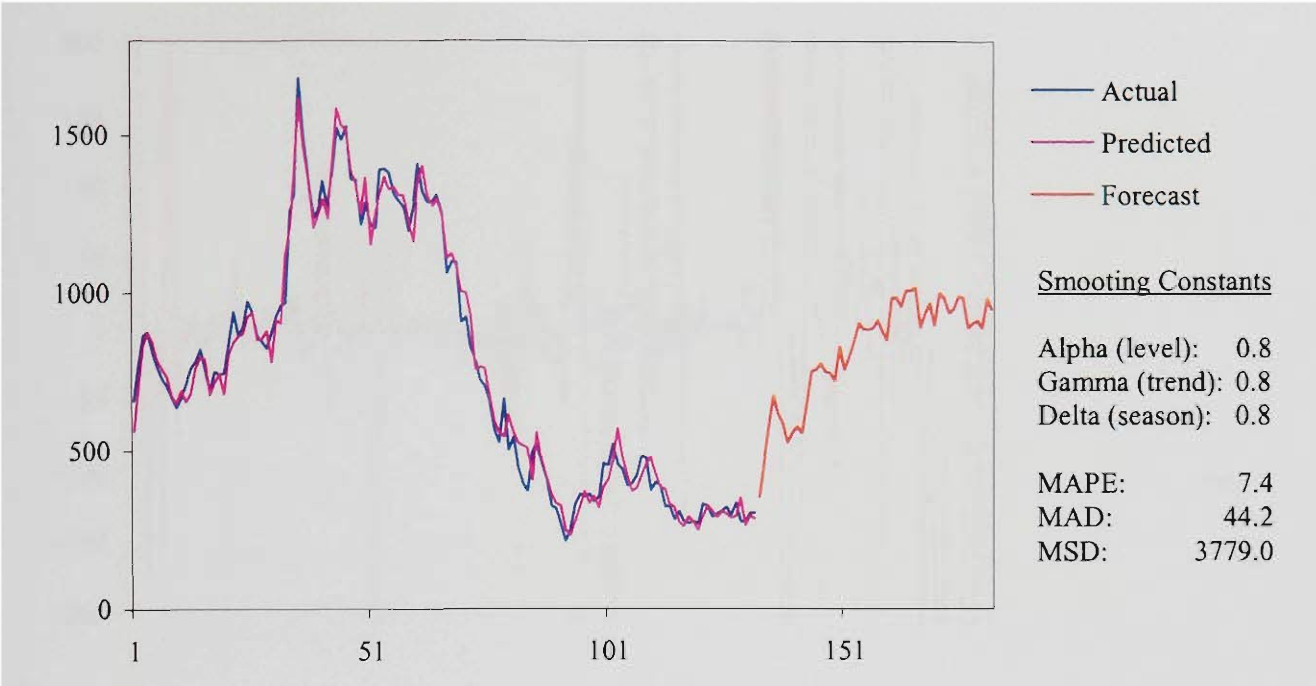
Source: Author's estimate.

Figure 3.16: Holt Winters Model of the SET Index Price (*L, T, S* = 0.5)



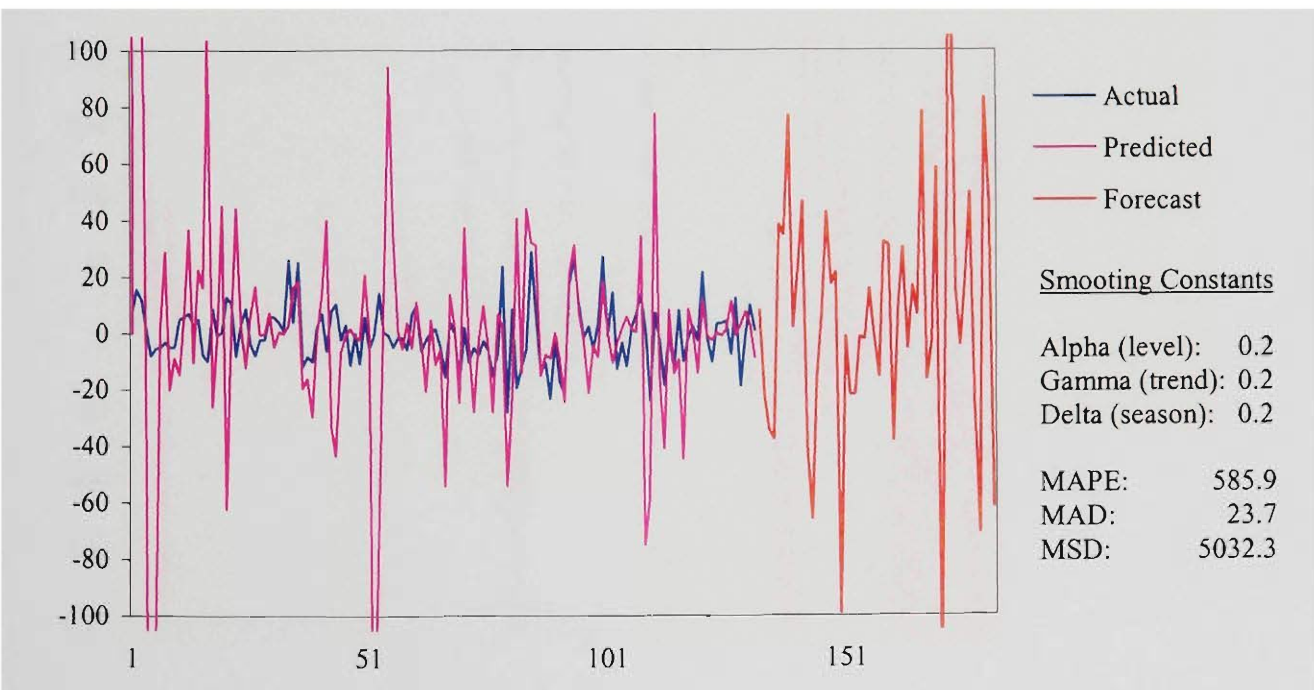
Source: Author's estimate.

Figure 3.17: Holt Winters Model of the SET Index Price (*L, T, S* = 0.8)



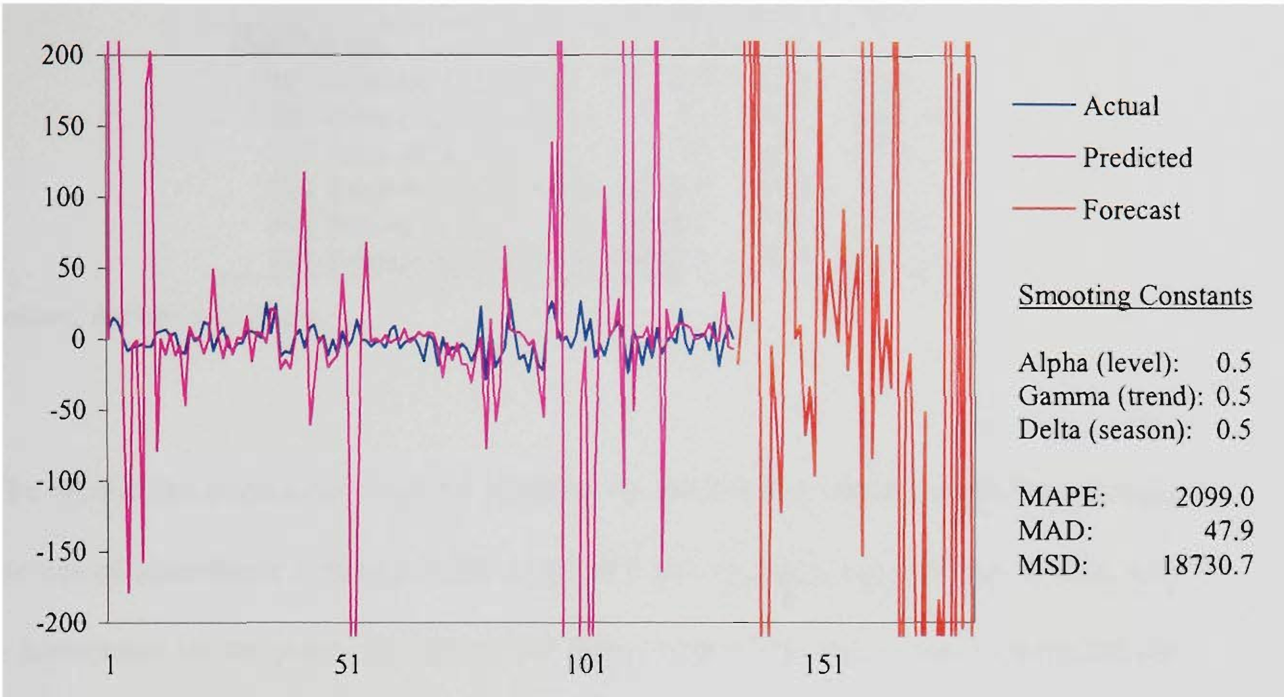
Source: Author's estimate.

Figure 3.18: Holt Winters Model of the SET Returns (*L, T, S* = 0.2)



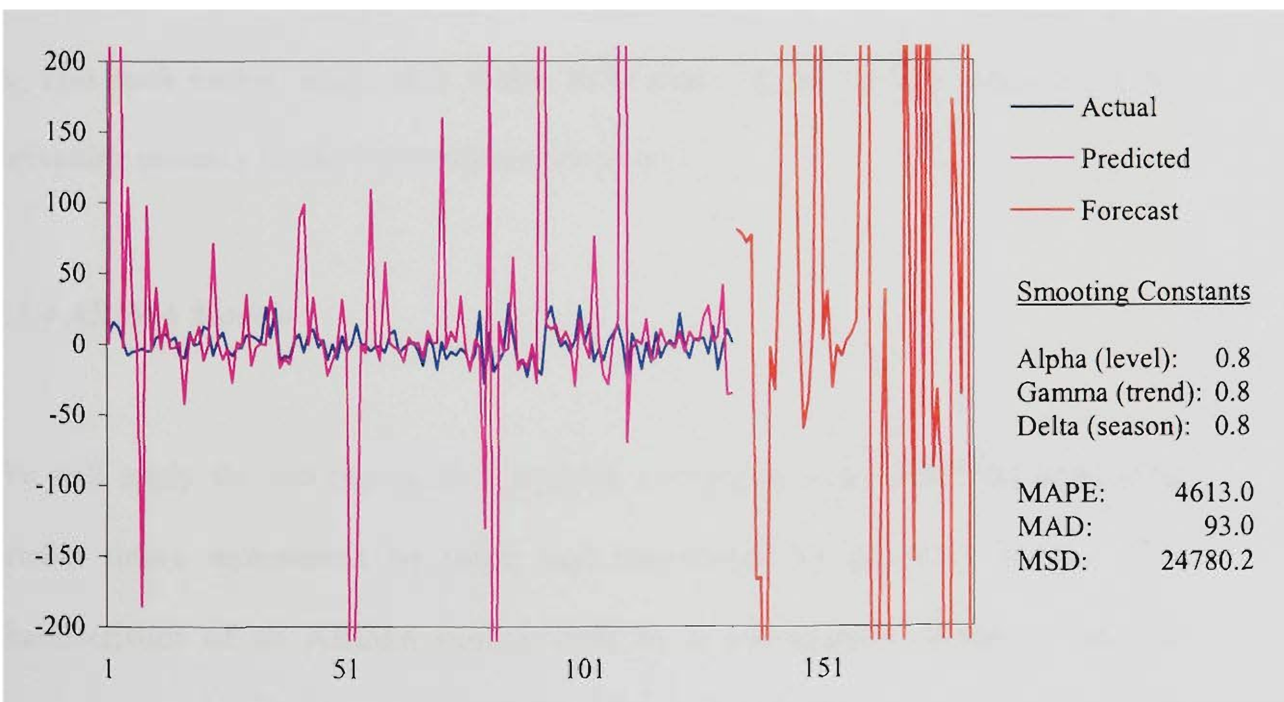
Source: Author's estimate.

Figure 3.19: Holt Winters Model of the SET Returns (*L*, *T*, *S* = 0.5)



Source: Author's estimate.

Figure 3.20: Holt Winters Model of the SET Returns (*L*, *T*, *S* = 0.8)



Source: Author's estimate.

Table 3.5: Summary of the Forecasting Assessment Measures Results

	MAPE	MAD	MSD
Holt Winters			
SET Index (α, T, S = 0.2)	12.9	72.0	8085.6
SET Index (α, T, S = 0.5)	7.7	45.7	3657.4
SET Index (α, T, S = 0.8)	7.4	44.2	3779.0
SET Returns (α, T, S = 0.2)	585.9	23.7	5032.3
SET Returns (α, T, S = 0.5)	2099.0	47.9	18730.7
SET Returns (α, T, S = 0.8)	4613.0	93.0	24780.2

Source: Author's estimate.

The results are consistent with the findings on double exponential smoothing where the use of smoothing constant value α, trend T and seasonal value S that are close to 0 is appropriate for the prediction of the SET index, whereas the use of these values that are close to 1 is appropriate for the returns prediction. According to the assessment measures such as MAPE, MAD and MSD in evaluating the forecast accuracy of the Thai stock market index and returns, Winter Holts model is superior to all exponential models. We can conclude that Winter Holts model (α, T, S = 0.2) produces a better forecasting accuracy for the Thai stock market index, while Winter Holts model (α, T, S = 0.8) produces a better forecasting accuracy for the Thai stock market returns.

3.3.4 ARIMA Models

We will apply the autoregressive integrated moving average (ARIMA) process to predict future movements by using past movements of the stock index. The characteristics of an ARIMA process will be a combination of those from the autoregressive (AR) and moving average (MA) part in differenced d times (or being integrated, I). This model is well grounded in financial or economic theory despite its limitation to forecast unusual movement in prices or returns. Usually, variables are exploited solely for their time series properties to achieve a forecast.

Autoregression in order p, [AR(p)] can be expressed as:

$$y_t = \gamma_1(y_{t-1}) + \gamma_2(y_{t-2}) +, \ldots, + \gamma_p(y_{t-p}) + \varepsilon_t$$

where y_t = the actual or data value at time t, γ = the constant value, and ϵ = the residual or error term.

Moving average of order q, [MA(q)] can be expressed as:

$$y_t = \varepsilon_t - \theta_1(\varepsilon_{t-1}) - \theta_2(\varepsilon_{t-2}) -, \ldots, -\theta_q(\varepsilon_{t-q})$$

Combining both (AR) and (MA) processes, an autoregressive moving average is expressed as:

$$y_t = \gamma_1(y_{t-1}) + \gamma_2(y_{t-2}) +, \ldots, + \gamma_p(y_{t-p}) + \varepsilon_t - \theta_1(\varepsilon_{t-1}) - \theta_2(\varepsilon_{t-2}) -, \ldots, -\theta_q(\varepsilon_{t-q})$$

ARIMA estimates a model of dependent variables on independent variables where the disturbances are allowed to follow a linear autoregressive moving average (ARMA) specification. However, in using the Thailand stock market index when the independent variables are not specified, these models are reduced to autoregressive integrated moving average models in the dependent variable. The persistence of error terms could be identified through the autocorrelation function (ACF) and the partial autocorrelation function (PACF) which will be discussed in Chapter 4.

We will use the ARIMA(p,d,q) model applied to the Thailand stock market index between 1992-2001, where p denotes the number of autoregressive terms, d is the number of times the series has to be differenced before it becomes stationary, and q is the number of moving average terms. Thus the result of ARIMA(1,1,1) is reported as follows (for details, see Appendix 4).

Observing the autocorrelation function, we see one large positive correlation at 1 lag, and 3 large negative correlation at 3 lags, compared to the partial autocorrelation which contains 2 large positive correlations at 2 lags and 1 negative at 1 lag. Therefore, after accounting for the ACF and PACF, the overall lags show a very small correlation, since our model of AR(1) process shows correlations at a 5 per cent level of significance. The critical value for the chi-square distribution with 10 *DF* (Dickey Fuller's unit root test) at the 5 per cent level of significance is 18.31. Since the Modified Box-Pierce (Ljung-Box) Q is 16.1, which is less than 18.31, we accept the null hypothesis and there is scant evidence of correlation. However, the AR(1) process is statistically significant at the 10 per cent level where 16.1 is greater than *DF* 15.99. Therefore, according to the results, we can forecast the SET index at time t by using the following formula:

$$y_t = 6.54 + (-.6925)y_{t-1} + (-0.6282)\varepsilon_{t-1}$$

We can conclude that the autocorrelation function for the residuals shows only white noise with no significant values in any of the 48 lags. The value from the chi-square table is about 16.1 for 12 lags, 22.5 for 24 lags, 36.5 for 36 lags, and 51.0 for 48 lags. This would indicate that the ARIMA (1,1,1) model is an accurate representation of the series.

3.5 Conclusions

This chapter presents a variety of statistical techniques and models that have been developed and applied in an attempt to understand the overall picture of the Stock Exchange of Thailand. Various descriptive statistics of the SET for both monthly and daily stock returns were calculated. The results of these statistics imply that during the Thai economic miracle years of the pre-crisis period the expected mean return is highly positive. During this period, Thailand maintained sound macroeconomic policies and carried out financial liberalisation presumably removing government intervention and its distortionary effects from the financial markets.

However, what Thailand should have done was to first develop a sound financial system and policy instruments before fully implementing financial liberalisation. The Thai economic crisis of 1997-1998 was an unfortunate outcome of the confluence of a weak domestic financial system and volatile international capital movements where the post-crisis period yields negative mean return and the standard deviation or risk is also higher. Higher standard deviation in the post-crisis period means greater volatility, which in turn could mean extraordinary gains or losses, thus greater uncertainty in the Thai stock market. In addition, the shape of the kurtosis suggests that the unconditional distribution of the volatility is nearly a normal distribution.

Univariate time series econometrics models such as moving average, exponential smoothing, Holt Winters and ARIMA models have produced useful results for technical analysts and investors to monitor the market and determine changes in trends of the key indicators of the Thai stock market performance. The use of multiple models and techniques will enhance the accuracy of the forecasting process and thus improve the decision making of investors. The implication of the financial models and technical analysis in forecasting is that if these models are used by investors to earn extraordinary returns, it reflects that the market is weak-form efficient. Under weak-form EMH, historical data for stock prices can be used in order to predict future prices. A discussion of market efficiency follows.

Chapter 4

MARKET EFFICIENCY

4.1 Introduction

Possibly the most controversial issue in finance is whether the financial market is efficient in allocating economic resources or not. Other financial theory issues such as volatility, predictability, speculation and anomalies are also related to the efficiency issue and are all interdependent (Islam and Oh 2003; Cuthbertson 1996). An investigation of the Efficient Market Hypothesis (EMH) of the Thai stock market is provided in this chapter while the other related issues of finance theory are included in subsequent chapters.

"An efficient capital market is a market that is efficient in processing information… In an efficient market, prices 'fully reflect' available information" (Fama 1976, p. 133). In the broadest terms of EMH, there are three types of market efficiency. Firstly, in *weak form efficiency*, the information set includes only the history of prices or returns themselves. Secondly, in *semi-strong form efficiency*, the information set includes most information known to all market participants. Finally, in *strong form efficiency*, the information set includes all information known to any market participant.

In the 1960s and early 1970s, the controversy focused on the extent to which successive changes in prices of the stocks were independent of each other or whether stock prices followed a random walk. The early tests to answer this question were conducted by Fama (1965) and Samuelson (1965), in which they concluded that most of the evidence seems to have been consistent with the efficient market hypothesis (EMH). Stock prices followed a random walk model and the predictable variations in equity returns, if any, were found to be statistically insignificant. Other studies in the US with similar findings included those of Sharpe (1966), Friend et al. (1970), and Williamson (1972).

Throughout the 1980s, EMH has provided the theoretical basis for much of the research, and most empirical studies during these years focused on predicting prices from historical data, while also attempting to produce forecasts based on variables such as P/E ratios (Campbell and Shiller 1987), dividend yield (Fama and French 1988), term structure variables (Harvey 1991), and announcement of various events, i.e. earnings, stock splits, capital expenditure, divestitures, and takeovers (Jensen and Ruback 1983; McConnell and Muscarella 1985).

The concept of EMH in relation to stock prices is fundamental for an investigation of the characteristics of the Thai stock market. Some recent studies have maintained EMH and also stimulated models, which reflect the influence of various factors toward stock prices. The results from testing the EMH can assist in the identification of these factors, which could be seen as the influence of anomalies (Nassir and Mohammad 1987; Ho 1990; Berument and Kayimaz 2001), insider trading and asymmetric information (Jaffe 1974; Jagadeesh, and Titman 1993), stock splits (Ikenberry, Ranikine and Stice 1996), dividend initiations and omissions (Michaely, Thaler, and Womack 1995), etc.

Various methods for testing market efficiency of the stock market have been used in this thesis such as the run-test, autocorrelation test, rational speculative bubble test, seasonal anomalies test and autoregressive (AR) test. Our focus in this chapter is to build a theory-free paradigm of non-parametric testing of market efficiency. The non-parametric run-test and autocorrelation test target consistent statistical characteristics of the price and returns process using few interlinkages with a specific model of asset pricing. If the stock exchange of Thailand was efficient, the stock prices would correctly and fully reflect all relevant information and hence, no arbitrage opportunities would exist. Thus in this type of test, the rejection of the null hypothesis would reject market efficiency for the Thai stock market. The implication of efficiency, in its broadest sense, is that stock prices always reflect their intrinsic worth and can be taken at their face value.

This chapter is structured as follows: Section 4.2 provides a literature review of the market efficiency hypothesis. Section 4.3 discusses the most common non-parametric methods such as the run-test and the autocorrelation function (ACF) test in testing the EMH. The results are also shown in this section. A conclusion is given in Section 4.4.

4.2 Market Efficiency Hypothesis

In this chapter, we empirically examine the efficiency issues of the Stock Exchange of Thailand. The efficient market hypothesis (EMH) is a statement about: (1) the theory that stock prices reflect the true value of stocks; (2) the absence of arbitrage opportunities in an economy populated by rational, profit-maximizing agents; and (3) the hypothesis that market prices always fully reflect available information (Fama 1970). In Jensen (1978), an efficient market is defined with respect to an information set Φ_t if it is impossible to earn economic profits by trading on the basis of Φ_t. Fama (1970) presented a general notation describing how investors generate price expectations for stocks. This could be explained as (Cuthbertson 1996):

$$E(p_{j,t+1} \mid \Phi_t) = [1 + E(r_{j,t+1} \mid \Phi_t)]p_{jt}$$

where E is the expected value operator, $p_{j,t+1}$ is the price of security j at time $t+1$, $r_{j,t+1}$ is the return on security j during period $t+1$, and Φ_t is the set of information available to investors at time t.

The left-hand side of the formula $E(p_{j,t+1} \mid \Phi_t)$ denotes the expected end-of-period price on stock j, given the information available at the beginning of the period Φ_t. On the right-hand side, $1 + E(r_{j,t+1} \mid \Phi_t)$ denotes the expected return over the forthcoming time period of stocks having the same amount of risk as stock j.

Under the efficient market hypothesis (EMH), investors cannot earn abnormal profits on the available information set Φ_t other than by chance. The level of over value or under value of a particular stock is defined as:

$$x_{j,t+1} = p_{j,t+1} - E(p_{j,t+1} \mid \Phi_t)$$

where $x_{j,t+1}$ indicates the extent to which the actual price for security j at the end of the period differs from the price expected by investors based on the information available Φ_t. As a result, in an efficient market it must be true that:

$$E(x_{j,t+1} \mid \Phi_t) = 0$$

This implies that the information is always impounded in stock prices. Therefore the rational expectations of the returns for a particular stock according to the EMH may be represented as:

$$P_{t+1} = E_t P_{t+1} + \varepsilon_{t+1}$$

where P_t is the stock price; and ε_{t+1} is the forecast error. $P_{t+1} - E_t P_{t+1}$ should therefore be zero on average and should be uncorrelated with any information Φ_t. Also $E(x_{j,t+1} \mid \Phi_t) = 0$ when the random variable (good or bad news), the expected value of the forecast error, is zero:

$$E_t \varepsilon_{t+1} = E_t (P_{t+1} - E_t P_{t+1}) = E_t P_{t+1} - E_t P_{t+1} = 0$$

Underlying the efficient market hypothesis, it is opportune to mention that expected stock returns are entirely consistent with randomness in security returns. This position is supported by the *law of iterated expectations* (Campbell, Lo and MacKinlay 1997; Samuelson 1965). The expectational difference equation can be solved forward by repeatedly substituting out future prices and using the law of iterated expectations:

$$E_t\, [E_t{+}I_t\, (X)] = E_t(X)$$

Campbell, Lo and MacKinlay state that:

> *...if one has limited information I_t, the best forecast one can make a random variable X is the forecast of the forecast one would make of X if one had superior information J_t, rewritten as $E_t\ [X\text{-}E[X|\ J_t]|\ I_t$ is equal to zero. One cannot use limited information I_t to predict the forecast error one would make if one had superior information J_t.(1997, p.23)*

Non-parametric testing of market efficiency is based on the premise of no arbitrage opportunities, i.e., that opportunities for earning unusual returns do not exist (Fama 1970; Jensen 1978). Along with other empirical studies (Ball 1978; Charest 1978; Banz 1981; Schwert 1983; Fama and French 1989; Fama 1991; Fama et al. 1993; Lo 1996) have also jointly tested the market efficiency with an asset pricing model. If the null hypothesis is rejected, the failure of either market efficiency or the model does exist. However, the authors have often preferred to conclude that difficulties in asset pricing theory, rather than market efficiency, underlie the rejection of the null which have been uncovered in tests of asset pricing. In addition, the rejection of the null hypothesis is likely to have resulted from the misspecification of the asset pricing theory and not market efficiency itself.

To reiterate, the absence of arbitrage opportunities expresses the idea that the only chance for speculators to gain an opportunity to earn abnormal profits occurs if mispriced stocks exist in an economy populated by rational agents. In fact, the mispriced stocks will be automatically adjusted.

Since this scenario will be replayed every time an arbitrage opportunity arises, price levels will be continuously maintained according to the Samuelson's fair game theory or martingale difference. Samuelson (1965) modeled this property of prices as the random walk:

$$Y_t = Y_{t-1} + \varepsilon_t$$

and random walk with drift (time trend):

$$Y_t = \mu + Y_{t-1} + \varepsilon_t$$

Random walks also exhibit Markov and martingale properties. A Markov property is the information for determining the probability of a future value of the random variable already contained or expressed in the current status of that variable. The martingale property is the conditional expectation of a future value of the random variable. The positive drift (called sub-martingale) in random walk exists when α is greater than zero. On the other hand, negative drift (called super-martingale) in random walk exists when α is less than zero. However, if α is equal to zero, then it would be a normal random walk. The martingale property is defined as:

$$Y_t = Y_{t-1} + \alpha + \varepsilon_t$$

Campbell, Lo and MacKinlay (1997, p. 29) summarize the classification of random walk and martingale hypotheses as in Table 4.1.

Table 4.1: Classification of Random Walk and Martingale Hypotheses

$Cov[f(r_t), g(r_{t+k})] = 0$	$g(r_{t+k}), \forall g(.)$	$g(r_{t+k}), \forall g(.)$
$f(r_t), \forall f(.)$ Linear	Uncorrelated Increments, Random Walk 3: $\Pr oj[r_{t+k} \mid r_t] = \mu$	
$f(r_t), \forall f(.)$	Martingale/Fair Game: $E[r_{t+k} \mid r_t] = \mu$	Independent Increments, Random Walks 1 and 2: $pdf[r_{t+k} \mid r_t] = pdf(r_{t+k})$

Source: Campbell, Lo and MacKinlay 1997, p. 29.

If the stock prices follow a random walk, then price changes are white noise. Therefore, testing whether returns are white noise is observationally equivalent to the test of random walk in stock prices. Given r_t as the percentage change in Y_t, the null hypothesis of market efficiency is thus formed as testing for the standard statistical properties of a homoscedastic white noise process as follows:

$$\begin{aligned} H_0 : E(r_t) &= 0; \\ E(r_t r_t) &= \sigma_r^2; \\ E(r_t r_s) &= 0; \forall t \neq s \end{aligned}$$

Chapter 5 will discuss in greater depth the alternative methods of returns predictability for stocks trading on the Thai stock exchange.

4.3 Stock Market Efficiency Tests

Keane (1983, p. 31) provides some basic explanations of what makes markets inefficient. One of his ideas is called "Gambler's Fallacy". This may be described as the belief that what "goes up must come down". This phenomenon exhibits itself amongst investors whose stocks' price has risen for a period of time and so is deemed to be "due for a fall".

Generally speaking, by knowing the relationship of the current price to recent price movements, one can better estimate the likely direction of future price movements, i.e. historical data such as price movement can be used to predict future prices. This provides credibility to the argument that the market is predictable and inefficient. Therefore, the issue is to see whether the stock market is predictable or not by detecting the autocorrelation of stock returns. In this chapter, the most common tests of market efficiency are applied, which are the run test and autocorrelation function (ACF) test.

4.3.1 Run Test

The run test, also called Geary test, is a non-parametric test whereby the number of sequences of consecutive positive and negative returns is tabulated and compared against its sampling distribution under the random walk hypothesis (Campbell, Lo and MacKinlay 1997; Gujarati 2003). A run is defined as the repeated occurrence of the same value or category of a variable. It is indexed by two parameters, which are the type of the run and the length. Stock price runs can be positive, negative, or have no change. The length is how often a run type occurs in succession. Under the null hypothesis that successive outcomes are independent, the total expected number of runs is distributed as normal with the following mean:

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

and the following standard deviation:

$$\sigma_\mu = \left[\frac{\sum_{i=1}^{3}[\sum_{i=1}^{3} n_i^2 + N(N+1)] - 2N(\sum_{i=1}^{3} n_i^3 - N^3)}{N^2(N-1)}\right]^{\frac{1}{2}}$$

where n_i is the number of runs of type i. The test for serial dependence is carried out by comparing the actual number of runs, a_r in the price series, to the expected number μ. The null proposition is:

$$H_0 : E(runs) = \mu$$

In this section, runs in the monthly SET index for the total period, pre-crisis, and post-crisis are studied. The test results are tabulated in Table 4.2.

Table 4.2: Run Tests for the Monthly Data SET Index

Period	Observed No. of Runs	Expected No. of Runs	Negative	Positive	Test Value
1975-2001	13	145.99	209	111	454.26
1992-1996 (Pre-crisis)	3	30.70	27	33	1132.62
1997-2001 (Post-crisis)	10	29.37	37	23	399.33

Source: Author's estimate.

A remarkable aspect of runs of all periods is that the observed number of runs is significantly less than the expected number of runs, approximately only ten percent of the expected number of runs, especially in the overall period (1975-2001), and the pre-crisis period (1992-1996). This is evidence that the residuals change sign frequently, thus indicating a strong positive serial correlation. Table 4.3 shows the test results for the daily SET index. Two periods, pre-crisis and post-crisis, are studied.

Table 4.3: Run Tests for the Daily Data SET Index

Period	Observed No. of Runs	Expected No. of Runs	Negative	Positive	Test Value
1992-1996 (Pre-crisis)	551	613.99	611	615	0.01
1997-2001 (Post-crisis)	570	611.99	657	571	-0.82

Source: Author's estimate.

A run test using daily data produces a different result to the monthly results in the degree of autorrelation. This is caused by the difference in the number of data being used. However, we can notice that the observed and expected number of runs for both the pre-crisis and post-crisis period are very similar. In addition, the test value is not significant and we can conclude that, for both periods, the null hypothesis is rejected and there is an evidence of autocorrelation.

Many papers on market efficiency have employed run tests in a similar framework for verification of the weak-form efficiency of the U.S. and other countries' stock markets, such as the studies by Fama (1965), Sharma and Kennedy (1977), Cooper (1982), Chiat and Finn (1983), Wong and Kwong (1984), Yalawar (1988), Ko and Lee (1991), Butler and Malaikah (1992), and Thomas (1995). These typically find that in most markets (except Hong Kong, India, Kuwait and Saudi Arabia), the null hypothesis is not rejected. Thailand, as elsewhere in developing countries, experiences relative underdevelopment of the capital market especially the stock market, which can be attributed to inadequate market and legal infrastructure. Therefore, the results of the run tests indicate that Thailand's stock market is not efficient.

4.3.2 Autocorrelation Function Test

The autocorrelation function (ACF) test is examined to identify the degree of autocorrelation in a time series. It measures the correlation between the current and lagged observations of the time series of stock returns, which is defined as:

$$p_k = \frac{\sum_{t=1}^{n-k}(R_t - \overline{R})(R_{t+k} - \overline{R})}{\sum_{t=1}^{n}(R_t - \overline{R})^2}$$

where k is the number of lags, and R_t represents the real rate of return calculated as:

$$R_t = \ln\left(\frac{I_t}{I_{t-1}}\right) \times 100 = \alpha + u$$

Two important elements for estimating of autocorrelation are the standard error test and the Box Pierce Q (BPQ) test. The standard error test measures the autocorrelation coefficient for individual lags and identifies the significant one, while the Box Pierce Q test, measures the significant autocorrelation coefficients at the group level.

The standard error σ_k is defined as:

$$\sqrt{\frac{1 + 2\sum_{t=1}^{k-1} \theta_t^2}{N}}$$

where N is the total number of observations and θ_k is the autocorrelation at lag (k).

Box Pierce Q is identified as:

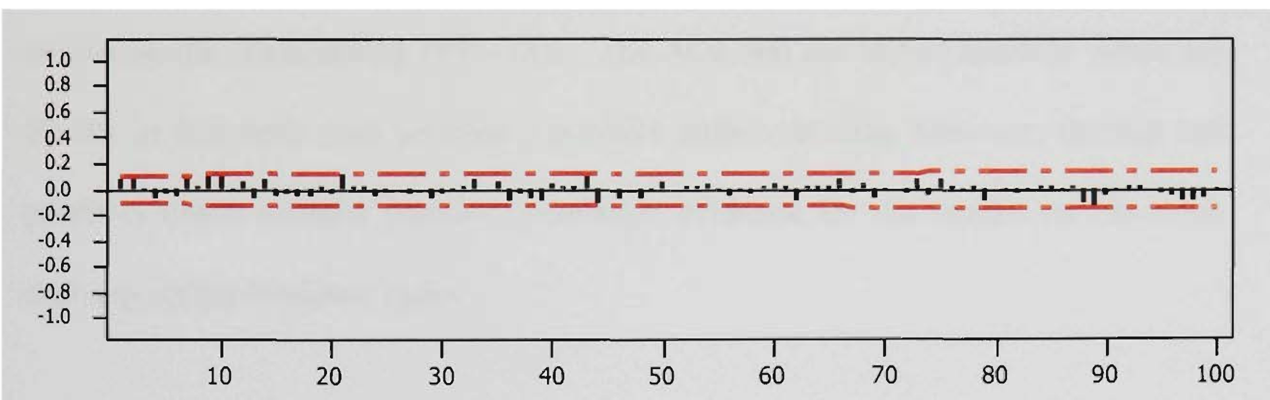
$$N(N+2)\sum_{t=1}^{k} \frac{R_t^2}{N-t}$$

One hundred lags length have been run, as Gujarati (2003) suggests, computing ACF of around one-quarter to one-third of the length of the time series. The calculation results of the autocorrelation function and partial autocorrelation for both monthly and daily returns are reported in Appendix 5.

ACF Results of Monthly Returns

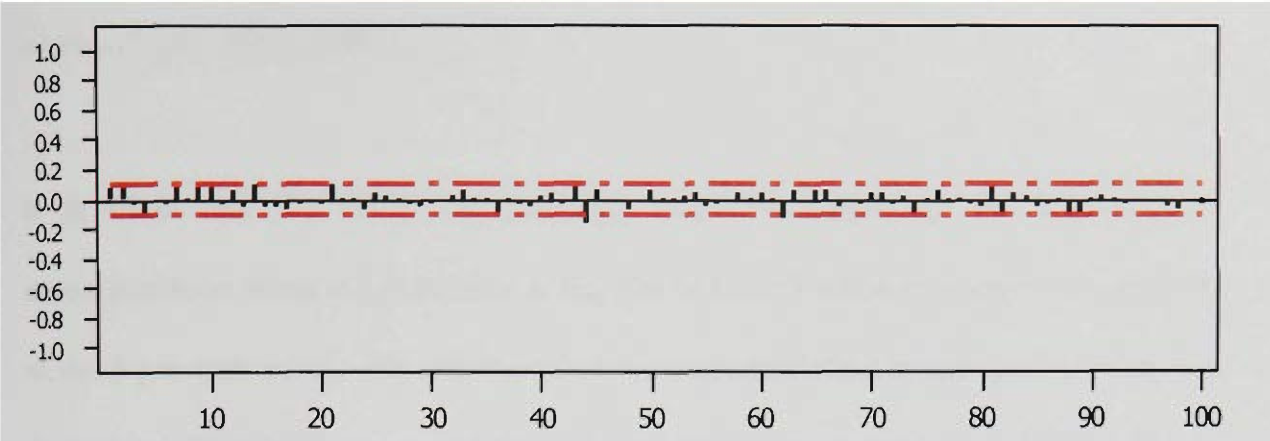
We use monthly data of the stock return to calculate ACF. Figures 4.1 and 4.2 show the correlograms of the autocorrelation and partial correlation function on stock returns during 1992-2001.

Figure 4.1: Correlogram of the Autocorrelation Function on Stock Returns, 1992-2001



Source: Author's estimate.

Figure 4.2: Correlogram of the Partial Autocorrelation Function on Stock Returns, 1992-2001



Source: Author's estimate.

According to the results, there are movements of autocorrelation at various lags that hover around positive numbers and zero. This explains the non-stationarity time series. The results exhibit the small level of positive autocorrelation of the monthly returns on the stock during 1992-2001. The ACF and run test of monthly return are similar in that both tests produce a positive autocorrelation, however, the run test produces much stronger positive correlation evidence for the returns on the stock exchange of the Thailand index.

To see if ACF is significant, we calculate the Q statistics for 100 lags. The critical value for the chi-square distribution with 100 DF at the 5 per cent level of significance is 124.3. The ACF result at lag 100 yields 122.86. With the ACF test on the monthly stock price, the test statistic is significant at a 10 per cent level, when $Q = 122.86 > 118.5$. Therefore, we can accept the null hypothesis of the presence of autocorrelation at the 10 per cent level of significance.

ACF Results of Daily Returns

a) Pre-Crisis, 1992-1996

It is clear that the ACF test produces evidence supporting the existence of autocorrelation when the Q statistic at lag 100 is 136.23 which is greater than 100 DF at the 5 per cent level. We conclude that the autocorrelation is stronger by using the daily data. Therefore, we accept the null hypothesis (see appendix 5, table A5.2).

b) Post-Crisis, 1997-2001

The result of pertaining to the post-crisis period is very similar to the pre-crisis period. In fact, during this period, there is a strong autocorrelation existed in the data. The Q statistic at lag 100 yields 161.33, which is considered very significant (see Appendix 5, Table A5.3).

4.4 The Market Efficiency of the Thai Financial System

The implication of the tests for the efficient market hypothesis of the Thai stock market is that the market is not efficient, or it falls into a weak form of market efficiency since there is a strong chance that investors or stock analysts could use historical data to earn extraordinary gains by purchasing and selling stocks. Strong-form efficiency suggests that securities prices always reflect all available information, including private information. The semi-strong form of EMH asserts that stock prices reflect all publicly available information, thus there are no undervalued or overvalued securities, and trading schemes are incapable of producing superior returns. The weak form of the hypothesis suggests that past prices or returns reflect future prices or returns and technical analysts could use various univariate forecasting models and technical analysis, discussed in Chapter 3, to predict the stock movement and make extraordinary gains. However, Fama (1991) expanded the concept of the weak form to include predicting future returns with the use of accounting or macroeconomic variables (see Chapter 5).

Studies such as Islam and Oh (2003), Fama (1991), and Seyhun (1986) agree that the weak and semi-strong form of EMH has formed the basis for most empirical research. The result of the tests confirms the presence of autocorrelation on the Thai stock market returns, which implies that the market falls into a form of EMH. However, the theory of stock market behaviour and anomalies, which will be discussed in Chapter 6, provides evidence against the EMH.

4.5 Conclusions

The theoretical and empirical studies of the efficient market hypothesis have made an important contribution to the understanding of the stock market. The results show that there is an autocorrelation on the Thai stock market returns especially during the post-crisis period. The result from the run test on daily return data, rejects the null hypothesis. From this we may conclude that the Stock Exchange of Thailand is an inefficient market.

The inefficiency of the Thai stock market follows from the violation of the necessary conditions for an efficient market with a developed financial system (see Chapter 1) and also implies financial and institutional imperfections. This leads to the conclusion that Thai financial policies and regulations such as those concerning liberalisation, deregulation and privatization, perceived inconsistency and tendency to produce instability. The implication is that the benefits of a well functioning stock market are not being realized in the economy. Indeed, the weak-form inefficiency of the stock market demonstrated in this study is most likely caused by a combination of the lack of its development and the implication of policy choices.

It is necessary to gain more insights into the operation and characteristics of the stock market of Thailand in terms of its efficiency and the valuation processes to make an informed assessment of the empirical characteristics of the Thai financial market. The next chapter will introduce the fundamental methods of stock valuation such as discounted cash flow methods, capital asset pricing theory, and arbitrage pricing theory. A new muti-factor valuation model is developed by incorporated relevant economic and international factors to model the appropriate valuation processes in the Thai stock market and to gain an in depth understanding of the operation of the Thai market. Further analysis and the use of econometric models such as multiple regression with dummy variables (anomalies) and volatility models are necessary to identify the level of EMH in the Thai stock market.

Chapter 5

STOCK VALUATION

5.1 Introduction

There are many different emerging and enduring financial issues in the financial sectors of developing countries, however a central issue is the valuation of stocks, i.e. the mechanism (process and factors) for determining the value of stocks. Valuation is closely related to market efficiency – if the market is efficient then stocks should be valued approximately by market forces and factors. There are various models appropriate for valuating stocks in developing countries such as the discounted cash flow model (DCFM), the capital asset pricing model (CAPM), and the arbitrage pricing model (APM). In recent years multi-factor modeling has become prominent (Islam and Oh 2000; Dabek 1999; Mishkin 1997).

Some progress has been made towards understanding the relationship between two or more variables determining stock prices and returns in particular markets such as the U.S. stock market (Dhalkal, Kandil and Sharma 1993), U.K. stock market (Cheng 1995), and some Asian stock markets (Wongbangpo and Shama 2002).

The objective of this chapter is to analyse the principles of valuation of stocks in a developing economy, especially in Thailand. A valuation is an estimate of the value of some financial assets. There are many approaches in stock valuation such as DCFM, CAPM, and APM. Limitations of the existing models are based on their assumptions of market equilibrium and the existence of a perfect market. In many developing countries, there are market imperfections and other market characteristics which make the existing models unsuitable for countries like Thailand and other developing countries. Therefore, there is a need to develop a suitable approach to valuation of stocks trading on the Thai stock exchange.

This chapter reviews the existing theories of valuation of financial assets and also proposes a new valuation model which supports the existence of a significant, long-run relationship between stock prices and macroeconomic factors affecting stock prices on the Stock Exchange of Thailand. The valuation model is developed and empirically applied to the data gathered between 1992 and 2000.

5.2 Literature Review: Why a Multifactor Model?

In this section we look at models that seek to determine how investors decide what is the real value V_t of a particular stock. We start with the basic valuation models of analysis used in finance and econometrics literature. The most commonly used models are the Rational Valuation Model, the Capital Asset Pricing Model and the Arbitrage Pricing Model.

5.2.1 The Rational Valuation Model

According to Bodie et al. (1993), Peirson et al. (1995) and Chew (1997), the rational valuation model is one of the most widely used valuation models for determining the market values of firms and is based on the Discounted Cash Flow (DCF) method. The DCF Model is widely accepted as a basic valuation model for a security that is expected to generate cash payments. According to the *efficient market hypothesis*, stock prices should always fully reflect all relevant information. Therefore, the fundamental value under expected discounted present value of future cash flow and dividends should always underline the expected value of the stock. The value of a particular stock is defined as:

$$V_0 = \frac{CF_1}{(1+K)^1} + \frac{CF_2}{(1+K)^2} + \frac{CF_3}{(1+K)^3} + \ldots \frac{CF_n}{(1+K)^n}$$

or:

$$V_0 = \sum_{n=1}^{\infty} \frac{CF_n}{(1+K)^n}$$

where V_0 is the present value of the anticipated cash flows from the security, its current value, $CF_{1,2,3...n}$ is cash flows expected to be received, and K is the discount rate or the required rate of return.

The periodic cash flows from an investment in shares are dividends D. Valuating common stock by estimating the present value of the expected future cash flows or dividends from the common stock could be done by applying the general valuation model to common stocks as follows:

$$P_0 = \frac{D_1}{(1+K_s)^1} + \frac{D_2}{(1+K_s)^2} + \frac{D_3}{(1+K_s)^3} + \cdots \frac{D_n}{(1+K_s)^n} + \frac{P_n}{(1+K_s)^n}$$

or:

$$P_0 = \sum_{n=1}^{n} \frac{D_n}{(1+K)^n} + \frac{P_n}{(1+K)^n}$$

where P_0 is the current price of the common stock, $D_1, D_2 \ldots D_n$ are dividends expected to be received at the end of the periods, P_n is the anticipated selling price of the stock in n periods, and K_s is the required rate of return on this common stock investment.

This model takes potential into account the source of return (anticipated selling price of the stock) from an investment in stock P. Hence, the capital gain or loss is the difference between P_n and P_{n-1}. The price of the stocks when they are sold is the discounted value of all future dividends from year $n+1$. Therefore, after substituting the equation, we obtain the DCFM expression on the stock price:

$$P_0 = \sum_{n=1}^{\infty} \frac{D_n}{(1+k)^n}$$

The basic model for stocks valuation is the discounted cash flow or present value model. A key proposition running through this model is that stock returns and stock prices are closely linked (for details, see Cuthbertson 1996). This model relates the price of a stock to its expected future cash flow and dividends discounted to the present using a time-varying discount rate. Since cash flows in all future periods enter the discounted rate, the cash flow in any one period is only a component of the stock price. Therefore, persistent movements in cash flows have much larger effects on prices than temporary movements. The simple net return formula for a stock with constant expected return is defined as:

$$R_{t+1} = \frac{(P_{t+1})(D_{t+1})}{P_t} - 1 \qquad \text{(a)}$$

where, R_{t+1} is the return on the stock held from time t to time $t+1$, P_t is the price of a share of stock measure at the end of period t or equivalently an ex-dividend price, and D_t is dividends or cash flow at the period $t+1$.

An alternative measure of return is the log or continuously compounded return:

$$r_{t+1} = \log(1 + R_{t+1})$$

Law of Iterated Expectations

Is it assume that the expected stock return is equal to a constant R:

$$E_t[R_{t+1}] = R \tag{b}$$

Taking expectations of the identity (a), imposing (b), and rearranging, the equation relating the current stock price to the next expected stock price and dividend is:

$$P_t = E_t\left[\frac{P_{t+1} + D_{t+1}}{1+R}\right] \tag{c}$$

The most commonly used discounted cash flow (DCF) valuation approaches are those based on either intrinsic financial reports or on earnings (Islam and Oh 2000). The intrinsic method is based on the present value of expected cash flows projected from data that is considered subjective and associated with specific strategic or management choices. The earnings method is generally characterised by the use of profits, dividends or free cash flows for valuing the firm. The use of future cash flows to determine stock prices is consistent with the randomness in security returns under the efficient market hypothesis (Campbell, Lo, and MacKinlay 1997).

This position is supported by the *law of iterated expectations* (Campbell, Lo and MacKinlay 1997; Samuelson 1965). In (c), the expectational difference equation can be solved forward by repeatedly substituting out future prices and using the law of iterated expectations:

$$E_t \{E_t + I_t (X)\} = E_t(X)$$

To eliminate future-dated expectations, after solving for the forward k periods we have:

$$P_t = E_t\left[\sum_{i=1}^{k}\left(\frac{1}{1+R}\right)^i D_{t+1}\right] + E_t\left[\left(\frac{1}{1+R}\right)^k P_{t+k}\right] \tag{d}$$

The second term on the right-hand side of (d) is the expected discounted value of the stock price k periods from the present.

In some circumstances, dividends can grow at different rates. Applying the DCF and the Dividend Discount Model (DDM) incorporating growth may be difficult because these models assume stock dividends are paid regularly and grow at a constant rate (FitzHerbert 1998, p. 172). When constant growth occurs, the model could be seen as:

$$P_0 = \frac{D_1}{k-g}$$

where: P_0 is the Current price of the stock, D_1 is the Dividend in period 1, k is the discount rate, g is the growth rate. In addition, the discount rate k acts as proxy for the expected rate of return required by investors.

5.2.2 Capital Asset Pricing Model (CAPM)

According to Cuthbertson (1996), the Capital Asset Pricing Model (CAPM) is interpreted as a model of *equilibrium asset return*. It is one of the economic models and relevant to business valuation where businesses and business interests are subsets of investment opportunities available in the total capital market. It predicts a trade off between expected return under specific conditions and systematic risk β (Pratt et al. 1996). Sharpe (1964) suggests that much of the nonsystematic (or security specific) risk is not relevant to investors in the company's stock, as this risk could be diversified away in a well-managed portfolio.

Many studies such as Chen et al. (1986), Fama (1990) and Balvers et al. (1990) use CAPM to explain the relationship between interest rates, macroeconomic activity and stock returns. Theoretically, the determination of stock prices should be subject to the same economic forces and relationships that determine the prices or values of other investment assets (Peirson et al. 1995; Pratt et al. 1996; Brigham and Gapenski 1994).

According to Sharpe (1964) and Lintner (1965), CAPM is defined as:

$$E(Ri) = R_f + \beta \ (E(Rm) - Ri)$$

where ER_i is the expected return on investment, R_f is the risk free rate of return, β is the investment's systemic risk, and $E(R_m) - R_i$ is the expected risk premium in the market.

Some of the assumptions behind the CAPM need to be followed in order to apply CAPM to the valuation of stocks (Sharpe 1995; Fama 1970). These assumptions are:

a) investors evaluate portfolios by looking at the expected returns and standard deviations of the portfolios over a one-period horizon;
b) investors are never satiated, so when given a choice between two portfolios with identical standard deviations, they will choose the one with the higher expected return;
c) investors are risk averse, so when given a choice between two portfolios with identical expected returns, they will choose the one with the lower standard deviations;
d) individual assets are infinitely divisible, meaning that an investor can buy a fraction of a share if he or she so desires;
e) there is a risk-free rate at which an investor may either lend or borrow money;
f) taxes and transaction costs are irrelevant;
g) all investors have the same one-period horizon;
h) the risk-free rate is the same for all investors;
i) information is freely and instantly available to all investors; and

j) investors have homogeneous expectations regarding the expected returns, standard deviations, and covariances of stocks.

Throughout this and subsequent chapters the following equivalent ways of expressing expected returns, variances and covariances will be used.

Expected return:	$\mu_i = ER_i$
Variance of returns:	$\sigma_i^2 = \mathrm{var}(R_i)$
Covariance of returns:	$\sigma_i = \mathrm{cov}(R_i)$

CAPM is a conceptual cornerstone of modern capital market theory and stock valuations. Sharpe and Cooper (1992) and Black, Jensen and Scholes (1972) have provided evidence on the stability of betas by holding the stocks of 10 particular classes over the entire period and found that the relationship between strategy and return whilst not perfect is close. Black (1986) comments that correlation of stock prices and return are observable. It is also possible to observe the correlations among the returns on different stocks.

The CAPM is specified ex-ante the event and it is a theory based on investors' unobservable beliefs about future returns on securities in equilibrium. The CAPM proves that the relationship between asset prices in general equilibrium, where the investors select assets to maximize the mean-variance utility, is linear (Islam and Oh 2000).

According to Oh (2001), and Islam, Oh and Watanapalachaikul (2001), the capital asset pricing equation from the microeconomic foundations of portfolio choice could be explained as:

$$V_t(s) = \sum_{k=1}^{K} r_{tk} s_k$$

where vector s is (s1, s2,..., sk), v is the value of the portfolio, s is the quantities of each of the K assets held in portfolio, and r_{tk} is the return of the assets in each period t.

The expected value of the portfolio s equals the sum of the expected returns of from the individual assets weighted by the quantities of the assets held in the portfolio:

$$\mu(s) = \sum_{k=1}^{k} \mu_k s_k$$

where μ_k is the expected return from asset k $(k=1, \ldots \ldots, k)$. The variance of the value of holding portfolio s for a specific period is denoted by:

$$\sigma^2(s) = \left[\sum_{k=1}^{K} s_k\right]\left[\sum_{j=1}^{J} s_j \sigma_{jk}\right]$$

When we differentiate $\mu(s)$ and $\sigma^2(s)$ with respect to asset s_H we get:

$$\mu_H(s) = \mu_H$$

where $\mu_H(s) = \partial\mu_H(s)/\partial\mu_H$ denotes the partial derivative of $\mu_H(s)$ with respect to s_H, and denoting the partial derivative of $\sigma^2(s)$ with respect to s_H by $\sigma_H^2(s) = \partial\sigma^2(s)/\partial\sigma_H$:

$$\sigma_H^2(s) = 2\left(\sum_{k=1}^{K} s_k \sigma_{HK}\right)$$

or:

$$\sigma_H^2(s) = 2\sigma(s, H)$$

Thus, $\sigma(s,H) = \sum_{k=1}^{k} s_k \sigma_{Hk}$, is the covariance between the return of the entire portfolio and the return of the single asset H.

In optimising the value of the asset portfolio of some investor $i \in (1, 2, \ldots \ldots, i)$:

$$\text{Max } s = V^i(\mu(s), \sigma^2(s))$$

subject to $\sum_{k=1}^{K} p_k s_k = \sum_{k=1}^{K} P_k \bar{s}_k$, and denoting that $V^i_1 = \partial V^i/\partial\mu$ and $V^i_1 = \partial V^i/\partial\sigma^2$, the first order conditions for this problem are as follows:

$$\left[V_1^i(\mu(s), \sigma^2(s))(\mu_H(s))\right] + \left[V_2^i(\mu(s), \sigma^2(s))(\sigma_H^2(s)\right] - \left[\lambda(P_H)\right] = 0 \qquad \text{(e)}$$

for $H = 1, \ldots, k$, and

$$\sum_{k=1}^{k} p_k s_k = \sum_{k=1}^{k} P_k \bar{s}_k$$

where λ is the Lagrange multiplier of the budget constraint. The CAPM is derived from the first order condition of equation (e) at equilibrium, and assuming that one of the assets is riskless.

The first order conditions implicitly define share demand as follows:

$$s_H^i = f_H^i(p_1, p_2, \ldots, p_k; \bar{s}_1^i, \bar{s}_2^i, \ldots, \bar{s}_k) = \sum_{i=1}^{i} \bar{s}_k^i = S_k$$

where S_k is the aggregate quantity of the asset (stocks) available in the market. If we assume all the assets to be stocks, then the quantity of stocks demanded is the equilibrium with the available supply.

To derive the CAPM equation from equation (e), we assume asset k is risk-free, then the return is $r_{tk}=r$ for all $t=1, \ldots, t$. The partial derivatives of the expected return and variance function with respect to the changes in the size of asset k in the portfolio are:

$$\mu_k(s) = r$$

and:

$$\sigma_H^2(s) = \sigma(s, k) = 0$$

Substituting these values into the first-order conditions and choosing the riskless asset as numeraire $p_k=1$, we solve the k th first order condition for the Lagrange multiplier as:

$$\lambda = V_{i1}[\mu(s^{*i}), \sigma^2(s^{*i})](r)$$

Substituting for λ, $\mu_H(s)$ and $\sigma_H^2(s)$, the first *K-1* first-order condition of equation (e) becomes:

$$\left[V_1^i\left(\mu(s^{*i}), \sigma^2(s^{*i})\right)\left(\mu_H - p_H^*(r)\right)\right] + 2\left[V_1^i\left(\mu(s^{*i}), \sigma^2(s^{*i})\right)\right]\left[\sum_{j=1}^{k} s_j^{*i}(\sigma_{jH})\right] = 0$$

Rewriting this equation as:

$$\Phi^i(s^{*i})(\mu_H - p_H^*(r)) = \sum_{j=1}^{k} s_j^{*i}(\sigma_{jH})$$

where:

$$\Phi^i(s^{*i}) = -\frac{V_1^i(\mu(s^{*i}), \sigma^2(s^{*i}))}{2V_1^i(\mu(s^{*i}), \sigma^2(s^{*i}))}$$

This could be seen as the marginal rate of substitution along an investor's indifference curve in (μ, σ) space.

