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The Behaviour of Stock Returns in Amman Stock Market; A Thin Emerging Market

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[1] Any errors are the responsibility of the author.

Synopsis

In this thesis the behaviour of stock returns of firms listed on the Amman Stock Market is examined. The thin trading characteristic of the market is emphasised and its possible effects on empirical investigations are analysed.

The first four chapters contain a review of the literature on the importance of stock markets, the Efficient Market Theory and the Capital Asset Pricing Model. The literature suggests that the allocative efficiency of funds via stock markets is related to the operational and pricing efficiency of these markets. In such an efficient market, the expected return on an investment is related only to its risk.

Chapter 5 tests the weak form efficiency of the ASM with particular emphasis on the problem of thin trading. To achieve this, three alternatives for filling missing data gaps are examined. In particular, it was found that extrapolation, based on market movements, induces more dependence patterns. Yet, Examining the other two alternatives, using daily price changes, statistical inefficiencies were detected, on the one day level. Fewer dependence patterns were reported for longer intervals. The reported first order positive serial correlation can be a consequence of pricing limits imposed on trading in the market.

Chapter 6 provides a database of individual stock and market returns. Compiling this database was a major contribution of this research.

Chapter 7 investigates the effects of different return measurement and beta estimation approaches on tests of the CAPM. Specifically, the evidence indicates that the use of different return measurement approaches can affect the results of tests of this equilibrium model. Also, the adjustment of the trade-to-trade method, used for beta estimation, reduces heteroscedasticity resulting from using non equal time intervals when applying the market model.

The first part of chapter 8 provides an investigation of the sensitivity of the results, of CAPM tests, to the length of the period used to estimate beta. The results suggest that the longer the period, used to estimate beta, the more are the reported deviations from the implied relationships of the model. The second part of Chapter 8 provides a test of the CAPM using pooled data, and employing four lengths of periods to estimate beta. The evidence was not consistent with the model. But, when specific attention was given to the problem of thin trading, by constructing sub samples of the most traded stocks, the validity of the model was established. However, this was only the case when beta is estimated using 24 months of past returns, suggesting that market risk in Jordan changes fairly rapidly.

Chapter 9 investigates the power of some firm-specific variables in explaining the cross section of stock returns on the ASM. The evidence suggests that the book value, earnings, leverage and the firm size, do not help in explaining the cross section variation of firms listed on the ASM. This evidence is in accord with the CAPM.

CHAPTER ONE

I.

Introduction

1.1. Problem

The key question investigated in this thesis is the return generating process for stocks listed on the Amman Stock Market[2] (hereafter the ASM) -an emerging market with all the complications this engenders of thin trading, microstructure influences and possible collusive actions by trading agents. The behaviour of stock returns has been a field of extensive research in the developed markets, particularly in the USA, the UK, Canada, Australia and Japan. However, as noted by Jennergren (1976) findings based on studies of well-developed markets cannot be generalised to developing ones due to their different market characteristics and microstructures. Therefore, investigating the appropriateness of such findings on emerging markets is called for and discussed in this thesis. On the other hand, although the developing markets have recently been given more attention, due to increased evidence of international diversification opportunities[3] (attributed primarily to less return correlation between developed and developing markets), Jordan, among other countries, has not been given much attention either by internal or external researchers for several reasons. Firstly, the stock market in Jordan, (the ASM), is relatively new compared to other markets (established in 1978). Secondly, the small number of stocks listed on the ASM. Thirdly, the unavailability of machine readable security data that is a prerequisite to conducting any reasonable research directed towards studying various aspects of a stock market. Fourthly, the ASM is plagued by the phenomenon often referred to as thin trading[4] (not a specific characteristic of only the ASM). These factors are very important impediments to the encouragement

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[2] Previously known as the Amman Financial Market.
[3] See for example (V. Errunza, Emerging Markets: "*A New Opportunity for Improving Global Portfolio Performance*," Financial Analyst Journal, September-October 1983.
[4] This issue is discussed in more detail in chapter two.

of research in stock prices in the ASM. As a result the ASM is in a desperate need of empirical research in many aspects, particularly in respect of the process generating stock returns and the efficiency of the market. These interrelated issues are highly important for policy making and investment management in Jordan. Therefore, this research is designed to address the issue of price formation on the ASM bearing in mind the above mentioned obstacles, consequently, trying to adopt the most unbiased tools that can efficiently deal with issues resulting from such impediments.

This chapter is structured as follows: next section discusses the importance of this research, while section 3 presents the empirical component of the research plan. Section 4 introduces the data set and shows the selection procedure of the companies whose data was used for empirical work in later chapters. Finally, section 5 outlines the organisation and the plan of the thesis.

1.2. The Importance of the Study

The aim of this research is to enhance the understanding of the process generating stock returns and stock price behaviour in the ASM. To achieve this, the present study builds on prior work [e.g. Quaider (1993), Omet (1990), Al Kawasmi (1990), Al-Hmoud (1987)] on the ASM and provides a starting point for further work in the area. The issue of the trade off between risk and return is extensively discussed and investigated in the context of an emerging thin market and various factors, which have been proposed in the literature as having significant influence on security returns, are also investigated.

Specifically, there are two main significant developments in the Capital Market Theory that this research provides evidence on from a market whose characteristics are different from those extensively used in much of the empirical work. Firstly, the recent evidence questioning the importance of beta (the classical measure of risk) in explaining the cross section variations of returns, is investigated in the context of the thin emerging ASM (discussed in chapter four). Second, the asserted power of many variables in explaining this relationship, most notably the size variable and the book-to-market variable, is also analysed and discussed in chapter nine. In fact the evidence supporting these variables is being challenged (e.g. Black (1993)) on the basis that such results are products of data mining and are sample specific. Thus, the investigation of these developments in this research, using a different data set to those used previously, adds more evidence, on the alleged explanatory power of these variables, to this debate. In addition, the results of this research provide investors from various backgrounds with empirical evidence towards enhanced predictability and understanding of stock returns in the ASM. Finally, and perhaps most importantly for future work, in the process of conducting this research an extensive database of security prices on the ASM has been constructed.

1.3. Components of the Research Plan

The main components of this research are the following:

(I.) An investigation of whether or not the weak form of the Efficient Market Hypothesis could be supported in the ASM, in the context of the thin trading characteristic of the market Two main tests were applied: the serial correlation test and the runs test (Chapter five).

(II.) Constructing a daily, monthly stock market price and return index for the ASM. Besides constructing a daily and monthly individual stock price and return index for the companies included in the sample of stocks employed in the empirical investigations (Chapter six).

(III.) A study of the effects of using different return and beta estimation approaches on tests of the CAPM in the context of the ASM, employing a standard test of the CAPM based on the assumption of beta stability in the market. A second test was also employed to investigate the effects of using small portfolios on tests of the CAPM (Chapter seven).

(IV.) Testing the sensitivity of the CAPM tests to different assumptions of beta stability in the ASM; this was achieved by:

(A) Testing the CAPM using rolling betas estimated over three, four and five years.

(B) Testing the CAPM using rolling betas estimated over two, three, four and five years and employing the Pooled data methodology.

(C) Testing the CAPM (as in (B)) employing two sub samples; the construction of these sub samples aimed at investigating the effects of thin trading on the results. This was achieved through using:

1. Stocks with the Highest Number of Available Monthly Returns.
2. Stocks with the Highest Average Trades Per Year (Chapter eight).

(V.) An investigation of the explanatory power of various variables in explaining the cross section of stock returns. These variables were:

(A) The Earning Yield (or the Earning Price Ratio (E/P)).

(B) The Book-to-Market ratio, expressed as the ratio of the stock's book value to its market value.

(C) The Market Value of the firm (Firm Size). The market value of the stock multiplied by the number of stocks outstanding.

(D) Firm Leverage. Total Assets to Market Equity (Chapter nine).

The following section describes the data set used in this thesis and summarises the procedure used in the construction of the sample employed for various empirical investigations.

1.4. Data & Sample

The database used in this study consists of daily stock prices for the period between 1987-1994 for all the companies listed on the ASM. Although it was desirable to include all the companies in the database, some companies had to be excluded from the sample due to data requirements and various conditions which should be met in order to avoid some problems that might distort the estimates obtained by this empirical work.

Consequently, sampling was used to construct the database for testing purposes. The sample used in this thesis, however, is not randomly chosen, because if stocks were selected randomly the number of thinly traded stocks to be included in the sample would be greater than the number of frequently traded stocks, which causes the database to be populated with predominantly thinly traded firms that do not lend themselves to empirical investigation. Consequently, the stocks that have sufficient data available for analysis are limited.

The selection procedure was carried out as follows:

In 1994 all firms in the database were ranked based on the number of years of listing on the market; the maximum number of years of available trading data was eight years (1987-1994)[5]. For a firm to be included in the sample it had to satisfy all the following conditions:

First condition:

The company must have at least five years of daily price data. This was required to provide a reasonable length of time series for investigation purposes.

Second condition:

Continuous trading for at least five years was also a requisite. Therefore, if a company had a missing year of data, the years preceding the missing year will be excluded as well.

Third condition:

For a company to be included in the sample it must have at least an average of 100 trading days per year. This condition is postulated to reduce the effect of non trading on the results of the present study. Although, the 100 days figure was arbitrary, there was a trade off between the sample size and the need to use stocks that have a small degree of non-trading, thus it was desired to select the companies that have traded for at least 60% of the days in which the market was operating. The number of

[5] The start date of the database, compiled by the ASM, was 1987.

companies that satisfied this condition (of at least 60% of trading days) was only 37 companies, therefore, more companies were allowed into the sample although they traded less than 60% of the trading days. Consequently, the minimum required average trading days per year was lowered to 40 % of the total trading days of the market.

Fourth condition:

In addition, the inclusion of a company in the sample is dependent on the accessibility and accuracy of that company's data, without any serious doubts regarding the validity of such data.

As a result of the selection criteria above, the total number of companies investigated in this research is 52 companies[6]. Table (**1.1**) shows the selection process and the effect of the above conditions on the resultant sample size.

Table (**1.1**)
Universe of Companies in 1994 Sorted on the Number of Years of Trading

# of years	# of firms	# of firms Included	# of firms Excluded due to thin trading	# of firms Excluded due to missing years	# Excluded because they have less than 5 years listing	# of firms Excluded due to doubts surrounding their entries in database
8	64	40	20	2	0	2
7	17	7	9	1	0	0
6	6	4	0	1	0	1
5	6	1	3	2	0	0
4	6	0	0	0	6	0
3	6	0	0	0	6	0
2	12	0	0	0	11	1
1	26	0	0	0	26	0
Total	**143**	**52**	**32**	**6**	**49**	**4**

[6] Summarized in table (A1.1) in Appendix one.

With reference to table **(1.1),** it can be noted that the first condition is accountable for excluding 34.2 % of the stocks available in 1994, implying that these stocks have started trading after 1991. On the other hand after excluding 10% of the remaining stocks, due to the second and fourth conditions, the third condition (thin trading) lead to the exclusion of 38% of the stocks remaining, indicating the seriousness of the problem. A more detailed display of the sample components is available in table **(A1.1)** and **(A1.2)** shown in Appendix one[7].

However, the size of the resulting sample is illustrated in tables **(1.2)** and **(1.3)** below. Table **(1.2)** shows the size and number of companies listed on the ASM over the period 1987-1994.

Table (1.2)
Market Capitalisation[8] & Number of Listed Firms of the ASM

Year	1987	1988	1989	1990	1991	1992	1993	1994
Size (Million JD)[9]	930	1106	1361	1293	1707	2296	3464	3397
Number of stocks	116	116	116	112	112	119	148	166

Source: Toukan (1995)

Table **(1.3)** shows the sample size in each of the years covered by the research, both in terms of the number of companies in the sample relative to the number of stocks listed on the market and in terms of the market capitalisation of the stocks in the sample relative to the size of the universe of stocks listed on the ASM.

[7] In particular table (A1.1) shows the market capitalization of the companies covered by the study for the overall period of analyses. Table (A1.2) offers additional descriptions of the stocks in the sample, i.e. the start date of trading after the beginning of 1987, the number of trading days, the number of missing years and average trading per year for each company.

[8] JD is an abbreviation for Jordanian Dinar, the currency of Jordan. On the 23rd January 1997 the exchange rate of one Pound Sterling to one Jordanian Dinar was 1.164.

[9] Organized and Parallel Market.

Table (1.3)
Sample Size (1987-1994)

	1987	1988	1989	1990	1991	1992	1993	1994	Average
Sample Size * / Total Size **	76%	78%	90%	87%	77%	73%	61%	60%	76%
Sample Size / Total Size (# of firms)	46%	46%	44%	46%	46%	44%	36%	31%	46%

* SS = Sample Market Equity. ** TS = Total Market Equity.

It is also obvious from table (1.3) that in spite of the fact that the average number of listed companies of the sample is only 46% of the total market size of the companies in the market, these companies account for 76% of the total market capitalisation of the ASM. Further, the 52 companies constituting the sample are distributed among all the sectors of the ASM. The ASM classifies companies into industrial, banking, insurance and services. The sectoral distribution of the stocks of the sample is illustrated in table (1.4).

Table (1.4)
Sectoral Distribution of Firms in Relation to 1989 (Number of Stocks)

Sector	Total Sample	Total 1989	Sector representation 1989	Sample sector / Sample	Sample / 89
Services	9	29	26%*	17%*	31%
Industrial	31	43	37%	60%	72%
Banking	9	24	21%	17%	37.5%
Insurance	3	19	17%	6%	15.7%
Total	52	115	100%	100%	45.2%

* Approximation due to rounding.

From table (1.4) we notice that the sample is influenced largely (60%) by industrial firms although the industrial companies comprised (37%) of the stock market in terms of the number of listed firms. This could be attributed to two factors. The first being that the listed companies of industrial nature were amongst the first to need and benefit from the stock market due to the large capital needed for these companies' operations and continuity. The second factor is that trading in industrial companies is more frequent since they are large and their stocks are always on offer in the market.

However, looking at table (**A1.2**) in Appendix one, we notice that the sample is overwhelmed by the huge market capitalisation of the Arab Bank Plc., which accounts for about (38.6%) of the market capitalisation of the sample. As illustrated by table (**1.5**) below If we exclude this bank from the sample, however, the sample becomes heavily influenced by another three industrial companies, the market values of these companies, on average, relative to the total market value of the sample, after excluding the Arab bank being Jordan Phosphate (14.66%), Jordan Cement (10.99%) and Jordan Petroleum (6.48%). Combined the three companies make (32.02%) of the sample. Overall, these four companies form (68.27%) of the sample size by value.

Table (**1.5**)
Sectoral Distribution of Firms in Relation to 1989 (Market Value)

Sector	Sector ME / Sample ME* 100%	Sector ME Excluding Arab Bank/ Sample ME 100%	Sector ME Excluding Biggest 4** companies/ Sample ME 100%
Industrial	39.6	64.66	47.84
Services	6.46	8.86	13.04
Insurance	2.26	3.63	6.36
Banking	62.7	22.96	33.76
	100	100	100

* ME = Market Equity. ** Arab Bank, Jordan Phosphates, Jordan Cement and Jordan Petroleum.

Therefore, it is extremely important to keep these companies' stock price behaviour under constant observation. In fact this issue is highlighted when the value weighted index is constructed in chapter six of this thesis.

For the purpose of testing market efficiency, the database used in this thesis utilises daily stock prices over the period of 1987-1994 for the ASM. The reason behind the choice of this period is governed by the availability of the raw data which was obtained from primary sources. The database contains stock prices from July 1987 - December 1994.

As for the data used for various tests of the capital market theory, monthly prices were utilised for the analysis. The use of monthly time interval for return measurement has become the norm in the empirical world of Finance, particularly when investigating the generating process of stock returns. This came as a result of the evidence against the normality of the distribution of daily price changes. Monthly price changes, in contrast have been found to conform more to the normal or Gausian distribution (Gonedes and Blattberg (1974), Fama (1976) and Kon Stanley (1984)).

The selection of the sample, as pointed out above, is not random mainly due to the problem of thin trading. This problem was treated in part by the selection of the most traded stocks using, as a selection measure, the number of average trading days per year. Out of approximately 239 trading days per year the most traded stock scored 239 while the least traded stock in the sample scored 1 trade per year. The number of stocks that reported on average fewer than 10 trades per year was 18 companies; that is 13% of the stocks listed on ASM. Moreover, the number of stocks that had on average less than 200 trades per year was 112 stocks which, expressed as a percentage of the total number of firms in the market, is equal to 80%

of the stocks listed on the ASM, indicating the large degree of thin trading in the market. Indeed the fact that although the average number of stocks in the sample is only 46% of the total number of listed companies while the average capitalisation of the sample to the market is 76%, is an evidence that the market is dominated by the large market capitalisation of few companies.

The accounting variables used in this research are obtained from various issues of the Jordanian Shareholding Companies Guide published by the ASM's research department[10]. The risk free rate of return is obtained from the Central Bank of Jordan which supplied the prices of the three month treasury bill from which the monthly returns on the treasury bill could be computed (this return is assumed to proxy for the risk free rate of return).

Dividends are not adjusted for in the analysis due to the following considerations. Firstly, as informed by the ASM, the dividend date in the period before 1991 was considered the 31st of December. At the same time the fiscal year for most of the companies ended in March of the following year. This makes it difficult to make the adjustment for dividends in the appropriate year. The second reason was that although the it was attempted to tackle this issue, the ASM failed to supply the author with the dividend figures for most of the companies of the database.

1.5. Organisation and Plan of the Thesis

This thesis is organised as follows. Chapter 2 discusses the importance of stock markets, the evolution of the emerging markets and the development of the Amman

[10] Department of Research and Studies, Amman Financial Market, Amman, P.O. Box 8802, Jordan.

Stock Market. The issue of thin trading which is a main characteristic of the ASM (and many other emerging markets) is also highlighted. Dealing with this issue is of extreme importance as it has been ignored in many other studies of the ASM[11]. Chapter 3 discusses the efficient market theory and its effect on research in capital markets. The theory is outlined and some of the various anomalous evidence documented in the literature is also brought into the discussion of the validity of the theory. Chapter 4 discusses capital asset pricing and introduces the Capital Asset Pricing Model and the testability of the various developments of the theory is also discussed.

Chapters 5-9 contain the empirical investigations carried out in this thesis. Thus, Chapter 5 provides tests of the weak level of the Efficient Market Hypothesis using Jordanian data. These tests comprise the classical approach of using the serial correlation test and the runs test. This chapter also, investigates the effects of thin trading on the weak form tests of EMH. Chapter 6 describes the index construction and the database used for empirical work. While, Chapters 7 & 8 summarise an empirical attempt to test the Capital Asset Pricing Model using various methods. In particular Chapter 7 investigates the effects of using different return measurement and beta estimation approaches on tests of the CAPM. While Chapter 8 applies the concept of the rolling betas and tests various assumptions of the stability of beta across various time periods. It is also, the purpose of this chapter to test the CAPM using pooled data and to examine the effects of thin trading on the results of this test. Chapter 9 traces the alleged explanatory power of various accounting variables

[11] See for example Omet (1990) Quaider (1993), Al Kawasmi (1990), Alami and Civelek (1991) and Abdelhaleem (1993).

and provides an analysis of this issue. The evidence supporting the role of these variables in explaining the cross section variations of stock returns is a turning point in the theory of modern Finance and casts great doubt on asset pricing models like the CAPM, which advocates the ability of beta to solely, explain stock returns. Thus, this chapter provides another empirical investigation of the CAPM in the context of the ASM.

Chapter 10 provides a summary and concludes with the key findings of the study.

CHAPTER TWO

II.

Emerging Stock Markets

&

Amman Stock Market

2.1. Introduction

The stock markets make only one part of the capital market in any economy. Increasingly the role of stock markets has become greater in mobilising savings into the capital formation and growth of economies. Thus, attention is being increasingly given by analysts to these financial intermediaries in an attempt to understand the conditions that best render these markets as effective and efficient as possible. Emerging markets, and Jordan, are not exceptional cases, however, these markets may require more attention since most of the research is being conducted on developed markets. This chapter discusses the importance of stock markets and introduces the concept of emerging markets. The ASM is presented and the development of the market is also discussed. The most important characteristic of the ASM that needs to be highlighted, since it plays an important role in the subsequent empirical work, is the infrequency of trading that many of the stocks listed on the market suffer from. This issue is discussed fully below and various methods to deal with it are summarised in the analysis.

2.2. The Importance of stock Markets

Capital markets embrace all financial institutions that deal with capital, both in the short and long term (Patric and Wai, 1973); while stock markets, are those markets where companies sell stocks in order to generate long term capital that can be channelled into their profitable operations. When stocks are issued (sold), no redemption date is specified: buyers either hold on to their stocks for future dividend payouts, or exercise their right of selling their holdings at a very small transaction cost hoping for capital gains due to price appreciation. Thus, stock markets are, in essence, long term capital markets because once companies have sold their stocks they do not have to redeem them in any future date (although in certain instances they may wish to do so). However, the importance of security markets stems not only from them being markets of long term capital, but also, from their "*allocative efficiency of funds*" (Dryden (1970), Fama (1970)).

In this sense, Patric and Wai (1973), argued that funds raised via the capital market are channelled to the *"most efficient companies"* which are the most profitable, because people would like to invest in winners rather than losers. Bruce (1976) put it in a different way: The growing companies of an economy are those where the demand for their stocks is greater, hence, the stock market helps those companies by providing them with the needed capital for growth which reflects on the national economy's expansion rate.

Drake (1977) addresses the issue of the importance of stock markets by indicating that a stock market is worthwhile if it increases real savings, "*increases net capital inflow from abroad*", increases the return on investment and decreases the cost of capital in that economy. While few would argue with Drake, Wai and Patric (1973), who had previously pointed that what is more important than the rate of savings is "*the allocative effect of capital markets*". They pointed to the odds that stock markets might induce people to invest in these markets while channelling such investments to genuinely unprofitable projects. In short, they argued that, it is quite possible for a stock market to increase the savings rate in a country while at the same time giving inaccurate signals for resource allocation.

Nevertheless, in their basic form, stock markets are financial intermediaries that definitely assist lenders and borrowers of funds to meet conveniently and cheaply (primary markets). This function on its own identifies stock markets as an extremely important financial venue in any economy. Following from this, it is also, argued that stock markets are markets for liquidity (Firth and Keane, 1986). The secondary market in any stock market is a massive vehicle for enhancing (perhaps creating) the liquidity of the investment sector in the economy. In fact, some argue that stock markets were actually created to provide liquidity for long term financing (Bruce, (1976)).

In contrast, Wai and Patric, (1973) stated that stock markets were established to finance companies that were short of finance due to technological change and to finance government expenditures in the developed world. *Still, although liquidity is* a very important driving force behind having a stock market, it has to do more with the secondary market, where stocks are traded, rather than the primary market, where stocks are issued.

Whatever the reason might be behind the establishment of a particular stock market, stock markets have many advantages and vital contributions to any nation's capital market and Jordan is no exception. Opening up family owned businesses (Bruce, 1976), broadening the range of financial instruments that is available to investors and reducing the costs of financing, are just some of these advantages (Drake, 1977).

Nonetheless, for stock markets to be more effective in fulfilling their roles of efficient allocation of funds and the expansion of the national growth rate, various conditions of operational efficiency are expected to be satisfied. One of these conditions is the suitability of the political and the legal environment within which capital markets operate (Mullin 1996). This is a particularly necessary and crucial requisite to the developing countries where there is a large degree of political intervention in the market powers affecting and reducing the certainty levels within which companies and investors make decisions. This increased uncertainty stems from volatile environment and unguided anticipation that could affect the evaluation of future prospects of projects instantaneously influencing Stock prices which are essentially the present value of discounted future dividends. The more uncertain investors are about the future, the more will be the risk attached to their evaluation of future scenarios. This added risk makes potentially profitable projects unprofitable and forces investors into short term investments.

The legal environment, on the other hand, is of crucial importance to the well being of a stock market, since in the absence of legal regulations the market will most certainly be a power struggle and small investors will be the victims of the resulting conflict. Information disclosure requirements imposed on companies listed on a specific stock market is one example of such legal requirements, without which the very existence of stock markets will be jeopardised.

An immediate outcome of conflicting influences on any stock market is the prevalence of higher levels of risk associated with trading in such a market. This higher level of risk leads investors to demand higher rates of returns from their investments, since the conventional financial axiom is that *the higher the risk the higher is the expected return.* Not only, expensive financing will be the result, but also, less confidence in the stock market as a whole, which jointly could cause money to out flow rather than to flow into the countries in which such markets function.

The critical issue here is that, although a stock market could provide great benefits to an economy, it is of prime importance that the country within which that stock market is operating provides the essentials for such a market to deliver. In this respect, authorities should, beside encouraging companies to go public, assume a vital role in creating effective and efficient stock markets. This could be accomplished through reducing the degree of uncertainty and providing a fair and comprehensive regulatory system without actually interfering in stock price determination mechanism, since that is exactly what the stock market -secondary market- is there for.

Patric and Wai (1973), support this argument by stating that "*lack of confidence is probably the most important inhabitation to capital market development*". Whether or not that lack of confidence stems from a lack of adequate regulation or from political instability and consequently uncertainty or even from the price determination mechanism of stock markets, such a lack of confidence must be eliminated by all means starting from penalising misconduct and providing the regulations for fair play in the market.

2.3. Emerging Stock Markets

The term *"emerging market"* is a labelling, by the world bank, given to that group of stock markets belonging to a common level of GDP per capita[12]. As has happened in many developed countries, many developing countries' governments needed to finance their development plans especially in 1950's and 1960's after the decline of foreign aid to these countries. Therefore, government borrowing through stock markets was inevitable (Wai and Patric, 1973).

Errunza, (1983) categorises emerging markets into three categories:

1. Old Markets: which are not effective in raising equity capital (e.g. Argentina, Chile, Brazil,...).
2. Markets that emerged as a result of specific situations. Jordan for example, emerged as a result of petro-dollars remitted into it, both as economic aid and as remittances made by Jordanians working in the Gulf States.
3. Markets that were organised to participate in the economic growth of their countries (e.g. the Philippine and Thailand).

However, special circumstances of many developing countries lessened the roles of their stock markets in economic development than their counterparts in the developed world. Foreign dominance over many businesses and family owned enterprises trivialised the need for stock markets since capital was concentrated in the hands of few families and foreign companies who were financed from abroad.

[12] Jordan's GDP per capita of US$ 1,595 in 1995, equipped it to be in the "take off" stage on the emerging market scale.

This necessitated the interference of the authorities to redistribute wealth and to stop the accumulation of capital in the hands of few.

With two goals in mind: raising the growth rate of the economy and the re-distribution of income, governments in many developing countries backed the establishment of new markets and the activation of existent ones. Accordingly, and inspite of many obstacles (such as the reluctance of many large firms in many developing countries to go public, mainly in fear of loss of control and loss of secrecy), capital markets in developing countries are standing on their feet, facilitating capital formation and fuelling the economic growth in their countries. The economies behind emerging markets performed well in the past 10 years with a positive flow of local private savings into their stock markets attracted by favourable investment performance. Mullin (1993) argues that, the annualised equity returns for many developing countries between the period 1976-1992 exceeded 20% (Argentina, Chile, South Korea), while for the same period annualised equity returns for the US was 16% and for Japan was 17%. A more dramatic example is that in 1990-1992 equity returns for Chile and Mexico has risen to almost 60% per annum. Table (**2.1**) below shows the growth rate of these emerging markets which peaked in the late 1980's.

Table (**2.1**)
Market Capitalisation of Developed & Emerging Stock Markets
1983-1991(Million US Dollars)

Market	*1983*	*1984*	*1986*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
Developed	3,301,117	3,349,770	4,661,942	6,378,234	7,639,736	9371462	11,106,681	9,077,039	10,760,028
Growth rate	-	1.47%	36.89%	40.12%	19.78%	22.67%	18.62%	-18.27%	18.64%
Emerging	83,222	92,127	116,224	136,066	189,997	366,433	606,382	471,049	647,969
Growth rate	-	10.70%	26.07%	17.21%	40.68%	87.60%	69.84%	-22.19%	37.66%
TOTAL	3,384,339	3,441,897	4,667,166	6,613,290	7,829,732	9,727,886	11,712,06	9,648,088	1,407,987

Source: Different IFC reports.

Although the market capitalisation of many emerging markets was swelling, the major growth is really restricted to few of all these markets. Table **(2.2)** below illustrates such concentration in growth:

Table (**2.2**)
Market Capitalisation of the Largest Emerging Stock Markets
1984 -1992 (Billion $ US Dollars)

MARKET	*1984*	*1986*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
BRAZIL	28996	42768	42096	16900	32149	44368	16364	42769	46261
INDIA	6370	14364	13688	17067	23623	27316	38667	47730	66119
KOREA	6223	7381	13924	32906	94238	140946	110694	96373	107448
MALAYSIA	19401	16229	16066	18631	23318	39842	48611	68627	94004
MEXICO	2197	3816	6962	8371	13784	22660	32726	98178	139061
TAIWAN	9889	10432	16367	48634	120017	237012	100710	124864	101124
TOTAL	73076	94989	106992	142398	307129	612034	347661	468631	662017
% of Total Emerging Markets	79.4%	82.6%	78.6%	76%	86.2%	84.6%	73.8%	72.3%	71.3%
TOTAL	**73076**	**94989**	**106992**	**142398**	**307129**	**612034**	**347661**	**468631**	**662017**

Source: IFC Emerging Markets Fact Book (1993).

Despite this large concentration rate, the emerging markets' share in the total market capitalisation of the world is on the increase. This is apparent in table **(2.3)** below.

Table (**2.3**)
Market Capitalisation of Emerging Markets as a Percentage of the Capitalisation of the World Capital Markets(1983 - 1992)

1983	*1984*	*1986*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
2.46%	2.68%	2.47%	2.07%	2.43%	3.66%	6.17%	4.93%	6.68%	6.98%

Source: IFC Emerging Markets Fact Book (1993).

However, the desired effectiveness and efficiency of stock markets is adversely affected by some common factors plaguing many developing countries, but, to varying degrees. Infrequent trading[13], inadequate information disclosure and insider trading are some of those factors that obstruct the efficiency and effectiveness of those markets.

[13] Infrequent trading is used interchangeably with thin trading and nonsynchronous trading.

3. To collect and publish necessary information and statistics to realise the said objectives[14].

The ASM as an institution is a stock exchange and a regulatory body that regulates the issuance and dealings in stocks in Jordan. Stocks are sold and bought through stock brokers operating on the market floor and the trading takes the form of continuous (during trading hours) auctioning.

The market operates a price limit policy which necessarily means that stock prices should not go above or below a pre-specified limit within one day. This limit is expressed as a percentage of the opening price of the stock. Currently[15] the price limit is 6% of the opening price of any stock. Through the years this limit was changed in magnitude as the authorities considered fit. The reason behind having such a price limit is, as viewed by the director general of the market, to *"prevent large price fluctuations in addition to eliminating unnecessary speculation and protecting the interests of the small saver"* (Toukan 1996).

It is noted here that the presence of such a price limit[16] is expected to interfere in the daily operational efficiency of the market. This is simply the consequence of the logic which argues that since the efficiency of the market means that prices adjust instantaneously to new information[17], a market operating a price limit will be

[14] Although the Market collects the information, the way this information is published leaves much to be desired in the sense that a machine readable information is not widely available.
[15] In 1996.
[16] Between 1978-1982 there was no limits in the market, but from 1982 the market imposed pricing limits of varying magnitudes. So, between 1982-1985 the limit was 10%, between 1985-1990 the limit was 5%, between 01/01/1990 and 01/04/1990 the limit was 2% and since 01/04/1990-to date it is 5%.
[17] Fama (1970).

hindered by such limits if the real change in the price due to new information is larger than the specified limit. It will be argued later[18] that these limits are of possible influence of a large degree of serial correlation in price changes in the ASM.

As noted earlier, companies listed on the ASM are subdivided into four sectors. Banking, Insurance, Services and Industrial[19]. The market is open to international investors and there are no barriers to entry or exit from the market, however, foreign investors are not allowed to own more than 49% of any company's stocks. However, capital gains and dividends belonging to foreigners can be remitted outside the country without any restrictions provided that this capital has originated from abroad.

The following table provides a summary of the development of the ASM, since its establishment.

Table (2.4)
Development of the ASM[20] in Terms of the Number of Listed Companies and Market Capitalisation

Year	*# of Firms listed on organised market*	*Growth rate %*	*Market Capitalisation Million JD*	*Growth rate %*
1978	67	-	286	-
1979	71	26%	462	68%
1980	71	0%	496	10%
1981	72	1%	834	68%
1982	86	19%	1034	24%
1983	96	10%	1063	2%
1984	103	8%	911	-13%
1985	104	1%	926	2%
1986	104	0%	891	-4%

[18] in chapter five.
[19] Which is the largest of the four.
[20] Umayya Toukan, *Amman Financial Market; Structure and performance*, Paper presented to the conference on Middle East Stock Markets. Held by MEED. London, May 2, 1995.

Table (2.4) **Continued**

Year	*# of Firms listed on organised market*	*Growth rate %*	*Market Capitalisation Million JD*	*Growth rate %*
1987	116	11%	929	4%
1988	116	0%	1104	19%
1989	116	0%	1360	23%
1990	112	-3%	1293	-6%
1991	112	0%	1707	32%
1992	119	6%	2296	34%
1993	148	24%	3463	61%
1994	139	-6%	3397	-2%

From the above table it is clear that the ASM has developed rapidly over the past few years in all aspects. In fact it is obvious that the market is small, both in terms of market capitalisation and the number of stocks listed, but this characteristic is vanishing, to an extent, in both aspects. Thus, given the short period of the life of the market the growth rate in these two measures is quite good. Thus, compared to other markets in the region the ASM is now being considered as one of the leading stock markets in the Arab world. This issue is discussed in the following section.

2.4.1. Characteristics of the ASM

The ASM is very small, both in terms of market capitalisation and the number of firms listed on it. This small size attribute is shared with many markets in the developing world. In fact the ASM might seem large compared to some other Arab markets in the region, such as Oman, Morocco and Tunisia, as highlighted by table **(2.5)** which shows the size of some of the leading Arab stock markets including the ASM.

Table (**2.5**)
Market Capitalisation of Leading Arab Stock Markets (1989-1994)
(Billion $ US Dollars)

Country	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*
Egypt	3.966	2.636	2.666	3.267	3.800	N.A
Jordan	2.161	1.927	2.604	3.286	4.773	4.912
Morocco	0.621	0.966	1.627	1.876	2.662	3.813
Oman	*0.726	*0.967	*1.122	1.048	1.093	1.443
Tunisia	N.A	646	0.630	0.834	0.966	1.760

* The Dollar Exchange Rate is the 1992 Exchange rate.

The above table shows that the ASM could be considered a large market in regional standards, but in international standards, however, the ASM remains a small market.

Another key characteristic of the market is the level of non-trading or thin-trading encountered by the companies listed on the market. Thin trading is a problem relating to the infrequency of trading in some of the stocks that are listed on any stock market (see, among others, Dimson and Marsh (1983), Brown and Warner (1986), Cohen et al. (1983), Errunza (1986)). However, If the infrequency of trading is prevalent, the situation is characterised as *"non-trading"* rather than just *"thin-trading"* where we can consider non-trading as a severe presence of thin trading or infrequent trading. There are many reasons for the existence of thin trading in any market; the most important of which is the concentration of stocks in the hands of the few who are reluctant to sell or give up control of the companies, thus, prohibiting to a great extent the trading in the stocks of certain companies, resulting in the presence of the problem of thin trading.

2.4.2. Thin trading

As stated above, thin trading is the infrequency of trading in a particular stock or market. It is argued that thin trading hinders the flow of funds in stock markets and negatively affects the growth and expansion of stock markets leading to adverse effects on their development (Gandhi et al. 1980).

Furthermore, thin trading creates several problems for research in the pricing of capital assets. Fama (1966) argued that non trading in a specific stock could lead analysts to assume that since no price change was reported, no change in the value of the stock did occur. Market factors could influence a change in the underlying price of an asset but, due to a lag in reporting, the change could go unnoticed. Marchal (1974), emphasised this point and argued that for insiders or informed traders, prices of stocks would change without trading in the market. This could be more relevant in some small emerging markets, where disclosure requirements are not strictly satisfied and insider dealings are not adequately monitored.

A second problem surfaces when constructing an index for frequently and infrequently traded stocks. For a given time interval the computed return for the market index is a weighed average of the returns of the stocks included in the index. If the prices are not synchronously recorded -i.e. not representing the same time period- the index will suffer positive serial correlation, although individual stocks are not positively correlated (Heinkel and Kraus (1988); Atchinson, Butlet and Simonds (1987); Copley, Cooley and Roenfeldt (1984)). This complication is evident in the Amman stock market, since the serial correlation reported for the index is large and positive. In fact the first order serial correlation computed for the purposes of this research (30%) is larger than that for any stock in the index.

The third problem is the bias introduced in estimating beta. This bias results from using the returns on stocks over a particular time period to estimate the beta of the stock whereas this return could represent a previous time period (Dimson, 1979). This phenomenon is particularly disturbing to the analysis of stock returns if daily returns or shorter intervals are used (Scholes and Williams, 1977). However, it could also be disturbing even when longer time intervals (monthly prices rather than daily or weekly) are used, depending on the thinness of the market and the infrequency of trading in relevant stocks.

Thus, the estimation of CAPM betas is immensely affected due to the bias introduced to the market model that is used in estimation. Since the true beta for a given stock is unobservable, beta is usually estimated using the market model:

$$R_{j,t} = a_j + b_j R_{mt} + e_{j,t} \qquad \textbf{(E.2.1)}$$

where (b_j), which is the slope of the regression line between the return on the stock (R_{jt}) and the return on the market portfolio (R_{mt}), is a measure of the beta (β_j) of stock j.

e_{jt} is a random error term at time t, which has a zero mean $E(e) = 0$, and a constant variance ($\sigma_e^2 = \sigma^2$) and not correlated with itself or with the market return. $\begin{matrix} \operatorname{cov}(e_{j,}e_i) = 0 \\ \operatorname{cov}(e_{i,}R_m) = 0 \end{matrix}$

To yield an unbiased estimate of beta the values of R_j and R_m have to be synchronous thus, allowing the terms to be subscript with t which is the same time interval so that they become R_{jt} and R_{mt}. That is security returns, measured over the same time period, have to be regressed against the corresponding market returns, whether it is daily or weekly or monthly. If stock j is thinly traded compared to the market, then the beta and alpha estimates are biased; the beta estimate will be biased downward due to large underestimation of the covariance with the market (Dimson 1979).

Several researchers have endeavoured to address thin trading issue so that beta could be estimated without any bias, since the correct estimation of the beta of the stock is the basis for much work investigating stock return behaviour such as tests of the CAPM. Ibbotson (1976), for example, suggested that for thinly traded stocks the beta of concern is a sum of the lagged and unlagged betas, thus the model of (**E.2.1**) becomes:

$$R_{j,t} = \alpha_t + B_{t,j}(R_{mt}) + B_{j,t-1}(R_{m,t-1}) + e_{jt} \qquad \textbf{(E.2.2)}$$

where,

t is time (month).

$R_{j,t}$ is the return on security j during month t.

Consequently, true beta is:

$$Bj \cong Bj,t + Bj,t-1 \qquad \textbf{(E.2.3)}$$

Ibbotson argued that the rationale behind this model is that, because of thin trading, a part of the monthly return of a thinly traded stock is reflected in its next month's return. This is particularly relevant when a stock's end of month price is not the actual price at the actual end of month, leading the return measured for the next month to cover part of the previous month's return. Further, he argued that because of the month to month independence of the market portfolio's returns no multicollinearity is to be expected. However, if month to month returns are dependent then there would be multicollinearity, which would affect this measure of beta. Given the evidence, discussed in chapter three, that stock prices are not strictly drawn from a normal distribution, if monthly returns are dependent, this dependence might be difficult to detect using statistical techniques that assume the normality of time series (Fama 1965).

Another technique to correct for thin trading could be to linearly interpolate prices for non trading days. Heinkel and Kraus (1988), building on the assumption that stock prices change without trading due to information affecting these specific stocks, assumed that the information affecting a specific stock has two components:

- Systematic information, influencing similar stocks sharing common factors.
- Unsystematic or peculiar information affecting a specific stock.

Heinkel and Kraus progressed to estimate the possible change in the price of the non-traded stock by regressing the return of that stock on the return of an index of returns for stocks, therefore inferring the amount by which a stock price could change by comparing it to similar stocks. The variables they sought to estimate were a_j and b_j of the following equation:

$$R_{j,t} = a_j + b_j R_{xt} + u_{jt} \qquad \textbf{(E.2.4)}$$

where,

u_{jt} is the peculiar or "idiosyncratic" information affecting stock j on day t.

R_{xt} is the return on index x at time t.

This equation differs from the market model of equation **(E.2.1)** in that the return index (R_{xt}) used here can be any index of stocks that are similar to the stock for which beta is to be estimated, rather than the return on the market portfolio (R_{mt}).

As argued by Jennergren (1976), the interpolation alternative can be rejected based on two reasons. Firstly, interpolation does not guarantee generating prices that could be believed to resemble actual prices which we are interested in. Secondly, linear interpolation leads to more dependence structure of successive price changes leading to non randomness in the time series of price changes. In addition, in the context of the Amman Stock Market, the fact that many stocks did not report price changes for fairly long periods of time (sometimes months) suggests that interpolation will distort the data set used for analysis if such a procedure was adopted.

Franks et al. (1977), used a different method to correct for thin trading. In essence, they suggested that market returns in the regression equation should be matched with actual security returns that are reported as a result of actual transaction prices. In other words, stock returns for a particular period must be regressed on the corresponding market returns for the same period. This method is called the *"trade-to-trade"* method. Franks et al. also argued that the chief advantage of this method is that it does not discriminate against thinly traded stocks therefore, allows utilising all the available information, i.e. it does not reduce the sample size.

However, Dimson (1979), argued that *trade-to-trade* requires that the specific stock has known dates of transaction for each price recorded. The market, as well, must have exact dates and negligible level of non trading. However, Dimson's treatment (1979) was similar to that suggested by Ibbotson (**E.2.2**) but using more than one period for producing beta coefficients. Dimson's method is called the aggregated coefficients method, where in this method the market model of (**E.2.1**) becomes:

$$\hat{R}_{it} = \hat{\alpha} + \sum_{k=-n}^{n} \hat{B}_{ik} R_{mt+k} + w_{t1} \qquad \textbf{(E.2.5)}$$

where,

$\hat{R}_{it}$ is the measured return for stock i.

$\hat{\alpha}$ *and* $\hat{B}_i$ are obtained from Ordinary Least Square (OLS) multiple regression.

R_{mt+k} is the measured return for the market portfolio over period $t+k$ where, k is any number of months.

This equation is a multiple regression equation regressing observed returns on preceding, synchronous and subsequent market returns. Beta, then, is calculated by aggregating the slope coefficients from this regression (hence the name).

However, the criticism that applies to **(E.2.4)** suggested by Heinkel and Kraus apply to Dimson's beta. Thus, for very thinly traded stocks it appears that the trade-to trade method provides a good measure of the beta of the stock. However, Marsh (1979), argued that the use of *trade-to-trade* will introduce heteroscedasticity, due to estimating beta over different lengths of periods. If the residual's variance is proportional to the length of the period, the variance will not be constant, then heteroscedasticity results. Marsh developed a weighting scheme to avoid heteroscedasticity, by dividing the variables by the square root of time, so the model of equation **(E.2.1)** becomes:

$$\frac{R_{jti}}{\sqrt{t_i}} = \frac{\alpha_{ip}}{\sqrt{t_i}} + \beta_{ip}\frac{R_{mti}}{\sqrt{t_i}} + e_{it} \qquad \textbf{(E.2.6)}$$

where,

R_{jti} and R_{mti} are the returns on stock j on the market portfolio during period t_i which is the period separating two recorded prices for stock j.

t_i is the time between trades.

α_{ip} is redefined as the continuously compounded rate of return per day during estimation period p.

β_{ip} is the beta estimate of stock i for the period p.

However, the most widely used of these methods for dealing with thin trading are the *Dimson's aggregated coefficients* approach and the *trade-to-trade* procedure and more recently the *Marsh adjusted trade-to-trade* method. But, based on the above, and for the purpose of this research the *Marsh adjusted trade-to-trade* method of equation **(E.2.6)** to correct for thin trading in the Amman Stock Exchange will be used, because of the severe thin observed in the ASM, along with the *unadjusted trade-to-trade* method for comparison purposes.

2.5. Conclusion

This chapter introduced the ASM and discussed its main developments. In addition, the infrequency of trading in the ASM was highlighted. In fact this is a characteristic shared by many small emerging markets constituting a big challenge to research conducted in this area. The problem of thin trading has been given considerable attention in developed markets and ignored in developing markets where it is most severe. In fact, in many small stock markets (e.g. ASM) the problem of the infrequency of trading could almost be non-trading rather than thin trading. Therefore, this issue has to be dealt with in order to facilitate research on emerging markets. Various proposed solutions to tackle the issue were outlined above. Because the phenomenon of thin trading in ASM is sever the most appropriate method for dealing with it is the Marsh adjusted trade-to-trade method because it avoids interpolation which is rejected for its possible distorting effects if prices are dependent, and it avoids using more than one period to estimate beta which might lead to incorrect beta estimates if multicollinearity results again if monthly returns are dependent. It is noteworthy that any suggested method cannot totally deal with the effects of thin trading and that should be remembered when analysing the results.

Having introduced the ASM and discussed its thin-trading characteristic we move on to outlining the Efficient Market Theory with particular attention given to its weak form level, which is tested in chapter five.

CHAPTER THREE

III.

Efficient Market Theory

(EMT)

3.1. Introduction
Whether it is a market in a developed country or a developing one, "*the ideal is a market in which prices provide accurate signals for resource allocation*" (Fama, 1970). As discussed in chapter two of this thesis, the stock market is not necessarily a useful channel for the allocation of funds in an economy unless it is characterised with operational effectiveness as well as efficiency. Firth and Keane (1986), argue that, the consequence of the poor performance could easily lead to more speculation resulting in an increase in the cost of capital.

Although, *"stock"* markets are similar to other asset markets, in the sense that they have all the market components, i.e. buyers, sellers and goods, stock markets still differ in many aspects from other markets resulting in more efficiency. An important attribute, for instance, is homogeneity, which essentially means the substitutability between different stocks. This implies that the investor is only concerned with risk-return trade off rather than having particular preference for holding a specific stock. Consequently, if an investor is faced by two different stocks representing the same risk-return preference, the investor is not expected to favour one stock to the other. Furthermore, the location independence nature of these markets together with the huge information support available for traders make investors in stock markets considerably better informed than any traders in any market. These factors, *inter alia*, as argued by Keane (1985) should enhance the efficiency of stock markets, to the extent that they "*make the stock market more likely than most to be capable of generating prices that fully reflect the worth of assets being traded*".

This idea of efficiency was illustrated in greater details by Fama (1970) who stated that *"a market in which prices always fully reflect available information is called efficient"*. Differently expressed, market efficiency requires that in setting stock prices at any time $t-1$, the market correctly uses all available information (Fama, 1976, Reply to LeRoy).

These statements could be interpreted to highlight different implications of market efficiency, but the most important implication of efficiency is that, market efficiency that is based on information set (I) essentially suggests the impossibility of profiting *"consistently"* by trading on this set of information (Jensen, 1978).

The *"consistently* " term is of prime importance to the theory of efficiency, since, it is meant to rule out the influence of luck or chance, since it is impossible for an investor to make abnormal profits *"consistently"* based merely on luck. In contrast abnormal profits should be made on the basis of better understanding of the price generating process.

A central issue to the notion of efficiency is the concept of the intrinsic value of a security. Beaver (1981) defines the intrinsic value of a security as the price of that security if all investors agreed upon its worth. This means that the intrinsic value of a security is its real value at that specific point of time. Thus, a security's price is the actual net collective assessment of the future potentials of that security at that point of time.

A market is efficient if the security price at any point of time is believed to be equal to the intrinsic value of that security at that time. If inequality is thought to prevail, market inefficiency also prevails. What causes discrepancy between the intrinsic value of a security and its price, according to Beaver (1981), is the "*superior information*" being possessed by some investors and the different interpretations of the implications of available information which are due to "*different education backgrounds*". On the other hand, Keane (1985) argues that the lack of confidence in the ability of stock markets to provide correct pricing of future potentials of stocks could result in the divergence between a security price and its intrinsic value.

Fama (1970), indicated that competition between market participants is the key issue to efficiency provided that "*a sufficient number have ready access to available information*". In this sense, Henfery, Albrecht and Richards (1977), argued that what makes the market efficient is the existence of competing investors who believe that the market is inefficient. They asserted that once the information subset (I) is released, many investors alter and update their assessments of future performance of the stocks affected by the information released. Thus, by doing so they affect the market by "*bidding up or down*" the prices of stocks. The crucial belief here is that, when investors actually bid the price up or down, at that very minute, they essentially do so because they think that these stocks are under or over priced. Consequently, and by so doing they cause the market to be efficient.

However, it is rare that a stock market is identified as efficient or inefficient; instead, it could be efficient to some and inefficient to some, at least as a mater of belief. This point is also highlighted by the many studies that attempted to tackle the issue of efficiency and sometimes found a market efficient and in other times the same market was found to be inefficient[21].

This introduces the existence of two major categories of investment strategies, passive and active investment. Passive investors believe that the market is at least economically[22] efficient and, therefore, concentrate on portfolio management and adopt the strategy of holding portfolios for long term. On the other hand, active investors reflect a belief of the existence of over and under priced stocks and involve in active buying and selling of stocks in the hope of realising above average rates of return (Fuller and Farrell, 1987).

3.2. Implications of Market Efficiency

The efficiency debate that commenced in the 1950's in the USA and spread from there to many countries of the world was crucial for many reasons. If capital markets are efficient in terms of pricing stocks, then, there is allocative efficiency of a nation's wealth to those units where the potentials for growth are most obvious (Haugen, 1993). This is because in an efficient market the information will be transmitted quickly and incorporated instantaneously in prices, thus favourable information will result in higher prices which will reward such successful companies.

[21] As shall be argued later, ASM is a perfect example of this.

[22] Economic efficiency means that even if statistical techniques could detect inefficiencies in a specific market, trading on these inefficiencies is not profitable because of the transaction costs.

An additional implication of the efficient market theory is that there is no under or overvalued stocks with respect to publicly available information. As a result of market efficiency, stocks are always correctly priced. Therefore, there is no such right or wrong time for companies attempting to raise capital on the market (Lumby, 1989).

Although efficiency is important for listed public companies, it is also important for investors and investment managers alike. For investors, the most rewarding implication is the construction of a well diversified portfolio that corresponds to the risk preferences of those investors, consequently the best strategy is to buy and hold stocks for either capital gains or simply for future dividend payments (Henfery, Albrecht and Richards, 1977).

For investment managers, more time and resources should be spent on fundamental analysis rather than technical analysis, i.e. stocks should be valued based on the information affecting their future prospects. This implies that resources are wasted if they are used to *"beat the market"* by trying to identify under or over priced stocks. More savings are made from reducing the large transaction costs and commissions paid to brokers through excessive buying and selling in hope for achieving abnormal high returns (Firth and Keane, 1986).

Another substantial implication of market efficiency is related to the regulatory authorities in charge of stock markets. The efficient market theory implies that regulators are not to interfere in the price formation of stocks in any stock market.

However, authorities are still required to prosecute illegal activities in the market, encourage by all means better disclosure practices by companies and facilitate the dissemination of information as soon as they are generated in time (Firth and Keane, 1986).

In addition, a common view prior to market efficiency was that, private information is very important for profit making and many believed in the existence of privileged groups (insiders). As a result, confidence in stock markets was lost and attention was diverted to other investment channels. Market efficiency has restored such confidence, by showing that such a phenomenon is not necessarily true (Fama, 1991).

Last but not least, the most significant implication of market efficiency is the role of information. Since all the information is impounded in stock prices this implicitly suggests that the information is fully absorbed by market participants. Thus, an efficient market is a market that is heavily researched and the securities in which are continuously scrutinised by market traders. Therefore, market efficiency does allow people with superior information and analysis skills to make financial gains in such a market.

3.3. The Random Walk Model

Before delving into the details of the market efficiency hypothesis (or theory as Keane (1985) argues) it is of prime importance to trace back the very beginning of the issue. "*The genesis of the efficient market hypothesis was with the observation* *that stock price changes appeared to follow a random walk"* (Fuller and Farrell, 1987).

The issue discussed was: what describes -rather than explains- the behaviour of security price changes?. Early researchers -as early as Bachelier's work (1900)- indicated that the best model that describes the behaviour of stock price changes could be the random walk model. Kendal (1953), on the basis on his analysis of 22 price series ranging between 486-2386 weekly observations, stated that *"it seems that the change in prices from one week to the next is independent of the change from that week to the one after. This alone is enough to show that it is impossible to predict the price from week to week from the series and if the series really is wandering, any systematic movement such as trends or cycles which may be observed in such series are illusory".*

Robert (1959), also showed, by comparing the actual behaviour of the Dow Jones industrial index on weekly basis for a year with a *"hypothetical year's experience generated randomly"*, that the behaviour of the weekly changes of the Dow Jones Index corresponded to the behaviour of *"the chance model"* which essentially is a random walk model. The random walk model does not explain why stock prices change, but describes the behaviour of these changes. Fama (1965) argues that the random walk tells everything, but it does not tell you anything.

However, shedding more light on this random character, Cootner (1964) pointed out that stock prices change in response to the release of new information that alters potential performance assessments of specific companies. The release of this information affects stock prices because traders respond to these information released by bidding up and down stock prices. The point is that, the timing of the information release is the random factor which makes stock price changes random. This is exactly what Fama (1965) meant when he noted that *"the existence of intrinsic value for individual stocks is not inconsistent with the random walk hypothesis"*. Fama, whose work in this area has become somewhat classic, noted that the random walk model entails that:

- Successive price changes are independent.
- Price changes conform to some probability distribution.

In mathematical terms the Random walk model is expressed as:

$$P_t = P_{t-1} + e_t \qquad \textbf{(E.3.1)}$$

where,

P_t is the price of the stock at time t.

p_{t-1} is the price of the stock at time $t-1$.

e_t is the residual at time t. The residual has zero mean and is non correlated with previous terms in the residual series. That is:

$E(e_t)=0$

$\operatorname{cov}[e_{t,}e_{t-s}]=0$

All $s \neq 0$ (Granger and Morgenstern, 1970).

Although the model does not posit any particular probability distribution, it was generally assumed that the residual series are independent identically distributed (iid) series. Also it was assumed that the residual term e_t, is a random variable with constant variance (Dryden, (1970)).

The most widely held interpretation of the random walk model was that if the model actually describes the behaviour of price changes, it means that no one can predict future price changes based on previous price changes (Fama, (1965), (1970), Cootner, (1964)). Moreover, the model says that the probability of a price change of a specific stock is entirely independent of the probability of previous changes (Dryden, (1970)).

This random character of price changes attracted many researchers who applied the model to many markets around the world trying to develop a better understanding of stock[23] price changes. As mentioned earlier, although Bachelier (1900) proposed the model, serious attention was not given to it until Kendal (1953), with British data, found support for the model using weekly index prices. Similar support was documented for the random walk using US data (Robert H. (1959)). However, the use of weekly price changes and indices rather than daily price changes and individual stocks did not warrant a generalisation of such results. Kendal stated that the use of index numbers could result in a higher degree of correlation than would be expected from the use of the index's components. This correlation could reduce the degree of randomness.

[23] Sometimes other price series were used, such as commodity prices (for example Alexander(1961), used wheat prices).

However, tests of the model concentrated on the main two assumptions upon which the model rests, i.e. the independence of price changes and the normality assumption of the distribution of price changes.

3.4. The Independence of Stock Prices

The independence of successive price changes simply implies that a change in a stock's price that occurs at time t is not influenced or related to previous price changes of that stock (Fama (1965)). An immediate implication of the independence assumption is that previous sequences of price changes are of no value in predicting future price changes. The rationale is that: the random generation process of new information and the non systematic noise -or overreaction- lead essentially to successive price changes being independent of one another (Fama (1965)).

To test the independence assumption two types of statistical tests were widely employed; the serial correlation test and the runs test. In the context of the present research these tests were employed to test the independence of price changes in the ASM over the period (1987-1994). The formulation of these tests and the results are discussed in chapter five of this thesis. However, the following sections introduce these tests and discuss the evidence presented from various markets.

3.4.1. Serial Correlation Test

Serial correlation test is, in fact, an investigation of the randomness of a price series. If there is an insignificant degree of serial correlation the price series under consideration will be considered random. However, it is worth mentioning here that a reliable serial correlation test requires that the residual term in the regression equation, e_t must be normally distributed with a zero mean and a stationary variance (Roux and Gilbertson, 1978).

The serial correlation coefficient determines if a stock's price change at day t, is related to the same stock's price change the day before (Conrad and Juttner, 1973). The first order serial correlation coefficient (r_x) of interest for each price series at lag x is given by:

$$r_x = \frac{\operatorname{cov} ariance(u_t, u_{t-1})}{\operatorname{var} iance(u_t)} \qquad \textbf{(E.3.2)}$$

where,

$$u_t = \log p_{t+1} - \log p_t \qquad \textbf{(E.3.3)}$$

The standard error for sample of N size is

$$\sigma(r_x) = \sqrt{1/(N-x)} \qquad \textbf{(E.3.4)}$$

We note that in implementing the tests we use changes in log prices rather than changes in price. Hong (1978) argues that log prices are preferred to prices because the variance of $(p_{t+1} - p_t)$ increases with the price of the stock p_t, but the variance of (u_t) of equation **(E.3.3)** does not.

Fama (1965) also, argues that "*the change in log price is the yield with continuous compounding from holding the security for that day*".

The British researcher Kendal, was probably the first researcher to use the serial correlation test as a tool for testing the random walk hypothesis. In his study of 22 price series in (1953) he concluded "*an analysis of stock exchange movements revealed little serial correlation with series and little lag correlation between series*" (Kendal, 1953). Further series of serial correlation tests were carried out by Fama (1965) who studied 30 companies comprising the Dow Jones Industrial Index for the period 1957-1962. For Lags of $X = 1$ to 30 days, serial correlation coefficients were obtained for each stock.

Using 1200-1700 observations per stock, Fama found that "*all sample serial correlation coefficients are quite small in absolute value, the largest is 0.123*". A 0.123 correlation coefficient equals 0.015 coefficient of determination which means that only 1.5% of today's price change could be explained by yesterday's price change. This points to the weak predictive powers of previous price changes.
However, Fama found that 11 out of 30 coefficients for lag $x = 1$ day are more than twice their computed standard errors, which could indicate dependence, but, as Fama argued they are too small in value to imply dependence patterns. Fama defies the importance of these non zero coefficients as signs of dependence by stating "*dependence of such a small order of magnitude is, from a practical point of view, probably unimportant for both the statisticians and the investors*".

As for longer differencing intervals the "*absolute*" size of the coefficients are noticed to increase with the increase of differencing intervals and the "*average*" size of the coefficients decrease with longer intervals. The reason behind this, argues

Fama, is that "*the variability of "r" is inversely related to the sample size*" (Fama, 1965).

Fama's famous study was replicated by large number of researchers all over the world. Dryden, (1970) analysed 15 stocks listed on the London Stock exchange (LSE) and found that almost all the correlation coefficients were statistically insignificant, although, like Fama, he noticed a preponderance of positive signs for the first order coefficients. Furthermore, no definite pattern was found for longer than 1 day lag. Dryden concluded that, "*In sum, there is no evidence based on this analysis to refute the random walk hypothesis*".

3.4.2. Runs Analysis

Even if the distribution of price changes is not normal, the random walk model can be tested using the runs test. This is possible because the runs test in essence is a non- parametric test. Webster (1995) defines the run test as "*a nonparametric test for randomness in the sampling process*". He also defines nonparametric tests as "*statistical procedures that can be used to test hypothesis when no assumptions regarding parameters or population distribution are possible*". However, another reason for using the runs test is the possibility that the correlation coefficient might be dominated by extreme values (Fisher and Jordan, 1987). The runs rest takes into consideration only the signs rather than values. The actual number of runs that is computed from a time series is then compared to the number of runs expected from a randomly generated time series. The expected number of runs (M) is computed using the following formula (Lawrence, 1986):

$$M = [N(N+1) - \sum_{i=1}^{3} n_i^2] / N \qquad \textbf{(E.3.5)}$$

where,

N total number of price changes.

n_i total number of price changes of each sign.

The standard error S_m is:

$$s_m = [(\sum_{i=1}^{3} n_i^2 (\sum_{i=1}^{3} n_i^2 + N(N+1) - 2N \sum_{i=1}^{3} n_i^3) / N^2 (N-1)]^{\frac{1}{2}} \qquad \textbf{(E.3.6)}$$

In the previous equation it is assumed that there are 3 price changes (+, -, 0). That is the price of the stock could go up (+) or could go down (-) or could remain unchanged, thus (0).

To test for statistical significance it is straight forward, since for large samples the distribution of the expected runs is approximately normal (Martin, 1982). For this purpose the standardised variable K is used.

$$K = (J - M \pm \frac{1}{2}) / S_M \qquad \textbf{(E.3.7)}$$

J total observed number of runs of all types

$\frac{1}{2}$ discontinuity adjustment, the sign of which is plus if $J \leq M$, and minus if $J \geq M$.

If the actual number of runs is significantly different from the expected number of runs generated by a random mechanism then the series under consideration is not randomly generated. The larger the difference between the actual and expected number of runs, the greater is the divergence from randomness. Furthermore, if the actual number of runs is considerably less than the expected number of runs, this indicates a positive correlation in successive signs stemming from a clustering of symbols of the same sign which could lead to an inference of a trend. On the other hand, if the actual number of runs is more than the expected, this means that there is a negative correlation in successive signs. A possible explanation of this relationship is that "*short period movements may influence the series systematically*" (Conrad and Jutner, 1973).

The runs test and the serial correlation test often give consistent results. Thus, a negative standardised variable suggests positive serial correlation, because in both incidents the actual runs are less than the expected ones, and vice-versa (Martin, 1986). However, in this study the serial correlation and the runs tests are employed.

3.4.3. Filter Rules

Filter rules are trading rules suggested by Alexander (1961). Based on the assumption that there might be smooth trends that could not be picked up by the basic tests of serial correlation, Alexander designed several trading filters in the following manner: "*If the market goes up X % go long and stay long until it moves down X % at which time sell and go short until it again moves up X %. Ignore moves of less than X%*". Alexander argued that a trend could be a result of slow reactions of investors to market news and a trend in the price generation process that cause security prices to change. He, then, applied filters ranging from 1% to 4.5% to the daily average closing prices of Standard and Poor's industrials for the 9592 trading days from 1928 to 1961. The outcome of Alexander's filter tests was that "*The results uniformly favour the smaller filter over the buy and hold method*".

Alexander, noted that transaction costs could have an effect on his results, but did not measure them.

These results appear to contradict with the Efficient Market Theory (EMT). In defence of the EMT, Mandelbrot (1963) argued that Alexander's assumptions are far from reality since the investor will always pay more than assumed and gets less than suggested by Alexander. The reason is the very low probability of any move that triggers the X % filter to be exactly equal to X %. Therefore, the trader losses both buying and selling. Alexander (1964), on the other hand, pointed out another source of bias in his calculations, that is the use of daily closing prices rather than daily highs and lows. He stated that the use of daily highs and lows would trigger more transactions *"each of these additional transactions would have involved a loss. The magnitude of this loss is the filter itself, since these highs and lows are beyond the trigger point and they reverse instantly"*. After correcting for this bias, Alexander undertook the study again and noted that although profits are reduced sharply, *"filters that showed profits in earlier study still show profit"*. The significance of Alexander's study was that it is the first to tackle the possible presence of a non linear relationship in price changes that could not be detected using standard statistical tools.

Two main EMT enthusiasts, Fama and Blume (1966), concluded after investigating the filter rules on the Dow Jones Industrial Average for the period 1957-1962 that, *"the filter technique cannot be used to increase the expected profits of the investor who must pay the brokerage commissions"*. Apparently, the results of the filter rules replicate the runs test that were performed by Fama in (1965). In (1970) Fama pointed out that the dependence level in security price changes could be utilised if a trading rule is constructed, but, he argued that such a trading rule will generate enough transaction costs to demolish the benefits of trading on such a rule.

Evidence from the UK was provided by Dryden (1970) who studied the UK stock prices by analysing 15 stocks in the period 1963-1964, and 1966-1970. Dryden stated that *"except for the two smallest filters, filter rates are on average less than the corresponding buy and hold rates, thus providing some support for the random walk hypothesis "*.

A study of Stockholm Stock Market by Jennergren (1975) examined 30 stocks listed on the market between the period 1967-1971. Using daily closing prices and applying filters ranging from 1% to 20% Jennergren found that *"all filters were on the average, considerably less profitable than the buy and hold policy"*. On the other hand, Jennergren has shown that, employing large filters and to the institutional investors and brokers, the use of filters produced higher profits than the buy and hold strategy.

However, this study differs from previous filter studies (i.e. Fama and Blume, (1966), Dryden, (1970)) in that the transactions take place next day after the transactions are triggered and no short sale was included. Instead a bank account was used when the investor is not long on a security. It is quite obvious that the basic assumption behind the use of filter trading rules is that information is not fully and instantaneously reflected in prices (Taylor, 1982).

From the above it seems that tests of filter rules must take into consideration the transaction costs to enable a general conclusion of market efficiency. Moreover, tests that are based on closing prices may not be appropriate since it is impossible to act on these prices, since by definition they are closing prices. Consequently, the unavailability of intraday stock price data together with the unavailability of transaction costs, did not allow a meaningful examination of the possible use of various filters on the efficiency of the ASM.

3.5. Distribution of Price Changes

The foregoing discussion dealt with the independence of security price changes which is the most important of the two assumptions constituting the random walk model. Nevertheless, the determination of independence (or dependence) of price changes is based upon statistical tools that assume a specific distribution of price changes, i.e. normal or Gausian distribution (Bachelier (1900), Fama (1965)).

Bachelier (1900) was the first to introduce the notion of the identically independent distributed price changes, arguing that, as the central limit theorem indicates, large numbers of changes are normally distributed. Moreover, Osborne (1959) argued that "*the normal distribution arises in many stochastic processes involving large numbers of independent variables, and certainly the market place should fulfil this condition at least*". However, many researchers who have empirically investigated stock price behaviour have reached the conclusion that the distribution of stock price changes "approximates" normality rather than being normal in nature (Elton & Gruber (1991) Levy & Sarnat (1984), Fama & Miller (1972) and for emerging markets Errunza & Losq[24] (1985), and for Jordan Omet (1990)). Mitchell (1915) was the first to note that *"the empirical distributions of price changes are usually too peaked to be relative to samples from Gaussian populations"*[25]. Mandelbrot (1963) suggested the stable Paretian distribution which is *"another family of probability laws"*. The reason behind this radical change in the theory of the distribution of price changes, was that more observations have occurred around the mean and in the tails of the distribution than would be expected from a normal distribution.

Mandelbrot's hypothesis was that *"log prices behave randomly and the distribution of price changes has infinite variance"*. The importance of this hypothesis is that it has implications for the tests of market efficiency since, if the assumption of normality does not hold, the use of some tests like the serial correlation test, for example, is fruitless. This is what Fama (1976) meant by stating that the rejection of the normality assumption is very costly. Looking at the monthly returns rather than daily returns Fama (1976) asserted that monthly returns are closer to normality than daily returns. Fama stated that *"the monthly returns are close enough to normal for the normal model to be a good working approximation"*.

[24] Interestingly Errunza and Losq found that returns on some emerging markets do follow a log normal distribution.
[25] Noted by Mandelbrot (1963) Footnote 3.

3.6. Weak Form Efficiency

The foregoing discussion regarding stock price behaviour has resulted in a hypothesis that is strongly becoming a solid theory called the Efficient Market Theory (EMT). As pointed out earlier, Fama (1970) defines an efficient market as "*a market in which prices always fully reflect available information*". Drawing on Fama's work the term *"fully reflect available information"* is not testable. To make it testable, Fama posited that equilibrium prices (or expected returns) are generated by a specific model conditional upon information subset (I_t).

In the case of equilibrium prices as a result of expected return conditional on some information (I_t) we find:

$$E(\tilde{P}_{j,t+1}|I_t) = [E(1+\tilde{r}_{j,t+1}|I_t)]P_{jt} \quad \textbf{(E.3.8)}$$

[26]

where,

$\tilde{P}_{j,t+1}$ price of security j at time $t+1$.

$\tilde{r}_{j,t+1}$ one period percentage return on security j and equals $\dfrac{(P_{j,t+1} - P_{jt})}{P_{jt}}$.

I_t any set of information at time t assumed to be used in determining equilibrium expected returns.

This is what is meant by fully reflected. Based on this argument three subsets of information were used to test market efficiency:

1. Past historic prices. These prices were used to test if such information is valuable in determining future stock returns. This subset of information is only relevant for the weak form efficiency of the market.

[26] Which is a fair game.

2. All publicly available information. It is believed by those who are pro market efficiency that, possessing all publicly available information about a stock cannot lead to *"consistently"* making abnormal profits. The term "consistently" means that it might be possible for an investor to sometimes make abnormal profits based on mere chance, but, it is impossible for him to beat the market based on the currently available information. If the market is found to satisfy this condition, the market is semi-strong efficient.
3. All information. Past, public, or private information is thought to be of no importance to an investor in outperforming the market. This means that the market is strong-form efficient.

The fundamental theme of the efficient market theory is that "*the true expected return on any security is equal to its equilibrium expected value*" which necessarily means that, the available set of information at time t is the same set of information the market uses to set the equilibrium price of a security at time t (Fama, 1970).

Fama (1976) argues that there are two main models of market equilibrium that are used in tests of the efficient market hypothesis:

1. *Expected returns are positive*: based on information subset (I) at time t, the market determines the price of security a at time t assuming that the expected return of security a from t to $t+1$ is positive. That is:

$$E\ (\tilde{R}_{at+1} | I_t) = \frac{E\ (\tilde{P}_{at+1} | I_t) - P_{a,t}}{P_{a,t}} > \text{Zero} \qquad \textbf{(E.3.9)}$$

which means,

$$E\ (\tilde{R}_{at+1} | I_t) > 0$$

The expected return at time $t+1$ based on the information (I) at time t utilised by the market is positive. This model of market equilibrium has been used to test the trading rules that are used by traders to beat the market.

2. *Expected returns are constant*: at any time t the market sets the price of security a based on the information subset at that time, assuming the expected return to be constant.

$$E\ (\tilde{R}_{at+1} | I_t) = \frac{E(\tilde{P}_{at+1} | I_t) - P_{a,t}}{P_{a,t}} = E(\tilde{R}_a) \qquad \textbf{(E.3.10)}$$

If the market is efficient then the true expected return of security a is equal to the market assessment of expected return $E(\tilde{R}_a)$.

In an efficient market, this model of **(E.3.10)** implies that it is impossible for any investor to use the information available at time t to make better predictions of a stock's return at time $t+1$ than the market prediction.

The available information consists of three sets of information, each is suitable for testing a different level of market efficiency. For the weak form efficiency the information set is past security prices. The model is:

$$E(\tilde{R}_{at+1} | \tilde{R}_{a,t}, \tilde{R}_{a,t-1}, R_{a,t-2}, \ldots) = E(\tilde{R}_a) \qquad \textbf{(E.3.11)}$$

This means that the expected return on security $E(\tilde{R}_a)$, given the past sequence of its returns, equals the expected return on security a. This directly implies the futility of the knowledge of past returns as means of forecasting future stock returns. Thus, in chapter five of this thesis this model is assumed to be the underlying model of stock returns, so the weak form efficiency of the EMT is investigated under the equilibrium assumption of equation **(E.3.11)**.

A direct way to test this assumption is to test for serial correlation between past price series. If serial correlation coefficients are found to be close to zero, then the previous model holds. If the correlation coefficients are at least twice their standard errors, significant serial correlation results, casting doubts on the previous model and supporting the likelihood of making predictions based on past return series.

Nevertheless, in testing the market equilibrium model, the main approach was to perform the same tests that were used to test the random walk model; serial correlation and runs tests. The other test was the filter rules test, which is based on the market equilibrium model of positive returns (Henfry, Albrecht and Richards, 1977).

3.6.1. Evidence of Market Efficiency

It was important to provide evidence from as many stock markets as possible, not only because the evidence from the US market was not clear cut, but also because markets around the world do differ from each other warranting specific research for each market. However, it is important to focus in this review on the evidence from emerging markets.

One such piece of evidence was provided by Hong (1978), who tested the weak form efficiency in some Far Eastern countries; Japan, Australia, Hong Kong and Singapore. Utilising the serial correlation and runs tests on weekly prices of market data for the period 1973-1976, Hong noted that for all the countries studied there was little evidence of serial independence. However, he noticed that Japan[27] had the highest degree of independence of price changes, therefore, highest degree of market efficiency. Australia, on the other hand, had more serial dependence than Hong Kong and Singapore, as detected by the serial correlation and runs tests.

Another important study of the Far Eastern countries was carried out by Ko and Lee (1991), who conducted a comparative analysis of the daily behaviour of stock returns of the USA, Japan and NICs (Hong Kong, Korea, Taiwan and Singapore). Ko and Lee, used a value weighted stock market index of all the stocks for each stock market from January 1981 through December 1988, while for Hong Kong the Hang Seng index was used. Employing daily returns all tests were performed by dividing the entire period into four sub periods, each of 2 years length. Regarding Singapore, they stated, that "*very high dependent structure in daily return data and negative serial correlation in the last sub period are noted*". However, the runs test suggest that "*the weak form market efficiency does not hold except in the USA*" while Hong Kong and Taiwan show significant dependence only in the last sub period of the total period considered, Japan and Singapore have significant dependence in all sub periods.

Another examination of the Hong Kong Stock Exchange was carried out by Dawson (1984) using a different technique to examine the trend towards efficiency in the Hong Kong Exchange. If the recommended stocks (by stock brokers) made higher

[27] Hong used this evidence to argue that larger markets are more efficient than smaller ones.

risk adjusted returns than non recommended stocks then the market is not efficient. Dawson examined the trend of such recommendations over the period 1974-1982 and found that there is a trend towards efficiency.

Roux and Gilberson (1978) investigated the efficiency of the Johannesburg's Market using daily prices of 24 stocks, covering the period of 1971-1976 and employing the usual autocorrelation and runs tests. Their primary finding was that *"Price changes were not completely independent"*. However, the deviation from independence was not large, but, did not allow a conclusion of randomness.

Laurence (1986) examined the efficiency of the Kuala Lumpur and Singapore Stock Markets. Employing the serial correlation and runs tests and using 24 stocks from Singapore and 16 stocks from Kuala Lumpur over the period 1973-1978, Laurence found that some sample stocks exhibit random walk behaviour while others deviate from the random walk. However, more deviations from random walk came from the Singapore Stock Exchange. Laurence concluded that, small deviations from perfect independence has been found.

Dickinson and Muragu (1994) examined the Nairobi stock exchange concluding that *"The vast majority of coefficients are not statistically significantly different from zero"*.

Not much widely available evidence is available for the Arab stock markets. However, Al Ajami (1994) examined the efficiency of four Gulf States' markets.

The countries studied were, Kuwait, Saudi Arabia, Oman and Bahrain. Using serial correlation test and runs test Al Ajami concluded that *"The finding of this study provides evidence to substantiate the claim that a small and thin stock market does not conform to the efficient market hypothesis"*. Similar results for Arab markets were provided by (Gandhi, Sunders and Richards (1980) and Eltijani (1986)). In particular, Gandhi et al. (1980) investigated if the Kuwaiti market was efficient over the 1974-1976 period. Characterising the market as, a highly thin and volatile market Gandhi et al. found that the Kuwaiti market was inefficient. Using autocorrelation and runs tests, they noted that *"share prices tend to move systematically over time"*.

Even in the more developing markets the evidence does not strongly support the efficient market theory. Dryden (1970) studied the price changes of 15 stocks listed on the LSE, stating that the results of some statistical tests agree with the random walk model, despite, the presence of small systematic changes *"which suggest that perhaps there are some patterns present in share prices"*. Kemp and Reid (1971) used non parametric tools to test the random walk model on British data. Applying these tools on 50 stocks' daily prices and covering the period of about 70 days (October 28, 1968 to January 10, 1969). Kemp and Raid concluded that *"share price movements were conspicuously non random over the period considered"*. However, although Kemp and Raid considered their conclusion as a warning to those *"startled"* by the randomness hypothesis, they justified their use of such a short time series, that they are only interested in *"investors behaviour over a short time horizon"*.

Using more British data, Benjamin and Grimes (1974) examined 543 stocks listed on London Stock Exchange covering the period 1968-1971 and found that:

1. 20% of stocks behave in a non random fashion, while 30% behave according to a random walk.
2. Larger companies' stocks exhibit more random behaviour than smaller stocks.

Cunrad and Juttner (1973) using Germany data to test the random walk model have investigated daily price changes of 54 stocks over the period 1968-1971, and concluded that there is high degree of dependence revealed by the runs analysis and the serial correlation test. Therefore, they refuted the random walk model as a model describing security price changes in Germany.

Solnik (1973) examined the random walk model in European countries employing the serial correlation and runs tests. He used daily prices for a sample of 234 stocks from 8 European stock markets, covering the period between 1966-1971. From a statistical point of view, Solnik concluded that there is a degree of non randomness that is greater than that found by Fama (1965) using American data. However, this randomness is *"negligible from an investor point of view"*. Solnik attributed the departures from the random walk to *"loose requirements for disclosure of information, no control on insider's trading, thin markets and discontinuity in trading"*.

Considering the above -and the enormous amount of research evidence- it is notable that the main verdict of empirical work is to refute the strict form of the efficient market hypothesis. As a result a distinction between economic efficiency and statistical efficiency was crucial to the debate of market efficiency. While statistical efficiency is no more accepted due to unanimous agreement upon the existence of a small degree of dependence in stock price changes. Economic efficiency, on the other hand, asserts that a market is efficient as long as no profits could be made from it based upon the statistical inefficiency. The crucial factor here, it seems, is the presence of transaction and data processing costs.

Nevertheless, it is of prime importance to note that it is quite possible for a filter rule to produce positive returns, and still agree with the random walk model. This is due to the case where expected price changes do not have zero mean, instead the process is a random walk with a drift. The important issue here is that such a trading strategy in such circumstances must not outperform a buy and hold strategy, and that is reasonable, since the expected price changes in both cases should be positive (Dryden 1970).

3.6.2. Evidence From the ASM

Although the efficient market theory was suggested in the 70's of this century, the earliest publicly available evidence on such a theory from the ASM dates back to 1990. Al Kawasmi (1990) tested the weak form efficiency of the ASM by analysing the weekly abnormal returns for 23 industrial companies listed on the ASM for the period 1986-1987. He, also tested for the presence of serial correlation using weekly price changes for the same sample. Al Kawasmi reported significant serial correlation coefficients between changes in prices and changes in abnormal returns for most of the companies of the sample studied[28]. The author concluded that the ASM is not efficient at the weak form level for the period 1986-1987.

This result was challenged (although using a different time period) by another study of the ASM, which reported findings that are contradictory to those of Al Kawasmi. Quaider (1993) used weekly price changes for 26 companies for the period 1988-1991, to test the filter rules. The author found that a strategy of buy and hold outperformed any filter used, indicating that weekly stock prices are independent. Using the runs test, the author found that the actual number of runs is very close to the expected number of runs of a stochastic process. Based on the above Quaider concluded that "*prices on the ASM follow a random walk pattern, therefore, the market is efficient on the weak form level*".

Another examination of the efficiency of the ASM was carried out by Alami & Civelek (1991) who used serial correlation tests and runs test on a sample of 25 industrial listed companies. The time period covered was 1981-1989 with monthly stock returns. Using the serial correlation test Alami & Civelek concluded that "*there is no statistical evidence to support the independence of successive price changes, and that is due to high degree of average serial correlation 0.147 for all sub periods studied and for all stocks included in the sample*". The runs test also refuted the independence hypothesis, leading Alami and Cevilik to conclude that the ASM is not weak form efficient for the period 1981-1989.

[28] Transaction costs were not considered in this study, because of they were not available.

Using daily closing prices of 16 industrial companies listed on the ASM for the period 1979-1986 Omet (1990) employed serial correlation tests, runs tests and filter rules to investigate the efficiency of the ASM. He computed the serial correlation coefficient for lag X = 1, 2, 3, 4 and 5 days and found that for a lag of one day, 15 out of 16 stocks had positive coefficients that are more than twice their computed standard errors (i.e. significant). The largest coefficient was (+0.269) while the average coefficient for lag 1 for the 16 stocks was (+0.118). This was seen by Omet as evidence of non randomness of stock price changes in the ASM. Further, using the runs test he found that for 1 day lag the actual number of runs are on average less than the expected number of runs by 16.8% which lead Omet to conclude that there is positive dependence[29] patterns as suggested by the serial correlation tests. With regard to longer than two day time intervals, however, Omet concluded that his results support the independence hypothesis.

However, it is noted here that the above tests used price changes as they were generated in time and this can effect the above documented results due to the infrequency of trading in the ASM. With regard to this problem and its effects on the serial correlation and runs tests non of the surveyed work that is carried out on the ASM (and emerging small markets) acknowledged this empirical problem. Chapter five of this thesis highlights this issue and examines possible approaches to deal with it.

Using a number of filters ranging from 0.1% to 5.0% Omet found that the smaller than 2% filters outperformed buy and hold strategy. Even after transactions costs the

[29] The same result, for the same period, was reached by Al-Hmoud (1987) where he found the mean correlation coefficients was 0.135.

filter rule provided higher rates of returns than the buy and hold strategy. The author stated that during 1979-1986 the filter rules outperformed the buy and hold strategy by a compounded interest of some 4.4% per year.

However, Omet noted that for filters of 1% and less the profitability of these rules is due to one stock, by excluding it from the test, the profitability of smaller filters is greatly reduced, but still outperformed buy and hold strategy. In this case the overall average of filters outperformed the buy and hold strategy by 2.1% per year. Based on the above, Omet concluded that the ASM *"provides us with contrary evidence to the random walk hypothesis between the years 1979- 1986"*[30].

Similar to Alexander's filter rules it was assumed in Omet's study that the trader could always buy and sell at the previous closing price. In fact, Omet has shown that the microstructure of the ASM does not facilitate such a mechanism, stating that *"The trader had to buy at a higher price and sell at a lower price"*. This means that there is a bias in the filter rule conclusion in this case in favour of non randomness.

Regarding the issues of normality of the distribution of price changes, Alami and Civelek (1991) based on their analysis of monthly price changes of 25 companies, covering the period 1981-1989, reported that stock price changes on the ASM do not conform to normal distribution. Omet, as well, arrived at the same conclusion of non normal distribution of stock price changes while implying that such a distribution is better described as a stable Paritian distribution due to peaked centres and fat tails.

[30] Again Al-Hmoud made the same conclusion with reference to the same period studied. He stated *"the random walk hypothesis is probably not an accurate description of the Amman Stock Exchange"*.

From the preceding discussion, evidently there are different conclusions arrived at using similar techniques, but to some extent, different time periods. However, the most dominant evidence is in support of the inefficiency of the ASM. Therefore, an important objective of this thesis is to investigate the independence hypothesis of the ASM covering the period of (1987-1994). This empirical investigation is the subject of chapter five.

3.7. Criticism of Efficient Market Theory

Nearly all studies that utilised serial correlation tests have found significant serial correlation coefficients. In fact, Fama (1965) has pointed out that there might never be a time series that is characterised by perfect independence. In his sequel to the 1970's article, Fama (1991) stated that *"a weaker and economically more sensible version of the efficiency hypothesis says that prices reflect information to the point where marginal benefits of acting on information do not exceed the marginal costs"*. This new definition allows for a degree of dependence without refuting the hypothesis of efficiency. It is economic efficiency rather than statistical efficiency that is of interest.

This was seen as a retreat by the theory. In addition, the pro technical analysis criticised the basis upon which markets are declared efficient by challenging the statistical tools employed by researchers to discover *"compact, historical price relationships"* (Fisher and Jordan, 1987). In fact, much of the evidence of market efficiency came as a result of using serial correlation tests. Many argued that such a technique lacks statistical power, consequently, inferences based on such a technique are weak. Even Fama (1991) who is considered a major advocate of market efficiency stated that *"tests based on autocorrelation lack power because past realised returns are noisy measures of expected returns* ".

Nevertheless, a more serious criticism of the theory was what is known in the financial economics literature as the anomalous evidence of market efficiency. This is discussed briefly below.

3.8. Anomalous Evidence

The main challenge to the efficient market hypothesis came as a result of various empirical evidence referred to in the literature as anomalous evidence. Such evidence was documented by several authors and came from many markets around the world. In particular, systematic regularities in stock returns that are not being explained by the EMT or any other theory were documented (Lakonishok and Maberly, 1990). The most perplexing evidences was relating to: the day of the week effect[31], the holiday effect, the January effect[32], the price/earning ratio effect, the small firm effect and the book-to-market ratio effect[33]. To discuss all this evidence is beyond the scope of this thesis, but a quick reference to some of it is outlined below.

The day of the week effect refers to the evidence that on particular days stock returns earn higher (or lower returns) than on other days. The actual days differ from country to country but mainly the evidence was mostly documented to be associated

[31] Also known as the weekend effect.
[32] Ariel (1987) reported a monthly effect where stocks earn higher returns in the beginning of any calendar month. This is different from the January effect.
[33] The latter three are discussed in length in chapter nine of this thesis.

with Mondays[34] (For evidence from the UK see (O'Hanlon (1988), Board and Sutcliffe (1988)), Choy and O'Hanlon (1989)) and for international evidence see (Condoyanni et al. (1987), Jaffe and Westerfield (1985b)). Specifically, stocks were found to earn negative returns on Mondays. Suggested explanations for the phenomenon are as voluminous as the evidence. However, amongst some of the interesting explanations, was that of Rystrom (1989) who argued that since investors' decisions are results of psychology as well as rational justification, such psychological influences change across days. He argued that, by and large, people are more pessimistic on Mondays than Fridays, for example, which influences their investment behaviour, thus people want to sell more on Mondays and by more on Fridays. As a result stock prices will be depressed on Mondays and the opposite on Fridays. Another interesting explanation is the settlement procedure, which results in higher stock returns for Fridays and less stock returns for Mondays (Lakonishok and Levi (1982), Gibbons and Hess (1981)). However, many rejected this explanation as the sole force behind the week day effect (Jaffe and Westerfield, (1985a, 1985b)). For example, while Lakonishok and Levi (1982) pointed out that the settlement practice in the USA that is causing the week day effect was adopted in 1968, Keim and Satmbaugh (1984) found that the day of the week effect is most notable in the period of 1882-1952, that is long before the adoption of the practice. Moreover, many did not accept this evidence and suggested that the evidence is a product of inadequacy of the methodologies and statistical tools used in identifying this evidence (Connolly, 1989). Similar to the evidence reported for the day of the

[34] Jaffe and Westerfield (1985a, 1985b) found that in Japan and Australia the day of the week effect is on Tuesdays.

week (the Monday effect), a wave of evidence was documented that stocks earned higher returns on the days before holidays (Ariel, 1990).