In equilibrium and over all investors:

$$\sum_{i=1}^{I} s_k^{*i} = S_k$$

and:

$$\theta(s^*)(\mu_H - p_H^*(r)) = \sigma(S, H) \tag{f}$$

where:

$$\theta(s^*) = \sum_{i=1}^{I} \Phi^i(s^{*i}),$$

$$\theta(S, H) = \sum_{j=1}^{k} S_j \sigma_{jH}$$

The covariance of asset H with the aggregate of assets A *is* $(A_1, \ldots, A_k)$. Multiplying equation (f) by S_H and summing up all risky assets $H=1, \ldots, K-1$, we obtain:

$$\theta(s^*)[(\mu(S) - r)(V_0(s)] = \sigma^2(S) \tag{g}$$

The mean return on aggregate assets is defined as:

$$\mu(S) = \sum_{H=1}^{k} \mu_H S_H$$

and the market value of the market portfolio is defined as:

$$V_0(S) = \sum p_H A_H$$

Solving equation (g) for $\theta(s^*)$ and substituting into equation (f) we are able to obtain the CAPM equation for asset units:

$$\left[(\mu - r)(p_H^*)\right] = \frac{\sigma(S,H)}{\sigma^2(S)}\left[\mu(S) - rV_0(S)\right] \qquad \text{(h)}$$

In financial economics, the pay-off unit of investment is measured by the expected rate of return in equilibrium represented by:

$$(E)\mu_k = \frac{\mu_k}{p_k^*}$$

and by the optimal investment share in total expenditure on asset k, instead of the optimal quantity of assets in investment. Expected investment in asset k is measured by:

$$(E)A_k^* = A_k^* \frac{p_k^*}{V_0^i}$$

Dividing equation (h) by p_H and $V_0(S)$ on the right-hand side, we have:

$$(\hat{\mu}_H - r) = \frac{\hat{\sigma}(S,H)}{\hat{\sigma}^2(S)}(\hat{\mu}(S) - r) \qquad \text{(i)}$$

where:

$\hat{\mu}(S) = \dfrac{\mu(S)}{V_0(S)}$ = the average return on the market portfolio per unit of investment;

$\hat{\sigma}(S,H) = \dfrac{\sigma(S,H)}{p_h V_0(s)}$ = the covariance between the asset H and the market portfolio per unit of investment; and

$\hat{\sigma}^2(S) = \dfrac{\hat{\sigma}^2(S)}{V_0(S)^2}$ = the variance of the market portfolio per unit of investment

Replacing $\dfrac{\hat{\sigma}(S,H)}{\hat{\sigma}^2(S)}$ with β_H in equation (i), we have the CAPM expression for the expected return on a particular stock:

$$(\hat{\mu}_H - r) = \beta_H(\hat{\mu}(S) - r)$$

or:

$$(\hat{\mu}_H) = r + \beta_H(\hat{\mu}(S) - r)$$

The above equation, which states that in equilibrium, the expected return of each risky asset is equal to the riskless rate of return plus the difference between the expected rate of return on the market portfolio and the riskless rate for each individual risk class.

Finally, expected return is $\mu_i = ER_i$ then the CAPM expression is:

$$ER_i = R_f + \beta\ (ER_m - R_i)$$

The CAPM is a useful method and relevant to stock valuation where it posits a simple and stable linear relationship between an asset's systematic risk and expected returns. Three factors need to be determined in order to use the CAPM for estimating the required rate of return: the risk-free rate, the market risk premium and the systematic risk (beta, β).

According to Islam and Oh (2003, 2000), the standard procedure for estimating beta is simply to regress stock returns against market returns and to use the slope of the regression as the beta. However, some studies such as Akdenis, Salih and Caner (2002), and Fama and French (1992), have found weak or no statistical evidence in support of this simple relationship between an asset's systematic risk and expected return. Criticisms against the CAPM include the suggestion that since the market portfolio could never be observed, the CAPM could never be tested and that all tests of the CAPM were effectively joint tests of the model and the market portfolios used in the tests (Islam and Oh 2003). Stimulated by these findings, a number of researchers have sought to find alternative explanations for the risk and return trade off.

5.2.3 The Arbitrage Pricing Theory

The Arbitrage Pricing Theory (APT)[1] can be seen as an alternative to the CAPM to determine the expected rate of return on particular stocks and on portfolios of stocks. In the CAPM there is only one factor that influences expected return which is the covariance between the return on the stock and the return on the market portfolio (Cuthbertson 1996). However, the APT incorporates a larger number of factors that affect the rate of return on a particular stock (Madala 2001; Cuthbertson 1996). Empirical evidence suggests that the APT explains expected returns better than the single factor CAPM (Cuthbertson 1996; Berry, Burmeister and McElroy 1988; Chen Ross and Roll 1986; Chen 1983). The APT is defined as:

[1] The APT is often referred to as a *multi-factor* or *multi-index* model (Madala 2001; Cuthbertson 1996).

$$R_{it} = R_{it}^{e} + u_{it}$$

where R_{it} is the actual rate of return on the i^{th} stock, R_{it}^{e} is the expected rate on the i^{th} stock and u_{it} is the unexpected, surprise and news element. The element u_{it} could also be seen as a combination of *systematic* or *market risk* m_t, and *unsystematic*[2] risk ε_{it}. This could be written as:

$$u_{it} = m_t + \varepsilon_{it}$$

given that, $m_{it} = \sum_j \beta_{ij}(F_j - EF_j)_t$, where F is the economy-wide factors (indexed by *j*).

The crucial assumption of the APT worth mentioning is that the unsystematic risk is uncorrelated across different stocks:

$$\operatorname{cov}(\varepsilon_i, \varepsilon_j) = 0$$

Assuming that all investors have homogeneous expectations E and that the return R_{it} on any stock is linearly related to a set of k factors F_{ij}, the return will be defined as:

$$R_{it} = \alpha_i + \sum_{j=1}^{k} \beta_{ij} F_{ij} + \varepsilon_{it} \qquad \text{(j)}$$

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[2] Sometimes called idiosyncratic or specific risk.

where β_{ij} is the factor weights or the sensitivity of the stock return. Taking the expectations E of (j) and assuming $E\varepsilon_{it} = 0$, and subtracting it from actual value of F_{jt}:

$$R_{it} = ER_{it} + \sum_{j=1}^{k} \beta_{ij}(F_{jt} - EF_{jt}) + \varepsilon_{it} \tag{k}$$

Equation (g) shows that the impact of any particular F_j depends on the value of β_{ij} being different for each stock.

According to Cuthbertson (1996), the APT could be summed up in two equations. One is (j) and the other is:

$$ER_{it} = \lambda_0 + \sum_{j=1}^{k} \beta_{ij}\lambda_j$$

It is possible to interpret λ_j assuming that the value of β_{ij} is known. Then $\lambda_0 = r_t$ or the risk free rate.[3]

5.2.4 Limitation of Current Models

Today, most stocks earning history has fluctuated in recent years and stock prices are too volatile to be rational forecasts of future dividends (Islam and Oh 2000). The DCFM and CAPM do not fully reflect all the important factors for valuating the

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[3] for details see Cuthbertson (1996, pp. 64-65).

stocks such as the changes in economic conditions and technology. These factors or variables include: changes in the financial market; the money and capital market; the foreign exchange market; goods; the gold and commodities market; the stock market; changes in government regulation and policies; and changes in consumer behavior. A multi-factor model can overcome these limitations of the equilibrium models. Therefore a multi-factor modeling approach is adopted.

5.2.5 Relation between Macroeconomic Factors and Stock Prices

There is a growing number of empirical studies regarding the fundamental connection between stock price and key macroeconomic factors. Fama (1981) found a positive relationship between stock returns and economic factors such as GNP, money supply, capital expenditure, industrial production and interest rates. Chen, Roll and Ross (1986) also found a correlation between stock market returns and macroeconomic factors such as inflation, industrial production, money supply, the exchange rate, and interest rates by using an APT model.

Other recent studies that focus on the relationship between stock prices or returns and macroeconomic, microeconomic and international factors in different countries include: Dhakal, Kandil and Sharma (1993) and Abdullah and Hayworth (1993) on the US stock market; Cheng (1995) studies U.K. stock price returns and macroeconomic factors; Fung and Lie (1990) investigate the Taiwanese stock market and macroeconomic factors; Sukhamongkhon (1994) studies the relationship between Thai stock returns and microeconomic factors; Brown and Otsuki (1990) study the stock returns and macroeconomic factors in Japan; and Kwon, Shin and

Bacon (1997) examine the Korean stock market and macroeconomic factors. Wongbangpo and Sharma (2002), Nasseh and Strauss (2000), and Kiranand (1999) study the relationship between stock returns and macroeconomic factors in five or more Asian countries. Finally, Islam and Oh (2000) and Oh (2001) study the relationship between the return of e-commerce stocks and macroeconomic factors.

5.3 Methodology and Data

5.3.1 Variable Selection - Economic and International Factors

In the discussion in Chapter 2, we hypothesized the need for a new stock valuation model that is interrelated among different markets which are subsets of the Thai financial system. These markets are the financial market, money and capital market, foreign exchange market and stock market. In addition, since we expect our model to operate in an open economy at the international level, national accounts such as goods, gold and commodities markets, along with government investment, have been added to the analysis. These factors are identified under the separate categories in Table 5.1.

Table 5.1: Factors Categories

a) Financial Market Factors	Regressor Code
Bank Deposit	BD
Bank Loan	BL
Interest Rate	IR

b) Money and Capital Market Factors	Regressor Code
Money Market Instruments	MMI
Bonds	BND

c) Foreign Exchange Market Factors	Regressor Code
Exchange Rate	FX

d) Stock Market Factors	Regressor Code
Stock Market Index	SMI
Price Earning Ratio	PE
Dividend Yield	DY
Market Capitalization	MC

e) Goods, Gold and Commodities Market Factors	Regressor Code
Gross Domestic Product	GDP
Gold Reserve Value	GLD
Export	EX
Import	IM
Consumer Price Index	CPI

f) Government Investment Factors	Regressor Code
Government Expenditure	GE

Source: Defined by author.

Financial Market Factors

Commercial banks play a major role in the Thai financial market where they hold around seventy per cent of the total financial assets; therefore, bank deposits, bank loans and interest rates are chosen as variables for the model. Generally, bank deposits reflect household saving levels and bank loans reflect household investment levels which are also dependent on the interest rate. The ability of interest rates to affect returns is regarded as an important factor in the understanding of investments (Peiro 1996).

Money and Capital Market Factors

The money market instruments consist of securities that are used to transfer funds from one party to the other and usually are short-term funds. Some money market instruments are provided by the Central Bank of Thailand, but most are private sector securities. On the other hand, bonds are usually long-term capital market funds with more than one year to maturity (Juttner and Hawtrey 1997).

Foreign Exchange Market Factors

In addition to the discussion in Chapter 2, the exchange rate expresses the price of the US dollar in terms of the Thai Baht. The devaluation of the Thai currency in July 1997 had an immediate impact on: 1) the national balance of trade – a devaluation is expected to stimulate an economy by encouraging the growth of net exports; 2) the inflation rate –aggravating pre-existing problems with inflation; and 3) international liabilities – increasing the country's external debts especially the lending from international banks, mainly in Japan and U.S.A. (CSES 1998).

Stock Market Factors

The stock market index measures the market value of all local and foreign companies which have their stocks listed on the stock exchange of Thailand. Price changes in each security cause a rise or a fall of the SET index, in proportion to the security's market value. The P/E ratio is a measure of the market sentiment regarding the attractiveness of a particular stock, in this case, the P/E ratio is measured for all stocks listed on the SET. Several studies such as those by Ball (1978), Shiller (1984) and Fama and French (1988) find evidence that dividend yields and returns are correlated. According to Oh (2001), market capitalization represents the total market value of listed domestic equities calculated at month-end for all equities listed on the SET including preference shares and excluding overseas domiciled stocks compiled by the Central Bank of Thailand.

Goods, Gold, and Commodities Market Factors

The basis of the relationship between stock prices, returns and future economic growth rates of real activities is evident in the studies of Tongzon (1998) and Chia and Pacini (1997), who measure gross domestic product (GDP). The gold and commodities market in Thailand has given rise to opportunities for investors, brokers, and overseas bullion dealers to trade, hedge or arbitrage gold and other commodities in Thailand. Exports and imports are commonly used in identifying the relationship between stock prices/returns and international trade. Finally, the consumer price index measures the average level of prices of goods and services.

Government Investment Factors

Government expenditure, especially transfer payments, is the most important economic stabilizer particularly when the economy goes into recession or crisis. Government expenditure is one effective way to stimulate the economy, and hence it could stimulate the stock prices.

5.3.2 Multi-Factor Model

The development of this valuation model makes a valuable contribution to our understanding of the effects of the internal and external factors that influence stock prices, return and volatility. Significant factors/variables, that influence the value of stocks are identified using the multiple regression technique. Hypothesis testing will be conducted to find a basis for making a probability statement about the true values of population regression coefficients (Islam and Watanapalachaikul 2001; 2002c; 2002d).

We argue that the standard valuation models DCFM and CAPM are based on a perfect financial market. However, as we have discussed in Chapter 2, there are market imperfections in the Thai financial system. Therefore, a valuation model for Thai stocks will be developed based on the multiple-factor modeling approach incorporating key factors/variables. Factor modeling provides identification of the key factors and variables and proves the time convergence at an appropriate rate by model simulation as well as identifying the relationship between an exogenous variable and multiple endogenous factors. Mathematically, a linear multiple factor model can be expressed as follows:

$$R_{it} = \alpha_i + (\beta_1)_i (F_1)_t + (\beta_2)_i (F_2)_t + \ldots + (\beta_n)_i (F_n)_t + \varepsilon_{it}$$

where R_{it} is the return of stock i in period t, α_i is the expected value if each factor has a value of zero, $(F_1)_t$ & $(F_2)_t$ are the values of factors 1 & 2 with pervasive influence in period t, $(F_n)_t$ is the value of factor n, $(\beta_1)_i$ & $(\beta_2)_i$ are the price of factor 1 & 2 (the risk premium) for stock i, $(\beta_n)_i$ is the price of factor n (the risk premium) for stock i, and ε_{it} is the stock specific return.

For the initial development of this new model, the correlation coefficient, unit root and cointegration were tested using Islam and Oh's (2001) process. If macroeconomic variables are significant and consistently priced on the index, they should be cointegrated. This cointegration relationship between the index price and the underlying factors is a necessary condition of the equilibrium model of the stock market price and return. The cointegration analysis takes place in two stages: first, the unit root test is applied to determine their non-stationarity, and when the results indicate that the first differenced series of each variable is stationary, a subsequent test is used to determine whether these two variables are cointegrated. The test for unit root is done by using the augmented Dickey Fuller (ADF) test.

5.3.3 Data

Monthly data for the closing SET index from 1992 to 2001 are used in this study (given in Appendix 2). The choice of time period corresponds to the pre- and post-crisis period. These stock price indexes are obtained from the Stock Exchange of Thailand CD-ROMs and SET Data Service Department. The economic factors are gathered from the Bank of Thailand, the United Nations Research Department, and the International Monetary Funds (International Financial Statistics CD-ROM).

5.4 Results and Implications for Valuation

5.4.1 Unit Root and Cointegration Test

According to Islam and Watanapalachaikul (2001), the factors which are considered to have influence on the value of stock generally need to be tested to determine which ones have the relatively higher impact on valuation. This can be done by examining the correlation coefficient and cointegration of each factor (see appendix 6 for details). The correlation coefficient gives the quality of a Least Squares Fitting to the original data. The results show that market capitalization, P-E ratio and gold deposit rate have a positive correlation of more than 70 per cent, which means that these variables should tend to increase or decrease together with the stock market index, while bond rate, money market instruments, foreign exchange rate, export and consumer price index have negative correlation of more than 70 per cent.

Table 5.2 summarises the estimation of the correlation coefficient of stock prices and macroeconomic factors, numbers in bold are regarded as having a high correlation coefficient.

Table 5.2: Summary of Correlation Coefficient for the Studied Period

	1992-2001	Pre-Crisis	Post-Crisis
BD	-64%	68%	-66%
BL	22%	51%	72%
IR	39%	-65%	36%
PE	**93%**	**91%**	48%
MMI	**-76%**	49%	-34%
BND	-64%	52%	**-75%**
FX	**-84%**	-47%	-73%
DY	4%	**-95%**	40%
MC	**85%**	**88%**	**79%**
GDP	-19%	36%	-14%
EX	**-75%**	56%	-70%
IM	-55%	52%	-45%
GLD	**86%**	62%	**78%**
CPI	**-77%**	46%	**-88%**
GE	-51%	35%	-14%

Source: Defined by author.

In addition, we use the augmented Dickey-Fuller (ADF) test to identify the stationarity of each factor. Using the following regression, we can distinguish unit root as:

$$\Delta y_t = \alpha_o + \sum \alpha_j (\Delta y_{t-j}) + \beta t + \gamma (y_{t-j}) + \mu_t$$

where μ_t is a pure white noise error term (Model 1). The proposition is defined as:

$$y_t = \mu + \varepsilon_t$$

and trend stationary (Model 2) is defined as:

$$y_t = \mu + \beta(t) + \varepsilon_t$$

Model 1 is the model with a non-zero mean and with white noise stationarity, while model 2 represents the model with a non-zero mean and with trend stationarity. Test statistics are shown in parentheses in Table 5.3.

The optimal lag length for each of the autoregressive processes of the ADF test is settled by Schwert's (1987) formula:

$$L = Int\left[4\frac{n}{100}\right]^{\frac{2}{9}}.$$

where n is the number of the observations in the series.

The results of the unit test for macroeconomic factors are shown in Table 5.3.

Table 5.3: Unit Root Test for Stock Prices and Macroeconomic Factors

Augmented Dickey Fuller (ADF) Test							
	ADF Test (Model 1)			ADF Test (Model 2)			
Factors	α_t	α_{t-1}	F	$(\alpha_t)^{\sim}$	$(\alpha_{t-1})^{\sim}$	$(y_{t-1})^{\sim}$	F
BD	192.98 (1.49)	-0.01 (0.01)	0.37	247.71 (1.90)	-0.09 (-2.28)	11.90 (2.20)	5.21
BL	220.54 (1.02)	-0.01 (-0.94)	0.88	1051.56 (4.34)	-0.002 (-0.36)	-15.89 (-5.61)	0.13
IR	-0.29 (0.17)	-0.01 (-0.54)	0.29	0.39 (1.28)	-0.03 (-1.32)	-0.002 (-1.43)	1.75
MMI	5.23 (1.25)	-0.02 (-1.13)	1.28	2.11 (0.32)	-0.03 (-1.24)	0.08 (0.62)	1.55
BND	3.08 (3.43)	-0.01 (-2.02)	4.08	3.15 (2.90)	-0.02 (-0.73)	0.01 (0.12)	0.53
FX	0.78 (1.12)	-0.02 (-0.92)	0.85	2.06 (2.40)	-0.10 (-2.57)	0.02 (2.43)	6.60
SMI	7.18 (0.45)	-0.01 (-0.78)	0.61	81.30 (2.17)	-0.01 (-2.13)	-0.70 (-2.19)	4.45
PE	0.44 (1.03)	-0.04 (-1.36)	1.84	2.64 (2.71)	-0.12 (-2.78)	-0.02 (-2.50)	7.81
DY	0.13 (1.65)	-0.06 (-1.96)	3.83	0.17 (1.39)	-0.06 (-1.96)	-0.001 (-0.42)	3.84
MC	80.22 (1.52)	-0.04 (-1.57)	2.46	17.04 (2.32)	-0.05 (-2.01)	-11.02 (-1.74)	4.04
GDP	11.03 (7.43)	-0.94 (-1.03)	1.02	66.20 (3.21)	-1.02 (-1.09)	8.36 (2.99)	1.18
EX	4.92 (1.46)	-0.02 (-1.10)	1.21	13.53 (3.60)	-0.28 (-4.35)	0.48 (4.20)	18.99
IM	8.96 (1.90)	-0.05 (-1.70)	2.89	21.91 (3.88)	-0.26 (-4.16)	0.31 (3.76)	17.34
GLD	13.30 (0.81)	-0.02 (-0.93)	0.87	56.42 (1.89)	-0.06 (-1.92)	-0.18 (-1.73)	3.71
CPI	0.92 (2.53)	-0.01 (-1.62)	2.63	-0.04 (-0.02)	-0.01 (0.34)	-0.004 (-0.66)	0.12
GE	18.63 (4.52)	-0.30 (-4.58)	2.10	29.01 (7.37)	-0.74 (-8.19)	2.96 (6.26)	6.71

Source: Author's estimate.

The results show that all the Model 1 ADF tests with white noise stationarity, fail to reject the null hypothesis of the existence of a unit root in log levels except GE, since the test statistics in α_{t-1} is greater than (-3.33). However, the correct procedure is then to take first differences of y before using it in a regression. Therefore, according to the Model 2 ADF tests with trend stationarity, we can reject the null of a unit root for all factors except EX and IM (since most of the factors yield F statistics which are less than 7.24, where as EX and IM yield 18.99 and 17.34 respectively). As a result, EX and IM are discarded in the further analysis.

According to Watsham and Parramore (1997) cointegration is used in analysing the relationship between groups of economic factors over time and gives a more conceptually and empirically valid measure of that relationship in the light of nonstationarity of the time series. Applying the ordinary least square (OLS) regression in the following model, we now have the cointegration regression:

$$y_t = \alpha_0 + \alpha x_t + \mu_y$$

To obtain the *error correction model*, we need to estimate residuals of the long-run relationship; where $\mu_y = y_t - \alpha_0 - \alpha x_t$ (results are shown in Appendix 6, Table A6.4, where α is the coefficient). These ADF tests in the present context are known as *augmented Engle-Granger* (AEG) tests. Then we repeat the unit root process on the residuals.

Table 5.4: Unit Root Test for Macroeconomic Factors Residuals

Augmented Engle-Granger (AEG) test			
	AEG test (Model 1)		
Factors	α_t	α_{t-1}	F
BD	2.69 (0.32)	-0.05 (-1.77)	3.16
BL	-4.13 (-0.54)	-0.02 (-1.93)	0.86
IR	-0.72 (-0.09)	-0.04* (-2.18)	1.40
MMI	-0.05 (-0.01)	-0.08* (-2.11)	4.47
BND	2.98 (0.38)	-0.05** (-2.82)	3.50
FX	2.92 (0.28)	-0.13** (-2.97)	8.83
PE	2.01 (0.25)	-0.19** (-3.43)	11.75
DY	-3.67 (-0.46)	-0.02 (-0.85)	0.72
MC	-5.59 (-2.17)	-0.02* (-2.07)	2.46
GDP	-3.35 (-0.28)	-0.05 (-1.60)	1.02
GLD	1.48 (0.17)	-0.11** (-2.631)	6.92
CPI	3.89 (0.52)	-0.06* (-2.25)	2.63
GE	1.84 (0.12)	-2.85** (-4.58)	2.10

Note: (*) indicates rejection of the null hypothesis at 5% significant level and (**) indicates rejection of the null at 1% significant level.

Source: Author's estimate.

Next, we regress the error corrected factors with statistical significance between 1 and 5 per cent. As a result, BD, BL, DY, and GDP were dropped in the cointegration regression. Therefore, *the cointegration regression* of the remaining variables can be expressed as seen below.

Interest Rate (IR)

$$\Delta\hat{y}_t = 297 + 52.9\Delta x_t - 0.04e_{t-1} \qquad R^2 = 15.1\%$$

Money Market Instrument (MMI)

$$\Delta\hat{y}_t = 1048 - 172\Delta x_t - 0.08e_{t-1} \qquad R^2 = 57.8\%$$

Bonds (BND)

$$\Delta\hat{y}_t = 1409 - 4.83\Delta x_t - 0.05e_{t-1} \qquad R^2 = 41\%$$

Foreign Exchange Rate (FX)

$$\Delta\hat{y}_t = 2172 - 43.7\Delta x_t - 0.13e_{t-1} \qquad R^2 = 70.5\%$$

Price Earning Ratio (PE)

$$\Delta\hat{y}_t = -119 + 64.6\Delta x_t - 0.19e_{t-1} \qquad R^2 = 86.5\%$$

Market Capitalisation (MC)

$$\Delta\hat{y}_t = -49 + 0.001\Delta x_t - 0.02e_{t-1} \qquad R^2 = 71.7\%$$

Gold (GLD)

$$\Delta\hat{y}_t = -1639 + 2.92\Delta x_t - 0.11e_{t-1} \qquad R^2 = 73.7\%$$

Consumer Price Index (CPI)

$$\Delta\hat{y}_t = 3269 - 23.19\Delta x_t - 0.06e_{t-1} \qquad R^2 = 58.5\%$$

Government Expenditure (GE)

$$\Delta\hat{y}_t = 1566 - 0.01\Delta x_t - 2.85e_{t-1} \qquad R^2 = 26.3\%$$

5.4.2 The Thai Stock Market Multi-Factor Model

A new stock valuation model is proposed, based on a generic six-factor model, the factors being selected from the significant results of the cointegration test. The new valuation model, named the Thai Stock Multi-factor Model (TSMM), is described as follows:

$$Y = \alpha + \beta_1\text{IR} + \beta_2\text{BND} + \beta_3\text{FX} + \beta_4\text{PE} + \beta_5\text{MC} + \beta_6\text{CPI} + \varepsilon_t$$

All six factors in the estimated equation are the highest factors which are significant at the 5 per cent significance level. The result shows an $\overline{R}^2$ of 0.987 which is regarded as very significant (Appendix 6, Table A6.5). It is interesting to see that TSMM includes at least one factor from each of the five different markets identified in Table 5.5.

Table 5.5: Classification of Significant Factors

Markets in Financial System		*Significant Factors*
1. Financial Market	⇨	Interest Rate (IR)
2. Money and Capital Market	⇨	Bonds (BND)
3. Foreign Exchange Market	⇨	Foreign Exchange Rate (FX)
4. Stock Market	⇨	Price Earning Ratio (PE) Market Capitalisation (MC)
5. Goods, Gold and Commodities Market	⇨	Consumer Price Index (CPI)

Source: Defined by author.

According to the regression result, the systematic risk measured by the multi-factor model explains 98.7 per cent of the Thai stock market index. The estimated equation of the TSMM model is shown below (tests statistics are shown in parentheses):

$$Y = \underset{(2.953)}{760.18} + \underset{(3.894)}{8.58(IR)} - \underset{(-3.156)}{2.24(BND)} + \underset{(4.301)}{6.49(FX)} + \underset{(3.711)}{7.548(PE)} + \underset{(22.734)}{0.0003(MC)} - \underset{(-2.245)}{7.11(CPI)} + \varepsilon_t$$

This study used the cointegration test to investigate the relationship between the SET index and the underlying economic and financial variables. All six factors in the estimated equation are statistically significant at the 10% significance level and this confirms the evidence of their pervasiveness on the stock price. The unit root test is conducted in identifying the stationarity of the factors and the results indicated that the first differenced series of each factor of the TSMM model are stationary. The TSMM model explains that the financial market, money and capital market, foreign exchange market and goods, gold and commodities market are determinants of stock price value.

5.5 Cointegration Test of the Six-Variable Model

Section 5.4.1 shows the integration of the individual explanatory factors cointegrated with the dependent variable by using the ADF and AEG tests. There is a need to test the TSMM to see whether all six factors are integrated in long-run equilibrium. According to Islam and Oh (2002), the cointegration technique was used in the multi-factor model in which the authors conclude that e-commerce stock returns are cointegrated with the combination of three macroeconomic variables at a 5 per cent significance level in a long-run equilibrium. In addition, it is suggested that the stationarity of the individual explanatory factors can be checked by the means of an ADF test. Similar technique can be applied to the TSMM. From a single-equation perspective of the multi-factor model considerable use has been made of the cointegration specification where a cointegration analysis can be conducted between the dependent variable or stock price and interest rate, bond rate, foreign exchange rate, price earning ratio, market capitalisation, and consumer price index.

Cointegration Test Summary for the TSMM model

$$Y = \underset{(2.953)}{760.18} + \underset{(3.894)}{8.58(IR)} - \underset{(-3.156)}{2.24(BND)} + \underset{(4.301)}{6.49(FX)} + \underset{(3.711)}{7.548(PE)} + \underset{(22.734)}{0.0003(MC)} - \underset{(-2.245)}{7.11(CPI)} + \varepsilon_t$$

$\overline{R}^2 = 0.987$

Augmented Dickey-Fuller

$$\text{ADF } \varepsilon_t = -\underset{(-1.231)}{0.5784\varepsilon_{t-1}} - \underset{(-0.7454)}{0.8474\varepsilon_{t-2}} - \underset{(-1.0069)}{0.4738\varepsilon_{t-3}} - \underset{(-2.1452)}{0.4321\varepsilon_{t-4}} - \underset{(-1.6521)}{0.6451\varepsilon_{t-5}} - \underset{(-0.0451)}{0.9741\varepsilon_{t-6}}$$

We can conclude that the individual factors of the TSMM are cointegrated and there is no spurious unit root in the test (using the t-statistics of the ADF test for the unit root of the lagged cointegrated residuals). The test for cointegration between IR, BND, FX, PE, MC and CPI which in the long-run reveal a sufficient condition for a joint cointegration among the variables in a long-run regression, is that the error ε_t should be stationary. The residuals based on the ADF test statistics for ε_t demonstrated the rejection of the null of no cointegration at a 5% significance level. The cointegrating relation of the linear combination of the six variables is interpreted as an equilibrium relationship.

5.6 The Real Value of Stocks

In this chapter, we have investigated the factors which determine the value of stocks in Thailand. Currently, some organisations are still using financial statements such as ratio analysis, and growth models such as the Gordon growth model or a historical and fundamental growth rate as the basic methods of analysis in determining the real value of businesses or stocks. Generally, there are a large number of investors and stakeholders who rely on financial statement to access the performance of firms and managers (Palepu, Healy and Bernard 2000). However, these methods sometimes contains noise (Black 1986) where communication by the corporations to investors is not completely credible because of the existence of inside information, moral hazard, asymetric information and adverse selection problems which considerably affect outside parties who evaluate firms' current and prospective performances, and hence leads to an inaccurate valuation of the firms and their stocks. Furthermore, since these methods can only be applied to individual stocks (as opposed to the aggregate stock market index), they have not been applied in this study.

The results of this multi-factor valuation model show a strong relationship between the financial and real sectors. This implies that macroeconomic, financial and international factors are interdependent. It is clear that all six significant variables appear to play an important role in explaining as much as 98.7 per cent of the Thai stock market. The results therefore support the premise that macroeconomic, financial and international factors such as interest rate, bonds price, foreign exchange rate, price-earning ratio, market capitalisation and consumer price index are important forces in determining Thai stock market values and these factors are interdependent. The interdependence between each factor makes the issue of valuation even more complex to understand by some relatively simple theoretical statements of the financial market such as DCFM and CAPM. Therefore, the estimated TSMM model provides a better valuation of the Thai stock market by incorporating macroeconomic, financial and international factors.

Whilst this finding is consistent with recent studies such as Islam and Oh (2003), Fifield, Power and Sinclair (2002), Wongbangpo and Sharma (2002), Nasseh and Strauss (2000), and Kiranand (1999), which have found a significant role for economic and international factors in explaining the returns of emerging markets, it does contradict the results of Harvey (1995a, 1995b) who suggested that international factors were not significant in explaining emerging market share return.

5.7 Conclusions

The derivation process of the TSMM revealed a strong, significant long-run relationship during 1992-2001 between stock prices and macroeconomic factors such as interest rate, bonds price, foreign exchange rate, price-earning ratio, market capitalisation and consumer price index. It is very interesting to see there is at least one factor of the model that represents individual markets that sum up to incorporate the entire Thailand financial system. In addition, these factors explain 98.7 per cent of the stock price, which is regarded as very significant.

We observe that in the long-run, the stock index prices are positively related to the interest rate, foreign exchange rate, price-earning ratio, and market capitalisation, while a negative long-run relationship is present for the bonds price and consumer price index. The unit root, augmented Dickey Fuller and augmented Engle Granger tests detected the causal relationships from the selected factors to the stock index prices.

Chapter 6

RATIONAL SPECULATIVE BUBBLES

6.1 Introduction

Binswanger (1999, p. 116) states that "speculative bubbles are thought of as having a negative overall impact on the economy. They are supposed to create additional price risk and increase the instability of the economy". In recent years, there have been a number of empirical studies attempting to identify rational speculative bubbles in stock prices and returns.

Several studies for instance by Rappoport and White (1993) and West (1987) found evidence of rational bubbles in stock prices and returns. On the other hand, Diba and Grossma (1988) show empirical evidence to prove the absence of rational bubbles in stock prices. Surprisingly, Harman and Zuehlke (2001) found both existence and non-existence of rational bubbles on the New York Stock Exchange by applying different empirical models, resulting in contradicting conclusions.

Therefore, there is a need to correctly identify and analyse the existence of the rational speculative bubbles in the Thai stock market by applying suitable approaches such as Duration Dependence test and Weibull Hazard model. Data gathered from the SET includes both the monthly and daily market index from January 1992 to December 2001.

This chapter is organized in five sections. Section 2 provides an overview of bubbles and financial market behaviour. Section 3 underlines the theoretical background, literature reviews and discusses the methods used to identify the existence of bubbles. Section 4 describes the selected models used in the analysis of the Thai stock market. Section 5 contains the source of data used in this analysis and reports the empirical findings on the rational speculative bubbles. Section 6 discusses the rational speculative bubbles issue in the Thai stock market. Finally, Section 7 provides the conclusions of the chapter.

6.2 Rational Speculative Bubbles and Financial Market Behaviour

Bubbles in the stock market arise when stock prices are not at levels consistent with economic fundamentals or stocks are over-valued in comparison with real economic activity. Bubbles or rational bubbles (b_t) can be written in the form of:

$$b_t = p_t - f_t$$

where p_t is the stock price at time t, and f_t is the fundamental value.

Bubbles cause stock price to be more volatile and over valued, which creates stock market instability and inefficiency. Generally when the stock price diverges from economic fundamentals a bubble will emerge due to excessive optimism with respect to fundamentals. In some cases, investors might recognize excess in stock prices compared with economic fundamentals, and they might find an arbitrage opportunity and believe that the excess will continue. However, in the long term, it is quite impossible that such rises in stock prices can be sustained beyond levels consistent with economic fundamentals. Therefore, when stock prices are inflated by a bubble, sooner or later, there will be an inevitable collapse or bursting of the bubble.

Rational speculative bubbles are often used by behavioral finance theorists in an attempt to identify behaviour of investors who act irrationally, such as when 'herding' occurs (Cuthbertson 1996). Statman (1988) identifies irrational behaviour of investors as: 1) trading for both cognitive and emotional reasons; 2) trading because they think they have information when they have nothing but noise; and 3) trading because it brings personal satisfaction.

The rational bubbles literature assumes that stock prices can diverge from economic fundamentals and that a bubble will emerge due to excessive optimism with respect to these fundamentals, making changes in stock prices unforecastable. Therefore, investors cannot beat the market in order to earn extraordinary gain (Bond 2001). In some cases, a minority of investors (called noise traders) might not trade in a fully rational way (when their stocks are known to be overvalued relative to fundamentals) and therefore sustain the presence of significant bubbles in share prices.

6.3 Different Models

Many approaches have been developed to identify the existence of rational bubbles in stock prices and returns. One of the earlier and most popular approaches is the unit-root process (see Diba and Grossman 1988; Campbell and Shiller 1987) where the unit-root process is tested on stationarity or nonstationarity of the residuals between asset prices and market fundamentals. This process has been criticized by Wu and Xiao (2002) and Charemza and Deadman (1995) for having serious drawbacks in detecting bubbles. They found that the unit root process could not identify bubbles correctly when the market price contains *collapsible bubbles*, so that the hypothesis of a bubble is not equivalent to the hypothesis of a unit root by conducting a Monte Carlo simulation.

Other approaches include the Duration Dependence Test (McQueen and Thorley 1994), Weibull Hazard Model (Mudholkar, Srivastava and Kollia 1996) and Simulation Time Series Analysis (Wu and Xiao 2002; Fung 2001). The Duration Dependence test and Weibull Hazard model are more widely accepted (Fung 2001; Harman and Zuehlke 2001), because of their robustness in testing for rational speculative bubbles. However, the use of time series simulation is considered to be in the early stages of model development, and hence, this approach is not yet fully accepted.

Two classical models of rational speculative bubbles are *rational expectation model* (see Mills 1999; Campbell, Lo and MacKinlay 1997; Wu 1997; Cuthbertson 1996) and a stochastic process (see Fung 2001).

The rational expectation model is explained as:

$$P_t = \frac{1}{(1+r)} E_t(P_{t+1} + D_{t+1})$$

where P_t is the real stock price at t, r is the constant rate of return and thus $1/(1 + r)$ is the discount factor, and D_{t+1} is the dividend paid to the owner of the stock between t and $t+1$.

According to Campbell, Lo and MacKinlay (1997), if the conditional distribution of prices is normal, then there will always be a positive probability of obtaining a negative price (violation of limited liability). Therefore, the price and dividend could be interpreted in terms of logarithm or logarithm neperiano:

$$p_t + q = k + \delta E_t p_{t+1} + (1 - \delta) E_t d_{t+1}$$

where p_t and d_t are logarithms of P_t and D_t, q is the log gross return rate and is the average ratio of the stock price to the sum of the stock price and dividend, and k is a function of δ (Wu 1997). Under the following transversality condition:

$$\lim_{k \to \infty} \delta^k E_t p_{t+k} = 0$$

If the transversality condition does not hold, the logarithm of the price has the following form:

$$p_t = f_t + b_t$$

where b_t is a rational speculative bubble generated by extraneous events, and f_t is the market fundamental given by:

$$f_t = \eta + (1-\delta)\sum_{j=0}^{\infty}\delta^j E_t d_{t+1+j}$$

and:

$$E_t b_{t+1} = \frac{1}{\delta} b_t$$

The second type of bubble is a stochastic process (see Fung 2001) where the next period bubbles grow with a random error. Rational speculative bubbles are b_t, and u_{t+1} is an error term which can either be additive or multiplicative. Addictive random errors are defined as:

$$b_{t+1} = \lambda_{t+1} b_t + u_{t+1}$$

where λ_{t+1} is the random variable such that the expected value of λ_t, $E\lambda_t$ is $1+r$. In addition, bubbles with multiplicative random error are defined as:

$$b_{t+1} = \lambda_{t+1}(b_t u_{t+1})$$

The rational bubbles with a multiplicative error must satisfy sub-martingale and non-negativity conditions. The sub-martingale condition assumes that $E_{t-1}(b_t) = (1+r)b_{t-1}$. The Non-negativity is achieved by assuming that $\lambda_t = \exp(\Theta_t)$ and $u_t = \exp(U_t)$, where $\Theta_t \sim IIN(\ln(1+r) - \frac{\sigma_\theta^2}{2}, \sigma_\theta^2)$ and $U_t \sim IIN(-\frac{\sigma_\theta^2}{2}, -\sigma_\theta^2)$ (Fung 2001).

6.4 Adopted Models

To investigate the existence of rational speculative bubbles, we employ the Duration Dependence Test using the Discrete Log Logistic Model developed by McQueen and Thorley (1994) and the Weibull Hazard Model by Mudholkar, Srivastava and Kollia (1996).

6.4.1 Discrete Log Logistic Model

The discrete log logistic model is defined as (Harman and Zuehlke 2001, Zorn 2000):

$$\ln L(\alpha, \beta) = \sum_{i=1}^{N} \{J_i \ln[g(t_i)] + (1 - J_i)\ln[1 - G(t_i)]\}$$

where α is the shape parameter of the lognormal distribution, β is the duration elasticity of the hazard function, J_i is a duration of the process or time to exit from a state, g_t is the discrete density function for duration, and G_t is the corresponding distribution function. The discrete density and distribution functions for duration are related as:

$$G(t_i) = \sum_{k=1}^{t_i} g(k)$$

However, if the law of conditional probability is applied (Harman and Zuehlke 2001), the density for completed duration is:

$$g(k) = h(k)\prod_{m=0}^{k-1}[1 - h(m)]$$

In addition, McQueen and Thorley (1994) use the logistic distribution function ψ evaluated at a linear transformation of log-duration as:

$$h(k) = \psi[\alpha + \beta \ln(k)] = \{1 + \exp[-\alpha - \beta \ln(k)]\}^{-1}$$

6.4.2 Weibull Hazard Model

The Weibull model is defined as (Harman and Zuehlke 2001):

$$S(t) = \exp(-\alpha t^{bt+1})$$

where S(t) is the probability of survival in a state to at least time (t) and the corresponding Hazard function is:

$$h(t) = \alpha(\beta + 1)t^{\beta}$$

where α is the shape parameter of the Weibull distribution, and β is the duration elasticity of the hazard function. The fundamental assumption of the Weibull Hazard model is a linear relationship between the log of the hazard function and the log of duration, where:

$$\ln[h(t)] = \ln[\alpha(\beta + 1] + \beta \ln(t)$$

To demonstrate the existence of rational speculative bubbles using the Duration Dependence and Weibull Hazard test, the closing stock index of the Stock Exchange of Thailand and dividend yield are required. Fama and French (1989) argue that the dividend yield is useful in predicting time-varying risk primia. The dividend yield is the value weight of the SET portfolio. The corresponding sequence of runs is determined by the length of the runs, which is the number of consecutive periods.

It is hypothesized that rational speculation bubbles exist when the rate of return of the stock price between the period *t-1* and *t* is growing faster than the rate of return of the dividend yield at the same period. According to the rational expectation theory, we hypothesize that:

$$E_t P_t = P_t + b_t$$

given that:

$$P_t = \delta(P_{t+1} + D_{t+1})$$

Therefore, the gap between the expected return and the real return is considered to be caused by a bubble.

6.5 Data and Empirical Results

Both monthly and daily data for the closing SET index during 1992 to 2001 is used in this study. Four time frame periods are analyzed, which can be described as:

1) Overall period 1992 to 2001

2) Pre-crisis period 1992 to 1996

3) Post-crisis period 1997 to 2001

4) Yearly period 1992 to 2001

The model, $\ln L(\alpha, \beta) = \sum_{i=1}^{N} \{J_i \ln[g(t_i)] + (1 - J_i)\ln[1 - G(t_i)]\}$, lays the foundation for the Duration Dependence test, and $\ln[h(t)] = \ln[\alpha(\beta + 1] + \beta \ln(t)$, lays the foundation for the Weibull Hazard test. The empirical results of the estimates of Duration Dependence Test are shown in tables 6.1 and 6.2.

The estimates of Weibull Hazard Model are presented in tables 6.3 and 6.4, where the maximum likelihood estimates and likelihood ratio tests with one degree of freedom are reported.

Table 6.1: Runs of the Duration Dependence Test for Monthly Data

Year	α	ln (gamma)	gamma	Log likelihood	LR test (p-value)
1975-2001	-0.2554458 (0.0111571)	-1.154472 (0.0451927)	0.3152238 (0.0142458)	-258.62402	341.72 (0.0001)
1992-1996	-0.3437964 (0.0141064)	-3.230768 (0.1058562)	0.0395271 (0.0041842)	74.811012	151.09 (0.0001)
1997-2001	0.0699114 (0.026636)	-1.843861 (0.1052656)	0.1582055 (0.0166536)	-7.7879065	6.91 (0.0086)
1992	-0.2823224 (0.0267149)	-4.076108 (0.2466283)	0.0169734 (0.0041861)	24.873279	25.80 (0.0001)
1993	-0.434855 (0.0353349)	-3.434757 (0.2508061)	0.0322332 (0.0080843)	16.912234	29.44 (0.0001)
1994	-0.4166478 (0.0280917)	-4.67472 (0.2397103)	0.0093281 (0.0022361)	32.309664	35.74 (0.0001)
1995	-0.3755235 (0.0505471)	-4.285004 (0.2608526)	0.0137736 (0.0035929)	26.732696	18.16 (0.0001)
1996	-0.3670404 (0.0070696)	-5.157012 (0.2360175)	0.0057589 (0.0013592)	38.218429	68.16 (0.0001)
1997	-0.2860517 (0.0184719)	-3.530403 (0.244953)	0.0292931 (0.0071754)	18.387793	36.79 (0.0001)
1998	0.1261683 (0.0737642)	-1.967396 (0.2396864)	0.1398204 (0.033513)	-0.21148199	2.25 (0.1338)
1999	-0.473512 (0.0801291)	-3.290612 (0.238095)	0.037231 (0.0088645)	15.748259	17.05 (0.0001)
2000	0.9217006 (0.0491837)	-3.972409 (0.2535856)	0.018828 (0.0047745)	23.346423	40.07 (0.0001)
2001	-0.1912209 (0.0370454)	-3.997495 (0.2439925)	0.0183616 (0.0044801)	23.906298	16.14 (0.0001)
1992-2001	0.0988104 (0.0517808)	-1.023221 (0.0732415)	0.3594352 (0.0263256)	-112.0697	3.63 (0.0566)

Note: α is the size of the bubbles, *gamma* is the instantaneous exit rate and *ln(gamma)* is the instantaneous hazard rate. Numbers shown in parentheses are standard errors except those in LR test column which are p-values. The log likelihood is the logarithm of the joint probability density function. The LR test is for null hypothesis of no duration dependence. The LR statistic is asymptotically x^2 with 1 degree of freedom.

Source: Author's estimate.

Table 6.2: Runs of the Duration Dependence Test for Daily Data

Year	α	ln (gamma)	gamma	Log likelihood	LR test (p-value)
1975-2001	n/a	n/a	n/a	n/a	n/a
1992-1996	-0.2916168 (0.0033108)	-3.772322 (0.0299659)	0.0229986 (0.0006892)	1325.938	1670.61 (0.0001)
1997-2001	0.0724716 (0.0061592)	-1.801347 (0.0232381)	0.1650765 (0.0038361)	-210.60045	139.49 (0.0001)
1992	-0.0134382 (0.0304208)	-3.082863 (0.0523617)	0.0458279 (0.0023996)	271.17296	0.20 (0.6577)
1993	-0.2925718 (0.0517918)	-2.477065 (0.0576296)	0.0839894 (0.0048403)	102.12342	28.94 (0.0001)
1994	-0.4208818 (0.0092622)	-4.325018 (0.0538752)	0.0132333 (0.0007129)	566.17372	553.87 (0.0001)
1995	-0.3604701 (0.0145475)	-4.031672 (0.0562642)	0.0177446 (0.0009984)	492.46764	293.68 (0.0001)
1996	-0.3694731 (0.0013676)	-5.289596 (0.0532441)	0.0050438 (0.0002686)	804.27146	1416.35 (0.0001)
1997	-0.2905493 (0.0058184)	-3.281716 (0.0520219)	0.0375637 (0.0019541)	324.1679	618.41 (0.0001)
1998	0.0640916 (0.0141478)	-1.862141 (0.0517502)	0.1553397 (0.0080389)	-24.71454	20.95 (0.0001)
1999	-0.4928002 (0.0207041)	-3.18918 (0.0520699)	0.0412056 (0.0021456)	298.95147	315.92 (0.0001)
2000	-0.5146781 (0.0078808)	-3.716554 (0.0533464)	0.0243176 (0.0012973)	423.51517	723.96 (0.0001)
2001	-0.1795834 (0.0106396)	-3.758785 (0.0534838)	0.023312 (0.0012468)	430.19351	198.89 (0.0001)
1992-2001	0.0525267 (0.0125552)	-0.937515 (0.0179952)	0.3915998 (0.0070469)	-1991.2174	17.70 (0.0001)

Note: α is the size of the bubbles, *gamma* is the instantaneous exit rate and *ln(gamma)* is the instantaneous hazard rate. Numbers shown in parentheses are standard errors except those in LR test column which are p-values. The log likelihood is the logarithm of the joint probability density function. The LR test is for null hypothesis of no duration dependence. The LR statistic is asymptotically x^2 with 1 degree of freedom.

Source: Author's estimate.

Table 6.3: Runs of the Weibull Hazard Model Test for Monthly Data

Year	α	ln (p)	λ	Log likelihood	LR test (p-value)
1975-2001	-0.3026306 (0.0082211)	0.871083 (0.0465068)	0.4184981 (0.019463)	-233.91833	400.41 (0.0001)
1992-1996	-0.36355 (0.0171356)	2.568233 (0.0882538)	0.0766709 (0.0067665)	66.002712	124.18 (0.0001)
1997-2001	0.1004323 (0.0228812)	1.342938 (0.0965923)	0.2610775 (0.0252181)	-10.852175	16.01 (0.0001)
1992	-0.2600498 (0.0254046)	3.570913 (0.2184628)	0.0281302 (0.0061454)	24.434472	26.40 (0.0001)
1993	-0.4404215 (0.0191582)	3.203887 (0.2426705)	0.0406041 (0.0098534)	18.735513	38.95 (0.0001)
1994	-0.4051263 (0.028886)	4.202728 (0.2176924)	0.0149547 (0.0032555)	32.040349	34.95 (0.0001)
1995	-0.4055728 (0.0375804)	4.044625 (0.2442673)	0.0175163 (0.0042787)	28.625375	22.50 (0.0001)
1996	-0.3645129 (0.0041297)	4.837509 (0.2347478)	0.0079268 (0.0018608)	39.022552	67.23 (0.0001)
1997	-0.3041832 (0.0141972)	3.085473 (0.2277681)	0.0457084 (0.0104109)	18.297541	35.25 (0.0001)
1998	0.1296854 (0.0536876)	1.718529 (0.2394707)	0.1793298 (0.0429442)	1.2407267	5.02 (0.0250)
1999	-0.4855359 (0.0596152)	2.84221 (0.217934)	0.0582967 (0.0127048)	15.65927	16.35 (0.0001)
2000	0.9587039 (0.0800682)	3.297015 (0.2051994)	0.0369934 (0.007591)	21.683378	39.49 (0.0001)
2001	-0.2429695 (0.077069)	3.316192 (0.2156043)	0.0362908 (0.0078244)	21.810742	11.48 (0.0007)
1992-2001	-0.0383979 (0.0607906)	0.6840408 (0.0750723)	0.504574 (0.0378795)	-107.4341	0.39 (0.5340)

Note: α is the size of the bubbles, λ is the instantaneous exit rate and *ln(p)* is the instantaneous hazard rate. Numbers shown in parentheses are standard errors except those in LR test column which are p-values. The log likelihood is the logarithm of the joint probability density function. The LR test is for null hypothesis of no duration dependence. The LR statistic is asymptotically x^2 with 1 degree of freedom.

Source: Author's estimate.

Table 6.4: Runs of Weibull Hazard Model Test for the Daily Data

Year	α	*ln (p)*	λ	Log likelihood	LR test (p-value)
1975-2001	n/a	n/a	n/a	n/a	n/a
1992-1996	-0.3010924 (0.0044295)	3.378639 (0.0288365)	0.0340938 (0.0009831)	1339.4972	1596.09 (0.0001)
1997-2001	0.1052452 (0.0053264)	1.300478 (0.0212306)	0.2724016 (0.0057833)	-272.00398	324.15 (0.0001)
1992	-0.1337965 (0.0303465)	2.596602 (0.048598)	0.0745264 (0.0036218)	260.56381	17.07 (0.0001)
1993	-0.0288201 (0.1006075)	1.577039 (0.0448364)	0.2065859 (0.0092626)	27.786541	0.08 (0.7741)
1994	-0.4055613 (0.0082904)	3.697654 (0.0448854)	0.0247816 (0.0011123)	538.6777	526.55 (0.0001)
1995	-0.4067694 (0.0106083)	3.847093 (0.0556868)	0.0213417 (0.0011885)	533.83879	384.00 (0.0001)
1996	-0.366379 (0.0010435)	4.783944 (0.0476576)	0.0083629 (0.0003986)	794.62446	1342.53 (0.0001)
1997	-0.3022275 (0.0038941)	2.87833 (0.0498287)	0.0562286 (0.0028018)	326.8198	606.64 (0.0001)
1998	0.0972772 (0.0136097)	1.524079 (0.0514433)	0.2178217 (0.0112055)	-12.502168	48.92 (0.0001)
1999	-0.4990586 (0.0155711)	2.711054 (0.0481698)	0.0664667 (0.0032017)	289.79564	306.56 (0.0001)
2000	-0.5732041 (0.0133963)	3.157503 (0.0501872)	0.0425318 (0.0021345)	399.78557	713.58 (0.0001)
2001	-0.2372162 (0.0188664)	3.233549 (0.0496832)	0.0394174 (0.0019584)	415.13481	164.43 (0.0001)
1992-2001	-0.0344637 (0.0162868)	0.5579295 (0.0180312)	0.572393 (0.0103209)	-1966.3999	4.34 (0.0373)

Note: α is the size of the bubbles, λ is the instantaneous exit rate and *ln(p)* is the instantaneous hazard rate. Numbers shown in parentheses are standard errors except those in LR test column which are p-values. The log likelihood is the logarithm of the joint probability density function. The LR test is for null hypothesis of no duration dependence. The LR statistic is asymptotically x^2 with 1 degree of freedom.

Source: Author's estimate.

Table 6.5: Summary of the Results of the Duration Dependence and Weibull Hazard Tests

Year	DD – Monthly α	WH – Monthly α	DD – Daily α	WH – Daily α
1975-2001	-0.2554458	-0.3026306	n/a	n/a
1992-1996	-0.3437964	-0.36355	-0.2916168	-0.3010924
1997-2001	0.0699114*	0.1004323*	0.0724716*	0.1052452*
1992	-0.2823224	-0.2600498	-0.0134382	-0.1337965
1993	-0.434855	-0.4404215	-0.2925718	-0.0288201
1994	-0.4166478	-0.4051263	-0.4208818	-0.4055613
1995	-0.3755235	-0.4055728	-0.3604701	-0.4067694
1996	-0.3670404	-0.3645129	-0.3694731	-0.366379
1997	-0.2860517	-0.3041832	-0.2905493	-0.3022275
1998	0.1261683*	0.1296854*	0.0640916*	0.0972772*
1999	-0.473512	-0.4855359	-0.4928002	-0.4990586
2000	0.9217006*	0.9587039*	-0.5146781	-0.5732041
2001	-0.1912209	-0.2429695	-0.1795834	-0.2372162
1992-2001	0.0988104*	-0.0383979	0.0525267*	-0.0344637

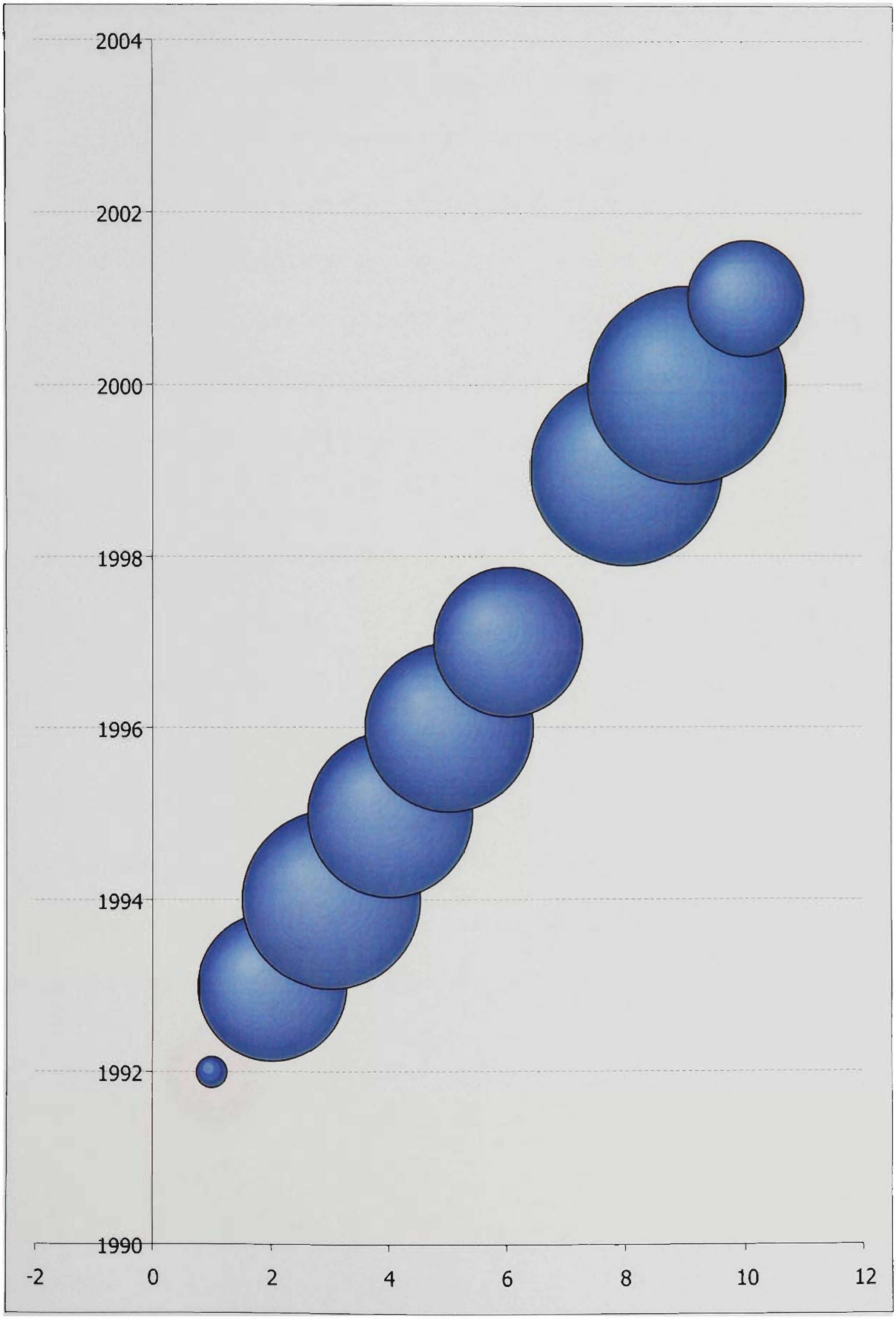
Note: (*) indicates the rejection of the null where no rational speculative bubble is present.
Source: Author's estimate.