Further evidence reported that in January stock returns are systematically higher than other months in the year (Givoly and Ovadia (1983) and Angel et al. (1984)). This regularity was mainly attributed to the observed practice of selling in December and re-buying in January, thus bidding the prices up resulting in high stock returns. Such an explanation was the most widely accepted, although not considered the sole reason behind the phenomenon (Van Den Bergh[35] and Wessels (1985), Tinic et al. (1987) with Canadian data, Reinganum[36] and Shapiro (1987) with British data, Dyl and Maberly (1992)).

Nevertheless, this documented evidence against the EMT remains without explanation; at least the EMT does not offer a satisfactory explanation of the underlying causes for the seasonal behaviour of stock returns. Such seasonalities must be accounted for in tests of the efficient market hypothesis and tests of the capital market theory which implicitly tests the capital market efficiency hypothesis. What causes more concern in the real world is that people trade on such anomalies therefore, the non random character of security returns is violated, since these phenomenon are becoming systematic.

3.9. Conclusion

The foregoing discussion of the efficiency issue indicates that the theory is too strict

[35] They found a January effect in Holland although the Dutch Tax System differs greatly from that in the USA.
[36] They found an April effect that is consistent with the tax selling hypothesis.

to be true. Prices do not, always, fully and instantaneously reflect all the available information, instead what might be a better description of reality is that although randomness is violated in many markets (dependence is so small), correct predictions of the future based on past prices is not viable, but, such a small dependence resulting from slow reflection of information in security prices allows some institutional investors and some brokers to profit from this non randomness.

However, it is argued by few that in their attempt to act on trading strategies' signals, traders cause the market to move and thus such profitable opportunities disappear. Probably this is why the weak form efficiency of the efficient market hypothesis did not posit the serial independence of price changes but posited that no investor can continuously earn above average return based solely on analysing past prices (Fuller and Farell, 1987).

Those who are pro market efficiency say that what is being proved wrong is the random walk model rather than market efficiency, because if such trends are present then traders will arbitrage them away and consequently make the market efficient. Yet, if past price series are showing trends, such trends are not in the present as to be acted upon, therefore, no abnormal profits could be made, which implies market efficiency.

However, some of the main conclusions reached at from the previous discussion can be summarised in few points:

1. Absolute independence of price changes does not seem to exist.

2. Although a study of a specific market agrees with the random walk model, another study of the same market could either agree or disagree, therefore, no result is final[37].
3. The question of randomness is a matter of an average, hence it is quite obvious that many studies have found that although some stock price changes are not random, the majority are, and vice versa.
4. There is a place for other theories that attempt to describe the behaviour of stock price changes. One such theory is the overreaction theory first implied by Kendal (1953) who pointed out that a potential reason for the presence of negative serial correlation coefficients is "*The tendency of the market to swing too far and to correct itself*".

In relation to the last point, De Bondt (1990) found, in a study about the economists' forecasting behaviour, that they "*tend to overreact, and their forecast error is systematic*". De Bondt argues that it is possible that a better model of stock price behaviour could be identified by "*admitting to some irrationality and exploring its equilibrium implications* ".

In any case, the present study examined the efficiency of the ASM using a time series that covers a period of the (1987-1994) and analysed that efficiency in the context of sub periods to find out in which periods the market is efficient and in which it is not. The objective being to provide more evidence on the efficiency of the ASM on the weak form level[38]. Moreover, the discussion above directed the research in an important direction; the problems of thin trading. Thus, the weak

[37] For example Al Kawasmi (1990) has shown that the ASM is not efficient while Quaider (1993) has shown that it is.
[38] Results are discussed in chapter five.

form efficiency of the ASM is examined in the context of the infrequency of trading evident in the market. This required the use of different approaches to deal with non-trading to infer a price for the non trading days.

The next chapter discusses the developments of the Capital Asset Pricing Model and provides the framework for the empirical work of chapters six, seven, eight and nine.

CHAPTER FOUR

IV.

Capital Asset Pricing

4.1. Introduction

Investigating equilibrium prices in the stock market is the driving force behind the development of equilibrium models such as the Capital Asset Pricing Model. But Explaining the prices in stock markets has never been an easy or a straightforward task, making the development of models that provide an insight into such a complex pricing mechanism as exciting as actually determining the influences behind the pricing of stocks. Thus, any model that attempted to provide an answer to the issue has been received with extensive testing and verifications.

Perhaps the most discussed and tested of all these models is the Capital Asset Pricing Model. This model of Sharpe (1964)-Lintner (1965) is an extension of Markowitz portfolio theory to encompass the risk-return trade off of capital assets in equilibrium (Markowitz (1952), (1959)). The portfolio theory provided a solution to the investment decision making under conditions of uncertainty and the presence of risk.

The main prediction of the Capital Asset Pricing Model (CAPM) is that in equilibrium the market portfolio is mean-variance efficient. This efficiency implies that there is a positive relationship between expected security returns and their market risks (Beta). Also, this efficiency implies that the market risk or undiversifiable risk (beta) is the one and only explanatory variable in the cross section of expected returns (Fama and French, 1992). This is exactly to say that the variation of expected returns between stocks is only attributed to their risk sensitivities to the market.

This is clearly a convenient and simple relationship based on very stringent assumptions allowing the development of the CAPM primarily to establish the mean variance efficiency relationship on the market level (Fama and Merton, 1972). If the Markowitz mean-variance model is valid in the sense that investors behave according to the two parameter model, the risk-return trade off is certainly established, and according to the risk averse utility of wealth maximizer investors, more return is stipulated for taking on more risk. However, to reach a market equilibrium, investors are assumed to operate in the framework of the CAPM. Such a framework is built on many assumptions about investors and the environment within which they operate, the plausibility of which are doubtful. In addition to the mean variance efficiency of the portfolio theory, in the world of the CAPM investors have homogeneous expectations and agreement on prospects of investments, there is a risk free interest rate which is the same for borrowing and lending, the investment horizon is a single period horizon, the capital market is frictionless and information is freely and simultaneously available for investors.

Such assumptions were very necessary to develop the model as it stands. However, relaxing these assumptions was one of the main exercises undertaken by researchers to test the validity of the model (see, for example, Lintner (1969), Brennen (1970), Black (1972), levy (1978) and Markowitz (1990)). Looking at each assumption in greater detail would give an idea on the need for it and the consequences of avoiding it. In fact relaxing most of the assumptions results in many efficient frontiers which cause the model to be more complex than it is under these assumptions. Firstly, the assumption of homogenous expectations was needed to create the equilibrium condition in the market. If expectations were heterogeneous then equilibrium would not be attainable and we would end up with many efficient frontiers. The homogeneous expectation's assumption is far from realistic, since investors do not always agree on the risk and return of various investments (Miller 1977). Investors effectively assign different probability distributions to the value of the same asset. Prior to Miller, Lintner (1969) had extended the CAPM with heterogeneous expectations. In this case the market portfolio is not necessarily efficient and the CAPM is not testable.

Secondly, the investment *time horizon is assumed to be a single period which means* that investments are undertaken for a *specified single common period; such an* assumption is needed to construct a single period model. However, if investors have different time horizons, each investor will have a different efficient frontier depending on the length of his investment horizon. Thus, they will not hold the same market portfolio, and there will not be a common market price for risk.

Thirdly, the capital market is frictionless and information is freely and simultaneously available. The availability of free information is needed to form a consensus and consequently is a vital prerequisite for the homogeneity of expectations. If information is not available or if information is costly then many investors would not be able to use it, consequently heterogeneous expectations would result. Again, such an assumption is not realistic since there is a cost for processing information as well as acquiring it in the real world. This contradicts with the rational expectations theory (the economics counterpart to the EMT), which asserts that incentives for gathering costly information, to achieve excess returns, is what keeps markets efficient (Sheffrin, 1983). A market that is frictionless, implies that in such a market there are no taxes, no transaction costs or any restrictions in the market such as restrictions on short sales.

The issue of taxes is of great importance, especially in relation to the treatment by tax systems of capital gains and dividends. If tax systems treat these two forms of wealth in the same way then taxes would have no effect on the CAPM, but, if tax systems treat capital gains and dividends differently, then the main statement about beta being the sole variable explaining returns has to be revised. Different treatments of dividends and capital gains lead to the situation where investors choose between investments according to their tax characteristics and consequently preferences. This diminishes the equilibrium relationship predicted by the Model, since the efficient frontier will be multiple and each investor will be faced with his unique efficient frontier[39]. For example, Ben Yousef and Kolodny (1976) have shown that investors have net preference for dividends over capital gains which limits the applicability of the CAPM. This implies that investors do not make their choice solely based on risk, but also based on dividend policy. This evidence was confirmed by Litzenberger and Ramaswamy (1979), who found that including the dividend yield as another independent variable to the CAPM produced a statistically significant coefficient for the dividend yield variable. They have also found that investors acquire stocks based on their tax brackets, which again indicates that stock dividends play an important

[39] Elton Edwin J and Gruber Martin J. *Modern Portfolio Theory and Investment Analysis,* 1991, John Wily.

role in the investor's choice, thus, the beta of the stock is not the only variable in explaining returns.

Fourthly, there is an asset with a risk free rate of return and investors can borrow and lend money at such rate. This is a very important assumption for the development of the model, therefore, the prediction of a linear relationship between risk and return is achieved by assuming that investors can borrow or lend unlimited amounts of money at a risk free rate of return. This makes the efficient market frontier of the mean variance model linear[40]. However, Fama and Miller (1972) have argued that, without this assumption there are many efficient portfolios leading to different equilibrium risk-return relationships for every asset. This assumption is greatly unrealistic, because even if people could lend at a risk free rate they cannot borrow at a risk free rate (Elton and Gruber (1991)). In this regard Fama and Miller (1972) asserted that borrowing must be repaid from risky investments, consequently there is a default risk resulting in two different rates, one for borrowing and one, essentially lower, for lending. Therefore, the modification of this assumption changes the intercept and the slope and this continues to change for each borrowing and lending rate, which severely damages the linearity prediction of the model. Roll (1977) made the same point and stated that without this assumption there may be no unique market portfolio.

The central message of the model, stated by Sharpe (1964), is that "*In equilibrium, capital asset prices have adjusted so that the investor, if he follows rational*

[40] Sharpe William F., (1964), *Capital Asset Prices: A Theory Of Market Equilibrium Under Conditions of Risk,* The Journal Of Finance, Vol. . XIX, No. 3, September.

procedures (primarily diversification), is able to attain any desired point along a capital market line". If investors were completely risk averse they would only favour those portfolios that minimise the variance of returns. However, under the CAPM, given the existence of a competitive capital market and a risk free asset, the optimal portfolio for any investor, irrespective of his risk preference, is a composition of a risk free asset and market portfolio. This is the so called "two fund separation theorem".

In deriving the CAPM Sharpe (1964) has shown that when combining any security or portfolio of stocks with a risk free security all the values of the expected return and variance of the resultant portfolio will lie *"along a straight line between the points representing the two components"*; this line is called the capital market line. The capital market line suggests that investors should expect a minimum amount of return when investing plus a varying amount that is proportionate to the level of risk assumed; that is risk and return have a linear relationship. This holds for efficient portfolios and in equilibrium the slope of the capital market line equals (Sharpe, 1964):

$$\text{Slope} = \frac{E(R_m) - R_f}{\sigma_m} \qquad \textbf{(E.4.1)}$$

where,

$E(R_m)$ is the expected return on the market portfolio.

R_f is the risk free rate of return.

σ_m is the standard deviation of the market portfolio.

This slope denotes the relationship between risk and expected return in capital markets, and this relationship measures the market price of risk, which enables us to measure the expected return on efficient portfolios (all the portfolios on the line).

Thus, the expected return on portfolio p is,

$$E(R_P) = R_f + \frac{\left(E(R_m) - R_f\right)}{\sigma_m}\sigma_p \qquad \textbf{(E.4.2)}$$

where,

σ_p is the standard deviation of the returns of portfolio p.

The equation means that the expected return on efficient portfolio p equals the risk free rate of return plus (the market price of risk times the standard deviation of the portfolio's returns); Equation (**E.4.2**) is known as the Capital Market Line. This relationship only relates to efficient portfolios and indicates that the market only rewards the risk that could not be diversified away.

However, the Capital Market Line (CML) is used to derive a more useful relationship (the security market line (SML)), which is the relationship between the expected return on a security or portfolio and its risk. To do that it is first noted that under the CML relation, the risk that is priced and rewarded is only the undiversified risk, i.e. the systematic risk. *"Diversification enables the investor to escape all but the risk resulting from swings in economic activity- this type of risk remains even in efficient combinations"* (Sharpe (1964)).

Systematic risk, hence, is a measure of how expected returns on assets move relative to returns on the market, i.e. the extent to which market factors are influencing asset returns. The security market line (SML) depicts the relationship between an individual asset's expected return and its risk. The expression of this line is[41]:

$$E(R_i) = R_f + \frac{\left[E(R_m) - R_f\right]}{\sigma^2{}_m}\text{cov}_{im} \qquad \textbf{(E.4.3)}$$

where,

$E(R_i)$	is the expected return on security i.
$E(R_m)$	is expected return on the market portfolio of all assets.
R_f	is the rate of return on the risk free asset for the period.
σ_m^2	is the variance of the market portfolio.
cov_{im}	is the covariance between returns on security i and returns on the market m.

This expression implies that the expected return on an individual security is the risk free rate of return plus a risk premium times the systematic risk of the asset.

The expression $\frac{\text{cov}\, p_{im}}{\sigma^2{}_m}$ is called beta and it measures the covariance of the stock with the market. With Beta (β) replacing $\frac{\text{cov}\, p_{im}}{\sigma^2{}_m}$ in equation **(E.4.3)** we obtain Equation **(E.4.4)** which is known as the Capital Asset Pricing Model:

$$E(R_i) = R_f + [E(R_m) - R_f]\beta_i \qquad \textbf{(E.4.4)}$$

The model suggests that beta is the only relevant measure of risk that investors should consider. The prices will adjust to allow a linear risk-return relationship

[41] For a simple and rigorous derivation of the model see Elton and Gruber (1991).

between return and risk, this adjustment of prices shows that the CAPM is an equilibrium model.

Since the introduction of the model various extensions of it were formulated relaxing some of its assumptions. Brennen (1970) has dealt with the issue of taxation where he looked at the model in a world of differential tax rates on capital gains and dividends. The existence of various tax treatments makes the investment decision dependent also on the tax preference of the investor. Brennen stated that *"for a given level of risk, investors require a higher total return on a security the higher its prospective dividend yield because of the higher rate of tax levied on dividends than on capital gains"*. Thus, the CAPM will also include the dividend yield as well as the beta of the stock as determinants of stock returns. As noted above this was also confirmed by Litzenberger and Ramaswamy (1979).

Kraus and Litzenberger (1976) have developed the model incorporating the third moment of the return distribution (skewness). The assumption of normally distributed returns was and still is a convenient assumption because the normal distribution is categorised by its two moments (the higher moments are functional of the first two); the mean and the variance. However, stock returns are skewed because an investor cannot lose more than 100% of his investment but can make gains of more than a 100%. Thus, downward reduction in stock prices is limited but upward potential is unlimited, therefore, investors will prefer positive skewness, but on the basis of risk aversion would be averse to variance. In light of their empirical work, Kraus and Litzenberger have argued that the traditional CAPM is misspecified due to the exclusion of systematic skewness. Others have dealt with the effect of transaction costs (Levy (1978)), the effects of restrictions on short sales (Markowitz (1990)) and the effect of the assumption of the existence of a riskless asset[42] (Black, 1972).

The above discussion indicates that although the simple version of the CAPM might be theoretically accurate in describing stock returns, relaxing some of the assumptions upon which it is built might distort the theoretical relationship of the model. With regard to the ASM this cannot be empirically accomplished. For example, short sales that are required to test the zero beta form of the model is not allowed in ASM, nor the use of options to create synthetic assets for testing purposes. Moreover, as noted earlier dividends data was not available as part of the data set employed in this research, in addition to the fact that the dividend announcement dates were not also available from the ASM. Nevertheless, a prime goal of this thesis was to analyse the effects of thin trading on tests of the CAPM, whatever form this model takes. Thus, the empirical investigations of the CAPM were related to the basic model.

4.2. Tests of the CAPM

Tests of the CAPM of equation **(E.4.4)** are essentially tests of whether or not the CAPM explains variations of stock returns. That is whether or not beta explains the variations of stock returns.

In terms of expected excess returns Equation **(E.4.4)** can be expressed as:

$$E(r_i) = \beta_i E(r_m)\,, \qquad \textbf{(E.4.5)}$$

[42] The zero beta Capital Asset Pricing Model relies heavily on the assumption that short sales are not restricted.

where,

$E(r_i)$ is the expected excess return on stock i.

$r_i = E(R_i) - R_f$.

$r_m = E(R_m) - R_f$; and

β_i is the beta of asset i and equals $\beta_i = \dfrac{\text{cov}(r_{i,} r_m)}{\text{var}(r_m)}$.

The above relationship is the relationship between expected excess returns and risk, which is essentially an *ex anti* relationship. To test the model we have to transform it into its *ex post* form (Copeland and Weston (1988). To achieve that, we must make the assumption that on average the expected rate of return on the stock is equal to its realised rate of return (i.e. the return on the stock is a fair game). This is the main link between the efficient market theory and the CAPM. Since if stock prices do not follow the random walk model, then this transformation is not possible. However, based on this assumption we obtain the ex post form of the model which is expressed mathematically in equation **(E.4.6)**:

$$R_{it} - R_{ft} = (R_{mt} - R_{ft})\beta_i + \varepsilon_{it} \qquad \textbf{(E.4.6)}$$

To test this relationship, the market model of (Sharpe 1963) is usually used as the return generating process to provide an estimate of stock i beta (β_i). This model is:

$$R_{it} = a_i + b_i R_{mt} + e_{it}, \qquad \textbf{(E.4.7)}$$

where,

R_{it} is the return on security i at time t.

R_{mt} is the return on market portfolio at time t.

a_i and b_i are parameters.

e_{it} is a random error term at time t. Where, $E(e) = 0$,

$\sigma_e^2 = \sigma^2$ $\quad$ $\text{cov}(e_j, e_i) = 0$
$\text{cov}(e_i, R_m) = 0$

Thus, b_i of the market model[43] **(E.4.7)** is used as β_i of the Capital Asset Pricing Model **(E.4.6)**.

However, both equations are not similar unless the risk free rate is constant over time, otherwise if the risk free rate is stationary and correlated with market returns[44] then we will have a missing variable bias and the result would be bias the estimated b_i. On the other hand if the risk free rate is constant, b_i will be an unbiased estimate of β_i (Elton and Gruber, 1991). To avoid this problem the market model can be used in excess returns form, thus allowing the risk free rate to fluctuate through time. Therefore, this thesis uses the empirical CAPM to estimate the beta of the stock so that it can be used in the *ex post* form of the model **(E.4.6)**.

From the CAPM, the return on security i has two components, one that is dependent on the market (β_i) and one that is not α_i. Therefore, when we test the CAPM we expect from equation **(E.4.6),** that:

1. $\alpha_i = 0$, which means that the average value of the unsystematic return of the security is zero.
2. The relationship between β_i and $E(R_i)$ to be linear.

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[43] Essentially the market model is a by-product of the Sharpe's (1963) "diagonal model" which came into play to minimize the data requirements of the full Markowitz portfolio model.

[44] Merton and Miller (1972) found that there is negative correlation between the risk free rate of return and the return on the market portfolio for the NYSE.

3. β_i to be the only firm specific measure of risk that explains returns.
4. High risk should be associated with higher return: $E(\hat{R}_m)$ - $E(\hat{R}_f)$> 0.

Tests of the CAPM are usually accomplished by regressing the average returns of the cross sectional sample of stocks over a specific time period against the stocks' betas.

Then we estimate the cross sectional regression[45]:

$$\tilde{R}_i = y_0 + y_1 \hat{\beta}_i + \tilde{e}_i \qquad \textbf{(E.4.8)}$$

Where we obtain $\hat{\beta}_i$ from regressing individual security returns against a proxy of the returns on the market portfolio using the excess returns form of equation **(E.4.7)**, consequently, using cross section regressions to estimate y_0 and y_1. Theoretically, however, y_0 should equal R_f and expressed in expected excess return it should equal zero. Further, y_1 should equal the difference between the average return on the market and the risk free rate, $\tilde{R}_m - R_f$.

Early tests by Douglas (1969) did not support the basic relationship predicted by the CAPM. Specifically, Douglas found that the average realised returns were positively related to the variance of returns rather than the covariance with the market. In addition, Douglas summarised an empirical test carried out by Lintner showing the same finding. Lintner's results indicated that y_0 was greater than the risk free rate of

[45] Jensen Michael C , *The Foundations and Current State of Capital Market Theory*. in Jensen (ed.) Studies in the Theory of Capital Markets (1972).

return R_f and y_1 was less than the difference between return on the market and the risk free rate of return $R_m - R_f$.

Miller and Scholes (1972) questioned these results and in an effort to explain what went wrong they replicated Lintner's results on a different sample, but using the same time period (1954-1963). The model they used was that of Lintner:

$$\overline{R}_i = y_0 + y_1 b_i + y_2 S^2(e_i) \qquad \textbf{(E.4.9)}$$

where,

$S^2(e_i)$ is the residual variance, which is the non market connected component of each stocks' total variance. This residual variance is taken from the first pass regression.

Therefore, the first pass regression was employed to obtain estimates for $\overline{R}_i$, b_i and $S^2(e_i)$. The second pass regression used these estimates to find estimates for y_0, y_1 and y_2. The results of their analyses were that:

1. y_2 is positive and very large relative to its standard error.
2. the coefficient of b_i, although positive, it is smaller than Lintner's result.

Consequently they accepted Lintner's result, but started to search for biases in the estimation procedure.

The first bias they found was due to excluding the risk free rate of interest. This is particularly relevant because the expected return explained by the CAPM is necessarily conditional on a known value of R_f. Therefore, neglecting R_f in estimating beta in the first pass regression affects the beta estimate (β_i) due to a missing variable bias and consequently biasing the estimates in the second pass regression. They found that the direction of the bias is in favour of the CAPM and partially explains the deviations from the model documented by these tests. However, after conducting the tests using the risk premium form of the model, they found that the magnitude of the effect of this bias is too small to fully explain such results. Consequently, they moved to explore another source of bias that is, nonlinearity in the risk-return relationship. However, after testing this possibility they ruled it out and moved to a third source of bias; heteroscedasticity. Hetroscedasticity occurs *when the error terms do not have the same variance* (Webster, 1995). Miller and Scholes found that the error terms resulting from regressing return values on beta values did not have constant variance. In fact the higher were the beta and return values the higher was the error term's variance. This could lead some extremely high values to affect the slope of the relationship so that it becomes flat and shows no relationship between risk and return. After allowing for this possibility by using the natural logarithms of the variables, however, they reported similar results to those obtained previously.

Therefore, no adequate explanation was provided for such results based on possible biases due to misspecification of the tested equation. They turned to test for possible biases arising from using variables as proxies for returns and risk. Essentially the CAPM is an expectational model describing what should happen in the future, therefore, all the variables used in testing the model are not observed, instead they are estimated with possible error.

The first variable that could be estimated with error is beta. Miller and Scholes have shown that there could be a measurement error in estimating beta coefficient, which lead to a downward bias of beta, consequently this bias could flatten the slope and inflate the intercept[46]. Miller and Scholes estimated this bias to be less than two thirds of the true value of beta. The errors in estimating beta can also affect the estimated coefficient for the residual variance term if it was included in the equation. They found that this bias explains some of the puzzling results obtained earlier.

The fact that the market portfolio is not observed and the index used is usually a proxy for the true market portfolio, suggests a bias in using this proxy index instead of the true one. However, after testing the sensitivity of the results to the use of other indices they concluded that the choice of index cannot be regarded as being of paramount importance to these results.

Looking at the skewness possibility of stock returns, they argued that if there was positive skewness of returns (i.e. skewed to the right) then the expected value of the regression coefficient will be positive, therefore, we would notice an obvious ex post association between mean returns and residual variance. The skewness of the returns to the right was evident in their sample, leading them to place part of the blame for these results on skewness. They concluded that they could not accept the Lintner-Douglas result as "definitive".

[46] See Elton and Gruber (1991) for a formal proof of this.

Black, Jensen and Scholes (1972) introduced a time series test of the CAPM by testing equation **(E.4.6)**; if the CAPM is valid then $\alpha_i = 0$. Although this equation could be tested on the individual security level, the use of portfolios makes use of more information. So, they moved on to form portfolios and ranked them according to beta values. To avoid selection bias and to provide maximum dispersion of risk coefficients they estimated betas using past data. Stocks were allocated to portfolios based on the ranks of the estimated betas.

For the period tested, 1926-1966, they computed 35 yearly betas and α's for each portfolio and using the above equation they found that α's are consistently negative for high beta portfolios and positive for low beta portfolios. This is contrary to the CAPM predictions since the alpha under the model should be zero for all portfolios. Testing the CAPM using cross sectional tests they concluded that the CAPM is misspecified and suggested another model that better fits the data.:

$$E(R_i) = E(R_z)(1-\beta_i) + E(R_m)\beta_i \qquad \textbf{(E.4.10)}$$

where R_z represents the return on a zero beta portfolio.

To provide evidence for this model they tested the traditional CAPM from the point of view that the CAPM is consistent with the beta factor as long as excess returns of the beta factor have a zero mean. That is $\bar{r}_Z = R_z - R_f = 0$

Furthermore, they stated that if $\bar{r}_z$ is positive, high beta stocks will tend to have negative intercepts and low beta stocks will have positive intercepts and vice versa. The results provided strong rejection of the traditional CAPM. They also found that

$\bar{r}_z$ was positive in their study, which explains their results. However, Black, Jensen and Scholes argued that many reasons could account for their results. The presence of non marketable assets, for example, as argued by Mayers (1970) or the effect of taxes as stated by Brennen (1970) could provide such results. Moreover, Black (1972) stated that, the empirical results of (BJS) *"are consistent with a model in which borrowing at a riskless rate is restricted"*.

Fama & MacBeth (1973) tested both the traditional CAPM and its version suggested by Black, Jensen and Scholes. According to both models:

- The relationship between the expected return on a security and its risk is linear.
- Only betas of stocks explain returns.
- High risk should be compensated by higher returns, that is $E(\tilde{R}_m) - E(\tilde{R}_0) > 0$.

Fama & MacBeth chose a stochastic generalisation of the CAPM of the following form to test the CAPM,

$$\overline{R}_{it} = \alpha_{0t} + \alpha_{1t}\beta_{it-1} + \alpha_{2t}\beta^2_{it-1} + \alpha_{3t}S_{eit-1} + \eta_{it} \qquad \textbf{(E.4.11)}$$

where,

$\overline{R}_{it}$ is the average expected return on portfolio i at time t.

β_{it-1} is the beta of portfolio i at time $t-1$.

S_{eit-1} is the residual variance of the first pass regression (from the market model) at time $t-1$.

η_{it} is random error which has a mean of zero and a constant variance.

This model helps in testing the linearity of the risk-return relationship ($\beta^2{}_i$ = o) and the role of the residual variance in explaining returns. Moreover, we notice that the test is predictive in the sense that it is designed to test the relationship between expected return and risk. They used monthly percentage returns for all common stocks traded on the NYSE during January 1926 through to June 1968. To avoid the errors in variables problem they used a grouping technique that is similar to that used by (BJS) which is a better technique for providing estimates of beta rather than using individual stocks. Running the tests using different versions, Fama & MacBeth had estimates for α_{ot}, α_{1t},α_{2t} and α_{3t} by obtaining estimates for each month over the entire test period. Then these estimates were averaged and tested whether or not they are significantly different from zero. The results of their tests are:

1. β^2_{it-1} does not affect returns (there is no nonlinearity detected by the model).
2. S_{eit-1} does not affect returns (the residual risk is not priced).
3. The relationship between expected return and systematic risk is a positive linear relationship.

The above referred to studies are some of the main empirical tests of the CAPM. However, the importance of these tests is that they have influenced the theory of finance from the 1970's and up to the present. In fact these tests and in particular the Fama & MacBeth test are becoming the main tools for testing the CAPM in many countries of the world. A major assumption behind these tests, however, is that portfolio beta is stationary across time. If this assumption is not valid then the inferences drawn from these tests are spurious. This matter will be returned to later (chapters seven and eight) and discussed more fully in the context of the ASM.

4.3. Criticism of the Capital Asset Pricing Model

Although the CAPM has traditionally been criticised from the view that it is based on restrictive assumptions and that in a real world the relationship implied by the model could change, recent evidence has shown that the relationship between return and beta does not appear to hold. In particular, research carried out by Fama & French (1992), Jegadeesh (1992) Lakonishok, Chan and Hamao (1991) had favoured other variables to beta. Moreover, beta, as claimed by these studies, is "proclaimed dead". This evidence reinforced previous concerns by researchers like Reinganum (1981) who stated that *"average returns are no more explained by beta"*. Fama and French discussed possible reasons behind the poor performance of beta and focused on two possible reasons. The first could be that beta is not accurately estimated. Generally speaking, all the research done on the risk-return relationship in stock markets supports this possibility leading to massive work on developing models that can enhance the computation of beta. The second reason is that, in the past, beta performed well because the effect of other variables was not isolated from the effect of beta because beta is correlated with such variables. Therefore, when proper attention was given to studying those variables the effect of beta vanished.

Moreover, the CAPM is criticised on the grounds of its testability. The model is essentially an expectational model and any expectational model should be tested using expectational variables. However, what is used in testing the CAPM is historical variables rather than expectational variables. This practice was justified assuming that the past is a reasonable approximation of the future, based on the premises that certain variables, such as interest rates and prices follow a random walk and the best estimate of the future's value is today's value.

Nevertheless, a very important methodological criticism of the model was introduced by Roll (1977) and is widely known as the Roll's critique. Roll stated that it is requisite in testing the CAPM to use the correct market portfolio. If the market portfolio is mean variance efficient, then the relationship between a stock's expected return and its beta is perfectly linear. Since the measurement of this portfolio is impossible[47], tests of the CAPM are joint tests of the validity of the model and of the mean variance efficiency of the market portfolio. Therefore, what is merely testable is the mean variance efficiency of the market proxy. More recently, Roll and Ross (1994) have shown that the use of inefficient proxies could possibly imply a spurious validity of the CAPM by showing a strong relationship between return and risk. *"This implies that an index proxy can conceivably be substantially inefficient and still produce a strong cross sectional regression between expected returns and betas"* (Roll and Ross 1994). The same point was argued by Roll (1977) where he has shown that strongly correlated indices (0.89 correlation coefficient) can give different inferences about the CAPM, so that one index can give supporting evidence of the CAPM and the other rejects the model completely. Thus, any test of the CAPM is essentially a joint hypothesis of the model and the efficiency of the market portfolio.

[47] The market portfolio contains all risky assets; the return on some of which is not measurable e.g. Human Capital.

4.4. Other Capital Asset Pricing Models

The CAPM is usually referred to as the one factor Capital Asset Pricing Model (Elton and Gruber (1991)). It is the first equilibrium model to be introduced and after its development many other equilibrium and factor models were introduced. It is worth noting that all equilibrium models are consistent with factor models. That is an equilibrium model can be a one factor model or two factors model or X-factors model. Sharpe (1984) provided a discussion of the differences between equilibrium and factor models where he argued that although the basic CAPM as an equilibrium model is a one factor model it was extended according to many market or investor's preferences incorporating more factors in the equilibrium relationship. Further, he noted that the main difference between a factor model and an equilibrium model is that *"equilibrium theories of securities prices generally make statements about the relationship between security returns and attributes of securities"* while factor models *"represent the behaviour of security prices"*. A perfect example of a single factor model is the market model or the diagonal model first suggested by Markowitz (1959) and expanded by Sharpe (1963). On the other hand, Connor (1995) argued that there are three types of multi factor models; macroeconomics factor models, fundamental factor models and statistical factor models. Where macroeconomics factor models use macroeconomics factors as determinants of security prices, fundamental factor models use firm specific factors (such as firm size and earning yield) to explain stock returns; and statistical models use factor analysis to identify priced common factors.

However, the main three major equilibrium models are the CAPM, the Consumption based CAPM (CCAPM) and the Arbitrage Pricing Theory (APT). Having discussed the CAPM we shall turn to the Arbitrage Pricing Theory (APT). However, first we shall briefly describe the Consumption CAPM (hereafter CCAPM) which was introduced by Rubinstein (1976) and developed by Breedon (1979).

In essence, the CCAPM[48] says that the expected excess returns are proportional to their consumption betas[49]. The investor here is assumed to be interested in the utility of life time consumption. An asset's covariance with aggregate consumption is the only relevant input for the pricing of that asset. Since asset returns are related to aggregate wealth which is highly related to aggregate consumption, then asset returns are linked to aggregate consumption (Huang and Litzenberger (1988)). This relationship was shown under restricted assumptions to be linear between asset returns and the growth rate of aggregate consumption, with a residual that is un-correlated with consumption growth, has a zero mean and not correlated with other residuals.

The CCAPM can be represented mathematically as:

$$R_{it} = \alpha_i + \beta_i C_t + e_{it}, \qquad \textbf{(E.4.12)}$$

where,

R_{it} is the return on security i at time t.

C_t is the growth rate in aggregate consumption per capita at time t.

[48] The same logic of the CCAPM was the logic of other Capital Asset Pricing Models like the production Capital Asset Pricing Model (see, for example, Cochrane, John H. *Production based asset pricing and the link between stock returns and economic fluctuations*, The Journal of Finance Vol. XLVI, No 1 March, 1991.

[49] The CCAPM is consistent with the broader Intertemporal CAPM of Merton (1973). In this model uncertainty is not only a product of consumption uncertainty, but many other factors can effect the investors levels of future uncertainty. Thus, investors will be interested in hedging against these risks, by forming special portfolios. Basically, the difference between this model and the CAPM is that the expected return of an asset is a function of more than the sensitivity of that asset's returns to the returns of the market.

$$\beta_i = \frac{\mathrm{cov}(R_{it}, C_t)}{\mathrm{var}(C_t)}, \quad \text{and } E(e_{it}) = 0,\ E(e_{it}, C_t) = 0.$$

The main difference between this model of equilibrium and the basic CAPM in **(E.4.6)** is that the growth rate in aggregate consumption substitutes for the return on the market portfolio as an independent variable (Breedon, Gibbons and Litzenberger, 1989). The advocates of the CCAPM argue that the empirical testing of CAPM does not include all the relevant assets that comprise the market portfolio and the consumption data required by the CCAPM are readily available. However, the testability of the model has been challenged with many empirical realties. The most important of which is that aggregate consumption statistics are not reported; instead aggregate expenditure are. Further, aggregate expenditure is reported over some period of time rather than at a point of time. Many attempts has been undertaken to solve these problems (see Breedon, Gibbons and Litzenberger, 1989) but the model still requires more empirical testing and modifications. For example, Ferson and Harvey (1992) argued that, the use of seasonally adjusted consumption data is a major influence on the rejection of the model. They argued that, the seasonal adjustment of the data smoothes the data to a point where it does not explain the variations of asset returns. They proceeded to test the model with seasonally unadjusted data and found that such approach works better than approaches with seasonally adjusted data. Restoy and Rockinger (1994) criticised the model on the basis that other variables of production like investment and output are more volatile and representative of economic fluctuations than consumption[50].

[50] An important criticism came from Mehra and Prescot (1985) known in the literature as the "equity premium puzzle", where they found that the model does not predict average returns on US stocks.

4.4.1. Arbitrage Pricing Theory (APT)

In response to some of the criticisms of the CAPM as an equilibrium model more models that attempted to explain the behaviour of stock returns were introduced. The arbitrage pricing theory, introduced by Ross (1976), states that the expected return on a stock is a function of many factors (not only one factor as in the Capital Asset Pricing Model). Thus, unlike the CAPM, the APT requires a factor model (Sharpe, 1984).

Since the price of an asset is the discounted sum of future dividends:

$$P_o = \sum_{t=1}^{\alpha} \frac{E(D_t)}{(1+R)^t}, \qquad \textbf{(E.4.13)}$$

where,

P_o is the price of asset o,

D_t is the dividend paid at time t, and

R is the discount rate (Clare and Thomas (1994));

then it is only natural that factors related to profitability and the discount rate, for example, should be among the factors to be proposed as determinants of stock returns (Chen, Roll and Ross, 1983).

The model mainly gives less role to the market portfolio and in fact the model proposed by the APT does not mention any specific portfolio (Ross, 1976). The factor(s) under consideration by the theory could be any factor(s). Therefore, in a way, this is an improvement on the CAPM which requires the market portfolio as the independent factor in determining stock returns. Moreover, the theory does not specify any distribution of stock returns nor does it explain how investors make their decisions (unlike the mean variance decision criteria in the CAPM). In addition, unlike the CAPM the APT does not assume homogeneous expectations. Yet, homogeneous agreement on the factors that play a role in pricing stocks is essential to the theory (Ross, 1976).

Nevertheless, the main line of the APT is that in the absence of arbitrage opportunities in the capital market there are no under or overpriced securities. In fact the theory says that there should be no arbitrage opportunities because these will be traded on by investors and disappear as soon as they arise. Inspite of the theory's appeal, since investors would expect more than one factor to influence stock returns, it does not specify these factors or their number, although it requires that investors entirely agree on them (Ingersoll, 1984).

The theory assumes that asset returns are generated by a factor model of the form:

$$\widehat{R}_i = E(R_i) + \sum_{j=1}^{k} b_{ij}\widehat{\delta}_j + \widehat{\varepsilon}_i \qquad \textbf{(E.4.14)}$$

where,

$\widehat{\delta}$ is a vector of systematic factors which commonly influence assets returns (Dybvig and Ross, 1985).

b_i is the vector of factor loadings on asset (i).

$E(R_i)$ is the expected return on asset (i); and

ε_i is the noise term for asset (i).

Assuming that the error term is independent across assets and of the factors and has a mean of zero, the APT states that, the expected return on an asset equals the risk free rate of return on a riskless asset plus the sum of the risk premia of the factors that affect the asset's return:

$$\mathrm{E}(R_i) = R_f + \sum_{j=1}^{k} \lambda_j \beta_{ij} \qquad \textbf{(E.4.15)}$$

where,

λ_j is a vector of risk premia; and

R_f is a rate of return on a riskless asset.

The arbitrage is simply that the error term should be zero to allow the above linearity to hold. If the error term is zero and the linearity of the above does not hold arbitrage opportunities arise (hence the name of the theory). However, the derivation of the theory defines the error term as the systematic risk of the asset which is deversifiable away if sufficient assets are used. This diversification leads the error term to be zero across portfolios (Dybvig and Ross, 1985).

- **Tests of the APT**

In testing the APT we use factor analysis to identify the number of factors influencing asset returns, then we determine the factor loadings. The next step is then to estimate the coefficients or the risk premia using generalised least squares regressions. Shanken (1982) has shown that, forming different portfolios, you can produce different factors. Therefore, it is vital that in testing the APT we use a large number of assets. Similar evidence was provided by Abeysekera and Mahajan (1987) who formed seven portfolios of stocks listed on the London Stock Exchange and did not find *"a unique number of factors which was consistent for all the seven portfolios"*. Chen (1983) argued that this evidence by Shanken should not be interpreted as evidence against the testability of the APT, rather, *"it should serve as a reminder of the potential problems involved in doing statistical analysis on unrepresentative samples"*.

Abeysekera and Mahajan (1987) tested the APT on the LSE and could not conclude in favour of the model. In fact they found that the risk premium is not significantly different from zero. On the other hand they found that the intercept term was equal to the empirical risk free rate of return prevailing in the British market.

Dhrymes et al. (1984) have shown that as the number of securities used in testing the APT increases the number of factors discovered also increases. Roll and Ross (1984) replied to this criticism by arguing that, although different samples of stocks result in different factors, the number of factors discovered in the first stage is not conclusive. A study of the factors' structure across groups is necessary to substantiate that certain factors are common to all groups. Thus, if factors are found to be significant in the first stage but not significant in the second stage they are not priced.

Dhrymes et al. (1985) repeated the two stage test and for larger groups of assets have found that the number of priced factors (significant in the second stage) have increased with increasing the number of stocks. Furthermore, they have found that subdividing the test period into two periods, a group of stocks have more factors in the second period than in the first period. This evidence as argued by Dhrymes et al. does not support the empirical applicability of the APT. In fact Chen (1983) argued that the APT can be rejected if we can find factors that *are "priced after the factor loadings are accounted for"*. Recalling that the CAPM was attacked on the basis of some anomalous evidence, it is worth noting that the APT was also criticised using the same evidence. Gultekin and Gultekin (1987) have found that the January effect also applies to the APT; that is the APT explains stock returns only in January. They also, found that January returns are correlated more with standard deviations than with covariance risk measures. Gultekin and Gultekin have provided, however, a very important piece of evidence on problems of the testability of the APT, stating that there is a serious problem resulting from excluding large numbers of observations[51].

4.5. Conclusion

The CAPM in essence is a theory that endeavoured to describe how risky assets are priced in equilibrium. Based on the portfolio theory the CAPM has provided a solid starting point for understanding the behaviour of stock returns in capital markets. Although, the evidence up to now is not entirely in favour of the basic predictions of the model, the research inspired by the development of the model has provided greater understanding of the problem under consideration. However, although the model does say much about a world that is not entirely real, the simple CAPM is not necessarily around for good, since if all the extensions of the model are considered simultaneously and the model is run in a more dynamic environment the practical simplicity of the model will not be a valid characteristic of the model any more. However, for those who decided to move on from the CAPM, the APT has emerged not strictly as a replacement, but more as an extension of the model (Sharpe 1984). Since many researchers have come up with evidence that security returns are

[51] Also see Dhrymes et al. (1984).

influenced by more than one factor, the APT was encouraging and inspired a further wave of research. The differences between the two models show that the APT can be viewed as a development of the CAPM, since it is less stringent in its assumptions. However, both models have been subjected to scrutiny and both models have been criticised as untestable theories. Perhaps the main criticism of the CAPM was that of Roll (1977), where he argued that to test the model correctly the true (but unknown) market portfolio has to be used. Of course the return on the true market portfolio cannot be observed therefore, the CAPM is not testable. On the other hand the main criticism of the APT is the empirical evidence that if the construction of portfolios is changed or the number of stocks in portfolios is changed the number of priced factors increases accordingly.

Which of the two theories is of more relevance to the ASM, *i.e. which of the two* describes equilibrium pricing of Jordanian stocks?. To answer this extensive testing of the two theories on the market is required. However, since the equilibrium pricing has not been thoroughly investigated on the ASM this research was devoted to testing the CAPM in the context of ASM.

The following chapters contain an empirical investigation of the CAPM and the weak form efficiency of the ASM, with special reference to the difficulties imposed by the problem of thin trading in the market. We start with the latter, which is the subject of chapter five.

CHAPTER FIVE

V.

Empirical Tests- Weak Form Efficiency of the ASM

5.1. Introduction

This chapter reports the results of two tests of the weak form of the EMT for the ASM. This level of efficiency implies that the stock market has no memory; that is stock price changes are independent across time periods and stock returns cannot be predicted from past returns, i.e. past prices have no information content. As argued in chapter three, tests of efficiency must be conducted based on an equilibrium model for market returns, thus to test the semi-strong and strong forms of the theory we require an equilibrium model that adjusts returns for risk. The main model that enables this adjustment is the CAPM, which investigated in the context of the ASM in chapters 7-9. Therefore, if the CAPM applies to the ASM then it is possible for us to carry out an investigation of the other two forms of market efficiency. Moreover, tests of the weak form efficiency are related to the CAPM in that, these tests investigate the dependence patterns in stock returns, which are employed by the CAPM.

To test the weak form hypothesis, the tradition has been to test for the presence of serial correlation in price changes based on the assumption that the expected return of the stock, given by the equilibrium model generating stock returns, is constant (i.e. the expected return at time t equals the return at time $t-1$) for each stock in the market. The following analysis will employ two methods for testing the weak form efficiency; the serial correlation test and the runs test. In the process, this chapter highlights a problem in using stock prices generated in a thin market, causing an empirical complication for applying these prices in tests investigating daily price behaviour. The problem is discussed in the context of the ASM and three possible courses of actions are investigated.

5.2. Autocorrelation in Stock Price Series

To test the weak form hypothesis of the EMT, a commonly used test is to test for the presence of serial correlation in stock price series. The variable used is the continuous daily return measured as the daily change of log prices (Fama, 1965): [52]

$$u_{t+1} = \log_e p_{t+1} - \log_e p_t \,. \qquad \textbf{(E.5.1)}$$

p_t is the price of the stock at time t.

p_{t+1} is the price of the stock at time $t+1$.

The serial correlation coefficient at lag x is measured by:

$$r_x = \frac{Covariance(u_t, u_{t+x})}{Variance(u_t)} \qquad \textbf{(E.5.2)}$$

Fama argued that if the distribution of u_t has a finite variance then for a large samples of size N the standard error of r_x will be calculated by,

$$\sigma(r_X) = \sqrt{1/(N-x)} \qquad \textbf{(E.5.3)}$$

The test, then, is to see if the autocorrelation coefficient (r) is significantly different from zero[53]. For the independence of a time series to be established, there should be no autocorrelation between the variables of that time series at any lag. Fama has tested for serial correlation using the first difference of log daily prices using up to 10 lags, although longer differencing intervals could be used. Fama used 4, 9, 16 day non overlapping differencing intervals and used lags from 1 to 10. However, as

[52] Please note that equations (E.5.1) to (E.5.3) are the same as equations (E.3.2) to (E.3.4) in chapter three.

[53] So the test hypothesis can be formulated as:

Hypothesis test (5.1); H_0 $r = Zero$ H_1 $r \neq Zero$; at 5% significance level.

Fama (1965) argued, the longer the differencing interval the smaller will become the sample size. In this research the presence of serial correlation is investigated using for the differencing interval from one, two and four days and lags of 1 to 10. The sample used comprises all the stocks in the sample (discussed in chapter one).

Before discussing the results of the test it is noted here that, daily prices in the ASM suffer from thin trading which, which in turn causes a problem in calculating daily price changes. Assuming that the price of stock i at time t is available but the price at time $t-1$ is not, we are left with the problem of measuring stock $i's$ price change from time t to time $t-1$. This problem was more severe for some stocks than the other, depending on the level of non-trading observed (which ranged from 10% to 45% in terms of the percentage of non-trading to total trading days and has an average of 16%).

The first possible course of action, which in fact was adopted by other work on the ASM (e.g. Omet (1990), Quaider (1993)), is to deal with the time series of prices as it was actually generated in time, although none of these researchers has discussed the nature of the problem which is a serious impediment to empirical work on the daily level of price changes. This approach was also adopted by Fama (1965) although it is not clear from Fama's work if there was any significant non-trading suffered by the companies examined in his study[54]. Obviously, the underpinning assumption behind this approach is that any other possible solution would involve

[54] Fama used the 30 stocks of the Dow-Jones Industrial Average.

inferring a price for the missing day's price, thus this might distort the data set, let us call this data set of prices as Actual Prices (AP).

Another possible treatment is to assume that the missing price of stock i is equal to the last reported price for the stock. This treatment builds on the assumption that if stock prices only change because information affecting the value of these stocks have become available, and that there is no impediments restricting market mechanisms (i.e. buying and selling of stocks is not restricted) then if the price of any stock has not changed, there is no need to assume that the value of the stock has changed and hence that stock's price is equal to the last reported price. In this regard Davidson (1986) argued that on some days investors are not motivated to trade on the basis of the current price, consequently causing non-trading. This lack of motivation implies that the current price of the stock is seen by investors as its equilibrium price[55]. Thus, we shall call this treatment Previous Price Adjustment.

An alternative assumption is that if trading in the market is restricted, i.e. the supply of stocks is not a function of the demand for stocks, then the stock price should change even though it is not reported as long as the market shows activity of trading in other stocks. This can happen in the case of tightly held stocks by certain groups of people (e.g. family held). In this case it is crucial to obtain a price for the missing day's price reflecting the possible change of the value of the stock. A possible treatment, as argued by Heinkel and Kraus (1988) is to estimate the beta of the stock

[55] Davidson argues that due to the presence of transaction costs the price of the stock could be close to, but not exactly, its equilibrium price. However, this is a plausible assumption for large and highly liquid markets.

in relation to similar stocks' movements. However, because most of the stocks in the index suffer from thin trading (as discussed in chapter two) we assume that the stock price changes in relation to the change of the price of the market index; the magnitude and direction of this change can be measured using the beta of the stock[56], we refer to this treatment as the Beta Price Adjustment.

The issue here is how to distinguish between these two possible underlying causes of non-trading? Unfortunately this is not possible since it is difficult to distinguish between the stocks whose value has changed from the ones whose value did not. Thus, we apply these two methods in addition to using the data as they were actually generated in time and compare the results so that we can see the magnitude of the difference between the adoption of these methods. Because distortions are expected using these three possible methods the analysis was carried out using the stocks with the highest number of trading days.

Table **(5.1)** shows daily first order serial correlation coefficients for lags 1, 2, ..., 10, with significant autocorrelation (at the 5% level) being tagged with asterisks (daily returns measured using Actual Prices). It can be seen that the first order serial correlation coefficient is significant for 30 companies of the 33 companies in the sample (i.e. 90%).

The first order serial correlation, as shown in table **(5.1)**, ranges between a maximum of (0.25) and a minimum of (-0.04); with an average of (+0.15), while for the other lags the trend is not clear cut. Amongst the other lags the largest number of

[56] Beta estimation and application are discussed in chapter seven of the thesis.

significant coefficients is, for the lag of 2, coefficients where 7 out of the 33 companies show significant positive serial correlation.

Table (5.1)
Daily Serial Correlation Coefficients for Lag r = 1,2,...,10.
(Returns Measured Using Actual Prices)

Code	*Lag 1*	*Lag 2*	*Lag 3*	*Lag 4*	*Lag 5*	*Lag 6*	*Lag 7*	*Lag 8*	*Lag 9*	*Lag 10*
2109	0.17*	0.01	0.06	0.03	-0.01	0.03	-0.01	-0.05	-0.04	0.02
1323	0.26*	0.08*	0.01	-0.04	-0.10*	-0.06	-0.07	-0.03	0.01	0.02
1101	0.21*	0.05	0.08*	0.00	-0.02	-0.01	-0.01	-0.03	-0.01	0.00
1102	0.17*	0.03	0.02	-0.02	-0.02	-0.06	0.01	0.03	0.04	-0.02
1104	0.13*	0.07	0.02	-0.02	-0.01	0.02	0.01	-0.03	-0.02	0.00
1107	0.17*	0.07*	0.07	-0.01	-0.03	-0.02	0.00	-0.03	0.01	0.01
1113	0.18*	0.01	-0.04	-0.08	0.01	-0.01	0.03	0.06	0.03	0.02
1114	0.08*	0.10*	0.05	0.00	-0.02	-0.02	0.01	0.02	0.00	0.04
4118	0.17*	0.01	0.06	0.03	-0.01	0.03	-0.01	-0.05	-0.04	0.02
4119	0.18*	0.02	-0.06	-0.04	0.00	-0.01	-0.01	-0.05	0.00	-0.01
4123	-0.04	0.02	0.00	0.01	0.00	0.01	0.03	-0.02	-0.01	0.04
4126	0.15*	0.00	0.07	0.02	0.05	-0.03	-0.06	-0.03	0.00	0.05
4127	0.13*	0.04	0.01	0.00	0.01	-0.02	0.00	0.05	-0.01	0.02
4128	0.14*	0.01	-0.03	0.05	0.02	0.03	-0.04	-0.06	-0.04	0.02
4132	0.14*	0.01	0.04	-0.02	0.00	0.00	-0.05	-0.03	-0.01	0.05
4135	0.25*	0.09*	0.03	0.00	0.04	-0.01	-0.02	0.00	0.01	0.03
4139	0.26*	0.09*	0.03	0.01	0.04	-0.01	-0.01	0.01	0.01	0.04
4140	0.22*	0.03	-0.05	-0.02	0.00	0.00	-0.03	0.02	0.07	0.07
4142	0.11*	0.02	-0.01	-0.05	0.00	0.02	-0.05	-0.01	-0.05	-0.02
4145	0.06	0.02	0.03	0.00	0.01	0.03	0.01	-0.01	0.02	0.00
4151	0.10*	0.01	0.04	-0.01	0.01	-0.01	0.03	0.00	0.02	0.02
4158	0.19*	-0.03	0.02	0.06	-0.01	0.02	-0.02	0.00	-0.03	-0.05
4241	0.15*	0.03	0.00	-0.01	0.01	-0.03	-0.04	-0.04	0.05	-0.01
1222	0.22*	0.08*	-0.02	-0.03	-0.07	-0.08	-0.04	-0.02	0.01	-0.05
3104	0.12*	0.02	-0.02	-0.05	-0.05	-0.05	0.01	0.02	0.04	0.03
3117	0.08*	-0.03	0.01	0.10	0.03	0.06	0.01	0.02	0.02	0.06
3121	0.12*	0.04	0.01	-0.02	0.00	0.00	0.01	-0.01	-0.01	0.00
4106	0.16*	-0.01	0.02	-0.02	-0.03	-0.04	-0.04	0.03	0.04	0.00
4108	0.24*	0.06	0.03	0.02	-0.01	0.00	-0.02	-0.04	-0.02	0.03
4113	0.15*	0.00	0.03	-0.01	-0.02	-0.02	-0.03	-0.02	0.01	0.00
4112	0.22*	0.07*	0.00	-0.06	-0.06	-0.02	-0.01	-0.02	0.01	0.03
4109	0.21*	0.06	0.05	-0.02	-0.01	-0.01	0.00	-0.03	-0.01	0.00
4111	0.13*	-0.03	-0.06	-0.02	-0.06	-0.04	-0.02	0.03	-0.02	0.05
Average	**0.158**	**0.031**	**0.015**	**-0.007**	**-0.010**	**-0.009**	**-0.012**	**-0.010**	**0.002**	**0.015**

* Coefficient is twice its standard error.

Since all of the one day first order coefficients are significant and positive, it implies that if these companies' stock prices make an upward (downward) move it will most likely be followed by an upward (downward) move (i.e. same direction price movement seems to persist in the short term).

Having produced these results using Actual Prices, the next step is to produce the first order serial correlation coefficients using the other two approaches, using Equation (**E.5.1**) the Previous Price and the Beta Price were employed (as discussed above) for inferring the missing days' prices. The results are shown in tables (**A5.1**) and (**A5.2**) in Appendix five. However for the purpose of our analysis we reproduce the one day results for lags one and two for both methods. These are presented in table (**5.2**).

We notice from table (**5.2**) below that the use of the Previous Price treatment produced an average of (+0.12) first order serial correlation at a lag of 1 which is lower than that produced using the other two approaches. This is due to the fact that when we use as the Previous Price as the missing price we are actually increasing the number of the no-change prices, thus decreasing the number of either a positive or negative changes.

Table (**5.2**)
First Order Serial Correlation Coefficients for Lags 1 and 2 using Previous Prices & Beta Prices to Calculate Missing Prices

Code	Previous Price		Beta Price	
	Lag 1	Lag 2	Lag 1	Lag 2
2109	0.143*	0.031	0.141*	0.03
1323	0.252*	0.086*	0.252*	0.085
1101	0.206*	0.067*	0.182*	0.062
1102	0.166*	0.02	0.168*	0.016
1104	0.148*	0.022	0.141*	0.023
1107	0.177*	0.099	0.158*	0.09*
1113	0.185*	0.017	0.182*	0.02

Table (5.2) **Continued**

Code	Previous Price		Beta Price	
	Lag 1	Lag 2	Lag 1	Lag 2
1114	0.094*	0.048	0.107*	0.061
4118	0.124*	0.074*	0.133*	0.055
4119	0.107*	-0.211*	0.169*	0.019
4123	-0.046	0.001	-0.048	0.02
4126	0.076*	-0.297*	0.187*	0.034
4127	0.039	-0.364*	0.155*	0.011
4128	0.073*	-0.236*	0.135*	-0.011
4132	0.037	-0.349*	0.112*	-0.007
4135	0.155*	-0.018	0.158*	-0.016
4139	0.074*	-0.327*	0.249*	0.075*
4140	0.21*	0.00	0.205*	-0.001
4142	0.119*	0.017	0.205*	-0.001
4145	-0.049	0.019	0.062*	0.006
4151	0.018	-0.453*	0.097*	0.018
4158	0.031	-0.351*	0.211*	-0.001
4241	0.008	-0.469*	0.155*	0.021
1222	0.242*	0.086	0.236*	0.078*
3104	0.119*	0.024	0.121*	0.017
3117	0.088*	-0.022	0.061*	-0.010
3121	0.125*	0.021	0.084*	0.034
4106	0.165*	-0.013	0.163*	-0.015
4108	0.234*	0.055	0.235*	0.055
4113	0.154*	0.008	0.153*	0.007
4112	0.203*	0.065	0.209*	0.066
4109	0.205*	0.059	0.214*	0.056
4111	0.115*	-0.046	0.114*	-0.044
Average	0.12*	-0.07	0.15*	0.02

* Coefficient is twice its standard error.

On the other hand we notice that the Beta Price gave similar results, in terms of the average of the serial correlation (+0.15), to the results of the use of the actual data as they were generated in time. This is inconsistent with the observation that the market index is positively serially correlated with a first order serial correlation of (+0.30). This observation is important since when we use the beta of the stock to obtain the missing price we *"could"* increase the serial correlation in the price series since these new prices are functions of the index price which is serially correlated, therefore, we expect a larger degree of serial correlation to be reported using the Beta Price treatment. Thus, the average serial correlation reported above seems to be misleading, therefore, we must use another measure for comparison purposes. We look at the percentage number of the significant coefficients resulting by the three treatments and find that in the case of Actual Prices 31 companies had positive coefficients where in the case of the Previous Price adjustment 26 companies reported serial correlation and using the Beta Price treatment 32 companies report serial correlation. This confirms our expectations that the use of the Beta Prices will induce more serial correlation than the other two approaches. Moreover, the above analysis implies that the use of any treatment method will affect the reported serial correlation and consequently affects the conclusions on the efficiency of the market.

Having tested the use of the beta of the stock to generate stock prices on the days when these stocks have not traded, we note that, this treatment does increase the dependence pattern in the individual stock price series, since the generated price is a function of the price of the index used for inferring missing prices, which is found to suffer from positive first order serial correlation. This finding is supported by Jennergren (1976), who argues that interpolation of stock prices might increase the dependence pattern of a random series. Consequently we drop the use of the Beta Price adjustment, although the results using this treatment for two and four days are summarised in table (**A5.3**) in Appendix five. We move on next to more serial correlation investigations in the context of the ASM using Actual Prices and Previous Prices.

Returning to our hypothesis test (**5.1**) we reject the null hypothesis of no first order serial correlation in the ASM, at 5% significance level, for 26 companies using returns measured employing Previous Prices and for 30 companies using returns measured employing Actual Prices as they were generated in time which allows the conclusion that there is a positive first order serial correlation in the daily price changes of companies listed on the ASM over the period of (1987-1994). With regard to the other lags we can not reject the null for most of the companies, therefore, price changes do not seem to be serially correlated across different lags other than one. To investigate the presence of serial correlation across longer intervals, returns measured using Actual and Previous Prices were used and examined using Equations **(E.5.1)** to **(E.5.3)**.

Tables (**(A5.4), (A5.5), (A5.6) (A5.7),** in Appendix five respectively present the results of the serial correlation test of price changes for two and four days time intervals. Again, using Actual Prices, serial correlation is documented for 11 companies for the two days interval and for 3 companies using Previous Prices. On the other hand, for the four days time interval the tests show that using returns of Actual Prices 6 companies report serial correlation and using returns of Previous Prices 3 companies report positive serial correlation. Thus, for these companies the null hypothesis of hypothesis test **(5.1)** is rejected at 5% significance level. However, for the other companies we cannot reject the null, thus we can conclude that, most of the companies do not show serial correlation of any nature using two and four days time intervals (lags from 1 to 10).

To shed more light on the first order positive serial correlation pattern revealed by the analysis above, the entire period was subdivided into 6 periods using Actual

Prices. Four subperiods, each with a length of 2 years, and 2 subperiods, each with a length of 4 years. Three companies were selected randomly and the daily serial correlation coefficient for 1, 2, 3, 4 and 5 lags was computed. The results are displayed in table **(5.3)**.

Table **(5.3)** below, shows that the above documented first order positive serial correlation persisted across sub periods and is not a result of an extraordinary period of the Amman Stock Market.

Table (**5.3**)
Autocorrelation Across Periods for Three Randomly Selected Companies

Code	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Sub period 1		***1987-1988***			
1323	0.22*	0.12*	-0.01	-0.12*	-0.04
2109	0.11	-0.03	-0.02	-0.04	-0.02
4118	0.21*	0.028	0.01	0.06	0.04
Sub period 2		***1989-1990***			
1323	0.43*	0.17*	0.05	-0.04	-0.15*
2109	0.28*	0.15*	0.02	0.10	-0.02
4118	0.13*	-0.05	0.22*	0.06	-0.02
Sub period 3		***1991-1992***			
1323	-0.04	-0.01	-0.03	0.07	-0.04
2109	0.17*	0.02	0.05	-0.01	0.03
4118	0.06	0.15*	-0.01	0.04	0.02
Sub period 4		***1993-1994***			
1323	0.20*	-0.042	-0.01	-0.07	-0.07
2109	-0.02	-0.09	-0.02	-0.06	-0.03
4118	0.21*	-0.06	-0.06	-0.06	-0.06
Sub period 5		***1987-1990***			
1323	0.36*	0.15*	0.04	-0.06	-0.013
2109	0.15*	0.02	-0.01	-0.01	-0.01
4118	0.17*	-0.01	0.12*	0.06	0.01
Sub period 6		***1991-1994***			
1323	0.097*	-0.026	-0.02	-0.01	-0.05
2109	0.10*	-0.022	0.03	-0.02	0.01
4118	0.165*	0.023	-0.03	-0.02	-0.03

* Coefficient is twice its standard error.

Moreover, although the results of the analysis above relate to a relationship over a particular time period (1987-1994), previous research of this relationship found similar results for different time periods. In particular, the one day positive serial correlation was documented to be a characteristic of the ASM for the period (1978-1986)[57]. Omet (1990) analysed price changes of 16 companies listed on the Amman Stock Market and found significant daily serial correlation for 15 companies out of the 16 analysed. However, for the two days interval the serial correlation was significant only for 6 companies.

Combining the results of the above analysis and the results of Omet, it can be concluded that there is a significant first order positive serial correlation for the stocks on the Amman Stock Exchange for the entire life of the market up to the end of 1994.

A possible rationale for a positive first order serial correlation could be that the stocks adjust slowly to information (Errunza and Losq (1985)). This possibility is supported by the effect of having pricing limits in the market. A price limit implies that if new information affect a stock in the market with a magnitude that is greater than the limit imposed, the stock price movement will have to continue on the next trading day, so that the price of the stock reflects the information content. Of course the change will be in the same direction, thus, positive serial correlation will be the result. In the context of the ASM the use of price limits has been a well-known strategy for preventing large price fluctuations and controlling excessive speculation in market (Toukan 1995). These price limits were changed from time to time as seen appropriate by the market management. Table (**5.4**) shows the imposed price limits since the start of operations in the ASM and up to 1994:

[57] Note that the two periods analyzed by this research (1987-1994) and Omet's research (1978-1987) form, up to the beginning of this research, the entire life of the ASM.

Table (5.4)
Price Limits Imposed in the ASM *

period	1978-82	1982-85	1985-90	Jan. 90- Apr. 90	Apr. 1990-94
Limits	No limits	10%	5%	2%	%5

* Source: ASM files.

From the above table we see, for example, that over the period between January 1990 and April 1990 which is the period over which the Gulf War took place, the price limit is very small (2%) indicating that this period was seen by the market authorities as a period of excessive speculation and price changes. Thus, the market has virtually stopped both price increases and decreases beyond 2% per day. Based on the above, we can conclude that part of the serial correlation documented above is due to the presence of these limits. This is simply because the efficiency of the market means that prices adjust instantaneously to new information, but a market operating a price limit will be hindered by such limits if the real change in the price due to new information is larger than the specified limit, in such a case the price of that stock will continue its adjustment when it trades next, thus there will be positive dependence patterns on the one day level, and to a lesser extent on the two days. Obviously this would be the case whether the price change was positive or negative. Therefore, the direction of this serial correlation (positive) reported above is evidence supporting this conclusion.

However, although we have concluded that positive serial correlation is evident in the context of the ASM, this conclusion is based on the serial correlation test which can be affected by large values since it is a parametric test (Fisher and Jordan, 1983). Thus, to isolate the effects of possible existence of extreme values that might be distorting the results, a non parametric test is used. In the following section the results obtained using the runs test are presented and discussed.

5.3. Runs Test

A run is a sequence of changes in the same direction (i.e. having the same sign). This test is used in the following sense. If the series is random or independent, then the expected number of runs, of a random series with the same size as the series investigated, should equal the actual number of runs. Therefore, for each stock's price series the actual and expected number of runs are computed. If the actual number of runs is significantly greater than the expected, then the time series suffers from negative serial correlation. This means that price changes reverse directions more than what would be expected from a random series. On the other hand, if the actual number of runs is significantly less than the expected number of runs, this means that the series suffers from positive serial correlation which means that a positive (negative) price change is more likely to be followed by a positive (negative) price change than what would be expected from a random series.

The expected number of runs is calculated using the formula;

$$M = \left[N(N+1) - \sum_{i=1}^{3} n_i^2 \right] / N \qquad \textbf{(E.5.4)}$$

where,

M is the expected number of runs.

N is the total number of price changes.

i is the sign of the price change where price changes have three signs: negative, zero and positive.

n is the number of price changes of each size.

The significance of the test is enabled by calculating the standard error of the expected number of runs M (σ_m) as;

$$\sigma_m = [(\sum_{i=1}^{3} n_i^2 (\sum_{i=1}^{3} n_i^2 + N(N+1)) - 2N\sum_{i=1}^{3} n_i^3 - N^3)/N^2(N-1)]^{\frac{1}{2}} \quad \textbf{(E.5.5)}$$

The amount of dependence that results from the runs test can be measured as the size of the difference between the total actual number of runs and the total expected number of runs.

There are two ways to standardise these differences:

1. $K = \dfrac{(R+\frac{1}{2}) - M}{\sigma_M}$, **(E.5.6)**

where,

1/2 discontinuity adjustment.

R the actual number of runs.

M the expected number of runs.

For large samples K will be approximately normal with a zero mean and a variance.

2. $K = (R - M)/M$.

For each stock the K value is calculated and the percentage differences between the actual and expected number of runs $(R - M)/M$ is also calculated (Fama 1965). However as argued by Fama the second standardised variable is more stable since the first is positively related to the square root of the sample size while the expected number of runs is positively related to the sample size, thus the second standardised shall be used in the analysis below.

As discussed in section (5.5) the ASM daily price series suffers from non-trading, therefore, the analysis will be carried out using Actual Prices as generated in time and also using Previous Prices to estimate missing stock prices. Table (**5.5**) presents total actual and expected runs and the difference between them using Actual Prices. The sample used below comprises the 18 companies with the highest level of trading.

Table (**5.5**)
Actual, Expected Number of Runs & Percentage Difference
(Returns Based on Actual Daily Prices)

Code	Actual Number of Runs	Expected Number of Runs	R-M/M
2109	878	945	-0.08
1323	1032	1175	-0.14
1102	998	1131	-0.13
1101	829	939	-0.13
1113	936	1083	-0.16
4127	901	984	-0.09
4132	964	1040	-0.08
4135	1046	1139	-0.09
4139	932	1127	-0.21
4140	972	1097	-0.13
4142	1183	1275	-0.08
4145	943	1085	-0.15
4241	1095	1203	-0.10
3104	1072	1182	-0.10
4104	863	1000	-0.16
4106	1009	1180	-0.17
4113	1050	1147	-0.09
4112	922	1076	-0.17
Average	**979**	**1100**	**-0.125**

From the table above we notice that for all the companies tested the actual number of runs is less than expected by the runs test, thus the percentage differences $((R-M)/M)$ in column four show consistently negative signs. This means that price changes do not change sign as would be expected from a random series, thus implying that there is positive dependence in the daily price changes. This result was reached using returns of Actual Prices, thus based on the above discussion regarding the appropriate use of Actual Prices rather than a complete data set of continuous trading, we move on to applying the same test using the Previous Price of the stock as the missing price of that stock. Table (**5.6**) presents the results of the test.

Table (5.6)
Actual, Expected Number of Runs & Percentage Difference
(Returns Based on Previous Daily Prices)

Code	Actual number of Runs	Expected number of Runs	R-M/M
2109	1002	1284	-0.28
1323	1093	1257	-0.15
1102	1118	1284	-0.15
1101	1012	1234	-0.22
1113	1046	1260	-0.20
4127	1100	1270	-0.15
4132	1148	1276	-0.11
4135	1127	1271	-0.13
4139	1009	1252	-0.24
4140	1054	1229	-0.17
4142	1183	1277	-0.08
4145	1041	1267	-0.22
4241	1152	1257	-0.09
3104	1142	1278	-0.12
4104	1041	1261	-0.21
4106	1038	1218	-0.17
4113	1115	1218	-0.09
4112	1066	1281	-0.20
Average	**1083**	**1260**	**-0.17**

We notice from table (**5.6**) that the average percentage difference is greater that its counterpart obtained using Actual Prices, producing a stronger evidence of positive dependence in daily price changes for the stocks of the ASM. Thus, using both approaches for dealing with thinly traded stocks we can confirm that the actual number of runs documented for the ASM is less than the expected number of runs of a random series, therefore, we confirm the results of positive first order serial correlation reported in the previous section.

With regard to longer time intervals we note that the runs results for 2 days time interval, reported in tables (**A5.8**) and (**A5.9**) in Appendix five, point to an increase in the positive independence pattern of 2 days price changes, implying that positive dependence spans for two days, although at a lesser degree than that reported for daily price changes.

Based on the results of the serial correlation test and the runs test we conclude that positive first order serial correlation is reported for most of the companies investigated over the period (1987-1994). However, whether or not this dependence pattern in daily price changes is economically significant (i.e. trading on the basis of its presence is rewarding to traders) is a matter that is not confirmed. As argued earlier, the presence of price limits in the ASM can play a distorting role by halting the effects of information from being instantaneously reflected in prices, thus causing a delay in the adjustment of prices. This can count for some of the positive serial correlation and dependence of price changes if not most of it, depending on the size of the price limit employed.

So what does this inefficiency imply? If we look at the average first order autocorrelation revealed by the above tests, we find that using the two approaches we got an average of (0.15) and (0.12) first order serial correlation. Since, as pointed out by Fama (1976), the square autocorrelation is a measure of how much the return of stock i at time t is explained by the return of stock i at time $t-1$, then by squaring the above autocorrelation we find that successive returns explain only between 1.4% and 2.25% of the variation of stock returns. From a practical point of view, then, this amount of serial correlation can not really be evidence of economic inefficiency of the ASM.

5.4. Conclusion

The weak form efficiency of the ASM was investigated using the serial correlation test and the runs test. In the process of testing the independence assumption of the weak form level of the EMT, the problem of thin trading and its effects on empirical work employing daily prices was discussed. Consequently, three approaches were suggested and the results employing these approaches were analysed. Using the most appropriate two approaches (measuring returns based on Actual Prices as generated in time and assuming Previous Prices to represent missing prices) it was found that for daily price changes there is significant first order positive serial correlation for most of the companies examined, however, using longer time intervals a lower degree of this serial correlation was reported. To account for the fact that the serial correlation test is built on the assumption of the normality of stock prices and to avoid the possible effects of extreme values a non parametric test was employed. Using the runs test and employing the above two approaches for treating missing prices, it was found again that the stock price series examined suffer positive dependence patterns at the daily level. It was also found that using two day price changes, the companies examined suffer less, but significant dependence patterns. This evidence of inefficiency however, does not imply a trading strategy for the investors since, although serial correlation was documented in the context of the ASM, the reliance on this dependence pattern might not imply the achievement of excess returns for two reasons. Firstly, if this dependence pattern is a result of the price limits imposed on trading in the market, then it seems reasonable to suggest that the price adjustment will be resumed first thing next day so that the information content is reflected in the opening price of the stock. Since no trading is allowed overnight, then, whatever the strategy devised, the opening price of the stock at time

$t+1$ will be its new equilibrium price. Secondly, the square of the autocorrelation implies that very small degree of the return of the stock at time t is explained by the return of the stock at time $t-1$.

Thus, the conclusion is that stock prices suffer positive dependence patterns, hence, the Amman stock market is not weak form efficient with relation to daily price changes. The presence of price limits in the market was suggested as a possible reason behind this positive dependence (market inefficiency). Although, the effect of these limits has not been formally addressed it could be argued that, based on common sense, price limits can cause daily price changes to have positive serial correlation. This is entirely due to the fact that if the information content was not fully reflected in the price of the stock, because of these limits, then the natural thing is that the price of the stock will resume its adjustment on the next day of trading in the same direction as the day within which a price limit was reached and triggered. This causes successive price changes to be positively correlated, suggesting that a possible trading strategy would be to buy any stock whose price change has reached the upper price limit and to sell any stock whose price change has reached the lower price limit. The problem with testing such a strategy is that the price change would reach the upper or lower limit for one day and then trading in that stock is not allowed, thus the price of the stock would be its closing price. It is highly possible that the opining price of the next trading day would reflect the possible adjustment of the price of the stock. Thus, making the applicability of such a strategy not possible, which casts doubts on the profitability of this strategy if adopted. Moreover, since statistical significance is different from economic significance, even though the market was found to be inefficient on the weak form level, due to the presence of transaction costs the inefficiency of the market does not suggest that abnormal profits could be made. However, the un-availability of transaction costs data does not allow a testing of this proposition.

As pointed out earlier, the tests of the other two forms of the EMT require a general equilibrium model that adjusts the returns of the stocks by their respective risks. The equilibrium model usually employed to achieve this is the CAPM. Thus, prior to any investigations of these two forms of the EMT in the context of the ASM, the validity of the CAPM must be investigated in the market. Next chapter obtains the data inputs required for testing the CAPM; that is constructing the monthly returns database and the stock market index.

CHAPTER SIX

VI.

Database & Index Construction

6.1. Introduction

One of the general aims of this chapter is to construct a database of individual stock and index returns for empirical investigation of stock return behaviour in the context of the ASM. In particular, prior to the commencement of this work there did not exist a reliable publicly available database in the form of individual stock returns or market index returns to be used for empirical work purposes. To achieve the above goal and to provide the needed data for empirically testing the CAPM, thus, to enable an investigation of the behaviour of Jordanian stock returns, an individual securities' daily return database was constructed together with a daily index return database. Also, a monthly stock and market return database was constructed.

The second section of this chapter describes the choice of the index constructed for this research while, the third section describes the data file and the company selection procedure. The fourth and fifth sections describe the construction of daily price and return indices as well as the construction of the market index.

6.2. Index Construction

The CAPM maintains that an asset's expected return is linearly related to the expected return on a market portfolio of risky assets. This market portfolio contains all risky assets in the economy in proportional quantities, (i.e. is a value weighted portfolio), and should be a combination of all marketable and non marketable assets, lands, durable and even human capital. Such a portfolio is unobservable, not only for its *ex ante* nature, but also, for the impossibility of measuring the return of every asset in that portfolio, even on *ex post* basis.

The problem of *ex ante* nature of market returns has been addressed by assuming that the *ex post* market returns are reasonably stationary and can be assumed to provide unbiased proxies for *ex ante* returns; (i.e. characterised as a fair game). Thus, we can use the realised market returns as a proxy for the expected market returns.

Moreover, as argued by Lorie (1966) the index does not have to comprise all stocks available, hence, it can be constructed using a sample of stocks. This is meaningful for convenience but, limited by the degree of bias introduced by excluding certain stocks. However, as long as it is believed that the index is based on a sample of stocks that represent and proxy for the entire population of stocks, the use of sample indices is viable. With regard to the ASM, and due to the presence of a large number of companies whose stocks suffer large levels of infrequent trading, as shown earlier in chapter one[58], the construction of a sample index to proxy for the market portfolio is empirically justified. The reason being that the inclusion of those few companies in the index proxies to a large extent for the value weighted portfolio comprising all the stocks listed on the market.

Two alternative indices can be identified as proxies for the market index; the value weighted index and the equally weighted index. Both indices could be used on the grounds of the empirical evidence which reported that both indices have the same properties (Jensen (1979)). The same conclusion was reported for smaller markets by Palacios (1975) who tested the CAPM in Spain using both indices and produced

[58] This was discussed in chapter one and was shown that, out of an average of approximately 239 trading days per year the number of stocks that had an average of less than 200 trading days was 80% of the total number of the stocks in the market. Further, 13% of the stocks listed on the market had an average of less than 10 trades per year.

"*similar results*". However, Palacios noticed that betas based on the value weighted index were less stable than betas based on the equally weighted index, although this observation does not necessarily help in favouring one index over the other since beta is not known to be either stable or not in Spain.

As pointed out by Fisher (1966) infrequent trading could lead the market index to suffer from serial correlation, since the return on the market portfolio at time t is comprised of the returns of the assets within the portfolio at time t and in the case that some of these assets experience thin trading, then the index return will be comprised of the returns of unequal time periods. Thus, market returns at time t and $t+1$ will be positively correlated, therefore, to lessen the effect of thin trading on the index many stocks must be excluded from the index for non-trading effect. The exclusion of stocks from the index on the basis of the infrequency of trading is not defensible nor desired unless we have severe thin trading, which is the case for the ASM, almost to the extent of non-trading in certain stocks. However, it is believed that as long as the number of stocks in the sample used to construct an index is large and randomly selected[59], the resulting index can be assumed to serve as a reasonable proxy for the market portfolio (Emmery and Finnerty (1991)). Consequently, for the purposes of this research the choice of the index will be governed by the desire to avoid or minimise this potential serial correlation in the market index, since the choice of the index used is of prime importance for the estimation of beta which depends largely on the index applied in the market model[60]. Consequently, all the parameters estimated based on these beta estimates from the market model will be affected.

[59] After excluding thinly traded stocks.

[60] See Frankfurter (1976), *"The effect of market indices on the Ex-Post performance of the Sharpe Portfolio Selection Model"*, Journal of Finance, 31 (June 1976), pp 953.

Since in many cases only one of these indices can be used[61], researchers[62] studying asset pricing use the equally weighted index rather than the value weighted index for computational ease and availability. More reasons for preferring the equally weighted index to the value weighted index are provided by Blume (1973) who argued that the value weighted index may provide less efficient estimators and is more subject to measurement error.

However, as indicated above, in small markets, where the problem of thin trading is severe, the use of an equally weighted *index could distort the estimates since the equally* weighted index gives equal weights to small size companies which are more prone to problems of thin trading than larger ones, thus, inducing a larger degree of autocorrelation in the market index (Roll (1981)).

In this regard, Atchinson et al (1987) argued that this autocorrelation observed in the NYSE index is not solely a product of thin trading. They developed a model to measure the theoretical autocorrelation implied by non-synchronous trading and compared their results with the level of actual autocorrelation in both the value and equally weighted indices. They found that the theoretical autocorrelation is only 15.8% of the observed autocorrelation in the equally weighted index and 13.4% of the observed autocorrelation for the value weighted index. They asserted that non-synchronous trading is only one aspect of the problem of price adjustment delays.

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[61] Saving research effort and expenses.

[62] For example, Woo et all (1995), Lau, Quay and Ramsey (1973), Fama & MacBeth (1973), Black, Jensen and Scholes (1972).

Chan (1993) provided more insight into the observed autocorrelation in the index returns. He argued that market makers who follow specific stocks cannot condition the prices of these stocks on the signals of all stocks, which contain market wide information due to the inability of other stocks being priced instantaneously. Consequently, they price their stocks solely conditioned on the available signals from the priced stocks at time t conditional upon late signals from other stocks at time $t-1$. Such a practice causes their pricing to be incorrect and in need for revision conditional upon late signals from other stocks. These errors are correlated with the signals from other stocks, therefore, whatever was the signal of the other stock, the correction of these errors will be in the same direction of the late signal, thus, the autocorrelation in the index will be positive. But due to the fact that larger stocks have better signalling qualities the smaller stocks will be, most of the time, in the position of revising their prices based on large stock prices' signals at time $t-1$. Therefore, one implication of Chan's model is that *"the covariance of smaller companies' current returns with large companies' past returns is greater than the covariance of large companies' current returns with small companies' past return"*.

However, as observed while constructing the index for the purpose of this study, for each day of trading we require a daily price for each stock that is included in the index. The missing daily prices for many stocks have to be obtained based on any valid assumption. The most widely used and accepted assumption is to assume that if the price of the stock was not reported for any trading day, then it should be equal to the last traded price of that stock (i.e. the value of the stock has not changed to warrant a change in the price). This would induce dependence patterns. If we use the equally weighted index, then we are giving greater weights to small companies (compared to their weights in the value weighted index) which are more prone to infrequent trading, thus we introduce a larger degree of dependence in the index.

Based on the above this research adopted the use of the value weighted index which was constructed and employed. Roll and Ross (1994) support this choice arguing that *"beating or trailing a value weighted index has become the most widely accepted criterion of business performance"*. This is also, in line with the theoretical market portfolio of the CAPM which is a value weighted portfolio of all risky assets.

Having decided on the appropriate index to be used throughout this research, the next section describes the data file used and the criteria used to select the companies to be included in the index.

6.3. Data File and Company Selection

prior to conducting any tests the data set was screened for errors[63]. Some trading days with zero prices were found. Based on the principle of price reporting adopted by the ASM it is unlikely that these zero prices were actually zero, therefore, it is more likely that these were the results of typing mistakes or that there was no trading on those days. Two alternatives were available to deal with this problem:

1. To give the zero price the price of the preceding trade for that share, giving an apparent zero return for the period.
2. The zero price could be considered a non trade and eliminated. This procedure was adopted since it is potentially less distorting.

[63] The database used by this research was not easily obtained. Formal requests to obtain the data set were not answered, therefore, the database was obtained informally from the ASM.

In the event, the magnitude of the problem was not very severe since the number of zero prices found was not very large. The maximum reported zero prices for one company[64] was thirty-one zero prices out of eight years of daily trading data.

However, since we are more concerned with monthly prices, the monthly price series, fortunately, was not greatly affected. For the this company only three monthly prices were affected.

Although a more detailed selection procedure is presented in section (1.4) of chapter one, the following shows the main criteria used for the selection procedure:

1. Firms were ranked according to the number of average trading days per year.
2. Firms were initially selected on the basis of three conditions, viz.:

- The firm should not have any missing year of trading.
- The firm had at least 5 years of data.
- The firm's average trading days per year was not less than 100 trading days.

3. To increase the sample size (so that the sample encompasses as many companies as possible) the companies with at least 100 trading days per year and have some missing years but the number of continuous years of trading is at least 5 were included.

The outcome of this selection was 52 companies. The daily prices of these companies were used to construct a daily price index.

This step and the problems encountered in the process are the subject of the next section.

64 The company is the Arab Finance Corporation which changed to Union Bank for Saving and Investment in 1991.

6.4. Constructing a Daily Price Index

There are two alternative daily price indices that could be used; the equally weighted index and the value weighted index. The first index gives the same weight to all the companies in the sample, while the second weights its components by their market values. As discussed above, in the context of the ASM, the use of the equally weighted index however, can cause a problem since the ASM is heavily populated with small companies whose stocks are not frequently traded. Moreover, the market portfolio of the CAPM is a value weighted index rather than an equally weighted portfolio.

Therefore, a value weighted index was constructed using the formula below[65]:

Let index I be a value weighted index at time t:

$$Index(I) = \left(\frac{M_t}{B_t} \right) * 100 \qquad \textbf{(E.6.1)}$$

where,

$$B_t = B_{t-1} * \left(\frac{M_t}{\overline{\overline{M}}_t} \right), \text{ and}$$

$$M_t = (\overline{M}_t + I_t + N_t + Q_{t-1})$$

At time $t = 1$ the base value (B_t) of the index will equal the market value (M_t).

[65] This formula was supplied by the Amman Stock Market.

M_t is the market value of the components of the index at time t, which equals the sum of the products of the closing prices of the index components and the number of subscribed shares of all the index components in the same time period t.

B_t is the base value, which equals the market capitalisation of all the components of the index at base time.

$\overline{M_t}$ is the adjusted market value of the components of the index at time t.

I_t is the market value of new issues of the companies comprising the index at time t.

N_t the market value of any new stock added to the index at time t.

Q_{t-1} the market value of any stock that was in the index at time $t-1$ and was withdrawn at time t.

These adjustments were made when:

- If a new company was added to the index.
- If a company was removed from the index. Companies were eliminated from the index only if they were delisted or suffer severe non-trading which could affect the index.
- If companies raised new capital.
- If companies distributed stock dividends or made stock splits or other capital changes.

The first step in constructing the index was to obtain a daily market capitalisation value for each company. The problem here was that many stocks have no market prices on some days because they did not trade on those particular days, yet, they have to be included in the index; this is an immediate effect of the problem of thin trading. In such a case we have to assume a price for that stock on that day. Generally, this problem has not been addressed much in the literature, since major stock markets never or rarely suffer from non-trading problems: what they suffer from is thin trading or infrequent trading or non-synchronous trading. All these expressions refer to the problem of reporting closing prices that are reported for all the companies that have traded during a specific day with some doubts surrounding the exact timing of the actual closing price.

In contrast, in many thin markets some stocks do *in fact* experience non-trading which lasts in some cases for few months, so, the central problem is non-trading rather than infrequent trading. This is exactly the case in the ASM where many stocks did not report prices for relatively long periods of time. Therefore, if a stock has not a reported price at time t and we use the stock's last price reported at time $t-1$, we are in effect assuming that the return on the stock during that period is zero. Furthermore, the beta of the stock during that period is assumed to be also zero, since the price has not changed although the market represented by an index of other stocks has reported a change. If the market is informational efficient -in the sense of Fama (1970)- all these assumptions rest on a more important assumption, that is no significant information affecting the price of the stock was available for the period under consideration. So, the question is how to solve this problem? A possible solution is offered below and investigated.