The estimates of the Duration Dependence and Weibull Hazard models reported in Table 6.5 are consistent with the presence of rational speculative bubbles. For the overall period (1975-2001), rational bubbles are indicated where α is negative. The presence of bubbles was significantly high before the crisis period, especially in 1993, 1994, 1995 and 1996 with monthly α value of approximately –0.43, -0.42, -0.38, and –0.37 respectively. These results are evidence for the conclusive existence of rational speculative bubbles during the pre-crisis period (1992-1996). The tests of daily data produce similar results in all test periods.

In contrast, estimates of these two models provide evidence against the presence of rational speculative bubbles after the crisis period (1997-2001) where α is positive. The presence of rational bubbles is significant in the years 1993, 1994, 1995, 1996 and 1999 with an average negative α of less than -0.3. In short, this indicate that during these periods there are speculation and arbitrage opportunities which make returns on stock prices grow even faster than the return on dividends. Hence, this influences the bubble to grow over time.

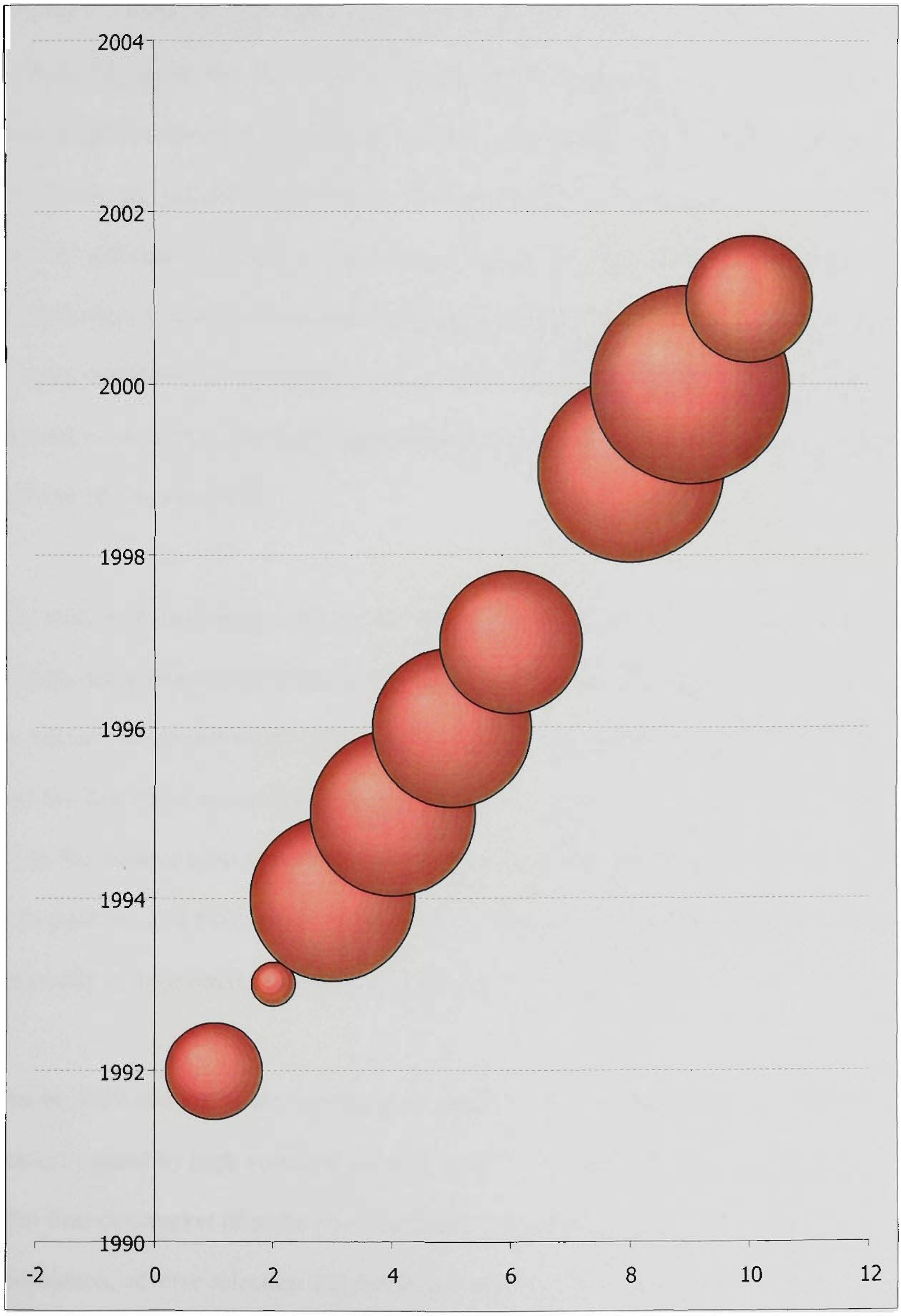
The finding implies that bubbles keep growing until a crisis point is reached where either bursts and is no longer present or demises to a much smaller size. A simulation of sizes of rational speculative bubbles for the Stock Exchange of Thailand is shown in figures 6.1 and 6.2.

Figure 6.1: Simulation of Sizes of Rational Speculative Bubbles on Daily Data – Duration Dependence Test, 1992-2001.



Source: Author's estimate.

Figure 6.2: Simulation of Sizes of Rational Speculative Bubbles on Daily Data – Weibull Hazard Model, 1992-2001.



Source: Author's estimate.

6.6 Rational Speculative Bubbles in the Thai Stock Market

Thailand's economy has experienced extremely large fluctuations of stock price bubbles during the past decade due to its periods of emergence, expansion and crisis. If stock prices are at levels consistent with economic fundamentals, price fluctuations would not be considered a serious problem for the Thai economy. However, rational speculative bubbles over-expanded during the stock market boom and the rapid decline in stock values while followed had a negative effect on the economy causing instability in the capital market. Rational speculative bubbles were also blamed as one of the reasons for poor market performance during the past few years (Moosa 2003b; Fox 2001).

The results of the rational speculative bubble tests in figures 6.1 and 6.2 clearly indicate the existence of bubbles in the Thai stock market. The bubbles were driven by various factors especially speculation, and as a result, stock prices rose too high and too fast (from about 600 points in 1990 to 1,700 points in 1994). Eventually when the bubbles burst after the Asian financial crisis (indicated in Table 6.5 where α is positive in 1998), stock prices dropped rapidly to their fundamental values especially in the property, communications and technology sectors.

During 1999 and 2000, the bubbles grew larger because of uncertainty in the stock market, caused by high volatility in stock prices. The increase in uncertainty of the Thai financial market after the crisis and stock market crash, increased the severity of speculation, adverse selection and moral hazard problems in the market. Because of worsening investment conditions and uncertainty about the health of the stock market, investors, especially overseas, began to withdraw their funds and postpone future investment. Regarding the real value of stocks, the existence of bubbles imply that the Thai stock market during the periods of 1992-1997 and 1999-2002 was overvalued.

6.7 Conclusions

These results are consistent with McQueen and Thorley's (1994) Duration Dependence Test results, where a rational speculative bubble is present when α is negative. The Weibull Hazard model of Mudholkar et al. (1996) also provides similar results.

For the Duration Dependent Test, the negative value of gamma heterogeneity is observationally equivalent to a Weibull Hazard λ The presence of rational speculative bubbles is significant during the pre-crisis period especially in 1993 and 1994, before the bubble started to burst in 1996. After the crisis when the price of the closing index was down from an average of 1600 points in 1994 to just around 300 points in 1997, the size of the bubble was much smaller and disappeared in 1998. However, the bubble grew larger again during 1999. This could have resulted from arbitrage and speculative behaviour of investors trading on the Stock Exchange of Thailand.

The following chapter will examine another issue regarding market imperfections called anomalies. A multiple regression with dummy variables will be used in the analysis of anomalies in the Thai stock market.

Chapter 7

ANOMALIES

7.1 Introduction

Much attention has been paid to stock market anomalies such as the day of the week effect, the January effect, the weekend and holiday effects, the semimonthly effect, and turn of the month effect. There have been extensive studies which document long-term historical anomalies in the stock market that seem to contradict the efficient market hypothesis.

This chapter examines daily seasonal anomalies (day of the week effect) and the monthly seasonal anomalies (January effect) for the case of the Thai stock market. A thorough analysis is made using returns derived from the SET index, adjusted for geometric returns by using logarithm neporiano to identify the behaviour of investors in this market. Data gathered from the SET includes both monthly and daily returns prices from January 1992 to December 2001.

This chapter is organized in four sections. Section 1 introduces the chapter. Section 2 provides an overview of the anomalies in the stock market. Section 3 describes the nature of the methodology. Section 4 reports the empirical findings on the day of the week effect and January effect. Section 5 discusses the anomaly issues in the Thai stock market. Finally, the conclusion of the chapter is provided in Section 6.

7.2 Anomalies in the Stock Market

Anomalies refer to regularities that appear in the trading of stocks. Many researchers have found certain empirical regularities that influence stock returns and which are not predicted by any of the traditional asset pricing models. Two most significant forms of regularities are the day of the week effect and the January effect.

Some empirical studies on the day of the week and weekend effects, include Cross (1973), Fama (1965), French (1980), Gibbons and Hess (1981), Keim and Stambaugh (1984), Jaffe and Westerfield (1985), Abraham and Ikenberry (1994), Aggarwal and Tandon (1994), Al-Loughani and Chappell (2001), and Cabello and Ortiz (2002). According to the EMH, the expected daily returns on stocks are the same for all days of the week, i.e. the expected returns of a selected stock is the same for Monday as it is for the rest of the week. However, French (1980) examined the average daily return on the NYSE-listed securities and found evidence that the average returns on Monday were negative, whereas the other days of the week had positive average returns.

The January effect could be viewed as a similar phenomenon to the weekend effect except that the stock prices appear to be higher during the early days of January. The studies of Henk (2001), Nassir and Mohammad (1987) and Roll (1983) found average monthly returns in January were higher than the average returns in any other months. According to Sharpe, Alexander and Bailey (1999), there is no certain explanation to what actually causes expected stock returns to be higher in certain months than in others. However, in some cases, investors sell stocks at the end of the year to accrue capital losses which can be offset against capital gains to reduce tax liability, producing the so called tax loss selling effect (but only if the tax year ends in December and this is not the case in the U.S. or Australia). This could cause average returns in January to be higher than any other month. This anomaly has also been documented by Reiganum (1983), Chen and Singal (2001), and Cabello and Ortiz (2002).

7.3 Tests of Anomalies in the Thai Stock Market

7.3.1 Day of the Week Effect

A standard methodology is initially employed to test for daily seasonality in stock market adjusted returns by estimating the following regression formula:

$$R_t = \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4 + \beta_5 D_5 + \varepsilon_t$$

where $\beta_1, \beta_2, \ldots, \beta_5$ are parameters, ε_t is an error term and D_1, D_2, D_3, D_4 and D_5 are dummy variables for Monday, Tuesday, Wednesday, Thursday, and Friday (i.e. $D_1 =$ 1, if t is Monday, 0 otherwise).

The closing stock market index was used in the analysis. The period examined is from January 1992 to December 2001. The comparisons between pre-crisis and post-crisis periods are also undertaken. The Thai stock exchange market is open from Monday to Friday, so Saturday and Sunday were excluded from this period and the review covered 2454 trading days. Tested results are given in Appendix 7.

Adjusted returns were used in testing seasonal daily anomalies, and is calculated as $R_t = \ln(I_t / I_{t-1}) \times 100$, which is the logarithmic neporiano difference. In the case of a day following a non-trading day, the return is calculated using the closing price indices of the latest trading day.

7.3.2 January Effect

Many empirical studies have found evidence of high returns during the month of January. Ho (1990), using daily returns for the period between 1975 and 1987, found that six of the Asia Pacific stock markets (Hong Kong, Korea, Malaysia, Philippines, Singapore and Taiwan) had significantly higher returns during January. Henke (2001) found positive returns in the Polish Stock Market for the months of January and February. In addition, Cabello and Ortiz (2002) also found positive returns during January in the Mexican Stock Market.

A typical model that is quite similar to seasonal daily anomalies is employed to test the month of the year effect or January effect on adjusted returns for the Stock Exchange of Thailand by estimating the following regression formula:

$$R_t = \beta_1 M_1 + \beta_2 M_2 + \beta_3 M_3 +,\ldots, +\beta_{12} M_{12} + \varepsilon_t$$

where $\beta_1, \beta_2, \beta_3,\ldots,$ β_{12} are parameters, ε_t is an error term, and M_1, M_2, M_3,..., and M_{12} are dummy variables for January, February, March ,..., until December (where $M_1 = 1$, during January, 0 otherwise).

7.4 Empirical Results

7.4.1 Day of the Week Effect

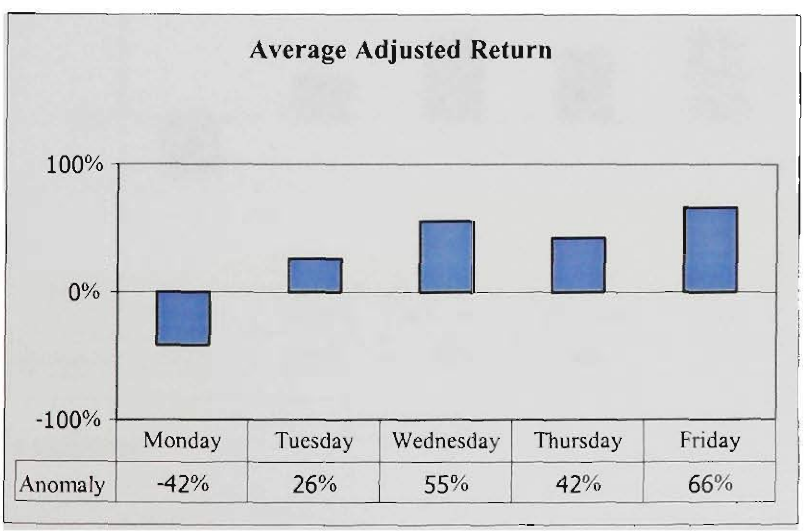
The results of the estimating model along with the test degree of freedom, t-test, p-value, and adjusted R^2 are shown in Appendix 7.

a) The Overall Period, 1992-2001

$$R_t = -0.42\, D_1 + 0.26D_2 + 0.55D_3 + 0.42D_4 + 0.66D_5 + \varepsilon_t$$

The estimated ordinary least-squares (OLS) regression equation indicates that the SET returns R_t is inversely related to the Monday D_1 returns but directly related to the Tuesday D_2, Wednesday D_3, Thursday D_4 and Friday D_5 returns.

Figure 7.1: Day of the Week Effect, 1992-2001 (Annualized)



Source: Author's estimate.

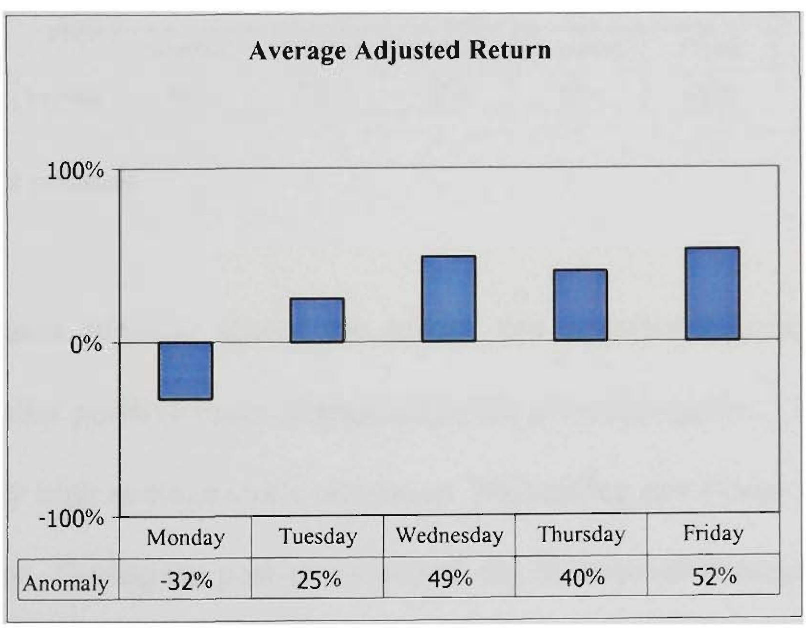
Tests for seasonality on daily returns during the pre-crisis and post-crisis periods are shown in figures 7.2 and 7.3. The results, with some differences in the magnitude of average returns, are very similar to the overall period.

b) The Pre-Crisis Period, 1992-1996

$$R_t = -0.32\, D_1 + 25D_2 + 0.49D_3 + 0.40D_4 + 0.52D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.2: Day of the Week Effect, Pre-Crisis (Annualized)



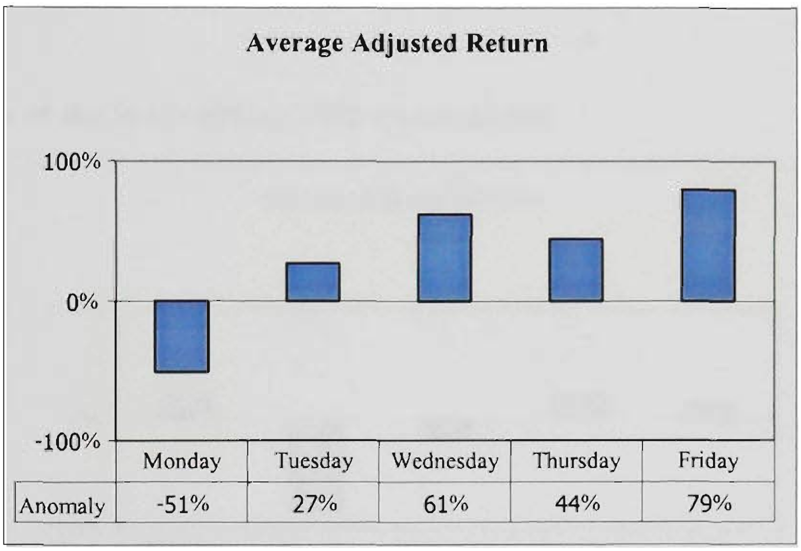
Source: Author's estimate.

c) The Post-Crisis Period, 1997-2001

$$R_t = -0.51\, D_1 + 0.27D_2 + 0.61D_3 + 0.44D_4 + 0.79D_5 + \varepsilon_t$$

Again, the estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.3: Day of the Week Effect, Post-Crisis (Annualized)



Source: Author's estimate.

In all three cases Monday shows the lowest and negative returns and Tuesday produces a similar positive return compared to the pre-crisis period. It is interesting to see relatively high average stock returns on Wednesday and Friday compared to a low on Monday. During the post-crisis period, the differential between Monday and the best performing day is significantly large, reflecting the high volatility of the market after the crisis and the possibilities of obtaining extraordinary gains.

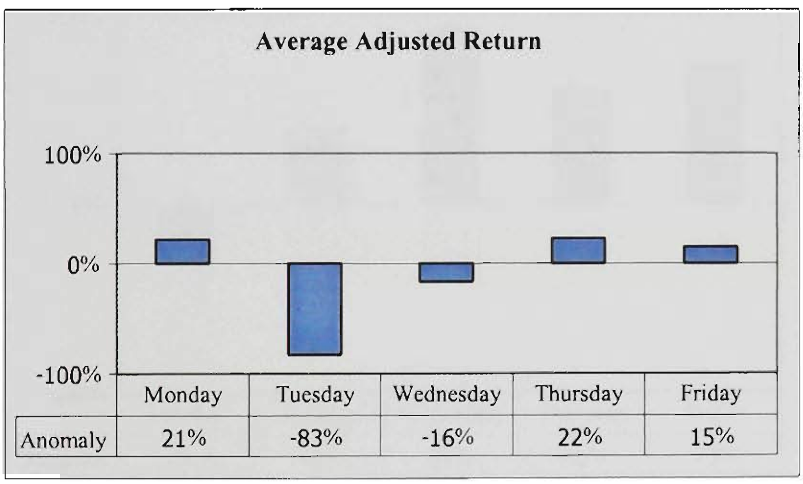
Examining the day of the week effect for particular years, between 1992-2001, we get the following results.

1) Year 1992

$$R_t = 0.21\, D_1 - 0.83D_2 - 0.16D_3 + 0.22D_4 + 0.15D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Tuesday and Wednesday returns but directly related to the Monday, Thursday and Friday returns. This result contradicts the other findings where average stock returns are usually negative on Monday but positive on other days of the week.

Figure 7.4: Day of the Week Effect, 1992 (Annualized)



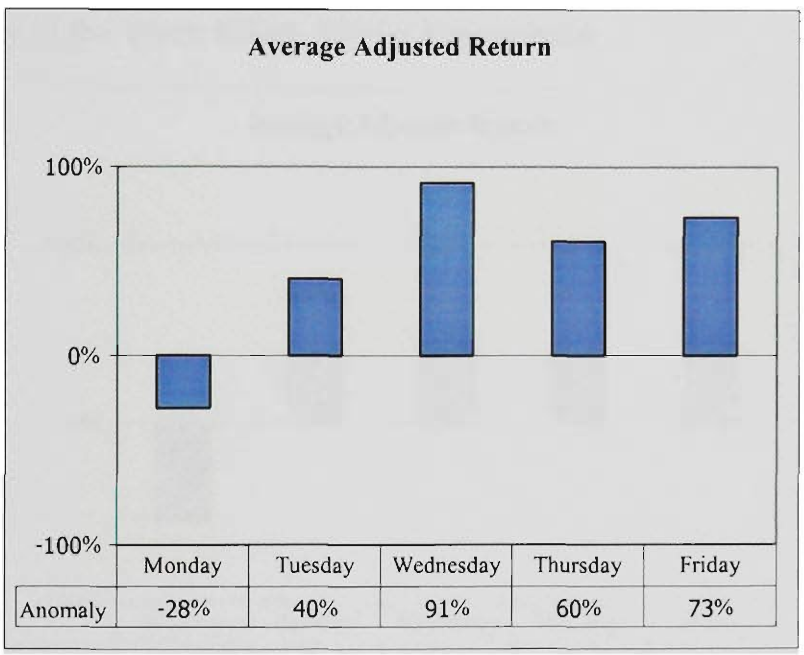
Source: Author's estimate.

2) Year 1993

$$R_t = -0.28\, D_1 + 0.40D_2 + 0.91D_3 + 0.60D_4 + 0.73D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the 1993 SET returns follows the usual pattern and is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.5: Day of the Week Effect, 1993 (Annualized)



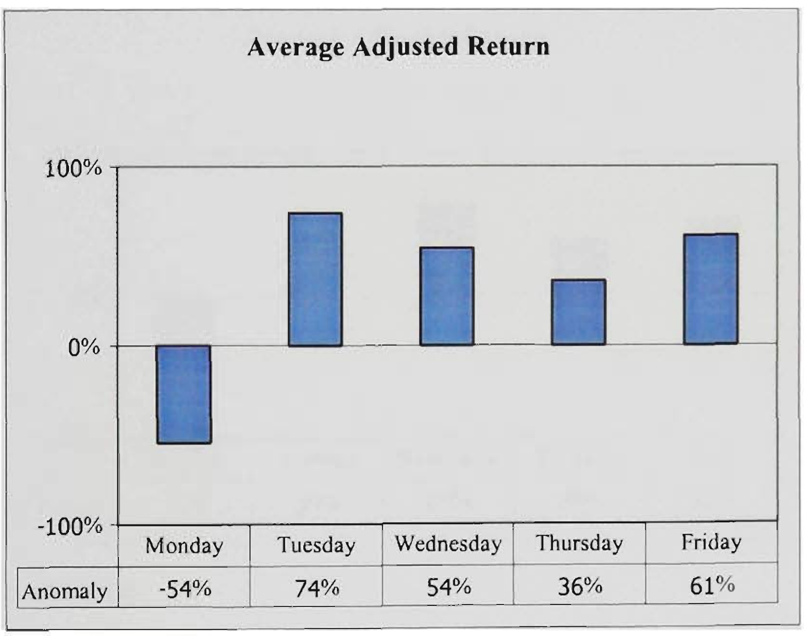
Source: Author's estimate.

3) Year 1994

$$R_t = -0.54\, D_1 + 0.71 D_2 + 0.54 D_3 + 0.36 D_4 + 0.61 D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.6: Day of the Week Effect, 1994 (Annualized)



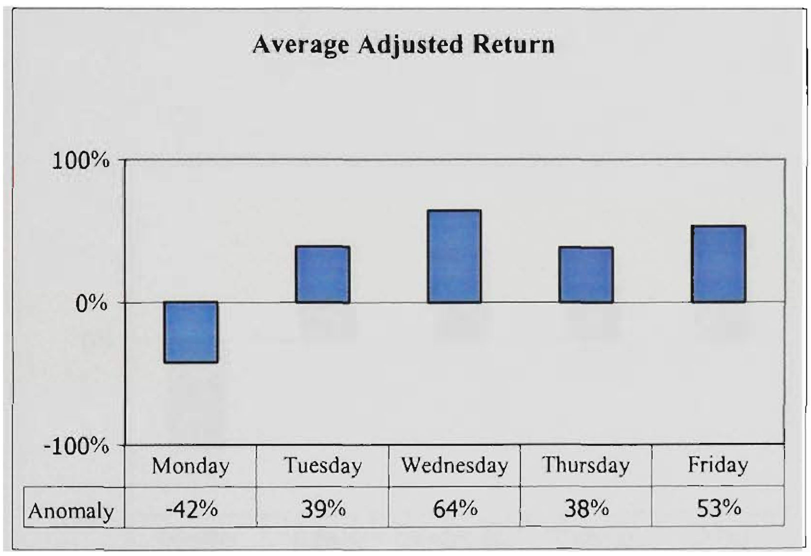
Source: Author's estimate.

4) Year 1995

$$R_t = -0.54\, D_1 + 0.71 D_2 + 0.54 D_3 + 0.36 D_4 + 0.61 D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.7: Day of the Week Effect, 1995 (Annualized)



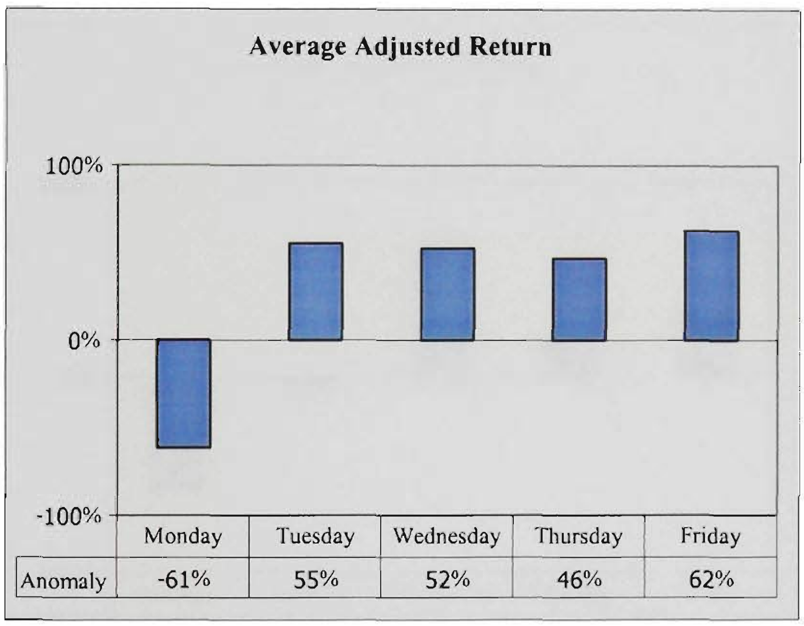
Source: Author's estimate.

5) Year 1996:

$$R_t = -0.61\,D_1 + 0.55D_2 + 0.52D_3 + 0.46D_4 + 0.62D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.8: Day of the Week Effect, 1996 (Annualized)



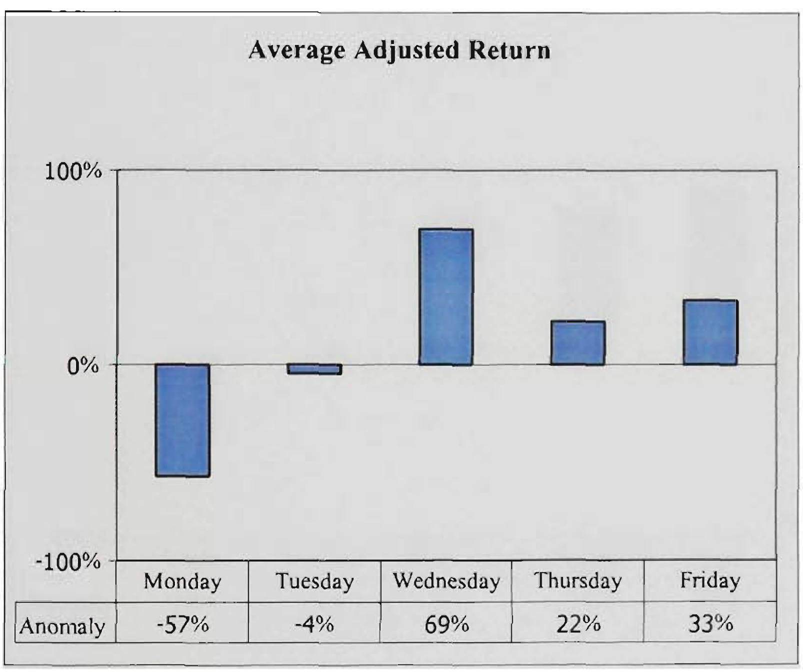
Source: Author's estimate.

6) Year 1997

$$R_t = -0.7\ D_1 - 0.04D_2 + 0.69D_3 + 0.22D_4 + 0.33D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday and Tuesday returns but directly related to the Wednesday, Thursday and Friday returns.

Figure 7.9: Day of the Week Effect, 1997 (Annualized)



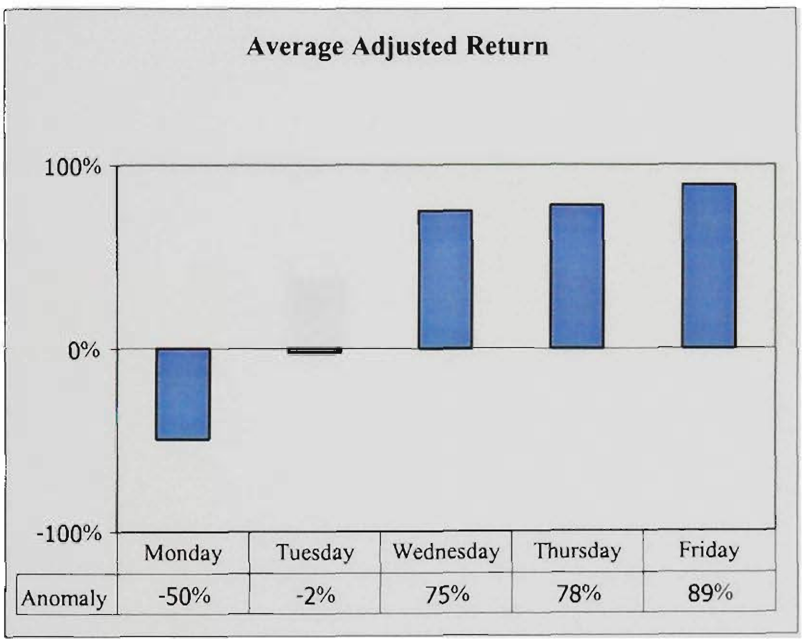
Source: Author's estimate.

7) Year 1998:

$$R_t = -0.50D_1 - 0.02D_2 + 0.75D_3 + 0.78D_4 + 0.89D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday and Tuesday returns but directly related to the Wednesday, Thursday and Friday returns.

Figure 7.10: Day of the Week Effect, 1998 (Annualized)



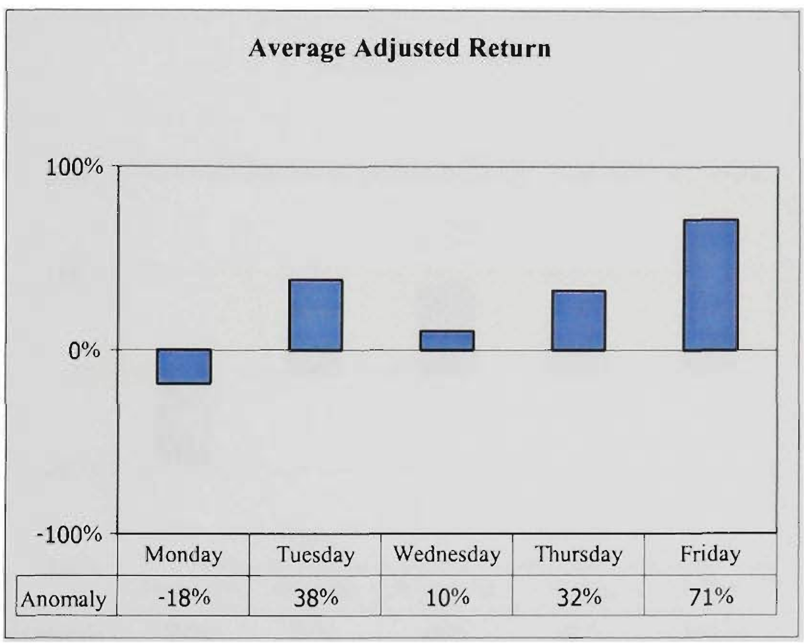
Source: Author's estimate.

8) Year 1999:

$$R_t = -0.18\,D_1 + 0.38D_2 + 0.10D_3 + 0.32D_4 + 0.71D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.11: Day of the Week Effect, 1999 (Annualized)



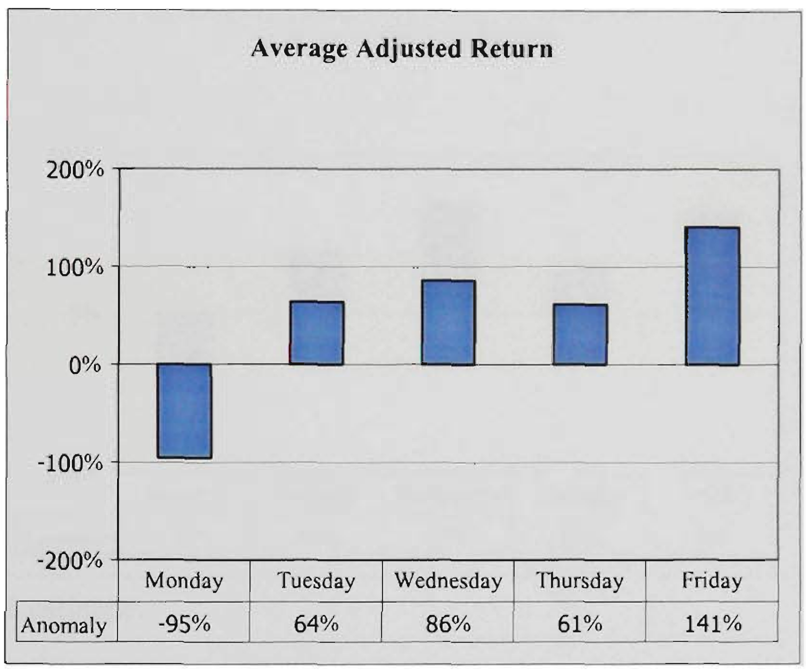
Source: Author's estimate.

9) Year 2000

$$R_t = -0.95D_1 + 0.64D_2 + 0.86D_3 + 0.61D_4 + 1.41D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.12: Day of the Week Effect, 2000 (Annualized)



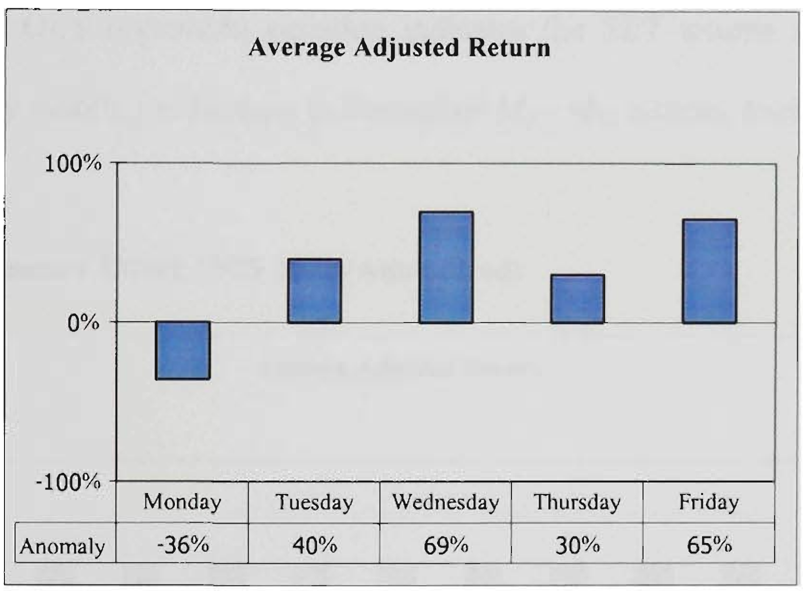
Source: Author's estimate.

10) Year 2001

$$R_t = -0.36D_1 + 0.40D_2 + 0.69D_3 + 0.30D_4 + 0.65D_5 + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to Monday returns but directly related to the Tuesday, Wednesday, Thursday and Friday returns.

Figure 7.13: Day of the Week Effect, 2001 (Annualized)



Source: Author's estimate.

To sum up, in most of the results, Monday shows the lowest negative returns. Tuesday generally reports positive returns, however, during 1997 and 1998, it shows negative return but at a much lower rate than Monday. Seasonality is also present in Wednesday, Thursday and Friday with positive returns. Friday records the highest percentage of anomalies in stock returns followed by Wednesday and Thursday respectively.

7.4.2 January Effect

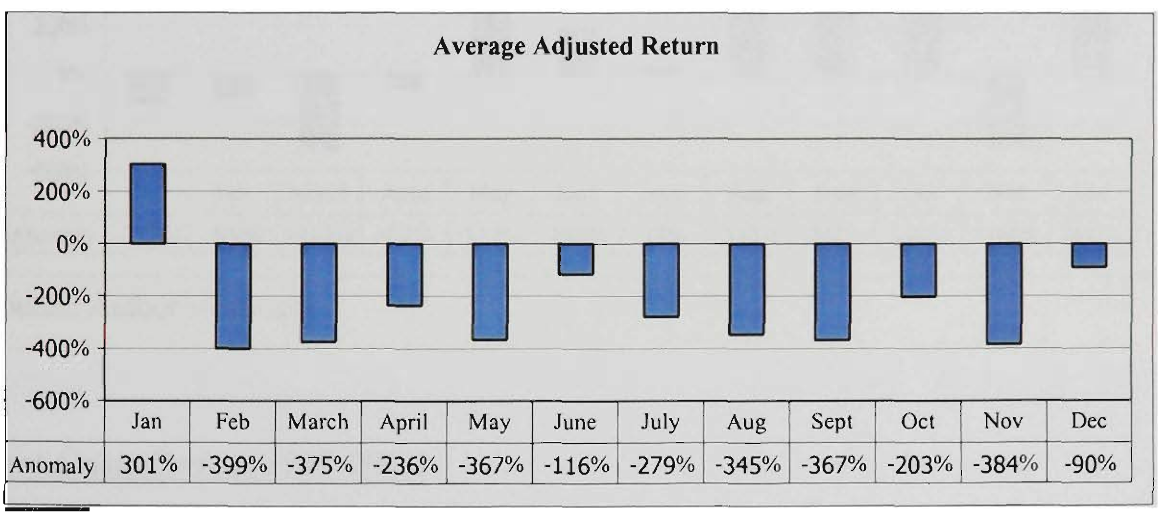
The Month of the Year Anomaly (January Effect) results are illustrated as follows.

<u>*Overall Period (1975-2001)*</u>

$$R_t = 3.01M_1 - 3.99M_2 - 3.75M_3 - 3.66M_4 - 1.16M_5 - 3.66M_6 - 2.79M_7 - 3.45M_8 - 3.67M_9 - 2.03M_{10} - 3.84M_{11} - 0.90M_{12} + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns R_t is inversely related to every month, i.e. January to December $M_1 - M_{12}$ returns, except January.

Figure 7.14: January Effect, 1975-2001 (Annualized)



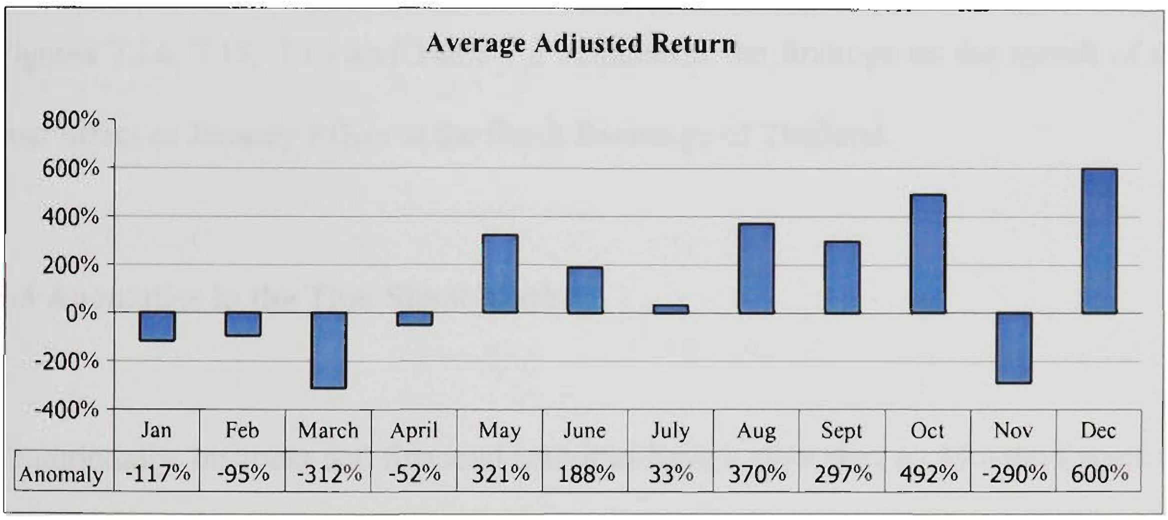
Source: Author's estimate.

Pre-Crisis Period (1992-1996)

$$R_t = -1.17\,M_1 - 0.95M_2 - 3.12M_3 - 0.52M_4 + 3.21M_5 + 1.88M_6 + 0.33M_7 + 3.70M_8 + 2.97M_9 + 4.92M_{10} - 2.90M_{11} + 6.00M_{12} + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns is inversely related to January, February, March, April and November returns but directly related to the May, June, July, August, September, October and December returns.

Figure 7.15: January Effect, 1992-1996 (Annualized)



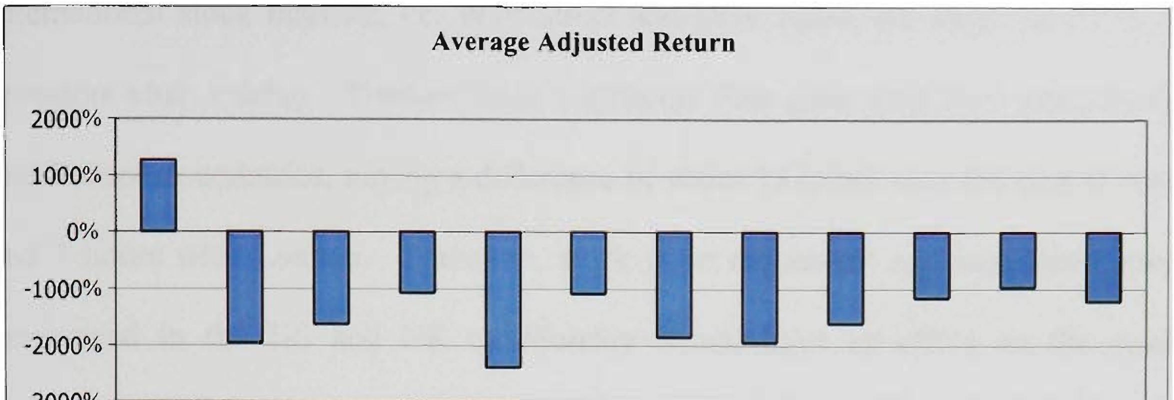
Source: Author's estimate.

Post-Crisis Period (1997-2001)

$$R_t = 12.68 - 19.57\beta_2 - 16.29\beta_3 - 10.72\beta_4 - 23.90\beta_5 - 10.84\beta_6 - 18.50\beta_7 - 19.45\beta_8 - 16.07\beta_9 - 11.52\beta_{10} - 9.67\beta_{11} - 12.17\beta_{12} + \varepsilon_t$$

The estimated OLS regression equation indicates the SET returns R_t is inversely related to every month, i.e. February to December $\beta_2 - \beta_{12}$ returns, except January.

Figure 7.16: January Effect, 1997-2001 (Annualized)



	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Anomaly	1268%	-1957%	-1629%	-1072%	-2390%	-1084%	-1850%	-1945%	-1607%	-1152%	-967%	-1217%

Source: Author's estimate.

Figures 7.14, 7.15, 7.16 and Table 7.2 summarize the findings on the month of the year effect or January Effect at the Stock Exchange of Thailand.

7.5 Anomalies in the Thai Stock Market

Traditionally, business and financial activities have a slow start on Mondays since all financial intermediaries, stock market, and other organizations are closed on Saturday and Sunday. This pause produces an inertia effect and slow start on Mondays as well as a quiet space where information such as bad news occurring during the weekend may have more effect on the Monday performance than it might, had it occurred during the busy workweek.

Interestingly, the evidence of some negative returns on Tuesdays for the first two years of the post-crisis period is not in line with the traditional view of the day of the week effect. This may caused by international factors which have considerable influence on emerging markets in most developing countries including Thailand. Movements in stock prices and the announcement of information from major international stock markets, i.e. Wall Street and Dow Jones, are observed by local investors after a delay. Thailand is in a different time zone than the United States and European countries, having a difference of about 13 hours with US central time and 7 hours with London. Therefore, stock price movement and any information announced in the US and UK on Monday would have an effect on the stock exchange of Thailand on Tuesday.

Friday generally records the highest anomalies in returns of the week and is most likely influenced by foreign portfolio investor behaviour. Table 7.1 sums up the empirical results of the day of the week effect.

Table 7.1: Empirical Results – Day of the Week Effect

	1992-2001	1992-1996	1997-2001	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Monday	-0.42	-0.32	-0.51	0.21	-0.28	-0.54	-0.42	-0.61	-0.57	-0.50	-0.18	-0.95	-0.36
Tuesday	0.26	0.25	0.27	-0.83	0.40	0.74	0.39	0.55	-0.04	-0.02	0.38	0.64	0.40
Wednesday	0.55	0.49	0.61	-0.16	0.91	0.54	0.64	0.52	0.69	0.75	0.10	0.86	0.69
Thursday	0.42	0.40	0.44	0.22	0.60	0.36	0.38	0.46	0.22	0.78	0.32	0.61	0.30
Friday	0.66	0.52	0.79	0.15	0.73	0.61	0.53	0.62	0.33	0.89	0.71	1.41	0.65

Source: Author's estimate.

The 1992 result contradicts the classical view of seasonal daily anomalies where Monday and Friday appear to have undergone a certain reversal in roles. In this case, Monday (and Thursday) recorded the highest anomalies in returns while Friday on ly posted a very moderate return compared to its usual high. Also, the volatility in stock returns on Thursday and Friday in 1992 dropped significantly to just around and below 20 per cent respectively. This compares to the pre-crisis period, which recorded positive returns of around 40-50 per cent. Continuing the contrary pattern for 1992, Tuesday exhibited the second largest negative return along with the only negative return on a Wednesday for the period 1992-2001.

In fact, speculative factors could come into play in this low-return Monday and high-return Tuesday and Friday. The differential between Monday and Tuesday is significantly large and creates a distinct possibility of obtaining extraordinary gains in this market through speculative activities. One scenario is that speculators could employ short-term trading to buy stocks on Monday and then sell on Tuesday. This would cause the stock return on Wednesday to be lower compared to Tuesday. Then speculators would buy again and sell on Friday. The result of such speculative behaviour and the effect from international portfolio markets is that stock market returns on Monday appear be the lowest and on Friday the highest.

The typical seasonal monthly anomalies were present and clear in most of the periods, except during the pre-crisis period, when a positive January effect was present. From the first day of trading on the Stock Exchange of Thailand in 1975, a positive January effect was present throughout the whole period, 1975-2001. This behaviour is consistent with the null hypothesis advanced to explain the January effect in the U.S. stock market (Roseff and Kinney 1976; Ho 1990) where six Asian stock markets, Hong Kong, Korea, Malaysia, Philippines, Singapore, and Taiwan were investigated and higher returns were found during January. Table 7.2 summarizes the empirical results of the January effect.

Table 7.2: Empirical Results – January Effect

Month	1975-2001	1992-2001	1992-1996	1997-2001
January	3.0143	4.5190	-1.1694	12.6812
February	-3.9920	-9.0208	-0.9485	-19.5670
March	-3.7461	-8.4667	-3.1205	-16.2867
April	-2.3641	-4.3848	-0.5188	-10.7247
May	-3.6661	-9.1060	3.2097	-23.8955
June	-1.1638	-3.2446	1.8774	-10.8404
July	-2.7919	-7.8525	0.3252	-18.5042
August	-3.4544	-6.6355	3.7021	-19.4471
September	-3.6694	-5.3155	2.9692	-16.0741
October	-2.0271	-2.0660	4.9156	-11.5216
November	-3.8384	-5.0485	-2.8992	-9.6718
December	-0.9024	-1.8478	5.9959	-12.1654
Degree of Freedom	317	118	58	58
Adjusted R Square	-0.0143	-0.0267	-0.0975	0.0090

Source: Author's estimate.

February and May effect were also found with extra low market returns. The presence of an overall "cycle" appears throughout the whole period, especially during the post-crisis period (but not the pre-crisis period) (See Figure 7.16). This cycle could be summarized as: January produces the highest return, followed by large negative returns on February and a general upturn in stock market performance to a high in June. There is a downward trend in July and August, followed by an upward trend through to December.

The most unusual stock market returns were found during the pre-crisis (1992-1996) period where the above cycle is not evident and January stock returns were low contrary to traditional January effect views, where high stock returns are found. According to Sharpe, Alexander and Bailey (1995), there is no obvious reason to expect stock returns to be higher or lower in certain months than in others. However, for the case of Thailand, these unusual results could be explained that investors' rational speculative behaviour and asymmetric information problems which dramatically increased during the peak of the Thai economy. Seven of the twelve months report positive returns which result in high May, June, August, September, October and December return, with December the best performing month. As we have discussed in Chapter 2, the Thai economy during the boom period was characterised by foreign capital flows and a financial liberal policy. These factors combined with cheap labour to attract foreign investment in the Thai economy and in the stock market which drove the stock market index from 800 points to just around 1600 points within 5 years. In addition, speculative bubbles also contributed to the abnormally high rate of return in the Thai stock market during this pre-crisis period.

Comparing the results with other studies on the New York and Tokyo Stock Exchange, we found that our results are similar to the existing literature where the average return in January was clearly higher than the average monthly return in the remaining 11 months.

7.6 Anomalies and Investors Motives

It is suggested that investors could use these anomaly results to predict stock market movements on any particular days or months in order to generate extraordinary profit. For example, investors may buy a number of diversified stocks on Monday, and sell them on Friday to get an average return of approximately 130% (see Figure 7.3), or buy them during December then sell them later during January (see Figure 7.16). By doing so, the primary motivation of the stock market investment can be violated where investors are assumed to secure their returns commensurate with risks for a particular stocks, and for a longer period of time. In fact, they could enjoy this extraordinary excess returns in a short-term, and this could became their dominant motives (Moosa 2003b).

7.7 Conclusions

Empirical evidence from the analysis in this chapter suggests the existence of the day of the week effect and January effect. The returns differential between Monday and the best performing day is significantly large. This raises the issue of speculation, which we discussed in the previous chapter, where there was an opportunity to obtain extraordinary gains in the Thai stock market especially during the pre-crisis period. However, the return volatility after the crisis was greater than before and contributed to the instability of the market immediately after the crisis.

The January effect was also present in most of the time period except during the pre-crisis periods examined when an unusual negative return in January was identified, along with an unusual positive return in seven other months, December being the month with the highest return followed closely by October. Financial liberalization, massive foreign capital inflows and low labour costs were the major factors that contributed to the boom in the Thai economy as well as its stock market. In addition, speculative factor also contributed to this "mostly every month" high return on the Thai stock market.

During the post-crisis period, the January effect was identified. The result showed a seasonal trend of returns where February and May were the poorest performing months followed by an overall upward trend until June. A downward trend was detected during July and August, with an improvement in stock return until November and slightly lower return in December.

In the next chapter we will discuss various models to test the volatility in the Thai stock market. Various linear and non-linear Generalised Autoregressive Conditional Heteroscedasticity (GARCH) models are used to identify the level of volatility in the market.

Chapter 8

VOLATILITY

8.1 Introduction

Following the Asian economic crisis and the devaluation of the Thai baht, most financial markets in South East Asian countries, particularly in Thailand, experienced a crash in capital markets and dramatic declines in exchange rates with major currencies (Titman and Wei 1999). The Thai currency lost half of its value against the US dollar within a few months after the announcement of its currency devaluation in 1997. As a result of the crisis, the Thai stock market become very volatile and stock prices suddenly fell by 70 per cent by the end of 1997.

Volatility modelling in the financial markets, especially in the stock exchange market, has attracted growing attention by academics in recent years. Volatility modelling is used as a simple risk measure in asset pricing models and undoubtedly, it has been of enormous use in applications such as stocks and derivatives pricing. The study of volatility in the stock market is also crucial for portfolio and risk management. A good understanding of volatility is very useful for investors in the stock market, since high volatility could mean extraordinary gains or losses and hence greater uncertainty.

In fact, there are a large number of volatility models now used throughout the financial industry. Several are accepted and used are: 1) Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized Autoregressive Conditional

Heteroscedasticity (GARCH) models; 2) Autoregressive Moving Average (ARMA) models; and 3) Stochastic Volatility (SV) models.

Even though there is a large literature on forecasting volatility with various types of models being used, the choice of which is the best volatility model is not agreed up among financial experts. Yu (2002) states that there is no single superior model in forecasting volatility. Therefore, different stock analysts, who have identical expectations and positions, could have different preferences and views of what constitutes risk and choice of which volatility models should be used.

In this study, ARCH and GARCH type models are adopted due to limitations of these volatility models. The purpose of this study is not to test the models but to compare the results of five ARCH and GARCH type models, consisting of both linear and non-linear models, used for identifying and predicting volatility on the stock price and seasonal anomalies in Thailand.

This chapter is set out as follow. Section 8.2 reviews various volatility models such as ARCH, ARMA and SV; comments on their limitations are also provided. Section 8.3 shows the adopted GARCH type volatility models to be used in this empirical study to investigate the level of volatility in the Thai stock market. Section 8.4 reports the empirical results on the volatility of the Thai stock market. Section 8.5 discusses the volatility issues in the market. Finally, Section 8.6 concludes this chapter.

8.2 Models for Volatility

For a volatility model to be considered reliable, it should provide accurate risk or volatility results across different assets, time horizons and risk levels within the same asset class (Danielsson 2002). Some good examples of evaluation and comparison between volatility models are the studies of Poon and Granger (2003), Barndorff-Nielsen, Nicalato and Shephard (2001), Hansen and Lunde (2001), Brooks et al. (2000), and Aydemir (1998).

8.2.1 Autoregressive Conditional Heteroscedasticity (ARCH) Models

Engle (1982) developed a model to describe time-varying variance. The methodology is called Autoregressive Conditional Heteroscedasticity (ARCH). The concept of the ARCH model has led to the development of other related formulations in order to identify and explain the variance of time series. Engle introduced the linear ARCH(q) model where the time varying conditional variance is postulated to be a linear function of the past q squared innovations. The ARCH (q) model is defined by:

$$\begin{cases} r_t = \mu + \sigma_t \varepsilon_t \\ \sigma_t^2 = \lambda + \alpha_1 (r_{t-1} - \mu)^2 +, \dots, +\alpha_q (r_{t-q} - \mu)^2 \end{cases}$$

where r_t is the SET returns, μ is the conditional mean of the return process and is constant, $\varepsilon_t \sim NID(0,1)$ is conditionally Gaussian (NID denotes normally and independently distributed), σ_t is the first alternative of the stochastic volatility models and is modelled by a stochastic process, λ_1 and α are real constants, and ε_t are zero mean, uncorrelated, random variables or white noise.