6.4.1. A Possible Solution

In an attempt to address the effects of thin trading on the index in a non conventional way[66], a daily beta of unity was assumed for the stocks that did not trade in any particular day, so instead of assuming a beta of zero we assumed a beta of one as an average. When we construct the index filling the gaps for the non traded stocks by the price of the last trade we assume for the related stock a beta of zero on those days where no trade has occurred. This assumption is based on the premise that these stocks were available at that price and there was no significant change in their values. In contrast it is assumed here that the price of the stock that did not report any trade has changed corresponding to the change of the market portfolio on a whole. A new index was calculated using the above method assuming that the price of the stock on a non trade day has changed corresponding to the market, i.e. its beta is one.

The two indices were compared with each other, *the "last trade"* price index and the *"beta of one"* price index. The correlation coefficient between the two indices was calculated and found to be (0.999), which is approximately unity. This is not altogether surprising, since the index calculated (using 52 companies) is highly influenced by the market capitalisation of the biggest three companies in the market which are shown in table **(6.1)**.

[66] The conventional way is to use the last trade price.

Table (6.1)
Capitalisation of the Largest Three Companies Listed on the ASM

Companies	Average cap	Average
	Million JD	of the sample's cap
Arab Bank	536	%38
Jordan Phosphate Mines	123	%9
Jordan Cement Factories	94	7%

To test whether or not these three companies were the primary cause for the high correlation between the indices, two new indices were calculated excluding the biggest three companies. The **"last trade"** price index and the **"beta of one"** price index were calculated and the correlation coefficient between them was estimated and found to be (0.996); again not significantly different from unity.

It appears from the forgoing analysis that the proposed method does not have much effect on the index, although this adjustment may be more important at the individual stock level because, non-trading days are not shared by all the companies, making this adjustment negligible on the index level. Thus, we move on to calculate the index and provide an analysis of how it is affected by the huge capitalisation of some firms in the market.

6.4.2. Three Indices

Three indices were calculated motivated by the need to examine the effect of the dominance of three companies (in terms of market capitalisation) on the sample index. The first index is for the 52 companies, while the second index is for the largest three companies (in terms of average market capitalisation) and the third index is for the remaining 49 companies. These three indices were compared with each other and the correlation coefficients between them were calculated and reported in table **(6.2)**.

Table (6.2)
Correlation Matrix for the Three Indices

	3 firms index	*52 firms index*	*49 firms index*
3 firms index	1	-	-
52 firms index	0.979	1	-
49 firms index	0.91	0.97	1

We notice that there is a high correlation (0.979) between the 3-firms index and the 52-firms index, while the correlation between the 3 firms index and the 49 firms index is slightly lower (0.91). This is evidence that the index is, to an extent, influenced by the biggest three companies. Moreover, the index constructed (52 companies) was compared with the index prepared by the ASM[67] which includes 60 companies. The correlation between the two indices is (0.99). This allows the conclusion that the index used in this investigation is an index that adequately describes prices and returns on the ASM.

After constructing the daily price index, the next step was to measure this index's monthly returns as well as measuring the returns on individual stocks that are constituting the index. This is discussed in the next section.

6.5. Measuring Monthly Returns

Returns could be measured either as the difference between log prices for any required interval (continuous or logarithmic returns) or as the difference between the price at time t and the price at time $t-1$ relative to the price at time $t-1$ (discrete or proportional returns). So, there is now a need to determine an approach for measuring returns.

[67] It was not possible to use the index of ASM because that index was a monthly index and part of this research needed a daily market index, besides the ASM index was not made available by the ASM.

Hawawini and Vora (1985) argued that the difference between both methods of measuring returns is substantial. They stated that the way return is measured could affect test results to a greater extent than the models used in these tests.

However, they argued, that logarithmic[68] returns could be more suited to tests of the CAPM for many reasons. The first reason is that the distribution of logarithmic returns is almost symmetric and closer to the normal distribution. This is significant for the CAPM because it is based on the normality assumption and because the *Ordinary Least Square* method, that is often utilised by tests of the CAPM, is based on normally distributed error terms. A *further advantage of logarithmic returns is* that a stock's systematic risk is not as sensitive to the return interval used under the logarithmic return as is the case under the discrete return.

Nevertheless, the return on a stock or an index can be measured by the two methods as follows (Hawawini and Vora 1985):

- **Discrete returns:**

The discrete return on stock i at time t equals:

$$R_t = \frac{P_t + D_t - P_{t-1}}{P_{t-1}}, \qquad \text{which equals} \quad \frac{P_t + D_t}{P_{t-1}} - 1 \qquad \textbf{(E.6.2)}$$

where,

p_t is the price of the stock at time t.

p_{t-1} is the price of the stock at time $t-1$.

D_t is dividend at time t.

[68] Continuous returns.

- **Logarithmic returns:**

The logarithmic return of stock i is equal to[69]:

$$R_i = \ln(P_t / P_{t-1}) \qquad \textbf{(E.6.3)}$$

The logarithmic return could also be measured by the following equation:

$$Logarithmic\,\mathrm{Re}\,turn = \ln(1 + R_t), \qquad \textbf{(E.6.4)}$$

where,

R_t is the discrete return of **(E.6.2)**.

However, since part of this research is concerned with testing the sensitivity of tests of the CAPM to the approach employed for measuring returns, both approaches were used and the results were compared. After calculating both returns and comparing them, some of the results of Hawawini and Vora (1985) are confirmed for returns on the ASM:

1. The time series average of discrete returns is always greater than the time series average of logarithmic returns for securities. The average difference between monthly discrete returns and monthly logarithmic returns is (1.6%)
2. The cross sectional mean of the time series average of discrete returns is greater than the mean of the time series average of logarithmic returns.
3. The cross sectional distribution of discrete returns is more dispersed than the distribution of logarithmic returns. In fact our estimates showed that the standard deviation of discrete returns is (0.027) while the standard deviation of the logarithmic returns is (0.09); which is a large difference.

[69] Equivalently it can be expressed as $\ln(p_t) - \ln(p_{t-1})$.

It was also found that, for all the stocks in the sample, the correlation coefficient between the average monthly stock discrete returns and the average monthly stock logarithmic returns is (0.85). Table (**A6.1**) in Appendix six provides descriptive statistics of the average logarithmic and discrete monthly returns.

However, the key question of relevance for preferring one method of measuring returns over the other is that: to what extent the use of one method would affect beta estimates?. To answer this question for the ASM, beta was measured using both methods. Beta is usually measured as the regression coefficient of a stock's return series on the market return series, i.e. beta is the slope of the regression line between the stock's returns and the returns on the market. The results of beta measurement using both returns are analysed in the following chapter.

6.6. Conclusion

This chapter described the data file used in this research and the selection criteria were outlined. The resulting sample constituted of 52 stocks making 45% of the size of the market in terms of the number of stocks and 75% of the market in terms of the total market capitalisation in 1994. Moreover, the construction of a value weighted daily price index for the ASM, was also described. When comparing the resulting index with the official ASM index the correlation coefficient between the two indices was (0.99). Moreover, returns were measured using logarithmic and discrete methods and the properties of both return measures were analysed. The importance of using both methods in the analysis stems from the fact that most studies with relation to testing the CAPM on the ASM have used discrete returns rather than logarithmic returns. Thus, the effect that this would have on the results of the tests will be investigated in the following chapter, which provides tests of the CAPM using the two approaches for return measurement.

CHAPTER SEVEN

VII.

Empirical Investigations- Return and Beta Estimation

7.1. Introduction

The obstacles to testing the Capital Asset Pricing Model in this and the next chapter, ranging from the unreadiness of data to the presence of thin trading, had the effects of hindering a straightforward application of the model. In particular, trading infrequency stood out as a main complication to a thorough understanding of the price formation in the ASM, and particular attention has been given to the problem (this matter was discussed in length in chapter two of the thesis).

In this chapter the CAPM was tested using more than one method in an attempt to highlight problems associated with their use in the context of small thinly traded markets, thus, the model was investigated on the individual stock level and on the portfolio level. Further, carrying out these tests (discussed in chapter four) on the ASM will provide a background for future investigations of the market. The lack of research on the ASM made the testing task even more challenging and tedious since there was not much empirical work provided to build upon.

This chapter describes the results of basic tests of the CAPM, while chapter eight describes a series of more advanced tests of the model.

7.2. Tests of the CAPM

The issue investigated here is the process governing the generation and formation of prices in ASM; this could be achieved by testing models such as the CAPM. When we test the CAPM, however, we test the assumption that stock price formation is a result of the investors being most interested in holding portfolios rather than individual stocks (Fama, 1976). In a portfolio context, a stock's risk is measured by its beta (provided that the portfolio composition reflects the market generally), then, the expected return on a stock is linearly and positively related to that stock's risk. Tests of the CAPM are generally concerned with testing this hypothesis. Since the CAPM is an expectational model, testing it requires the use of *ex post* variables that adequately proxy for the *ex ante* variables required by the model. Mainly, we have to provide estimates for the expected returns of the model. Moreover, the stock or portfolio risk of relevance in the model, beta, is unobservable thus we have to estimate it. So if we assume that beta is stationary through time then we can use any period's beta and use it as an accurate estimate of the stock's beta. But is beta stationary through time? And if not how stable beta is?.

In addition the problem of thin trading in the ASM leads to erroneous beta estimates, therefore, causing the estimate to be different from the true, but unobservable, beta. To provide an analysis of these issues this chapter investigates the CAPM using various approaches for beta and return measurement.

This chapter starts by conducting a standard CAPM test suggested by Lintner (1969) where the stocks' beta in the sample is measured using the overall period covered by the test, thus assuming an overall stability of beta, then we proceed to another CAPM test suggested by Black, Jensen and Scholes (1972) where the essential difference between this test and the first test is that the first test was carried out on the individual stock level while the second was carried out on the portfolio level.

However, it is noted here that with regard to the first test, assuming the stability of beta over the test period is not an appropriate assumption, since true beta (as a measure of risk) is expected to be non stationary over time. Also, as pointed out by Fama (1976), with regard to the second test the relationship investigated by Black, Jensen and Scholes is actually an investigation of the relationship between return and risk while the CAPM is concerned with the relationship between expected return and risk, since it is an expectational model. Bearing that in mind the analysis that follows, although carries out both tests and investigates the relationships implied by CAPM, the results of this analysis will not be used to draw conclusions about the risk-return relationship in the ASM. Nevertheless, the analysis serves to understand the difficulties and challenges associated with the use of these methodologies in the context of a small and thin market.

7.2.1. A Standard CAPM Test

We start by applying one of the earliest tests of the CAPM; the widely known test procedure of Lintner (1969). The main reason for replicating Lintner's test (in addition to the argument above) is to enable a comparison between the results of this test obtained in this study and the results of a similar test carried out on the ASM by Abdelhaleem (1993). What makes Abdelhaleem's study important is that it is the only study investigating the validity of the CAPM on the ASM[68]. Therefore, it is thought essential to produce some results following the same methodology but using a different set of data. This test was a straightforward test of the relationship between return and risk as measured by beta. Abdelhaleem used discrete monthly returns for measuring betas, whereas our tests used four methods for measuring betas. Betas were measured using discrete and logarithmic trade-to-trade returns and

[68] Up to the commencement of this research.

discrete and logarithmic Marsh[69] adjusted trade-to-trade returns. Thus, the tests also, serve as a sensitivity analysis of using different methods for measuring beta on tests of the CAPM.

The CAPM states that in equilibrium a stock's expected return is positively linearly related to that stock's risk (where the risk is measured as beta).

The model is expressed as:

$$E(R_i) - R_f = \{E(R_m) - R_f\}\beta_i \qquad \textbf{(E.7.1)}$$

Where, β_i is the coefficient of the regression of the expected return ($E(R_i)$) of asset i on the expected return ($E(R_m)$) of the investor's total portfolio; R_f is the risk free rate of return. So, the expected excess return on the stock is equal to the beta of the stock times the risk premium prevailing in the market. Lintner's beta is the coefficient of regressing annual rates of returns for 301 companies' stocks over the period 1954-1963 on the annual average rate of return of all the companies in the sample[70] (i.e. using the market model). This methodology rests on using a first pass regression (time series) to obtain beta estimates for all the stocks in the sample and then to use these estimates in a second pass regression (cross section) to test the CAPM. Another variable that was used by Lintner is the residual variance around the first pass regression. This variable is used as an independent variable which is considered as the non systematic risk (Miller & Scholes, 1972).

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[69] This method was discussed in chapter two.
[70] As a proxy for the market portfolio.

Based on the discussion presented in chapter four, this study uses the empirical CAPM (the market model in excess return form) to measure the beta of the stock using monthly rather than yearly returns. Thus, the first step was to regress monthly excess rates of return (r_{it}) for each company under consideration on the monthly average excess rate of return (r_{mt}) on all the stocks that make the market index.

The first pass regression equation has the form:

$$R_{it} - R_{ft} = a_i + b_i(R_{mt} - R_{ft}) + e_{it}, \qquad \textbf{(E.7.2)}$$

where,

R_{it} is the rate of return on stock i known at time t.

R_{mt} is the rate of return on the market portfolio known at time t.

a_i is the vertical intercept of the regression line.

b_i is the slope of the regression line.

e_{it} is the residual, or the deviation around the regression line. It is assumed that this residual is a normally distributed random error term with a zero expected value and a constant variance.

That is $E(e) = 0$ and $\sigma^2(\mathrm{e}) = \sigma^2$.

$\sigma_{ij} = \sigma^2$ for $i = j$ and 0 otherwise.

The second step is to regress the mean monthly excess returns of each stock on the beta value of the stock and the residual variance.

The regression equation here is,

$$\overline{r_i} = \alpha_0 + \alpha_1 b_i + \alpha_2 S^2{}_{ei} + \eta_i. \qquad \textbf{(E.7.3)}$$

where,

$\bar{r}_i$	is the average monthly excess return over the test period for stock i.
$S^2(e_i)$	is the variance of the residual from (**E.7.2**).
b_i	is the beta of stock i estimated using (**E.7.2**), i.e. Beta is assumed to be stationary.
α_1, α_2	variables.

In testing the CAPM it is noteworthy that the model makes the following predictions:

- There is a positive relationship between risk (β_i) and return (average return in the second pass regression).
- The coefficient (α_1) should equal the risk premium of stock i ($R_i - R_f$).
- Any other variable should not be able to explain returns. This means that the third coefficient (α_2) should equal zero.
- The intercept (α_0) should also equal zero.

The test then is to see if the empirical values of these parameters are significantly different from their theoretical values.

(I) Beta Estimation

Beta values to be used in the second pass regression using (**E.7.3**), were estimated using four alternative methods over the period 1987-1994 (the results are shown in tables (**A7.1, A7.2, A7.3, A7.4**) in Appendix seven). Beta was estimated using 4 different methods:

1. Monthly Marsh adjusted trade-to-trade *logarithmic* excess returns, which are regressed against corresponding index excess returns (as discussed in chapter two).

The model adjusted was the market model in excess return terms (**E.7.2**):

$$\frac{r_{jti}}{\sqrt{t_i}} = \frac{a_{ip}}{\sqrt{t_i}} + b_{ip}\frac{r_{mti}}{\sqrt{t_i}} + u_{it} \qquad \textbf{(E.7.4)}$$

where,

r_{jti} is the return on stock j during period t_i which is the period separating two recorded prices for stock j.

t_i is the time between trades.

a_{ip} is redefined as the continuously compounded rate of return per day during estimation period p.

b_{ip} is the beta estimate of stock j for the period p.

2. Monthly Marsh adjusted trade-to-trade *discrete* excess returns, which are regressed against corresponding index excess returns i.e. using discrete excess returns in (**E.7.4**).
3. Monthly trade-to-trade *logarithmic* excess returns which are matched with corresponding index excess returns i.e. using logarithmic excess returns in (**E.7.2**).
4. Monthly trade-to-trade *discrete* excess returns, which are matched with corresponding index excess returns i.e. using discrete excess returns in (**E.7.2**).

These methods were adopted to achieve two additional goals. The first was to allow for studying the effect of return measurements on beta estimates, while the second was to allow for a study of the adjustment made by Marsh (1979) to the trade-to-trade method for estimating beta. These two objectives are extremely important since the evidence documented by Abdelhaleem (1993) for the ASM did not take them into consideration. In addition, it is of prime importance to analyse the effects of these estimation approaches on the results of the CAPM.

Tables (**7.1**) and (**7.2**) represent some descriptive statistics of beta measured using the four methods:

Table (**7.1**)
Descriptive Statistics of Trade-To-Trade Betas

Logarithmic Beta		*Discrete Beta*	
Mean	0.98	Mean	0.97
Standard Error	0.04	Standard Error	0.04
Median	1.02	Median	1.03
Standard Deviation	0.30	Standard Deviation	0.30
Sample Variance	0.09	Sample Variance	0.09
Kurtosis	-1.02	Kurtosis	-0.90
Skewness	-0.02	Skewness	0.01
Range	1.09	Range	1.13
Minimum	0.42	Minimum	0.40
Maximum	1.51	Maximum	1.54

In terms of beta values there was little difference between both beta values for each stock. To highlight this difference, beta values for each stock were given a rank. The rank correlation coefficient was calculated and found to be (0.99), which implies that there is not much difference between both methods if used to estimate beta.

Table (7.2)
Descriptive Statistics of Marsh Adjusted Trade-To-Trade Betas

Logarithmic Beta		*Discrete Beta*	
Mean	1.00	Mean	0.99
Standard Error	0.04	Standard Error	0.04
Median	0.99	Median	0.99
Standard Deviation	0.31	Standard Deviation	0.30
Sample Variance	0.09	Sample Variance	0.09
Kurtosis	-0.76	Kurtosis	-0.57
Skewness	-0.07	Skewness	-0.05
Range	1.18	Range	1.32
Minimum	0.33	Minimum	0.31
Maximum	1.52	Maximum	1.63

Beta was also measured using the Marsh adjusted trade-to-trade method. This was applied using logarithmic and discrete returns; the results being shown in table (7.2). The rank correlation between both beta values was (0.96) which also indicates that both methods would give similar results.

Below is a comparison between betas measured using logarithmic returns and betas measured using discrete returns:

The average difference between discrete and logarithmic trade-to-trade betas is (-0.004).

- The average difference between discrete and logarithmic adjusted trade-to-trade betas is (-0.007) which show that on average the logarithmic returns' betas are larger than the discrete returns' betas, however the difference is minute.

Thus, it appears that the return measurement approach does not appear to affect the estimation of beta, however, it is shown below that these approaches do affect the results of the tests of the CAPM, by affecting the measurement of the risk premium.

Using Jordanian data to replicate Lintner's test (using monthly data instead of yearly data to provide more data points, however) it was found that the average monthly risk free rate of return over the test period is (0.004) and the average monthly risk premium over the test period using discrete returns was (0.0108) and using logarithmic returns is (0.0056) where the $R_m - R_f$ is calculated here as the difference between the monthly return on the market and the monthly risk free rate of return[71]. This shows that the method used to measure returns can affect the calculation of the risk premium due to the fact that the time series average of discrete returns is always greater than the time series of logarithmic returns for securities and in terms of the risk premium this difference is almost doubled.

Having obtained beta estimates using various approaches, these estimates were used in the second pass regressions and the details of the testing results outlined and reported in the following sections.

(II) Sample and Variables

The data used for testing purposes are monthly trade-to-trade rates of return[72] on 52 stocks listed on the ASM[73]. The market portfolio used here is an index constructed from 52 companies of the sample, which was described in chapter six. The average market rate of return is the average value weighted monthly rate of return of the stocks in the index. To obtain the beta estimate for each stock and the residual variance of the regression, the monthly trade-to-trade stock excess returns were

[71] The monthly rate of return on the market is the discrete rate of return. The monthly risk free rate of return is the monthly return on three months treasury bill.

[72] The reasons for not adjusting for dividends are discussed in section four of chapter one.

[73] The database was described in chapter one and chapter six of the thesis.

regressed on the monthly trade-to-trade market excess returns i.e. employing Equation (**E.7.2**).

(III) Regression Results

Regressions were carried out using four different beta measurement methods. Discrete and logarithmic returns were used estimating beta using trade-to-trade method and using the Marsh adjusted trade-trade method[74]. The results of three regressions are summarised in tables ((**A7.5**) - (**A7.7**) in Appendix seven), while the regression results using discrete returns and trade-to-trade method for measuring beta are shown in table (**7.3**).

Table (**7.3**)
Second Pass Regression

$$\bar{r}_i = \alpha_0 + \alpha_1 b_i + \alpha_2 S^2_{ei} + \eta_i$$

α_0	t-value	α_1	t-value	α_2	t-value	R-squared
0.002	0.159	0.02	1.578	-	-	0.047
0.022	3.461*	-	-	-0.085	-0.156	0.024
0.0033	0.2531	0.0208	1.6231	-0.2512	-0.4579	0.051

* Asterisks indicate significance. $t_{5\%,50} = \pm 2.01$; $t_{5\%,50} = 1.67+$

Hypothesis Testing:

In testing the CAPM there are four hypotheses embedded in the model; these hypotheses are formulated and compared to the values of the coefficients resulting from the application of the model to the data in the regression summarised in table (**7.3**) above. Below are the hypothesis tests which are tested at the 5% and 10% significance levels:

Hypothesis test (7.1); H_0: α_2 = Zero. The relationship between systematic risk and return is linear.

H_1: $\alpha_2 \neq$ Zero.

[74] Thin trading was discussed in section (2.4.2) in chapter two.

The result of the second pass regression presented in table (**7.3**) showed that α_2 equals -0.25. The t-value of the coefficient is -0.45 while the tabulated t-value (two tailed test) at 0.95 level of confidence and 50 degrees of freedom is **2.01**. This indicates that we cannot reject the null hypothesis of a linear relationship between systematic risk and return.

The second prediction made by the model was that there is a positive relationship between risk and return, thus, α_1 is expected to be significantly greater than zero. In this case the null hypothesis is formulated so that the equality sign appears in the null, so that negative and close to zero t-values are rejected; therefore:

Hypothesis test (7.2); $H_0 : \alpha_1 \leq$ Zero. The relationship between risk and return is not positive.

$H_1 : \alpha_1 >$ Zero

From the second pass regression α_1 = 0.0208. The t-value of one tailed test of this coefficient is **1.60**; where at a confidence level of 0.95 and 50 degrees of freedom we find a t-value that is equal (one tailed test) to **1.67**. Since the computed t-value is smaller than the tabulated t-value we cannot reject the null hypothesis that $\alpha_1 \leq$ zero at the 5% significance level.

Hypothesis test (7.3); H_0: $\alpha_1 = (\widehat{\overline{R_m - R_f}})$. The slope of the security market line equals the risk premium.

H_1: $\alpha_1 \neq (\widehat{\overline{R_m - R_f}})$.

The value of the realised risk premium $R_m - R_f = 0.0108$, whereas the value of α_1 = 0.0208, so the t-value of the difference between the observed (theoretical) value and the estimated value is given by;

$$\text{t-value} = \frac{\textit{The observed risk premium - The estimated risk premium}}{\textit{The standard error of the estimated risk premium}} \quad \textbf{(E.7.5)}$$

which equals $\frac{0.0108 - 0.0208}{0.0128}$ = -0.78, which is lower than the tabulated t-value therefore, the difference is not significantly different from zero at the 5% significance level. Therefore, we cannot reject the null hypothesis that the average risk premium does equal the slope of the regression line.

Hypothesis test (7.4); H_0: α_0 = Zero. The intercept equals zero.

H_1: $a_0 \neq$ Zero.

We find that the value of α_0 from the regression is 0.0033 with a t-value of **0.25**, which is not significant at the 5% level. Therefore, we cannot reject the null hypothesis that α_0 (the intercept term) is not significantly different from zero at the 5% significance level.

To provide more evidence using different return measurement methods and beta estimation techniques the analysis was carried out employing three other methods for return measurement and beta estimation. Having tested the model using discrete returns it is appropriate to test it using logarithmic returns. The results are shown in table (**A7.5**) in Appendix seven. Also, noting that beta was measured using trade-to-trade method it is very important to test the effect of not adjusting for heteroscedasticity on the results (which as discussed in chapter two, results from the use of the trade-to-trade method without adjusting for effects of using different time periods for beta estimation). To achieve this, in addition to replicating the test using logarithmic returns, the test was replicated twice; once using logarithmic Marsh adjusted trade-to-trade method and the other using discrete Marsh adjusted trade-to-trade method[75]. The results are shown in tables **(A7.6)** and **(A7.7)** respectively in Appendix seven.

In table (**7.4**) a summary of the results of the above regressions and the decision criteria at 5% and 10% levels of significance are presented. If the coefficient estimated below is in accord with the CAPM, it will be tagged as CAPM consistent otherwise it will be tagged as Reject.

As discussed earlier, from the above methods of testing the CAPM the most appropriate test is the one test employing the Marsh adjusted trade-to-trade beta estimation, and measuring returns using logarithmic returns, although different approaches for measuring beta were employed for comparison purposes. Using logarithmic returns is more suitable for the CAPM since the distribution of these returns conforms more closely to the normal distribution required by the CAPM (Hawawini and Vora (1985)). Besides, the Marsh adjustment of the trade-to-trade method was motivated by the fact that measuring beta over different lengths of periods produces heteroscedasticity.

[75] Deviding by the square root of time as discussed in chapter two.

Table (7.4)
CAPM Test Results for Different Return Measurement Methods

		$\alpha_0 = 0$	$\alpha_1 \leq 0$	$\alpha_1 = R_m - R_f$	$\alpha_2 = 0$
Discrete Returns	**value**	0.003	0.020	0.02 = 0.011	-0.25
	t-value	0.25	1.62	-0.78	-0.46
	5%	**CAPM**	**REJECT**	**CAPM**	**CAPM**
	10%	**CAPM**	**CAPM**	**CAPM**	**CAPM**
Log Returns	**value**	0.002	0.005	0.005 = 0.0056	-0.17
	t-value	0.40	1.21	0.147	-0.67
	5%	**CAPM**	**REJECT**	**CAPM**	**CAPM**
	10%	**CAPM**	**REJECT**	**CAPM**	**CAPM**
Marsh Discrete returns	**value**	0.006	0.019	0.019 = 0.011	-0.15
	t-value	0.50	1.46	-0.62	-0.70
	5%	**CAPM**	**REJECT**	**CAPM**	**CAPM**
	10%	**CAPM**	**CAPM**	**CAPM**	**CAPM**
Marsh log returns	**value**	0.002	0.005	0.005 = 0.0056	-0.71
	t-value	*0.54*	*1.10*	*0.12*	*-0.74*
	5%	**CAPM**	**REJECT**	**CAPM**	**CAPM**
	10%	**CAPM**	**REJECT**	**CAPM**	**CAPM**

$t_{5\%,50} = \pm 2.01$ and $t_{5\%,50} = +1.67$. $t_{10\%,50} = \pm 1.678$ and $t_{10\%,50} = +1.30$.

From the above table, we can note that the use of discrete returns biases the regression coefficients and their t-values upwards and could provide biased inferences. In fact the use of discrete returns did not reject all the hypotheses tested at the 10% significance level. Thus, the main goal behind carrying out the test using different methods for beta measurement was achieved. The use of different return measurement approaches seems to affect tests of the CAPM.

However, looking at the results estimating beta using the Marsh adjusted trade-to-trade and using logarithmic returns we can state the following:

1. The prediction that the intercept term is equal to zero is not rejected and as implied by the model the constant is not significantly different from zero.

2. The positive risk-return relationship implied by the model is rejected, which implies that there is no positive relationship between risk and return. This result is reached at using the 5% and 10% significance levels.
3. The difference between the theoretical risk premium and the empirical risk premium is statistically insignificant. This is in line with the model's prediction where the slope of the regression is expected to represent the risk premium. Here the slope is almost equal to the risk premium.

4. The relationship between risk and return is linear. There is no relationship between return and the variance of the residual terms, which is a common conclusion to all the tests carried out.

To investigate the effects of the Marsh adjustment on the trade-to-trade method for beta estimation, the market model was employed with and without the Marsh adjustment, thus allowing us to note the following. First the average residual variance resulting from the market model[76] without the adjustment is 0.008 while after the adjustment it is reduced to 0.002. Moreover, the standard deviation of this average variance was calculated for the model without adjustment to be 0.005, while for the model after the adjustment it was 0.00015. This shows that the adjustment made by Marsh plays a great role in reducing the residual variance and providing a more stable measure of it, consequently reducing heteroscedasticity.

[76] Using logarithmic returns. However, using excess returns we obtained the same results.

Thus, with regard to the second goal (i.e. the effect of the Marsh adjustment on the results), we can state, after comparing the results of the four tests, the use of the adjustment made by Marsh resulted in producing lower t-values for the slope and higher t-values for the intercept terms, although their values were not greatly altered. This means that this adjustment plays a crucial role in the tests. Given the fact that the tests employed without this adjustment gave close to zero intercepts and slopes, the effect of the Marsh adjustment would result in more departures from the model. Thus, it is possible that tests that do not incorporate this adjustment into the analysis might give support for the model, even if it is not valid. Moreover the standard deviation of the residual variances of the companies resulting from the adjustment made by Marsh greatly reduced the variance.

If we base our judgement on the above test we conclude that over the 1987-1994 period, the CAPM does not seem to hold in the ASM, since there is no discernible risk-return relationship in the market.

However, the test used above was used only for comparing the effects of using different beta measurement methods on tests of the CAPM and to compare its results with the only CAPM test on the ASM; that test was carried out by Abdelhaleem (1993) covering the period 1987-1992 on the ASM and using 47 stocks. Abdelhaleem employed a similar test to the test used above, however, beta was measured without the use of either the trade-to-trade or the Marsh adjusted trade-to-trade methods. Also he used discrete returns rather than logarithmic returns. The results of his test were; the intercept does equal zero ($\alpha_0 = 0$), there is no relationship between risk and return ($\alpha_1 = 0$), the slope of the security market line does equal the risk premium ($\alpha_1 = (R_m - R_f)$) and the relationship between risk and return is not linear ($\alpha_2 \neq 0$). It is noted that Abdelhaleem's results are very close to the results reported above obtained using discrete returns, which was also used by Abdelhaleem. Thus, this empirical investigation of the CAPM in the ASM provided by Abdelhaleem must be viewed in light of the suitability of using discrete returns and not adjusting for the thin trading in the market.

However, to avoid the effect of misestimating betas in the results above, resulting from misestimating individual stocks' betas which might be produced with some random measurement error, the use of portfolios can cancel out these errors, thus, the beta of the portfolio provides a better estimate of the true beta of the stocks within that portfolios (Black, Jensen and Scholes (1972)). This issue is incorporated in the test below.

Consequently, the following is a test using the portfolio approach which is employed to reduce the effects of misestimating the betas of the individual stocks. This test was carried out, mainly, to investigate the problems associated with forming portfolios in the context of small markets.

7.2.2. The Portfolio Approach to Testing the CAPM

Immediately after the well known tests of Lintner and Douglas of the CAPM were published and analysed, empirical tests of the CAPM were carried out using portfolios rather than individual stocks[77]. This is in line with the theory because in

[77] The use of portfolios was first used by Black Jensen and Scholes (1972) and Fama & MacBeth (1973).

the framework of the CAPM investors are expected to hold portfolios rather than to specialise in individual assets. In fact the CAPM suggests that in equilibrium investors hold the market portfolio (which contains all the assets in the economy) and a risk free asset.

Moreover, in testing the CAPM the norm was to measure stocks' betas and compare them with the stocks' rates of returns and test whether or not the risk is compensated for in terms of higher realised rates of returns. If this is the case then the expected rate of return on a stock is directly related to the stock's beta. The main difficulty in testing the CAPM is to obtain accurate beta estimates. If the true beta value of any stock is constant or stable through time the task then is relatively easy, but with more and more evidence on the instability of stocks' betas, tests of the CAPM are becoming more difficult exercises.

The risk measure that is postulated in the CAPM is the true beta of the stock:

$$E(R_i) = R_{ft} + \{E(R_{mt} - R_{ft})\}\beta_i \qquad \textbf{(E.7.6)}$$

This beta value (β_i) is the true beta of stock i. However, the beta value estimated by the market model is only an estimate of the true beta value. This estimate could be used only if the beta estimate is stationary. That is to use any estimate as a substitute for the true value can only be justified if the true value is stable through time and the estimate is unbiased. However, if there is an error in estimating beta then the results of any test using this erroneous estimate is not reliable. This error is widely known and referred to as the errors in variable problem.

Fama (1976) has shown that there are two ways to reduce the estimation error. To minimise the estimation error is to minimise the sampling variance of b_i which is used as an estimate of the true beta (β_i) of stock i. This variance is equal to:

$$\sigma^2(b_i) = \frac{\sigma^2(\varepsilon_i)}{\sum_{t=1}^{T}(R_{mt} - \overline{R_m})^2} \qquad \textbf{(E.7.6)}$$

To minimise the sampling variance one option is to maximise the denominator. This could be achieved by estimating beta using a long time series of monthly returns. This alternative, however, is affected largely by the instability of the beta values of stocks. The other alternative is to minimise the variance of the disturbance of the market model. Since, the *variance of the portfolio disturbance is just the weighted average of the disturbance variances of the stocks within that portfolio, this* measurement error can be reduced by using portfolios instead of individual stocks. For this procedure to be successful the disturbance variances of the securities in any portfolio must not be correlated. Though, even a small degree of independence between these values is helpful in reducing the measurement error. The idea is that, if measurement errors are random then the use of portfolios will cause individual measurement errors to cancel out. The use of portfolios is a one solution to this measurement error. Other solutions involve the use of time varying models that allow the risk measure (beta) to vary through time.

The following test discusses the use of portfolios, in the context of small markets, in tests of the CAPM. Mainly it shows the possible effects of the inappropriate use of portfolios on the results of the Market Model and the CAPM.

(A) Details of the Test

In this test the available stocks in the sample were used to test the relationship between risk (beta) and return on the ASM. This test is a direct test of the *ex post* security market line of the CAPM, which is a test of the hypothesis that the relationship between risk (beta) and expected return is linear and positively sloped. Hence, we are merely testing the hypothesis that different portfolios formed of stocks sorted on the basis of their beta values will have rates of returns that are representing the positive relationship implied by the CAPM.

The test procedure follows that used by Black, Jensen and Scholes (BJS (1972)). BJS formed portfolios over a specific time period and measured their returns. Then, they computed the average return on each portfolio for the entire period and compared these returns with the beta values of these portfolios. If the betas used to rank stocks within portfolios are used as the betas of these stocks then a regression phenomenon or a selection bias will be the result. This is because ranking beta values gives the effect of ranking the estimation errors of those betas, thus extreme beta values will be overestimated for large beta values and under estimated for low beta values, since they contain larger estimation errors (BJS (1972), Fama (1976)). To overcome this problem, betas of the stocks will be estimated using a different time period but subsequent to the time period for testing purposes, so the errors of the estimation in both periods are not correlated but independent from each other. To calculate the beta of the stock for ranking purposes BJS have used at least 24 preceding monthly returns to measure the beta of the stock as an instrumental variable. With respect to our sample which covers 8 years of data this choice means the loss of at least 2 years of data if such technique is used. In fact BJS used 60 monthly past returns for most of the stocks. Therefore, if this methodology is to be used a solution that utilises the methodology and the whole database has to be devised, otherwise a great loss of data will be the case prohibiting many new small markets from using the portfolio approach to testing the CAPM.

(B) A novel Approach to Estimating Betas of Stocks with a Short Time Series

This approach attempts to find a solution to the problem of estimating betas for short time series of data. As pointed out above, BJS used five years of stock data to estimate the beta of the stock to be used for portfolio allocation purposes . But for the ASM this would mean the loss of 5 years of our data base leaving us with only 3 years of data for testing purposes. Thus, leading to the impossibility of using the above approach for estimating betas. But, the reason behind BJS choice of the preceding five years of data is that they wanted to estimate the beta of the stock (to be used in the testing stage) from a variable that is correlated with the beta of the stock but independent from its measurement error. This variable was the beta of the stock in the past period. Thus, based on the same logic we can use, instead of the preceding period's beta, the succeeding period's beta. Consequently, for example, if we are interested in the beta of the stock for the year 1987, we estimate the beta of that stock using the data of the stock from 1988-1992 to measure its beta, then we allocate the stock to a portfolio according to this beta estimate. In this way we can carry out the test using all the available information, noting that this is only possible for testing requirements only. However, this solution was only used when not enough data was available for the stock to allow measuring its beta using the returns of the subsequent period. If enough data were available the beta of the stock was estimated using the preceding period's returns.

Using the portfolio approach to test the CAPM we carried out the test as follows:

1. For the year 1987, betas for all the stocks were measured using 1988-1992 data. The beta of the stock is the regression coefficient obtained from Equation (**E.7.4**).
2. Stocks were ranked according to their beta values.
3. Five portfolios were formed based on beta values for the year 1987. The first portfolio contained the n smallest beta value stocks and the fifth portfolio contained the n largest beta value stocks.
4. Monthly rates of returns for each portfolio for the 1987 period were computed.
5. Steps 1-4 were repeated estimating beta using other periods' data.

The same procedure is repeated to obtain monthly rates of returns for the period 1987-1994 and so on. The following table shows the procedure in detail:

Table (**7.5**)
Testing Procedure

	87	88	89	90	91	92	93	94
Estimation period	88-92	89-93	90-94	87-89	87-90	87-91	88-92	89-93
Months	60	60	60	36	48	60	60	60

The first portfolio contained the stocks with the smallest beta values; the second contained the next highest-values and so on. Table (**A7.8**) in Appendix seven shows the number of stocks in each portfolio.

After forming the portfolios (value weighted portfolios) the monthly excess rates of returns on these portfolios were measured. Thus, we obtain 96 (12 months * 8 years) monthly excess returns for each portfolio. These excess rates of returns were then regressed on the monthly market excess returns for the overall period using Equation (**E.7.4**).

The results of this regression are summarised in the table (**7.6**).

Table (**7.6**)
Regression of Portfolio Excess Returns on the Market Excess Returns

	Beta	**alpha**	**t-value**	R^2	**correl (ri, rm)**	**average Excess return**
First*	0.82	0.004	1.42	0.68	0.82	0.008
Second	0.98	0.001	0.95	0.44	0.66	0.009
Third	0.94	-0.003	-0.7	0.60	0.74	0.003
Fourth	0.89	-0.002	-0.57	0.60	0.78	0.003
Fifth**	1.08	-0.0002	-0.05	0.61	0.78	0.006

* The first portfolio contains the stocks with the smallest betas.
** The fifth portfolio contains the stocks with the largest betas.

The first thing we notice from the above table is the spread of betas; the *smallest* beta value was 0.82 and the highest was 1.08. Betas across portfolios are not showing the advantage of grouping stocks into portfolios based on their beta estimates. The grouping on the basis of beta was used to guarantee a reasonable dispersion of the risk measure. So, the first portfolio should contain the stocks with the smallest betas, the second contains the stocks with the next highest betas and so on. Therefore, a portfolio's beta should reflect the betas of the stocks within that portfolio. But, looking at the table above we notice that the beta of the third portfolio is less than the beta of the second portfolio. Likewise the fourth portfolio has a beta that is lower than the beta of the third or even the second portfolio. This is important to notice since it could be evidence against the use of the portfolio approach to testing the CAPM in thin emerging markets with limited numbers of stocks suitable for analysis.

Three possible explanations were explored to try to understand the cause of the problem. The first is the assumption of beta stationarity, second is the way beta is measured and the third is the way portfolios were formed. Taking the first possibility we remember that the stocks comprising the portfolios were ranked based on betas measured using previous (next) 3-5 years of monthly returns. This was used to avoid the use of stocks' betas for the years in which they were allocated to portfolios. The use of an instrumental variable such as the last period (next period) stock's beta helps to avoid the selection bias since beta will be measured with an error. But, it appears that the betas used for allocating stocks into portfolios, are not correlated with true stocks' betas. The fact that the portfolios' betas are not representing the betas of the stocks for the previous periods shows that those betas are not reliable estimates of the future betas of the stocks.

The second explanation of the empirical observation could be the technique by which betas are measured. Looking back at the way "*ranking betas*" were measured it is noticed that betas were the result of regressing stocks' excess monthly returns on the market's excess monthly returns. However, these monthly excess returns are Marsh Adjusted trade-to-trade monthly excess returns. These trade-to-trade excess returns were used to lessen the effect of non-trading on the regression results from the market model. Now if we look at the way portfolios' betas were measured we notice that these betas are the result of regressing the portfolios' monthly excess returns on the market portfolio's monthly excess returns. This means that we did not use trade-to-trade, since that is not possible on the portfolio level because different stocks within any portfolio do not trade synchronously. The result of this difference in the methods of measuring beta could lead to different beta estimates. In fact this possibility could be further investigated on the stock level. To achieve that, six securities were chosen randomly and their beta values based on monthly returns and trade-to-trade monthly returns are shown in table (**7.7**).

Table (**7.7**)
Beta Estimates using Two Methods (log)

Code	Trade-to trade	Monthly	Difference %
3115	1.14	1.08	**6**
3117	1.13	1.10	03
3119	0.87	0.90	-03
4104	0.77	0.75	02
4103	1.00	0.85	**15**
3121	1.43	1.30	**13**

From the table above we see that, although for most of the stocks the measured trade-to-trade and the monthly return betas are relatively close, in fact they do differ. Specifically, for 2 companies there is relatively large difference between the two betas. This evidence could be supportive of the second assumption especially that the period for measuring betas in the above table used around 8 years of data while the period for measuring betas for ranking securities ranges from 3-5 years which could mean more difference in the two betas estimated.

The third possible explanation could be that the portfolios formed were value weighted portfolios that are very small to the extent that the beta of a single large company in a portfolio whose beta was estimated inaccurately -since it is unstable- dominates the portfolio and shows a different beta from the expected beta. This in fact was verified by excluding from the analysis the largest three companies in the sample. Table (**7.8**) shows the average market capitalisation of the largest six companies expressed in millions of Jordan Dinars and in terms of the percentage of the market capitalisation of the company to the total market capitalisation of the companies in the sample.

Table (7.8)
The Largest Six Companies in the Sample

Company	Average Capitalisation	Average Capitalisation
	Million JD	%
Arab Bank Plc	536	39
Jordan Phosphate Mines	124	9
Jordan Cement Factories	94	7
Jordan Petroleum Refinery	54	4
Housing Bank	35	3
Jordan National Bank	34	2

The largest three companies in the sample were excluded from the analysis and removed from the portfolios since it is expected that they will dominate the portfolios in which they are considered[78]. Table (**A7.13**) in Appendix seven shows the formation of portfolios after the exclusion of these companies. However, the regression results without these firms are presented in table (**7.9**).

Table (7.9)
Summary of Coefficients for Portfolios Excluding the Largest Three Companies

	beta	alpha	t-value	R^2	correl (rp, rm)	residual var.	Average Excess R	var.
First *	0.61	0.000	0.03	0.51	0.71	0.0007	0.003	0.001
Second	0.91	0.004	1.03	0.50	0.71	0.0017	0.009	0.003
Third	1.00	- 0.0006	-0.16	0.58	0.76	0.0015	0.005	0.003
Fourth	1.08	0.0029	0.58	0.52	0.72	0.0023	0.010	0.005
Fifth **	1.25	-0.001	-0.16	0.55	0.74	0.0027	0.006	0.006

* The first portfolio contains the stocks with the smallest beta values
** The fifth portfolio contains the stocks with the largest beta values

The first thing we notice from the table above is that the betas of the portfolios better reflect the betas of the stocks within them. Second, a better spread of risk is attained here. The beta values range from 0.61 in the smallest beta portfolio to 1.25 in the highest beta portfolio. Whereas, the analysis with the largest three companies shows a range between 0.82 and 1.08. This portfolios' better representation of the stocks' betas is an obvious improvement resulting from excluding the largest three

[78] The number of stocks in each portfolio is shown in table (A7.8) in Appendix 7.

companies which could imply that the beta values of those three firms or some of them are estimated with large error or has dramatically shifted in short period of time, that affected the values of the portfolios' betas.