The model could also be represented as:

$$\sigma_t^2 = \lambda + \sum \alpha_1 r_{t-1}^2 + \varepsilon_t$$

Hence the volatility σ_{t+1}^2 can be represented by:

$$\sigma_{t+1}^2 = E((r_{t+1} - \mu)^2 \mid \Phi_t)$$

$$\sigma_{t+1}^2 = \lambda + \alpha_1 (r_{t-1} - \mu)^2 +,\ldots, +\alpha_q (r_{t-q} - \mu)^2$$

where Φ_t is the information set at the end of period t. This is an AR(q) model in terms of $(r_t - \mu)^2$. Therefore, the optimal one-day ahead forecast of period $t+1$ volatility can be obtained based on the returns on the most recent q days. In general, an h-day ahead step forecast can be formed as follows:

$$\hat{\sigma}_{t+h}^2 = \lambda + \alpha_1 (\hat{r}_{t+h-1} - \mu)^2 +,\ldots, +\alpha_q (\hat{r}_{t+1-q} - \mu)^2$$

where $\hat{r}_{t+h-1} = r_{t+h-j}$ if $1 \leq h \leq j$ and ($\hat{\sigma}_{t+h-j}^2 = (\hat{r}_{t+h-1} - \mu)^2$ if $h > j$.

The ARCH (1) Model

This simple ARCH model exhibits constant unconditional variance but non-constant conditional variance. Recall the following formula:

$$r_t = \mu + \sigma_t \varepsilon_t$$

given that:

$$\varepsilon_t = u_t \sqrt{(\lambda + \alpha \varepsilon_{t-1}^2)}$$

where $u_t \sim IID(0,1)$ (IID, Independent and Identically Distributed, or strict white noise); and λ and $\alpha > 0$

Note that $\sqrt{(\lambda + \alpha \varepsilon_{t-1}^2)}$ is the conditional standard deviation; and σ_t is defined as:

$$\sqrt{E(\varepsilon_t^2 \mid \varepsilon_{t-1}^2, \varepsilon_{t-2}^2, \ldots, \varepsilon_{t-i}^2)}$$

The simplest form of ARCH (1) model for the:

a) *conditional expectation* of ε_t given that ε_t is equal to zero, is defined as:

$$E(\varepsilon_t \varepsilon_{t-1}) = E(u_t \mid \varepsilon_{t-1}) \sqrt{\lambda + \alpha \varepsilon_{t-1}^2} = 0$$

note that $E(u_t \mid \varepsilon_{t-1}) = E(u_t) = 0$ since $u_t \sim IID(0,1)$;

b) *conditional variance* is defined as:

$$Var(\varepsilon_t \mid \varepsilon_{t-1}) = E(u_t^2 \mid \varepsilon_{t-1})(\lambda + \alpha\varepsilon_{t-1}^2)$$

Note that $E(u_t^2 \mid \varepsilon_{t-1}) = E(u_t^2) = 1$ since $u_t \sim IID(0,1)$.

Thus, the conditional mean and variance of r_t are given by the following formulae:

$$E(r_t \mid r_{t-1}) = \mu$$

$$Var(r_t \mid r_{t-1}) = (\lambda + \alpha\varepsilon_{t-1}^2)$$

Therefore, the conditional variance of r_t is time varying. However, it can be easily seen that the unconditional variance is time invariant given that ε_t^2 is stationary:

$$Var(r_t) = Var(\varepsilon_t) = \frac{\lambda}{(1-\alpha)}$$

<u>First Order Autoregressive Process with ARCH Effects</u>

For more complicated models such as AR(1)-ARCH(1), we obtain similar results provided that the process for *t* is stationary given that the autoregressive parameter is smaller than one in absolute value.

Assume the following first order autoregressive process:

$$r_t = \theta r_{t-1} + \varepsilon_t$$

where $\varepsilon_t = u_t\sqrt{\lambda + \alpha\varepsilon_{t-1}^2}$, $u_t \sim$ IIN(0,1), and $\lambda > 0$, $\alpha = 0$.

a) The *conditional expectation* of ε_t given that ε_t is equal to zero is:

$$E(\varepsilon_t \varepsilon_{t-1}) = E(u_t^2 \mid \varepsilon_{t-1})(\lambda + \alpha\varepsilon_{t-1}^2) = 0$$

note that $E(u_t \mid \varepsilon_{t-1}) = E(u_t) = 0$.

b) The *conditional variance* is given by the following formula:

$$Var(\varepsilon_t \mid \varepsilon_{t-1}) = E(u_t^2 \mid \varepsilon_{t-1})(\lambda + \alpha\varepsilon_{t-1}^2) = \lambda + \alpha\varepsilon_{t-1}^2$$

note that $E(u_t^2 \mid \varepsilon_{t-1}) = E(u_t) = 1$ since $u_t \sim$ IIN(0,1).

Then the conditional mean and variance of r_t are given by the following formulae:

$$E(r_t \mid r_{t-1}) = \theta r_{t-1}$$

$$Var(r_t \mid r_{t-1}) = (\lambda + \alpha\varepsilon_{t-1}^2)$$

To find the unconditional variance of r_t we recall the following property for the variance.

$$Var(r_t) = E(Var(r_t \mid r_{t-1})) + Var(E(r_t \mid r_{t-1}))$$

The left hand-side formula $E(Var(r_t \mid r_{t-1}))$ is equal to $E(\lambda + \alpha\varepsilon_{t-1}^2)$, $\lambda + \alpha E(\varepsilon_{t-1}^2)$ and $\lambda + \alpha Var(\varepsilon_{t-1})$. The right hand-side formula $Var(E(r_t \mid r_{t-1}))$ is equal to $\theta^2 Var(r_{t-1})$. Then if the process is covariance stationarity, we have:

$$Var(r_t) = \frac{\lambda + \alpha Var(\varepsilon_{t-1})}{1 - \theta^2}$$

or:

$$Var(r_t) = \frac{1}{(1-\alpha)(1-\theta^2)}$$

since:

$$Var(\varepsilon_{t-1}) = \frac{\lambda}{(1-\alpha)}$$

According to Aydemir (1998), the important property of ARCH models is their ability to capture the tendency for volatility clustering in stock prices data, i.e. a tendency for large or small swings in prices to be followed by large or small swings of random direction. In addition, Barndorff-Nielsen, Nicolato and Shephard (2001) and Aydemir (1998) also found that the ARCH/GARCH type models are significantly outperformed by other models including the ARMA and SV models.

8.2.2 Autoregressive Moving Average (ARMA) Models

Recalling the ARMA models in Chapter 3 where autoregressive in order p, [AR(p)] can be expressed as:

$$y_t = \gamma_1(y_{t-1}) + \gamma_2(y_{t-2}) +, \ldots, + \gamma_p(y_{t-p}) + \varepsilon_t$$

where y_t = the actual or data value at time t, γ = the constant value, and ϵ_t = the residual or error term.

Moving average of order q, [MA(q)] can be expressed as:

$$y_t = \varepsilon_t - \theta_1(\varepsilon_{t-1}) - \theta_2(\varepsilon_{t-2}) -, \ldots, -\theta_q(\varepsilon_{t-q})$$

The general presentation for ARMA models is:

$$y_t = \gamma_{0,1} + \sum_{j=1}^{p} \gamma_j y_{t-j} + \sum_{j=0}^{q} \theta_j \varepsilon_{t-j}$$

These models are widely used in the finance literature especially during the last decade. Some studies such as Schwert (1990), French, Schwert and Stambaugh (1987) and Poterba and Summer (1986) use the ARMA process for modelling volatility of the stock market. According to Aydemir (1998), the advantages of these models include the following: 1) the theory of the Gaussian model is well understood, therefore, the ARMA models are well developed; 2) modelling data with in an ARMA structure is considerably easy; and 3) these models are capable of data analysis, forecasting and control. However, several limitations of the ARMA models include: 1) these models have definite limitations in mimicking the properties where sudden bursts of the data at irregular time intervals, and periods of high and low volatility are detected, i.e. the data of the SET returns that covers the pre- and post-Asian economic crisis; and 2) the ARMA type models are based on the assumption of constant variance. Most financial data exhibit changes in volatility and this feature of the data cannot be captured due to this assumption.

8.2.3 Stochastic Volatility (SV) Models

There are several types of SV models, one the most popular being the discrete-time SV model, the continuous-time SV model and the jump diffusion model with SV. The most relevant type of SV model applying to Thai stock data is the discrete-time SV model, where s_t denotes the stock price at time t and the detrended return process y_t is defined as (Jiang 1998):

$$y_t = \ln\left(\frac{s_t}{s_{t-1}}\right) - \mu_t$$

The SV model of stock return may be written as:

$$y_t = \sigma_t \varepsilon_t$$

where $\epsilon_t \sim IID$. The most popular SV specification assumes that h_t follows an AR(1) process as:

$$h_{t+1} = \phi h_t + \eta_t, \quad |\phi| < 1$$

where η_t is an innovation. This process is satisfied using the idea of Exponential GARCH (EGARCH) and this specification ensures that the conditional variance remains positive.

According to Barndorff-Nielsen, Nicolato and Shephard (2001) and Aydemir (1998), there are several advantages of using SV models. SV properties can be found and manipulated much easier than ARCH/GARCH type models and they can also mimic the fat tail property observed in the data. Finally, they also induce an incomplete market. However, Hansen and Lunde (2001) disagree that these SV models are superior to the ARCH/GARCH type model when using returns of stock indices or bonds. Furthermore, in SV models the persistence in volatilities can be captured by specifying a random walk process. This specification is analogous to the IGARCH specification.

8.3 Adopted Volatility Models – GARCH type Models

The use of univariate parametric models such as ARCH and GARCH type models in estimating and forecasting the financial market volatility has been growing in popularity, especially when dealing with incomplete or emerging financial markets such as in Thailand. A most commonly used modified ARCH model has been the

Generalized ARCH (GARCH) model developed by Bollerslev (1986). Other ARCH-type models are characterized by Nelson (1991), who introduced the Exponential GARCH (EGARCH). Glosten, Jagannathan and Runkle (1993) has developed the GJR-GARCH(p,q) model to estimate the relationship between the expected value and the volatility of nominal excess return on stocks. Ding, Granger and Engle (1993) developed a model which extends the ARCH class of models to identify a wider class of power transformations, called Power Generalized ARCH or PGARCH.

These models consist of linear and non-linear types - non-linear models are EGARCH, GJR-GARCH and PGARCH. Franses and Dijk (2000) conclude that linear time series models do not yield reliable forecasts. However, this does not imply that linear models are not useful, and these models are used in comparing the results for the index price of the Stock Exchange of Thailand.

8.3.1 GARCH(p,q)

In empirical applications of the ARCH(q), model it is often difficult to estimate models with a large number of parameters. This motivates Bollerslev (1986) to use the Generalized ARCH or GARCH(p,q) specification to circumvent this problem.

The GARCH(p,q) model is defined as:

$$\begin{cases} r_t = \mu + \sigma_t \varepsilon_t \\ \sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i (r_{t-i} - \mu)^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 \end{cases}$$

The model could also be represented as:

$$\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

$$\sigma_t^2 = \lambda + \alpha(L)\varepsilon_{t-1}^2 + \beta(L)\sigma_{t-1}^2$$

A sufficient condition for conditional variance in the GARCH(p,q) model to be well defined is that all the coefficients in the infinite order linear ARCH model must be positive. Given that $\alpha(L)$ and $\beta(L)$ have no common roots and that the roots of the polynomial in L, $1 - \beta(L) = 0$ lie outside the unit circle, this positive constraint is satisfied, if and only if, the coefficients of the infinite power series expansion for $\dfrac{\alpha(L)}{1-\beta(L)}$ are non-negative.

Rearranging the GARCH(p,q) model by defining $v_t \equiv \varepsilon_t^2 - \sigma_t^2$, it follows that

$$\varepsilon_t^2 = \lambda + (\alpha(L) + \beta(L))\varepsilon_{t-1}^2 - \beta(L)v_{t-1} + v_t$$

which defines an ARMA (Max(p,q),p) model for ε_t^2.

In addition, the model is covariance stationary if and only if all the roots of $(1 - \alpha(L) - \beta(L))$ lie outside the unit circle. If all the coefficients are non-negative, this is equivalent to the sum of the autoregressive coefficients being smaller than 1. The analogy to the ARMA class of models also allows for the use of standard time series techniques in the identification of the order of p and q. In most empirical applications with finitely sampled data, the simple GARCH(1,1) is found to provide a fair description of the data.

The GARCH(1,1) is used to construct multi-period forecasts of volatility. When $\alpha + \beta < 1$, the unconditional variance of ε_{t+1} is $\dfrac{\lambda}{1-\alpha-\beta}$. If we rewrite the following GARCH(1,1) as:

$$\begin{aligned}\sigma_t^2 &= \lambda + \alpha(\varepsilon_{t-1}^2) + \beta(\sigma_{t-1}^2) \\ &= \lambda + \alpha(\varepsilon_{t-1}^2 - \sigma_{t-1}^2) + (\alpha + \beta)\sigma_{t-1}^2\end{aligned}$$

The coefficient measures the extent to which the impact of volatility will extend into the next period's volatility, while $(\alpha + \beta)$ measures the rate at which this effect reduces over time. Recursively substituting and using the law of iterated expectation, the conditional expectation of volatility j periods ahead is:

$$E_t[\sigma_{t+j}^2] = (\alpha + \beta)^j \left[\frac{\sigma_t^2 - \lambda}{1-\alpha-\beta}\right] + \left[\frac{\sigma_t^2 - \lambda}{1-\alpha-\beta}\right]$$

Note that the multi-period volatility forecast reverts to its unconditional mean at rate $(\alpha + \beta)$.

8.3.2 EGARCH

Even though, the GARCH model has the capability to capture thick tailed returns, volatility clusterings are not well suited to capture the leverage effect since the conditional variance is a function only of the magnitudes of the lagged residuals and not their signs. Nelson (1991) introduced the exponential GARCH (EGARCH) where σ_t^2 depends on both the sign and the size of lagged residuals.

The EGARCH(1,1) model is represented as follows:

$$\ln \sigma_t^2 = \lambda_1 + \beta_1 \ln \sigma_{t-1}^2 + \gamma_1 \left(\left[\left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| - (2/\pi)^{1/2} \right] + \delta \left[\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right] \right)$$

In fact, the EGARCH model always produces a positive conditional variance σ_t^2 for any choice of λ_1, β_1, γ_1 so that no restrictions need to be placed on these coefficients (except $|\beta_1| < 1$). Because of the use of both $|\varepsilon_t / \sigma_t|$ and $(\varepsilon_t / \sigma_t), \sigma_t^2$, it will also be non-symmetric in ε_t and, for negative δ, it will exhibit higher volatility for large negative ε_t. In addition, the EGARCH model is capable of capturing any asymmetric impact of shocks on volatility. This model allows volatility to be affected differently by good and bad news.

8.3.3 GARCH-M

A number of theories in finance assume some kind of relationship between the mean of a return and its variance. A way to take this into account is to explicitly write the returns as a function of the conditional variance or, in other words, to include the conditional variance as another regressor. The GARCH in Mean Models (GARCH-M) allow for the conditional variance to have mean effects. Most of the time this conditional variance term will have the interpretation of time varying risk premium.

Recall the GARCH(1,1) formula:

$$\begin{aligned}\sigma_t^2 &= \lambda + \alpha(\varepsilon_{t-1}^2) + \beta(\sigma_{t-1}^2) \\ &= \lambda + \alpha(\varepsilon_{t-1}^2 - \sigma_{t-1}^2) + (\alpha + \beta)\sigma_{t-1}^2\end{aligned}$$

and ARCH-M:

$$r_t = \psi\sigma_t^2 + \varepsilon_t$$

where $\varepsilon_t = v_t\sigma_t$, and $v_t \sim N(0,1)$:

$$\sigma_t^2 = w + \lambda + \alpha\varepsilon_{t-1}^2$$

Then r_t may be expressed as:

$$r_t = \psi(\lambda + \alpha\varepsilon_{t-1}^2) + \varepsilon_t$$

Consider the following formula (extension form of the above equation):

$$r_t = \theta x_t + \psi \sigma_t^2 + \varepsilon_t$$

Therefore, GARCH-M could be defined as:

$$\sigma_t^2 = \lambda + \alpha(L)\varepsilon_{t-1}^2 + \beta(L)\varepsilon_{t-1}^2$$

Consistent estimation of θ and ψ is dependent on the correct specification of the entire model. The estimation of GARCH in mean type of models is numerically unstable and many empirical applications have used the ARCH-M type of models which are easier to estimate.

8.3.4 GJR-GARCH

Glosten, Jagannathan and Runkle (1993) have extended the GARCH(p,q) model to estimate the relationship between the expected value and the volatility of nominal excess return on stocks. Their GJR-GARCH is an alternative model capturing asymmetries in financial data. A univariate regression GJR-GARCH(p,q) process, with q coefficients α_i, …, q, p coefficients, β_i, for i=1, …, p and k linear regression coefficients b_i, for i=1,…, k, can be represented by:

$$r_t = \mu + x_t^T b_i + \varepsilon_t$$

$$\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i + (\gamma S_{t-1})\varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-1}$$

This model allows the impact of the squared residual on conditional volatility to be different when the residuals are negative (first lagged) than when the residuals (first lagged) are positive. For $\gamma > 0$, all negative residuals are weighted and thus generate a different volatility in subsequent periods than do positive residuals of equal magnitude. In other words, negative shocks increase volatility more than positive shocks. Thus, the leverage of firm increases with negative return, inducing a higher volatility.

8.3.5 PGARCH

Ding, Granger and Engle (1993) suggest a model which extends the ARCH class of models to identify a wider class of power transformations than simply taking the absolute value or squaring the data as in the conventional models. This class of models is called Power ARCH (PARCH) and Power Generalized ARCH (PGARCH).

PGARCH is defined as:

$$\sigma_t^2 = \lambda + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 + \sum_{i=1}^{q} \alpha(|\varepsilon_{t-i}| + \lambda \varepsilon_{t-i})^2$$

It has been found that the sample autocorrelation function for absolute returns and squared returns remains significantly positive for very long lags. The pattern of the sample autocorrelation for various speculative returns is quite different from that of the theoretical autocorrelation functions given by the GARCH(p,q) or EGARCH(p,q) process. Ding and Granger (1996) propose a two-component GARCH model which gives a much better description of the real data:

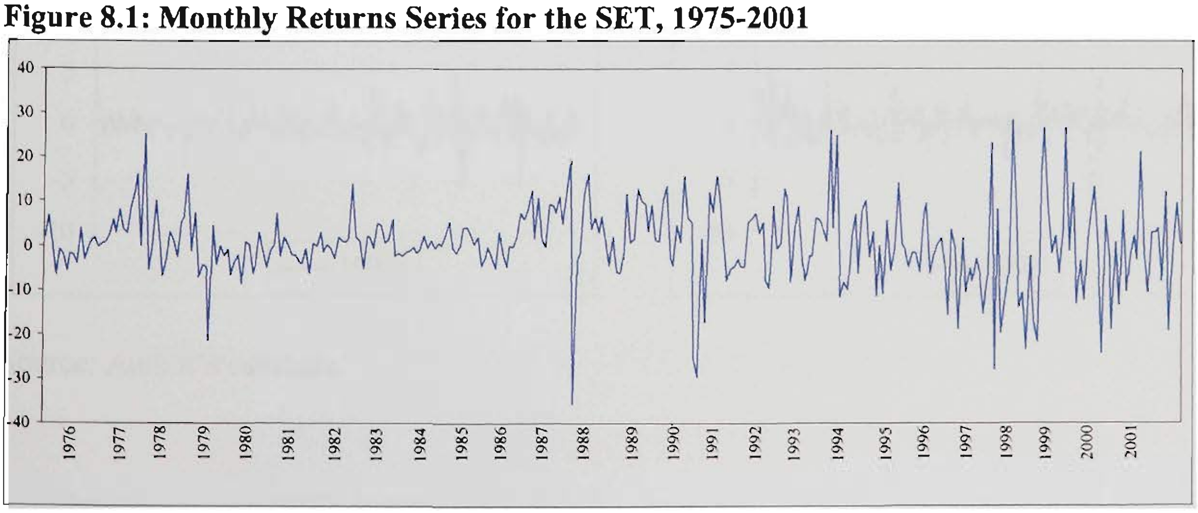
$$\sigma_t^2 = \frac{\lambda}{(1-\beta_1)(1-\beta_2)} + \sum_{i=1}^{p} \alpha_1 \beta_1^{i-1} \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \alpha_2 \beta_2^{j-1} \varepsilon_{t-j}^2 .$$

The intuition behind this two-component model is that one can use two different variance components, each of them having an exponentially decreasing autocorrelation pattern, to model the long-term and short-term movements in volatility.

8.4 Data and Estimation Results

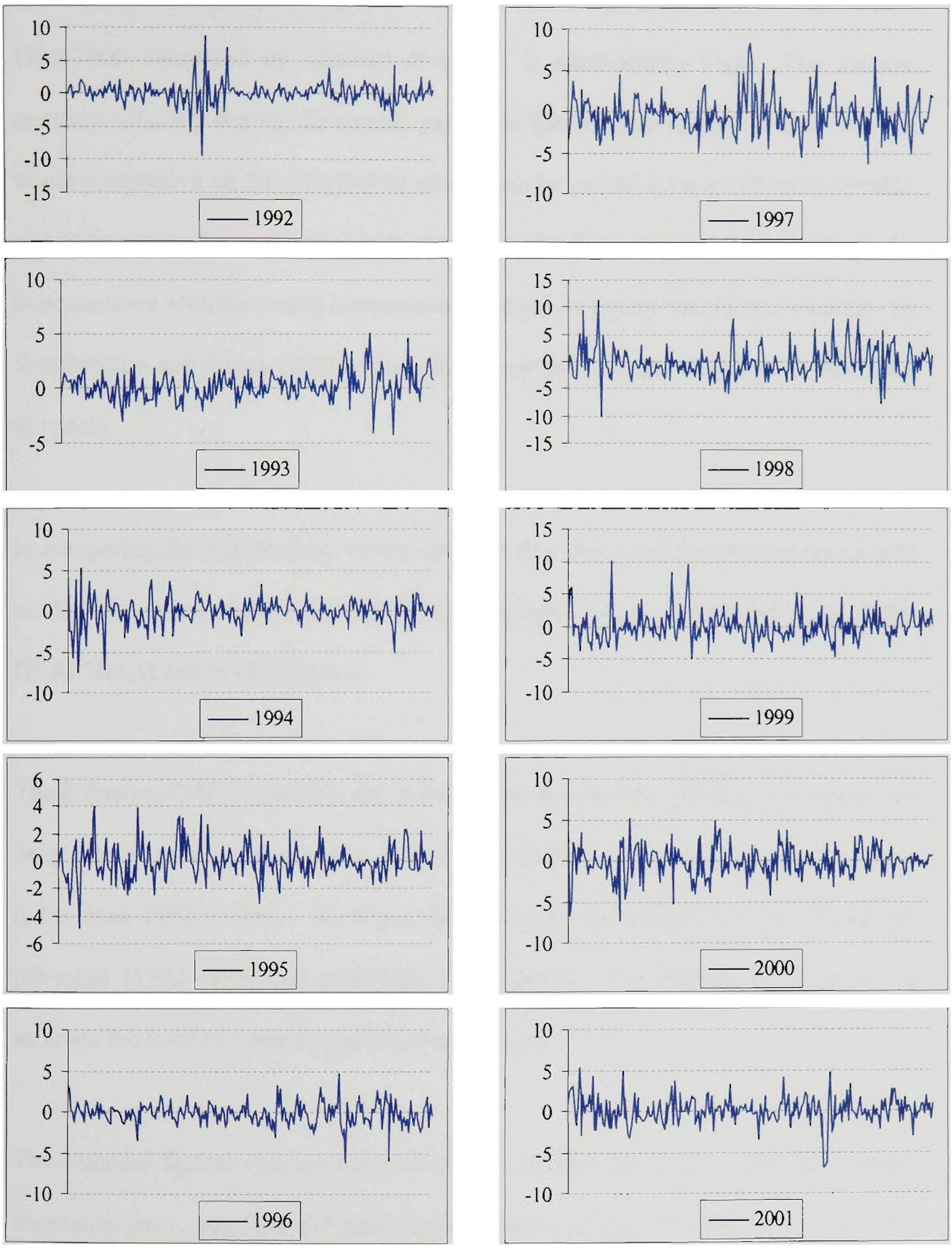
In GARCH models estimate, we use daily adjusted return data of the Thai stock market closing index from 2nd January 1992 to 28th December 2001. The adjusted return is calculated as $R_t = \ln(I_t / I_{t-1}) \times 100$. Monthly data is used only for the estimate of standard deviation.

Figure 8.1: Monthly Returns Series for the SET, 1975-2001



Source: Author's estimate.

Figure 8.2: Daily Returns Series for the SET, 1992-2001



Source: Author's estimate.

Yu and Bluhm (2001), use the historical return information to compute the volatility of the stock market. As anticipated, volatility of the Thai stock market index during 1992-2000, measured by standard deviation, is considerably high. The average monthly volatility during the overall period in Table 3.2 is around 11 per cent. A visual perspective on the volatility of returns can be gained from the plots of monthly and daily returns for each series in figures 8.1 and 8.2. In Figure 8.2, the findings are in accordance with the recent international analysis of equity returns and volatility by Worthington and Higgs (2001) where high volatility was present immediately after the crisis.

In comparing the five models, we use only the first order and the first lag for all five models for consistency, i.e. GARCH(1,1), EGARCH(1,1), GARCH-M(1,1), GJR-GARCH(1,1) and PGARCH(1,1).

The following GARCH models are developed to examine the volatility relating to the daily rate of return and seasonal factors (see Chapter 7) for the Thai stock market index from 1992 to 2001. We focus the test on two time-frame periods, which are pre-crisis (1992-1996) and post-crisis (1997-2001). The comparison is made to estimate the level of volatility during these periods.

The seasonal factors include seasonal daily anomalies ($d_1,\ldots,d_5$), seasonal monthly anomalies ($m_1,\ldots,m_{12}$) and the yearly series effect ($y_1,..,y_{10}$). Overall, there are a total of 27 variables. The results for the coefficient, standard error, α, and β are found using an *iterative procedure*. Under this iterative procedure, we assume the given value of λ, and estimated parameters α and β, we then use the estimate of λ to re-estimate α and β. Tables 8.1 to 8.10 present the results of these estimates.

The Thai stock market has been the most volatile during the post-crisis period. The performance of the volatility models is dependent on how much historical data has been used to specify the model. The estimation horizon used in the study covers the SET returns data during the pre- and post-crisis periods separately in order to ensure the accuracy of the estimation.

Table 8.1: Estimation Results of the GARCH(1,1) during the Pre-Crisis, 1992-1996

Explanatory Variables	Model Coefficient (β)	Standard Error
$\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$		
d_1	-0.5360	0.1426
d_2	*0.2694	0.1070
d_3	*0.5888	0.0970
d_4	*0.3220	0.1022
d_5	*0.4986	0.1014
m_1	*0.3000	0.1723
m_2	-0.0767	0.1723
m_3	-0.1172	0.1534
m_5	0.1877	0.1412
m_6	0.0043	0.1807
m_7	0.0599	0.1548
m_8	0.1039	0.1595
m_9	0.0419	0.1609
m_{10}	0.1628	0.1705
m_{11}	-0.2826	0.0153
m_{12}	*0.2266	0.1814
y_1	*0.3256	0.1162
y_2	*0.3045	0.1116
y_3	0.1765	0.1197
y_4	0.1200	0.1128

Iteration = 15 Log-Likelihood = -2045 Wald Chi-Square Test = 82.76

Note: the variables m_4 and y_5 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for our GARCH(1,1) model $\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$, the estimates are $\lambda = 0.0812$, and $\alpha = 0.8258$.

Source: Author's estimate.

Table 8.2: Estimation Results of the EGARCH(1,1) during the Pre-Crisis, 1992-1996

Explanatory Variables	Model Coefficient (β)	Standard Error
$\ln \sigma_t^2 = \lambda_1 + \beta_1 \ln \sigma_{t-1}^2 + \gamma_1 \left(\left[\left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| - (2/\pi)^{1/2} \right] + \delta \left[\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right] \right)$		
d_1	-0.5484	0.1428
d_2	*0.2807	0.1039
d_3	*0.5994	0.1100
d_4	*0.3265	0.1022
d_5	*0.4950	0.1021
m_1	*0.2986	0.1671
m_2	-0.0816	0.1775
m_3	-0.1573	0.1624
m_5	0.1330	0.1378
m_6	-0.0317	0.1748
m_7	0.0455	0.1421
m_8	0.0892	0.1477
m_9	-0.2297	0.1529
m_{10}	0.1339	0.1628
m_{11}	-0.2297	0.1529
m_{12}	0.1798	0.1646
y_1	*0.3057	0.1121
y_2	*0.2856	0.1079
y_3	*0.2034	0.1123
y_4	0.1115	0.1081

Iteration = 40 Log-Likelihood = -2039 Wald Chi-Square Test = 82.89

Note: the variables m_4 and y_5 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results of the EGARCH(1,1) model, $\ln \sigma_t^2 = \lambda_1 + \beta_1 \ln \sigma_{t-1}^2 + \gamma_1 \left(\left[\left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| - (2/\pi)^{1/2} \right] + \delta \left[\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right] \right)$, the estimates are λ = 0.0322, and α = 0.9580.

Source: Author's estimate.

Table 8.3: Estimation Results of the GARCH-M(1,1) during the Pre-Crisis, 1992-1996

Explanatory Variables	Model Coefficient (β)	Standard Error
	$\sigma_t^2 = \lambda + \alpha(L)\varepsilon_{t-1}^2 + \beta(L)\varepsilon_{t-1}^2$	
d_1	-0.5789	0.1494
d_2	*0.2660	0.1070
d_3	*0.5872	0.0969
d_4	*0.3174	0.1023
d_5	*0.4944	0.1012
m_1	*0.2999	0.1722
m_2	-0.0726	0.1727
m_3	-0.1196	-0.1196
m_5	0.1841	0.1413
m_6	0.0070	0.1798
m_7	0.0671	0.1544
m_8	0.1166	0.1593
m_9	0.0532	0.1608
m_{10}	0.1654	0.1702
m_{11}	-0.2947	0.1552
m_{12}	*0.2110	0.1800
y_1	*0.3262	0.1158
y_2	*0.3081	0.1145
y_3	0.1685	0.1197
y_4	0.1222	0.1123

Iteration = 22 Log-Likelihood = -2045 Wald Chi-Square Test = 83.59

Note: the variables m_4 and y_5 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for the GARCH-M(1,1) model $\sigma_t^2 = \lambda + \alpha(L)\varepsilon_{t-1}^2 + \beta(L)\varepsilon_{t-1}^2$, our estimates are λ = 0.0848, and α = 0.0285.

Source: Author's estimate.

Table 8.4: Estimation Results of the GJR-GARCH(1,1) during the Pre-Crisis, 1992-1996

Explanatory Variables	Model Coefficient (β)	Standard Error
$\sigma_t^2 = \lambda + \sum_{i=1}^{q}\alpha_i + (\gamma S_{t-1})\varepsilon_{t-1}^2 + \sum_{i=1}^{p}\beta_i\sigma_{t-1}$		
d_1	-0.5216	0.1377
d_2	*0.2573	0.1070
d_3	*0.5813	0.0971
d_4	*0.3155	0.1044
d_5	*0.4936	0.1053
m_1	*0.2765	0.1639
m_2	-0.1062	0.1694
m_3	-0.1609	0.1537
m_5	0.1650	0.1447
m_6	-0.0362	0.1758
m_7	0.0250	0.1494
m_8	0.0623	0.1559
m_9	0.0602	0.1508
m_{10}	0.1424	0.1636
m_{11}	-0.2865	0.1469
m_{12}	*0.2102	0.1686
y_1	*0.3175	0.1116
y_2	*0.3014	0.1052
y_3	0.1679	0.1160
y_4	0.1206	0.1084

Iteration = 22 Log-Likelihood = -2041 Wald Chi-Square Test = 83.82

Note: the variables m_4 and y_5 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. The GJR-GARCH(1,1) model $\sigma_t^2 = \lambda + \sum_{i=1}^{q}\alpha_i + (\gamma S_{t-1})\varepsilon_{t-1}^2 + \sum_{i=1}^{p}\beta_i\sigma_{t-1}$, gives the results of λ = 0.0853, and α = -0.0836.

Source: Author's estimate.

Table 8.5: Estimation Results of the PGARCH(1,1) during the Pre-Crisis, 1992-1996

Explanatory Variables	Model Coefficient (β)	Standard Error
$\sigma_t^2 = \lambda + \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 + \sum_{i=1}^{q} \alpha(\lvert\varepsilon_{t-i}\rvert + \lambda\varepsilon_{t-i})^2$		
d_1	-0.5494	0.0439
d_2	-0.1809	0.0578
d_3	0.1369	0.0690
d_4	-0.1717	0.0547
d_5	*0.3261	0.0641
m_1	*0.3781	0.0647
m_2	0.0286	0.1357
m_3	-0.0376	0.0750
m_5	0.1091	0.0675
m_6	-0.0134	0.0215
m_7	0.1010	0.0817
m_8	0.1581	0.0612
m_9	0.0884	0.0732
m_{10}	0.1949	0.1088
m_{11}	-0.1200	0.0982
m_{12}	0.1801	0.1082
y_1	*0.3110	0.4328
y_2	*0.2849	0.0614
y_3	*0.2553	0.0541
y_4	0.1131	0.0520

Iteration = 78 Log-Likelihood = -2041 Wald Chi-Square Test = 141.46

Note: the variables m_4 and y_5 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for the PGARCH(1,1) model $\sigma_t^2 = \lambda + \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 + \sum_{i=1}^{q} \alpha(\lvert\varepsilon_{t-i}\rvert + \lambda\varepsilon_{t-i})^2$, our estimates are λ = 0.0382, and α = 0.8596.

Source: Author's estimate.

Table 8.6: Estimation Results of the GARCH(1,1) during the Post-Crisis, 1997-2001

Explanatory Variables	Model Coefficient (β)	Standard Error
	$\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$	
d_1	-0.4435	0.2540
d_3	*0.2486	0.1756
d_4	*0.4418	0.1692
d_5	*0.2427	0.1731
m_1	*0.6923	0.1740
m_2	*0.2924	0.2769
m_3	-0.0412	0.2459
m_4	-0.1877	0.2862
m_5	-0.0872	0.2872
m_6	-0.5993	0.2792
m_7	-0.0909	0.2927
m_8	-0.3927	0.2982
m_9	-0.1281	0.2767
m_{10}	-0.0811	0.2798
m_{11}	-0.0555	0.2891
m_{12}	0.0621	0.2999
y_6	-0.1904	0.1743
y_8	*0.3329	0.1636
y_9	-0.0316	0.1777
y_{10}	*0.3235	0.1770

Iteration = 11 Log-Likelihood = -2622 Wald Chi-Square Test = 63.29

Note: the variables d_2 and y_7 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for the GARCH(1,1) model $\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$, our estimates are $\lambda = 0.4427$, and $\alpha = 0.7323$.

Source: Author's estimate.

Table 8.7: Estimation Results of the EGARCH(1,1) during the Post-Crisis, 1997-2001

Explanatory Variables	Model Coefficient (β)	Standard Error
$\ln\sigma_t^2 = \lambda_1 + \beta_1 \ln\sigma_{t-1}^2 + \gamma_1\left(\left[\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| - (2/\pi)^{1/2}\right] + \delta\left[\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right]\right)$		
d_1	-0.4702	0.2356
d_3	*0.2976	0.1636
d_4	*0.5158	0.1602
d_5	*0.2963	0.1623
m_1	*0.7656	0.1715
m_2	*0.2966	0.2623
m_3	-0.0684	0.2211
m_4	-0.2053	0.2587
m_5	-0.0354	0.2676
m_6	-0.5745	0.2618
m_7	-0.0813	0.2653
m_8	-0.4934	0.2244
m_9	-0.1540	0.2580
m_{10}	-0.0633	0.2579
m_{11}	-0.1739	0.2940
m_{12}	0.0502	0.2940
y_6	-0.2876	0.1771
y_8	*0.3799	0.1600
y_9	-0.0589	0.1756
y_{10}	*0.3023	0.1706

Iteration = 44 Log-Likelihood = -2620 Wald Chi-Square Test = 74.62

Note: the variables d_2 and y_7 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results of EGARCH(1,1), $\ln\sigma_t^2 = \lambda_1 + \beta_1 \ln\sigma_{t-1}^2 + \gamma_1\left(\left[\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| - (2/\pi)^{1/2}\right] + \delta\left[\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right]\right)$. Our estimates are λ = 0.1729, and $\alpha = 0.8919$.

Source: Author's estimate.

Table 8.8: Estimation Results of the GARCH-M(1,1) during the Post-Crisis, 1997-2001

Explanatory Variables	Model Coefficient (β)	Standard Error
	$\sigma_t^2 = \lambda + \alpha(L)\varepsilon_{t-1}^2 + \beta(L)\varepsilon_{t-1}^2$	
d_1	-0.6846	0.2842
d_3	*0.2482	0.1752
d_4	*0.4521	0.1700
d_5	*0.2191	0.1721
m_1	*0.6865	0.1734
m_2	*0.2090	0.2730
m_3	-0.1133	0.2434
m_4	-0.2049	0.2860
m_5	-0.0821	0.2838
m_6	-0.6256	0.2744
m_7	-0.1262	0.2899
m_8	-0.4299	0.2689
m_9	-0.1479	0.2689
m_{10}	-0.1995	0.2793
m_{11}	-0.1012	0.2852
m_{12}	0.0080	0.3013
y_6	-0.1189	0.1700
y_8	*0.4013	0.1620
y_9	0.0880	0.1786
y_{10}	*0.4462	0.1818

Iteration = 12 Log-Likelihood = -2620 Wald Chi-Square Test = 70.34

Note: the variables d_2 and y_7 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for the GARCH-M(1,1) model $\sigma_t^2 = \lambda + \alpha(L)\varepsilon_{t-1}^2 + \beta(L)\varepsilon_{t-1}^2$, our estimates are λ = 0.4139, and α = 0.0503.

Source: Author's estimate.

Table 8.9: Estimation Results of the GJR-GARCH(1,1) during the Post-Crisis, 1997-2001

Explanatory Variables	Model Coefficient (β)	Standard Error
$\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i + (\gamma S_{t-1})\varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-1}$		
d_1	-0.4376	0.2540
d_3	*0.2398	0.1747
d_4	*0.4273	0.1674
d_5	*0.2289	0.1719
m_1	*0.6809	0.1735
m_2	*0.2982	0.2755
m_3	-0.0410	0.2488
m_4	-0.1968	0.2832
m_5	-0.0899	0.2832
m_6	-0.5910	0.2775
m_7	-0.0842	0.2950
m_8	-0.3946	0.2950
m_9	-0.1080	0.2740
m_{10}	-0.0902	0.2810
m_{11}	-0.0532	0.2868
m_{12}	0.0583	0.2990
y_6	-0.1908	0.1746
y_8	*0.3319	0.1617
y_9	-0.0465	0.1775
y_{10}	*0.3106	0.1766

Iteration = 13 Log-Likelihood = -2621 Wald Chi-Square Test = 62.51

Note: the variables d_2 and y_7 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for the GJR-GARCH(1,1) model, where $\sigma_t^2 = \lambda + \sum_{i=1}^{q} \alpha_i + (\gamma S_{t-1})\varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-1}$, our estimates are $\lambda = 0.3964$, and $\alpha = -0.0311$.

Source: Author's estimate.

Table 8.10: Estimation Results of the PGARCH(1,1) during the Post-Crisis, 1997-2001

Explanatory Variables	Model Coefficient (β)	Standard Error
$\sigma_t^2 = \lambda + \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 + \sum_{i=1}^{q} \alpha(\lvert\varepsilon_{t-i}\rvert + \lambda\varepsilon_{t-i})^2$		
d_1	-0.4530	0.2492
d_3	*0.2649	0.1736
d_4	*0.4664	0.1684
d_5	*0.2559	0.1759
m_1	0.0708	0.1751
m_2	*0.2982	0.2756
m_3	-0.0445	0.2393
m_4	-0.1849	0.2803
m_5	-0.0728	0.2829
m_6	-0.5868	0.2762
m_7	-0.0848	0.2888
m_8	-0.4003	0.2904
m_9	-0.1078	0.2738
m_{10}	-0.0713	0.2742
m_{11}	-0.0821	0.2832
m_{12}	0.0682	0.2998
y_6	-0.2097	0.1748
y_8	*0.3369	0.1637
y_9	-0.0461	0.1785
y_{10}	*0.3101	0.1768

Iteration = 14 Log-Likelihood = -2621 Wald Chi-Square Test = 63.94

Note: the variables d_2 and y_7 have been dropped due to multi-colinearity problems. The figures with asterisks indicate significant results. According to the result for the PGARCH(1,1) model $\sigma_t^2 = \lambda + \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 + \sum_{i=1}^{q} \alpha(\lvert\varepsilon_{t-i}\rvert + \lambda\varepsilon_{t-i})^2$, our estimates are λ = 0.3174, and $\alpha = 0.7502$.

Source: Author's estimate.

8.5 Volatility in the Thai Stock Market

According to the GARCH(1,1) model, six seasonal variables exhibit significant volatility of the stock returns. These variables are Tuesday, Wednesday, Thursday, Friday, January and December, years 1992 and 1993. GARCH-M(1,1) also exhibits similar results. Interestingly, non-linear exponential GARCH models such as EGARCH(1,1), GJR-GARCH(1,1) and PGARCH(1,1) produce very similar results but with less significant variables. PGARCH exhibits the least number of significant variables, where only Friday, January and years 1992, 1993 and 1994 are significant. EGARCH adds four seasonal daily variables which are Tuesday, Wednesday, Thursday, and Friday. GJR-GARCH gives one additional significant variable which is December. The results of volatility on stock return for the post-crisis period are reported in tables 8.6 to 8.10.

We can summarize the finding as follows:

a) During the pre-crisis period, Wednesday and Friday exhibit the highest volatility among all tested models except PGARCH. This finding is consistent with the day of the week effect discussed in Chapter 7 (see figures 7.4 to 7.8 for comparison).

b) Return volatility is present during January and years 1992 and 1993 on all models. During the pre-crisis, the unusual rate of return on January opposes the traditional view of the January effect, as negative returns were reported. Looking at the stock prices during 1992 and 1993, the closing index on 2nd January 1992 recorded 712.02 points, and 2 years later it jumped to 1682.85

points on 30 December 1993. The issues of speculative and arbitrage opportunity on stock return explain this high volatility.

c) The average return volatility throughout the pre-crisis period records between 0.03 to 0.08 which is not considered significant. During this period there was an upward trend on the Thai stock market index price and return. Average monthly volatility β is considered low at between -0.2 and 0.2.

For the post-crisis analysis, the degree of volatility between stock market index return and seasonal anomalies could be seen as follows:

a) There are commonalities between all GARCH-type models, where Wednesday, Thursday, Friday, January, February, years 1999 and 2001 exhibit significant volatility.

b) Stock returns during January are very volatile compared to other variables with results of around 0.6-0.7. The January effect plays a major role in this high fluctuation in stock price.

c) For the day of the week effect, Thursday exhibits the highest volatility. According to the daily seasonal anomalies results in figures 7.8 to 7.12, high volatility in return is present on Thursday where the return was 22% in 1997, 78% in 1998, 32% in 1999, 61% in 2000 and 30% in 2001.

d) The return volatility for the post-crisis period is much higher than the pre-crisis period at around 0.16 to 0.44 compared to pre-crisis volatility of only 0.02.

8.6 Conclusions

The purpose of this chapter has been to compare models and identify stock market volatility by examining the determinants of movements in the volatility of stock return with seasonal factors such as the day of the week effect, the month of the year effect, and the year effect. The Stock Exchange of Thailand market index return serves as an interesting example for analysis of such volatility.

The empirical analysis found that distributions of the stock market index deviate from normality with volatility changing over time and being serially correlated, which described in Chapter 4. The results show that Monday is the least volatile, while other working days exhibit significant volatility. January, February and December are among the most fluctuating months in stock returns. During the economic boom in 1992 and 1993, there was high speculative and arbitrage opportunity as well as in 1999 and 2001. These results correspond results from the previous chapters pertaining to rational speculative bubbles and anomalies. The comparison between the pre- and post-crisis periods provides evidence that following the crisis, the volatility in stock market returns was much higher than in the pre-crisis period.

The results of high volatility on the volatility tests in the Thai stock market are due to a number of financial and institutional characteristics of a developing economy such as: 1) the level of transactions costs of trading; 2) the effectiveness of reporting standards and disclosure requirements; 3) availability of professional processing of new information; and 4) financial market imperfection such as asymmetric information, adverse selection and moral hazard (see chapter 2).

Chapter 9

CONCLUSIONS

9.1 Introduction

The Stock Exchange of Thailand was established in 1975, its growth as the center of the capital market was very slow until the late 1980s. However, during and after the financial and economic liberalization in Thailand, the growth rate was considered to be one of the highest in the region. Prior to the crisis, the market had a different institutional structure and investor constituency compared to that of developed markets along with different levels of efficiency, stability, information and information processing mechanisms available to the average investor. Given that the SET sets its benchmark against other developed markets, such as the New York Stock Exchange, the issue is whether the SET serves as a capital market that allocates resources efficiently. If it does not so, what are the implications to investors and policy planners in terms of issues such as stock valuation, speculative bubbles, anomalies, volatility and market efficiency.

This situation is also aggravated by the conditions of the financial system in Thailand where the system and its policies were not well developed before recent changes such as globalisation and liberalisation. According to the found in these chapters, it is suggested that existing problems such as asymmetric information, adverse selection and moral hazard have worsened.

An understanding of the empirical characteristics of the financial system is crucial especially for policy makers who design and develop appropriate policies for the country's financial system. The present application of financial econometric methods provide detailed insights into the Thai financial system and the stock market, which are useful for financial and policy planning.

9.2 Major Findings

The major findings of the present study, in terms of the characteristics of the financial market in developing countries like Thailand, are summarised below. It should be emphasised that although the empirical evidence generated in this study is specified to the Thai stock market, similar socio-economic, financial and economic structures are expected to exist in other developing economies and emerging stock markets.

9.2.1 Efficiency

The empirical results provide the evidence of a weak-form EMH in the Thai financial system and the stock market, which can be explained by such characteristics as the existence of market failure, absence of developed systems and policies, unavailability of information, inside information, asymmetric information, moral hazard, and an incomplete market. Proofs from the run test and ACF test of stock returns confirm the validity of the weak-form EMH. However, the presence of daily and monthly seasonal anomalies is opposed to the EMH theory. In the real world, markets cannot be absolutely efficient or wholly inefficient. The Thai stock market is essentially a mixture of both, and daily decisions and events cannot always be reflected immediately into a market.

9.2.2 Valuation

The Thai stock market is considered as a part of the whole financial system, which also includes the financial market, foreign exchange market, money and capital markets, and goods, gold and commodities markets. They are interdependent, if the conditions of one market change, there will be a change in the stock market index price and return. According to the TSMM model, we conclude that the interest rate, bond price, P/E ratio, market capitalization, foreign exchange rate, and consumer price index have a long-run relationship with the stock price and hence determine its value.

9.2.3 Rational Speculative Bubbles

The empirical evidence concerning speculative behaviour in the Thai stock market is also consistent with that of the financial markets in many developing counties. Rational speculative bubbles were present in the Thai stock market especially during the pre-crisis period, while there was none present immediately after the post-crisis period but were observed after a few years of the crisis. Both the duration dependence test and Weibull Hazard model confirm this finding. The present of a high degree of speculative risks and a detection of collapsible bubbles in the stock market enables investors to avoid their speculative investment decisions because the chance that purchases were unlikely to provide a stable and growing rate of return for long-term investment.

9.2.4 Anomalies

Empirical evidence from the analysis proves the existence of the day of the week effect and January effect. This raises the issue of speculative behaviour where investors see the opportunity for extraordinary gains. Mondays always exhibit negative returns, and this is consistent with the findings of other researchers. The January effect is also present in most of the time period except during the pre-crisis. The unusual positive returns during the pre-crisis period were shown to be caused by speculation and massive foreign capital inflow.

9.2.5 Volatility

The volatility of stock returns in the Thai market appears to be consistent in terms of the standard deviation and volatility modelling. Comparing both linear and non-linear GARCH models we conclude that there is evidence of high volatility in the Thai stock market especially in 1992, 1993 and after the crisis period. January, February and December exhibit high volatility and so do most of the working days except Monday.

9.3 Financial System and Institutions, Stock Market Behaviour and Policy Implications

Fry (1995) stated four major differences in the characteristics of a financial system of developed and developing countries (see Chapter 1). In addition, there are also some other problems in the financial market operation and in the development of the financial implications such as banking institutions, money and capital market including stock exchanges, and governments. These problems include market failures, asymmetric information, moral hazard, adverse selection, insider trading, etc. Because of these characteristics of the financial market institutions and systems of developing countries, especially Thailand, these countries experienced such instability and high volatility of their financial market throughout the last decade.

Fry (1995) and Stiglitz (1993) argue that there is an important role for government intervention to ensure that the long-term stability, functionality and performance of the financial market are achieved. The findings of this research regarding different financial sector issues such as an inefficient financial market, speculative bubbles, anomalies and volatility in the stock market, are due to these characteristics of the Thai financial market, institutions and system. The evidence of inefficient market in Chapter 4 and 7, which implies that historical data can be used to predict the movement of the future stock prices, violates an essential function of the efficient financial market in term of an inappropriate use of information, which is caused by market failures, externalities and other characteristics of the Thai stock market discussed above and in Chapter 2. The evidence of inefficient market implies that such markets are unlikely to be fully competitive.

For example, the stock market failure arises from costly information which is accentuated because of asymmetric information, adverse selection and moral hazard. The rational speculative behaviour often occurs due to the lack of the required information available in the market, discussed in Chapter 6, as if one individual obtains valuable information or conducts research to determine the profitability of particular stocks and then trading upon that information, others can benefit from following this action. On the other hand, if the reaction is opposite when one withdraws or sells stock accordingly to the negative information or noise, the stock market may experience institutional and information failure and also produces greater volatility. The evidence of stock market volatility found in Chapter 8 has been, therefore, the characteristics of the Thai stock market. This is also often the case in the most developing countries.

According to Hunter and Terry (2002), and Fry (1995), a successful stock market should have at least two main features. First, the stock prices and returns should not fluctuate much from real prices and returns. Second, the stock market should grow at a rapid, but steady pace. While the fluctuation of prices and returns is the focus of volatility and anomalies theories, the determination of stable real prices and returns is the concern of stabilisation. It should perform good allocative and payment function, and foster economic development. Implicit in financial system and stock market theories are questions about the role of relevant financial policies in the stabilisation and growth of the stock market making the financial system more efficient and suitable for economic development.

According to Hossain and Chowdhury (1996), the role of economic, monetary and financial policies for developed countries is associated with the taming of business cycles. Whereas, in developing countries, the role of economic, monetary and financial policies is linked with the promotion of economic growth and development. Such disparity in the role of policy reflects the differences in economic issues and priorities of policies-makers in developed and developing countries. The principles for appropriate government intervention in the financial and stock market have been stressed by leading economists such as Stiglitz (1993).

Stiglitz (1993) argues that there is an important role for government intervention in the financial market due to pervasive market failure, especially, when the market is not efficient in a functional sense, and thus more regulation and policies should be considered to control the behaviour of stock market operation in order to reduce volatility, and anomalies and ultimately to reduce the opportunity for speculation and arbitrage. The outcome of the EMH test and the characteristics of institutions and markets in the Thai financial system can be used in "public policy assessment of the desirability of mergers and acquisitions, short-termism and regulation of financial institution" (Islam and Oh 2001, p. 233) which are all relevant and contemporary issues relating to the improvement of the Thai stock market.

A set of financial and other related policies need to be formulated which can help develop the Thai financial system to produce efficient allocation of financial and real resources, macro-economic stability, and social welfare enhancing economic development. Leading economists such as Stigliz (1993) and Fry (1995) suggest a number of policy options to improve the stock market as well as the overall financial system of developing countries. Most developing countries, however, should focus on creating macroeconomic stability, the development of efficient legal, social and institutional set up, and allocating supervision in order to develop a sound financial system. Macroeconomic stability also necessitates consistent macroeconomic policies, particular by in the fiscal and monetary areas. Adequate financial supervision in financial and stock market sectors should be undertaken to strengthen the financial system. This involve incentive for agents and institutions to conduct effective information processing and monitoring functions, strengthen disclosure, accounting and auditing requirements, and encouraging financial and stock market development. A detailed discussion the functions and roles of the government may be seen in Fry (1995).

9.4 Future Research

In the present thesis, most financial econometric issues have been addressed. However, some issues need an in-depth investigation such as the techniques used to study volatility. Different order levels and lag times could be employed to compare these results with current findings. Future studies may also focus on a stochastic process for asset pricing with economic variables. The use of GARCH models with macroeconomic variables could also be an interesting area to investigate. The usefulness of assuming a normal distribution and finding alternatives could also be tested.

A study of a more qualitative nature such as one on investor behaviour could also be useful to gain an inside understanding of speculative issues. Other areas of possible future study on stock price and return are the identification of systematic and unsystematic risk, vector cointegration, and the effects of insider information.

9.5 Conclusions

This thesis provides a financial econometric analysis of the Thai stock market, during the pre- and post-crisis periods. The results of these studies show that the Thai financial system and market do not show the characteristics of a developed or sound financial system and they are generally consistent with the characteristics of the financial system of a developing economy as stated in Mishkin (1997), Fry (1995), McKinnon (1976, 1973) and Shaw (1973), among others.

All the characteristics of the SET from the point of view of its market index prices and returns reveal an inefficient market. Substantial empirical evidence throughout these chapters supports the rejection of the hypothesis of the process being white noise in either the short term or long term analysis. Run tests and autocorrelation function tests also confirm the existence of a weak-form efficient market. The notion of existing market inefficiency is supported by the evidence of rational bubbles, anomalies and volatility.

Although further research is necessary, the findings appear to be consistent with the view that significant market imperfections and failures exist in the financial system of a developing economy (Stiglitz 1993), especially in the Thai financial system. However, the explanations and implications of these market imperfections can be only be properly understood within the context of the characteristics and institutional foundations of the economy and society of a developing economy, rather than in terms of the emerging information paradigm in finance and economics.

Appropriate policies are necessary for the development of an efficient and appropriate financial system which has the characteristics required for efficient allocation of resources, stability of the macro-economy and economic development in which they provide optimum social welfare (Clarke and Islam 2003).

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Appendix 1

Figure A1.1: Structure of Financial Institution in Thailand

Regulatory Agency

Bank of Thailand
4 Branches
- 2 in Northern region
- 1 in Northeastern region
- 1 in Southern region

2 Representative Offices
- New York
- London

Securities and Exchange Commission of Thailand (SEC)

Commercial Banking System
- 35 Commercial Banks
  - 15 domestic
  - 20 foreign
- 48 International Banking Facilities (BIBF)
  - 12 domestic
  - 36 foreign
- 40 Foreign Bank Representative Offices

12 Credit Foncier Companies

14 Finance Companies

22 Finance and Securities Companies

24 Securities Companies

12 Mutual Fund Management Companies
- 79 close-ended funds
- 128 open-ended funds

Stock Exchange of Thailand (SET)
- 431 listed companies (excluding mutual funds)

Ministry of Finance

Specialized Financial Institution
- Government Saving Bank
- Government Housing Bank
- Bank for Agriculture and Agricultural Cooperatives
- Industrial Finance Corporation
- Export-Import Bank of Thailand
- Small Industry Credit Guarantee Corporation
- Property Loan Management Organization
- Secondary Mortgage Corporation
- Financial Sector Restructuring Authority
- Asset Management Corporation

Ministry of Agriculture and Cooperatives

Savings Cooperatives
- 1240 saving cooperative
- 3530 agricultural cooperatives

Minister of Finance

Insurance Companies
- 25 Life Insurance companies

Source: Bank of Thailand 2002.

Appendix 2

Table A2.1: Monthly Statistics Table of the Thai Stock Exchange Index

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
May-75	89.98	5.23		9.72		-
Jun-75	91.64	5.61		8.64		1.8280
Jul-75	98.02	6.14		7.91		6.7304
Aug-75	98.39	6.16		8.42		0.3768
Sep-75	92.1	6.05		8.57		-6.6064
Oct-75	91.1	5.99		8.65		-1.0917
Nov-75	89.07	6.21		8.78		-2.2535
Dec-75	84.07	4.98		10.16		-5.7773
Jan-76	82.55	4.65		7.51		-1.8246
Feb-76	80.9	4.8		7.66		-2.0190
Mar-76	77.57	4.77		7.63		-4.2033
Apr-76	80.7	4.65		7.78		3.9558
May-76	78.12	4.65		7.92		-3.2492
Jun-76	77.63	5.43		7.69		-0.6292
Jul-76	78.38	5.8		8.32		0.9615
Aug-76	79.92	5.91		7.53		1.9457
Sep-76	79.65	5.53		7.44		-0.3384
Oct-76	80.08	5.72		7.38		0.5384
Nov-76	80.66	5.78		7.34		0.7217
Dec-76	82.69	5.83		7.28		2.4856
Jan-77	87.55	6.07		7.05		5.7111
Feb-77	89.95	6.09		6.95		2.7044
Mar-77	97.68	6.66		6.63		8.2443
Apr-77	101.24	6.59		6.51		3.5797
May-77	104.15	6.78		6.47		2.8338
Jun-77	113.47	6.99		6.08		8.5706
Jul-77	127.8	7.84		5.29		11.8928
Aug-77	150.07	8.49		5.01		16.0635
Sep-77	149.93	8.91		4.78		-0.0933
Oct-77	192.62	11.13		3.97		25.0551
Nov-77	182.45	11.45		3.83		-5.4243
Dec-77	181.58	11.34		3.93		-0.4780
Jan-78	201.01	13.47		3.39		10.1658
Feb-78	202.05	13.16		3.48		0.5161
Mar-78	188.61	12.31		3.85		-6.8834
Apr-78	182.38	9.62		4.09		-3.3589

(*) geometric average return R_t is used in the notation of general continuously compounded multi-period returns:

$$R_t = \ln\left(\frac{I_t}{I_{t-1}}\right) \times 100 = a + u$$

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
May-78	187.91	9.96		4.01		2.9871
Jun-78	189.99	9.62		4.29		1.1008
Jul-78	184.75	9.24		4.56		-2.7968
Aug-78	194.18	9.11		4.6		4.9782
Sep-78	206.93	10.82		4.2		6.3595
Oct-78	242.85	11.54		3.93		16.0063
Nov-78	239.8	9.61		4.83		-1.2639
Dec-78	257.73	8.46		5.74		7.2107
Jan-79	239.81	7.7		5.86		-7.2066
Feb-79	229.43	7.24		6.29		-4.4249
Mar-79	218.09	7.08		6.9		-5.0690
Apr-79	175.88	6.41		7.9		-21.5106
May-79	183.72	6.44		7.89		4.3611
Jun-79	175.58	6.32		8.07		-4.5318
Jul-79	175.09	6.32		8.12		-0.2795
Aug-79	170.91	6.22		8.41		-2.4163
Sep-79	169.32	6.55		8.39		-0.9347
Oct-79	158.47	6.28		8.82		-6.6225
Nov-79	152.45	5.88		9.15		-3.8729
Dec-79	149.4	5.84		9.18		-2.0209
Jan-80	136.84	5.56		8.93		-8.7815
Feb-80	137.91	5.82		8.98		0.7789
Mar-80	138.25	6.07		8.54		0.2462
Apr-80	129.63	6.16		8.36		-6.4379
May-80	124.11	6		8.68		-4.3516
Jun-80	127.81	6.01		8.71		2.9377
Jul-80	126.61	5.99		9.41		-0.9433
Aug-80	120.36	6.08		9.22		-5.0624
Sep-80	118.87	6.03		9.18		-1.2457
Oct-80	119.04	6.12		9.14		0.1429
Nov-80	127.88	6.52		9.08		7.1633
Dec-80	124.67	6.4		9.42		-2.5422
Jan-81	126.88	6.49		9.44		1.7572
Feb-81	127.05	6.83		9.36		0.1339
Mar-81	124.31	7.2		9.8		-2.1802
Apr-81	121.62	7.67		9.33		-2.1877
May-81	116.99	7.54		9.57		-3.8813
Jun-81	112.41	7.78		9.21		-3.9936
Jul-81	111.61	7.65		9.38		-0.7142
Aug-81	104.68	8.54		9.26		-6.4103
Sep-81	105.12	8.62		9.78		0.4194
Oct-81	105.04	8.4		9.67		-0.0761
Nov-81	108.35	9.42		9.76		3.1025
Dec-81	106.62	9.52		9.57		-1.6096
Jan-82	106.77	9.19		9.56		0.1406

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
Feb-82	106.16	8.89		9.8		-0.5730
Mar-82	102.98	9.11		9.59		-3.0413
Apr-82	104.89	9.3		9.02		1.8377
May-82	105.83	9.82		9.04		0.8922
Jun-82	106.61	11.04		8.99		0.7343
Jul-82	108.16	10.55		9.32		1.4434
Aug-82	124.09	11.6		8.69		13.7395
Sep-82	126.24	12.06		8.54		1.7178
Oct-82	127.49	12.22		8.63		0.9853
Nov-82	120.84	11.47		8.86		-5.3571
Dec-82	123.5	11.83		8.53		2.1774
Jan-83	125.8	12.72		8.36		1.8452
Feb-83	125.03	11.42		8.32		-0.6140
Mar-83	131.33	12.99		8.02		4.9160
Apr-83	137.27	13.31		7.92		4.4237
May-83	138.04	11.49		7.45		0.5594
Jun-83	139.88	10.9		7.35		1.3241
Jul-83	148.36	11.51		6.9		5.8857
Aug-83	144.73	10.13		6.82		-2.4772
Sep-83	142.04	9.88		6.85		-1.8761
Oct-83	138.6	9.06		6.98		-2.4517
Nov-83	136.31	8.61		6.78		-1.6660
Dec-83	134.47	6.54		6.97		-1.3591
Jan-84	133.77	6.57		6.91		-0.5219
Feb-84	131.4	6.48		7.24		-1.7876
Mar-84	130.09	7.21		7.66		-1.0020
Apr-84	132.73	6.85		7.8		2.0090
May-84	131.64	7.1		7.62		-0.8246
Jun-84	133.14	5.95		7.81		1.1330
Jul-84	132.24	5.94		7.81		-0.6783
Aug-84	132.89	6.34		7.65		0.4903
Sep-84	132.89	6.37		7.85		0.0000
Oct-84	135.84	5.94		7.74		2.1956
Nov-84	143.22	7.75		7.76		5.2904
Dec-84	142.29	7.19		9.07		-0.6515
Jan-85	139.65	6.96		9.22		-1.8728
Feb-85	139.47	7.15		9.02		-0.1290
Mar-85	145.11	7.65		9.2		3.9643
Apr-85	151.14	8.53		8.04		4.0714
May-85	155.02	8.99		7.52		2.5348
Jun-85	155.19	8.7		7.79		0.1096
Jul-85	158.08	8.47		7.7		1.8451
Aug-85	150.71	8.46		7.65		-4.7744
Sep-85	146.74	8.71		7.94		-2.6695
Oct-85	146.11	8.75		8.09		-0.4303
Nov-85	142.11	9.32		8		-2.7758

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
Dec-85	134.95	9.59		8.15		-5.1697
Jan-86	139.02	9.85		8.25		2.9713
Feb-86	136.5	10.07		8.18		-1.8293
Mar-86	129.85	9.56		7.63		-4.9945
Apr-86	129.54	9.13		7.05		-0.2390
May-86	129.08	9.75		7.05		-0.3557
Jun-86	131.51	9.95		6.94		1.8651
Jul-86	141.51	10.23		6.61		7.3287
Aug-86	149.84	11.07		5.89		5.7198
Sep-86	162.37	12.06		5.28		8.0310
Oct-86	183.77	13		4.95		12.3807
Nov-86	186.46	11.77		4.5		1.4532
Dec-86	207.2	12.34		4.3		10.5468
Jan-87	209.92	13.19		3.99		1.3042
Feb-87	208.79	12.16		4.25		-0.5398
Mar-87	228.97	12.69		4.38		9.2262
Apr-87	250.19	13.27		3.98		8.8630
May-87	269.07	12.78		3.71		7.2751
Jun-87	299.87	14.07		3.25		10.8377
Jul-87	313.96	14.56		3.09		4.5917
Aug-87	353.15	14.99		2.93		11.7627
Sep-87	428.19	17.12		2.65		19.2674
Oct-87	299.83	12.43		3.54		-35.6351
Nov-87	290.42	10.17		3.86		-3.1887
Dec-87	284.94	9.31		3.86		-1.9050
Jan-88	318.87	10.6		3.78		11.2505
Feb-88	374.83	12.21		3.37		16.1689
Mar-88	388.9	12.92		3.44		3.6850
Apr-88	413.91	13.27	3.07	3.4		6.2326
May-88	424.93	13.5	3.16	3.2		2.6276
Jun-88	452.7	14.89	3.52	3		6.3305
Jul-88	457.01	14.97	3.51	3.09		0.9476
Aug-88	436.55	13.6	3.33	3.3		-4.5802
Sep-88	444.61	14.02	3.45	3.28	246,675	1.8295
Oct-88	418.74	13.19	3.29	3.35	233,773	-5.9947
Nov-88	392.86	12.35	2.97	3.59	220,849	-6.3797
Dec-88	386.73	12.03	2.85	3.84	223,647	-1.5727
Jan-89	433.68	13.51	3.23	3.36	252,402	11.4580
Feb-89	435.78	14.29	3.35	3.29	254,484	0.4831
Mar-89	440.88	14.78	3.45	3.37	261,900	1.1635
Apr-89	500.21	16.76	3.87	3.04	295,665	12.6255
May-89	552.54	16.82	4.04	2.81	332,206	9.9498
Jun-89	606.21	19.92	4.79	2.41	367,339	9.2701
Jul-89	624.13	21.08	5.05	2.26	386,372	2.9132
Aug-89	681.92	23.18	5.42	2.12	436,156	8.8554
Sep-89	689.51	23.39	5.61	2.21	461,018	1.1069

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
Oct-89	695.01	21.74	5.24	2.36	472,391	0.7945
Nov-89	769.83	21.57	5.33	2.56	528,026	10.2243
Dec-89	879.19	26.39	6.75	2.07	659,497	13.2831
Jan-90	853.72	26.55	6.92	2.06	659,209	-2.9398
Feb-90	813.67	24.5	6.4	2.18	633,517	-4.8048
Mar-90	851.53	24.32	6.19	2.11	665,677	4.5480
Apr-90	855.97	25.01	6.36	2.09	695,677	0.5201
May-90	1,000.71	29.1	7.11	1.79	827,400	15.6230
Jun-90	1,060.22	28.81	7.21	1.75	874,060	5.7767
Jul-90	1,115.73	28.14	7.32	1.78	942,351	5.1032
Aug-90	862.75	19.99	5.03	2.36	749,338	-25.7139
Sep-90	641.56	15.58	3.88	3.22	573,934	-29.6222
Oct-90	649.37	15.07	3.79	3.28	604,550	1.2100
Nov-90	544.3	13.71	3.13	3.65	541,382	-17.6502
Dec-90	612.86	13.81	3.2	3.63	613,515	11.8636
Jan-91	658.47	14.46	3.33	3.51	663,395	7.1782
Feb-91	769.13	16.78	3.79	3.06	776,798	15.5341
Mar-91	865.74	19.48	4.2	2.5	892,053	11.8325
Apr-91	876.01	19.08	4.13	2.53	894,751	1.1793
May-91	808.19	17.45	3.72	2.7	839,220	-8.0580
Jun-91	765.21	16.47	3.53	2.88	806,478	-5.4647
Jul-91	728.7	14.5	3.14	3.27	763,691	-4.8888
Aug-91	705.65	14.18	2.98	3.47	765,478	-3.2143
Sep-91	670.79	13.68	2.79	3.85	744,953	-5.0663
Oct-91	638.84	13.44	2.69	4.34	754,646	-4.8802
Nov-91	671.07	14.81	2.71	3.69	843,926	4.9219
Dec-91	711.36	15.59	2.82	3.59	897,182	5.8305
Jan-92	763.45	15.93	2.93	3.45	974,621	7.0669
Feb-92	782.85	15.84	2.83	3.56	1,108,514	2.5093
Mar-92	822.72	16.79	3.04	3.24	1,196,592	4.9675
Apr-92	760.97	16.01	2.87	3.41	1,109,030	-7.8022
May-92	688.84	14.44	2.48	3.8	1,008,262	-9.9585
Jun-92	751.45	15.58	2.67	3.52	1,107,805	8.6996
Jul-92	744.42	14.98	2.77	3.34	1,201,895	-0.9399
Aug-92	746.51	15.06	2.81	3.33	1,205,425	0.2804
Sep-92	847	16.79	3.17	2.96	1,364,841	12.6292
Oct-92	940.35	17.47	3.33	2.77	1,522,865	10.4551
Nov-92	865.21	16.01	3	3.01	1,428,459	-8.3280
Dec-92	893.42	16.29	3.05	2.91	1,485,018	3.2085
Jan-93	974.48	16.43	3.17	2.79	1,635,800	8.6847
Feb-93	937.65	15.64	3	2.97	1,603,571	-3.8527
Mar-93	865.23	15.03	2.81	3.32	1,494,542	-8.0381
Apr-93	845.29	14.35	2.69	3.49	1,474,767	-2.3316
May-93	825.71	14.48	2.58	3.64	1,457,414	-2.3436
Jun-93	877.52	15	2.68	3.44	1,568,978	6.0856
Jul-93	928.2	15.47	2.77	3.31	1,669,376	5.6147

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
Aug-93	963.18	16.39	2.92	3.14	1,743,715	3.6993
Sep-93	971.44	16.35	2.91	3.13	1,778,665	0.8539
Oct-93	1,260.91	20.29	3.61	2.53	2,323,122	26.0809
Nov-93	1,309.95	21.05	3.5	2.52	2,409,567	3.8155
Dec-93	1,682.85	26.09	4.31	2.01	3,325,393	25.0500
Jan-94	1,493.45	26.73	4.36	1.53	2,995,354	-11.9400
Feb-94	1,372.93	23.33	3.73	1.87	2,840,827	-8.4142
Mar-94	1,239.99	22.9	3.45	2.04	2,654,288	-10.1844
Apr-94	1,266.67	23.46	3.54	2	2,766,969	2.1288
May-94	1,356.87	23.17	3.72	1.81	3,063,460	6.8789
Jun-94	1,273.34	21.82	3.48	1.92	2,896,722	-6.3537
Jul-94	1,376.88	23.74	3.8	1.76	3,202,114	7.8177
Aug-94	1,524.83	24.94	4.05	1.57	3,711,081	10.2063
Sep-94	1,485.71	24.29	3.95	1.62	3,571,101	-2.5990
Oct-94	1,528.83	24.89	4.06	1.57	3,643,779	2.8610
Nov-94	1,362.44	20.57	3.44	1.8	3,275,471	-11.5226
Dec-94	1,360.09	19.51	3.46	1.86	3,300,756	-0.1726
Jan-95	1,217.74	17.32	3.1	2.16	2,958,180	-11.0554
Feb-95	1,288.47	18.83	3.25	2.07	3,189,515	5.6459
Mar-95	1,216.68	19.14	2.92	2.35	3,163,950	-5.7330
Apr-95	1,208.69	19.13	2.89	2.4	3,168,778	-0.6589
May-95	1,392.31	21.89	3.21	2.08	3,695,201	14.1427
Jun-95	1,394.77	22.28	3.2	2.02	3,717,168	0.1765
Jul-95	1,383.10	22.06	3.17	2.05	3,732,441	-0.8402
Aug-95	1,314.90	20.48	2.93	2.13	3,615,220	-5.0567
Sep-95	1,294.23	19.93	2.89	2.2	3,575,012	-1.5845
Oct-95	1,270.76	19.6	2.84	2.24	3,531,407	-1.8301
Nov-95	1,196.62	18.41	2.58	2.39	3,314,032	-6.0114
Dec-95	1,280.81	19.75	2.75	2.25	3,564,569	6.7992
Jan-96	1,410.33	21.65	3.01	2.04	3,969,804	9.6331
Feb-96	1,321.87	20.27	2.78	2.14	3,760,686	-6.4776
Mar-96	1,289.73	19.59	2.63	2.29	3,665,165	-2.4615
Apr-96	1,292.61	19.66	2.64	2.28	3,681,676	0.2231
May-96	1,311.91	19.35	2.59	2.24	3,739,123	1.4821
Jun-96	1,247.08	18.42	2.46	2.35	3,600,389	-5.0679
Jul-96	1,064.04	15.98	2.14	2.77	3,176,687	-15.8732
Aug-96	1,102.32	16.71	2.18	2.67	3,304,896	3.5344
Sep-96	1,099.01	16.61	2.17	2.68	3,303,064	-0.3007
Oct-96	910.33	13.83	1.81	3.22	2,744,521	-18.8358
Nov-96	925.97	13.33	1.76	3.15	2,832,362	1.7035
Dec-96	831.57	11.97	1.58	3.5	2,559,579	-10.7526
Jan-97	788.04	11.36	1.5	3.65	2,423,518	-5.3767
Feb-97	727.56	10.5	1.37	3.9	2,239,268	-7.9852
Mar-97	705.43	10.59	1.32	3.75	2,173,957	-3.0889
Apr-97	661.29	10.1	1.28	3.86	2,034,125	-6.4615
May-97	566.39	9.18	1.11	4.49	1,738,963	-15.4910

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
Jun-97	527.28	8.57	1.04	4.78	1,614,920	-7.1551
Jul-97	665.62	11.04	1.31	3.78	2,047,145	23.2987
Aug-97	502.23	8.39	0.99	4.82	1,556,780	-28.1661
Sep-97	544.54	9.74	1.1	4.26	1,691,242	8.0883
Oct-97	447.21	8.12	0.91	5.14	1,394,498	-19.6913
Nov-97	395.47	6.79	0.89	5.8	1,232,844	-12.2953
Dec-97	372.69	6.59	0.89	6.04	1,133,344	-5.9328
Jan-98	495.23	8.94	1.22	4.26	1,545,007	28.4275
Feb-98	528.42	8.94	1.27	3.75	1,689,529	6.4869
Mar-98	459.11	13.31	1.2	2.15	1,476,520	-14.0602
Apr-98	412.13	15.49	1.17	1.75	1,347,745	-10.7951
May-98	325.59	12.66	0.9	2.08	1,121,225	-23.5700
Jun-98	318.16	12.52	0.89	2.12	1,101,222	-2.3085
Jul-98	266.72	10.5	0.74	2.5	932,313	-17.6355
Aug-98	214.53	8.03	0.58	2.56	759,451	-21.7750
Sep-98	253.82	9.53	0.72	2.07	898,555	16.8176
Oct-98	331.29	10.38	0.95	1.6	1,187,122	26.6369
Nov-98	362.82	9.76	1.01	1.3	1,295,940	9.0913
Dec-98	355.81	10.04	1.05	1.34	1,268,199	-1.9510
Jan-99	363	10.15	1.07	1.33	1,290,493	2.0006
Feb-99	340.94	4.39	1.1	1.3	1,317,245	-6.2696
Mar-99	352.01	3.75	1.18	1.09	1,373,322	3.1953
Apr-99	459.35	4.64	1.56	0.76	1,796,478	26.6153
May-99	453.6	13.55	1.52	0.75	1,886,220	-1.2597
Jun-99	521.77	15.35	1.8	0.64	2,280,632	14.0011
Jul-99	456.81	14.62	1.59	0.73	2,011,620	-13.2959
Aug-99	440.27	9.93	1.5	0.77	1,922,311	-3.6879
Sep-99	389.49	8.66	1.34	0.89	1,692,402	-12.2550
Oct-99	395.55	8.66	1.38	0.74	1,731,947	1.5439
Nov-99	422.12	10.88	1.48	0.71	1,896,879	6.5012
Dec-99	481.92	14.7	1.72	0.61	2,193,067	13.2488
Jan-00	477.57	14.35	1.7	0.62	2,167,758	-0.9067
Feb-00	374.32	11.61	1.32	1.08	1,668,929	-24.3600
Mar-00	400.32	9.06	1.47	1.19	1,803,510	6.7153
Apr-00	390.4	8.73	1.44	1.21	1,741,984	-2.5092
May-00	323.29	7.37	1.24	1.45	1,485,339	-18.8622
Jun-00	325.69	7.06	1.25	1.44	1,506,570	0.7396
Jul-00	284.67	6.71	1.08	1.65	1,322,773	-13.4615
Aug-00	307.83	7.51	1.19	1.51	1,437,064	7.8217
Sep-00	277.29	6.28	1.08	1.67	1,300,536	-10.4484
Oct-00	271.84	6.13	1.06	1.68	1,275,692	-1.9850
Nov-00	277.92	5.67	1.15	1.63	1,312,791	2.2120
Dec-00	269.19	5.52	1.11	1.78	1,279,224	-3.1916
Jan-01	332.77	6.57	1.38	1.43	1,609,009	21.2034
Feb-01	325.2	6.64	1.36	1.71	1,573,163	-2.3011
Mar-01	291.94	5.24	1.25	2.25	1,408,793	-10.7892

End of	Index	P/E	P/BV	Dvd Yield (%)	Mkt Cap (Mil Baht)	Return*
Apr-01	300.63	5.31	1.29	2.19	1,453,153	2.9332
May-01	310.13	5.24	1.29	2.09	1,508,780	3.1111
Jun-01	322.55	5.55	1.34	2.03	1,565,412	3.9267
Jul-01	297.69	5.15	1.24	2.2	1,439,637	-8.0205
Aug-01	335.57	5.47	1.41	2.01	1,625,691	11.9778
Sep-01	277.04	3.54	1.11	2.44	1,346,209	-19.1669
Oct-01	275.09	3.52	1.11	2.42	1,348,255	-0.7064
Nov-01	302.62	4.82	1.24	2.22	1,492,675	9.5380
Dec-01	303.85	4.92	1.29	2.06	1,607,310	0.4056

Source: IMF 2002.

Appendix 3

Table A3.1: Moving Average Results

Index Price	Moving Avg	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
763.45	*	*	*	297.60	538.76	56.44
782.85	*	*	*	297.60	538.76	56.44
822.72	763.77	*	*	297.60	538.76	56.44
760.97	761.37	*	*	297.60	538.76	56.44
688.84	753.68	*	*	297.60	538.76	56.44
751.45	738.44	763.77	-12.32	297.60	538.76	56.44
744.42	755.64	761.37	-16.95	297.60	538.76	56.44
746.51	805.95	753.68	-7.17	297.60	538.76	56.44
847.00	828.70	738.44	108.56	297.60	538.76	56.44
940.35	858.50	755.64	184.71	297.60	538.76	56.44
865.21	904.09	805.95	59.26	297.60	538.76	56.44
893.42	922.22	828.70	64.72	297.60	538.76	56.44
974.48	907.20	858.50	115.98	297.60	538.76	56.44
937.65	903.21	904.09	33.56	297.60	538.76	56.44
865.23	889.67	922.22	-56.99	297.60	538.76	56.44
845.29	870.28	907.20	-61.91	297.60	538.76	56.44
825.71	868.39	903.21	-77.50	297.60	538.76	56.44
877.52	887.98	889.67	-12.15	297.60	538.76	56.44
928.20	913.21	870.28	57.92	297.60	538.76	56.44
963.18	1000.25	868.39	94.79	297.60	538.76	56.44
971.44	1086.74	887.98	83.46	297.60	538.76	56.44
1260.91	1237.67	913.21	347.70	297.60	538.76	56.44
1309.95	1343.72	1000.25	309.70	297.60	538.76	56.44
1682.85	1424.02	1086.74	596.11	297.60	538.76	56.44
1493.45	1419.83	1237.67	255.78	297.60	538.76	56.44
1239.99	1345.98	1424.02	-184.03	297.60	538.76	56.44
1266.67	1301.96	1419.83	-153.16	297.60	538.76	56.44
1356.87	1302.75	1411.18	-54.31	297.60	538.76	56.44
1273.34	1359.72	1345.98	-72.64	297.60	538.76	56.44
1376.88	1403.53	1301.96	74.92	297.60	538.76	56.44
1524.83	1437.92	1302.75	222.08	297.60	538.76	56.44
1485.71	1455.74	1359.72	125.99	297.60	538.76	56.44
1528.83	1452.38	1403.53	125.30	297.60	538.76	56.44
1362.44	1390.96	1437.92	-75.48	297.60	538.76	56.44
1360.09	1351.51	1455.74	-95.65	297.60	538.76	56.44
1217.74	1289.08	1452.38	-234.64	297.60	538.76	56.44
1288.47	1258.33	1390.96	-102.49	297.60	538.76	56.44
1216.68	1264.78	1351.51	-134.83	297.60	538.76	56.44
1208.69	1300.18	1289.08	-80.39	297.60	538.76	56.44
1392.31	1319.11	1258.33	133.98	297.60	538.76	56.44
1394.77	1338.75	1264.78	129.99	297.60	538.76	56.44
1383.10	1355.86	1300.18	82.92	297.60	538.76	56.44
1314.90	1331.55	1319.11	-4.21	297.60	538.76	56.44
1294.23	1291.92	1338.75	-44.52	297.60	538.76	56.44
1270.76	1271.46	1355.86	-85.10	297.60	538.76	56.44
1196.62	1290.55	1331.55	-134.93	297.60	538.76	56.44
1280.81	1296.08	1291.92	-11.11	297.60	538.76	56.44
1410.33	1299.87	1271.46	138.87	297.60	538.76	56.44

Index Price	Moving Avg	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
1321.87	1319.07	1290.55	31.32	297.60	538.76	56.44
1289.73	1325.29	1296.08	-6.35			
1292.61	1292.64	1299.87	-7.26			
1311.91	1241.07	1319.07	-7.16			
1247.08	1203.59	1325.29	-78.21			
1064.04	1164.87	1292.64	-228.60			
1102.32	1084.56	1241.07	-138.75			
1099.01	1020.33	1203.59	-104.58			
910.33	973.84	1164.87	-254.54			
925.97	910.98	1084.56	-158.59			
831.57	836.69	1020.33	-188.76			
788.04	795.71	973.84	-185.80			
727.56	742.78	910.98	-183.42			
705.43	689.74	836.69	-131.26			
661.29	637.59	795.71	-134.42			
566.39	625.20	742.78	-176.39			
527.28	584.56	689.74	-162.46			
665.62	561.21	637.59	28.03			
502.23	537.38	625.20	-122.97			
544.54	511.01	584.56	-40.02			
447.21	452.43	561.21	-114.00			
395.47	451.03	537.38	-141.91			
372.69	447.80	511.01	-138.32			
495.23	450.18	452.43	42.80			
528.42	453.52	451.03	77.39			
459.11	444.10	447.80	11.31			
412.13	408.68	450.18	-38.05			
325.59	356.34	453.52	-127.93			
318.16	307.43	444.10	-125.94			
266.72	275.76	408.68	-141.96			
214.53	276.90	356.34	-141.81			
253.82	285.84	307.43	-53.61			
331.29	303.65	275.76	55.53			
362.82	333.35	276.90	85.92			
355.81	350.77	285.84	69.97			
363.00	354.92	303.65	59.35			
340.94	374.22	333.35	7.59			
352.01	393.78	350.77	1.24			
459.35	425.53	354.92	104.43			
453.60	448.71	374.22	79.38			
521.77	466.36	393.78	127.99			
456.81	452.39	425.53	31.28			
440.27	440.78	448.71	-8.44			
389.49	420.85	466.36	-76.87			
395.55	425.87	452.39	-56.84			
422.12	433.33	440.78	-18.66			
481.92	430.30	420.85	61.07			

Index Price	Moving Avg	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
477.57	431.25	425.87	51.70			
374.32	424.91	433.33	-59.01			
400.32	393.18	430.30	-29.98			
390.40	362.80	431.25	-40.85			
323.29	344.87	424.91	-101.62			
325.69	326.38	393.18	-67.49			
284.67	303.75	362.80	-78.13			
307.83	293.46	344.87	-37.04			
277.29	283.91	326.38	-49.09			
271.84	280.81	303.75	-31.91			
277.92	285.80	293.46	-15.54			
269.19	295.38	283.91	-14.72			
332.77	299.40	280.81	51.96			
325.20	303.95	285.80	39.40			
291.94	312.13	295.38	-3.44			
300.63	310.09	299.40	1.23			
310.13	304.59	303.95	6.18			
322.55	313.31	312.13	10.42			
297.69	308.60	310.09	-12.40			
335.57	301.59	304.59	30.98			
277.04	297.60	313.31	-36.27			
275.09 *		308.60	-33.51			
302.62 *		301.59	1.03			

Source: Author's estimate.

Table A3.2: Single Exponential Smoothing Results of the SET Index (α = 0.2)

Smoothing	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
763.70	763.77	-0.32	300.68	532.53	68.82
767.53	763.70	19.15	300.68	532.53	68.82
778.57	767.53	55.19	300.68	532.53	68.82
775.05	778.57	-17.60	300.68	532.53	68.82
757.81	775.05	-86.21	300.68	532.53	68.82
756.54	757.81	-6.36	300.68	532.53	68.82
754.11	756.54	-12.12	300.68	532.53	68.82
752.59	754.11	-7.60	300.68	532.53	68.82
771.47	752.59	94.41	300.68	532.53	68.82
805.25	771.47	168.88	300.68	532.53	68.82
817.24	805.25	59.96	300.68	532.53	68.82
832.48	817.24	76.18	300.68	532.53	68.82
860.88	832.48	142.00	300.68	532.53	68.82
876.23	860.88	76.77	300.68	532.53	68.82
874.03	876.23	-11.00	300.68	532.53	68.82
868.28	874.03	-28.74	300.68	532.53	68.82
859.77	868.28	-42.57	300.68	532.53	68.82
863.32	859.77	17.75	300.68	532.53	68.82
876.30	863.32	64.88	300.68	532.53	68.82
893.67	876.30	86.89	300.68	532.53	68.82
909.23	893.67	77.77	300.68	532.53	68.82
979.56	909.23	351.68	300.68	532.53	68.82
1045.64	979.56	330.39	300.68	532.53	68.82
1173.08	1045.64	637.21	300.68	532.53	68.82
1237.16	1173.08	320.37	300.68	532.53	68.82
1264.31	1237.16	135.77	300.68	532.53	68.82
1259.45	1264.31	-24.32	300.68	532.53	68.82
1260.89	1259.45	7.22	300.68	532.53	68.82
1280.09	1260.89	95.98	300.68	532.53	68.82
1278.74	1280.09	-6.75	300.68	532.53	68.82
1298.37	1278.74	98.14	300.68	532.53	68.82
1343.66	1298.37	226.46	300.68	532.53	68.82
1372.07	1343.66	142.05	300.68	532.53	68.82
1403.42	1372.07	156.76	300.68	532.53	68.82
1395.22	1403.42	-40.98	300.68	532.53	68.82
1388.20	1395.22	-35.14	300.68	532.53	68.82
1354.11	1388.20	-170.46	300.68	532.53	68.82
1340.98	1354.11	-65.64	300.68	532.53	68.82
1316.12	1340.98	-124.30	300.68	532.53	68.82
1294.63	1316.12	-107.43	300.68	532.53	68.82
1314.17	1294.63	97.68	300.68	532.53	68.82
1330.29	1314.17	80.60	300.68	532.53	68.82
1340.85	1330.29	52.81	300.68	532.53	68.82
1335.66	1340.85	-25.95	300.68	532.53	68.82
1327.37	1335.66	-41.43	300.68	532.53	68.82
1316.05	1327.37	-56.62	300.68	532.53	68.82
1292.17	1316.05	-119.43	300.68	532.53	68.82

Smoothing	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
1289.89	1292.17	-11.36	300.68	532.53	68.82
1313.98	1289.89	120.44	300.68	532.53	68.82
1315.56	1313.98	7.89	300.68	532.53	68.82
1310.39	1315.56	-25.83			
1306.84	1310.39	-17.78			
1307.85	1306.84	5.07			
1295.70	1307.85	-60.77			
1249.37	1295.70	-231.66			
1219.96	1249.37	-147.05			
1195.77	1219.96	-120.95			
1138.68	1195.77	-285.44			
1096.14	1138.68	-212.71			
1043.22	1096.14	-264.57			
992.19	1043.22	-255.18			
939.26	992.19	-264.63			
892.50	939.26	-233.83			
846.25	892.50	-231.21			
790.28	846.25	-279.86			
737.68	790.28	-263.00			
723.27	737.68	-72.06			
679.06	723.27	-221.04			
652.16	679.06	-134.52			
611.17	652.16	-204.95			
568.03	611.17	-215.70			
528.96	568.03	-195.34			
522.21	528.96	-33.73			
523.46	522.21	6.21			
510.59	523.46	-64.35			
490.90	510.59	-98.46			
457.83	490.90	-165.31			
429.90	457.83	-139.67			
397.26	429.90	-163.18			
360.72	397.26	-182.73			
339.34	360.72	-106.90			
337.73	339.34	-8.05			
342.75	337.73	25.09			
345.36	342.75	13.06			
348.89	345.36	17.64			
347.30	348.89	-7.95			
348.24	347.30	4.71			
370.46	348.24	111.11			
387.09	370.46	83.14			
414.03	387.09	134.68			
422.58	414.03	42.78			
426.12	422.58	17.69			
418.79	426.12	-36.63			
414.15	418.79	-23.24			

Smoothing	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
415.74	414.15	7.98			
428.98	415.74	66.18			
438.69	428.98	48.59			
425.82	438.69	-64.38			
420.72	425.82	-25.50			
414.66	420.72	-30.32			
396.38	414.66	-91.37			
382.24	396.38	-70.69			
362.73	382.24	-97.57			
351.75	362.73	-54.90			
336.86	351.75	-74.46			
323.85	336.86	-65.02			
314.67	323.85	-45.93			
305.57	314.67	-45.48			
311.01	305.57	27.20			
313.85	311.01	14.19			
309.47	313.85	-21.91			
307.70	309.47	-8.84			
308.19	307.70	2.43			
311.06	308.19	14.36			
308.38	311.06	-13.37			
313.82	308.38	27.19			
306.47	313.82	-36.78			
300.19	306.47	-31.38			
300.68	300.19	2.43			

Source: Author's estimate.

Table A3.3: Single Exponential Smoothing Results of the SET Returns (α = 0.2)

Smoothing	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
7.07	1.13	1.01	6.06	-0.87	19.76
2.51	1.16	1.13	1.38	-0.87	19.76
4.97	1.23	1.16	3.81	-0.87	19.76
-7.80	1.05	1.23	-9.04	-0.87	19.76
-9.96	0.83	1.05	-11.01	-0.87	19.76
8.70	0.99	0.83	7.87	-0.87	19.76
-0.94	0.95	0.99	-1.93	-0.87	19.76
0.28	0.94	0.95	-0.67	-0.87	19.76
12.63	1.17	0.94	11.69	-0.87	19.76
10.46	1.36	1.17	9.28	-0.87	19.76
-8.33	1.16	1.36	-9.69	-0.87	19.76
3.21	1.21	1.16	2.04	-0.87	19.76
8.68	1.36	1.21	7.48	-0.87	19.76
-3.85	1.25	1.36	-5.21	-0.87	19.76
-8.04	1.06	1.25	-9.29	-0.87	19.76
-2.33	0.99	1.06	-3.39	-0.87	19.76
-2.34	0.93	0.99	-3.34	-0.87	19.76
6.09	1.03	0.93	5.16	-0.87	19.76
5.61	1.12	1.03	4.58	-0.87	19.76
3.70	1.18	1.12	2.58	-0.87	19.76
0.85	1.17	1.18	-0.32	-0.87	19.76
26.08	1.67	1.17	24.91	-0.87	19.76
3.82	1.72	1.67	2.14	-0.87	19.76
25.05	2.19	1.72	23.33	-0.87	19.76
-11.94	1.90	2.19	-14.13	-0.87	19.76
-8.41	1.70	1.90	-10.32	-0.87	19.76
-10.18	1.45	1.70	-11.88	-0.87	19.76
2.13	1.47	1.45	0.67	-0.87	19.76
6.88	1.58	1.47	5.41	-0.87	19.76
-6.35	1.42	1.58	-7.93	-0.87	19.76
7.82	1.55	1.42	6.40	-0.87	19.76
10.21	1.72	1.55	8.66	-0.87	19.76
-2.60	1.63	1.72	-4.32	-0.87	19.76
2.86	1.66	1.63	1.23	-0.87	19.76
-11.52	1.39	1.66	-13.18	-0.87	19.76
-0.17	1.36	1.39	-1.57	-0.87	19.76
-11.06	1.11	1.36	-12.42	-0.87	19.76
5.65	1.20	1.11	4.54	-0.87	19.76
-5.73	1.06	1.20	-6.93	-0.87	19.76
-0.66	1.03	1.06	-1.72	-0.87	19.76
14.14	1.29	1.03	13.12	-0.87	19.76
0.18	1.27	1.29	-1.12	-0.87	19.76
-0.84	1.23	1.27	-2.11	-0.87	19.76
-5.06	1.10	1.23	-6.28	-0.87	19.76
-1.58	1.04	1.10	-2.68	-0.87	19.76
-1.83	0.99	1.04	-2.87	-0.87	19.76
-6.01	0.84	0.99	-7.00	-0.87	19.76

Smoothing	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
6.80	0.97	0.84	5.95	-0.87	19.76
9.63	1.14	0.97	8.67	-0.87	19.76
-6.48	0.99	1.14	-7.62	-0.87	19.76
-2.46	0.92	0.99	-3.45		
0.22	0.90	0.92	-0.69		
1.48	0.91	0.90	0.58		
-5.07	0.79	0.91	-5.98		
-15.87	0.46	0.79	-16.67		
3.53	0.52	0.46	3.08		
-0.30	0.50	0.52	-0.82		
-18.84	0.11	0.50	-19.34		
1.70	0.14	0.11	1.59		
-10.75	-0.08	0.14	-10.89		
-5.38	-0.19	-0.08	-5.30		
-7.99	-0.34	-0.19	-7.80		
-3.09	-0.40	-0.34	-2.74		
-6.46	-0.52	-0.40	-6.06		
-15.49	-0.83	-0.52	-14.97		
-7.16	-0.95	-0.83	-6.33		
23.30	-0.46	-0.95	24.25		
-28.17	-1.02	-0.46	-27.70		
8.09	-0.84	-1.02	9.11		
-19.69	-1.22	-0.84	-18.85		
-12.30	-1.45	-1.22	-11.07		
-5.93	-1.54	-1.45	-4.49		
28.43	-0.93	-1.54	29.96		
6.49	-0.78	-0.93	7.42		
-14.06	-1.05	-0.78	-13.28		
-10.80	-1.25	-1.05	-9.75		
-23.57	-1.70	-1.25	-22.32		
-2.31	-1.71	-1.70	-0.61		
-17.64	-2.03	-1.71	-15.93		
-21.78	-2.43	-2.03	-19.74		
16.82	-2.04	-2.43	19.25		
26.64	-1.46	-2.04	28.68		
9.09	-1.25	-1.46	10.55		
-1.95	-1.26	-1.25	-0.70		
2.00	-1.20	-1.26	3.26		
-6.27	-1.30	-1.20	-5.07		
3.20	-1.21	-1.30	4.49		
26.62	-0.64	-1.21	27.82		
-1.26	-0.66	-0.64	-0.62		
14.00	-0.36	-0.66	14.66		
-13.30	-0.62	-0.36	-12.94		
-3.69	-0.68	-0.62	-3.07		
-12.26	-0.92	-0.68	-11.57		
1.54	-0.87	-0.92	2.46		
6.50	-0.72	-0.87	7.37		
13.25	-0.44	-0.72	13.97		
-0.91	-0.45	-0.44	-0.47		

Smoothing	Fitted Value	Residual	Forecasting	Upper Limit	Lower Limit
-24.36	-0.93	-0.45	-23.91		
6.72	-0.78	-0.93	7.65		
-2.51	-0.81	-0.78	-1.73		
-18.86	-1.18	-0.81	-18.05		
0.74	-1.14	-1.18	1.92		
-13.46	-1.39	-1.14	-12.32		
7.82	-1.20	-1.39	9.21		
-10.45	-1.39	-1.20	-9.25		
-1.99	-1.40	-1.39	-0.60		
2.21	-1.33	-1.40	3.61		
-3.19	-1.36	-1.33	-1.86		
21.20	-0.91	-1.36	22.57		
-2.30	-0.94	-0.91	-1.39		
-10.79	-1.14	-0.94	-9.85		
2.93	-1.05	-1.14	4.07		
3.11	-0.97	-1.05	4.16		
3.93	-0.87	-0.97	4.90		
-8.02	-1.01	-0.87	-7.15		
11.98	-0.75	-1.01	12.99		
-19.17	-1.12	-0.75	-18.42		
-0.71	-1.12	-1.12	0.42		
9.54	-0.90	-1.12	10.65		

Source: Author's estimate.

Table A3.4: Double Exponential Smoothing of the SET Index (α = 0.2)

Smoothing	α = 0.2	T = 0.2	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1186.3	1186.3	-29.9926	1292.01	-528.563	287.246	559.65	14.838
1081.62	1081.62	-44.9309	1156.31	-373.458	288.081	566.17	9.997
993.89	993.89	-53.4896	1036.69	-213.966	288.916	573.11	4.72
904.52	904.52	-60.6669	940.4	-179.433	289.751	580.47	-0.967
812.85	812.85	-66.8673	843.85	-155.009	290.587	588.21	-7.035
747.07	747.07	-66.6485	745.98	5.47	291.422	596.3	-13.46
693.22	693.22	-64.0887	680.43	63.994	292.257	604.73	-20.217
652.61	652.61	-59.3937	629.14	117.374	293.092	613.47	-27.281
643.97	643.97	-49.2424	593.22	253.783	293.927	622.49	-34.631
663.85	663.85	-35.4177	594.73	345.619	294.762	631.77	-42.246
675.79	675.79	-25.9468	628.44	236.773	295.597	641.3	-50.106
698.56	698.56	-16.2038	649.85	243.575	296.433	651.06	-58.194
740.78	740.78	-4.5188	682.36	292.124	297.268	661.03	-66.492
776.54	776.54	3.5367	736.26	201.388	298.103	671.19	-74.986
797.11	797.11	6.9428	780.08	85.154	298.938	681.54	-83.66
812.3	812.3	8.5924	804.05	41.24	299.773	692.05	-92.503
821.85	821.85	8.7852	820.89	4.82	300.608	702.72	-101.501
840.02	840.02	10.6604	830.64	46.88	301.443	713.53	-110.643
866.18	866.18	13.7614	850.68	77.524	302.279	724.48	-119.919
896.59	896.59	17.0909	879.94	83.238	303.114	735.55	-129.321
925.23	925.23	19.4013	913.68	57.759	303.949	746.74	-138.839
1007.89	1007.89	32.0523	944.63	316.276	304.784	758.03	-148.464
1093.94	1093.94	42.8527	1039.94	270.009	305.619	769.43	-158.191
1246.01	1246.01	64.6948	1136.8	546.054	306.454	780.92	-168.012
1347.25	1347.25	72.0048	1310.7	182.749	307.289	792.5	-177.921
1409.99	1409.99	70.1517	1419.26	-46.326	308.125	804.16	-187.912
1432.11	1432.11	60.5456	1480.14	-240.152	308.96	815.9	-197.98
1447.46	1447.46	51.5061	1492.66	-225.988	309.795	827.71	-208.12
1470.55	1470.55	45.8223	1498.97	-142.096	310.63	839.59	-218.328
1467.76	1467.76	36.1011	1516.37	-243.029	311.465	851.53	-228.599
1478.47	1478.47	31.0217	1503.86	-126.985	312.3	863.53	-238.93
1512.56	1512.56	31.6354	1509.49	15.341	313.135	875.59	-249.317
1532.5	1532.5	29.296	1544.19	-58.483	313.971	887.7	-259.757
1555.2	1555.2	27.9776	1561.79	-32.962	314.806	899.86	-270.246
1539.03	1539.03	19.1481	1583.18	-220.737	315.641	912.06	-280.783
1518.56	1518.56	11.2245	1558.18	-198.088	316.476	924.32	-291.364
1467.38	1467.38	-1.2573	1529.78	-312.045	317.311	936.61	-301.986
1430.59	1430.59	-8.3632	1466.12	-177.649	318.146	948.94	-312.648
1381.12	1381.12	-16.585	1422.23	-205.546	318.981	961.31	-323.348
1333.36	1333.36	-22.8187	1364.53	-155.842	319.817	973.72	-334.083
1326.9	1326.9	-19.5481	1310.54	81.765	320.652	986.15	-344.851
1324.83	1324.83	-16.0513	1307.35	87.42	321.487	998.63	-355.652
1323.65	1323.65	-13.0786	1308.78	74.318	322.322	1011.13	-366.482
1311.43	1311.43	-12.9053	1310.57	4.333	323.157	1023.66	-377.342
1297.67	1297.67	-13.0772	1298.53	-4.299	323.992	1036.21	-388.228
1281.83	1281.83	-13.6305	1284.59	-13.832	324.828	1048.8	-399.141

Smoothing	α = 0.2	T = 0.2	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1253.88	1253.88	-16.4935	1268.19	-71.575	325.663	1061.4	-410.079
1246.07	1246.07	-14.7565	1237.39	43.424	326.498	1074.04	-421.04
1267.12	1267.12	-7.5959	1231.31	179.015	327.333	1086.69	-432.023
1271.99	1271.99	-5.102	1259.52	62.348	328.168	1099.36	-443.028
1271.46	1271.46	-4.1884	1266.89	22.841			
1272.34	1272.34	-3.1747	1267.27	25.341			
1277.71	1277.71	-1.4648	1269.16	42.747			
1270.41	1270.41	-2.6315	1276.25	-29.167			
1227.03	1227.03	-10.7812	1267.78	-203.742			
1193.47	1193.47	-15.3385	1216.25	-113.933			
1162.3	1162.3	-18.5032	1178.13	-79.118			
1097.11	1097.11	-27.8421	1143.8	-233.471			
1040.61	1040.61	-33.5738	1069.26	-143.295			
971.94	971.94	-40.5923	1007.03	-175.462			
902.69	902.69	-46.3246	931.35	-143.307			
830.6	830.6	-51.4766	856.36	-128.801			
764.39	764.39	-54.4244	779.12	-73.694			
700.23	700.23	-56.3713	709.96	-48.671			
628.36	628.36	-59.4699	643.86	-77.466			
560.57	560.57	-61.1344	568.89	-41.613			
532.67	532.67	-54.487	499.44	166.184			
482.99	482.99	-53.5252	478.19	24.044			
452.48	452.48	-48.9224	429.47	115.071			
412.29	412.29	-47.1764	403.56	43.649			
371.19	371.19	-45.9622	365.11	30.356			
334.72	334.72	-44.0635	325.22	47.467			
331.57	331.57	-35.8805	290.65	204.577			
342.23	342.23	-26.5712	295.69	232.732			
344.35	344.35	-20.8333	315.66	143.447			
341.24	341.24	-17.2889	323.52	88.611			
324.28	324.28	-17.2234	323.95	1.637			
309.28	309.28	-16.7792	307.06	11.103			
287.34	287.34	-17.8104	292.5	-25.778			
258.53	258.53	-20.0105	269.53	-55.002			
241.58	241.58	-19.3985	238.52	15.299			
244	244	-15.0342	222.18	109.108			
255.74	255.74	-9.6802	228.97	133.85			
268.01	268.01	-5.2902	246.06	109.75			
282.78	282.78	-1.279	262.72	100.28			
293.39	293.39	1.0988	281.5	59.443			
305.99	305.99	3.3998	294.48	57.526			
339.38	339.38	9.3982	309.39	149.961			
369.74	369.74	13.5911	348.78	104.82			
411.02	411.02	19.1285	383.33	138.435			
435.48	435.48	20.1949	430.15	26.66			
452.6	452.6	19.5786	455.68	-15.407			
455.64	455.64	16.2712	472.17	-82.684			
456.64	456.64	13.2169	471.91	-76.359			
460.31	460.31	11.3075	469.85	-47.734			

Smoothing	α = 0.2	T = 0.2	Fitted	Residual	Forecast	Upper Limit	Lower Limit
473.68	473.68	11.7197	471.61	10.305			
483.83	483.83	11.4067	485.4	-7.825			
471.05	471.05	6.57	495.24	-120.917			
462.16	462.16	3.4779	477.62	-77.304			
450.59	450.59	0.4683	465.64	-75.241			
425.51	425.51	-4.6426	451.06	-127.771			
401.83	401.83	-8.4495	420.86	-95.174			
371.64	371.64	-12.7979	393.38	-108.71			
348.64	348.64	-14.8383	358.84	-51.01			
322.5	322.5	-17.0987	333.8	-56.51			
298.69	298.69	-18.4411	305.4	-33.559			
279.78	279.78	-18.5341	280.25	-2.326			
262.84	262.84	-18.2164	261.25	7.943			
262.25	262.25	-14.6903	244.62	88.151			
263.09	263.09	-11.5847	247.56	77.641			
259.59	259.59	-9.9672	251.5	40.438			
259.82	259.82	-7.9269	249.62	51.007			
263.54	263.54	-5.5976	251.9	58.233			
270.87	270.87	-3.0134	257.95	64.604			
273.82	273.82	-1.82	267.85	29.836			
284.71	284.71	0.7228	272	63.569			
283.76	283.76	0.3869	285.44	-8.397			
282.33	282.33	0.0247	284.14	-9.055			
286.41	286.41	0.8351	282.36	20.261			

Source: Author's estimate.

Table A3.5: Double Exponential Smoothing of the SET Returns (α = 0.2)

Smoothing	α = 0.2	T = 0.2	Fitted	Residual	Forecast	Upper Limit	Lower Limit
7.0669	2.186	2.186	0.2159	0.9658	6.1011	1.395	23.6812
2.5093	2.4234	2.4234	0.2202	2.4019	0.1074	1.597	24.3475
4.9675	3.1084	3.1084	0.31315	2.6436	2.3239	1.799	25.0496
-7.8022	1.1768	1.1768	-0.1358	3.4215	-11.2237	2.0009	25.7851
-9.9585	-1.1589	-1.1589	-0.57578	1.041	-10.9995	2.2029	26.5519
8.6996	0.3522	0.3522	-0.15841	-1.7347	10.4343	2.4049	27.3479
-0.9399	-0.033	-0.033	-0.20375	0.1938	-1.1337	2.6069	28.1709
0.2804	-0.1333	-0.1333	-0.18307	-0.2367	0.5171	2.8089	29.0192
12.6292	2.2727	2.2727	0.33475	-0.3164	12.9456	3.0109	29.8908
10.4551	4.177	4.177	0.64866	2.6075	7.8477	3.2128	30.7841
-8.328	2.1949	2.1949	0.12251	4.8257	-13.1537	3.4148	31.6975
3.2085	2.4957	2.4957	0.15815	2.3175	0.891	3.6168	32.6294
8.6847	3.86	3.86	0.39939	2.6538	6.0309	3.8188	33.5787
-3.8527	2.637	2.637	0.07491	4.2594	-8.1121	4.0208	34.5438
-8.0381	0.5619	0.5619	-0.35509	2.7119	-10.75	4.2228	35.5238
-2.3316	-0.3009	-0.3009	-0.45663	0.2068	-2.5383	4.4247	36.5175
-2.3436	-1.0747	-1.0747	-0.52007	-0.7575	-1.5861	4.6267	37.524
6.0856	-0.0587	-0.0587	-0.21285	-1.5948	7.6804	4.8287	38.5422
5.6147	0.9057	0.9057	0.0226	-0.2716	5.8863	5.0307	39.5715
3.6993	1.4825	1.4825	0.13344	0.9283	2.771	5.2327	40.6109
0.8539	1.4635	1.4635	0.10296	1.6159	-0.762	5.4346	41.6599
26.0809	6.4694	6.4694	1.08354	1.5665	24.5145	5.6366	42.7177
3.8155	6.8054	6.8054	0.93404	7.5529	-3.7374	5.8386	43.7838
25.05	11.2016	11.2016	1.62646	7.7395	17.3105	6.0406	44.8575
-11.94	7.8744	7.8744	0.63574	12.828	-24.768	6.2426	45.9385
-8.4142	5.1253	5.1253	-0.04123	8.5102	-16.9244	6.4446	47.0262
-10.1844	2.0304	2.0304	-0.65197	5.0841	-15.2685	6.6465	48.1202
2.1288	1.5285	1.5285	-0.62196	1.3784	0.7504	6.8485	49.2201
6.8789	2.101	2.101	-0.38306	0.9065	5.9724	7.0505	50.3255
-6.3537	0.1036	0.1036	-0.70593	1.718	-8.0717	7.2525	51.4361
7.8177	1.0817	1.0817	-0.36913	-0.6023	8.42	7.4545	52.5516
10.2063	2.6113	2.6113	0.01062	0.7126	9.4937	7.6565	53.6717
-2.599	1.5777	1.5777	-0.19822	2.6219	-5.2209	7.8584	54.7961
2.861	1.6758	1.6758	-0.13896	1.3795	1.4815	8.0604	55.9246
-11.5226	-1.075	-1.075	-0.66133	1.5369	-13.0594	8.2624	57.0569
-0.1726	-1.4236	-1.4236	-0.59878	-1.7364	1.5637	8.4644	58.1928
-11.0554	-3.829	-3.829	-0.96011	-2.0224	-9.033	8.6664	59.3322
5.6459	-2.7021	-2.7021	-0.54271	-4.7891	10.435	8.8684	60.4748
-5.733	-3.7424	-3.7424	-0.64223	-3.2448	-2.4881	9.0703	61.6204
-0.6589	-3.6395	-3.6395	-0.4932	-4.3847	3.7258	9.2723	62.769
14.1427	-0.4776	-0.4776	0.23782	-4.1327	18.2754	9.4743	63.9203
0.1765	-0.1565	-0.1565	0.25447	-0.2398	0.4163	9.6763	65.0742
-0.8402	-0.0897	-0.0897	0.21695	0.0979	-0.9381	9.8783	66.2306
-5.0567	-0.9095	-0.9095	0.00959	0.1272	-5.1839	10.0802	67.3893
-1.5845	-1.0369	-1.0369	-0.01779	-0.9	-0.6845	10.2822	68.5503
-1.8301	-1.2097	-1.2097	-0.04881	-1.0546	-0.7754	10.4842	69.7134

Smoothing	α = 0.2	T = 0.2	Fitted	Residual	Forecast	Upper Limit	Lower Limit
-6.0114	-2.2091	-2.2091	-0.23892	-1.2585	-4.7529	10.6862	70.8785
6.7992	-0.5986	-0.5986	0.13096	-2.448	9.2472	10.8882	72.0456
9.6331	1.5525	1.5525	0.53499	-0.4676	10.1007	11.0902	73.2144
-6.4776	0.3745	0.3745	0.19239	2.0875	-8.5651	11.2921	74.3851
-2.4615	-0.0388	-0.0388	0.07126	0.5669	-3.0283		
0.2231	0.0706	0.0706	0.07888	0.0325	0.1906		
1.4821	0.416	0.416	0.13218	0.1495	1.3326		
-5.0679	-0.5751	-0.5751	-0.09246	0.5482	-5.6161		
-15.8732	-3.7086	-3.7086	-0.70069	-0.6675	-15.2057		
3.5344	-2.8206	-2.8206	-0.38294	-4.4093	7.9437		
-0.3007	-2.623	-2.623	-0.26683	-3.2035	2.9028		
-18.8358	-6.079	-6.079	-0.90467	-2.8898	-15.946		
1.7035	-5.2462	-5.2462	-0.55718	-6.9837	8.6871		
-10.7526	-6.7933	-6.7933	-0.75515	-5.8034	-4.9492		
-5.3767	-7.1141	-7.1141	-0.66828	-7.5484	2.1717		
-7.9852	-7.8229	-7.8229	-0.6764	-7.7823	-0.2029		
-3.0889	-7.4172	-7.4172	-0.45998	-8.4993	5.4104		
-6.4615	-7.5941	-7.5941	-0.40335	-7.8772	1.4157		
-15.491	-9.4961	-9.4961	-0.70309	-7.9974	-7.4935		
-7.1551	-9.5904	-9.5904	-0.58133	-10.1992	3.0441		
23.2987	-3.4776	-3.4776	0.75749	-10.1717	33.4704		
-28.1661	-7.8093	-7.8093	-0.26035	-2.7201	-25.4459		
8.0883	-4.8381	-4.8381	0.38597	-8.0697	16.158		
-19.6913	-7.4999	-7.4999	-0.2236	-4.4521	-15.2392		
-12.2953	-8.6379	-8.6379	-0.40647	-7.7235	-4.5718		
-5.9328	-8.4221	-8.4221	-0.282	-9.0444	3.1116		
28.4275	-1.2777	-1.2777	1.20326	-8.7041	37.1316		
6.4869	1.2378	1.2378	1.46572	-0.0745	6.5614		
-14.0602	-0.6492	-0.6492	0.79517	2.7035	-16.7637		
-10.7951	-2.0423	-2.0423	0.35753	0.1459	-10.941		
-23.57	-6.0618	-6.0618	-0.51788	-1.6847	-21.8853		
-2.3085	-5.7254	-5.7254	-0.34704	-6.5797	4.2712		
-17.6355	-8.3851	-8.3851	-0.80956	-6.0725	-11.563		
-21.775	-11.7107	-11.7107	-1.31277	-9.1946	-12.5804		
16.8176	-7.0553	-7.0553	-0.11913	-13.0235	29.841		
26.6369	-0.4121	-0.4121	1.23332	-7.1744	33.8113		
9.0913	2.4752	2.4752	1.56413	0.8212	8.2701		
-1.951	2.8413	2.8413	1.32451	4.0393	-5.9903		
2.0006	3.7327	3.7327	1.2379	4.1658	-2.1652		
-6.2696	2.7226	2.7226	0.78829	4.9706	-11.2403		
3.1953	3.4478	3.4478	0.77567	3.5109	-0.3156		
26.6153	8.7018	8.7018	1.67134	4.2234	22.3918		
-1.2597	8.0466	8.0466	1.20603	10.3732	-11.6328		
14.0011	10.2023	10.2023	1.39597	9.2526	4.7485		
-13.2959	6.6194	6.6194	0.4002	11.5983	-24.8942		
-3.6879	4.8781	4.8781	-0.0281	7.0196	-10.7076		
-12.255	1.429	1.429	-0.7123	4.85	-17.105		
1.5439	0.8822	0.8822	-0.67921	0.7167	0.8272		
6.5012	1.4626	1.4626	-0.42728	0.2029	6.2983		

Smoothing	α = 0.2	T = 0.2	Fitted	Residual	Forecast	Upper Limit	Lower Limit
13.2488	3.478	3.478	0.06126	1.0353	12.2135		
-0.9067	2.6501	2.6501	-0.11658	3.5393	-4.446		
-24.36	-2.8452	-2.8452	-1.19232	2.5335	-26.8935		
6.7153	-1.887	-1.887	-0.76221	-4.0375	10.7528		
-2.5092	-2.6212	-2.6212	-0.75661	-2.6492	0.1399		
-18.8622	-6.4747	-6.4747	-1.37599	-3.3778	-15.4844		
0.7396	-6.1326	-6.1326	-1.03238	-7.8507	8.5903		
-13.4615	-8.4243	-8.4243	-1.28424	-7.165	-6.2966		
7.8217	-6.2025	-6.2025	-0.58303	-9.7085	17.5302		
-10.4484	-7.5181	-7.5181	-0.72954	-6.7855	-3.6629		
-1.985	-6.9951	-6.9951	-0.47904	-8.2476	6.2626		
2.212	-5.5369	-5.5369	-0.0916	-7.4741	9.6861		
-3.1916	-5.1411	-5.1411	0.00588	-5.6285	2.4369		
21.2034	0.1325	0.1325	1.05943	-5.1353	26.3387		
-2.3011	0.4933	0.4933	0.91971	1.1919	-3.493		
-10.7892	-1.0274	-1.0274	0.43162	1.413	-12.2022		
2.9332	0.11	0.11	0.57278	-0.5958	3.529		
3.1111	1.1684	1.1684	0.66991	0.6828	2.4284		
3.9267	2.256	2.256	0.75345	1.8384	2.0883		
-8.0205	0.8035	0.8035	0.31225	3.0095	-11.03		
11.9778	3.2881	3.2881	0.74673	1.1157	10.8621		
-19.1669	-0.6055	-0.6055	-0.18134	4.0349	-23.2017		
-0.7064	-0.7707	-0.7707	-0.17812	-0.7868	0.0805		

Source: Author's estimate.