The correlation between the portfolios and the market ranges between 0.71 and 0.76. The advantage of using portfolios is best if the correlation between their returns and the returns on the market is large. The highest-value of the correlation coefficient between the returns on portfolios and the market is 0.76, which might not be considered large, but is good if we take into consideration the limited number of stocks within these portfolios.

However, comparing risk levels with their corresponding average excess returns we notice that there does not seem to be a relationship between the beta of the portfolio and the excess returns on that portfolio. Carrying out the analysis on the sub periods could shed more light on the persistence of the relationship. This division will allow, to an extent, an investigation of the stationarity of the coefficients. To do this, the total period was subdivided into four equal time periods. That is 1987-1988, 1989-1990, 1991-1992 and 1993-1994; each time period spanning two years.

From table (**7.10**) below, it is noticed that, in spite of the exclusion of the largest three stocks, the risks of the portfolios are not representing the systematic risks of the stocks within these portfolios. This is an obvious evidence against the stability of beta, because if betas were stable through time then the betas of the portfolios would correspond to the betas of the stocks constituting them.

Table (**7.10**)
Summary of Coefficients for Sub Periods

	Periods	*First*	*Second*	*Third*	*Fourth*	*Fifth*	*Market*
Beta	87-88	0.438	0.527	0.924	0.709	1.040	1
	89-90	0.333	0.590	0.832	0.998	1.184	1
	91-92	0.850	1.132	1.259	1.410	1.782	1
	93-94	0.948	1.363	0.948	1.137	0.922	1
Alpha	87-88	0.006	0.003	-0.0003	0.012	0.0009	
	89-90	-0.011	-0.015	-0.007	-0.011	-0.003	
	91-92	0.008	0.0315	0.008	0.008	0.007	
	93-94	-0.004	0.005	-0.010	0.0004	-0.015	
t-Alpha	87-88	2.072	0.690	-0.159	1.065	0.104	
	89-90	-2.062	-2.562	-0.673	-0.872	-0.278	
	91-92	1.558	2.673	1.024	1.078	0.516	
	93-94	-0.818	0.741	-1.708	0.067	-2.094	
Average R	87-88	0.008	0.001	0.006	0.019	0.001	0.004
	89-90	-0.006	-0.009	0.001	-0.003	0.011	0.006
	91-92	0.017	0.047	0.024	0.023	0.025	0.011
	93-94	-0.004	-0.004	-0.012	0.002	-0.015	0.001
Var R	87-88	0.0004	0.0009	0.0019	0.0036	0.0034	0.0016
	89-90	0.001	0.002	0.005	0.007	0.0084	0.0034
	91-92	0.0018	0.0049	0.0040	0.0044	0.0088	0.0016
	93-94	0.0023	0.0052	0.0025	0.0032	0.0027	0.0018

But, because betas of the stocks change through time the betas of the portfolios for the next (previous) period are not representative of their constituents. Moreover, the subperiods are not showing any consistent relationship which points to the nonstationarity of the relationship and the impossibility of detecting it using such short sub periods.

(C) The Cross Section Test

In this test excess returns computed for each portfolio over the entire period are regressed against the beta estimates, obtained in the previous section, for each portfolio over the same period, the model used taking the form;

$$\bar{r}_i = \alpha_0 + \alpha_1 \beta_i + e_i \qquad \textbf{(E.7.8)}$$

where,

$\bar{r}_i$ is the average monthly excess return for portfolio i.

β_i is the beta of portfolio i.

The hypotheses tested therefore, are formulated as follows:

Hypothesis test (7.6): H_0, $\alpha_0 = Zero$. H_1, $\alpha_0 \neq Zero$.

Hypothesis test (7.7): H_0, $\alpha_1 \leq Zero$. H_1, $\alpha_1 > Zero$.

Hypothesis test (7.8): H_0, $\alpha_1 = \bar{r}_m$. H_1, $\alpha_1 \neq \bar{r}_m$.

That is, α_0 should equal zero, α_1 should be positive and equal the average monthly excess return on the market ($\bar{r}_m$) over the same period, which equals 0.0056. The t-value of the difference between the monthly excess return on the market portfolio and α_1 is obtained from Equation (**E.7.5**), so for the overall period this is equal to

$\frac{0.0056 - 0.0058}{0.0093} = 0.19$ as shown in table (**7.11**).

Table (**7.11**) shows the results of the regression using Equation (**E.7.7**) for the subperiods as well as the overall period.

Table (**7.11**)
Results of the Regression for Sub Periods and the Overall Period

	α_0	$t(\alpha_0)$	α_1	t-value	$\bar{r}_m$	$t(rp - a_1)$
1987-88	0.01	0.83	-0.005	-0.3	0.0037	0.52
1989-90	-0.015	-2.19	0.018	2.11	0.007	-1.4
1991-93	0.027	1.05	0.0002	0.012	0.011	0.55
1993-94	-0.027	-1.48	0.019	1.14	0.001	-1.09
Overall period	*0.001*	*0.157*	*0.006*	*0.95*	*0.0056*	*-0.022*

* $t_{5\%,4} = \pm 2.77$, ** $t_{5\%,4} = +2.13$

The t-values in the above table tell a consistent story with relation to tests of the CAPM, since the alpha values for all the other sub periods as well as the overall period are not significantly different from zero, thus, we can confirm that the intercept is not statistically different from zero; as predicted by the model.

Hypothesis test (7.7), concerning the second coefficient (α_1), is not rejected for the over all period as well as for all the subperiods, implying there is no relation between risk and return. However, all the values of α_1 are positive, but with no statistical significance. With regard to *hypothesis test* (**7.8**) we notice that none of the reported coefficients is significantly different from the excess return on the market over the period and over the subperiods investigated.

In the final analysis it would seem, depending on the results of the overall period (1987-1994) using the portfolio approach, that the CAPM does not apply to the ASM, since the risk-return relationship is not established. This is also the case in the light of the sub periods with results that do not support the validity of the CAPM in the ASM. However, based on the discussion above regarding the appropriate use of portfolios for testing purposes and the apparent lack of aggregation through portfolio formulation in the context of thin small markets, the question that needs answering is to what extent the above results are reliable.

In fact the above tests were conducted to highlight the difficulties that are associated with the use of portfolios containing small numbers of stocks in testing capital asset pricing. The main side effect is the apparent dominance of large companies within portfolios. The aggregation required for reducing beta measurement error will not be achieved and thus the tests will be biased.

7.3. Conclusion

This chapter provided tests of the standard CAPM, using two methods for beta estimation and two return measurement approaches. Specifically, beta was estimated using the trade-to-trade and Marsh adjusted trade-to-trade methods. Also, returns were measured using logarithmic and discrete return measurement approaches. The result of testing the model using the logarithmic returns provided evidence rejecting the model in the context of the ASM. It was also found that the use of discrete returns can bias the results of the tests and the model was not rejected using discrete returns at the 10% significance level. This was compared with the only test of the model in the context of the ASM carried out by Abdelhaleem (1993) and found that his use of the discrete returns could account for some of his conclusions, that returns are related to the variance of returns. Also it was found that the use of discrete returns would bias the estimates by providing larger t-values of the coefficients when regressions are performed. So it is more likely to make wrong inferences using discrete returns than when using logarithmic returns. Moreover, Abdelhaleem did not adjust for thin trading and used monthly rather than trade-to-trade prices, which might have an additional effect on his results. With regard to the adjustment made by Marsh of the trade-to-trade method it was also found that, after allowing for this adjustment, the adjustment changes the estimated t-statistics of the coefficients to show more deviations from the model.

It was argued at the outset that the reason for following Lintner's methodology was to shed some light on the effects of using different approaches to measuring beta on the results of the tests. However, if this test is used to make inferences of the relationship between risk and return the CAPM will be rejected in the context of the ASM since there was no apparent relationship between risk and return.

Using the portfolio approach for testing the model gave similar results to those obtained using individual stocks. Mainly the intercept is not significantly different from zero and the slope is equal to the risk premium but not significantly different from zero, which again implies the rejection of the model if the results obtained were used for judgement. However, as stated by BJS the t-values are understating the departures from the model and should not to be used without questioning. This in fact might be the case because looking at the first pass regression the stocks or portfolios with different risk levels were not associated with corresponding levels of excess returns, thus giving less credit for the results of the second pass regression tests and casting doubt on the *statistical power of* these tests. In fact the main objective of the use of portfolios to test the CAPM was to highlight the difficulties of forming efficient portfolios from small numbers of stocks and it was shown that the aggregation resulting from this process in the context of the ASM is not efficient. Thus, the evidence provided here is not supporting the use of portfolios to investigate the behaviour of returns in small markets.

The above tests were based on the assumption of the stationarity of beta through time, thus to allow beta to vary through time is an essential objective of tests employed in the next chapter. Furthermore, the test carried out in section (7.2.2) is in fact an examination of the relationship between risk and return while the CAPM suggests a relationship between risk and expected returns. This will be the matter of the next chapter which employs two other tests of the CAPM.

CHAPTER EIGHT
VIII.

Empirical Evidence- Capital Asset Pricing Model

8.1. Introduction

The work of this chapter is concerned with investigating the validity of the CAPM in the ASM using more advanced tests. Such tests involve the use of rolling betas and pooled data. Rolling betas are used to overcome the problem of the non stationarity of beta which was assumed in the tests of chapter seven i.e. the risk of stocks does change. The question is how often risk changes and how confident can we be in dealing with beta estimates using short periods of time, since these *ex post* beta estimates are proxies for the *ex ante* true betas of the CAPM. To provide an answer for the question, various time periods have been used in this study to estimate beta. But, because the true beta of the stock (across any period) is not known to be stable or otherwise, any test of the CAPM is a joint hypothesis test of the validity of the model and the stability of beta across the period used for its estimation. If the CAPM is valid then any period, that produces beta estimates that lead to supporting the model, will be the best period for beta estimation. But, since the CAPM itself is under investigation, the joint hypothesis test cannot be separated.

However, the test of the following section is a low power test because of the limited database we are dealing with. Therefore, to effectively test the CAPM a more powerful test must be used. To achieve this the data was pooled to provide high degrees of freedom making the test more powerful. The effects of thin trading on the results are also investigated using pooling data regressions for two sub groups of the sample with different trading characteristics.

This chapter is structured as follows. Section two provides a test of the CAPM introducing the rolling beta technique for individual stocks and portfolios. Section three provides a test of the CAPM using rolling betas and the pooled data methodology.

8.2. Testing the CAPM Using the Rolling Beta Technique

One of the main challenges in testing the CAPM is to accurately estimate beta. Therefore, one suggested method, by Fama and MacBeth (1973), to solve this problem is to estimate a stock's beta for a given month using the previous five years of the stock's monthly returns and the market monthly returns. For the next month the procedure is to drop the first month's return and include another month's return. This would go on until the monthly betas of the stock are estimated for the entire duration of the study. This procedure is known as the rolling beta technique. However, although the five years figure, was arbitrarily used by researchers and reduced to two years when no sufficient returns were available (e.g. Fama and MacBeth (1973), BJS (1972)), it might pose a problem in the context of emerging markets with short lives of operation. The use of five years was based on the assumption that beta is stable across this time period, thus using five years of returns would produce accurate estimates of the true, but unobservable, beta (Fama, 1976). Therefore, since in small market, such as the ASM, beta stability is not, yet, established across any length of time, this research tackles the issue using different lengths of time to estimate rolling betas.

However, the main empirical work that used rolling betas was that of Fama & MacBeth (1973) who tested the CAPM by regressing portfolios' excess returns for a specific period against those portfolios' betas estimated using at least 24 monthly returns for the same period. The estimated beta values were used as explanatory variables of return.

The model employed by Fama & MacBeth was:

$$\overline{R}_{it} = \alpha_{0t} + \alpha_{1t}\beta_{it-1} + \alpha_{2t}\beta^2_{it-1} + \alpha_{3t}S_{eit-1} + \eta_{it} \qquad \textbf{(E.8.1)}$$

$\overline{R}_{it}$ is the average expected return on portfolio i at time t.

β_{it-1} is the beta of portfolio i at time $t-1$.

S_{eit-1} is the residual variance of the first pass regression at time $t-1$.

η_{it} is a random error which has a mean of zero and a constant variance.

The CAPM suggests that α_{2t}, α_{3t} should equal zero. That is residual risk should not affect returns and there is no nonlinearity in the security market line (Fama & MacBeth, 1973). However, the most important feature of the CAPM is that α_{1t} should be positive, implying that there is a positive relationship between risk and return. Fama (1976) argued that in testing the CAPM expected returns should be used rather than using realised returns because the CAPM is an expectational model. Thus, in the above model betas are matched with returns for the one period ahead.

The model estimated below is primarily a model that investigates the relationship between risk and expected excess return on the ASM and is expressed below. The test is designed to examine the effect of lengthening the time period used for beta estimation on the results of tests of the CAPM. The model used is:

$$r_{it} = \alpha_{0t} + \alpha_{1t}\beta_{it-1} + \eta_{it} \qquad \textbf{(E.8.2)}$$

Where the explanatory variable of returns is the stock's beta (β_{it-1}), and the dependant variable (r_{it}) is the expected excess return on stock i measured for month t; α_{0t} is the intercept which is expected to be zero and α_{1t} is the risk premium which is expected to be significantly different from zero and equal to the risk premium for the market; η_{it} is a random error term which has a mean of zero and a constant variance. Essentially we are using excess returns measured in month t and their explanatory variables (the beta risk measures) are known prior to the availability of that month's return. Thus, the test has a predictive aspect in the sense that if there is a risk-return relationship and the direction of this relationship is established then that would be evidence on the use of beta as an explanatory variable of returns.

In this test investors are assumed to be able to assess the risks of the stocks using previous return data. Utilising the market model in **(E.7.4)**[79], these beta values were estimated using 36, 48 and 60 months of excess returns. It is essential to estimate beta using different lengths of time periods since the betas of the stocks on the ASM are not known to be stable, therefore, it is important that the relationship is

[79] As shown in chapter seven this model takes the following form:

$$\frac{r_{jti}}{\sqrt{t_i}} = \frac{a_{ip}}{\sqrt{t_i}} + b_{ip}\frac{r_{mti}}{\sqrt{t_i}} + u_{it}$$

where,

r_{jti} is the return on stock j during period t_i which is the period separating two recorded prices for stock j.

t_i is the time between trades.

a_{ip} is redefined as the continuously compounded rate of return per day during estimation period p.

b_{ip} is the beta estimate of stock j for the period p.

investigated using alternative beta estimates, taking into consideration the effects of beta instability on the results. However, the model used assumes beta stability in the market over the time used to estimate beta, this assumption is required for a meaningful test of the model.

The procedure adopted below is to estimate the beta of the stock by regressing 36 monthly stock excess returns on the 36 corresponding monthly market excess returns. The outcome of the regression is the first beta value. The next beta value will be obtained by repeating the previous step but, dropping the first excess return value and adding a new excess return value. This, '*rolling beta*' procedure is repeated until the excess return series is exhausted. The next step is to regress excess returns for each stock against individual stocks' beta values following the model in Equation **(E.8.2)**. Clearly we are testing if a stock's beta in a subsequent period is an explanatory variable of that stock's excess returns.

In this test beta was estimated for each stock in the sample using 36, 48 and 60 monthly returns. In the 36 months, for example, 36 monthly excess returns on a single stock were regressed against 36 monthly excess returns on the market portfolio (the market index constructed in chapter six). After that the first monthly excess return in that series is dropped and the 37th excess monthly return is included. This procedure is repeated until the available series for each stock is exhausted. Then these beta estimates are regressed against the monthly excess returns for that stock. That is the first beta estimate using the first 36 monthly returns is matched with the monthly excess return number 37 for that stock. The same procedure is repeated using 48 and 60 monthly returns.

There are three test hypotheses to be investigated:

The first prediction made by the model is that the intercept term is equal to zero, thus the hypothesis to be tested is:

Hypothesis test (8.1); H_0 : α_0 = Zero.

The intercept term is equal to zero.

H_1: $\alpha_0 \neq$ Zero.

The second prediction is that α_1 is positive and significantly different from zero. Since zero values of the coefficient are not considered to be in line with the model's predictions the hypothesis to be tested is formulated as:

Hypothesis test (8.2); H_0: $\alpha_1 \leq$ Zero. The relationship between risk and return is not positive.

H_1: $\alpha_1 >$ Zero.

Thus, the decision rule is to reject the null using one tailed test if t-values are significantly positive.

The third prediction is that α_1 is equal to the risk premium prevailing in the market over the time period under investigation.

Hypothesis test (8.3); H_0: $\alpha_1 = (\overline{R_m - R_f}) =$ 0.0056

The slope of the security market line equals the average risk premium.

$$H_1: \quad \alpha_1 \neq (\overline{R_m - R_f}).$$

So, basically we are testing if there exists a positive relationship between risk of a magnitude that is equal to the risk premium. The regression results for the 36, 48 and 60 months are discussed below.

8.2.1. Results Employing Beta Estimated using 36 Months

Table (**8.1**) reports the results of the regressions of (**E.8.2**) with betas estimated using 36 monthly returns, as explanatory variables.

Table (**8.1**)
Testing the CAPM using Rolling Beta Method & Estimating Beta using 36 Monthly Excess Returns

Code	α_0	**t-value** α_0	α_1	**t-value** α_1	$t(rp-\alpha_1)$	R-Squared
4142	0.003	0.179	0.013	0.480	-0.27	0.004
4106	0.079	1.326	-0.053	-1.051	1.16	0.019
4241	0.003	0.223	-0.012	-0.361	0.53	0.002
4113	-0.074	-1.274	0.044	1.196	-1.04	0.024
4108	-0.152	-1.247	0.146	1.219	-1.17	0.025
1323	0.036	1.384	-0.031	-1.370	1.62	0.032
4123	-0.129	-0.876	0.087	0.886	-0.83	0.024
4139	-0.009	-0.153	0.005	0.134	0.02	0.000
4140	-0.061	-1.129	0.041	0.960	-0.83	0.016
4135	-0.008	-0.264	0.008	0.292	-0.09	0.001
3104	0.009	0.477	-0.019	-0.766	0.99	0.010
4109	0.085	2.565*	-0.075	-2.357	2.53*	0.089
1102	-0.118	-2.577*	0.103	2.779*	-2.63*	0.119
4145	-0.065	-0.736	0.030	0.564	-0.46	0.006
4111	-0.006	-0.258	0.019	0.464	-0.33	0.004
4112	0.045	1.084	-0.018	-0.660	0.87	0.008
3115	-0.011	-0.122	0.029	0.391	-0.32	0.005
4151	-0.079	-1.211	0.039	0.895	-0.77	0.030
3121	0.038	0.575	-0.007	-0.175	0.32	0.001
1113	0.011	0.654	0.001	0.056	0.26	0.000
4127	-0.106	-1.123	0.080	1.107	-1.03	0.021
3117	-0.069	-1.237	0.067	1.603*	-1.47	0.055
4132	-0.051	-0.790	0.023	0.504	-0.38	0.005
3105	0.074	1.216	-0.051	-0.962	1.07	0.024
4116	-0.073	-1.092	0.029	0.642	-0.52	0.009
4104	0.016	0.316	-0.013	-0.207	0.30	0.001

Table (8.1) **Continued**

Code	α_0	**t-value** α_0	α_1	**t-value** α_1	$t(rp-\alpha_1)$	R-Squared
2109	-0.097	-2.669*	0.103	2.902*	-2.74*	0.149
3118	-0.139	-0.993	0.097	0.983	-0.93	0.028
1101	0.015	0.196	-0.011	-0.201	0.30	0.001
4128	-0.035	-0.444	0.039	0.445	-0.38	0.004
4119	-0.207	-2.51*	0.203	2.452*	-2.38*	0.099
3120	-0.022	-0.557	0.016	0.555	-0.36	0.006
1114	-0.044	-0.767	0.028	0.533	-0.43	0.005
3119	-0.073	-1.793*	0.064	1.613*	-1.47	0.045
4115	-0.032	-0.674	0.050	0.882	-0.78	0.014
1222	-0.057	-1.488	0.162	1.797*	-1.73*	0.078
1104	0.016	0.689	-0.006	-0.289	0.56	0.001
4167	-0.413	-3.162*	0.340	2.970*	-2.92*	0.227
3112	0.006	0.131	-0.006	-0.134	0.26	0.000
4110	0.002	0.019	0.005	0.065	0.01	0.000
4118	-0.035	-0.605	0.027	0.417	-0.33	0.003
4126	-0.064	-0.815	0.090	0.875	-0.82	0.014
4103	-0.220	-1.821*	0.222	1.941*	-1.89*	0.070
1107	-0.028	-0.501	0.041	0.823	-0.71	0.014
4158	-0.154	-0.950	0.098	1.066	-1.01	0.044
1106	0.016	0.733	-0.015	-0.536	0.74	0.005
4114	0.110	1.327	-0.133	-1.336	1.39	0.035
4117	-0.008	-0.460	0.003	0.133	0.12	0.000
2117	0.034	1.215	-0.058	-1.047	1.15	0.020
2104	0.019	0.844	-0.026	-0.582	0.71	0.007
4138	-0.142	-0.981	0.179	1.031	-1.00	0.023
4130	0.008	0.292	-0.054	-0.852	0.94	0.023

* $t_{10\%,59} = \pm 1.671$ and $t_{10\%,59} = +1.29$.

As implied by the CAPM the intercept term is not expected to be significantly different from zero $(\alpha_0 = 0)$ as stated in *hypothesis test* (**8.1**). From table (**8.1**) above we notice that the intercept in most of the cases is not significantly different from zero (only 7 companies have significant intercept terms constituting 13% of the companies in the sample) which is in line with the CAPM.

The regression slope is the monthly risk premium which is expected under the CAPM to be positive and significantly different from zero. Also, since the above regression is a regression of the stocks' excess returns on their beta values, we expect the slope of the regression to be significantly positive in order to conform with the expectations of the CAPM. The regression results summarised in table (**8.1**) show that only 8 companies (15% of the sample) have t-values that are significantly positive, thus only for 8 cases there seems to be a positive relationship between risk and return. For the other 44 cases the results indicate a negative or zero risk premium. However, most of these t-values are very close to zero. This tells us that there is only 8 companies that agree with the model's main predictions; there is risk-return relationship of a positive nature. While for the other 44 companies risk is not related to expected returns.

Moving to the third prediction that the magnitude of this relationship equals the risk premium on the market the hypothesis that the regression slope is equal to risk premium is rejected only for seven out of the fifty two cases reported. Those 7 cases have significant t-values implying that the slope is statistically different from the risk premium. However, the other 45 companies show that their risk premiums do equal the risk premium in the market.

This indicates that risk is not priced in the ASM; assuming that the stock's risk is the stock's beta and beta is adequately estimated as the regression coefficient of 36 monthly stock returns on 36 market monthly returns.

Conducting the test using the above described sample, over the 1987-1994 time period the evidence suggests three things:

1. Most of the intercept terms are zero (86%).

2. Most of the coefficients are non positive but close to zero (82%).

3. Most of the coefficients are not significantly different from the risk premium (87%).

The above results imply that the CAPM does not hold in the context of the ASM in the sense that excess returns for most of companies do not seem to be related to the risk of these companies. Thus, based on the regression coefficient results there does not seem to be a discernible relationship between risk and expected returns which casts doubts on the power of the tests due to a lack of aggregation, since due to the problems of estimating beta, we require more aggregation in the form of portfolios rather than individual stocks. However, the results of the above tests could be used to for comparison with the results of using longer time periods for measuring beta. Thus, we move to testing the relationship using a longer time period for beta measurement to verify these results.

8.2.2. Results Employing Beta Estimated using 48 Months

As the period for beta estimation is increased the sample available for analysis decreases. Thus out of the sample of the 52 companies used only 40 companies had enough data to allow measuring beta using 48 months and still have enough time span for testing purposes The model tested is the model described in **(E.8.2),** where,

β_{it-1} is the beta of stock i estimated using 48 monthly returns.

Looking at the results, summarised in table (**8.2**), we notice that, using 48 months for rolling beta estimation, more intercepts are significantly different from zero (9 alpha terms which is 22.5% of the sample) than in the case of the 36-month betas (13% of the sample), implying an increase in the departure from the original model. We look at the regression coefficients and notice that now only 4 regression coefficients (10% of the sample) are significantly positive compared with 15% significant coefficients resulting from the use of 36 monthly betas. Moreover, 90% of the coefficients imply a non positive risk premium leading to an overall rejection of the hypothesis of a positive relationship between risk and return (notice that in 55% of these cases the coefficient is negative with very large t-values in many cases). So, the departure from the model is not only documented by the increase of the significant values of the intercept terms but, also the risk-return relationship documented for a few number of stocks has been also affected.

Table (**8.2**)
Testing the CAPM using Rolling Beta Method & Estimating Beta using 48 Monthly Excess Returns

Code	α_0	**t-value**	α_1	**t-value**	$t(rp-\alpha_1)$	R-Squared
4142	0.047	1.821*	-0.044	-1.132	1.28	0.028
4106	0.304	3.350*	-0.240	-3.110	3.18*	0.177
4241	0.035	1.681*	-0.077	-1.651	1.77*	0.057
4113	-0.157	-1.005	0.098	1.031	-0.97	0.023
4108	-0.145	-0.834	0.142	0.843	-0.81	0.016
1323	-0.015	-0.374	0.018	0.520	-0.36	0.006
4139	0.203	1.660	-0.121	-1.639	1.71*	0.056
4140	0.480	3.065*	-0.374	-3.088	3.13*	0.175
4135	-0.086	-0.973	0.084	1.132	-1.06	0.028
3104	0.063	2.497*	-0.086	-2.415	2.57*	0.115
4109	0.155	3.454*	-0.146	-3.244	3.37*	0.190
1102	0.161	2.366*	-0.112	-2.055	2.16*	0.086
4145	-0.283	-1.145	0.168	1.132	-1.09	0.028
4111	0.076	1.445	-0.111	-1.234	1.30	0.033
4112	0.105	1.675	-0.056	-1.319	1.45	0.037
1113	0.041	1.910	-0.027	-0.818	0.99	0.015
4127	-0.114	-0.667	0.087	0.689	-0.64	0.011
4132	-0.138	-1.346	0.093	1.310*	-1.23	0.038
4116	0.059	0.312	-0.062	-0.495	0.54	0.007
4104	-0.084	-0.863	0.117	0.990	-0.94	0.022
1101	0.113	1.238	-0.077	-1.197	1.28	0.032
4128	-0.123	-1.044	0.145	1.145	-1.10	0.030
4119	0.001	0.006	0.003	0.012	0.01	0.000
3120	0.124	1.883*	-0.087	-1.688	1.80*	0.068
1114	0.076	0.673	-0.080	-0.781	0.84*	0.014
3119	-0.029	-0.316	0.026	0.296	-0.23	0.002
4115	-0.079	-0.504	0.112	0.587	-0.56	0.008
1104	0.037	1.131	-0.018	-0.530	0.69	0.006

Table (**8.2**) **Continued**

Code	α_0	**t-value**	α_1	**t-value**	$t(rp-\alpha_1)$	R-Squared
3112	-0.036	-0.265	0.046	0.333	-0.29	0.003
4110	0.324	0.945	-0.216	-0.898	0.92	0.018
4118	-0.123	-1.581	0.120	1.484*	-1.41	0.048
4126	-0.072	-0.476	0.120	0.589	-0.56	0.009
4103	-0.296	-0.931	0.294	0.986	-0.97	0.024
1107	-0.165	-1.127	0.168	1.278	-1.24	0.045
1106	0.044	1.122	-0.058	-0.978	1.07	0.024
4114	0.126	1.208	-0.164	-1.296	1.34	0.042
4117	-0.061	-1.499	0.075	1.448*	-1.34	0.052
2117	0.071	1.711*	-0.135	-1.478	1.54	0.049
2104	0.034	1.095	-0.067	-1.027	1.11	0.032
4138	-0.186	-1.321	0.240	1.436*	-1.40	0.057

* $t_{10\%,47} = \pm 1.67$ and $t_{10\%,47} = +1.30$.

Thus, basically more intercept terms appear to be significantly different from zero, and more regression coefficients are negative with large t-values in many cases, than in the case of the 36 monthly betas. This of course leads the coefficient to be different from the risk premium because the risk premium for the market was positive. The fact that departures from the model were reported using a longer time period warranted an investigation of the relationship using a time period that is longer than the 48 months period. Thus, to shed more light on this conclusion and provide more evidence of the relationship, the test was carried out using 60 monthly returns to estimate betas.

8.2.3. Results Employing Beta Estimated using 60 Months

Out of the sample of the 52 companies, only 33 companies had enough data to allow measuring beta using 60 months and still have enough time span for testing purposes. Again, the model tested is Equation (**E.8.2**) where;

β_{it-1} is estimated using 60 monthly returns.

Results of the tests are summarised in table (**8.3**).

Table (8.3)
Testing the CAPM using Rolling Beta Method & Estimating Beta using 60 Monthly Excess Returns

Code	α_0	t-value	α_1	t-value	$t(rp-\alpha_1)$	R-Squared
4142	0.114	1.836*	-0.151	-1.478	1.53	0.062
4106	0.477	1.621	-0.402	-1.573	1.59	0.070
4241	0.037	0.760	-0.095	-0.793	0.84	0.019
4113	-0.213	-1.153	0.128	1.110	-1.06	0.036
4108	-0.234	-1.403	0.217	1.351*	-1.32	0.052
1323	-0.022	-0.203	0.026	0.272	-0.21	0.002
4139	0.562	1.447	-0.363	-1.462	1.48	0.061
4140	0.156	0.639	-0.140	-0.696	0.72	0.014
4135	-0.020	-0.328	0.012	0.215	-0.11	0.001
3104	0.094	1.807*	-0.163	-1.888	1.95*	0.097
4109	0.267	1.805*	-0.287	-1.810	1.85*	0.090
1102	0.114	1.387	-0.086	-1.224	1.30	0.043
4145	-0.448	-1.886*	0.271	1.856*	-1.82*	0.095
4111	-0.161	-2.227*	0.320	2.320*	-2.28*	0.140
4112	0.206	1.438	-0.128	-1.259	1.31	0.046
1113	0.058	1.667	-0.060	-0.999	1.09	0.030
4127	-0.375	-1.704*	0.269	1.606*	-1.57	0.075
4132	-0.114	-0.855	0.069	0.736	-0.68	0.017
4104	-0.097	-1.061	0.122	1.071	-1.02	0.036
1101	0.101	0.646	-0.074	-0.638	0.69	0.013
4128	-0.157	-1.467	0.175	1.519*	-1.47	0.069
4119	-0.508	-1.781*	0.510	1.769*	-1.75*	0.087
1114	-0.122	-0.544	0.105	0.496	-0.47	0.007
3119	0.003	0.020	-0.012	-0.078	0.11	0.000
4115	-0.185	-1.988*	0.243	2.112*	-2.06*	0.119
1104	0.101	1.525	-0.101	-1.239	1.31	0.046
3112	-0.263	-0.668	0.289	0.678	-0.66	0.014
4110	-0.238	-0.630	0.166	0.598	-0.58	0.011
4118	-0.085	-0.683	0.079	0.603	-0.56	0.011
4126	-0.078	-0.655	0.107	0.697	-0.66	0.016
1106	0.205	1.932*	-0.302	-1.841	1.88*	0.102
4117	-0.042	-0.547	0.046	0.457	-0.40	0.007
2117	0.092	1.108	-0.217	-1.132	1.16	0.041

* $t_{10\%,35} = \pm 1.69$ and $t_{10\%,35} = +1.30$.

From table (**8.3**) we notice that, with regard to the intercept terms, there are 9 significant terms which is 27% of the sample used. However, unlike the test using 48 months betas, 21% of the regression coefficients imply that there is a positive risk-return relationship and 27% t-values for the difference between the coefficient and risk premium are significantly different from zero.

The main finding here is that the longer the period used for beta estimation the greater the departures are from the model. When using the 36 months only 13% of the companies reported significantly different from zero intercept terms, where this increased to 22.5% of the companies in the case of the 48 monthly betas and to 27% of the companies in the case of the 60 months betas, bearing in mind that the number of stocks investigated dropped from 52 in the 36 monthly tests to 40 in the 48 monthly tests to 33 in the 60 monthly tests.

The above tests show that, based on the intercept terms the CAPM is supported by the results of the tests, but the risk-return relationship is not established. However, the results using 48 and 60 months show that the risk premium in most of the significant cases is non positive and in many cases negative.

In fact we can note that the longer the time period used the more negative regression coefficients that we get. Looking at the regression coefficients of the 36 monthly betas we find that the negative terms constitute 32% of the cases while it increased to 52% in the case of the 48 months and to 70% in the case of the 60 months.

Therefore, it appears that the risk-return relationship of the CAPM is not satisfied using Equation (**E.8.2**). In trying to interpret the above results we note that the CAPM does not seem to apply to the market and in fact the results of the above tests tell us that although the intercept is not significantly different from zero for most of the companies, no risk-return relationship appears to be discernible.

In comparing the above results with those of Fama & MacBeth (1973) who found that for the overall period (1935-1968) there is risk-return relationship in the NYSE, but for some sub periods they have obtained exactly the same results obtained above. In particular they have found for two sub periods (1935-1940 and 1946-1950) a non significant t-values for the all the coefficients in Equation (**E.8.2**). However, comparing our results with those of Fama and MacBeth (1973) is not strictly comparing like with like because the methodology used by them is different from the methodology used here. In particular their use of portfolios composed of hundreds of stocks and the use of individual stocks in this study makes the two tests differ. However, the short time period used in this study compares with the length of their sub periods and indicates that using such short periods produces results that are similar to the results reported above.

To investigate the effect of using portfolios on tests of the CAPM using rolling beta estimates, the following section provides a test employing portfolios rather than individual stocks.

8.2.4. Results of the Test Employing Portfolios

It is noteworthy that the above tests assumed the stability of beta. Beta estimates were assumed in the first test to be stable across three years; in the second and the third tests betas were assumed to be stable across four and five years respectively. However, true beta is not stable because risk does change and in small emerging markets with characteristics similar to the ASM risk would be expected to shift more often due to the high volatility of the region, and the effects of such volatility on the economic and the political environments is expected to be magnified.

Moreover, the short time series and the low number of degrees of freedom used in the tests above could cast some doubts on the robustness of the reported results.

Although the above test is supposed to be carried out on portfolios rather than individual stocks, the analysis aimed at investigating the relationship implied by the CAPM although it is known at the outset that these tests are inefficient due to inherited problems in estimating betas of individual stocks. In fact the use of portfolios is warranted to overcome such problems discussed earlier and by so doing better beta estimates are expected. As argued previously, in chapter seven, the use of portfolios in small markets is hazardous since there is not enough stocks to form reasonably large portfolios to achieve the benefits of the aggregation and diversification. However, the analysis below attempted to repeat the tests on the portfolio level, although complete aggregation is not achieved due to the small size of the market. The portfolio formation and description are available in section (7.2.2). However, the stocks were allocated to portfolios according to their beta values in the periods subsequent or previous to the testing period. So, portfolio one contains the lowest beta value stocks and portfolio five contains the largest beta value stocks.

The model tested is again **(E.8.2)** where;

β_{pt-1} is the beta of portfolio p at time $t-1$ measured using 36 monthly excess returns.

Using *hypothesis tests* **(8.1)** to **(8.3)**, formulated in section (8.2), to test the usefulness of Equation **(E.8.2)**, the results of the regressions are summarised in tables **(8.4 - 8.6)**

Table **(8.4)**
Testing the CAPM using Rolling Beta Method & Estimating Beta using 36 Monthly Excess Returns for Portfolios

36 Months						
	α_0	**t-value**	α_1	t-value	$t(rp-\alpha_1)$	R-Squared
Portfolio 1	0.07	2.19*	-0.08	-2.02	2.17*	0.07
Portfolio 2	0.01	0.62	0.01	0.21	-0.02	0.00
Portfolio 3	0.00	-0.23	-0.02	-0.13	0.16	0.00
Portfolio 4	0.01	0.69	0.06	0.92	-0.83	0.01
Portfolio 5	0.00	-0.09	0.00	0.25	0.04	0.00

* $t_{10\%,59} = \pm 1.67$ and $t_{10\%,59} = +1.29$.

Table **(8.5)**
Testing the CAPM using Rolling Beta Method & Estimating Beta using 48 Monthly Excess Returns for Portfolios

48 Months						
	Intercept	t-value	α_1	t-value +	$t(rp-\alpha_1)$	R-Squared
Portfolio 1	0.03	3.06*	-0.20	-2.46	2.53*	0.12
Portfolio 2	0.02	1.99*	0.08	1.59*	-1.48	0.05
Portfolio 3	0.03	1.66	0.43	1.65*	-1.63	0.06
Portfolio 4	0.02	2.38*	0.21	2.25*	-2.19*	0.10
Portfolio 5	0.00	0.44	-0.07	-1.25	1.36	0.03

* $t_{10\%,47} = \pm 1.67$ and $t_{10\%,47} = +1.30$.

Table **(8.6)**
Testing the CAPM using Rolling Beta Method & Estimating Beta using 60 Monthly Excess Returns for Portfolios

60 Months						
	α_0	**t-value**	α_1	t-value +	$t(rp-\alpha_1)$	R-Squared
Portfolio 1	0.03	2.83*	-0.40	-2.60	2.64*	0.18
Portfolio 2	0.05	1.67	0.20	1.15	-1.12	0.04
Portfolio 3	0.03	1.82*	0.74	2.03*	-2.01*	0.11
Portfolio 4	0.02	1.94*	0.30	1.20	-1.18	0.04
Portfolio 5	-0.01	-0.58	-0.18	-1.77	1.82*	0.09

* $t_{10\%,35} = \pm 1.69$ and $t_{10\%,35} = +1.30$.

Again testing the hypotheses stated in section (8.2), the results for the 36 months indicate that the risk-return relationship is not established since the t-values of the regression coefficient are not statistically significantly different from zero. It is also noted that when using 48 months to estimate beta, the results show that for most of the portfolios the intercept is statistically different from zero and significantly positive, while the regression coefficient is positive. On the other hand the use of 60 months also produced non zero intercepts but only one regression coefficient is significantly positive which is subsequently found not to be equal to the risk premium. The above results again imply that the use of different time periods for beta estimation produces different results.

These results can also tell us two things. The first is that if aggregation is partially achieved and beta is more accurately estimated on the portfolio level, then the basic CAPM is rejected using all the periods. This is evident from the fact that in the first period the regression coefficient is not statistically positive and using the second and the third periods the intercept is statistically different from zero in three out of the five portfolios. As to the difference between the prevailing risk premium and the slope of the regression line we note that the longer the time period used the more significant is the difference tends to be.

The R-squared results also show that the longer the time period employed for beta estimation the higher is the R-squared reported implying that increasing the time period for beta estimation increases the level of the variation in excess return that is accounted for by the regression equation. However, as discussed in chapter seven these portfolios are not efficient since they are comprised of a very small number of stocks and the aggregation resulting from this formation is incomplete.

After discussing the results of the above tests it is tempting to draw a conclusion, but, due to the lack of aggregation resulting from the small number of portfolios and the stocks within them, a test with more aggregation power is used in the following section to judge the validity of the CAPM. The need for such a test stems, also, from the low degrees of freedom associated with the above tests (for example, in the case of 60 months betas the maximum number of degrees of freedom was 35) because of the limited length of the time series available for analysis. To resolve the problem of this apparent low number of degrees of freedom and the inadequate aggregation of the data, one solution was to pool the data. Given that the assumed return generating process leads to a common linear model for all the securities, pooling should increase the power of the tests of the CAPM (Malkamaki, 1993). This test is the subject of section (8.3). Moreover, a shorter time period (24 months) for estimating beta was used to investigate further the effect of the length of time period for beta estimation on the results.

8.3. Testing the CAPM using the Pooled Data Technique

Malkamaki (1992) tested the CAPM on the Finnish Stock Market using 25 companies. The method used was to perform the usual regression technique on a pooled data. This test is useful in testing the CAPM on small thin markets such as the ASM because of size considerations and the limited availability of stock data.

The data used for this test is the previously described[80] data set for 52 stocks covering the period 1987-1994. The test is repeated four times, each time using a different length of time period to estimate beta as described in the next section.

[80] Described in chapters one and six.

8.3.1. Testing Details of the Pooled Data Methodology

As discussed earlier the use of different lengths of time periods for beta estimation does have a great influence on the results, thus, in this test the beta of each stock is estimated using 24, 36, 48 and 60 excess monthly returns. The excess return for the next month not included in the beta estimation is used, then, as the expected excess return. These beta values for each stock are then regressed against their respective expected excess returns. However, these variables are pooled now in the following form; if, for example, we estimate the beta of the stock using the first 36 monthly excess returns and the number of stocks in the sample is 40 then we shall have 40 beta estimates that will be matched with 40 monthly excess returns for the stocks in the sample i.e. cross section. Therefore, the first 40 observations in the pooled data regression would be monthly stock excess returns against stocks' beta values. Therefore, if the number of stocks used in the regression is 40 and the time period used for measuring beta is 36 months and the overall testing period is 8 years then the number of beta estimates per stock will be 60. Therefore, the pooled data regression will have 2400 betas and 2400 monthly excess returns. As stated by Malkamaki this implies that the test has extremely high degrees of freedom and is, consequently, very powerful.

Therefore, the test implies the following steps:

Firstly, estimate stock betas from the market model of **(E.7.4)**:

$$\frac{r_{jti}}{\sqrt{t_i}} = \frac{a_{ip}}{\sqrt{t_i}} + b_{ip}\frac{r_{mti}}{\sqrt{t_i}} + u_{it} \qquad \textbf{(E.7.4)}$$

where,

r_{jti} is the return on stock j during period t_i which is the period separating two recorded prices for stock j.

t_i is the time between trades.

a_{ip} is redefined as the continuously compounded rate of return per day during estimation period p.

b_{ip} is the beta estimate of stock j for the period p.

Secondly, match each beta estimate with the excess return on the month immediately outside the beta estimation period.

Thirdly, arrange these values in two arrays where, the first n observations correspond to the n number of stocks in the sample will be the first observation for each stock.

Fourthly, run the regression using the CAPM model as defined in **(E.8.2)**.

Fifthly, test the following hypotheses for step four only:

The first hypothesis is that the intercept term is equal to zero.

Hypothesis test (8.4); $H_0: \alpha_0 =$ Zero.

$H_1: \alpha_0 \neq$ Zero.

The second hypothesis is that α_1 is positive and significantly different from zero. Since we do not consider zero values of the coefficient to be in line with the model's predictions the hypothesis to be tested is formulated as:

Hypothesis test (8.5); $H_0: \alpha_1 \leq$ Zero.

$H_1: \alpha_1 >$ Zero.

Thus, we reject the null hypothesis using one tailed test if t-values are significantly positive.

It is important to note here that this test is the most appropriate test of the tests that we have discussed before, because it avoids most of the weaknesses of the previously discussed methodologies and provides strong test by providing large degrees of freedom. Therefore, the results of this test are used to make a decision regarding the initial examination of the return generating process and the investigation of the CAPM validity in the context of the ASM.

Using (**E.7.4**) for beta estimation enabled us to provide summary statistics in table (**A8.1**) which represents the means and the standard deviations of each stock's beta estimates obtained for varying lengths of time series. This table shows that the level of volatility in beta estimates (measured by the standard deviation) decreases with increasing the number of months used to estimate betas. This is evidence against the stability of beta in the ASM if estimated using short time series, since the average standard deviation of beta estimates in the two years beta case is 0.34 while it is 0.05 in the 60 months beta. The use of longer time periods provides more stable estimates of beta.

However, the test below will be showing which of these beta estimates are being used by investors in the market. The above analysis will be carried out measuring beta using 24, 36, 48 and 60 monthly returns. The following section employs these beta estimates in a test of the CAPM using the above described pooled data methodology.

8.3.2. Testing Results

The regression analysis was employed using 24, 36, 48 and 60 monthly excess stock and market returns to estimate beta values for all the stocks. These beta estimates were regressed against monthly excess returns using pooled data regression where, beta series and excess return series were pooled to obtain for all the stocks in the sample only two series. In the case of betas estimated using 24 months, for example, the total number of observations for all the companies was equal to 3187 observations.

Table (**8.7**) shows the results of the model for betas estimated using 24-60 monthly excess returns.

Table (**8.7**)
Regression Results of the CAPM using Pooled Data

	α_0	α_1	$t(rp-\alpha_1)$	Standard Error	R-Squared
24 Months	-0.007 (-2.00)*	0.013 (3.99)*	-2.27*	0.10	0.005
36 Months	-0.002 (-0.37)	0.003 (0.64)	-0.55	0.096	0.001
48 Months	0.022 (4.07)*	-0.016 (-3.29)	4.44*	0.09	0.005
60 Months	0.016 (2.35)*	-0.016 (-2.64)	3.56*	0.08	0.005

* Significant at the 5% level. T-values in parenthesis.

In the test above we are interested in the alpha (intercept) values and the regression slopes which indicate whether or not the CAPM is rejected. The t-values of the intercepts in the above estimation show clearly that the alpha values for all the periods used to estimate beta (except for the 36 month beta) are significantly different from zero, at the 5% significance level, with high significance levels. Using 24 months betas produced a lower intercept than zero while using 48 and 60 months betas produced higher than zero intercepts. Looking at the regression coefficients we note that they are significantly negative for the 48 and 60 months betas and significantly positive using 24 months betas while they are insignificantly different from zero for the 36 months.

The results of the above test imply that the CAPM does not hold in the ASM using four specific different time periods for beta estimation. However, estimating beta using 24 and 36 months the results indicate that the intercept is negative and the regression coefficient is positive (only significant using the 24 months). While using longer time periods the intercept is significantly positive and the regression coefficient is significantly negative, implying a negative risk premium. Thus, again, it appears that the use of different lengths of time to estimate beta seems to have large effects on the results of the pooled data regressions. However, in most of the cases departures from the CAPM are noted.

Thus, it appears that the model is not valid to provide a description of equilibrium pricing in the ASM. But, recalling that this test is a joint hypothesis[81] of the validity of the CAPM and the estimation of beta, therefore, perhaps we can look more deeply to the estimation of beta to give an explanation for the results reported above. Consequently, to test the robustness of the above results and to provide a better understanding of the risk-return relationship in the ASM, the same test was repeated

[81] In fact assuming a correct estimation of beta, the test is still a joint hypothesis of the validity of the CAPM and the efficiency of the market index (Roll, 1977).

using two sub samples of stocks where stocks were grouped into different sample groups. The reason behind the use of different samples is to investigate the effect of infrequent trading on the estimation of beta from the market model. Thin trading is a major problem in small markets to the extent that it could affect beta estimation although various methods have been suggested to reduce its effect on the estimation of beta (as discussed in chapter two). Nevertheless the following is an analysis of the effect of this empirical problem on the results.

8.4. Testing the CAPM Using Two Different Sub Samples

The results obtained in the previous sections indicate that there is no risk-return relationship in the ASM. Clearly we have been employing different methodologies to test the model and we have been showing that the results are sensitive to the methodologies used. Now the methodology used will be the same and the tests will be carried out on different sub samples, thus, providing sensitivity analysis for the results documented in the last section. The prime motive behind using sub samples is to investigate the effect of thin trading on the results of the above test. As discussed earlier, thin trading can affect the beta estimates which are proxies for the true, but unobservable, betas of the stocks. If these beta estimates are not proxying for the true betas of the stocks then the investigated relationship implied by the CAPM may not be established even if the CAPM is valid. Thus, the components of these sub samples were selected based on the level of their trading. To achieve this, two measures of trading were used in the analysis below, and the tests carried out above were repeated for 24, 36, 48 and 60 monthly returns.

The sub sample construction and company selection procedure adopted was as follows:

The first sub sample contains the stocks with the highest number of available monthly returns. This was chosen to lessen the effect of the missing monthly returns, since the Marsh trade-to-trade method to estimate the stocks' betas has been applied. The choice of the trade-to-trade method was discussed earlier and shown to be most effective when studying stocks (portfolios) that suffer from thin trading. However, certain stocks have some serious non-trading which could span over few months causing long time gaps between monthly observations. Thus, to investigate the effects such a problem could have on the results reported above, we chose a number of companies that have the highest number of monthly observations. The number of companies chosen for this sample was 32 companies[82].

The second sub sample contains the stocks with the highest average trades per year throughout the test period. This was chosen also, to investigate the effect of non-trading on the results. The companies that have the lowest trading frequency will be excluded and the test is carried out on a sample of the highest traded stocks. The number of the stocks chosen was again 32 companies[83]. Although we have excluded the lowest traded stocks the average number of trades per year of the least traded stock in the surviving sample was 171 days which means it suffers around 30% of non-trading.

[82] The number of companies chosen for this sample and the second sample was arbitrary. However, 22 companies did not have any missing monthly observation, 4 had only one missing monthly observation, 6 had two. All the other companies had more than two missing observations.
[83] Although this is a different sub sample the same number of stocks was used as the first sub sample.

Note that these are overlapping sub samples, i.e. stocks that appear in one sub sample may reappear in the other sub sample. This does not present any difficulty because the tests were carried out independently. However, out of 32 companies 22 companies (68%) appeared in both sub samples.

Tables (**8.8**) and (**8.9**) show the results of the regressions using Equation (**E.8.2**) for sample one and two:

Table (**8.8**)
Regression Coefficients of the CAPM using Pooled Data
Sample (1) Highest Number of Available Monthly Returns

	α_0	α_1	$t(rp-\alpha_1)$	Standard Error	R-Squared
24 Months	-0.005 (-1.098)	0.011 (3.00)*	-1.47	0.098	0.004
36 Months	0.002 (0.43)	-0.002 (-0.37)	1.41	0.09	0.000
48 Months	0.026 (4.12)*	(-0.017) (-2.95)	3.92*	0.086	0.006
60 Months	0.017 (2.33)*	-0.0162 (-2.33)	3.14*	0.083	0.005

* Significant at the 5% level. T-values in parenthesis.

Table (**8.9**)
Regression Coefficients of the CAPM using Pooled Data
Sample (2) Highest Average Trades Per Year

	α_0	α_1	$t(rp-\alpha_1)$	Standard Error	R-Squared
24 Months	-0.009 (-1.94)	0.013 (3.5)*	-1.99*	0.10	0.006
36 Months	-0.001 (-0.162)	0.002 (0.39)	-0.70	0.095	0.000
48 Months	0.032 (4.34)*	-0.023 (-3.75)	4.66*	0.09	0.01
60 Months	0.018 (2.09)*	-0.018 (-2.35)	3.08*	0.085	0.006

* Significant at the 5% level. T-values in parenthesis.

The above tables show that, as in the case using the overall sample, the model is rejected for the market using the 48 and 60 monthly betas, but not rejected for the 24 months where we find that the model's main predictions are satisfied. The intercept is not significantly different from zero, the risk premium is significantly positive and the difference between the risk premium and the regression coefficient is not significantly different from zero. This result is supported by both sub samples. Looking at the 48 and 60 months results we notice again that the intercept is significantly higher than zero and the risk premium is significantly negative. A negative risk premium is perplexing but evidence from other markets has also documented negative risk premium. Malkamaki (1991, 1992) has found that for the Finnish Market the use of five years to estimate beta have produced negative risk premiums

Of course it is difficult to believe that the relationship between risk and expected return is negative. This can only mean that high risk stocks earned returns that are less than the risk free rate of return and low risk stocks earned higher returns than the risk free rate of return. But, in fact as argued by Copeland and Weston (1988), the main difference between the *ex post* form and *the ex ante* form of the CAPM is that the *ex post* form can have a negative slope while the *ex ante* can not.

The 36 months, however, produced a non significantly different from zero t-values for the intercept and also, a non significantly different from zero t-values for the regression coefficient. An additional confirmed result is that the risk premium is only significantly positive in the case of using the 24 months betas.

Therefore, based on the results for the two sub samples we can conclude that over the period (1987-1994) and using the pooled data methodology to test the Capital Asset Pricing Model, the model seems to apply to the ASM using 24 months for beta estimation. This indicates that betas estimated using 24 months better capture the variations in the cross section of stock returns.

8.5. Conclusion

The use of rolling betas was adopted to provide better beta estimates under the assumption of the stationarity of beta. However, such a technique is most effective if used on the portfolio level rather than on the individual stock level. In the case of small markets the formation of portfolios cannot achieve the required aggregation, thus this chapter attempted to undertake the test using individual stocks but has shown results on the portfolio level for comparison purposes. Moreover, since no prior evidence is documented on the stationarity of beta in the context of ASM, three time periods were suggested and used for beta estimation. All the periods used have shown that the model does not hold in the ASM. However, the longer the time period used the more departures from the model were documented. This could suggest that using short time periods is better to capture the variations of returns. The risk premium, on the other hand, does not seem to be significantly different from zero, implying no relationship between risk and return for the majority of the companies in the market.

These results called for the need of aggregation for capturing the relationship better. Such aggregation could be achieved in two ways. The first is by forming portfolios and the second is by pooling the return and beta data as two time series. Although the formation of portfolios in small markets might not lead to efficient aggregation, as discussed in chapter seven, the advantages of such an exercise could outweigh the disadvantages although the treatment should be viewed with caution in terms of the possible domination of some stocks on the portfolios.

The results of the test using portfolios, confirmed the results obtained for individual stocks and showed that the evidence for all the periods does not support the model. Again the use of longer periods for estimating beta produced higher than expected intercept terms but in the case of the 48 months produced positive risk premiums.

To substantiate these results, the data was pooled and a shorter time period (24 months) was used to calculate beta along with the other used time periods. This test was considered as the most appropriate methodology to be used for small markets, thus its results were used to judge the validity of the CAPM in the ASM. After testing the CAPM employing the pooled data technique we note the following. Carrying out the test for the overall sample we found that non of the periods used to estimate beta gave supporting results of the model. The short time period of 24 months, gave lower intercept-values than expected, but positive risk premium. On the other hand, longer time periods -48 and 60 months- gave higher intercept terms and negative risk premiums. The only time period that gave similar intercept term to that predicted was the 36 months betas. However although the risk premium provided by this period is positive it lacks statistical significance with a t-value of (0.64). This is consistent with the evidence obtained using the rolling beta technique for individual stocks and portfolios.

Suspecting that these results might be a product of distortions resulting from thin trading, the same testing procedure was extended to two sub samples of the data set. These sub samples were constructed to account for the problem of thin trading and to reduce the effects of this phenomenon on our results, by removing the least traded stocks. For both sub samples we noticed that using the 24 months betas provided supportive evidence of the model. Basically we find that all the predictions of the model are satisfied. On the other hand longer time periods gave similar results to those given by the overall sample; higher intercepts and negative risk premiums. The 36 months beta results are still showing zero intercepts and zero risk premiums. Thus, the model was not rejected only when 24 months of returns were used for estimating beta, while it was rejected using all the other periods.

From the above discussion it seems safe to conclude that the CAPM is valid for the ASM, only if the beta of the stock is estimated using a short period of time (24 months), although these beta estimates are more volatile than those estimates produced by the use of longer time periods, in particular the use of five years time period.

CHAPTER NINE

X.

Empirical Evidence - Explaining Stock Returns

9.1. Introduction

The Capital Asset Pricing Model is one of the cornerstones of modern Finance theory. However, recently the model has been criticised on the basis of evidence of the ability of some variables (other than beta) to explain stock returns. Such evidence, in effect, is a revolution on the CAPM and a turning point in the modern Finance theory and practice, not only because it challenges the sole role of beta in explaining stock returns, but also because much of the evidence has been used to claim the death of beta itself. Thus, such evidence weakens the claim of the CAPM as being the central model of asset pricing, since the model states that beta should be the only explanatory variable of stock returns. As a result of some pioneering work, recent research efforts have been put into investigating the effect of many variables on the cross section distribution of returns. In particular firm size, earning yield (E/P ratio hereafter) and the book-to-market value of firms (BE/ME ratio hereafter) have received considerable attention and investigation in many developed markets of the world.

The evidence implies that forming portfolios based on the market value of stocks, the earning/price ratio or (and) the book-to-market ratio is rewarded with higher risk adjusted returns than any other technique for portfolio formation. In particular, portfolios consisting of small companies[84], portfolios that consist of stocks that have high earning/price ratios and portfolios consisting of stocks with high book-to-market ratios appear to earn higher risk adjusted returns than other portfolios.

[84] Size is measured in terms of market capitalisation.

These variables will be discussed and some of the evidence of their explanatory power is summarised in the sections below. Investigation of whether or not such variables are priced on the ASM is a matter for section (9.5) of this chapter. The following is a brief discussion of various research investigating these variables' influence on returns.

9.2. Firm Size (Market Value)

Under the CAPM the only priced variable is systematic risk which is captured in the CAPM world by the beta of the stock. No other variable is anticipated to have a relationship with expected returns of a well diversified portfolio. However, empirical evidence has revealed a relationship between portfolio returns and the size of the firms within the portfolio. That is small firms earn more than larger firms after adjusting for systematic risk.

Perhaps Reinganum (1981) was the first to indicate that abnormal returns that persist for two years could be earned if portfolios were formed based on the market value of stocks. Examining the effects of forming portfolios based on their Earning/Price ratios (E/P) and their market values, he concluded that the E/P ratio anomaly disappears when we control for the market value (size), implying that the E/P ratio anomaly and market value anomaly are proxies for the same set of missing factors of the CAPM; thus he stated that the CAPM is misspecified. Therefore, the CAPM has to be adjusted to include this variable on the right hand side of the equation. This is what Banz (1981) did when he studied the 1936-1975 period for stocks listed on the NYSE, and used a generalised asset pricing model which allows the expected returns of a common stock to be a function of risk (beta) and an additional factor θ;

the market value of the equity. Banz found that small firms had on average larger risk adjusted returns than large firms. He pointed out that it is not possible to relate this abnormal return to market size specifically, since there are no theoretical grounds for that, but market value could proxy for a more theoretically accepted variable. Banz argued that *"the lack of information about small firms leads to limited diversification and therefore to higher returns for the undesirable stocks of small firms".*

This phenomenon intrigued researchers around the world and one researcher in particular provided what seemed to be a major part of the *truth behind the size* effect. Roll (1981) pointed out that the CAPM might not be misspecified, but we cannot properly measure the risk of small firms, thus large returns of small firms is due entirely to spurious autocorrelation of returns of portfolios of small firms. This autocorrelation is a result of infrequent trading in small firms' stocks. Reinganum (1982), tested Roll's conjecture and found that the direction of the bias, resulting from infrequent trading effect on misestimating beta, is consistent with Roll's explanation. However, Reinganum claimed that the magnitude of the bias is too small to be explained by mismeasurement of beta.

Lustig and Leinbach (1983), provided more evidence on the small firm effect. Using monthly data from the NYSE covering the period 1926-1979, they found that portfolios of small firms outperformed portfolios of large firms. They attributed this finding to the lack of information about small firms that leads investors to collect such information with a cost which is compensated for in forms of high returns. They concluded that the CAPM is misspecified.

James and Edmister (1983), among other researchers, investigated Roll's conjecture and found that although firm size and trading activity are highly correlated, differences in trading activity do not fully explain the firm size effect. No significant differences between mean daily risk adjusted returns are found between active traded portfolios and thin traded portfolios. Investigating the possibility of a liquidity premium for thinly traded stocks, they concluded that it is firm size rather than trading activity that relates to differences in returns and no evidence is found to be consistent with the existence of a liquidity premium.

Moreover, Keane (1983) argued that the size anomaly could be attributed to a mismeasurement of returns rather than risk. This mismeasurment is a result of the bias of excluding bankrupt firms from the study samples (a result of excluding the companies that have exited from the market). As argued by Keane, small firms are more prone to failure and bankruptcy[85], thus, forming portfolios of only surviving firms would display small firms as earning higher than expected returns (survivorship bias).

Brown and Barry (1984) stated that the size anomaly is due to misspecification of the market model used to estimate beta. This misspecification is a result of the nonstationarity of the market model during the period used to estimate beta. This

[85] Keane argues that the reason behind this is the tendency of small firms to be less diversified than large firms. Also, argues Keane, many small firms are new and vulnerable.

misspecification leads to systematic bias in measuring beta. One source of nonstationarity is the January effect (as discussed in chapter four).

Researchers sought to provide empirical evidence from other markets than the US to determine if the phenomenon is merely an artefact of the data set used or the period investigated or if it is a genuine capital market regularity. Levis (1985) investigated the small size anomaly on the London Stock Exchange and found that for the period 1958-1982 small firms earned more risk adjusted returns than large firms. For the overall period smaller firms earned 6.5% per annum more than large firms. To test the hypothesis that infrequent trading is responsible for this anomaly, Levis used Dimson's betas[86]. Even using Dimson's betas, smaller firms were found to be less risky than large firms.

Roll (1983) argued that the small firm effect could also be a result of tax loss selling, since small firms have more probability of capital loss during the year, therefore, they are sold in December by holders who want to realise losses for tax considerations. Consequently, the prices of small firms' stocks are depressed during December but in January they pick up again.

Carvel and Strebel (1987) argued that the size anomaly is entirely a proxy for the neglected firm effect. Essentially they argue that the least followed and analysed firms will be perceived by investors as more risky than other analysed firms, while

[86] Measured using Dimson's Aggregated Coefficients method to correct for the effect of thin trading on estimating beta.

in fact they are not, therefore, they would earn abnormal profits. The lack of information about these firms makes them sell at a discount.

To test this hypothesis, firms were classified according to the level of coverage they are given by analysts. Average monthly returns were computed for each of them, and compared. Carvel and Strebel concluded that the neglected firm effect is more robust than the small firm effect and dominates it, which implies that the small firm effect is a proxy for the neglected firm effect.

Friend and Lang (1988) argued that the small firm effect is merely a consequence of inadequate measurement of risk. Since all our measures of risk are ex post, what we should use is an ex ante measure of risk. They went on to argue that an appropriate ex ante measure of risk is the quality rankings for common stocks prepared by Standard & Poor. After examining this measure they found it superior to beta as a measure of risk in explaining returns and that it subsumes the size effect. Further, they argued that part of the small size effect is explained by the January effect since returns in that month (and in particular the first few days of the month) are extremely large for small firms than for large firms.

However, whatever the explanation of the small size effect it is becoming an accepted phenomenon that small firms generate higher market returns than large firms. Therefore, it is important in studying a capital market that this variable is considered. In fact the small size might not, *per se*, be the variable of significance but it is most likely that the size of the firm proxies for other variables representing risk that are not adequately captured by the CAPM.

9.3. Earning Yield (E/P ratio)

Another variable that has been empirically confirmed to be relevant in pricing stocks is the earning yield of the stocks. Specifically, forming portfolios on the basis of the earning to price ratio (E/P) -or the price to earning ratio in the UK (P/E)- produces higher risk adjusted returns for the high E/P (low P/E- hereafter the analysis is in terms of E/P ratio) than the risk adjusted returns of the portfolios with low earning price ratios. This is a violation of either the efficient market theory or the theory of capital markets represented by various capital asset pricing models and in particular the CAPM (Basu (1977), Reinganum (1981)).

Although Keim (1988), noted that the E/P relationship with returns was discovered as early as 1940, this anomaly was rediscovered by Basu in a paper published in (1977). Basu, studied *"the performance of common stocks in relation to their price-earning ratios"* where he considered the period of 1956-1971 on the NYSE. Basu ranked stocks based on their earning price ratios in order to form portfolios based on E/P ratios. He formed five portfolios assuming that these portfolios are bought three months after the end of the fiscal year in order to allow for accounting reports to be published[87]. After calculating the monthly returns on these portfolios for the twelve months following portfolio formation, and assuming equal investments in each portfolio components -buy and hold policy was adopted-, these returns were

[87] In many countries accounting reports are published within three months of the end of the fiscal year. However, some companies do publish their reports within such a period and some do not.

adjusted for risk by applying three performance measurement methods. Treynor performance index, Jensen performance index and Sharpe's performance index[88]. The major results documented by Basu were that the two high E/P portfolios achieved 13.5% and 16.3% over the 14 year period, at the same time enjoying lower beta values than the low E/P. On the other hand, the two low E/P portfolios achieved 9.3% and 9.5% respectively per year. Moreover, after applying the three performance measures, Basu found that the high E/P portfolios significantly outperformed low E/P portfolios.

Basu, attributed these results to an inefficient market characterising the period covered by his work. Specifically, he argued that the information content of these accounting variables were not reflected *"instantaneously in prices"* as the semi-strong version of the efficient market hypothesis postulates. He concluded that *"the*

[88] These performance indices are used to evaluate the performance of mutual funds. Sharpe's performance index measures the risky asset's excess returns ($ER_i - R_f$) per unit of risk (σ_i), where the risk is represented by the standard deviation of the stock. Thus, the performance index PI is equal to

$$PI = \frac{ER_i - R_f}{\sigma_i}$$

where, Trynor's performance index measures the risk of the stock by the stock's beta thus;

$$PI = \frac{ER_i - R_f}{\beta_i},$$

on the other hand, Jensen's Performance index is given by the intercept term obtained from the time series regression of the market model in excess returns form, thus, applying the following regression equation gives:

$$(R_{it} - R_{ft}) = \alpha_i + \beta_i (R_{mt} - R_{ft}) + e_{it}$$

If we take the means of both sides we get;

$\overline{(R_i - R_f)} = \alpha_i + \beta_i \overline{(R_m - R_f)}$; then, Jensen's performance index is the α_i term which is statistically tested for significance form zero. If the t-value of the α_i is found to be significantly different from zero and positive this indicates that the fund under investigation has achieved abnormal excess returns. For further analysis of these performance indices see (Levy & Sarnat (1984)).

behaviour of security prices over the 14 year period studied is perhaps not completely described by the efficient market hypothesis".

Reinganum (1981), used annual and quarterly earnings figures and reached similar results to Basu's by forming portfolios on the basis of earning price ratios of the stocks. However, each portfolio was constructed in a way to have a beta equal to one so that all portfolios are equal in terms of risk. Nevertheless, Reinganum found that persistent abnormal returns could be earned following a buy and hold strategy of portfolios formed on the basis of high E/P ratio. Those results were robust to the index employed -he obtained the same results using the value and equally weighted indices- and the beta estimating procedure[89]. Interestingly, Reinganum reached different conclusions, to those of Basu, regarding the causes of the E/P anomaly. Rather than looking at efficient market theory for explanation, he argued that this anomaly is an outcome of a misspecified model. The CAPM contends that beta is the only variable that explains stock returns and no other variable can explain these returns except beta. According to this strong statement of the CAPM, when portfolios with the same beta levels are held, no variations in returns are to be expected. Evidently the persistence of the E/P ratio effect supported this logic, where Reinganum's analysis of annual earning figures showed persistence in the anomaly for two years. In conclusion, Reinganum rejected Basu's conjecture that the capital market is informationally inefficient and concluded that earnings proxy for a risk factor or factors that are not specified by the CAPM.

[89] Also, he obtained similar results using Scholes and Williams betas and the market model betas.

Nevertheless, Reinganum took the argument further by investigating the size anomaly along with the E/P anomaly with a view of determining whether or not these two anomalies were independent from each other and if not which subsumed the other. Reinganum found that by forming portfolios on the basis of market value an abnormal return could be achieved if these portfolios contained small size firms. The returns persisted for two years suggesting to Reinganum the possibility of a large correlation between the two anomalies. However, the main finding of Reinganum was that after controlling for the E/P effect the firm size was still strong but after controlling for size effect the E/P effect disappeared. As a result, Reinganum concluded that both size effect and E/P effect proxy for the same risk factors omitted from the CAPM relationship. But, these factors are better proxied for by the size effect.

This raises the question of what is the theoretical justification for any variable, other than beta, to predict returns?. In fact, many researchers admitted that the main motive behind empirically investigating relationships among certain variables -such as E/P, book-to-market ratio, market value, dividend yield, cash flow yield, etc.- was never theoretically motivated. It was merely because such variables were popular among practitioners and, lately, academics (Chan, Lakonishok and Hamao (1991)).

But, Davis (1994), gave several possible reasons as to why many variables -such as the earning price ratio and book-to-market ratio- could predict returns. Firstly, many of these variables measure the riskness of stocks, therefore they are able to predict returns based on the risk-return relationship. Secondly, these variables enable investors to identify mispriced stocks. Thirdly, these variables are artefacts of research methodology and databases used.

Davis embarked on tests of these variables' explanatory power at the same time trying to avoid some possible biases. To accomplish, this Davis used a totally different database- to the COMPUSTAT used in most previous research- taken from primary resources. He studied E/P ratio, BE/ME ratio, cash flow yield and historical sales growth. For the period 1940-1963 he found that book-to-market ratio is an important variable in explaining stock returns. In fact, following a strategy based on high book-to-market ratios an investor could on average earn 6.8% per year more than an investor buying on the basis of low BE/ME ratio stocks. At the same time, the difference between the estimated betas of those two portfolios is less than 0.3.

Earning yield also was found to play an anomalous role in the sense that portfolios with high E/P ratios earned on average higher risk adjusted returns than portfolios with low E/P. The magnitude of these returns was that the high E/P quintile earned 9.5% per annum more than the low earning price quintile. The difference in betas between these portfolios was approximately 0.4.

With the two contradicting views about the E/P anomaly (Basu (1977), (1983) and Reïnganum (1981)) many researchers around the globe started examining this variable's alleged relationship with return in more detail. However, most researchers adopted the view that the E/P anomaly is a result of a misspecified model rather than a market inefficiency (Chan, Lakonishok and Hamao (1991), Reinganum (1981), Basu (1983) and Ball (1978)).

The evidence, nevertheless was mixed. Some detected the presence of the E/P ratio effect (Basu (1983) Goodman and Peavy (1983), Cook and Rozef (1984)) while others did not find any relation between E/P and returns (Strong and Xu (1994)). On the other hand, although others found an E/P effect, they ruled it out in favour of other variables (Fama and French (1992), Reinganum (1981); Chan, Lakonishok and Hamao (1991)).

Chan, Lakonishok and Hamao (1991) analysed the earning price ratio among other variables, such as book-to-market ratio, size, and cash flow yield, on the Japanese Stock Market for the period 1971-1988 and found an E/P effect. However, after controlling for other variables this anomaly vanished. In this regard they concluded that the reason for previous evidence supporting E/P effect was that previous studies did not incorporate other variables together with the E/P variable. However, Chan, Lakonishok and Hamao maintained that these variables proxy for unspecified risk factors, therefore, they are correlated with returns.

A relatively similar result was achieved by Fama and French (1992) for USA stock markets. They investigated the cross-sectional variation of stock returns and its relation to accounting variables such as earnings and book-to-market ratio, leverage and size. Although they found a positive relationship between stock returns and high positive E/P ratio portfolios, adding both the size variable (ln (ME)) and the book-to-market variable (ln BE/ME) to the regression of stock returns on E/P lowered the slope on E/P from 4.72 to 0.87 with t-statistics of 1.23. However, the E/P ratio did not effect the slopes of the other variables. This indicated that the E/P effect was subsumed by the size variable and the book-to-market ratio.

Cook and Rozef, (1984) investigated the E/P anomaly hoping to distinguish it from the size effect. They studied the NYSE over the period 1964-1981 using nine different methods to compute abnormal returns, three portfolio formation procedures and using the methodologies of Reinganum (1983) and Basu (1977) over a different set of data. They concluded that both the E/P ratio and the size variable are important factors in explaining the cross section variation of stock returns. With respect to Basu's (1977) findings regarding *E/P effect, Rozef and Cook, argued that* Basu's results were *"sample specific"*, while Reinganum's (1983) result, opposing the E/P effect and favouring the size effect, was due to an accidental choice of methods.

Other researchers also tried to avoid some methodological problems in testing for the E/P ratio. Goodman and Peavy (1983) attempted to avoid three methodological problems. The first was thin trading, which was avoided by choosing frequently traded stocks. The second problem, the small firm effect, which was avoided through choosing large firms (although choosing frequent traded stocks would bias the selection towards bigger firms, therefore reducing the small firm effect). The third problem, the industry effect, is based on the argument that companies of the same industry tend to have approximately similar E/P ratios, more specifically they tend to cluster in the same relative trading price ranking. This might be the reason behind finding different rates of returns across portfolios ranked based on E/P ratio, which implies that, the reason behind such differential rates of returns are due to industry effects rather than E/P effect. This bias was alleviated by using EPR ratios instead of E/P ratios, where the EPR is the E/P of a stock relative to its industry. Consequently, for the period studied (1969-1980) they found that, higher EPR stocks *"substantially out performed"* low EPR stocks, again confirming the E/P effect.

Ball (1978), argued that there are three main reasons that could cause the E/P anomaly. Inefficient markets, misspecification of CAPM or errors in the estimation of the anomaly. However, after reviewing 20 studies that reported the anomaly he rejected the erroneous estimation hypothesis, although, he pointed at several methodological biases contributing to identifying the E/P ratio anomaly.

As usual, trading infrequency could contribute to the anomaly, since the use of monthly prices could lead the researchers into estimating the monthly returns for one month while what is really estimated is the return over two months, thus giving way to reporting spurious abnormal returns. Again the bias resulting from thin trading is not primarily responsible for the anomaly. A second possibility is that, if risk and earnings are related, that is if changes in earnings are results of shifts of risk, then it will be highly difficult to control for risk when estimating excess returns which as a result will not be unbiased. Yet, this bias was small. A third explanation is that risk measurement could be erroneous, i.e. beta could be misestimated. This could be a result of either choosing an inefficient market portfolio which would lead the estimated betas to be biased from the true betas, or of sample variations in stock returns. Mismeasurement of beta could be the explanation if these variables -such as earning price ratio or book-to-market ratio- are correlated with true beta therefore, proxying for it (Fama 1991). Ball argued that this could be the correct explanation if the measurement error was correlated with earnings. Other biases are related to the performance measure used, and the CAPM version used; in particular the Sharpe-Lintner version.

While all the foregoing explanations are related to testing errors, other biases are related to the processing of information by the market. This explanation of the anomaly is related to Efficient Market Hypothesis. In particular it claims that due to transaction costs stock prices are slow to reflect information contents of earnings (Black 1974). Also private costs (costs of processing earnings' information) could contribute to the same bias (Jones and Litzenberger (1970)). However, Ball argued that this explanation is not supported by the evidence that larger than normal transaction costs or any other private costs were available at times longer than to be justified by this explanation. Ball concluded that this anomaly results from a misspecified CAPM. If not directly responsible for the variation in returns, Ball argues, the omitted variables might be correlated with earnings which proxy for them as a result.

In the light of the above, it is concluded that the E/P ratio could play an important role in explaining stock returns variations. Consequently this research addresses this variable and tests its validity on the ASM. Also, the analysis was carried out investigating whether or not the E/P ratio proxies for any other variable of the variables tested.

9.4. Book- to- Market Value

The most influential variable, that has been documented in the literature, in explaining the cross section variations of returns, is the book-to-market equity variable. Rosenberg, Reid and Lanstein (1985), found that buying high book-to-market value stocks and selling low book-to-market stocks ensured profitability to investors. They gave an intriguing discussion of the theoretical justification for the power of several variables in predicting the variation of stock returns which was motivated by the relationship between book-to-market ratio and returns. The bottom line was that assuming that the market is not efficient in the sense that stocks are not correctly priced, this implies that the value of the stock V is different from the price of the stock P. The difference is a pricing error e where:

$$V = P - e. \qquad \textbf{(E.9.1)}$$

When the stock price adjusts towards its value, as a result of increased efficiency, the correction will be in the opposite direction of the error, which causes the rate of return to be negatively correlated with the pricing error. That is the rate of return on the stock in time period t is negatively correlated with pricing error at time $t-1$. Thus, to predict this rate of return we need a variable that is correlated with this pricing error e. Since this pricing error is the difference between the value of the stock and the price of the stock, it follows that a variable that is correlated with the value of the stock is also correlated with the pricing error. Therefore, we can use such variables to predict stock returns. Some of these variables are earning yield, book to market ratio and divided yield. This view was also adopted by Black (1993). With regard to book-to-market ratio, Black argued that *"the Book-to-Market equity may pick up a divergence between value and price across any of a number of dimensions"*. This reasoning, both by Black and Rosenberg et al., is in favour of attributing the anomaly to market inefficiency rather than to model misspecification. Following this logic, Rosenberg et al. investigated the use of a trading strategy based on the book-to-market ratio and found it was profitable, in the sense that it predicted stock returns.

More evidence was provided by Chan, Lakonishok and Hamao (1991) and Fama & French (1992). Chan, Lakonishok and Hamao studied the explanatory power of several variables on the Japanese Stock Market, over the period (1971-1988), and found strong evidence supporting the positive relationship between high book-to-market ratio and stock returns.

Fama and French (1992), found a strong relation between book-to-market ratio and stock returns on the NYSE and AMEX markets. However, they argued that a possible explanation of the ability of book-to-market ratio to predict stock returns is that the book-to-market ratio signals to the market future prospects of the stocks. A high book-to-market ratio signals weak performance causing investors to demand high expected returns as a result, and vice versa.

This explanation by Fama and French implies a misspecification in the CAPM, since they believe that the book-to-market ratio serves as a risk factor in return capturing the distress of companies. They confirmed this point by stating that *"The strong relation* *between Book-to-Market Equity and return is unlikely to be a beta effect in disguise".* Black (1993), argued that most of these anomalies are results of data mining, rather than any other reason.

Having found that the CAPM can be misspecified in the sense that other risk factors (than beta) are excluded from the model, we turn our attention to investigating this possibility in the context of the ASM. To achieve this, the next section summarises the results of an empirical investigation of the effects of four firm specific variables some of these variables on stock returns of the ASM over the period 1987-1994.

9.5. Empirical Investigation

The discussion above presented a non exhaustive evidence that is contradictory to the validity of the CAPM. Hence, even if beta shares the explanatory power with such variables the evidence is overwhelmingly warranting a questioning of the very basics of the model, because the CAPM postulates that only beta is related to the expected returns of stocks. Thus, a multi-dimensional risk-return relationship appears to be dominant declaring the end of the single-dimensional risk-return trade off. It does not appear that the explanatory power of these variables is merely a beta effect in disguise, rather they seem to proxy for risk factors not specified by the CAPM. However, whether the power of these variables stems from an inefficient market portfolio or a misspecified model, the effect of these variables can not be ignored. It is noteworthy that these variables are among many other variables that were shown to have some explanatory power. However, the above three variables have the strongest empirical evidence confirming their validity, although the E/P ratio is being found to be subsumed by the other two variables. The question, therefore, is to what extent can these factors help in explaining the cross section variations of stock returns for companies listed on the ASM?. To address this question, four main firm-specific variables were investigated; book-to-market ratio, E/P ratio, leverage and firm size. The measure of leverage used is the market leverage which is the ratio of total book assets to total market equity. These variables were chosen based on previous empirical evidence which has indicated their relationship with average returns (Fama & French (1992), Chan, Hamao and Lakonishok (1991)). It is hoped that this investigation will enrich the general debate since it is undertaken in a different market with different characteristics to those producing such evidence. The empirical investigation and the results are discussed in the following sections.

9.5.1. The Sample

The data set used to conduct the empirical work of this chapter is introduced and discussed in chapters one and six of this thesis. The sample selected for this test comprises all the firms listed on the ASM that satisfy the following selection criteria:

1. The firms that have an average of at least 100 trading days per year.
2. The firms that have available accounting data for the years covered by the test period (1987-1994).

The number of the stocks that satisfied the above two conditions was 47 companies. Fifty-two companies satisfied the trading condition and 47 firms of the sample satisfied the availability of data condition taking into consideration that the test period was 1987-1994 for most of the companies[90]. Accounting numbers were extracted from the various issues of the Jordanian Shareholding Companies Guide published yearly by the ASM.

[90] These companies are listed in table (A1.2) of Appendix one.

9.5.2. Testing Details

Each year all firms listed on the stock market are required by the stock market authority to publish their accounting results of the previous year. In the ASM firms are required to file their reports within three months from the end of their fiscal years[91]. The fiscal yearend in Jordan, for most of the companies is the 31st December. These reports are supposed to be informative to investors and interested parties of the operations of the companies in the previous year.

To test the relationship between these variables and stock returns we have to use the variables only when they are known to investors. Fama and French (1992) matched the accounting variables with returns after 6 months of the end of the fiscal year. This 6 months gap is used because it is evidenced that some companies do not file their reports within the specified period; the same practice is evidenced in the ASM. Therefore, the gap between the accounting data and the returns is necessary to ensure that these figures are well known to investors, since most of these variables are reported few months after the end of the fiscal year. Consequently, we use the reported variable for the end of fiscal year t and consider it known to the public in June of the year $t+1$.

The accounting variables are measured as follows:

1. E/P Ratio: is the ratio of total earnings (known to investors in June of year t) to total market equity of the firm. To measure the effect of negative earnings on returns we use a dummy variable which is zero if the earnings are positive and has a value of 1 if the earnings are positive.

[91] Amman Stock Market law.

2. Book-to-Market value (BE/ME): is the ratio of the reported book value of the firm (known to investors in June of year t) to total market equity of the firm.
3. Market Size (ME): is the market value of the firm measured in June of year t .
4. Assets to-market equity: is the ratio of total assets (known to investors in June of year t) to total market equity of the firm.

For each firm these variables were measured in June of year t and matched with that firm's excess returns from July of the year t to June of year $t+1$. After matching these variables with excess returns we carried out cross sectional regressions for each month covering the period of (1987-1994). The regression coefficients (slopes) are then averaged over all the months and used to test whether or not on average these variables provide explanatory power of stock returns. As in Fama and French (1992) the average slope is the time series average of the monthly regression slopes for July 1987 to November 1994, and the t-statistic is the average of the slope divided by its time series standard error. The variables were tested on univariate, bivariate and multivariate basis. This was necessary to do since there is a possibility that one or more variables may be proxying for the other variables. Thus, carrying out the tests on many levels help isolate the effect of each variable.

9.5.3. *Results of the Test*

Since there is no theoretical grounds behind the explanatory power of the variables under consideration, it is hypothesised that these variables do not help in explaining returns. In fact it would be contradictory to conventional asset pricing models if any of these variable showed any explanatory power. Thus, because the beta of the stock is the "only" explanatory variable of returns, as the CAPM contends, the use of these variables is a test of the Capital Asset Pricing Model.

Thus, the model used is a generalised version of Equation **(E.8.2)**, which is performed on the monthly cross section of stocks:

$$r_{it} = \alpha_{0t} + \alpha_{1t} W_{it-1} + \alpha_{2t} D_{it-1} \alpha_{3t} X_{it-1} + \alpha_{4t} Y_{it-1} + \alpha_{5t} Z_{it-1} + \eta_{it} \quad \textbf{(E.9.1)}$$

where,

W_{it-1} is equal to positive E/P ratio of stock i at time $t-1$.

D_{it-1} is a dummy variable for Negative Earnings of stock i at time $t-1$.

X_{it-1} is equal to the logarithm of Book Value to the Market Value of stock i at time $t-1$.

Y_{it-1} is equal to the logarithm of the Market Value of stock i at time $t-1$.

Z_{it-1} is equal to the logarithm of the Total Assets to the Market Value of stock i at time $t-1$.

Throughout the analysis the hypothesis tested was that α values of Equation **(E.9.1)** are not significantly different from zero at the 5% and 10% significance levels. Formally, this hypothesis was:

Hypothesis test (9.1); H_0, $\alpha_n =$ Zero

H_1, $\alpha_n \neq$ Zero

where n is from 1 to 5. That is the hypothesis applies to all α values that appear in Equation **(E.9.1)**.

The above equation was run using various versions of its basic form, mainly by carrying out the analysis using different components of the equation. This was done to disentangle the effects of any variable from the effects of the other variables.

The results of these regressions are summarised in table (**9.1**).

A glance look at table (**9.1**) reveals that all of the α values are very small with small t-statistic. In fact testing *hypothesis test* (9.1), for all the variables, we can reject the null hypothesis at the 5% and 10% significance levels, implying that none of these variables explains the cross section variations of stock returns.

Table (**9.1**)
Average Slopes from Month by Month Regressions of Stock Excess Returns on E/P ratio, Book-To-Market Value, Size & Leverage
July 1987- November 1994

E/P ratio	*Earning Dummy*	*LN (BE/ME)*	*LN (A/ME)*	*LN (ME)*
-0.03	-0.01	0.01	0.00	0.00
(-0.06)	(-0.17)	(0.22)	(0.05)	(-0.20)
		0.01	0.00	0.00
		(0.20)	(0.02)	(-0.15)
-0.02	0.00		0.00	0.00
(-0.03)	(-0.12)		(0.22)	(-0.23)
-0.01	0.00	0.01		0.00
(-0.01)	(-0.11)	(0.29)		(-0.18)
-0.01	0.00	0.01	0.00	
(0.01)	(-0.10)	(0.27)	(-0.02)	
0.00	0.00			
(0.07)	(0.04)			
		0.01		
		(0.27)		
			0.00	
			(0.13)	
				0.00
				(-0.18)
		0.01		0.00
		(0.25)		(-0.15)
-0.01	0.00			0.00
(0.01)	(-0.05)			(0.18)
0.00	0.00	0.01		
(0.06)	(-0.03)	(0.30)		
			0.00	0.00
			(0.19)	(-0.14)

* At 5% and 10 % significance levels.

This evidence is not surprising, since as argued before the explanatory power of the variables has no theoretical justification. This suggests that, if the documented explanatory power of these variables, in other markets, is evidence of a misspecification of the Capital Asset Pricing Model, in the sense that, these variables proxy for missing risk factors in explaining stock returns, as argued by some researchers (see, for example, (Chan, Lakonishok and Hamao (1991), Reinganum (1981), Basu (1983) and Ball (1978)), then the CAPM is not misspecified with relation to these variables since they do not seem to be priced by securities in the ASM.

Thus, the above evidence is in accord with the CAPM which was found to hold in the context of the ASM (as shown in chapter eight).

9.6. Conclusion

This chapter provided an additional test of the CAPM in the context of the ASM. The test was formulated based on various findings that certain accounting variables help explain stock returns in markets like the USA and Japan. These variables have no theoretical explanatory role in stock returns and the evidence produced for developed markets was seen as evidence against the CAPM.

The variables selected for examination were: Earnings, Book Value, Total Assets and Firm Size of firms. The investigation revealed that over the period of 1987-1994 none of these variables helped to explain the cross section of excess returns of a sample of stocks listed on the ASM. Thus, the evidence reported here supports the CAPM, on the basis that the t-statistics of the estimated α values of Equation **(E.9.1)** were not significantly different from zero, implying that we cannot reject the Capital Asset Pricing Model.