Table A3.6: Double Exponential Smoothing Results of the SET Index (α = 0.5)

Smoothing	α = 0.5	T = 0.5	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1027.73	1027.73	-140.991	1292.01	-528.563	282.844	481.74	83.95
834.8	834.8	-166.964	886.74	-103.891	278.173	503.7	52.65
745.28	745.28	-128.242	667.83	154.888	273.503	528.43	18.57
689	689	-92.258	617.03	143.936	268.832	555.09	-17.42
642.79	642.79	-69.234	596.74	92.096	264.162	583.1	-54.78
662.5	662.5	-24.761	573.56	177.892	259.492	612.09	-93.11
691.08	691.08	1.908	637.74	106.677	254.821	641.81	-132.16
719.75	719.75	15.288	692.99	53.52	250.151	672.07	-171.77
791.02	791.02	43.279	735.04	111.962	245.48	702.75	-211.79
887.32	887.32	69.792	834.3	106.052	240.81	733.76	-252.14
911.16	911.16	46.815	957.12	-91.906	236.139	765.04	-292.76
925.7	925.7	30.676	957.98	-64.558	231.469	796.53	-333.59
965.43	965.43	35.202	956.37	18.105	226.799	828.2	-374.6
969.14	969.14	19.457	1000.63	-62.98	222.128	860.01	-415.75
926.91	926.91	-11.385	988.6	-123.367	217.458	891.94	-457.02
880.41	880.41	-28.944	915.53	-70.239	212.787	923.97	-498.4
838.59	838.59	-35.383	851.47	-25.755	208.117	956.1	-539.86
840.36	840.36	-16.804	803.2	74.315	203.446	988.29	-581.4
875.88	875.88	9.356	823.56	104.642	198.776	1020.56	-623
924.21	924.21	28.842	885.24	77.945	194.106	1052.88	-664.66
962.25	962.25	33.44	953.05	18.39	189.435	1085.24	-706.37
1128.3	1128.3	99.746	995.68	265.225	184.765	1117.66	-748.13
1269	1269	120.223	1228.04	81.906	180.094	1150.11	-789.92
1536.03	1536.03	193.63	1389.22	293.63	175.424	1182.6	-831.75
1611.56	1611.56	134.577	1729.67	-236.215	170.753	1215.11	-873.61
1559.53	1559.53	41.276	1746.13	-373.204	166.083	1247.66	-915.49
1420.4	1420.4	-48.929	1600.81	-360.818	161.413	1280.23	-957.4
1319.07	1319.07	-75.129	1371.47	-104.8	156.742	1312.82	-999.34
1300.41	1300.41	-46.897	1243.94	112.929	152.072	1345.43	-1041.29
1263.42	1263.42	-41.939	1253.51	19.831	147.401	1378.06	-1083.26
1299.18	1299.18	-3.09	1221.49	155.394	142.731	1410.71	-1125.25
1410.46	1410.46	54.094	1296.09	228.737	138.061	1443.37	-1167.25
1475.13	1475.13	59.383	1464.56	21.155	133.39	1476.05	-1209.27
1531.67	1531.67	57.961	1534.52	-5.685	128.72	1508.74	-1251.3
1476.04	1476.04	1.163	1589.63	-227.194	124.049	1541.45	-1293.35
1418.64	1418.64	-28.115	1477.2	-117.11	119.379	1574.16	-1335.4
1304.14	1304.14	-71.312	1390.53	-172.79	114.708	1606.88	-1377.47
1260.65	1260.65	-57.4	1232.82	55.647	110.038	1639.62	-1419.54
1209.96	1209.96	-54.042	1203.25	13.434	105.368	1672.36	-1461.62
1182.31	1182.31	-40.85	1155.92	52.769	100.697	1705.11	-1503.71
1266.88	1266.88	21.864	1141.46	250.854	96.027	1737.87	-1545.81
1341.76	1341.76	48.37	1288.75	106.023	91.356	1770.63	-1587.92
1386.61	1386.61	46.613	1390.13	-7.028	86.686	1803.4	-1630.03
1374.06	1374.06	17.031	1433.23	-118.327	82.015	1836.18	-1672.15
1342.66	1342.66	-7.185	1391.09	-96.864	77.345	1868.96	-1714.27
1303.12	1303.12	-23.364	1335.48	-64.717	72.675	1901.75	-1756.4
1238.19	1238.19	-44.148	1279.75	-83.134	68.004	1934.55	-1798.54

Smoothing	α = 0.5	T = 0.5	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1237.42	1237.42	-22.455	1194.04	86.771	63.334	1967.35	-1840.68
1312.65	1312.65	26.385	1214.97	195.361	58.663	2000.15	-1882.82
1330.45	1330.45	22.094	1339.03	-17.165	53.993	2032.96	-1924.97
1321.14	1321.14	6.39	1352.55	-62.816			
1310.07	1310.07	-2.34	1327.53	-34.918			
1309.82	1309.82	-1.294	1307.73	4.181			
1277.8	1277.8	-16.656	1308.53	-61.445			
1162.59	1162.59	-65.932	1261.15	-197.107			
1099.49	1099.49	-64.518	1096.66	5.659			
1066.99	1066.99	-48.508	1034.97	64.037			
964.41	964.41	-75.547	1018.48	-108.153			
907.41	907.41	-66.269	888.86	37.11			
836.36	836.36	-68.663	841.15	-9.576			
777.87	777.87	-63.577	767.69	20.345			
720.93	720.93	-60.259	714.29	13.269			
683.05	683.05	-49.068	660.67	44.764			
647.63	647.63	-42.241	633.98	27.31			
585.89	585.89	-51.992	605.39	-39.004			
530.59	530.59	-53.647	533.9	-6.62			
571.28	571.28	-6.478	476.94	188.677			
533.52	533.52	-22.121	564.8	-62.574			
527.97	527.97	-13.835	511.4	33.144			
480.67	480.67	-30.566	514.13	-66.923			
422.79	422.79	-44.225	450.11	-54.636			
375.63	375.63	-45.693	378.56	-5.873			
412.58	412.58	-4.369	329.93	165.296			
468.32	468.32	25.683	408.21	120.207			
476.55	476.55	16.961	494	-34.889			
452.82	452.82	-3.386	493.52	-81.385			
387.51	387.51	-34.347	449.44	-123.847			
335.66	335.66	-43.099	353.17	-35.006			
279.64	279.64	-49.56	292.56	-25.844			
222.31	222.31	-53.448	230.08	-15.552			
211.34	211.34	-32.207	168.86	84.962			
255.21	255.21	5.832	179.13	152.158			
311.93	311.93	31.276	261.04	101.777			
349.51	349.51	34.427	343.21	12.602			
373.47	373.47	29.193	383.94	-20.936			
371.8	371.8	13.763	402.66	-61.721			
368.79	368.79	5.374	385.56	-33.553			
416.76	416.76	26.672	374.16	85.189			
448.51	448.51	29.215	443.43	10.173			
499.75	499.75	40.225	477.73	44.042			
498.39	498.39	19.434	539.97	-83.165			
479.05	479.05	0.045	517.83	-77.556			
434.29	434.29	-22.356	479.09	-89.603			
403.74	403.74	-26.452	411.94	-16.386			
399.71	399.71	-15.245	377.29	44.829			
433.19	433.19	9.12	384.46	97.46			

Smoothing	α = 0.5	T = 0.5	Fitted	Residual	Forecast	Upper Limit	Lower Limit
459.94	459.94	17.935	442.31	35.26			
426.1	426.1	-7.954	477.88	-103.555			
409.23	409.23	-12.41	418.14	-17.824			
393.61	393.61	-14.015	396.82	-6.422			
351.44	351.44	-28.092	379.6	-56.306			
324.52	324.52	-27.507	323.35	2.339			
290.84	290.84	-30.593	297.01	-12.344			
284.04	284.04	-18.698	260.25	47.581			
271.32	271.32	-15.711	265.34	11.948			
263.72	263.72	-11.652	255.61	16.235			
265	265	-5.19	252.07	25.849			
264.5	264.5	-2.844	259.81	9.384			
297.21	297.21	14.935	261.65	71.116			
318.67	318.67	18.198	312.15	13.052			
314.41	314.41	6.965	336.87	-44.932			
311	311	1.78	321.37	-20.742			
311.46	311.46	1.117	312.78	-2.651			
317.56	317.56	3.612	312.57	9.977			
309.43	309.43	-2.259	321.17	-23.483			
321.37	321.37	4.84	307.17	28.398			
301.63	301.63	-7.453	326.21	-49.171			
284.63	284.63	-12.223	294.17	-19.083			
287.51	287.51	-4.67	272.41	30.212			

Source: Author's estimate.

Table A3.7: Double Exponential Smoothing Results of the SET Returns (α = 0.5)

Smoothing	α = 0.5	T = 0.5	Fitted	Residual	Forecast	Upper Limit	Lower Limit
7.0669	4.0163	4.0163	1.4971	0.9658	6.1011	3.8817	32.633
2.5093	4.0114	4.0114	0.7461	5.5135	-3.0041	5.6768	38.278
4.9675	4.8625	4.8625	0.7986	4.7575	0.21	7.472	44.324
-7.8022	-1.0706	-1.0706	-2.5672	5.6611	-13.4633	9.2671	50.648
-9.9585	-6.7981	-6.7981	-4.1474	-3.6378	-6.3207	11.0622	57.168
8.6996	-1.123	-1.123	0.7639	-10.9455	19.6451	12.8573	63.829
-0.9399	-0.6495	-0.6495	0.6187	-0.3591	-0.5808	14.6524	70.595
0.2804	0.1248	0.1248	0.6965	-0.0309	0.3112	16.4476	77.439
12.6292	6.7252	6.7252	3.6485	0.8212	11.8079	18.2427	84.345
10.4551	10.4144	10.4144	3.6688	10.3737	0.0815	20.0378	91.298
-8.328	2.8776	2.8776	-1.934	14.0832	-22.4112	21.8329	98.29
3.2085	2.0761	2.0761	-1.3678	0.9436	2.2648	23.6281	105.313
8.6847	4.6965	4.6965	0.6263	0.7083	7.9764	25.4232	112.36
-3.8527	0.7351	0.7351	-1.6676	5.3228	-9.1756	27.2183	119.429
-8.0381	-4.4853	-4.4853	-3.444	-0.9325	-7.1056	29.0134	126.515
-2.3316	-5.1304	-5.1304	-2.0445	-7.9293	5.5977	30.8085	133.617
-2.3436	-4.7593	-4.7593	-0.8367	-7.175	4.8313	32.6037	140.73
6.0856	0.2448	0.2448	2.0837	-5.596	11.6816	34.3988	147.855
5.6147	3.9716	3.9716	2.9053	2.3285	3.2862	36.1939	154.989
3.6993	5.2881	5.2881	2.1109	6.8769	-3.1776	37.989	162.132
0.8539	4.1264	4.1264	0.4746	7.399	-6.545	39.7842	169.281
26.0809	15.341	15.341	5.8446	4.601	21.4799	41.5793	176.437
3.8155	12.5006	12.5006	1.5021	21.1856	-17.37	43.3744	183.599
25.05	19.5263	19.5263	4.2639	14.0026	11.0474	45.1695	190.765
-11.94	5.9251	5.9251	-4.6686	23.7902	-35.7302	46.9646	197.936
-8.4142	-3.5789	-3.5789	-7.0863	1.2565	-9.6706	48.7598	205.111
-10.1844	-10.4248	-10.4248	-6.9661	-10.6652	0.4808	50.5549	212.289
2.1288	-7.631	-7.631	-2.0862	-17.3909	19.5197	52.35	219.471
6.8789	-1.4192	-1.4192	2.0628	-9.7172	16.5961	54.1451	226.656
-6.3537	-2.855	-2.855	0.3135	0.6437	-6.9974	55.9403	233.843
7.8177	2.6381	2.6381	2.9033	-2.5415	10.3592	57.7354	241.033
10.2063	7.8738	7.8738	4.0695	5.5414	4.6649	59.5305	248.225
-2.599	4.6722	4.6722	0.4339	11.9433	-14.5424	61.3256	255.419
2.861	3.9835	3.9835	-0.1273	5.1061	-2.2451	63.1207	262.615
-11.5226	-3.8332	-3.8332	-3.972	3.8562	-15.3788	64.9159	269.813
-0.1726	-3.9889	-3.9889	-2.0639	-7.8052	7.6326	66.711	277.012
-11.0554	-8.5541	-8.5541	-3.3145	-6.0528	-5.0026	68.5061	284.213
5.6459	-3.1114	-3.1114	1.0641	-11.8687	17.5145	70.3012	291.415
-5.733	-3.8901	-3.8901	0.1427	-2.0473	-3.6857	72.0964	298.618
-0.6589	-2.2032	-2.2032	0.9148	-3.7475	3.0886	73.8915	305.823
14.1427	6.4272	6.4272	4.7726	-1.2883	15.4311	75.6866	313.029
0.1765	5.6881	5.6881	2.0168	11.1998	-11.0232	77.4817	320.235
-0.8402	3.4324	3.4324	-0.1195	7.7049	-8.5451	79.2768	327.443
-5.0567	-0.8719	-0.8719	-2.2119	3.3128	-8.3695	81.072	334.652
-1.5845	-2.3341	-2.3341	-1.8371	-3.0838	1.4993	82.8671	341.861
-1.8301	-3.0006	-3.0006	-1.2518	-4.1712	2.3411	84.6622	349.071
-6.0114	-5.1319	-5.1319	-1.6915	-4.2524	-1.759	86.4573	356.282

Smoothing	$\alpha = 0.5$	T = 0.5	Fitted	Residual	Forecast	Upper Limit	Lower Limit
6.7992	-0.0121	-0.0121	1.7141	-6.8234	13.6226	88.2525	363.494
9.6331	5.6675	5.6675	3.6969	1.702	7.9311	90.0476	370.706
-6.4776	1.4434	1.4434	-0.2636	9.3645	-15.8421	91.8427	377.919
-2.4615	-0.6408	-0.6408	-1.1739	1.1798	-3.6412		
0.2231	-0.7959	-0.7959	-0.6645	-1.8148	2.0378		
1.4821	0.0109	0.0109	0.0711	-1.4603	2.9424		
-5.0679	-2.493	-2.493	-1.2164	0.082	-5.1499		
-15.8732	-9.7913	-9.7913	-4.2573	-3.7093	-12.1639		
3.5344	-5.2571	-5.2571	0.1384	-14.0486	17.583		
-0.3007	-2.7097	-2.7097	1.3429	-5.1187	4.8179		
-18.8358	-10.1013	-10.1013	-3.0243	-1.3668	-17.469		
1.7035	-5.7111	-5.7111	0.6829	-13.1256	14.8291		
-10.7526	-7.8904	-7.8904	-0.7482	-5.0282	-5.7245		
-5.3767	-7.0076	-7.0076	0.0673	-8.6386	3.2619		
-7.9852	-7.4628	-7.4628	-0.1939	-6.9403	-1.0449		
-3.0889	-5.3728	-5.3728	0.948	-7.6567	4.5678		
-6.4615	-5.4431	-5.4431	0.4388	-4.4248	-2.0367		
-15.491	-10.2476	-10.2476	-2.1828	-5.0043	-10.4867		
-7.1551	-9.7928	-9.7928	-0.864	-12.4305	5.2753		
23.2987	6.321	6.321	7.6249	-10.6568	33.9555		
-28.1661	-7.1101	-7.1101	-2.9031	13.9459	-42.1119		
8.0883	-0.9624	-0.9624	1.6223	-10.0132	18.1015		
-19.6913	-9.5157	-9.5157	-3.4655	0.6598	-20.3512		
-12.2953	-12.6383	-12.6383	-3.294	-12.9812	0.6859		
-5.9328	-10.9326	-10.9326	-0.7941	-15.9323	9.9995		
28.4275	8.3504	8.3504	9.2444	-11.7267	40.1542		
6.4869	12.0409	12.0409	6.4674	17.5948	-11.1079		
-14.0602	2.2241	2.2241	-1.6747	18.5083	-32.5685		
-10.7951	-5.1229	-5.1229	-4.5108	0.5494	-11.3445		
-23.57	-16.6018	-16.6018	-7.9949	-9.6337	-13.9363		
-2.3085	-13.4526	-13.4526	-2.4228	-24.5967	22.2883		
-17.6355	-16.7555	-16.7555	-2.8628	-15.8754	-1.7601		
-21.775	-20.6966	-20.6966	-3.402	-19.6183	-2.1567		
16.8176	-3.6405	-3.6405	6.827	-24.0987	40.9162		
26.6369	14.9117	14.9117	12.6896	3.1865	23.4504		
9.0913	18.3463	18.3463	8.0621	27.6013	-18.5101		
-1.951	12.2287	12.2287	0.9723	26.4084	-28.3594		
2.0006	7.6008	7.6008	-1.8278	13.201	-11.2004		
-6.2696	-0.2483	-0.2483	-4.8385	5.773	-12.0426		
3.1953	-0.9458	-0.9458	-2.7679	-5.0868	8.2821		
26.6153	11.4508	11.4508	4.8143	-3.7137	30.329		
-1.2597	7.5027	7.5027	0.4331	16.2651	-17.5248		
14.0011	10.9685	10.9685	1.9494	7.9358	6.0653		
-13.2959	-0.189	-0.189	-4.604	12.9179	-26.2138		
-3.6879	-4.2405	-4.2405	-4.3277	-4.793	1.1051		
-12.255	-10.4116	-10.4116	-5.2494	-8.5682	-3.6868		
1.5439	-7.0586	-7.0586	-0.9482	-15.6611	17.205		
6.5012	-0.7528	-0.7528	2.6788	-8.0068	14.508		
13.2488	7.5874	7.5874	5.5095	1.926	11.3228		

Smoothing	α = 0.5	T = 0.5	Fitted	Residual	Forecast	Upper Limit	Lower Limit
-0.9067	6.0951	6.0951	2.0086	13.097	-14.0037		
-24.36	-8.1281	-8.1281	-6.1073	8.1037	-32.4637		
6.7153	-3.7601	-3.7601	-0.8696	-14.2355	20.9508		
-2.5092	-3.5695	-3.5695	-0.3395	-4.6297	2.1205		
-18.8622	-11.3856	-11.3856	-4.0778	-3.909	-14.9532		
0.7396	-7.3619	-7.3619	-0.0271	-15.4634	16.203		
-13.4615	-10.4252	-10.4252	-1.5452	-7.389	-6.0726		
7.8217	-2.0744	-2.0744	3.4028	-11.9705	19.7922		
-10.4484	-4.56	-4.56	0.4586	1.3285	-11.7768		
-1.985	-3.0432	-3.0432	0.9877	-4.1013	2.1163		
2.212	0.0782	0.0782	2.0546	-2.0555	4.2674		
-3.1916	-0.5294	-0.5294	0.7235	2.1328	-5.3244		
21.2034	10.6987	10.6987	5.9758	0.1941	21.0093		
-2.3011	7.1867	7.1867	1.2319	16.6745	-18.9757		
-10.7892	-1.1853	-1.1853	-3.5701	8.4186	-19.2078		
2.9332	-0.9111	-0.9111	-1.6479	-4.7554	7.6886		
3.1111	0.2761	0.2761	-0.2304	-2.559	5.6701		
3.9267	1.9862	1.9862	0.7399	0.0457	3.881		
-8.0205	-2.6473	-2.6473	-1.9468	2.726	-10.7466		
11.9778	3.6919	3.6919	2.1962	-4.594	16.5718		
-19.1669	-6.6394	-6.6394	-4.0676	5.888	-25.0549		
-0.7064	-5.7067	-5.7067	-1.5674	-10.707	10.0006		
9.538	1.1319	1.1319	2.6356	-7.2741	16.812		

Source: Author's estimate.

Table A3.8: Double Exponential Smoothing Results of the SET Index (α = 0.8)

Smoothing	$\alpha = 0.8$	T = 0.8	Fitted	Residual	Forecast	Upper Limit	Lower Limit
869.16	869.16	-347.131	1292.01	-528.563	304.92	497.19	112.65
730.69	730.69	-180.207	522.03	260.818	317.026	574.98	59.08
768.27	768.27	-5.973	550.48	272.241	329.133	657.68	0.59
761.24	761.24	-6.823	762.3	-1.329	341.24	742.7	-60.22
701.95	701.95	-48.79	754.41	-65.572	353.347	828.99	-122.29
731.79	731.79	14.113	653.16	98.285	365.453	916.02	-185.11
744.72	744.72	13.162	745.91	-1.486	377.56	1003.53	-248.41
748.78	748.78	5.886	757.88	-11.369	389.667	1091.37	-312.04
828.53	828.53	64.977	754.67	92.33	401.774	1179.44	-375.89
930.98	930.98	94.954	893.51	46.839	413.881	1267.68	-439.92
897.36	897.36	-7.911	1025.94	-160.726	425.987	1356.04	-504.07
892.62	892.62	-5.366	889.44	3.975	438.094	1444.51	-568.32
957.04	957.04	50.455	887.26	87.222	450.201	1533.05	-632.65
951.62	951.62	5.757	1007.49	-69.841	462.308	1621.65	-697.04
883.66	883.66	-53.216	957.38	-92.145	474.414	1710.31	-761.48
842.32	842.32	-43.714	830.44	14.847	486.521	1799.01	-825.96
820.29	820.29	-26.368	798.61	27.103	498.628	1887.74	-890.48
860.8	860.8	27.135	793.92	83.598	510.735	1976.5	-955.03
920.15	920.15	52.904	887.94	40.264	522.841	2065.29	-1019.6
965.15	965.15	46.587	973.05	-9.872	534.948	2154.09	-1084.2
979.5	979.5	20.794	1011.74	-40.301	547.055	2242.92	-1148.81
1208.79	1208.79	187.588	1000.29	260.616	559.162	2331.76	-1213.44
1327.23	1327.23	132.276	1396.37	-86.425	571.268	2420.62	-1278.08
1638.18	1638.18	275.213	1459.51	223.339	583.375	2509.49	-1342.74
1577.44	1577.44	6.448	1913.4	-419.945	595.482	2598.37	-1407.4
1415.12	1415.12	-128.564	1583.89	-210.957	607.589	2687.26	-1472.08
1249.3	1249.3	-158.367	1286.56	-46.567	619.696	2776.16	-1536.77
1231.52	1231.52	-45.898	1090.94	175.734	631.802	2865.06	-1601.46
1322.62	1322.62	63.699	1185.63	171.244	643.909	2953.98	-1666.16
1295.94	1295.94	-8.608	1386.32	-112.98	656.016	3042.9	-1730.87
1358.97	1358.97	48.705	1287.33	89.552	668.123	3131.82	-1795.58
1501.4	1501.4	123.685	1407.67	117.155	680.229	3220.75	-1860.3
1513.58	1513.58	34.486	1625.08	-139.373	692.336	3309.69	-1925.02
1532.68	1532.68	22.172	1548.07	-19.24	704.443	3398.63	-1989.74
1400.92	1400.92	-100.971	1554.85	-192.41	716.55	3487.58	-2054.48
1348.06	1348.06	-62.482	1299.95	60.139	728.656	3576.52	-2119.21
1231.31	1231.31	-105.9	1285.58	-67.84	740.763	3665.47	-2183.95
1255.86	1255.86	-1.54	1125.41	163.062	752.87	3754.43	-2248.69
1224.21	1224.21	-25.628	1254.32	-37.637	764.977	3843.39	-2313.43
1206.67	1206.67	-19.157	1198.58	10.111	777.084	3932.35	-2378.18
1351.35	1351.35	111.914	1187.51	204.799	789.19	4021.31	-2442.93
1408.47	1408.47	68.078	1463.26	-68.494	801.297	4110.27	-2507.68
1401.79	1401.79	8.272	1476.55	-93.447	813.404	4199.24	-2572.43
1333.93	1333.93	-52.631	1410.06	-95.161	825.511	4288.21	-2637.19
1291.64	1291.64	-44.357	1281.3	12.929	837.617	4377.18	-2701.95
1266.07	1266.07	-29.334	1247.29	23.473	849.724	4466.16	-2766.71
1204.64	1204.64	-55.005	1236.73	-40.111	861.831	4555.13	-2831.47

Smoothing	α = 0.8	T = 0.8	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1254.58	1254.58	28.945	1149.64	131.173	873.938	4644.11	-2896.23
1384.97	1384.97	110.103	1283.52	126.809	886.044	4733.08	-2961
1356.51	1356.51	-0.746	1495.07	-173.201	898.151	4822.06	-3025.76
1302.94	1302.94	-43.008	1355.76	-66.035			
1286.07	1286.07	-22.092	1259.93	32.681			
1302.32	1302.32	8.582	1263.98	47.928			
1259.85	1259.85	-32.267	1310.91	-63.826			
1096.75	1096.75	-136.931	1227.58	-163.538			
1073.82	1073.82	-45.729	959.82	142.504			
1084.83	1084.83	-0.34	1028.09	70.92			
945.16	945.16	-111.8	1084.49	-174.156			
907.45	907.45	-52.53	833.36	92.609			
836.24	836.24	-67.473	854.92	-23.348			
784.19	784.19	-55.138	768.77	19.273			
727.86	727.86	-56.09	729.05	-1.487			
698.7	698.7	-34.546	671.77	33.662			
661.86	661.86	-36.377	664.15	-2.862			
578.21	578.21	-74.198	625.48	-59.095			
522.63	522.63	-59.306	504.01	23.269			
625.16	625.16	70.166	463.32	202.3			
540.85	540.85	-53.416	695.33	-193.096			
533.12	533.12	-16.867	487.43	57.106			
461.02	461.02	-61.054	516.25	-69.041			
396.37	396.37	-63.93	399.96	-4.494			
364.64	364.64	-38.169	332.44	40.251			
461.48	461.48	69.837	326.47	168.76			
529	529	67.984	531.31	-2.895			
486.68	486.68	-20.255	596.98	-137.873			
422.99	422.99	-55.007	466.43	-54.3			
334.07	334.07	-82.138	367.98	-42.393			
304.91	304.91	-39.751	251.93	66.23			
266.41	266.41	-38.755	265.16	1.557			
217.15	217.15	-47.154	227.65	-13.124			
237.06	237.06	6.49	170	83.819			
313.74	313.74	62.646	243.55	87.744			
365.53	365.53	53.963	376.39	-13.567			
368.55	368.55	13.204	419.5	-63.686			
366.75	366.75	1.203	381.75	-18.751			
346.34	346.34	-16.085	367.95	-27.013			
347.66	347.66	-2.164	330.26	21.753			
436.58	436.58	70.703	345.5	113.854			
464.34	464.34	36.346	507.28	-53.682			
517.55	517.55	49.842	500.68	21.087			
478.93	478.93	-20.932	567.39	-110.585			
443.81	443.81	-32.276	457.99	-17.725			
393.9	393.9	-46.387	411.54	-22.049			
385.94	385.94	-15.643	347.51	48.038			
411.76	411.76	17.522	370.3	51.821			
471.39	471.39	51.213	429.28	52.642			

Smoothing	α = 0.8	T = 0.8	Fitted	Residual	Forecast	Upper Limit	Lower Limit
486.58	486.58	22.391	522.6	-45.035			
401.25	401.25	-63.784	508.97	-134.648			
387.75	387.75	-23.557	337.47	62.854			
385.16	385.16	-6.784	364.19	26.208			
334.31	334.31	-42.038	378.37	-55.084			
319.01	319.01	-20.648	292.27	33.421			
287.41	287.41	-29.408	298.36	-13.687			
297.86	297.86	2.483	258	49.831			
281.9	281.9	-12.273	300.35	-23.057			
271.4	271.4	-10.858	269.63	2.212			
274.44	274.44	0.266	260.54	17.38			
270.29	270.29	-3.267	274.71	-5.52			
319.62	319.62	38.809	267.03	65.743			
331.85	331.85	17.541	358.43	-33.23			
303.43	303.43	-19.225	349.39	-57.447			
297.34	297.34	-8.713	284.2	16.425			
305.83	305.83	5.046	288.63	21.498			
320.22	320.22	12.517	310.88	11.674			
304.7	304.7	-9.91	332.73	-35.042			
327.41	327.41	16.19	294.79	40.782			
290.35	290.35	-26.411	343.6	-66.564			
272.86	272.86	-19.276	263.94	11.148			
292.81	292.81	12.107	253.58	49.036			

Source: Author's estimate.

Table A3.9: Double Exponential Smoothing Results of the SET Returns (α = 0.8)

Smoothing	α = 0.8	T = 0.8	Fitted	Residual	Forecast	Upper Limit	Lower Limit
7.0669	5.8467	5.8467	3.8766	0.9658	6.1011	3.5004	41.361
2.5093	3.9521	3.9521	-0.7403	9.7232	-7.2139	3.1512	53.946
4.9675	4.6163	4.6163	0.3833	3.2118	1.7557	2.8019	67.498
-7.8022	-5.2418	-5.2418	-7.8099	4.9997	-12.8019	2.4527	81.508
-9.9585	-10.5771	-10.5771	-5.8302	-13.0517	3.0932	2.1034	95.765
8.6996	3.6782	3.6782	10.2382	-16.4074	25.1069	1.7542	110.17
-0.9399	2.0313	2.0313	0.7302	13.9164	-14.8563	1.4049	124.67
0.2804	0.7766	0.7766	-0.8578	2.7615	-2.4811	1.0557	139.234
12.6292	10.0871	10.0871	7.2769	-0.0812	12.7103	0.7064	153.843
10.4551	11.8369	11.8369	2.8552	17.364	-6.9088	0.3572	168.485
-8.328	-3.724	-3.724	-11.8777	14.6921	-23.0201	0.0079	183.153
3.2085	-0.5536	-0.5536	0.1608	-15.6016	18.8101	-0.3413	197.84
8.6847	6.8692	6.8692	5.9704	-0.3928	9.0775	-0.6906	212.542
-3.8527	-0.5143	-0.5143	-4.7127	12.8396	-16.6923	-1.0398	227.256
-8.0381	-7.4759	-7.4759	-6.5119	-5.227	-2.8112	-1.389	241.981
-2.3316	-4.6628	-4.6628	0.9481	-13.9878	11.6562	-1.7383	256.714
-2.3436	-2.6178	-2.6178	1.8256	-3.7147	1.3711	-2.0875	271.453
6.0856	4.71	4.71	6.2274	-0.7922	6.8778	-2.4368	286.199
5.6147	6.6793	6.6793	2.8209	10.9375	-5.3227	-2.786	300.949
3.6993	4.8595	4.8595	-0.8917	9.5002	-5.8009	-3.1353	315.704
0.8539	1.4767	1.4767	-2.8846	3.9678	-3.1139	-3.4845	330.462
26.0809	20.5832	20.5832	14.7083	-1.4079	27.4888	-3.8338	345.223
3.8155	10.1107	10.1107	-5.4363	35.2915	-31.4759	-4.183	359.987
25.05	20.9749	20.9749	7.6041	4.6744	20.3756	-4.5323	374.754
-11.94	-3.8362	-3.8362	-18.328	28.5789	-40.5189	-4.8815	389.523
-8.4142	-11.1642	-11.1642	-9.528	-22.1643	13.7501	-5.2308	404.294
-10.1844	-12.2859	-12.2859	-2.803	-20.6922	10.5078	-5.58	419.066
2.1288	-1.3147	-1.3147	8.2164	-15.0889	17.2178	-5.9293	433.84
6.8789	6.8835	6.8835	8.2018	6.9016	-0.0227	-6.2785	448.616
-6.3537	-2.0659	-2.0659	-5.5191	15.0853	-21.439	-6.6278	463.392
7.8177	4.7371	4.7371	4.3386	-7.5851	15.4027	-6.977	478.17
10.2063	9.9802	9.9802	5.0622	9.0757	1.1306	-7.3262	492.949
-2.599	0.9293	0.9293	-6.2283	15.0423	-17.6414	-7.6755	507.729
2.861	1.229	1.229	-1.0059	-5.299	8.16	-8.0247	522.509
-11.5226	-9.1734	-9.1734	-8.5231	0.2231	-11.7457	-8.374	537.291
-0.1726	-3.6774	-3.6774	2.6922	-17.6965	17.5239	-8.7232	552.073
-11.0554	-9.0414	-9.0414	-3.7527	-0.9852	-10.0702	-9.0725	566.856
5.6459	1.9579	1.9579	8.0489	-12.7941	18.44	-9.4217	581.639
-5.733	-2.585	-2.585	-2.0245	10.0067	-15.7397	-9.771	596.423
-0.6589	-1.449	-1.449	0.5039	-4.6096	3.9507	-10.1202	611.208
14.1427	11.1251	11.1251	10.1601	-0.9451	15.0878	-10.4695	625.993
0.1765	4.3983	4.3983	-3.3495	21.2853	-21.1087	-10.8187	640.779
-0.8402	-0.4624	-0.4624	-4.5584	1.0488	-1.889	-11.168	655.565
-5.0567	-5.0495	-5.0495	-4.5814	-5.0209	-0.0358	-11.5172	670.351
-1.5845	-3.1938	-3.1938	0.5683	-9.6309	8.0464	-11.8665	685.138
-1.8301	-1.9891	-1.9891	1.0774	-2.6254	0.7953	-12.2157	699.925
-6.0114	-4.9915	-4.9915	-2.1864	-0.9118	-5.0996	-12.565	714.712

Smoothing	α = 0.8	T = 0.8	Fitted	Residual	Forecast	Upper Limit	Lower Limit
6.7992	4.0038	4.0038	6.7589	-7.1779	13.9771	-12.9142	729.5
9.6331	9.859	9.859	6.036	10.7627	-1.1296	-13.2634	744.288
-6.4776	-2.0031	-2.0031	-8.2825	15.895	-22.3726	-13.6127	759.076
-2.4615	-4.0263	-4.0263	-3.275	-10.2856	7.8242		
0.2231	-1.2818	-1.2818	1.5406	-7.3013	7.5244		
1.4821	1.2374	1.2374	2.3235	0.2587	1.2233		
-5.0679	-3.3422	-3.3422	-3.199	3.5609	-8.6288		
-15.8732	-14.0068	-14.0068	-9.1715	-6.5411	-9.3321		
3.5344	-1.8081	-1.8081	7.9246	-23.1782	26.7127		
-0.3007	0.9827	0.9827	3.8176	6.1165	-6.4172		
-18.8358	-14.1086	-14.1086	-11.3095	4.8003	-23.6361		
1.7035	-3.7208	-3.7208	6.0483	-25.4181	27.1215		
-10.7526	-8.1366	-8.1366	-2.323	2.3274	-13.0801		
-5.3767	-6.3932	-6.3932	0.9301	-10.4596	5.0829		
-7.9852	-7.4808	-7.4808	-0.684	-5.4631	-2.5221		
-3.0889	-4.1041	-4.1041	2.5646	-8.1649	5.076		
-6.4615	-5.4771	-5.4771	-0.5855	-1.5395	-4.922		
-15.491	-13.6053	-13.6053	-6.6196	-6.0626	-9.4284		
-7.1551	-9.7691	-9.7691	1.745	-20.2249	13.0698		
23.2987	17.0342	17.0342	21.7916	-8.024	31.3228		
-28.1661	-14.7677	-14.7677	-21.0832	38.8258	-66.9919		
8.0883	-0.6995	-0.6995	7.0379	-35.8509	43.9392		
-19.6913	-14.4854	-14.4854	-9.6211	6.3384	-26.0297		
-12.2953	-14.6576	-14.6576	-2.062	-24.1065	11.8111		
-5.9328	-8.0901	-8.0901	4.8415	-16.7195	10.7867		
28.4275	22.0923	22.0923	25.1143	-3.2486	31.6761		
6.4869	14.6308	14.6308	-0.9463	47.2066	-40.7197		
-14.0602	-8.5112	-8.5112	-18.7029	13.6845	-27.7447		
-10.7951	-14.0789	-14.0789	-8.1947	-27.2141	16.419		
-23.57	-23.3107	-23.3107	-9.0244	-22.2736	-1.2964		
-2.3085	-8.3138	-8.3138	10.1927	-32.3351	30.0267		
-17.6355	-13.7326	-13.7326	-2.2965	1.8789	-19.5144		
-21.775	-20.6258	-20.6258	-5.9739	-16.0292	-5.7458		
16.8176	8.1341	8.1341	21.8132	-26.5997	43.4173		
26.6369	27.299	27.299	19.6945	29.9473	-3.3104		
9.0913	16.6717	16.6717	-4.5629	46.9935	-37.9022		
-1.951	0.861	0.861	-13.5612	12.1088	-14.0598		
2.0006	-0.9396	-0.9396	-4.1527	-12.7002	14.7008		
-6.2696	-6.0342	-6.0342	-4.9062	-5.0922	-1.1774		
3.1953	0.3682	0.3682	4.1406	-10.9404	14.1357		
26.6153	22.194	22.194	18.2888	4.5088	22.1065		
-1.2597	7.0888	7.0888	-8.4264	40.4828	-41.7424		
14.0011	10.9334	10.9334	1.3904	-1.3376	15.3387		
-13.2959	-8.172	-8.172	-15.0062	12.3237	-25.6197		
-3.6879	-7.586	-7.586	-2.5324	-23.1782	19.4903		
-12.255	-11.8277	-11.8277	-3.8998	-10.1184	-2.1366		
1.5439	-1.9104	-1.9104	7.1539	-15.7275	17.2714		
6.5012	6.2497	6.2497	7.9588	5.2435	1.2578		
13.2488	13.4408	13.4408	7.3446	14.2085	-0.9597		

Smoothing	α = 0.8	T = 0.8	Fitted	Residual	Forecast	Upper Limit	Lower Limit
-0.9067	3.4317	3.4317	-6.5383	20.7854	-21.6922		
-24.36	-20.1093	-20.1093	-20.1405	-3.1066	-21.2533		
6.7153	-2.6777	-2.6777	9.9172	-40.2498	46.9651		
-2.5092	-0.5595	-0.5595	3.678	7.2395	-9.7487		
-18.8622	-14.4661	-14.4661	-10.3897	3.1185	-21.9807		
0.7396	-4.3794	-4.3794	5.9914	-24.8557	25.5953		
-13.4615	-10.4468	-10.4468	-3.6556	1.6119	-15.0735		
7.8217	3.4369	3.4369	10.3758	-14.1025	21.9242		
-10.4484	-5.5962	-5.5962	-5.1513	13.8127	-24.2611		
-1.985	-3.7375	-3.7375	0.4567	-10.7474	8.7624		
2.212	1.1134	1.1134	3.9721	-3.2808	5.4928		
-3.1916	-1.5362	-1.5362	-1.3253	5.0855	-8.2771		
21.2034	16.3904	16.3904	14.0762	-2.8614	24.0648		
-2.3011	4.2524	4.2524	-6.8952	30.4667	-32.7678		
-10.7892	-9.1599	-9.1599	-12.1089	-2.6427	-8.1465		
2.9332	-1.9072	-1.9072	3.3804	-21.2688	24.202		
3.1111	2.7835	2.7835	4.4287	1.4732	1.638		
3.9267	4.5838	4.5838	2.3259	7.2122	-3.2855		
-8.0205	-5.0345	-5.0345	-7.2294	6.9097	-14.9302		
11.9778	7.1294	7.1294	8.2853	-12.2639	24.2417		
-19.1669	-12.2506	-12.2506	-13.8469	15.4147	-34.5816		
-0.7064	-5.7846	-5.7846	2.4034	-26.0975	25.3911		
9.538	6.9541	6.9541	10.6716	-3.3812	12.9192		

Source: Author's estimate.

Table A3.10: Holts Winter's Model Results of the SET Index (L, T, S = 0.2)

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
762.48	776.09	14.0993	0.99497	777.09	-13.644	345.157	521.44	168.873
783.38	787.26	13.5144	1.00639	797.61	-14.759	343.794	523.75	163.837
799.78	802.59	13.8771	1.01773	813.51	9.21	415.68	599.59	231.767
783.59	809.06	12.3952	0.96917	797.14	-36.169	490.708	678.84	302.574
693.25	817.95	11.6933	0.85392	703.88	-15.036	613.794	806.39	421.193
733.62	831.28	12.0207	0.89832	744.11	7.341	564.004	761.3	366.705
745.69	840.61	11.4834	0.89474	756.47	-12.049	535.472	737.68	333.26
684.35	865.07	14.0784	0.82387	693.7	52.815	479.587	686.91	272.263
771.67	893.22	16.893	0.90328	784.23	62.768	501.281	713.9	288.661
791.72	940.27	22.9246	0.90911	806.69	133.655	514.23	732.32	296.141
774.19	980.72	26.4295	0.83514	793.06	72.145	479.778	703.49	256.062
798.23	1025.25	30.0504	0.82542	819.74	73.679	555.718	785.21	326.227
863.87	1075.55	34.0993	0.85528	889.19	85.288	668.709	904.11	433.308
877.61	1117.54	35.6786	0.82058	905.43	32.216	684.682	926.12	443.245
821.56	1157.97	36.6273	0.73756	847.79	17.436	690.229	937.82	442.637
844.59	1187.46	35.2007	0.72587	871.3	-26.014	642.286	896.14	388.432
896.75	1196.81	30.0296	0.74213	923.34	-97.628	621.38	881.6	361.163
843.66	1230.44	30.7498	0.70658	864.83	12.692	581.956	848.63	315.281
933.04	1253.76	29.2647	0.7547	956.35	-28.153	659.705	932.92	386.487
1101.47	1245.69	21.7978	0.85747	1127.18	-163.997	626.139	905.98	346.297
1059.9	1242.34	16.7673	0.83707	1078.45	-107.005	654.522	941.06	367.98
1258.83	1256.16	16.1787	1.01138	1275.82	-14.912	677.367	970.68	384.055
1414.31	1250.57	11.8238	1.11022	1432.53	-122.578	675.035	975.18	374.888
1722.41	1254.28	10.2019	1.37018	1738.7	-55.847	652.052	959.09	345.01
1527.4	1256.87	8.6787	1.21185	1539.82	-46.373	641.754	955.75	327.759
1401.03	1258.77	7.3233	1.1099	1410.7	-37.769	657.577	978.58	336.576
1230.23	1266.62	7.43	0.97766	1237.38	2.605	689.617	1017.67	361.56
1254.4	1275.05	7.6284	0.99096	1261.76	4.914	668.812	1003.97	333.652
1291.69	1294.02	9.8971	1.02015	1299.41	57.456	650.168	992.47	307.862
1201.2	1317.48	12.6097	0.93592	1210.39	62.951	720.841	1070.33	371.348
1343.89	1334.03	13.3988	1.02246	1356.76	20.123	695.652	1052.37	338.932
1554.48	1339.66	11.8449	1.15984	1570.1	-45.265	632.434	996.42	268.453
1559.6	1336.44	8.8322	1.15368	1573.39	-87.682	647.709	1018.99	276.431
1587.83	1333.58	6.4925	1.17976	1598.33	-69.496	651.407	1030.01	272.801
1455.69	1321.69	2.8156	1.07942	1462.78	-100.34	644.011	1029.98	258.046
1423.43	1312.18	0.3506	1.06889	1426.46	-66.368	575.72	969.07	182.367
1308.98	1294.16	-3.3219	0.98624	1309.33	-91.589	606.552	1007.32	205.785
1444.67	1263.52	-8.7861	1.09699	1440.96	-152.491	617.143	1025.35	208.935
1351.16	1231.34	-13.4651	1.05311	1341.77	-125.089	573.894	989.57	158.222
1370.03	1191.57	-18.7267	1.09298	1355.05	-146.356	645.427	1068.59	222.268
1412.37	1173.2	-18.6544	1.18559	1390.17	2.141	642.888	1073.56	212.219
1381.46	1160.54	-17.4562	1.18238	1359.5	35.274	597.514	1035.71	159.316
1319.92	1157.68	-14.536	1.14881	1300.07	83.03	597.365	1043.11	151.617
1273.94	1153.5	-12.4656	1.10832	1257.94	56.959	621.134	1074.45	167.818
1277.5	1146.55	-11.3627	1.11176	1263.69	30.537	610.994	1071.9	150.093
1302.18	1131.93	-12.0147	1.13312	1289.27	-18.513	554.691	1023.19	86.187
1231.19	1115.96	-12.8054	1.08461	1218.12	-21.502	561.506	1037.63	85.384

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1195.8	1121.58	-9.1198	1.08563	1182.08	98.732	575.886	1059.64	92.13
1316.39	1130.29	-5.5533	1.1885	1305.68	104.648	540.345	1031.75	48.941
1257.43	1137.44	-3.0141	1.12241	1251.25	70.621	590.663	1089.73	91.597
1131.71	1166.79	3.4593	1.01705	1128.71	161.02			
1174.24	1193.08	8.0255	1.0218	1177.73	114.884			
1214.24	1218.69	11.5433	1.02949	1222.4	89.506			
1181.12	1241.54	13.8038	0.97623	1192.31	54.77			
1060.18	1253.49	13.4325	0.85291	1071.97	-7.926			
1126.03	1258.95	11.8394	0.89377	1138.1	-35.778			
1126.44	1262.29	10.1395	0.88992	1137.03	-38.024			
1039.97	1238.93	3.4397	0.80605	1048.33	-137.995			
1119.1	1198.92	-5.2505	0.87709	1122.21	-196.242			
1089.95	1137.88	-16.4091	0.87345	1085.18	-253.61			
950.29	1085.9	-23.5237	0.81325	936.58	-148.542			
896.32	1026.19	-30.7609	0.80214	876.9	-149.344			
877.68	961.3	-37.5862	0.83099	851.37	-145.938			
788.82	900.15	-42.2994	0.80339	757.98	-96.688			
663.91	839.86	-45.8964	0.72493	632.72	-66.325			
609.63	780.46	-48.5985	0.71581	576.31	-49.034			
579.2	764.87	-41.9968	0.76776	543.14	122.483			
540.44	720.45	-42.4798	0.70468	510.76	-8.532			
543.73	686.69	-40.7377	0.76236	511.67	32.87			
588.81	621.07	-45.7136	0.82999	553.88	-106.668			
519.88	554.77	-49.83	0.81223	481.61	-86.142			
561.08	477.65	-55.2878	0.96515	510.69	-137.997			
530.3	427.11	-54.3398	1.12007	468.92	26.312			
585.21	375.34	-53.8241	1.37771	510.76	17.663			
454.86	332.99	-51.5309	1.24523	389.63	69.477			
369.58	299.43	-47.9362	1.1632	312.39	99.744			
292.74	267.8	-44.6746	1.02528	245.87	79.717			
265.38	242.71	-40.7572	1.05494	221.11	97.051			
247.6	213.85	-38.3774	1.06556	206.03	60.694			
200.15	186.23	-36.2277	0.97913	164.23	50.298			
190.41	169.65	-32.2979	1.11721	153.37	100.453			
196.76	167.01	-26.3665	1.32462	159.3	171.987			
192.67	175.41	-19.4125	1.33663	162.25	200.568			
206.94	185.12	-13.5886	1.32823	184.04	171.771			
199.82	204.48	-6.9981	1.21858	185.15	177.849			
218.57	221.78	-2.1387	1.16257	211.09	129.854			
218.73	247.1	3.3525	1.07391	216.62	135.392			
271.06	284.11	10.0841	1.20095	274.74	184.611			
299.2	321.5	15.5454	1.12467	309.82	143.784			
351.39	365.11	21.1591	1.1602	368.38	153.389			
432.87	386.08	21.1203	1.18512	457.96	-1.149			
456.49	400.23	19.7268	1.16591	481.46	-41.19			
459.79	403.77	16.49	1.11198	482.45	-92.961			
447.51	407.59	13.9552	1.08075	465.79	-70.235			
453.14	413.17	12.2809	1.09374	468.66	-46.535			
468.17	425.42	12.2749	1.13306	482.09	-0.169			

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
461.42	438.22	12.3796	1.08565	474.73	2.837			
475.75	429.44	8.1473	1.04283	489.19	-114.866			
510.39	417.44	4.117	1.1426	520.07	-119.753			
468.53	406.81	1.1678	1.08986	473.16	-82.755			
413.74	389.95	-2.4363	0.97945	414.93	-91.638			
398.45	373.76	-5.1873	0.99171	395.96	-70.274			
384.78	350.16	-8.8696	0.98618	379.44	-94.772			
341.84	336.1	-9.9084	0.96416	333.18	-25.351			
286.66	325.98	-9.9516	0.85246	278.21	-0.922			
291.35	313.65	-10.4266	0.88836	282.45	-10.613			
279.12	305.04	-10.0636	0.89416	269.84	8.075			
245.88	302.77	-8.5042	0.82266	237.76	31.426			
265.56	311.29	-5.0988	0.91547	258.1	74.671			
271.9	319.42	-2.4539	0.90238	267.45	57.754			
259.77	325.37	-0.7733	0.83005	257.77	34.168			
260.99	334.63	1.2344	0.82139	260.37	40.261			
278.08	343.34	2.7279	0.84545	279.1	31.028			
275.83	357.15	4.9448	0.82334	278.02	44.526			
258.91	371.8	6.8871	0.74007	262.49	35.2			
266.14	396.71	10.4912	0.74183	271.07	64.498			
304.58	397.93	8.6369	0.75345	312.63	-35.593			
280.41	403.33	7.9891	0.70015	286.5	-11.411			
307.48	408.44	7.4144	0.75807	313.57	-10.954			

Source: Author's estimate.

Table A3.11: Holts Winter's Model Results of SET Returns (L, T, S = 0.2)

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
7.0669	26.003	2.31056	-0.13767	8.148	25.442	-18.375	-7.657	50.493
2.5093	-5.153	1.5133	-0.26959	-1.453	-4.846	7.356	-29.423	29.938
4.9675	7.084	1.2072	-0.27689	4.568	5.822	-0.855	-129.492	-68.826
-7.8022	3.791	0.2473	-0.41349	-3.798	2.921	-10.723	24.536	86.594
-9.9585	5.805	-0.2178	-0.42382	27.923	-3.901	-6.057	-12.422	51.11
8.6996	1.426	-0.77907	-0.45131	-7.47	4.2	4.499	-7.105	57.977
-0.9399	0.509	-0.69682	-0.3446	-0.253	0.805	-1.744	-9.375	57.327
0.2804	-9.829	-0.82916	-0.30214	11.217	-14.689	14.97	-0.132	68.257
12.6292	19.138	-1.01448	-0.27878	-20.954	26.111	-13.482	-1.093	69.043
10.4551	-1.81	0.13734	0.007342	16.652	-2.307	12.763	-0.279	71.66
-8.328	2.182	0.01092	-0.01941	-139.812	2.299	-10.627	-1.464	72.332
3.2085	0.013	0.52966	0.088219	2.168	-0.01	3.219	-4.834	70.867
8.6847	-2.966	0.18412	0.001467	4.954	-3.46	12.145	-1.699	75.951
-3.8527	0.751	-0.04046	-0.04374	22.308	0.757	-4.61	0.889	80.531
-8.0381	-0.828	-0.14594	-0.05609	27.384	-1.723	-6.315	6.707	88.379
-2.3316	0.253	0.10768	0.005853	-5.716	0.35	-2.681	3.329	87.067
-2.3436	-0.11	0.54905	0.092956	-1.672	-0.116	-2.227	4.24	90.077
6.0856	8.148	0.59562	0.083678	13.916	9.528	-3.442	-25.377	62.589
5.6147	-9.005	0.46916	0.041651	-9.701	-10.27	15.885	5.415	95.54
3.6993	4.76	0.48157	0.035803	9.653	5.182	-1.483	-14.5	77.81
0.8539	5.372	0.42921	0.01817	9.322	5.772	-4.918	-2.306	92.214
26.0809	-8.292	0.08792	-0.05372	43.872	-8.644	34.724	2.191	98.944
3.8155	-2.759	0.00304	-0.05995	226.003	-1.073	4.889	8.831	107.839
25.05	-0.093	-0.2101	-0.09059	-48.202	1.733	23.317	3.581	104.863
-11.94	-5.296	-0.33528	-0.09751	27.29	-7.58	-4.36	-2.882	100.694
-8.4142	-6.248	-0.43653	-0.09826	18.763	-8.065	-0.349	-5.277	100.61
-10.1844	-14.322	-0.48992	-0.08928	30.404	-17.545	7.361	7.389	115.603
2.1288	-0.098	1.65742	0.358041	0.417	-0.116	2.245	572.903	683.46
6.8789	17.537	1.74239	0.303427	9.255	21.326	-14.447	-32.736	80.178
-6.3537	47.716	1.59025	0.212314	21.109	56.026	-62.379	15.822	131.107
7.8177	-38.108	1.3768	0.127162	-18.035	-43.195	51.013	20.531	138.199
10.2063	-49.379	1.14626	0.05562	-26.911	-53.94	64.146	-2.568	117.496
-2.599	-7.306	1.04305	0.023855	-5.598	-7.661	5.062	-14.396	108.075
2.861	-0.892	0.18427	-0.15267	2.421	-0.912	3.773	-13.37	111.519
-11.5226	1.69	-0.22605	-0.2042	17.53	0.29	-11.812	38.991	166.307
-0.1726	-1.423	-0.34968	-0.18809	5.136	-2.709	2.537	-8.972	120.78
-11.0554	-2.642	-0.72291	-0.22512	9.102	-4.062	-6.993	-1.086	131.112
5.6459	22.765	-0.79428	-0.19437	-26.614	29.854	-24.208	7.204	141.856
-5.733	-5.38	-0.9602	-0.18868	6.613	-6.696	0.963	-43.133	93.982
-0.6589	12.546	-0.90902	-0.14071	-10.308	15.011	-15.67	21.045	160.63
14.1427	0.599	-5.13383	-0.95753	-1.078	0.691	13.451	-283.909	-141.847
0.1765	-17.663	-4.86282	-0.71182	2.745	-20.957	21.134	14.044	158.589
-0.8402	-62.322	-4.47282	-0.49146	10.29	-71.444	70.604	11.551	158.587
-5.0567	-15.12	-4.2706	-0.35272	2.941	-16.782	11.725	50.898	200.43
-1.5845	20.658	-3.63314	-0.15468	-3.783	22.364	-23.948	89.04	241.074
-1.8301	40.744	-2.99762	0.003356	-8.85	42.479	-44.309	-4.716	149.826
-6.0114	-20.114	-2.57459	0.087292	5.835	-20.092	14.081	-0.295	156.76

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
6.7992	-44.549	-1.91125	0.202501	13.131	-43.039	49.838	39.87	199.443
9.6331	30.427	-1.48802	0.246647	-14.031	27.203	-17.57	-31.713	130.383
-6.4776	-13.004	-1.14134	0.266653	8.126	-10.849	4.371	28.591	193.215
-2.4615	-9.3	-0.76017	0.289557	7.166	-7.127	4.666		
0.2231	1.104	-0.4072	0.30224	-1.272	0.684	-0.461		
1.4821	-1.86	-0.01908	0.319416	-11.885	-0.479	1.962		
-5.0679	0.072	0.50716	0.36078	-5.037	-1.141	-3.927		
-15.8732	14.162	0.58066	0.303324	16.871	24.236	-40.109		
3.5344	-4.338	0.61256	0.24904	-4.822	-6.604	10.138		
-0.3007	-0.155	0.92669	0.262057	-0.268	-0.218	-0.082		
-18.8358	10.394	0.61514	0.147336	2.849	13.334	-32.169		
1.7035	-12.89	0.59372	0.113585	-16.19	-15.977	17.681		
-10.7526	9.887	0.4367	0.059464	8.397	11.778	-22.531		
-5.3767	-61.056	0.40462	0.041155	-114.507	-69.37	63.993		
-7.9852	0.877	-0.37987	-0.12398	5.939	0.967	-8.952		
-3.0889	-1.882	-0.52778	-0.12876	5.134	-2.496	-0.593		
-6.4615	-11.774	-0.58316	-0.11409	20.063	-14.646	8.185		
-15.491	-15.969	-0.67094	-0.10882	26.525	-19.093	3.602		
-7.1551	3.835	-0.37344	-0.02756	-0.74	4.457	-11.612		
23.2987	0.624	-3.10769	-0.5689	-2.837	0.67	22.628		
-28.1661	-43.247	-3.34607	-0.50279	12.816	-51.164	22.998		
8.0883	32.461	-3.24584	-0.38219	-8.259	37.339	-29.25		
-19.6913	-31.331	-3.31042	-0.31867	8.912	-35.02	15.329		
-12.2953	-30.86	-3.16705	-0.22626	8.234	-33.831	21.536		
-5.9328	-138.946	-2.7417	-0.09594	35.531	-148.873	142.94		
28.4275	-619.632	-2.24495	0.022599	178.27	-641.314	669.741		
6.4869	108.21	-1.8048	0.10611	-39.28	107.121	-100.634		
-14.0602	-49.253	-1.46199	0.153449	23.755	-46.357	32.297		
-10.7951	-27.431	-1.16191	0.182777	16.868	-24.552	13.757		
-23.57	-35.326	-0.93835	0.190933	29.347	-29.769	6.199		
-2.3085	-0.392	-1.70381	-0.00035	0.605	-0.312	-1.996		
-17.6355	-15.768	-1.74445	-0.0084	9.426	-15.771	-1.864		
-21.775	-36.824	-1.60859	0.020449	19.595	-37.001	15.227		
16.8176	29.011	-1.45701	0.046674	-16.737	28.642	-11.825		
26.6369	39.21	-1.32623	0.063495	-25.546	37.954	-11.317		
9.0913	7.424	-1.33501	0.04904	-5.84	7.068	2.023		
-1.951	-3.232	-1.18993	0.068248	2.265	-3.114	1.163		
2.0006	-20.86	-0.87452	0.11768	13.567	-19.663	21.664		
-6.2696	-4.492	-0.84961	0.099126	5.585	-3.887	-2.382		
3.1953	-7.733	-0.53018	0.143188	6.076	-6.831	10.026		
26.6153	14.11	-0.5096	0.118666	-31.737	10.299	16.316		
-1.2597	-3.37	-0.35084	0.126684	6.008	-2.585	1.325		
14.0011	3.616	-0.45098	0.081319	-14.456	2.311	11.69		
-13.2959	0.486	2.1712	0.589492	-2.087	0.398	-13.694		
-3.6879	5.96	1.93987	0.425327	1.816	7.578	-11.266		
-12.255	19.962	1.65397	0.283082	6.75	24.339	-36.594		
1.5439	4.865	1.65463	0.226597	2.54	5.697	-4.153		
6.5012	-6.259	1.16123	0.082598	-1.906	-7.116	13.617		
13.2488	-10.276	0.69564	-0.02704	-3.27	-11.007	24.256		

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
-0.9067	4.059	0.5038	-0.06	4.308	3.901	-4.808		
-24.36	6.616	-0.01598	-0.15196	315.314	5.828	-30.188		
6.7153	0.224	-0.23008	-0.16438	-17.062	2.356	4.359		
-2.5092	-1.87	-0.37732	-0.16096	7.831	-3.206	0.696		
-18.8622	-2.704	-0.95705	-0.24471	9.675	-3.857	-15.005		
0.7396	1.217	-1.07773	-0.2199	-1.155	1.528	-0.789		
-13.4615	12.808	-0.81157	-0.12269	-6.19	15.422	-28.883		
7.8217	4.088	-1.05799	-0.14744	-5.508	4.706	3.116		
-10.4484	-17.85	-1.0882	-0.12399	15.417	-20.337	9.889		
-1.985	5.248	-0.88743	-0.05904	-3.411	5.846	-7.831		
2.212	0.237	-2.41048	-0.35184	-0.398	0.253	1.959		
-3.1916	-6.868	-2.43389	-0.28616	2.542	-7.87	4.679		
21.2034	39.404	-2.43797	-0.22974	-14.691	44.037	-22.833		
-2.3011	-20.472	-2.18898	-0.13399	6.928	-22.401	20.1		
-10.7892	250.654	-1.83953	-0.03731	-90.433	265.997	-276.786		
2.9332	-10.925	-1.40269	0.057524	4.333	-11.146	14.08		
3.1111	-7.201	-0.95493	0.135571	3.455	-6.906	10.017		
3.9267	-19.159	-0.61635	0.176174	14.776	-16.439	20.365		
-8.0205	-16.348	-0.41261	0.181686	25.107	-11.675	3.655		
11.9778	0.306	-3.41991	-0.45611	-1.293	0.171	11.807		
-19.1669	9.702	-1.74963	-0.03083	-0.079	10.996	-30.163		
-0.7064	-22.424	-1.43539	0.038182	10.352	-22.819	22.113		
9.538	11.855	-1.34873	0.047878	-8.022	11.54	-2.002		

Source: Author's estimate.

Table A3.12: Holts Winter's Model Results of the SET Index (L, T, S = 0.5)

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
762.48	771.99	11.228	0.99336	777.09	-13.644	311.958	423.86	200.059
779.24	779.39	9.316	1.00691	790.57	-7.719	318.694	445.58	191.812
791.78	799.28	14.6	1.02261	801.25	21.474	386.503	529.93	243.077
780.35	796.65	5.987	0.96577	794.61	-33.637	474.681	635.73	313.631
682.62	803.27	6.305	0.8572	687.75	1.089	557.896	737.33	378.458
720.46	823.7	13.366	0.9046	726.12	25.334	485.811	684.19	287.434
738.89	833.47	11.566	0.8951	750.88	-6.46	431.973	649.69	214.252
678.53	881	29.55	0.83072	687.95	58.564	361.628	599	124.254
785.89	930.03	39.291	0.90138	812.24	34.755	361.041	618.3	103.777
824.35	1015.11	62.186	0.90636	859.18	81.174	352.3	629.64	74.96
835.81	1064.06	55.566	0.81825	887.01	-21.803	321.582	619.15	24.018
866.06	1108.65	50.078	0.80989	911.29	-17.867	370.837	688.75	52.928
934.14	1157.63	49.528	0.84219	976.33	-1.854	431.943	770.29	93.591
944.58	1178.14	35.022	0.80592	984.99	-47.345	420.951	779.83	62.075
866.11	1195.05	25.966	0.72958	891.86	-26.63	406.889	786.36	27.42
871.64	1189.97	10.444	0.71986	890.58	-45.287	373.396	773.52	-26.724
898.65	1146.9	-16.314	0.73757	906.54	-80.829	354.268	775.09	-66.551
808.48	1187.71	12.249	0.72188	796.98	80.54	331.97	773.53	-109.592
900.64	1212.01	18.273	0.76207	909.93	18.273	373.254	835.59	-89.087
1064.79	1163.32	-15.209	0.85324	1080.84	-117.661	346.359	829.51	-136.793
989.81	1144.92	-16.805	0.84967	976.87	-5.431	357.485	861.48	-146.506
1160.12	1186.25	12.264	1.03811	1143.09	117.819	357.456	882.31	-167.398
1335.6	1180.99	3.502	1.11755	1349.41	-39.458	356.77	902.51	-188.969
1626.59	1203.17	12.839	1.38799	1631.41	51.44	342.281	908.93	-224.363
1465.16	1221.2	15.438	1.22034	1480.79	12.657	339.414	926.98	-248.152
1361.27	1234.15	14.193	1.11357	1378.48	-5.551	342.359	950.86	-266.145
1206.17	1258.55	19.296	0.98129	1220.04	19.95	348.329	977.78	-281.126
1246.4	1278.43	19.588	0.99057	1265.51	1.159	322.592	973.01	-327.827
1295.12	1318.7	29.931	1.021	1314.96	41.911	295.342	966.74	-376.053
1224.12	1360.18	35.705	0.93221	1251.9	21.438	326.321	1018.7	-366.061
1387.46	1372.85	24.187	1.01149	1423.88	-46.996	314.22	1027.6	-399.157
1599.72	1352.81	2.074	1.1462	1627.9	-103.069	278.483	1012.86	-455.899
1574.91	1315.54	-17.6	1.14677	1577.32	-91.615	279.616	1035.01	-475.778
1562.99	1292.36	-20.389	1.18554	1542.08	-13.253	269.863	1046.28	-506.551
1410.7	1260.06	-26.345	1.08641	1388.45	-26.006	266.682	1064.12	-530.757
1357.06	1248.3	-19.054	1.08327	1328.68	31.407	228.882	1047.35	-589.59
1245.25	1224.98	-21.186	0.99583	1226.25	-8.506	230.153	1069.66	-609.358
1367.44	1179.01	-33.574	1.10457	1343.79	-55.317	228.786	1089.34	-631.769
1260.8	1141.6	-35.494	1.06757	1224.89	-8.213	207.192	1088.79	-674.411
1270.18	1096.22	-40.437	1.10761	1230.69	-21.997	226.749	1129.41	-675.907
1299.35	1115.22	-10.721	1.21688	1251.42	140.889	215.9	1139.61	-707.814
1313.18	1144.5	9.281	1.19809	1300.56	94.212	196.328	1141.1	-748.447
1301.68	1184.93	24.858	1.15229	1312.24	70.863	192.914	1158.75	-772.926
1303.92	1202.35	21.137	1.09701	1331.28	-16.377	195.565	1182.47	-791.344
1331.6	1196.05	7.417	1.09479	1355.01	-60.779	189.269	1197.25	-818.712
1358.39	1161.17	-13.727	1.11506	1366.82	-96.058	166.357	1195.41	-862.699
1263	1123.79	-25.554	1.07625	1248.07	-51.453	164.301	1214.44	-885.833

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1204.2	1146.77	-1.291	1.09422	1176.82	103.994	159.182	1230.4	-912.032
1345.95	1173.55	12.746	1.18773	1344.43	65.899	147.399	1239.7	-944.899
1305.55	1187.26	13.227	1.11293	1319.73	2.142	159.036	1272.42	-954.348
1179.37	1249.42	37.694	1.01281	1192.51	97.217			
1258.06	1285.42	36.849	1.00625	1296.01	-3.401			
1314.49	1302.58	27.006	1.01489	1352.18	-40.265			
1258	1310.44	17.429	0.95871	1284.08	-36.997			
1123.31	1284.58	-4.215	0.84276	1138.25	-74.21			
1162.03	1249.47	-19.661	0.89341	1158.21	-55.893			
1118.4	1228.81	-20.162	0.89474	1100.8	-1.791			
1020.8	1152.24	-48.367	0.81039	1004.05	-93.723			
1038.6	1065.58	-67.514	0.88518	995.01	-69.035			
965.79	957.77	-87.658	0.8873	904.6	-73.032			
783.69	916.6	-64.416	0.83899	711.97	76.073			
742.35	875.26	-52.876	0.82057	690.18	37.382			
737.14	830	-49.07	0.84605	692.61	12.823			
668.91	800.74	-39.167	0.81589	629.36	31.925			
584.2	768.95	-35.478	0.73308	555.63	10.764			
553.53	732.97	-35.726	0.71961	527.99	-0.712			
540.62	799.85	15.576	0.78487	514.27	151.353			
577.39	755.58	-14.349	0.69329	588.64	-86.408			
575.8	727.89	-21.016	0.75509	564.86	-20.324			
621.07	615.5	-66.703	0.78991	603.14	-155.928			
522.97	507.12	-87.543	0.81475	466.3	-70.826			
526.45	389.29	-102.685	0.99773	435.57	-62.877			
435.05	364.87	-63.552	1.23741	320.3	174.931			
506.44	341.01	-43.706	1.46877	418.23	110.186			
416.15	336.76	-23.979	1.29183	362.82	96.291			
375.01	341.44	-9.651	1.16031	348.31	63.824			
335.05	331.79	-9.649	0.9813	325.58	0.009			
328.67	321.67	-9.888	0.98984	319.11	-0.948			
328.42	286.51	-22.524	0.97597	318.32	-51.604			
267.09	247.06	-30.987	0.90028	246.09	-31.558			
249.9	233.5	-22.27	1.04925	218.55	35.267			
267.64	250.13	-2.82	1.23533	242.12	89.175			
286.84	281.85	14.448	1.21703	283.61	79.211			
334.14	298.21	15.405	1.18934	351.27	4.539			
323.98	323.87	20.533	1.10361	340.72	22.284			
350.84	329.57	13.115	1.05889	373.08	-32.143			
328.19	348.08	15.815	1.00355	341.25	10.756			
384.48	389.88	28.807	1.14137	401.95	57.399			
416.22	421.79	30.357	1.07149	446.98	6.622			
467.18	461.61	35.089	1.11897	500.81	20.965			
561.73	436.05	4.762	1.13225	604.43	-147.617			
522.43	404.14	-13.571	1.14374	528.13	-87.861			
465.69	364.29	-26.71	1.11073	450.05	-60.561			
399.63	349.08	-20.964	1.11507	370.33	25.217			
382.17	356.84	-6.599	1.13886	359.22	62.904			
397.9	391.22	13.889	1.17345	390.54	91.38			

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
421.05	424.42	23.546	1.10074	436	41.574			
464.41	395.03	-2.923	1.0209	490.17	-115.853			
469.19	364.58	-16.688	1.14288	465.71	-65.393			
405.75	349.34	-15.963	1.11524	387.18	3.225			
353.81	326.29	-19.507	1.00181	337.64	-14.355			
328.33	315.22	-15.285	1.01973	308.7	16.992			
319.92	290.22	-20.146	0.99789	304.4	-19.733			
278.23	295.58	-7.392	1.00008	258.92	48.911			
249.1	308.61	2.818	0.87064	242.87	34.417			
275.71	307.85	1.03	0.88822	278.23	-6.391			
275.44	309.75	1.465	0.89599	276.36	1.556			
251.02	321.69	6.705	0.82359	252.2	16.987			
284.76	352.17	18.589	0.91505	290.69	42.078			
312.48	368.63	17.527	0.88474	328.97	-3.769			
309.28	367.06	7.979	0.81717	323.98	-32.044			
301.2	370.7	5.811	0.81577	307.75	-7.116			
313.64	371.54	3.322	0.84039	318.55	-8.421			
303.13	385.1	8.442	0.82673	305.84	16.708			
282.31	399.81	11.577	0.73883	288.5	9.194			
287.71	438.85	25.31	0.74213	296.04	39.53			
344.44	408.57	-2.488	0.73147	364.31	-87.27			
283.26	401.44	-4.81	0.68928	281.53	-6.441			
303.12	398.7	-3.773	0.75705	299.49	3.134			

Source: Author's estimate.

Table A3.13: Holts Winter's Model Results of the SET Returns (L, T, S = 0.5)

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1.828	-0.8	-1.062	-1.356	-1.1	-0.79	2.62	-1.14	292.57
6.7304	-2.93	0.01	-0.142	342.52	-6.68	13.41	0.32	333.35
0.3768	0.01	0.091	-0.03	2.66	-0.16	0.53	6.93	383.38
-6.6064	-1.34	0.256	0.067	-20.26	-0.89	-5.71	15.67	438.38
-1.0917	1	0.022	-0.084	-23.4	1.26	-2.35	2.01	472.99
-2.2535	-0.06	0.371	0.133	-4.44	0.17	-2.43	-76.7	443.98
-5.7773	-2.3	0.717	0.24	-7.13	-3.13	-2.65	-40.27	531.19
-1.8246	8.26	0.399	-0.039	3.48	11.02	-12.85	-13.53	609.51
-2.019	-1.94	0.387	-0.026	-5.04	-1.75	-0.27	-29.07	646.18
-4.2033	-4.16	0.377	-0.018	-10.95	-3.88	-0.32	-24.8	703.14
3.9558	-0.07	-11.195	-5.795	-0.26	-0.06	4.02	745.46	1526.48
-3.2492	6.76	-5.803	-0.202	-0.02	10.25	-13.5	334.56	1168.98
-0.6292	22.29	-2.92	1.341	-1.81	23.07	-23.7	557.31	1445.39
0.9615	14.99	-0.884	1.689	-3.11	8.11	-7.15	-164.96	776.99
1.9457	-1.32	1.053	1.813	1.67	1.2	0.74	-536.58	459.42
-0.3384	2.77	1.369	1.064	1.19	7.54	-7.88	11.28	1061.48
0.5384	-5.72	1.152	0.424	-1.85	-10.16	10.7	8.87	1113.41
0.7217	15.38	0.815	0.043	7.12	21.04	-20.31	126.5	1285.47
2.4856	0.07	15.772	7.5	0.12	0.07	2.42	6.61	1220.13
5.7111	-15.91	8.806	0.267	-0.18	-23.48	29.19	83.26	1351.4
2.7044	102.36	4.653	-1.943	6.1	105.46	-102.76	672.89	1995.72
8.2443	72.36	1.62	-2.488	10.32	42.14	-33.9	-191.96	1185.64
3.5797	17.31	-0.266	-2.187	-1.38	-9.27	12.85	-401.99	1030.42
2.8338	1.72	-1.447	-1.684	-4.2	15.82	-12.99	130.35	1617.63
8.5706	2.45	-4.097	-2.167	-1.89	5.3	3.27	-27.78	1514.41
11.8928	44.03	-3.685	-0.878	-6.99	67.33	-55.43	2708.93	4306.09
16.0635	-8.24	1.311	2.059	7.25	-10.2	26.27	-4488.54	-2836.39
-0.0933	-0.17	2.039	1.394	-0.09	-0.44	0.35	-2409.91	-702.74
25.0551	-5.07	-3.326	-1.986	-5.01	-8.53	33.58	-217.13	1545.09
-5.4243	-39.33	-2.885	-0.772	6.85	-62.81	57.38	-261.44	1555.87
-0.478	-46.97	-1.843	0.135	8.27	-59.55	59.07	-61.85	1810.57
10.1658	-13.26	-0.148	0.915	-30.82	-12.29	22.46	-46.09	1881.46
0.5161	1.19	0.352	0.707	-3.31	-6.2	6.72	376.34	2359.04
-6.8834	-5.21	0.762	0.559	-11.93	-15.7	8.82	-11.85	2026.02
-3.3589	-0.65	2.637	1.217	-1.06	-1.12	-2.24	104.96	2198.02
2.9871	-13.57	1.637	0.108	-1.66	-19.83	22.82	1087.89	3236.15
1.1008	45.84	0.892	-0.318	14.62	48.88	-47.78	819.58	3023.06
-2.7968	0.19	-6.244	-3.727	0.33	0.12	-2.92	-195.3	2063.42
4.9782	-111.17	-4.846	-1.164	8.39	-177.53	182.51	533.55	2847.51
6.3595	-28.37	-2.462	0.61	1.64	-35.18	41.54	-1418.33	950.89
16.0063	-14.63	0.421	1.746	21.98	-11	27.01	-151.88	2272.61
-1.2639	-1.89	1.224	1.275	-2.76	-9.73	8.47	68.43	2548.2
7.2107	3.07	2.687	1.369	2.6	6.27	0.94	-15.56	2519.5
-7.2066	5.33	0.212	-0.553	-15.98	8.05	-15.26	-37.76	2552.6
-4.4249	1.59	-0.466	-0.615	8.5	-2.55	-1.87	54.5	2700.17
-5.069	2.17	0.002	-0.074	-1095.22	5.05	-10.12	-129.15	2571.83
-21.5106	-0.03	0.853	0.388	-18.66	0.86	-22.38	174.25	2930.56

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
4.3611	16.98	0.73	0.133	12.94	24.71	-20.35	71.94	2883.58
-4.5318	-13.09	0.558	-0.02	-13.03	-15.47	10.94	-244.02	2622.95
-0.2795	-4.31	0.287	-0.145	-4.35	-4.16	3.88	461.13	3383.45
-2.4163	-0.32	1.165	0.366	-1.59	-0.16	-2.26		
-0.9347	399.15	0.765	-0.017	170.65	524.68	-525.61		
-6.6225	2.04	-0.869	-0.825	5.14	1.99	-8.61		
-3.8729	17.61	-0.752	-0.354	-7.55	34.34	-38.21		
-2.0209	17.59	-0.51	-0.056	-9.72	25.87	-27.89		
-8.7815	2.26	0.707	0.58	-8.43	2.51	-11.29		
0.7789	-5.04	0.589	0.231	-2.9	-9.18	9.96		
0.2462	2.05	0.445	0.044	2.01	2.85	-2.6		
-6.4379	-2.24	0.883	0.241	-6.16	-2.47	-3.97		
-4.3516	-9.67	0.761	0.059	-8.33	-12.31	7.96		
2.9377	-0.2	-5.162	-2.932	-0.42	-0.22	3.15		
-0.9433	0.11	17.548	9.889	-0.04	0.18	-1.12		
-5.0624	-31.82	15.115	3.728	-1.07	-49.75	44.69		
-1.2457	-47.01	9.622	-0.883	-1.62	-58.6	57.35		
0.1429	16.08	4.412	-3.046	0.85	14.6	-14.46		
7.1633	5.26	3.689	-1.885	1.57	1.63	5.54		
-2.5422	-6.84	1.588	-1.993	-1.73	-3.35	0.8		
1.7572	11.3	-0.079	-1.83	-7.54	-2.88	4.64		
0.1339	-0.01	-0.393	-1.072	-0.11	-0.23	0.36		
-2.1802	0.07	5.316	2.318	-0.3	0.26	-2.44		
-2.1877	32.44	3.638	0.32	2.75	46.59	-48.77		
-3.8813	37.54	1.791	-0.763	4.08	40.85	-44.73		
-3.9936	-2.46	1.965	-0.295	-1.7	-1.41	-2.58		
-0.7142	-8.26	0.92	-0.67	-2.49	-7.02	6.31		
-6.4103	-1.74	1.819	0.115	-2.71	-0.47	-5.94		
0.4194	-12.71	0.937	-0.384	-3.27	-13.51	13.93		
-0.0761	6.79	0.271	-0.525	3.48	4.01	-4.08		
3.1025	-0.02	-17.616	-9.206	-0.13	0.02	3.08		
-1.6096	88.24	-13.25	-2.42	-2.44	134.35	-135.96		
0.1406	-90.8	-7.825	1.503	3.42	-107.38	107.53		
-0.573	-64.71	-3.196	3.066	4.22	-52.29	51.71		
-3.0413	98.51	-0.016	3.123	81.88	4	-7.05		
1.8377	0.05	1.276	2.207	-0.93	-10.28	12.12		
0.8922	-15.22	1.704	1.318	-5.7	-41.55	42.44		
0.7343	-1.81	1.165	0.389	-0.22	-3.21	3.94		
1.4434	-1.93	0.343	-0.217	1.28	-2.58	4.02		
13.7395	5.01	0.533	-0.013	20.2	1.84	11.9		
1.7178	0.18	2.854	1.154	0.47	0.17	1.55		
0.9853	23.95	2.063	0.181	4.43	33.63	-32.64		
-5.3571	3.37	-0.516	-1.199	6.01	3.67	-9.03		
2.1774	-11.33	-0.808	-0.745	9.64	-37.68	39.86		
1.8452	2.23	-1.111	-0.524	-2.21	4.29	-2.44		
-0.614	-2.88	-0.936	-0.175	1.63	-4.24	3.63		
4.916	14.95	-0.709	0.026	-11.45	17.74	-12.82		
4.4237	-6.03	-0.081	0.327	-22.98	-5.8	10.23		
0.5594	88.95	0.123	0.265	-545.33	-269.05	269.61		

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1.3241	-2.29	0.158	0.151	-5.15	-7.24	8.56		
5.8857	2.05	0.382	0.187	14.18	4	1.89		
-2.4772	-4.98	0.38	0.092	-9.78	-7.41	4.93		
-1.8761	-1.65	0.451	0.082	-4.25	-2.05	0.18		
-2.4517	-0.72	1.038	0.335	-1.97	-0.85	-1.6		
-1.666	177.2	0.682	-0.011	84.1	234.28	-235.95		
-1.3591	3.5	0.203	-0.245	-0.78	3.45	-4.81		
-0.5219	-1.53	0.014	-0.217	-22.91	0.32	-0.84		
-1.7876	-0.13	-0.01	-0.12	86.82	1.98	-3.76		
-1.002	0.08	-0.006	-0.058	85.26	1.1	-2.1		
2.009	0.02	-0.378	-0.215	-4.11	0.18	1.82		
-0.8246	-0.76	-0.501	-0.169	1.83	-1.19	0.37		
1.133	3.09	-0.427	-0.048	-4.41	4.13	-3		
-0.6783	3.56	-0.197	0.091	-2.44	3.96	-4.63		
0.4903	0.08	-0.641	-0.177	-0.59	0.04	0.45		
0	0.02	-0.409	0.028	-0.02	0.03	-0.03		
2.1956	0.44	-1.213	-0.388	-1.44	0.41	1.79		
5.2904	1.96	-2.433	-0.804	-1.9	2.59	2.7		
-0.6515	-2.07	-2.001	-0.186	0.59	-2.76	2.11		
-1.8728	-3.14	-1.691	0.062	1.34	-3.43	1.55		
-0.129	2.92	-0.777	0.488	-0.78	2.82	-2.94		
3.9643	5.87	-0.408	0.429	-8.64	2.18	1.78		
4.0714	0.05	-18.403	-8.783	-0.17	0	4.07		

Source: Author's estimate.

Table A3.14: Holts Winter's Model Results of the SET Index (L, T, S = 0.8)

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
762.48	767.88	5.895	0.99494	777.09	-13.644	325.969	434.16	217.78
775.1	775.21	7.039	1.00976	781.05	1.805	351.287	496.44	206.14
787.53	804.33	24.701	1.02148	794.68	28.035	421.931	606.81	237.06
785.28	789.34	-7.045	0.96651	809.4	-48.428	485.657	711.56	259.75
676.36	799.59	6.785	0.86057	670.32	18.516	559.118	826.77	291.47
717.15	831.53	26.915	0.90234	723.24	28.21	505.013	814.82	195.2
745.92	835.58	8.622	0.89213	770.06	-25.639	467.722	819.96	115.48
680.25	902.42	55.191	0.82461	687.27	59.239	409.202	804.06	14.35
804.99	951.13	50.011	0.89082	854.22	-7.221	424.095	861.7	-13.51
843.05	1048.95	88.258	0.89445	887.38	52.97	427.776	908.22	-52.66
863.67	1068.1	32.968	0.81271	936.34	-71.131	403.591	926.94	-119.76
869.35	1098.35	30.797	0.81352	896.18	-2.76	460.259	1026.58	-106.06
925.46	1151.05	48.319	0.8458	951.41	23.069	524.11	1133.44	-85.22
939.22	1159.18	16.166	0.81031	978.64	-40.993	517.564	1169.94	-134.81
852.17	1176.62	17.188	0.73531	864.06	1.173	521.648	1217.1	-173.8
858.19	1165.9	-5.136	0.72588	870.73	-25.441	496.254	1234.8	-242.29
880.48	1106.86	-48.262	0.74783	876.6	-50.887	483.521	1265.19	-298.14
780.26	1207.59	70.932	0.72232	746.23	131.285	461.939	1286.74	-362.86
915.71	1234.95	36.075	0.75295	969.5	-41.3	520.809	1388.76	-347.14
1084.94	1131.29	-75.716	0.85683	1116.64	-153.455	492.983	1404.09	-418.13
962.56	1124.5	-20.578	0.86128	898.14	73.304	522.401	1476.68	-431.88
1139.43	1216.29	69.323	1.032	1118.58	142.335	541.032	1538.49	-456.43
1369.43	1187.9	-8.852	1.10738	1447.48	-137.527	562.744	1603.39	-477.9
1636.1	1213.28	18.537	1.38508	1623.91	58.942	545.629	1629.47	-538.21
1477.48	1227.48	15.069	1.21689	1500.05	-6.599	539.109	1666.15	-587.93
1368.27	1233.84	8.098	1.11312	1385.07	-12.141	542.052	1712.3	-628.2
1205.86	1263.39	25.262	0.98065	1213.78	26.211	559.18	1772.64	-654.28
1251.2	1280.94	19.093	0.98916	1276.22	-9.546	533.38	1790.06	-723.3
1297.66	1331.52	44.279	1.01784	1317	39.867	512.2	1812.1	-787.7
1236.01	1372.54	41.675	0.92783	1277.12	-3.777	593.007	1936.13	-750.12
1400.06	1362.7	0.457	1.01234	1442.58	-65.696	569.548	1955.9	-816.8
1587.88	1319.5	-34.466	1.15754	1588.41	-63.584	505.173	1934.75	-924.41
1536.13	1277.96	-40.125	1.16289	1496	-10.294	515.092	1987.9	-957.72
1518.35	1276.99	-8.798	1.19539	1470.67	58.157	511.986	2028.03	-1004.06
1393.93	1252.16	-21.628	1.08877	1384.32	-21.884	515.487	2074.77	-1043.8
1348.55	1256.41	-0.926	1.08141	1325.25	34.838	446.804	2049.33	-1155.72
1253.35	1227.67	-23.176	0.99304	1252.42	-34.682	464.551	2110.32	-1181.21
1370.44	1164.29	-55.339	1.10859	1344.57	-56.098	475.908	2164.92	-1213.1
1245.05	1132	-36.9	1.07372	1185.87	30.809	436.386	2168.64	-1295.87
1259.5	1088.09	-42.508	1.1112	1218.44	-9.75	482.445	2257.94	-1293.05
1289.71	1148.83	40.095	1.20661	1239.33	152.984	471.408	2290.15	-1347.34
1352.77	1185.39	37.263	1.17681	1399.98	-5.211	443.835	2305.83	-1418.16
1348.19	1217.4	33.061	1.13636	1390.57	-7.467	445.574	2350.82	-1459.67
1339.65	1206.02	-2.492	1.09231	1376.03	-61.13	460.731	2409.23	-1487.77
1335.66	1175.59	-24.841	1.10223	1332.9	-38.674	454.553	2446.3	-1537.2
1335.16	1125.26	-45.234	1.13059	1306.95	-36.189	407.771	2442.77	-1627.23
1223.94	1096.12	-32.358	1.09089	1174.74	21.882	411.331	2489.59	-1666.93

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
1174.54	1168.99	51.822	1.09084	1139.87	140.942	411.653	2533.17	-1709.86
1372.02	1205.46	39.543	1.1707	1432.85	-22.517	398.022	2562.79	-1766.75
1341.05	1199.58	3.203	1.10405	1385.04	-63.169	436.102	2644.13	-1771.92
1193.5	1277.59	63.053	1.00659	1196.69	93.043			
1290.06	1292.22	24.312	1.00219	1353.73	-61.123			
1319.97	1290.77	3.703	1.0174	1344.8	-32.894			
1247.54	1291.13	1.029	0.96601	1251.12	-4.038			
1111.11	1247.58	-34.633	0.85442	1111.99	-47.953			
1125.74	1219.89	-29.077	0.90336	1094.49	7.834			
1088.3	1223.68	-2.785	0.89692	1062.36	36.649			
1009.06	1127.34	-77.629	0.81092	1006.76	-96.433			
1004.26	1041.51	-84.194	0.88942	935.11	-9.137			
931.57	935.22	-101.864	0.89022	856.27	-24.696			
760.07	942.39	-14.644	0.83152	677.28	110.758			
766.65	901.02	-36.024	0.80869	754.74	-27.176			
762.08	840.23	-55.834	0.84081	731.61	-26.18			
680.84	809.76	-35.544	0.81538	635.6	25.688			
595.42	771.06	-38.067	0.73471	569.29	-2.898			
559.7	727.72	-42.287	0.72483	532.07	-4.786			
544.21	849.14	88.68	0.77667	512.59	153.032			
613.35	743.8	-66.533	0.68464	677.41	-175.177			
560.04	714.02	-37.131	0.7607	509.95	34.591			
611.8	552.93	-136.303	0.81841	579.98	-132.771			
476.23	450.66	-109.078	0.87429	358.83	36.637			
465.08	357.22	-96.563	1.04104	352.51	20.181			
395.58	409.9	22.829	1.18801	288.65	206.582			
567.74	391.75	-9.952	1.3561	599.36	-70.944			
476.72	378.19	-12.844	1.21456	464.61	-5.5			
420.97	369.27	-9.705	1.11549	406.67	5.461			
362.12	337.52	-27.334	0.96784	352.6	-27.012			
333.86	319.36	-20.001	0.99483	306.83	11.333			
325.05	269.51	-43.88	0.9953	304.7	-37.977			
250.06	230.1	-40.303	0.93144	209.34	5.186			
232.94	238.54	-1.307	1.05371	192.14	61.683			
276.12	276.41	30.033	1.19035	274.61	56.683			
321.43	310.89	33.59	1.16621	356.36	6.464			
371.63	307.02	3.622	1.16622	411.79	-55.975			
334.27	328.85	18.191	1.10083	338.22	24.785			
355.62	321.63	-2.141	1.06432	375.29	-34.354			
319.39	347.48	20.253	1.00904	317.26	34.748			
385.21	405.03	50.094	1.129	407.66	51.689			
434.89	428.99	29.186	1.06064	488.68	-35.077			
476.69	467.28	36.469	1.11553	509.12	12.645			
563.82	403.62	-43.633	1.14674	607.83	-151.018			
474.99	371.29	-34.589	1.18398	423.64	16.63			
421.92	341.54	-30.718	1.13958	382.62	6.872			
373.07	351.86	2.112	1.11779	339.52	56.032			
387.84	377.17	20.667	1.11579	390.16	31.956			
426.42	420.57	38.855	1.14281	449.79	32.13			

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
458.8	442.11	25.002	1.08234	501.18	-23.613			
482.27	367.94	-54.334	1.03204	509.54	-135.222			
430.75	336.28	-36.195	1.18649	367.14	33.179			
371.27	342.9	-1.942	1.13162	331.31	59.089			
345.16	325.13	-14.605	0.99679	343.21	-19.916			
325.84	322.09	-5.357	1.00939	311.21	14.482			
327.69	287.19	-28.991	0.99647	322.24	-37.57			
277.43	306.57	9.707	0.99649	249.42	58.41			
261.94	322.88	14.993	0.85792	270.23	7.057			
291.68	308.31	-8.659	0.88604	305.23	-33.386			
276.53	307.82	-2.126	0.90168	268.76	9.156			
249.62	326.7	14.682	0.82135	247.89	21.297			
290.58	367.59	35.647	0.9021	303.63	29.136			
327.24	372.89	11.368	0.87573	358.97	-33.772			
310.06	357.73	-9.857	0.81918	319.52	-27.576			
289.29	366.97	5.425	0.81711	281.32	19.311			
308.55	369.56	3.152	0.83952	313.12	-2.986			
301.33	391.01	17.791	0.82301	303.9	18.651			
287.28	405.9	15.476	0.73366	300.35	-2.658			
294.21	454.65	42.09	0.73544	305.43	30.142			
353.11	384.71	-47.532	0.73143	385.8	-108.76			
263.39	388.88	-6.172	0.70284	230.85	44.244			
295.82	394.8	3.5	0.76536	291.12	11.496			

Source: Author's estimate.

Table A3.15: Holts Winter's Model Results of the SET Returns (*L, T, S* = 0.8)

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
7.0669	26	1.1403	-1.308	6.842	25.44	-18.37	82.6	311.6
2.5093	-2.54	-0.9336	-1.9207	-2.596	0.37	2.14	77.3	384.6
4.9675	-4.37	0.2781	0.5852	15.228	-13.36	18.33	70.3	461.6
-7.8022	0.87	-1.8151	-1.5575	4.067	2.71	-10.51	76	554.1
-9.9585	-42.61	-1.0139	0.3295	12.552	-79.17	69.21	-166.5	400
8.6996	6.64	-1.2	-0.083	-7.109	4.48	4.22	-164.8	491
-0.9399	0.78	0.8933	1.6581	-0.973	0.84	-1.78	-319.9	425.7
0.2804	12.6	0.5262	0.0379	3.247	35.99	-35.71	-3	832.8
12.6292	-12.14	-0.3249	-0.6733	-35.711	-13.02	25.65	-33.4	892.9
10.4551	-0.58	4.4881	3.7158	2.22	-1.78	12.24	77.6	1094.5
-8.328	71.31	1.2215	-1.8702	-2.277	130.35	-138.68	380	1487.7
3.2085	1.46	2.0161	0.2617	1.512	-0.78	3.98	391.8	1590.5
8.6847	-11.29	-0.7852	-2.1887	-9.968	-12.75	21.44	209.4	1499.2
-3.8527	-3.2	-1.3505	-0.89	3.098	-12.13	8.28	24.3	1405.2
-8.0381	-27.63	-0.7624	0.2925	12.527	-45.84	37.8	-60.5	1411.6
-2.3316	1.32	0.9832	1.455	-2.243	0.81	-3.15	-40.3	1523
-2.3436	-1.01	2.3205	1.3608	-1.013	-2.49	0.15	13.1	1667.6
6.0856	34.44	1.0643	-0.7328	7.542	54.64	-48.55	477.9	2223.7
5.6147	-16.09	-0.2308	-1.1827	-22.485	-5.01	10.63	-104.3	1732.9
3.6993	-2.34	0.009	-0.0447	330.544	-14.34	18.04	-52.4	1876.2
0.8539	0.1	0.0541	0.0271	14.857	-0.4	1.25	21.5	2041.4
26.0809	-1.05	-1.0637	-0.8888	-23.479	-1.57	27.65	173.1	2284.4
3.8155	33.38	-0.4878	0.283	-12.533	61.27	-57.45	-205.5	1997.3
25.05	14.85	-0.6992	-0.1126	-34.749	6.24	18.81	4192	6486.2
-11.94	-17.63	-0.5413	0.1039	22.69	-20.46	8.52	109.4	2495
-8.4142	-10.09	-0.4487	0.0948	18.728	-8.15	-0.26	198.8	2675.9
-10.1844	-14.72	-0.3191	0.1226	32.092	-11.61	1.43	-100.2	2468.3
2.1288	-0.06	8.4438	7.0349	0.242	-0.04	2.17	19927.3	22587.3
6.8789	89.35	3.6158	-2.4554	3.638	163.78	-156.9	2198.1	4949.6
-6.3537	99.02	0.0465	-3.3466	-103.897	31.78	-38.13	-374.2	2468.8
7.8177	-1.11	-0.921	-1.4433	-11.583	79.08	-71.26	-236.2	2698.3
10.2063	33.03	-0.7005	-0.1123	-18.829	84.8	-74.59	30.8	3056.8
-2.599	4.47	0.1636	0.6689	-13.981	5.18	-7.78	-594.4	2523.1
2.861	-0.14	-2.5105	-2.0055	-1.083	-0.71	3.57	-271	2938
-11.5226	-23.02	-1.9085	0.0805	6.664	-41.41	29.89	-2775.5	525
-0.1726	-12.02	-0.3875	1.2329	1.616	-11.51	11.34	500.2	3892.3
-11.0554	-2.93	-1.0017	-0.2448	10.34	6.39	-17.44	91	3574.6
5.6459	31.54	-0.3927	0.4382	-17.799	39.25	-33.61	-151.3	3423.8
-5.733	-2.66	-0.668	-0.1326	8.22	0.31	-6.04	412.2	4078.9
-0.6589	8.73	-0.1198	0.4121	1.787	10.46	-11.12	-89.5	3668.7
14.1427	0.08	-17.1177	-13.5159	-0.793	-0.19	14.34	376.7	4226.5
0.1765	-58.89	-6.0857	6.1224	0.665	-105.4	105.57	-88.5	3852.8
-0.8402	-77.99	-0.0451	6.057	17.469	0.47	-1.31	-33.3	3999.6
-5.0567	-0.15	0.0057	1.252	-710.092	20.32	-25.38	-114.8	4009.6
-1.5845	-0.03	0.5136	0.6567	-3.436	-6.08	4.5	-1010.9	3205
-1.8301	-5.76	0.3646	0.0122	-6.258	-13.12	11.29	170.5	4478
-6.0114	2.45	-0.6413	-0.8023	8.841	2.53	-8.54	96.2	4495.2

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
6.7992	-11.1	0.0256	0.3731	215.801	-24.98	31.78	-36.9	4453.7
9.6331	-0.41	-0.4043	-0.2693	-22.244	-6.35	15.98	805.2	5387.4
-6.4776	-3.53	-0.7277	-0.3126	8.869	-5.89	-0.59	-594.1	4079.6
-2.4615	-4.98	-0.4959	0.123	5.34	-7.12	4.66		
0.2231	1.29	-0.1433	0.3066	-1.764	0.97	-0.75		
1.4821	-2.18	0.1105	0.2644	13.773	2.49	-1.01		
-5.0679	0.45	-0.922	-0.7731	5.211	1.52	-6.59		
-15.8732	-11.57	-1.3507	-0.4976	11.912	-21.28	5.4		
3.5344	9.6	-0.7674	0.3671	-5.106	13.14	-9.6		
-0.3007	0.75	0.1673	0.8212	-1.632	0.39	-0.69		
-18.8358	0.54	-4.4426	-3.5237	4.041	3.21	-22.05		
1.7035	158.65	-1.6314	1.5442	-7.977	284.49	-282.78		
-10.7526	-3.62	-3.8915	-1.4992	2.655	-0.19	-10.56		
-5.3767	8.86	0.8112	3.4623	-5.758	12.27	-17.65		
-7.9852	1.23	-3.3692	-2.6519	2.199	6.46	-14.45		
-3.0889	33.59	-0.9563	1.4	0.59	60.02	-63.11		
-6.4615	-2.96	-1.5798	-0.2188	3.892	1.37	-7.84		
-15.491	-19.79	-1.3491	0.1409	11.692	-22.53	7.04		
-7.1551	3.03	2.3099	2.9554	-2.927	2.71	-9.87		
23.2987	-2.34	-17.3552	-15.141	-1.276	-5.33	28.63		
-28.1661	-130.9	-9.4867	3.2666	3.884	-245.1	216.93		
8.0883	213.31	-1.5318	7.0172	-8.721	139.86	-131.77		
-19.6913	-506.33	1.0494	3.4684	51.098	1813.18	-1832.87		
-12.2953	15.59	0.2415	0.0474	-37.753	67.12	-79.42		
-5.9328	-5.67	0.2599	0.0242	-22.956	-6.78	0.85		
28.4275	-3.26	-1.7577	-1.6092	-15.445	-3.56	31.99		
6.4869	61.08	-0.8227	0.4261	-13.258	117	-110.51		
-14.0602	-18.67	-0.5751	0.2834	24.098	-9	-5.06		
-10.7951	-10.77	-0.5195	0.1012	20.371	-5.46	-5.33		
-23.57	-16.67	-0.6712	-0.1012	34.511	-13.42	-10.15		
-2.3085	-0.16	-7.7907	-5.7158	0.285	-0.19	-2.12		
-17.6355	-28.34	-6.5792	-0.1739	2.872	-49.14	31.5		
-21.775	683.55	-1.183	4.2822	-6.053	701.62	-723.4		
16.8176	13.7	-0.5417	1.3695	-27.155	-35.9	52.72		
26.6369	10.2	-0.9662	-0.0657	-25.821	-15.59	42.22		
9.0913	13.51	-0.7266	0.1785	-12.806	14.43	-5.34		
-1.951	0.79	1.332	1.6826	-1.388	0.59	-2.54		
2.0006	8.88	0.8431	-0.0546	3.231	20.09	-18.09		
-6.2696	1.36	-2.9466	-3.0427	2.025	1.27	-7.54		
3.1953	-30.47	-0.9506	0.9882	-0.621	-61.93	65.13		
26.6153	16.92	-1.1887	0.0072	-21.472	-0.67	27.28		
-1.2597	-9.77	-0.3589	0.6653	4.452	-9.71	8.45		
14.0011	-0.64	6.3292	5.4836	2.127	0.55	13.45		
-13.2959	-5.02	15.7809	8.658	-0.833	-9.36	-3.93		
-3.6879	10.49	0.4505	-10.5327	-6.417	16.25	-19.94		
-12.255	7.87	-2.5777	-4.5291	7.297	-176.12	163.87		
1.5439	1830.4	-1.4231	0.0179	-142.886	5046.44	-5044.9		
6.5012	4.89	-1.7949	-0.2939	-3.585	4.83	1.67		
13.2488	11.23	-2.1114	-0.3119	-6.272	13.07	0.18		

Smoothing	L	T	S	Fitted	Residual	Forecast	Upper Limit	Lower Limit
-0.9067	-18.67	-0.5667	1.1733	3.048	-21.42	20.52		
-24.36	-122.3	0.031	0.7129	-585.07	130.91	-155.27		
430.75	336.28	-36.195	1.18649	367.14	33.179			
371.27	342.9	-1.942	1.13162	331.31	59.089			
345.16	325.13	-14.605	0.99679	343.21	-19.916			
325.84	322.09	-5.357	1.00939	311.21	14.482			
327.69	287.19	-28.991	0.99647	322.24	-37.57			
277.43	306.57	9.707	0.99649	249.42	58.41			
261.94	322.88	14.993	0.85792	270.23	7.057			
291.68	308.31	-8.659	0.88604	305.23	-33.386			
276.53	307.82	-2.126	0.90168	268.76	9.156			
249.62	326.7	14.682	0.82135	247.89	21.297			
290.58	367.59	35.647	0.9021	303.63	29.136			
327.24	372.89	11.368	0.87573	358.97	-33.772			
310.06	357.73	-9.857	0.81918	319.52	-27.576			
289.29	366.97	5.425	0.81711	281.32	19.311			
308.55	369.56	3.152	0.83952	313.12	-2.986			
301.33	391.01	17.791	0.82301	303.9	18.651			
287.28	405.9	15.476	0.73366	300.35	-2.658			
294.21	454.65	42.09	0.73544	305.43	30.142			
353.11	384.71	-47.532	0.73143	385.8	-108.76			
263.39	388.88	-6.172	0.70284	230.85	44.244			
295.82	394.8	3.5	0.76536	291.12	11.496			

Source: Author's estimate.

Appendix 4

Figure A4.1: Time Series Plot for ARIMA Model on the SET Index, 1992-2001

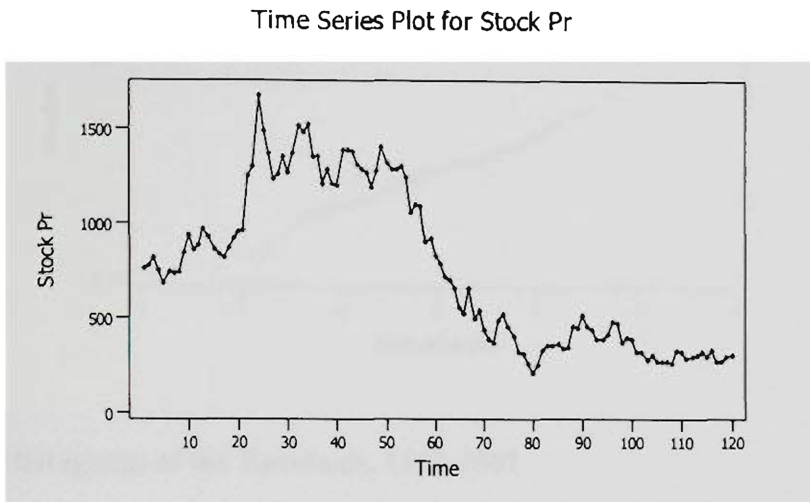


Figure A4.2: Correlogram of Autocorrelation Function, 1992-2001

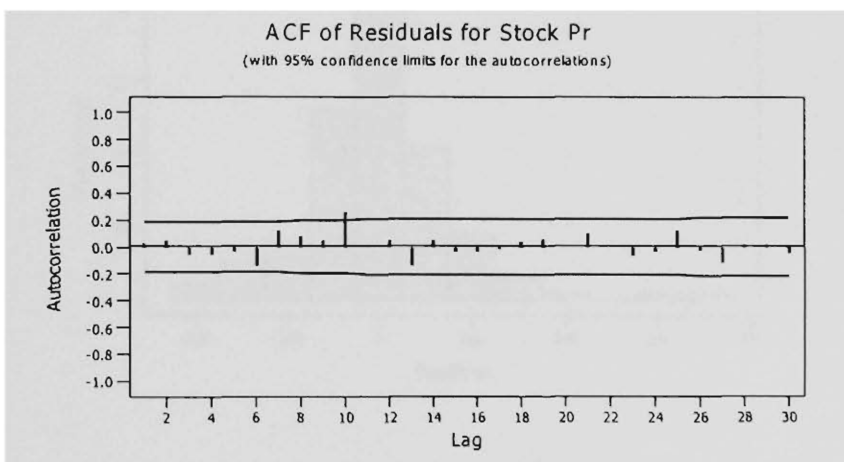


Figure A4.3: Correlogram of Partial Autocorrelation Function, 1992-2001

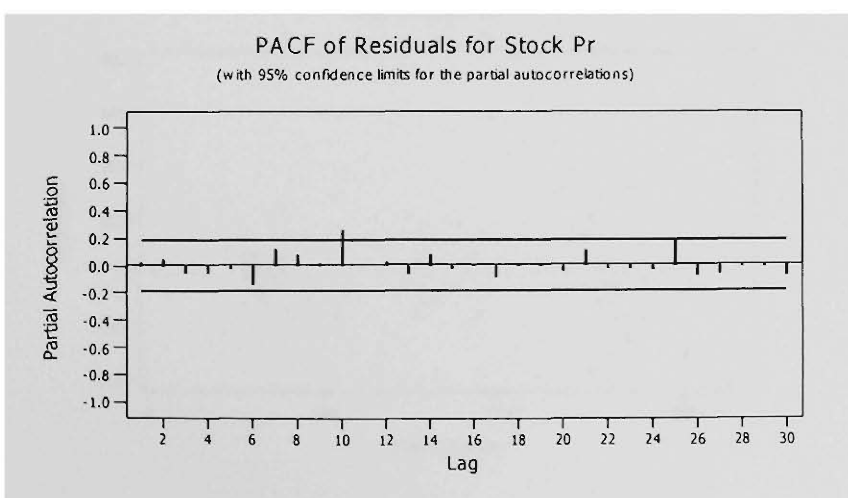


Figure A4.4: Normal Probability Plot of the Residuals, 1992-2001

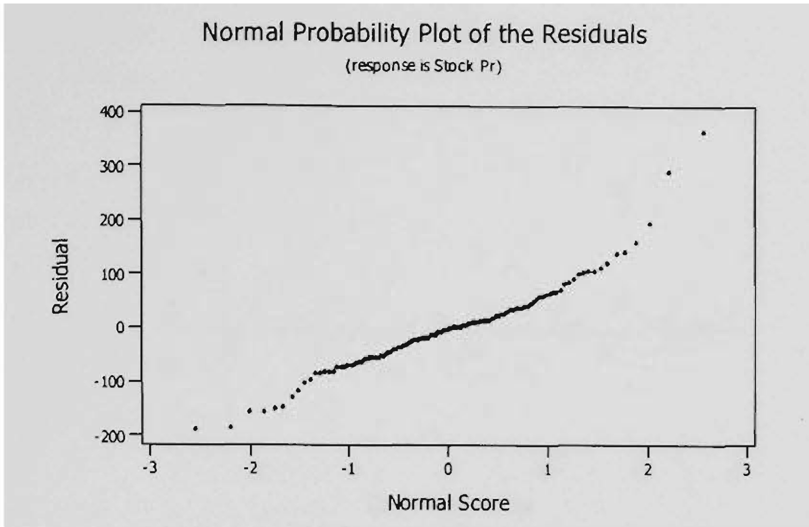


Figure A4.5: Histogram of the Residuals, 1992-2001

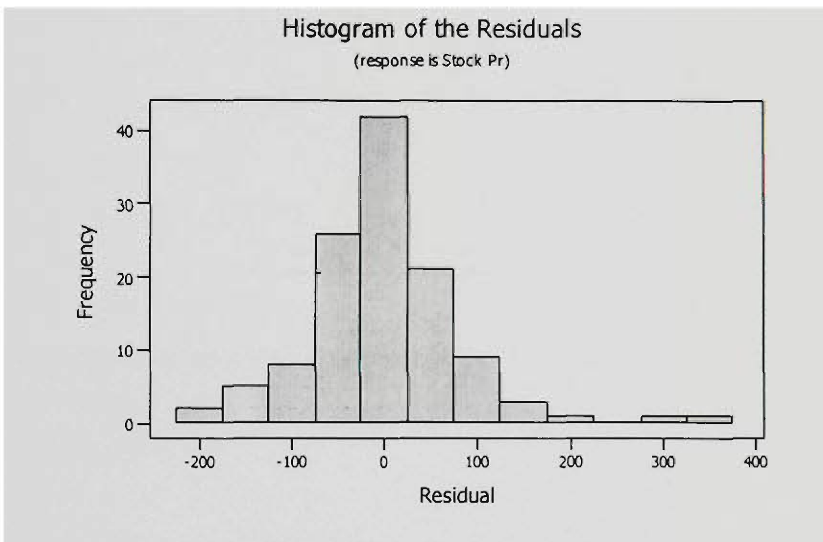


Figure A4.6: Residual Versus the Fitted Values, 1992-2001

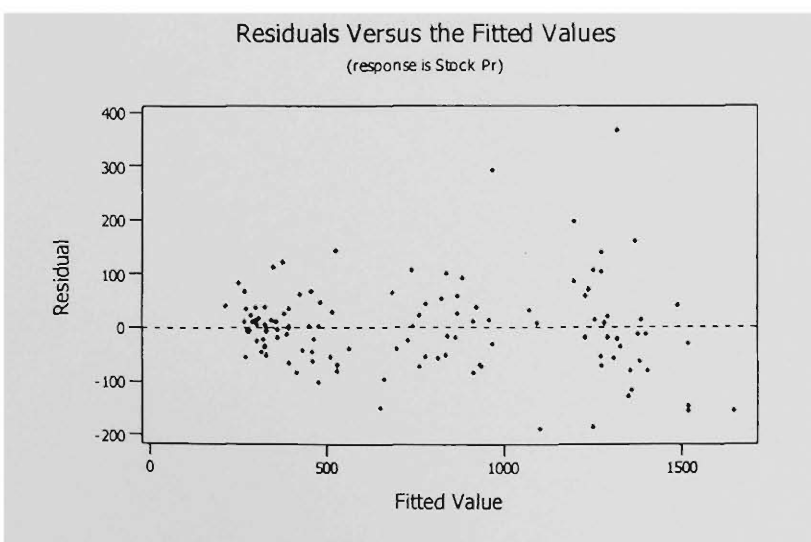
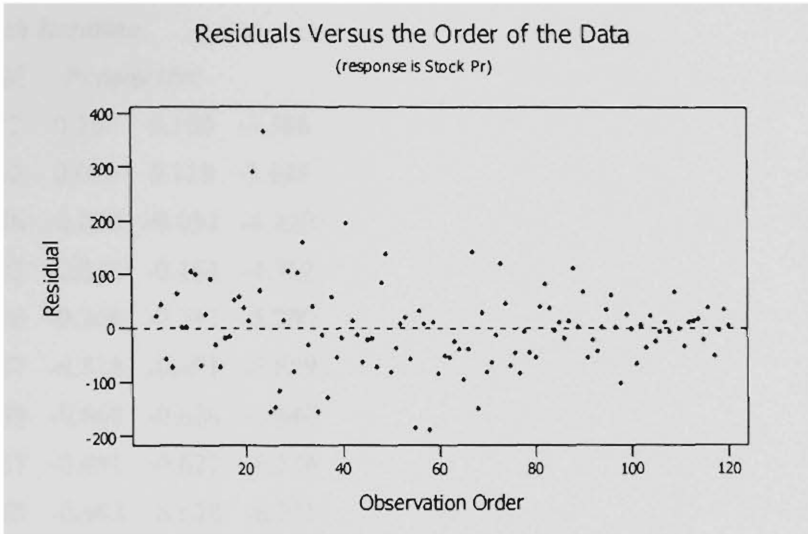


Figure A4.7: Residual Versus the Order of the Data, 1992-2001



Source: Author's estimate.

Table A4.1: ARIMA Results, 1992 – 2001

Estimates at each Iteration

Iteration	*SSE*	*Parameters*		
0	807012	0.100	0.100	-3.386
1	805962	0.082	0.118	-3.545
2	805256	-0.068	-0.032	-4.123
3	804382	-0.218	-0.181	-4.702
4	803416	-0.368	-0.331	-5.280
5	802487	-0.518	-0.481	-5.859
6	801489	-0.668	-0.626	-6.440
7	800657	-0.691	-0.627	-6.534
8	800655	-0.692	-0.628	-6.541
9	800655	-0.692	-0.628	-6.542

Relative change in each estimate less than 0.0010

Final Estimates of Parameters

Type	*Coef*	*StDev*	*T*
AR 1	-0.6925	0.6093	-1.14
MA 1	-0.6282	0.6564	-0.96
Constant	6.54	12.40	-0.53

Differencing: 1 regular difference

Number of observations: Original series 120, after differencing 119

Residuals: SS = 800655 (backforecasts excluded)

MS = 6902 DF = 116

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	16.1(DF=10)	22.5(DF=22)	36.5(DF=34)	51.0(DF=46)

Source: Author's estimate.

Table A4.2: Autoregressive Series, AR(1), 1992-2001

Period	Index Price	Residual	Fit
Jan-92	763.45	-	-
Feb-92	782.85	23.264	759.59
Mar-92	822.72	45.232	777.49
Apr-92	760.97	-56.014	816.98
May-92	688.84	-73.161	762
Jun-92	751.45	65.163	686.29
Jul-92	744.42	1.933	742.49
Aug-92	746.51	2.55	743.96
Sep-92	847.00	106.877	740.12
Oct-92	940.35	102.339	838.01
Nov-92	865.21	-68.244	933.45
Dec-92	893.42	25.59	867.83
Jan-93	974.48	91.061	883.42
Feb-93	937.65	-31.36	969.01
Mar-93	865.23	-71.682	936.91
Apr-93	845.29	-18.517	863.81
May-93	825.71	-15.214	840.92
Jun-93	877.52	54.35	823.17
Jul-93	928.20	58.956	869.24
Aug-93	963.18	39.58	923.6
Sep-93	971.44	14.16	957.28
Oct-93	1260.91	292.836	968.07
Nov-93	1309.95	72.075	1237.88
Dec-93	1682.85	368.124	1314.73
Jan-94	1493.45	-155.89	1649.34
Feb-94	1372.93	-147.21	1520.14
Mar-94	1239.99	-117.38	1357.37
Apr-94	1266.67	14.903	1251.77
May-94	1356.87	105.855	1251.02
Jun-94	1273.34	-81.024	1354.36
Jul-94	1376.88	103.138	1273.74
Aug-94	1524.83	161.4	1363.43
Sep-94	1485.71	-31.517	1517.23
Oct-94	1528.83	42.371	1486.46
Nov-94	1362.44	-156.61	1519.05
Dec-94	1360.09	-12.65	1372.74
Jan-95	1217.74	-129.49	1347.23
Feb-95	1288.47	60.042	1228.43
Mar-95	1216.68	-53.988	1270.67
Apr-95	1208.69	-17.246	1225.94
May-95	1392.31	195.463	1196.85
Jun-95	1394.77	13.366	1381.4
Jul-95	1383.10	-11.821	1394.92
Aug-95	1314.90	-62.314	1377.21
Sep-95	1294.23	-22.21	1316.44
Oct-95	1270.76	-17.29	1288.05
Nov-95	1196.62	-72.99	1269.61
Dec-95	1280.81	85.243	1195.57
Jan-96	1410.33	140.812	1269.52
Feb-96	1321.87	-80.686	1402.56
Mar-96	1289.73	-36.168	1325.9
Apr-96	1292.61	9.886	1282.72
May-96	1311.91	21.626	1290.28
Jun-96	1247.08	-58.509	1305.59
Jul-96	1064.04	-184.64	1248.68
Aug-96	1102.32	34.059	1068.26
Sep-96	1099.01	8.344	1090.67
Oct-96	910.33	-189.67	1100
Nov-96	925.97	10.676	915.29
Dec-96	831.57	-83.735	915.3
Jan-97	788.04	-49.756	837.8
Feb-97	727.56	-52.825	780.39
Mar-97	705.43	-24.285	729.71
Apr-97	661.29	-37.667	698.96
May-97	566.39	-95.262	661.65
Jun-97	527.28	-38.441	565.72
Jul-97	665.62	141.948	523.67
Aug-97	502.23	-150.22	652.45
Sep-97	544.54	30.077	514.46
Oct-97	447.21	-80.384	527.59
Nov-97	395.47	-62.1	457.57
Dec-97	372.69	-13.056	385.75
Jan-98	495.23	121.509	373.72
Feb-98	528.42	48.256	480.16
Mar-98	459.11	-70.099	529.21
Apr-98	412.13	-44.398	456.53

Period	Index Price	Residual	Fit
May-98	325.59	-84.64	410.23
Jun-98	318.16	-7.645	325.8
Jul-98	266.72	-45.241	311.96
Aug-98	214.53	-52.849	267.38
Sep-98	253.82	42.891	210.93
Oct-98	331.29	84.275	247.01
Nov-98	362.82	38.777	324.04
Dec-98	355.81	-2.994	358.8
Jan-99	363.00	10.758	352.24
Feb-99	340.94	-17.298	358.24
Mar-99	352.01	13.202	338.81
Apr-99	459.35	113.254	346.1
May-99	453.60	3.977	449.62
Jun-99	521.77	68.232	453.54
Jul-99	456.81	-54.075	510.89
Aug-99	440.27	-21.012	461.28
Sep-99	389.49	-42.492	431.98
Oct-99	395.55	4.131	391.42
Nov-99	422.12	34.713	387.41
Dec-99	481.92	62.934	418.99
Jan-00	477.57	4.067	473.5
Feb-00	374.32	-102.28	476.6

Period	Index Price	Residual	Fit
Mar-00	400.32	25.292	375.03
Apr-00	390.40	-1.262	391.66
May-00	323.29	-66.645	389.93
Jun-00	325.69	4.335	321.35
Jul-00	284.67	-35.54	320.21
Aug-00	307.83	23.622	284.21
Sep-00	277.29	-22.8	300.09
Oct-00	271.84	-5.734	277.57
Nov-00	277.92	12.45	265.47
Dec-00	269.19	-5.799	274.99
Jan-01	332.77	67.719	265.05
Feb-01	325.20	0.459	324.74
Mar-01	291.94	-32.248	324.19
Apr-01	300.63	12.458	288.17
May-01	310.13	14.233	295.9
Jun-01	322.55	16.599	305.95
Jul-01	297.69	-20.145	317.84
Aug-01	335.57	39.862	295.71
Sep-01	277.04	-50.798	327.84
Oct-01	275.09	-4.028	279.12
Nov-01	302.62	35.251	267.37
Dec-01	303.85	4.691	299.16

Source: Author's estimate.

Appendix 5

Table A5.1: ACF and PACF Test Results of Monthly Return at 100 Lags, 1992-2001

Lag	ACF	PACF	Q-Stat
1	0.0914	0.0914	2.6890
2	0.0944	0.0868	5.5700
3	-0.0125	-0.0288	5.6210
4	-0.0756	-0.0817	7.4780
5	-0.0266	-0.0098	7.7080
6	-0.0404	-0.0232	8.2410
7	0.1205	0.1297	13.0040
8	0.0256	0.0043	13.2190
9	0.1047	0.0771	16.8380
10	0.1061	0.0889	20.5690
11	-0.0109	-0.0274	20.6090
12	0.0653	0.0618	22.0310
13	-0.0651	-0.0506	23.4510
14	0.0949	0.1021	26.4740
15	-0.0436	-0.0472	27.1150
16	-0.0297	-0.0498	27.4130
17	-0.0475	-0.0663	28.1770
18	-0.0435	-0.0201	28.8190
19	0.0196	-0.0016	28.9510
20	-0.0322	-0.0271	29.3050
21	0.1320	0.1027	35.2880
22	0.0230	0.0039	35.4710
23	0.0330	0.0178	35.8470
24	-0.0391	-0.0590	36.3760
25	-0.0041	0.0558	36.3820
26	0.0179	0.0293	36.4940
27	-0.0378	0.0013	36.9940
28	0.0124	-0.0274	37.0480
29	-0.0606	-0.0563	38.3430
30	-0.0215	-0.0262	38.5070
31	-0.0013	-0.0059	38.5080
32	0.0250	0.0337	38.7310
33	0.0914	0.0576	41.7240
34	0.0012	0.0042	41.7250
35	0.0706	0.0182	43.5220
36	-0.0925	-0.0843	46.6150
37	-0.0215	0.0054	46.7830
38	-0.0748	-0.0233	48.8210
39	-0.0830	-0.0500	51.3410
40	0.0427	0.0353	52.0090
41	0.0381	0.0475	52.5430
42	0.0355	-0.0361	53.0110
43	0.1191	0.1245	58.2730
44	-0.1140	-0.1658	63.1150

Lag	ACF	PACF	Q-Stat
45	0.0128	0.0576	63.1760
46	-0.0595	-0.0163	64.5030
47	0.0008	-0.0069	64.5030
48	-0.0740	-0.0611	66.5690
49	-0.0079	-0.0055	66.5930
50	0.0593	0.0744	67.9300
51	0.0000	0.0128	67.9300
52	0.0350	0.0022	68.4000
53	0.0317	0.0304	68.7860
54	0.0404	0.0454	69.4160
55	-0.0170	-0.0558	69.5270
56	-0.0420	-0.0196	70.2140
57	-0.0082	-0.0179	70.2400
58	-0.0307	0.0386	70.6110
59	0.0238	0.0131	70.8340
60	0.0513	0.0470	71.8760
61	0.0362	0.0049	72.3960
62	-0.0860	-0.1299	75.3390
63	0.0238	0.0662	75.5650
64	0.0313	-0.0061	75.9600
65	0.0210	0.0730	76.1370
66	0.0945	0.0613	79.7520
67	-0.0260	-0.0478	80.0270
68	0.0414	-0.0055	80.7260
69	-0.0728	-0.0357	82.8990
70	-0.0013	0.0392	82.8990
71	0.0125	0.0467	82.9640
72	-0.0358	-0.0377	83.4950
73	0.0795	0.0298	86.1260
74	-0.0533	-0.0817	87.3120
75	0.0795	0.0035	89.9620
76	0.0258	0.0654	90.2440
77	-0.0041	0.0041	90.2510
78	0.0283	0.0127	90.5910
79	-0.0861	-0.0344	93.7560
80	0.0164	-0.0560	93.8720
81	-0.0056	0.0886	93.8860
82	-0.0308	-0.0964	94.2960
83	-0.0020	0.0468	94.2980
84	0.0270	0.0337	94.6160
85	0.0194	-0.0429	94.7800
86	-0.0079	-0.0262	94.8080
87	0.0322	0.0046	95.2660
88	-0.1019	-0.1083	99.8680

Lag	ACF	PACF	Q-Stat
89	-0.1601	-0.1032	111.2770
90	-0.0450	0.0062	112.1800
91	-0.0181	0.0259	112.3270
92	0.0276	0.0038	112.6710
93	0.0254	-0.0212	112.9640
94	0.0107	-0.0017	113.0150

Lag	ACF	PACF	Q-Stat
95	-0.0253	-0.0144	113.3080
96	-0.0514	-0.0089	114.5210
97	-0.0852	-0.0508	117.8720
98	-0.0847	-0.0590	121.1940
99	-0.0593	-0.0047	122.8320
100	-0.0089	-0.0237	122.8690

Source: Author's estimate.

Table A5.2: ACF and PACF Test Results of Daily Return at 100 Lags, the Pre-Crisis Period (1992-1996)

Lag	ACF	PACF	Q-Stat
1	0.1179	0.1179	17.0830
2	-0.0005	-0.0146	17.0830
3	0.0697	0.0725	23.0640
4	0.0109	-0.0062	23.2100
5	-0.0019	-0.0009	23.2150
6	-0.0559	-0.0616	27.0760
7	-0.0260	-0.0126	27.9090
8	0.0221	0.0257	28.5110
9	0.0067	0.0090	28.5660
10	-0.0020	0.0000	28.5710
11	-0.0112	-0.0145	28.7280
12	0.0224	0.0214	29.3520
13	0.0781	0.0719	36.9180
14	0.0158	0.0030	37.2280
15	-0.0108	-0.0125	37.3720
16	-0.0089	-0.0180	37.4710
17	0.0038	0.0031	37.4890
18	0.0264	0.0296	38.3590
19	0.0001	0.0057	38.3590
20	-0.0141	-0.0117	38.6050
21	-0.0090	-0.0156	38.7060
22	0.0400	0.0398	40.7060
23	0.0106	0.0044	40.8470
24	-0.0219	-0.0156	41.4490
25	-0.0366	-0.0406	43.1260
26	0.0023	0.0005	43.1320
27	-0.0204	-0.0228	43.6560
28	-0.0049	0.0137	43.6860
29	0.0311	0.0365	44.8990
30	-0.0257	-0.0367	45.7310
31	0.0182	0.0155	46.1470
32	0.0167	0.0063	46.4990
33	0.0567	0.0656	50.5500
34	0.0450	0.0313	53.1040
35	0.0121	0.0001	53.2900
36	-0.0248	-0.0427	54.0700
37	0.0502	0.0580	57.2640
38	0.0118	0.0094	57.4410
39	0.0293	0.0442	58.5310
40	0.0190	0.0074	58.9900
41	0.0252	0.0159	59.7950
42	0.0431	0.0266	62.1580
43	0.0040	0.0073	62.1780
44	-0.0168	-0.0169	62.5370
45	-0.0174	-0.0227	62.9240

Lag	ACF	PACF	Q-Stat
46	-0.0108	-0.0182	63.0740
47	-0.0450	-0.0463	65.6630
48	-0.0626	-0.0429	70.6740
49	-0.0174	0.0025	71.0620
50	0.0464	0.0448	73.8150
51	0.0253	0.0079	74.6360
52	-0.0225	-0.0329	75.2860
53	-0.0312	-0.0369	76.5330
54	-0.0062	-0.0070	76.5820
55	0.0145	0.0068	76.8550
56	0.0026	0.0108	76.8630
57	-0.0046	0.0006	76.8900
58	0.0009	0.0073	76.8910
59	0.0137	0.0116	77.1340
60	0.0349	0.0411	78.7030
61	0.0577	0.0656	83.0090
62	-0.0171	-0.0311	83.3860
63	0.0142	0.0052	83.6460
64	0.0461	0.0327	86.4000
65	-0.0845	-0.0825	95.6700
66	-0.0754	-0.0516	103.0500
67	0.0052	0.0244	103.0860
68	-0.0108	-0.0196	103.2390
69	-0.0305	-0.0197	104.4490
70	0.0144	0.0258	104.7190
71	0.0072	-0.0069	104.7870
72	0.0301	0.0061	105.9690
73	0.0518	0.0316	109.4790
74	0.0146	-0.0083	109.7550
75	0.0390	0.0394	111.7420
76	0.0064	-0.0113	111.7960
77	0.0347	0.0356	113.3740
78	-0.0161	-0.0187	113.7130
79	-0.0021	0.0152	113.7190
80	-0.0354	-0.0367	115.3670
81	-0.0897	-0.0716	125.9450
82	-0.0140	0.0071	126.2050
83	-0.0257	-0.0322	127.0720
84	-0.0105	0.0090	127.2160
85	0.0008	0.0067	127.2170
86	-0.0224	-0.0179	127.8770
87	0.0071	0.0114	127.9430
88	-0.0181	-0.0142	128.3750
89	-0.0144	-0.0112	128.6490
90	0.0172	0.0077	129.0400

Lag	ACF	PACF	Q-Stat
91	0.0224	0.0315	129.7060
92	0.0098	-0.0111	129.8330
93	0.0354	0.0307	131.5020
94	-0.0357	-0.0392	133.1980
95	-0.0344	-0.0375	134.7700

Lag	ACF	PACF	Q-Stat
96	0.0004	0.0037	134.7700
97	0.0163	0.0296	135.1250
98	-0.0280	-0.0225	136.1700
99	-0.0037	0.0186	136.1880
100	-0.0056	-0.0155	136.2290

Source: Author's estimate.

Table A5.3: ACF and PACF Test Results of Daily Return at 100 Lags, The Post-Crisis Period (1997-2001)

Lag	ACF	PACF	Q-Stat	Lag	ACF	PACF	Q-Stat
1	0.1430	0.1430	25.1740	47	-0.0153	-0.0105	97.0440
2	0.0426	0.0226	27.4080	48	-0.0412	-0.0322	99.2170
3	0.0049	-0.0043	27.4380	49	0.0046	0.0159	99.2440
4	0.0071	0.0062	27.5010	50	0.0339	0.0410	100.7190
5	0.0054	0.0037	27.5370	51	0.0319	0.0187	102.0220
6	-0.0196	-0.0217	28.0120	52	0.0043	-0.0071	102.0460
7	-0.0008	0.0047	28.0130	53	0.0370	0.0336	103.8020
8	0.0391	0.0408	29.9080	54	-0.0462	-0.0544	106.5470
9	0.0379	0.0272	31.6910	55	-0.0102	0.0129	106.6810
10	0.0727	0.0628	38.2520	56	-0.0062	-0.0127	106.7310
11	0.0581	0.0389	42.4360	57	0.0234	0.0180	107.4350
12	0.0500	0.0328	45.5410	58	0.0427	0.0350	109.7870
13	0.0508	0.0373	48.7480	59	-0.0311	-0.0416	111.0340
14	-0.0063	-0.0202	48.7980	60	0.0110	-0.0003	111.1910
15	-0.0408	-0.0408	50.8680	61	-0.0019	-0.0098	111.1960
16	-0.0068	0.0056	50.9260	62	-0.0268	-0.0236	112.1250
17	0.0022	0.0038	50.9320	63	0.0275	0.0441	113.1040
18	-0.0005	-0.0059	50.9320	64	-0.0459	-0.0539	115.8400
19	-0.0195	-0.0238	51.4060	65	-0.0368	-0.0321	117.6010
20	0.0294	0.0271	52.4880	66	-0.0423	-0.0315	119.9260
21	-0.0082	-0.0280	52.5720	67	-0.0052	0.0190	119.9620
22	-0.0262	-0.0329	53.4290	68	0.0108	0.0183	120.1130
23	0.0094	0.0140	53.5400	69	0.0284	0.0098	121.1630
24	0.0088	0.0058	53.6360	70	-0.0172	-0.0406	121.5490
25	-0.0426	-0.0457	55.9190	71	-0.0406	-0.0392	123.6980
26	-0.0707	-0.0573	62.2030	72	-0.0028	0.0284	123.7090
27	0.0093	0.0354	62.3110	73	-0.0163	-0.0248	124.0570
28	0.0539	0.0550	65.9630	74	-0.0043	-0.0035	124.0810
29	0.0864	0.0759	75.3710	75	-0.0263	-0.0074	124.9850
30	-0.0125	-0.0368	75.5670	76	0.0360	0.0640	126.6850
31	0.0102	0.0140	75.6970	77	-0.0308	-0.0358	127.9270
32	-0.0343	-0.0362	77.1820	78	0.0126	0.0158	128.1350
33	0.0017	0.0111	77.1860	79	-0.0200	-0.0296	128.6590
34	-0.0642	-0.0587	82.3960	80	-0.0110	-0.0161	128.8180
35	-0.0781	-0.0516	90.1250	81	-0.0494	-0.0490	132.0260
36	-0.0085	0.0158	90.2160	82	-0.0427	-0.0292	134.4240
37	-0.0012	-0.0031	90.2180	83	-0.0135	0.0135	134.6640
38	-0.0235	-0.0268	90.9160	84	-0.0249	-0.0162	135.4790
39	-0.0465	-0.0491	93.6650	85	-0.0207	-0.0050	136.0450
40	0.0089	0.0085	93.7660	86	0.0425	0.0329	138.4370
41	0.0342	0.0187	95.2520	87	-0.0084	-0.0245	138.5300
42	0.0042	0.0030	95.2750	88	-0.0385	-0.0340	140.4960
43	-0.0017	0.0122	95.2780	89	-0.0249	-0.0124	141.3160
44	-0.0278	-0.0164	96.2670	90	0.0285	0.0520	142.3980
45	-0.0160	0.0014	96.5920	91	0.0193	0.0199	142.8920
46	0.0110	0.0301	96.7460	92	-0.0327	-0.0371	144.3090

Lag	ACF	PACF	Q-Stat
93	-0.0392	-0.0124	146.3560
94	-0.0544	-0.0403	150.2980
95	-0.0714	-0.0430	157.0960
96	0.0028	-0.0045	157.1070

Lag	ACF	PACF	Q-Stat
97	-0.0461	-0.0431	159.9390
98	-0.0074	0.0049	160.0120
99	-0.0275	-0.0368	161.0230
100	0.0151	0.0193	161.3290

Source: Author's estimate.

Appendix 6

Table A6.1: Correlation Coefficients, 1992-2001

	SMI	PE	DY	MC	BD	BL	IR	MMI	BND	FX	EX	IM	GLD	GDP	CPI	GE
SMI	100%															
PE	93%	100%														
DY	4%	-7%	100%													
MC	85%	73%	-19%	100%												
BD	-64%	-65%	-57%	-21%	100%											
BL	22%	12%	24%	51%	-4%	100%										
IR	39%	42%	59%	14%	-75%	45%	100%									
MMI	-76%	-64%	-26%	-54%	62%	8%	-13%	100%								
BND	-64%	-67%	-31%	-16%	86%	38%	-43%	72%	100%							
FX	-84%	-80%	-21%	-59%	80%	-16%	-50%	79%	77%	100%						
EX	-75%	-76%	-31%	-37%	90%	-1%	-62%	69%	89%	93%	100%					
IM	-55%	-65%	-25%	-13%	85%	11%	-65%	41%	84%	75%	91%	100%				
GLD	86%	78%	37%	69%	-76%	42%	61%	-71%	-61%	-88%	-80%	-61%	100%			
GDP	-19%	-21%	-11%	-6%	25%	3%	-22%	13%	26%	22%	29%	29%	-20%	100%		
CPI	-77%	-76%	-35%	-33%	91%	18%	-51%	79%	97%	87%	93%	83%	-75%	27%	100%	
GE	-51%	-59%	-15%	-12%	68%	36%	-33%	53%	81%	59%	71%	70%	-43%	29%	78%	100%

Source: Author's estimate.

Table A6.2: Correlation Coefficients, the Pre-Crisis Period (1992-1996)

	SMI	PE	DY	MC	BD	BL	IR	MMI	BND	FX	EX	IM	GLD	GDP	CPI	GE
SMI	100%															
PE	91%	100%														
DY	-95%	-91%	100%													
MC	88%	65%	-83%	100%												
BD	68%	40%	-61%	91%	100%											
BL	51%	20%	-46%	86%	93%	100%										
IR	-65%	-67%	62%	-39%	-20%	-3%	100%									
MMI	49%	26%	-52%	77%	74%	85%	-21%	100%								
BND	52%	20%	-46%	86%	91%	99%	-6%	87%	100%							
FX	-47%	-41%	50%	-48%	-31%	-31%	22%	-28%	-32%	100%						
EX	56%	26%	-51%	86%	89%	95%	-11%	84%	96%	-41%	100%					
IM	52%	22%	-47%	84%	91%	96%	-1%	80%	96%	-38%	96%	100%				
GLD	62%	55%	-68%	75%	67%	68%	-24%	74%	65%	-30%	64%	63%	100%			
GDP	36%	8%	-31%	65%	77%	80%	-6%	70%	78%	-18%	72%	76%	50%	100%		
CPI	46%	14%	-40%	82%	91%	98%	-4%	85%	98%	-22%	92%	93%	64%	81%	100%	
GE	35%	6%	-28%	64%	73%	79%	-9%	67%	79%	-11%	79%	73%	44%	68%	83%	100%

Source: Author's estimate.

Table A6.3: Correlation Coefficients, the Post-Crisis Period (1997-2001)

	SMI	PE	DY	MC	BD	BL	IR	MMI	BND	FX	EX	IM	GLD	GDP	CPI	GE
SMI	100%															
PE	48%	100%														
DY	40%	-13%	100%													
MC	79%	41%	-7%	100%												
BD	-66%	-40%	-74%	-9%	100%											
BL	72%	41%	71%	17%	-97%	100%										
IR	36%	36%	60%	-24%	-85%	85%	100%									
MMI	-34%	25%	-25%	-50%	-6%	6%	44%	100%								
BND	-75%	-26%	-60%	-35%	78%	-86%	-57%	13%	100%							
FX	-73%	-42%	-18%	-53%	55%	-64%	-31%	28%	72%	100%						
EX	-70%	-49%	-30%	-34%	69%	-81%	-63%	-7%	80%	83%	100%					
IM	-45%	-58%	-10%	-10%	60%	-69%	-69%	-49%	60%	58%	85%	100%				
GLD	78%	29%	69%	37%	-83%	88%	60%	-22%	-87%	-74%	-75%	-52%	100%			
GDP	-14%	-11%	-6%	-9%	9%	-14%	-15%	-8%	12%	8%	17%	16%	-12%	100%		
CPI	-88%	-35%	-68%	-45%	88%	-92%	-60%	27%	91%	76%	78%	53%	-92%	11%	100%	
GE	-14%	-30%	6%	-12%	8%	-12%	-11%	-14%	6%	5%	15%	21%	3%	19%	7%	100%

Source: Author's estimate.

Table A6.4: Results of Residual Estimation ($\mu_y = y_t - \alpha_0 - \alpha x_t$)

e-PE	e-DY	e-MC	e-BD	e-BL	e-IR	e-MMI	e-BND	e-FX	e-GLD	e-GDP	e-CPI	e-GE
-147.03	-23.86	430.66	-383.55	124.69	-116.21	-284.15	-515.46	-298.32	-222.19	-43.91	-525.65	-383.55
-121.82	-6.30	397.57	-369.83	144.75	-96.81	-264.75	-491.27	-274.55	-202.79	-24.00	-498.36	-375.74
-143.33	38.93	402.91	-301.15	184.25	-56.94	-224.88	-432.89	-230.30	-162.92	18.60	-464.75	-326.94
-154.68	-25.67	375.49	-370.93	122.31	-118.69	-286.63	-499.23	-290.74	-224.67	-47.75	-518.85	-408.38
-125.36	-104.34	342.86	-446.13	48.30	-190.82	-358.76	-556.77	-369.43	-296.80	-118.66	-561.54	-453.72
-136.42	-37.03	366.45	-405.96	109.29	-128.21	-296.15	-489.86	-315.13	-234.19	-57.06	-489.65	-298.10
-104.67	-41.05	322.53	-391.45	102.14	-135.24	-303.18	-489.83	-321.28	-241.22	-63.01	-492.05	-340.45
-107.75	-38.79	323.24	-380.72	101.93	-133.15	-301.09	-482.23	-327.06	-239.13	-61.21	-473.03	-343.71
-119.05	67.90	361.23	-272.80	200.41	-32.66	-200.60	-377.44	-228.32	-138.64	39.28	-370.92	-132.62
-69.64	164.43	392.63	-197.63	293.08	60.69	-107.25	-276.41	-123.61	-45.29	132.85	-280.81	-86.73
-50.44	85.27	354.50	-270.20	219.93	-14.45	-182.39	-351.35	-191.75	-120.43	61.30	-366.62	-142.97
-40.32	115.15	360.54	-240.31	244.78	13.76	-154.18	-336.92	-163.10	129.68	93.83	-346.29	-132.13
31.69	198.23	382.49	-157.69	324.58	94.82	-73.12	-248.27	-83.35	210.74	175.68	-258.51	-152.50
45.91	158.38	358.29	-176.54	286.46	57.99	-109.95	-275.63	-122.81	173.91	140.29	-278.64	-191.88
12.90	80.10	328.62	-271.41	213.71	-14.43	-182.37	-311.85	-198.29	101.49	68.01	-351.06	-214.85
36.90	57.31	316.43	-283.98	187.85	-34.37	-202.31	-337.15	-225.22	81.55	45.70	-354.54	-196.27
8.92	35.22	303.65	-287.61	162.49	-1.05	-221.89	-322.95	-248.30	61.97	24.82	-368.56	-236.64
27.13	90.38	311.73	-240.81	203.08	50.76	-170.08	-272.74	-190.81	113.78	83.94	-309.56	-58.25
47.44	143.23	323.05	-138.61	251.94	101.44	-119.40	-224.76	-138.38	164.46	133.86	-245.90	-83.34
22.97	181.06	328.88	-78.88	282.25	136.42	-84.42	-170.31	-108.65	199.44	173.15	-205.58	-56.71
33.82	189.49	323.44	-53.15	285.69	197.58	-76.16	-161.23	-99.07	207.70	175.08	-179.01	111.96
68.70	489.01	399.47	276.15	575.29	487.05	213.31	142.84	196.52	497.17	463.83	108.61	308.58
68.63	538.22	414.62	348.65	622.13	536.09	262.35	183.28	249.06	546.21	514.53	152.32	503.88
115.85	919.66	428.49	716.54	989.27	908.99	635.25	591.07	627.20	498.66	891.38	536.11	715.30
-114.90	738.30	368.48	525.57	787.29	719.59	463.01	392.10	435.18	309.26	702.05	352.28	493.48
-15.72	612.09	308.54	388.23	657.01	599.07	344.50	297.15	306.35	188.74	581.60	250.07	341.96
-120.88	476.30	248.73	242.75	514.22	466.13	215.37	181.41	170.79	55.80	448.31	135.45	296.74
-130.38	503.65	231.23	287.81	533.15	492.81	243.22	219.35	194.41	82.48	475.06	162.13	208.81
-21.44	597.03	205.20	370.36	616.06	583.01	338.25	314.96	286.36	172.68	565.33	270.65	326.34
-17.74	511.66	187.03	285.69	520.35	499.48	252.49	253.86	193.64	89.15	484.75	205.44	367.67
-38.27	617.88	170.85	386.62	617.10	603.02	352.38	367.16	298.93	192.69	589.01	308.98	391.53
32.14	769.01	119.27	616.36	755.76	750.97	507.47	537.97	446.45	340.64	737.67	475.47	616.73
35.03	729.06	135.03	554.93	709.53	685.40	462.15	527.03	405.14	301.52	699.70	454.67	897.63
39.37	773.01	149.66	587.36	750.01	728.52	508.61	573.38	446.07	344.64	743.54	497.79	473.66
152.13	602.77	127.65	422.69	578.16	562.13	351.62	415.65	285.37	178.25	577.87	313.08	490.14
218.28	599.42	115.39	424.59	559.10	559.78	343.66	408.12	284.77	234.30	577.82	310.73	525.57
217.44	452.04	107.34	297.42	407.68	417.43	191.77	286.41	139.36	91.95	436.26	186.70	316.18
190.60	524.28	87.38	351.21	476.13	488.16	259.25	375.07	207.03	162.68	508.43	266.47	321.22
98.78	447.80	25.61	293.05	392.69	363.47	197.56	344.41	126.05	90.89	437.00	203.96	368.23
91.43	438.97	15.73	258.73	374.45	355.48	185.87	330.86	111.07	82.90	429.73	214.28	248.86
96.71	627.95	-7.02	499.06	542.88	539.10	367.36	560.63	296.87	266.52	614.07	423.64	502.98
73.97	631.41	-13.17	549.84	533.94	541.56	361.92	603.06	300.65	268.98	617.32	440.71	593.63
76.51	619.24	-30.83	531.46	520.38	529.89	352.37	591.58	292.91	257.31	606.37	438.08	497.55
110.41	549.70	-53.08	471.57	447.76	461.69	302.55	549.92	239.58	189.11	538.89	390.28	565.27
125.28	527.86	-57.98	441.98	414.88	441.02	289.40	538.24	218.03	168.44	511.53	393.26	685.23
123.13	503.72	-64.36	399.94	393.79	417.55	257.79	534.92	197.62	144.97	489.28	388.11	266.23
125.89	427.07	-53.28	348.24	311.60	343.41	194.92	476.49	124.36	70.83	415.86	313.97	279.99
123.49	513.60	-67.31	486.22	385.81	427.60	262.25	570.92	209.86	108.30	503.50	398.16	427.40

e-PE	e-DY	e-MC	e-BD	e-BL	e-IR	e-MMI	e-BND	e-FX	e-GLD	e-GDP	e-CPI	e-GE
130.24	646.64	-96.65	635.99	517.20	557.12	390.06	627.42	346.37	237.82	633.74	543.21	559.56
130.95	556.50	-103.13	564.49	425.43	468.66	290.93	524.17	250.48	149.36	546.72	465.65	541.75
142.75	521.85	-97.83	550.65	390.77	436.52	266.17	518.85	220.53	117.22	517.96	442.32	705.58
141.10	524.90	-101.42	568.23	384.80	439.40	269.28	529.12	223.41	120.10	521.56	456.33	496.77
180.44	544.87	-104.64	609.54	398.57	458.70	287.79	553.89	247.52	139.40	541.58	484.21	582.22
175.70	478.20	-115.08	499.30	339.38	393.87	221.41	496.16	183.56	74.57	478.90	421.70	515.18
150.33	288.12	-132.02	305.87	158.15	210.83	53.79	310.37	-3.41	-108.47	353.74	243.06	313.44
141.44	328.08	-144.00	291.48	200.26	249.11	94.74	363.53	35.74	-70.19	392.38	305.46	498.57
144.59	324.60	-146.59	237.07	194.60	245.80	78.26	385.25	38.12	-73.50	327.24	306.55	725.21
135.55	126.87	-116.31	-10.80	6.55	57.12	-97.77	184.49	-147.50	-262.18	139.28	130.86	165.04
183.49	143.68	-135.10	-2.43	20.00	72.76	-76.64	247.74	-130.99	-246.54	155.64	157.63	275.58
176.97	43.42	-122.57	-88.44	-79.38	-21.64	-166.89	153.58	-221.02	-197.87	61.45	63.23	353.70
172.86	-2.62	-112.76	-86.30	-125.98	-65.17	-207.18	123.92	-253.18	-241.40	18.07	26.19	165.42
167.95	-67.29	-101.01	-162.79	-191.02	-125.65	-271.21	64.60	-312.78	-301.88	-42.05	-23.39	58.42
140.01	-86.91	-97.53	-210.68	-222.67	-147.78	-187.78	65.09	-331.42	-324.01	-63.75	-32.31	178.81
127.53	-132.89	-86.85	-288.46	-263.35	-191.92	-172.09	19.01	-369.87	-368.15	-107.82	-72.04	-78.42
92.08	-238.34	-66.04	-373.72	-365.18	-286.82	-376.04	-78.45	-477.89	-463.05	-202.15	-156.05	-62.06
92.38	-282.31	-56.52	-357.08	-405.08	-325.93	-379.50	-102.96	-517.44	-502.16	-238.38	-190.75	-41.56
71.12	-127.22	-87.63	-248.28	-259.39	-293.39	116.20	32.43	-104.52	-363.82	-99.32	-34.79	103.15
78.97	-308.03	-58.78	-307.48	-385.25	-456.78	-108.19	-108.59	-169.10	-527.21	-261.99	-130.24	-44.45
34.04	-256.34	-69.18	-325.16	-337.04	-414.47	44.18	-72.08	-31.03	-484.90	-222.49	-77.04	116.24
41.39	-368.41	-50.18	-474.85	-438.41	-511.80	134.09	-166.46	11.55	-582.23	-321.33	-152.57	-270.02
75.59	-431.21	-38.55	-423.68	-473.49	-563.54	-60.61	-202.83	-21.83	-633.97	-372.35	-182.29	-277.73
65.74	-458.01	-22.32	-459.44	-485.60	-586.32	-105.91	-229.38	266.26	-69.88	-401.02	-205.07	-277.43
36.43	-305.65	-61.17	-287.49	-355.21	-463.78	181.38	-62.23	724.16	52.66	-278.34	-51.92	-285.65
69.62	-263.92	-84.63	-281.61	-320.22	-430.59	255.06	17.40	232.67	85.85	-244.43	0.98	-218.80
-282.07	-306.42	-70.44	-362.81	-381.91	-499.90	240.34	-59.21	-16.77	16.54	-315.03	-37.50	-220.45
-469.92	-346.70	-66.93	-402.27	-424.81	-546.88	266.48	-94.68	-67.69	-31.32	-361.94	-64.77	-464.83
-373.59	-438.77	-64.67	-437.16	-505.89	-633.42	143.36	-210.94	-88.21	-117.86	-446.18	-136.00	-451.38
-371.98	-446.87	-64.26	-408.35	-503.75	-640.85	147.77	-200.93	-4.26	-124.41	-450.73	-128.13	-183.43
-292.89	-504.68	-49.48	-393.08	-548.57	-692.29	115.58	-288.90	-120.41	-176.73	-501.82	-177.49	-450.02
-185.47	-557.87	-33.91	-427.74	-593.80	-744.48	142.18	-351.53	-123.19	-228.92	-553.65	-218.55	-326.19
-243.11	-510.37	-49.15	-386.53	-547.19	-705.19	137.64	-296.44	-199.77	-188.75	-516.73	-183.66	52.75
-220.56	-425.03	-84.81	-266.54	-476.95	-627.72	200.77	-213.46	-233.35	-111.28	-439.19	-110.60	-309.82
-148.97	-388.47	-95.94	-248.23	-431.49	-596.19	278.25	-170.04	-230.68	-80.63	-407.58	-87.88	-369.44
-174.07	-396.15	-92.07	-264.87	-432.58	-603.20	240.56	-165.65	-212.33	-81.51	-419.56	-105.78	-215.91
-173.99	-388.80	-93.62	-167.59	-421.25	-596.01	153.76	-174.60	-197.71	-74.32	-412.01	-87.70	-505.78
176.15	-410.35	-126.17	-124.25	-438.59	-327.12	120.79	-214.64	-194.41	-96.38	-433.35	-107.44	-451.55
228.57	-395.77	-137.08	-98.63	-421.16	-316.05	74.42	-220.29	-174.59	-85.31	-419.83	-100.77	-283.46
278.40	-282.90	-195.63	7.40	-301.78	-208.71	221.09	-109.18	-84.74	22.03	-311.77	-6.65	-110.07
-303.09	-288.48	-236.56	57.97	-304.55	-214.46	239.40	-86.32	-98.36	16.28	-316.80	-23.30	-291.73
-351.23	-218.47	-323.01	78.42	-231.96	-66.94	208.01	-38.69	-39.81	84.45	-245.11	42.55	-84.78
-369.02	-284.93	-282.51	-15.71	-287.65	-52.55	137.39	-106.31	-93.84	19.49	-311.01	-18.00	-326.33
-82.51	-302.14	-264.04	-48.92	-300.17	-69.09	99.59	-142.23	-57.48	2.95	-326.47	-23.64	-263.75
-51.22	-354.93	-224.69	-73.11	-345.67	-119.87	34.04	-176.53	8.92	-47.83	-377.03	-70.02	-2.31
-45.16	-346.36	-234.13	-69.40	-333.92	-113.81	-25.49	-155.77	-84.71	-41.77	-370.90	-59.55	-388.89
-162.04	-319.29	-272.22	-10.64	-305.17	-87.24	-177.98	-90.11	-44.15	-15.20	-342.10	-28.58	52.85
-349.08	-257.81	-328.53	-1.73	-245.00	-27.44	-268.09	-15.03	-52.12	24.45	-286.76	40.03	-158.94
-330.82	-262.33	-322.96	71.17	-248.96	-31.79	-141.10	-16.73	-55.59	20.10	-291.40	42.18	-309.65
-257.01	-373.29	-230.66	-19.98	-343.25	-135.04	-297.64	-135.44	-138.73	-83.15	-394.57	-50.18	-415.52

e-PE	e-DY	e-MC	e-BD	e-BL	e-IR	e-MMI	e-BND	e-FX	e-GLD	e-GDP	e-CPI	e-GE
-66.24	-349.13	-257.42	-25.17	-314.77	-109.04	-257.68	-119.69	-118.85	61.69	-366.78	-21.86	-180.60
-54.83	-359.39	-243.22	-90.29	-321.42	-118.96	-238.92	-146.28	-119.59	136.15	-377.42	-42.68	-124.97
-34.06	-430.52	-209.71	-123.22	-391.92	-186.07	-324.71	-219.04	-139.04	80.72	-388.45	-105.38	-371.56
-11.63	-427.95	-215.64	-99.79	-386.11	-183.67	-342.71	-189.15	-136.20	-26.66	-436.23	-98.81	-311.05
-30.04	-472.49	-184.60	-166.29	-421.10	-224.69	-389.00	-236.69	-75.35	11.15	-478.83	-135.42	-480.17
-58.57	-446.98	-206.25	-135.15	-396.65	-201.53	-314.23	-216.43	-77.11	32.56	-454.95	-94.64	-362.60
-9.63	-480.20	-183.27	-169.13	-422.94	-232.07	-346.37	-223.14	-49.50	25.08	337.89	-116.37	-151.60
-5.39	-485.82	-178.98	-181.80	-422.08	-237.52	-307.87	-217.67	21.13	82.99	-491.45	-135.04	-354.99
30.42	-478.90	-187.44	-169.86	-414.34	-231.44	-278.75	-208.11	24.15	57.25	-486.09	-124.55	-208.63
31.38	-490.14	-183.01	-134.83	-419.86	-240.17	-403.36	-225.01	-11.25	23.99	-494.96	-135.37	-377.97
27.11	-420.70	-248.72	10.03	-356.16	-176.59	-327.04	-141.32	20.85	143.63	-430.73	-65.30	-351.68
15.02	-432.96	-242.23	9.36	-363.16	-184.16	-332.36	-158.13	26.83	120.88	-437.58	-57.56	-404.94
72.22	-475.27	-211.06	-26.25	-395.77	-217.42	-401.23	-204.92	77.08	150.10	-472.21	-90.82	-313.89
76.39	-465.57	-219.76	-9.63	-383.49	-208.73	-402.11	-206.52	119.44	121.12	-463.38	-60.11	-212.00
90.41	-454.40	-232.06	22.25	-374.35	-199.23	-391.08	-191.90	118.01	100.55	-457.69	-39.71	-388.38
82.80	-440.97	-241.85	21.00	-361.50	-186.81	-375.46	-161.07	126.93	65.38	-445.99	-36.10	-288.48
83.79	-468.68	-217.40	-5.74	-381.05	-211.67	-387.98	-201.97	123.05	56.29	-467.97	-60.96	-377.73
100.99	-427.62	-252.46	-2.41	-339.86	-173.79	-363.30	-173.18	91.42	43.95	-432.03	-27.48	-335.93
167.17	-493.35	-201.42	-54.22	-399.70	-232.32	-396.52	-207.49	45.13	-156.78	-492.21	-77.20	-102.74
166.51	-494.97	-204.17	-104.36	-397.13	-234.27	-382.98	-183.78	53.67	-104.42	-494.16	-92.37	42.38
110.04	-464.09	-233.26	-69.50	-369.39	-206.74	-313.79	-172.20	53.66	-53.53	-461.60	-71.33	-189.65

Source: Author's estimate.

Table A6.5: Regression Result

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.994
R Square	**0.988**
Adjusted R Square	**0.987**
Standard Error	47.251
Observations	119.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6.000	20,449,926.954	3,408,321.159	1,526.583	0.000
Residual	112.000	250,056.402	2,232.646		
Total	118.000	20,699,983.356			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	760.179	257.468	2.953	0.004	250.039	1,270.318
PE	7.548	2.034	3.711	0.000	3.519	11.578
MC	0.0003	0.000	22.734	0.000	0.000	0.000
IR	8.576	2.203	3.894	0.000	4.212	12.941
BND	- 2.237	0.709	- 3.156	0.002	- 3.642	- 0.833
FX	6.493	1.510	4.301	0.000	3.502	9.485
CPI	- 7.109	3.167	- 2.245	0.027	- 13.384	- 0.834

Source: Author's estimate.

Appendix 7

Table A7.1: Day of the Week Effect, 1992-2001

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.121507
R Square	0.014764
Adjusted R Square	0.013155
Standard Error	1.874231
Observations	2454

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	128.9129	32.22823	9.174662	2.35E-07
Residual	2449	8602.707	3.512743		
Total	2453	8731.62			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.41671	0.086636	-4.80991	1.6E-06	-0.5866	-0.24683
Tuesday	0.256609	0.120899	2.122496	0.033896	0.019533	0.493684
Wednesday	0.550528	0.120663	4.562528	5.3E-06	0.313916	0.787141
Thursday	0.421704	0.120604	3.496588	0.00048	0.185207	0.658201
Friday	0.658788	0.12084	5.451733	5.49E-08	0.421828	0.895747

Source: Author's estimate.

Table A7.2: Day of the Week Effect, 1992-1996

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.130298
R Square	0.016978
Adjusted R Square	0.013757
Standard Error	1.439502
Observations	1226

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	43.69736	10.92434	5.271943	0.000328
Residual	1221	2530.114	2.072166		
Total	1225	2573.812			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.32334	0.094305	-3.42862	0.000627	-0.50835	-0.13832
Tuesday	0.246798	0.131464	1.87731	0.060714	-0.01112	0.504718
Wednesday	0.486297	0.131207	3.706326	0.00022	0.228881	0.743714
Thursday	0.401996	0.13108	3.066786	0.002211	0.144828	0.659163
Friday	0.523824	0.131464	3.984549	7.16E-05	0.265904	0.781744

Source: Author's estimate.

Table A7.3: Day of the Week Effect, 1997-2001

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.12176
R Square	0.014825
Adjusted R Square	0.011603
Standard Error	2.226192
Observations	1228

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	91.21048	22.80262	4.601078	0.001087
Residual	1223	6061.102	4.95593		
Total	1227	6152.313			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.5093	0.145221	-3.50705	0.00047	-0.79421	-0.22439
Tuesday	0.265624	0.202863	1.309374	0.190653	-0.13238	0.663623
Wednesday	0.613965	0.202466	3.032437	0.002477	0.216746	1.011184
Thursday	0.440322	0.202466	2.174795	0.029837	0.043102	0.837541
Friday	0.792788	0.202664	3.911838	9.66E-05	0.395181	1.190396

Source: Author's estimate.

Table A7.4: Day of the Week Effect, 1992

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.231804
R Square	0.053733
Adjusted R Square	0.038093
Standard Error	1.585358
Observations	247

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	34.53823	8.634557	3.435462	0.009393
Residual	242	608.2334	2.513361		
Total	246	642.7716			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	0.195829	0.22648	0.864664	0.388079	-0.25029	0.641952
Tuesday	-0.80814	0.320291	-2.52314	0.012273	-1.43905	-0.17722
Wednesday	-0.14607	0.320291	-0.45604	0.64877	-0.77698	0.484848
Thursday	0.243184	0.318685	0.763084	0.446156	-0.38457	0.870935
Friday	0.164402	0.318685	0.515874	0.606413	-0.46335	0.792153

Source: Author's estimate.

Table A7.5: Day of the Week Effect, 1993

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.240625
R Square	0.057901
Adjusted R Square	0.042199
Standard Error	1.26391
Observations	245

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	23.56296	5.890739	3.687548	0.006193
Residual	240	383.3922	1.597468		
Total	244	406.9552			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.27766	0.18436	-1.50605	0.13337	-0.64083	0.085516
Tuesday	0.402784	0.25805	1.560873	0.119871	-0.10555	0.911117
Wednesday	0.913021	0.256784	3.555598	0.000454	0.407183	1.418859
Thursday	0.602974	0.256784	2.348174	0.019678	0.097135	1.108812
Friday	0.730777	0.25805	2.831916	0.00502	0.222444	1.23911

Source: Author's estimate.

Table A7.6: Day of the Week Effect, 1994

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.152869
R Square	0.023369
Adjusted R Square	0.007092
Standard Error	1.645427
Observations	245

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	15.54811	3.887026	1.435688	0.22281
Residual	240	649.7832	2.70743		
Total	244	665.3313			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.5436	0.242605	-2.24069	0.025961	-1.02151	-0.0657
Tuesday	0.737864	0.336163	2.194958	0.029125	0.075657	1.400072
Wednesday	0.541704	0.336163	1.61143	0.1084	-0.1205	1.203911
Thursday	0.359432	0.336163	1.069217	0.286046	-0.30278	1.021639
Friday	0.611002	0.337803	1.808753	0.071741	-0.05444	1.276439

Source: Author's estimate.

Table A7.7: Day of the Week Effect, 1995

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.170744
R Square	0.029154
Adjusted R Square	0.01304
Standard Error	1.240937
Observations	246

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	11.14441	2.786102	1.809246	0.127675
Residual	241	371.1217	1.539924		
Total	245	382.2661			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.41957	0.182966	-2.29315	0.022701	-0.77999	-0.05915
Tuesday	0.389524	0.253525	1.536431	0.125744	-0.10988	0.888933
Wednesday	0.641742	0.253525	2.531274	0.012002	0.142334	1.141151
Thursday	0.382685	0.253525	1.509453	0.132493	-0.11672	0.882093
Friday	0.530211	0.253525	2.091353	0.037544	0.030802	1.029619

Source: Author's estimate.

Table A7.8: Day of the Week Effect, 1996

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.160099
R Square	0.025632
Adjusted R Square	0.009324
Standard Error	1.35328
Observations	244

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	11.51396	2.878489	1.571771	0.182502
Residual	239	437.6966	1.831367		
Total	243	449.2106			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.61476	0.19953	-3.08106	0.002304	-1.00783	-0.2217
Tuesday	0.548565	0.277826	1.974493	0.049477	0.001265	1.095864
Wednesday	0.521905	0.276477	1.887695	0.060278	-0.02274	1.066548
Thursday	0.464789	0.276477	1.68111	0.094048	-0.07985	1.009432
Friday	0.624387	0.277826	2.247404	0.025527	0.077087	1.171686

Source: Author's estimate.

Table A7.9: Day of the Week Effect, 1997

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.116937
R Square	0.013674
Adjusted R Square	-0.00263
Standard Error	2.285579
Observations	247

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	17.52648	4.38162	0.838769	0.501715
Residual	242	1264.177	5.22387		
Total	246	1281.703			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.57081	0.329895	-1.73029	0.084854	-1.22064	0.079019
Tuesday	-0.04408	0.466542	-0.09448	0.924808	-0.96308	0.874924
Wednesday	0.693376	0.45963	1.508554	0.132717	-0.21201	1.598762
Thursday	0.220842	0.461853	0.478164	0.632965	-0.68892	1.130606
Friday	0.328907	0.461853	0.712148	0.477059	-0.58086	1.238672

Source: Author's estimate.

Table A7.10: Day of the Week Effect, 1998

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.137986
R Square	0.01904
Adjusted R Square	0.002622
Standard Error	2.926769
Observations	244

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	39.73664	9.934159	1.159723	0.329289
Residual	239	2047.269	8.565979		
Total	243	2087.006			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.49542	0.422443	-1.17276	0.24206	-1.32761	0.336762
Tuesday	-0.02481	0.59142	-0.04196	0.96657	-1.18987	1.140248
Wednesday	0.746516	0.597424	1.249557	0.212684	-0.43037	1.923405
Thursday	0.777732	0.594368	1.308501	0.19196	-0.39314	1.948601
Friday	0.888724	0.594368	1.495241	0.136171	-0.28215	2.059593

Source: Author's estimate.

Table A7.11: Day of the Week Effect, 1999

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.112098
R Square	0.012566
Adjusted R Square	-0.00389
Standard Error	2.206302
Observations	245

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	14.86706	3.716765	0.763546	0.549905
Residual	240	1168.265	4.867769		
Total	244	1183.132			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.18327	0.321822	-0.56946	0.569574	-0.81722	0.450691
Tuesday	0.37972	0.448247	0.847124	0.39777	-0.50328	1.26272
Wednesday	0.10263	0.450457	0.227835	0.819969	-0.78472	0.989984
Thursday	0.32098	0.450457	0.712565	0.476807	-0.56637	1.208335
Friday	0.709909	0.448247	1.583746	0.114568	-0.17309	1.592908

Source: Author's estimate.

Table A7.12: Day of the Week Effect, 2000

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.234758
R Square	0.055111
Adjusted R Square	0.039493
Standard Error	1.862411
Observations	247

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	48.95812	12.23953	3.528692	0.00805
Residual	242	839.395	3.468575		
Total	246	888.3532			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.95305	0.277632	-3.4328	0.000703	-1.49994	-0.40617
Tuesday	0.637039	0.380908	1.672423	0.095733	-0.11328	1.387357
Wednesday	0.856388	0.380908	2.248282	0.025459	0.10607	1.606706
Thursday	0.611037	0.382689	1.596694	0.111639	-0.14279	1.364864
Friday	1.409037	0.382689	3.681937	0.000285	0.65521	2.162864

Source: Author's estimate.

Table A7.13: Day of the Week Effect, 2001

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.150633
R Square	0.02269
Adjusted R Square	0.006402
Standard Error	1.659292
Observations	245

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	15.3414	3.835349	1.393025	0.236995
Residual	240	660.7804	2.753251		
Total	244	676.1218			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Monday	-0.36179	0.242033	-1.49482	0.136276	-0.83857	0.114985
Tuesday	0.395828	0.340498	1.162496	0.246189	-0.27492	1.066575
Wednesday	0.694603	0.337113	2.060449	0.040434	0.030526	1.35868
Thursday	0.299904	0.335507	0.893883	0.37228	-0.36101	0.960819
Friday	0.647474	0.338775	1.911221	0.057167	-0.01988	1.314827

Source: Author's estimate.

Table 7.14: January Effect, 1975-2001

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.1449
R Square	0.020996
Adjusted R Square	-0.01408
Standard Error	8.940274
Observations	319

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	11	526.2466	47.8406	0.598542	0.82978
Residual	307	24538.05	79.9285		
Total	318	25064.3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
January	3.01433	1.753332	1.719201	0.086586	-0.43574	6.464394
February	-3.99204	2.479586	-1.60996	0.108434	-8.87116	0.887092
March	-3.74605	2.479586	-1.51076	0.131879	-8.62518	1.133074
April	-2.36412	2.479586	-0.95343	0.341122	-7.24324	2.515013
May	-3.66613	2.479586	-1.47853	0.140292	-8.54526	1.212995
June	-1.16459	2.456519	-0.47408	0.635779	-5.99833	3.669149
July	-2.79186	2.456519	-1.13651	0.256629	-7.6256	2.041881
August	-3.45443	2.456519	-1.40623	0.160667	-8.28817	1.379306
September	-3.66939	2.456519	-1.49374	0.136271	-8.50313	1.164346
October	-2.02708	2.456519	-0.82518	0.409909	-6.86082	2.806664
November	-3.83843	2.456519	-1.56255	0.119189	-8.67217	0.995312
December	-0.90235	2.456519	-0.36733	0.713626	-5.73609	3.931387

Source: Author's estimate.

Table 7.15: January Effect, 1992-1996

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.328296
R Square	0.107779
Adjusted R Square	-0.09669
Standard Error	9.006464
Observations	60

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	11	470.3373	42.75794	0.527118	0.875249
Residual	48	3893.587	81.11639		
Total	59	4363.924			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
January	0.477863	4.027813	0.118641	0.906055	-7.62059	8.576319
February	-2.59572	5.696188	-0.45569	0.650664	-14.0487	8.857223
March	-4.76775	5.696188	-0.83701	0.406736	-16.2207	6.685194
April	-2.16602	5.696188	-0.38026	0.705432	-13.619	9.286931
May	1.562455	5.696188	0.274298	0.785032	-9.89049	13.0154
June	0.230149	5.696188	0.040404	0.967939	-11.2228	11.6831
July	-1.32204	5.696188	-0.23209	0.817453	-12.775	10.1309
August	2.054875	5.696188	0.360746	0.719872	-9.39807	13.50782
September	1.321912	5.696188	0.23207	0.817471	-10.131	12.77486
October	3.268382	5.696188	0.573784	0.568793	-8.18457	14.72133
November	-4.54646	5.696188	-0.79816	0.42871	-15.9994	6.90649
December	4.348606	5.696188	0.763424	0.448947	-7.10434	15.80155

Source: Author's estimate.

Table 7.16: January Effect, 1997-2001

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.414652
R Square	0.171936
Adjusted R Square	-0.01783
Standard Error	13.13164
Observations	60

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	11	1718.632	156.2393	0.90605	0.541754
Residual	48	8277.12	172.44		
Total	59	9995.752			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
January	9.069628	5.872648	1.544385	0.129063	-2.73812	20.87737
February	-15.9554	8.305179	-1.92114	0.060663	-32.6541	0.743235
March	-12.6752	8.305179	-1.52617	0.133529	-29.3738	4.023518
April	-7.1131	8.305179	-0.85647	0.395996	-23.8118	9.585572
May	-20.284	8.305179	-2.44233	0.018326	-36.9826	-3.5853
June	-7.22886	8.305179	-0.8704	0.388412	-23.9275	9.46981
July	-14.8926	8.305179	-1.79317	0.079248	-31.5913	1.806085
August	-15.8355	8.305179	-1.90671	0.062554	-32.5342	0.863145
September	-12.4625	8.305179	-1.50057	0.140017	-29.1612	4.236175
October	-7.91001	8.305179	-0.95242	0.345656	-24.6087	8.788661
November	-6.06021	8.305179	-0.72969	0.469126	-22.7589	10.63846
December	-8.55381	8.305179	-1.02994	0.308202	-25.2525	8.144864

Source: Author's estimate.