This evidence is not surprising, since it is consistent with the CAPM, which asserts that the cross section variation of stock returns should only be explained by the betas of these stocks. Thus, in any stock market, if the cross section variations of stock returns were explained by any other variable than beta, then the CAPM is not a valid model of equilibrium in such a market.

The following chapter provides the conclusion of this thesis and makes some suggestions for the future direction of research with regard to the *ASM*.

CHAPTER TEN
X.

SUMMARY & CONCLUSION

Summary & Conclusion

For stock markets to be more effective in fulfilling their roles, of efficient allocation of funds and the expansion of the national growth rate, they have to be efficient. allocative efficiency means that, funds raised via the capital market are channelled to the most efficient (profitable) companies. This can be accomplished only if the market is characterised by both operational efficiency and pricing efficiency. Operational efficiency (e.g. the availability of information, the existence of an adequate legal and administrative framework), however, is a prerequisite of pricing efficiency (i.e. to price stocks so that their fundamental values are reflected in the prices), although it does not necessarily suggest it. This thesis has endeavoured to investigate pricing efficiency in the Amman Stock Market. If the market is efficient (at all levels) then, based on the assumption that investors are rational expected utility maximisers, investment choice under conditions of uncertainty dictates that investors choose between investment opportunities based on these investments' expected returns and risk levels, without any preference for any other factors. This implies that investors would only choose risky investments if the expected returns of these investments are rewarding for assuming this risk. The main model that describes this relationship for individual stocks is the Capital Asset Pricing Model. Consequently, this thesis investigates the validity of the model in the context of the ASM.

This thesis aimed at achieving a number of closely related objectives. Yet, prior to the commencement of this research there did not exist a reliable (machine readable) database of stock returns. This created a big problem, since the lack of such a database forbids a critical empirical investigation of stock price behaviour. The compilation of this database, which consists of daily and monthly individual stocks' returns, together with daily and monthly value weighted return index, is described in chapters 1 and 6.

An asserted feature of the ASM that has pervasive significance for empirical investigations is thin trading where, the market was found (not surprisingly) to be extremely thin. In fact, 38% of the stocks that were suitable for the analysis in this thesis, were thinly traded to the extent that they were, for long periods, effectively non-trading and there was little alternative other than to exclude them from the sample. This exclusion was a partial solution to the problem, since the remaining stocks still suffer from some degree of thin trading. This has pointed the research to a more broad direction. Thus, whatever this thesis sought to investigate, it was carried out in the context of thin trading, and this to some extent enriched this empirical work.

The resultant sample accounted for 76% of the total market capitalisation of the ASM, suggesting that this is a representative sample of the market. But, the market capitalisation of some individual companies dominated this sample (in fact they also dominate the market); a unique case was the Arab bank. This necessitated the construction of three indices, one for all the companies, one for all the companies excluding the largest three and one solely for the largest three companies. These three indices were closely correlated which allowed the conclusion that the use of any of these indices can serve the purposes of this thesis, thus the index of all the stocks was utilised. In fact, this choice of the index was also motivated by the necessity to include as many stocks as possible in the index to try to mimic the true (but not observable) market portfolio.

After constructing our database, we started to investigate empirically the above outlined objectives. The empirical work initiated by investigating the weak form level of the Efficient Market Theory on the ASM. Efficient Market Theory is essentially a statement about the formation of prices in capital markets. Specifically, the theory implies that the stock price at any point of time reflects all the information available prior to that time. Thus, stock prices adjust instantaneously to information influencing stock values. However, such a statement is a generalisation that should be carefully investigated for each market, because the validity of this theory depends largely on a set of conditions that must be satisfied in each market. Thus, before we accept the theory for all capital markets, it should be investigated on the individual market level. Consequently, we tried to test one level of this theory (weak form level) and provide the tools (the CAPM) required for testing other levels, since other levels require an equilibrium model that adjusts returns for risk (Copeland and Weston, 1988).

To test any level of efficiency we require an equilibrium model of expected returns (Fama, 1976). For the weak form level, however, stock expected returns are assumed to be generated by a fair game model. Thus, the best expectation of a stock's next period return is today's return. Accordingly, if past returns help in explaining the variations of expected returns, the theory is not valid on the weak form level, implying that the information content of past historic prices is not fully embodied in current prices, hence we can predict future returns, simply by analysing past return data.

To test this model of equilibrium, two tests were employed; the serial correlation and the runs test. But, the question that has risen in the process was that, is our "daily return data" suitable for the analysis, due to infrequent trading ?. This might cause a problem, because any test that uses daily returns will be affected due the difficulty of measuring daily returns of missing days. To give a price for each missing day we have to make an assumption explicitly about the rationale of thin trading. If thin trading is a an outcome of the absence of information affecting the values of the stocks, then we fill the gaps by assuming that the value of the stock has not changed i.e. the missing price will be equal to the last traded price before the gap. On the other hand, if thin trading is an outcome of impediments to trading (operational inefficiency) then we have to infer the missing price from any model that adequately describes price formation (e.g. price movement of other stocks).

To deal with this issue we identified three alternative. The first alternative was to ignore missing days and assume that these prices are daily prices, this treatment was implicitly adopted by other research conducted on the ASM (see Omet (1990), Quaider (1993), Al Kawasmi (1990)). The second alternative was to infer the missing price from the movement of the market, employing the beta of the stock. The third alternative was to assume that the price of the stock has not changed and give the missing day the last trade price before the gap.

All these alternatives were investigated and the findings were:

The first alternative produced more dependence patterns than the others, due to the positive first order autocorrelation of the market index (where the daily first order autocorrelation for the market index was found to be (+0.30)). Thus, we ruled out this approach and the analysis was carried out using the other two alternatives. Basically, the market was found to be *statistically inefficient* on the one day level and to a lesser extent on the two day level, because of the high first order positive serial correlation and dependence patterns. However, over longer time spans, there were no apparent inefficiencies. But, does this statistical inefficiency imply *economic inefficiency* i.e. can abnormal profits be made if such inefficiency is exploited?. This requires using filter rules tests incorporating the transaction costs data, which was not available. Nonetheless, it was argued that it is highly possible that this high degree of positive serial correlation would not lead to the realisation of any abnormal profits due to two rationales. The first is that, if we square this autocorrelation we get between 1.4% and 2.25% coefficient of determination. This means that successive returns explain only between 1.4% and 2.25% of the variation of stock returns. Is this economically significant to compensate for resources spent in studying past returns data?.

The second rationale rests on the underlying causes of this positive dependence pattern. One possible[92] cause might be price limits imposed in the ASM. The administration of the ASM uses price limits as a policy tool, mainly to prevent speculation, as stated by the Managing Director of the market (Toukan, 1995). By so doing, they impose an upper and lower bounds on price adjustments to information. Thus, if we have a price limit of, say 5%, and new information becomes available in the market, causing the stock value to diverge from the stock price by, say, +8%, then the market causes a delay in the price adjustment by 3%. This adjustment, naturally, will resume next day of trading[93] by 3%, inducing positive first order serial correlation (the same scenario occurs if the

[92] Another possibility as argued by Omet (1990), is the opinion leadership phenomenon. Basically, this means that investors follow other, perhaps more informed, investors in their buying or selling activities.
[93] Assuming that no further price affecting information affects the adjustment.

information content dictates -8% change in value). But, can an investor act upon this inefficiency?. Most likely, no. The reason being that, once a price adjustment triggers the limit, then trading will stop in that stock, thus stock will close at the limit level. It is highly possible that the opining price of the stock next day, will reflect the value of the stock, thus no possible trading strategy can be devised. However, this operational inefficiency can be alleviated by lifting these limits or by increasing their bounds. Otherwise, pricing efficiency cannot be sustained.

The second goal of the thesis was to examine the effects of measuring returns, using two different approaches, on tests of the CAPM. The first return measurement approach was in the form of logarithmic returns and the second was in the form of discrete returns. As argued, by Hawawini and Vora (1985), logarithmic returns are more suitable for tests of the CAPM since they approximate normality which is a prerequisite for meaningful tests of the model. However, it was found that the use of discrete returns would bias the estimates by providing larger t-values of the coefficients when regressions are performed. So it is more likely to make wrong inferences using discrete returns than when using logarithmic returns. Thus, the use of logarithmic returns was adopted in the remainder of the thesis.

The third goal of the research was to estimate the effect of the adjustment made by Marsh (1981) on the trade-to-trade method for estimating the beta of the stock. As discussed in chapter two, the beta of the stock for thinly traded stocks can be estimated using the trade-to-trade method, thus we match stock returns with market returns for the same time intervals. But, this as argued by Marsh, introduces heteroscedasticity due to estimating beta over different lengths of periods. If the residual's variance is proportional to the length of the period, the variance will not be constant and heteroscedasticity results. Marsh developed a weighting scheme to avoid heteroscedasticity, by dividing the variables by the square root of time. This adjustment was investigated using data from the ASM. The expected heteroscedasticity resulting from non adjusting the market model was documented, and the expected reduction of it after the adjustment was also confirmed. Specifically, it was found that if we do not adjust the trade-to-trade method we can get results that might be supporting the model even if the model is not valid. This conclusion meant that the market model used for estimating betas in our empirical work has to be adjusted as implied by Marsh.

The fourth goal was to analyse the effects of using portfolios on tests of the CAPM and the market model, in the context of small thin markets. The estimation of individual stocks' betas is problematic, because they are estimated with random error. Thus, portfolios were traditionally used to provide better beta estimates since these random errors cancel out, leading to a better beta estimate for the portfolio. This is extremely difficult in the context of small markets because of the limited number of stocks. However it was found in this thesis that, if such an option were attempted, it could be misleading. The reason being the possibility that large stocks dominate the portfolios that they are allocated to, thus the beta of the portfolio will be affected by the beta of these large stocks, consequently, giving spurious inferences.

In this process we have introduced a possible solution for estimating the stocks' beta if we have a short time series. This builds on the basic assumption made by Black, Jensen and Scholes (1972) who have used the past five years to measure the beta of the stock to be allocated to portfolios for testing purposes. This five years beta was considered as an instrumental variable that is correlated with the beta of the stock but independent from its measurement error. In the same sense, this research using the succeeding five years data for beta estimation, which essentially serves the same purpose. Thus, if we have a short time series that we need to utilise both for beta estimation and testing, this solution will serve such a need.

However, since portfolio formation is not possible for testing the CAPM we have to live with individual stocks' betas; which poses a question. If beta is not observable, how can we estimate it for individual stocks?. In addition what is the best time period to be used for estimating the true beta?.

Based on common sense, we know, that the true beta of firms (as a measure of risk) must be changing because the risks of these firms are changing; (e.g. changes in political and economical environments). Thus, if true beta changes and this beta is estimated using a specific time period, then the estimated beta is a proxy for the true beta only if beta across this time period is stationary i.e. beta is stable across the estimation period. But, again, what is the best time period that should be used to estimate beta?. If we assume that the Capital Asset Pricing Model is valid then we can estimate beta for various periods and see which one produces evidence that is consistent with the model. But, we are here investigating the validity of the CAPM. Consequently, our test must be a joint test of the validity of the CAPM[94] and the stationarity of beta.

[94] In fact, any test of the CAPM is a joint hypothesis test of the validity of the model and the efficiency of the market portfolio used (Roll, 1977).

Therefore, **the fifth goal** of the thesis was to test the sensitivity of our CAPM tests' results to the period used for beta estimation. To achieve this, we used three time periods (three, four and five years) to estimate the beta of each stock. These beta estimates were then fed into the model and the model was tested. It was found that if we use short time periods we get results that are more consistent with the model. Hence longer time periods for beta estimation provided more departures form the model. This was investigated further as detailed below.

Having obtained all the necessary data needed to conduct a reasonable testing of the CAPM, we proceeded in chapter eight to testing the model thus, achieving **the sixth goal** of the thesis. To provide a strong test we have pooled the data in two time series, return data and beta data and conducted a cross sectional test of the model. Building on the finding that longer time series produced more departures from the model, we have used four time periods for the pooled data test (two, three, four and five years). It was found that all the beta estimates lead to the rejection of the model. But, longer time periods showed negative risk premium and short time series showed positive risk premium. However, long time periods produced positive intercept terms (higher than the risk free rate of return) while the opposite happened in the case of the short time periods.

Can we accept these results?. In other words, is the model not valid for the ASM?.

We are tempted to reject either, the validity of the Capital Asset Pricing Model (or the efficiency of the market portfolio) or the estimation of beta. Thus, before we reject the validity of the model we must investigate the possibility that beta was misestimated. A possible reason might be thin trading.

Again, thin trading could cause a serious problem in estimating beta, since although we have used trade-to-trade prices to measure the beta but still there might be an effect that is not being accounted for that could be affecting beta (e.g. characteristics of thinly traded stocks). To isolate the effects of thin trading we constructed two sub samples based on two measures of frequent trading. The results were very interesting. The model's main predictions were satisfied only if beta is measured using 24 months. Thus, this estimate of beta, if the CAPM is valid, is the best estimate of the true beta of the stock. It implies that beta might be stationary for two years only (compared to the other three periods). This might be plausible for the ASM, taking into consideration that the economy of Jordan is a volatile economy that is constantly adapting to political and regional changes[95], which leads companies' risks to change as a result.

But is beta the only variable that explains *the cross section variations of stock returns?.* **The seventh goal** of our this thesis attempted to investigate whether or not beta is the only variable that should be incorporated in the CAPM. In fact recent evidence is pointing to the possibility that the CAPM is misspecified i.e. there are some variables, other than beta, that help in explaining the cross section variations of stock returns. These variables include accounting variables whose information should be instantaneously reflected in the prices. Thus, there is no theoretical grounds for their explanatory power of returns. But, since they are priced, it implies either market inefficiency or model misspecification, depending on the persistence of the relationship found. Hence, it was appropriate to test the CAPM, again, with relation to these

[95] See AlQatamin, *"The Role of Stock Markets in the Arab Region at a time of More Sustainable Peace and Internal Instability"*. A paper presented at the Conference on Management Development in the Middle East within the Framework of Peace. Held by the Arab Management Conference, University of Bradford. 3rd-7th July 1995.

variables. If these variables help in explaining the cross section variations of stock returns then, the Capital Asset Pricing Model will be misspecified. Chapter nine defined four variables to be investigated. The explanatory power of the variables, book-to-market ratio, E/P ratio, leverage and firm size was investigated in a multivariate and framework, and the evidence was clear cut. The cross section of returns is not explicable by these variables implying that the Capital Asset Pricing Model can not be rejected in favour of this approach in the context of the ASM.

What does all this imply for future research?. Two main areas of future research are identified, based on the above, so that our investigation of the price formation in the ASM can be improved. These are *"thin trading"* and *"beta estimation"*. Firstly, with regard to the problem of thin trading, in depth research can be carried out on the underlying causes for this phenomenon in the context of the ASM which helps in developing models capable of inferring prices for the missing prices due to thin trading. Second, with regard to the estimation of beta, since the stocks' betas do change rapidly in the market, it can be argued that using time varying beta models (allowing beta to vary) can provide more accurate estimates of the true, but not observable, betas, so that more precise investigations can be carried out.

In fact, this thesis provided a crucial building block for future research on the ASM, and emerging small markets, where thin trading is most severe. With regard to the ASM, bearing in mind the availability of this new database and this starting point, it is hoped that further work, by the author and others, will result in a better understanding of this important emerging market.

APPENDICES

Table (A1.1)
Market Capitalisation of Stocks in the Sample for the Period 1987-1994

		1987	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*
Code	Company	ME	ME	ME	ME	ME	ME	ME	ME
1101	Jordan Islamic Bank for Finance & Investment	11280000	11280000	15300000	19080000	22320000	26280000	65550000	53969314
1102	Jordan Kuwait Bank	8450000	7250000	6950000	5300000	8000000	13420000	26435000	29900000
1104	Housing Bank	20280000	22680000	24720000	22800000	27600000	43200000	66720000	68400000
1106	Industrial Development Bank	7967541	7162673	10200000	9420000	10560000	18840000	22650000	21750000
1107	Union Bank for Saving & Investment	5920000	9640000	18144000	12816000	14760000	27360000	44000000	38500000
1113	Jordan National Bank	24643534	24187173	23183177	20992641	26012620	41528919	56588857	71680000
1114	Jordan Investment & Finance Bank	10800000	11160000	14850000	12060000	13365000	21600000	32400000	41225000
1222	Jordan Bank	17850000	16327500	14700000	14059500	15225000	22470000	44205000	39900000
1323	Arab Bank	266200000	305800000	454300000	534600000	545600000	563200000	820600000	798600000
2104	Jordan Insurance	15950000	69500000	12500000	10400000	13300000	15550000	19000000	17000000
2109	Jordan French Insurance	7000000	5450000	3850000	3124000	4180000	8250000	7722000	5456000
2117	Arab Life and Accident Insurance	2040000	2100000	2600000	2300000	3620000	6300000	6040000	5080000
3104	Jordanian Electric Power	14040000	15570000	13230000	7560000	11700000	13950000	27360000	22800000
3105	Arab International Hotels	4141468	Missing	11439930	11005502	19404438	45976934	34754218	35834510
3112	Jordan National Shipping Lines	5894385	6726533	18376611	13245029	18376611	15810820	14215869	21774550
3115	The United Middle East & Commodore Hotels	-	-	2486175	1964880	3528764	11152000	11118000	12240000
3117	Real Estate Investment / Akarco	2200000	2137500	3262500	2175000	3750000	6750000	5775000	5062500
3118	National Portfolio Securities	1065000	1245000	2910000	2205000	4380000	8560000	9725000	12100000
3119	Machinery Equipment Renting & Maintenance	1855892	1855892	1995084	788754	1140000	1584000	1272000	924000
3120	Petra Enterprises & Leasing Equipment	1200000	1340000	670000	410000	560000	1160000	1070000	910000
3121	Jordan Gulf Real Estate Investment	1050000	990000	1680000	960000	1740000	2670000	1740000	5400000
4103	Arab Paper Converting & Trading	250000	300000	680000	310000	1474000	2398000	1672000	3174017
4104	Jordan Dairy	1855000	1750000	3115000	2397500	3342500	4515000	5565000	4287500
4106	Arab Aluminium Industry	7320000	8120000	11400000	10960000	19600000	47200000	47200000	60000000
4108	The Arab Pharmaceutical Manufacturing	10700000	11400000	25800000	22100000	29350000	51100000	73170000	46800000
4109	The Industrial , Commercial & Agricultural	4851888	4505324	9877057	9253243	18263891	32000000	38000000	22750000
4110	The Arab Chemical Detergents Industries	3425423	2871070	4422107	5082123	9900240	15960096	13266830	11039066

Table (A1.1) continued

		1987	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*
Code	Company	ME	ME	ME	ME	ME	ME	ME	ME
4111	National Steel Company	11120000	11920000	11560000	8640000	12560000	23920000	20080000	16600000
4112	Dar Al Dawa Development & Investment	2220000	3120000	5985000	9765000	10962000	23100000	46050000	48600000
4113	Intermediate Petrochemical Ind.	4360000	5680000	11600000	9280000	13920000	15680000	14040000	11320000
4114	The Jordan Worsted Miles	6615000	6750000	7236000	5508000	18000000	33000000	31800000	30800000
4115	Jordan Ceramic Industries	2180000	3220000	6400000	5820000	9600000	15625000	17625000	15750000
4116	Jordan Glass Industries	7357469	7923428	12600000	6570000	6570000	7110000	7110000	3330000
4117	Jordan Paper and Cardboard Factories	4757000	5250000	10800000	12600000	14400000	13320000	12750000	12600000
4118	Jordan Phosphate Mines	50000000	126540000	156636000	123120000	133380000	152190000	121781554	128140000
4119	The Jordan Pipes Manufacturing	3000000	3675000	8500000	5025000	7100000	8450000	9000000	8775000
4123	Arab Centre for Pharmaceutical &	-	-	9840000	5760000	9600000	21700000	17000000	13950000
4126	Jordan Chemical Industries	1731456	3203875	4280922	2931205	5889676	8316441	8180106	7348462
4127	Universal Chemical Industries	1590000	2450000	5250000	6000000	11500000	14000000	10500000	6225000
4128	Aladdin Industries	1140000	1360000	3700000	2150000	3250000	4200000	4450000	4130000
4130	Rafia Industrial	592948	579472	1644084	2263985	2506555	2439174	2440000	2720000
4132	Jordan Industries and Matches	-	1071000	3247000	1666000	2244000	2567000	1853000	2168790
4135	Jordan Spinning & Weaving	4000000	3840000	11520000	7320000	15250000	16250000	13750000	13500000
4139	National Cable & Wire Manufacturing	2300000	3710000	18655000	16765000	21035000	27300000	39250000	25500000
4138	Jordan Wood Industries JWICO	1455000	2205000	5445000	3450000	4350000	5700000	9225000	8400000
4140	Jordan Sulpho Chemicals	12840000	11560000	11400000	8400000	10960000	19840000	13920000	7840000
4142	Jordan Cement Factories	53000000	63500000	57000000	49500000	68302240	105173360	177706712	174684489
4145	Jordan Rockwool Industries	1145174	1699291	5910576	3527875	3417052	5116342	4045050	4560000
4151	Jordan Precast Concrete Industry	2240000	1417158	2260705	641095	1518384	2395672	2395672	1180965
4158	Livestock & Poultry	766138	717648	987500	1162500	1287500	3025000	2275000	3036000
4167	Jordan Kuwait Company for Agr. & Food Products	-	2629975	4700381	3189544	3805071	5427821	3553264	917314
4241	Jordan Petroleum Refinery	48000000	55040000	52224000	47680000	55360000	60160000	63360000	59776000
Total	52	680640316	880410512	1142023809	1106104376	1297820542	1664791579	2151955132	2068408477

Table (A1.2)
Basic Properties of the Stocks in the Sample

Code	*Name*	*# Years*	*# Days*	*Missing years*	*Trading Start*	*Sector*	*Average Trading per year*	*Average Capitalisation*	*Average firm size in the sample*
1101	Jordan Islamic Bank for Finance & Investment	8	1421	0	03/01/87	Banking	178	28132414	2.03%
1102	Jordan Kuwait Bank	8	1741	0	03/01/87	Banking	218	13213125	0.95%
1104	Housing Bank	8	1251	0	13/01/87	Banking	156	37050000	2.67%
1106	Industrial Development Bank	8	877	0	24/02/87	Banking	110	13568777	0.98%
1107	Union Bank for Saving & Investment	8	1051	0	08/03/87	Banking	131	21392500	1.54%
1113	Jordan National Bank	8	1626	0	03/01/87	Banking	203	36102115	2.60%
1114	Jordan Investment & Finance Bank	8	1313	0	03/01/87	Banking	164	19682500	1.42%
1222	Jordan Bank	7	1123	0	03/01/87	Banking	160	26391000	1.90%
1323	Arab Bank	8	1843	0	03/01/87	Banking	230	536112500	38.62%
2104	Jordan Insurance	8	802	0	18/01/87	Insurance	100	21650000	1.56%
2109	Jordan French Insurance	8	1515	0	06/01/87	Insurance	189	5629000	0.41%
2117	Arab Life and Accident Insurance	8	808	0	07/01/87	Insurance	101	3760000	0.27%
3104	Jordanian Electric Power	8	1778	0	05/01/87	Service	222	15776250	1.14%
3105	Arab International Hotels	7	1371	88	31/01/87	Service	196	23222429	1.67%
3112	Jordan National Shipping Lines	8	1175	0	04/01/87	Service	147	14302551	1.03%
3115	The United Middle East & Commodore Hotels	6	1252	0	14/01/89	Service	209	7081637	0.51%
3117	Real Estate Investment / Akarco	7	1418	0	02/01/88	Service	203	4444643	0.32%
3118	National Portfolio Securities	7	1313	89	19/01/87	Service	188	6027143	0.43%

Table (A1.2) continued

Code	***Name***	***# Years***	***# Days***	***Missing years***	***Trading Start***	***Sector***	***Average Trading per year***	***Average Capitalisation***	***Average firm size in the sample***
3119	Machinery Equipment Renting & Maintenance	8	1290	0	04/01/87	Service	161	1426953	0.10%
3120	Petra Enterprises & Leasing Equipment	8	1355	0	04/01/87	Service	169	915000	0.07%
3121	Jordan Gulf Real Estate Investment	7	1428	0	16/01/88	Service	204	2318571	0.17%
4103	Arab Paper Converting & TRADING	8	1073	0	07/01/87	Industrial	134	1282252	0.09%
4104	Jordan Dairy	8	1529	0	04/01/87	Industrial	191	3353438	0.24%
4106	Arab Aluminium Industry	8	1897	0	03/01/87	Industrial	237	26475000	1.91%
4108	The Arab Pharmaceutical Manufacturing	8	1865	0	05/01/87	Industrial	233	33802500	2.44%
4109	The Industrial , Commercial & Agricultural	8	1753	0	05/01/87	Industrial	219	17437675	1.26%
4110	The Arab Chemical Detergents Industries	8	1144	0	11/01/87	Industrial	143	8245869	0.59%
4111	National Steel Company	8	1732	0	03/01/87	Industrial	217	14550000	1.05%
4112	Dar Al Dawa Development & Investment	8	1698	0	05/01/87	Industrial	212	18725250	1.35%
4113	Intermediate Petrochemical Ind.	8	1866	0	03/01/87	Industrial	233	10735000	0.77%
4114	The Jordan Worsted Miles	8	839	0	07/01/87	Industrial	105	17463625	1.26%
4115	Jordan Ceramic Industries	8	1286	0	25/01/87	Industrial	161	9527500	0.69%
4116	Jordan Glass Industries	8	1533	0	05/04/87	Industrial	192	7321362	0.53%
4117	Jordan Paper and Cardboard Factories	8	827	0	20/01/87	Industrial	103	10809625	0.78%
4118	Jordan Phosphate Mines	8	1134	0	18/01/87	Industrial	142	123973444	8.93%
4119	The Jordan Pipes Manufacturing	8	1365	0	07/01/87	Industrial	171	6690625	0.48%

Table (A1.2) continued

Code	Name	# Years	# Days	Missing years	Trading Start	Sector	Average Trading per year	Average Capitalisation	Average firm size in the sample
4123	Arab Centre for Pharmaceutical &	6	1375	0	05/03/89	Industrial	229	12975000	0.93%
4126	Jordan Chemical Industries	8	1098	0	06/01/87	Industrial	137	5235268	0.38%
4127	Universal Chemical Industries	8	1623	0	18/01/87	Industrial	203	7189375	0.52%
4128	Aladdin Industries	8	1404	0	03/01/87	Industrial	176	3047500	0.22%
4130	Rafia Industrial	8	798	0	03/04/87	Industrial	100	1898277	0.14%
4132	Jordan Industries and Matches	8	1596	0	07/01/87	Industrial	200	1852099	0.13%
4135	Jordan Spinning & Weaving	8	1779	0	13/01/87	Industrial	222	10678750	0.77%
4139	National Cable & Wire Manufacturing	8	1412	0	29/11/94	Industrial	177	19314375	1.39%
4138	Jordan Wood Industries JWICO	8	1412	0	87/01/05	Industrial	177	5028750	0.36%
4140	Jordan Sulpho Chemicals	8	1806	0	03/01/87	Industrial	226	12095000	0.87%
4142	Jordan Cement Factories	8	1912	0	24/01/87	Industrial	239	93608350	6.74%
4145	Jordan Rockwool Industries	8	1735	0	04/01/87	Industrial	217	3677670	0.26%
4151	Jordan Precast Concrete Industry	6	1239	0	26/03/89	Industrial	207	2341609	0.17%
4158	Livestock & Poultry	7	913	0	03/01/88	Industrial	130	1893898	0.14%
4167	Jordan Kuwait Company for Agr. & Food Products	7	1039	0	18/01/88	Industrial	148	3460481	0.25%
4241	Jordan Petroleum Refinery	8	1877	0	03/01/87	Industrial	235	55200000	3.98%
	Total	52							
	Average Sample Capitalisation							1388088675	100

Table (A5.1)
Daily Serial Correlation Coefficients for Lag r = 1,2,...,10.
Missing Prices were Considered as Previous Price

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
2109	0.14*	0.03	0.02	-0.02	-0.02	-0.04	-0.01	0.02	0.00	0.06
1323	0.25*	0.09*	0.00	-0.03	-0.11*	-0.05	-0.07	-0.02	0.01	0.01
1101	0.21*	0.07*	0.07	0.02	-0.01	-0.01	0.00	-0.02	0.00	-0.03
1102	0.17*	0.02	0.00	-0.01	-0.03	-0.03	0.01	0.01	0.02	0.04
1104	0.15*	0.02	0.01	-0.01	0.00	0.05	0.06	-0.05	-0.01	-0.02
1107	0.18*	0.10*	0.08*	-0.04	0.01	-0.02	-0.01	-0.01	-0.02	0.00
1113	0.19*	0.02	-0.03	-0.06	-0.01	-0.02	0.02	0.06	0.05	0.02
1114	0.09*	0.05	0.04	0.00	0.01	0.02	0.01	0.00	0.02	0.04
4118	0.12*	0.07*	-0.01	0.04	0.04	-0.02	-0.02	0.03	0.04	0.02
4119	0.11*	-0.21*	-0.03	0.00	0.00	-0.01	0.01	-0.02	-0.03	-0.01
4123	-0.05	0.00	0.01	0.01	-0.01	0.04	-0.02	0.01	0.02	0.03
4126	0.08*	-0.30*	0.00	0.03	0.04	-0.02	-0.01	0.00	0.01	0.00
4127	0.04	-0.36*	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	0.03
4128	0.07*	-0.24*	-0.02	0.02	0.03	0.01	-0.05	-0.03	0.01	0.01
4132	0.04	-0.35*	0.01	0.00	-0.01	0.02	0.00	-0.01	0.01	0.01
4135	0.16*	-0.02	-0.02	0.05	0.05	0.00	-0.04	0.03	0.02	0.00
4139	0.07*	-0.33*	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.02
4140	0.21*	0.00	-0.04	0.00	-0.01	-0.02	0.01	0.02	0.06	0.05
4142	0.12*	0.02	-0.01	-0.04	0.01	0.01	-0.05	0.00	-0.06	-0.02
4145	-0.05	0.02	-0.02	0.02	0.03	0.02	-0.03	-0.01	0.00	0.00
4151	0.02	-0.45*	0.01	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00
4158	0.03	-0.35*	0.17*	0.01	-0.16*	0.02	0.00	-0.03	0.00	0.00
4241	0.01	-0.47*	0.00	-0.01	0.00	0.00	0.01	0.01	0.01	-0.01
1222	0.24*	0.09*	-0.03	-0.06	-0.04	-0.08*	0.00	0.03	0.01	-0.03
3104	0.12*	0.02	-0.03	-0.03	-0.05	-0.03	-0.01	0.00	0.04	0.04
3117	0.09*	-0.02	-0.01	0.10*	0.03	0.01	0.04	0.03	0.03	0.06
3121	0.13*	0.02	-0.02	-0.02	0.00	0.01	0.01	-0.01	-0.01	0.01
4106	0.17*	-0.01	0.02	-0.02	0.00	-0.04	-0.03	0.03	0.02	0.01
4108	0.23*	0.06	0.02	0.02	0.01	0.00	-0.02	-0.04	-0.03	0.01
4113	0.15*	0.01	0.04	0.00	-0.03	-0.03	-0.03	-0.04	0.02	0.01
4112	0.20*	0.07*	0.01	-0.06	-0.03	-0.01	-0.01	0.00	0.01	0.03
4109	0.21*	0.06	0.04	0.00	0.02	-0.01	-0.02	-0.01	0.01	-0.03
4111	0.12*	-0.05	-0.01	0.01	-0.08*	-0.07	-0.01	0.04	0.02	0.00
Average	**0.121***	**-0.071**	**0.008**	**-0.003**	**-0.010**	**-0.009**	**-0.009**	**0.000**	**0.009**	**0.011**

* Coefficient is twice its standard error.

Table (A5.2)
Daily Serial Correlation Coefficients for Lag r = 1, 2,...,10.
Missing Prices were Measured using the Beta of the Stock

Code	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
2109	0.14*	0.03	0.02	-0.02	-0.02	-0.05	-0.01	0.02	0.00	0.06
1323	0.25*	0.09*	0.00	-0.03	-0.11	-0.05	-0.07*	-0.02	0.01	0.01
1101	0.18*	0.06	0.07*	0.01	-0.02	-0.01	0.00	-0.01	0.02	-0.05
1102	0.17*	0.02	0.00	-0.01	-0.02	-0.04	0.01	0.01	0.02	0.03
1104	0.14*	0.02	0.00	-0.02	0.01	0.04	0.06	-0.04	0.01	-0.01
1107	0.16*	0.09*	0.06	-0.03	0.01	-0.02	0.00	0.00	-0.01	0.00
1113	0.18*	0.02	-0.02	-0.06	-0.01	-0.02	0.01	0.05	0.04	0.02
1114	0.11*	0.06	0.03	0.00	0.00	0.01	-0.01	-0.01	0.02	0.03
4118	0.13*	0.06	-0.02	0.05	0.04	-0.01	-0.03	0.03	0.04	0.02
4119	0.17*	0.02	-0.04	-0.03	0.01	0.00	0.00	-0.03	0.02	-0.03
4123	-0.05	0.02	0.00	0.01	0.00	0.04	-0.01	0.00	0.01	0.03
4126	0.19*	0.03	0.01	0.02	0.06	-0.05	-0.03	-0.01	-0.03	0.01
4127	0.16*	0.01	0.00	0.01	-0.03	-0.04	0.02	0.04	0.04	0.03
4128	0.14*	-0.01	-0.04	0.04	0.04	0.00	-0.04	-0.04	-0.05	0.01
4132	0.11*	-0.01	0.02	-0.01	0.00	-0.01	-0.05	-0.02	0.02	0.03
4135	0.16*	-0.02	-0.03	0.05	0.04	-0.01	-0.04	0.02	0.03	0.01
4139	0.25*	0.08	0.03	0.01	0.04	-0.01	-0.02	0.02	0.02	0.01
4140	0.21*	0.00	-0.04	0.00	-0.02	-0.02	0.00	0.02	0.06	0.05
4142	0.21*	0.00	-0.04	0.00	-0.02	-0.02	0.00	0.01	0.06	0.05
4145	0.06	0.01	0.02	-0.02	0.01	0.02	0.04	-0.02	0.02	-0.01
4151	0.10*	0.02	0.00	0.01	-0.01	-0.04	0.03	0.00	0.03	0.02
4158	0.21*	0.00	0.01	0.03	-0.01	0.03	0.02	-0.02	-0.03	-0.04
4241	0.16*	0.02	-0.01	-0.01	0.01	-0.03	-0.03	-0.06	0.04	-0.01
1222	0.24*	0.08	-0.03	-0.06	-0.04	-0.06	-0.01	0.03	0.01	-0.02
3104	0.12*	0.02	-0.02	-0.04	-0.06	-0.04	-0.01	0.01	0.04	0.04
3117	0.06	-0.01	-0.03	0.06	0.01	0.01	0.02	0.03	0.05	0.07*
3121	0.08*	0.03	-0.01	-0.01	-0.01	0.01	-0.02	-0.02	-0.03	0.02
4106	0.16*	-0.02	0.02	-0.02	0.00	-0.05	-0.03	0.03	0.02	0.01
4108	0.24*	0.06	0.02	0.02	0.01	0.00	-0.02	-0.04	-0.03	0.01
4113	0.15*	0.01	0.04	0.00	-0.03	-0.02	-0.03	-0.04	0.02	0.00
4112	0.21*	0.07*	0.02	-0.06	-0.04	-0.03	-0.01	0.01	0.01	0.02
4109	0.21*	0.06	0.04	0.01	0.01	0.00	-0.03	-0.02	0.01	-0.03
4111	0.11*	-0.04	-0.01	0.01	-0.08*	-0.07*	-0.02	0.04	0.02	0.00
Average	**0.155**	**0.026**	**0.002**	**-0.002**	**-0.006**	**-0.016**	**-0.009**	**-0.001**	**0.015**	**0.012**

* Coefficient is twice its standard error.

Table (A5.3)
Two and Four Days Correlation Coefficients (Beta price)

Code	*2 days*	*4 days*
	Lag1	Lag1
2109	0.03	-0.03
1323	0.00	-0.11*
1101	0.07*	-0.01
1102	-0.01	-0.04
1104	-0.05	0.05
1107	0.11*	0.05
1113	-0.03	0.06
1114	0.07*	0.07
4118	0.05	0.06
4119	-0.08*	-0.01
4123	0.06	0.02
4126	0.02	-0.05
4127	-0.01	0.03
4128	-0.01	0.09
4132	0.00	-0.02
4135	0.01	0.11*
4139	0.08*	0.05
4140	0.03	-0.03
4142	0.03	-0.03
4145	0.00	0.04
4151	0.03	0.03
4158	0.02	0.08
4241	-0.05	-0.08
1222	-0.09*	-0.27*
3104	0.01	-0.02
3117	-0.04	0.06
3121	0.03	0.01
4106	0.04	-0.03
4108	0.06	-0.03
4113	0.02	-0.02
4112	0.04	-0.02
4109	0.04	0.02
4109	-0.04	-0.12*
Average	**0.014**	**-0.003**

Table (A5.4)
2 Day Serial Correlation Coefficients for Lags r = 1, 2,...,10. (Actual Prices)

Code	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
2109	0.07	0.08	-0.04	0.01	-0.06	0.07	-0.04	0.00	0.03	-0.04
1323	0.13*	-0.14*	-0.06	0.02	0.09	-0.02	-0.05	-0.03	-0.03	0.05
1101	0.14*	0.02	0.01	0.01	-0.06	0.03	-0.06	0.02	0.01	-0.01
1102	0.06	-0.07	0.08	-0.03	0.03	0.03	-0.07	-0.05	-0.02	-0.01
1104	0.05	-0.03	0.01	-0.06	0.05	0.08	-0.03	-0.08	-0.06	0.04
1107	0.18*	-0.01	-0.01	-0.08	-0.10	-0.01	-0.04	0.01	0.08	0.02
1113	-0.02	-0.02	0.10*	-0.05	0.05	-0.06	0.04	-0.08	-0.11	0.05
1114	0.10*	-0.08	-0.02	0.06	-0.07	-0.13*	0.02	0.08	0.02	0.02
4118	0 07	0.08	-0.04	0.01	-0.06	0.07	-0.04	0.00	0.03	-0.04
4119	-0.11*	0.02	-0.05	0.05	0.06	0.05	0.05	-0.04	-0.09	0.05
4123	0.06	0.06	-0.07	0.05	-0.01	-0.05	-0.08	0.03	-0.04	0.07
4126	0.06	0.12*	-0.03	0.04	-0.01	0.05	-0.02	0.03	-0.11	-0.03
4127	0.02	-0.03	0.04	0.05	0.08	0.06	0.03	-0.03	-0.03	-0.02
4128	0.02	0.04	-0.11*	-0.02	-0.01	0.02	0.11	-0.03	0.02	0.05
4132	0.09*	0.03	-0.06	-0.01	-0.01	0.04	0.10	0.06	0.07	0.00
4135	0.09*	-0.06	0.01	0.08	0.05	-0.04	-0.01	0.07	0.03	0.00
4139	0.10*	0.01	0.01	0.07	0.06	-0.01	-0.06	0.01	-0.01	0.00
4140	0.01	-0.10*	0.01	0.05	0.10	-0.02	-0.01	0.00	0.04	-0.01
4142	0.03	-0.02	-0.02	-0.04	0.04	0.02	0.03	-0.03	0.01	0.03
4145	0.02	0.05	-0.02	-0.08	0.07	-0.08	0.08	0.01	0.03	0.04
4151	0.03	-0.01	0.03	-0.04	0.05	0.03	0.04	0.04	0.05	-0.05
4158	0.18*	0.02	0.01	-0.01	0.00	-0.11	-0.07	0.06	-0.03	-0.03
4241	0.03	-0.03	0.00	-0.04	0.05	-0.06	-0.01	-0.01	-0.06	-0.02
1222	0.07	-0.08	0.09	-0.11*	-0.01	-0.14*	-0.08	0.10	0.05	-0.03
3104	-0.06	-0.08	0.08	-0.09	0.01	0.05	-0.06	-0.02	0.00	-0.05
3117	-0.06	0.09	0.08	-0.01	0.03	-0.01	0.00	0.02	0.02	-0.07
3121	0.09*	0.07	0.03	0.04	-0.04	-0.02	0.09	0.00	-0.02	-0.01
4106	0.05	-0.06	0.08	0.09	0.02	0.03	-0.01	-0.10	-0.02	0.04
4108	0.07	-0.04	0.00	0.01	0.00	-0.04	-0.07	0.01	0.01	-0.01
4113	-0.02	-0.04	-0.01	-0.01	0.01	-0.05	0.02	-0.01	-0.01	0.00
4112	0.06	-0.06	-0.06	-0.02	0.02	0.07	0.00	-0.06	0.02	-0.04
4109	0.09*	-0.01	-0.03	0.04	0.03	-0.01	0.01	0.02	0.01	-0.04
4111	-0.05	-0.13*	0.04	0.06	-0.03	0.09	-0.08	-0.03	0.07	0.08
Average	**0.05**	**-0.01**	**0.00**	**0.00**	**0.01**	**0.00**	**-0.01**	**0.00**	**0.00**	**0.00**

Table (A5.5)

2 Day Serial Correlation Coefficients for Lags r = 1, 2,...,10. (Previous Prices)

Code	*Lag 1*	*Lag 2*	*Lag 3*	*Lag 4*	*Lag 5*	*Lag 6*	*Lag 7*	*Lag 8*	*Lag 9*	*Lag 10*
2109	0.01	-0.09*	-0.05	0.04	0.04	-0.07	-0.04	0.00	0.01	-0.01
1323	0.03	-0.17*	-0.02	0.07	0.03	-0.02	0.06	-0.05	-0.01	0.05
1101	0.09*	-0.04	-0.05	0.01	-0.04	-0.03	0.00	-0.05	-0.05	-0.02
1102	0.04	-0.09*	0.06	0.02	0.01	-0.03	-0.01	-0.04	-0.02	-0.07
1104	0.07	0.00	0.00	0.02	0.04	-0.01	-0.06	-0.11	-0.01	-0.02
1107	0.08	-0.01	-0.05	0.06	-0.01	-0.02	-0.04	-0.03	0.09	-0.02
1113	-0.10*	0.01	0.06	0.08	0.03	-0.04	0.04	-0.04	0.05	-0.07
1114	0.12*	0.01	0.05	0.06	-0.01	-0.03	-0.13	-0.01	-0.02	-0.02
4118	-0.01	-0.04	0.09	-0.02	-0.08	0.03	-0.02	0.03	-0.06	0.01
4119	-0.05	-0.02	-0.06	0.00	0.04	-0.04	0.01	0.01	0.02	-0.11
4123	0.02	-0.03	0.06	0.06	-0.01	-0.08	0.06	0.03	0.05	0.00
4126	0.01	-0.02	0.00	0.03	-0.01	-0.01	-0.01	0.02	-0.02	0.03
4127	0.01	-0.02	-0.04	-0.03	-0.02	-0.01	0.00	-0.01	0.02	0.03
4128	-0.02	-0.01	0.01	0.00	0.03	-0.01	0.12	-0.01	-0.01	-0.01
4132	0.04	0.01	0.03	0.00	-0.01	-0.01	0.03	0.07	-0.02	0.01
4135	-0.01	-0.04	0.09	0.11	0.02	-0.10	0.09	0.01	0.04	0.03
4139	0.01	-0.02	0.03	0.01	-0.02	-0.05	0.02	-0.04	0.03	-0.02
4140	-0.11*	-0.07	0.04	0.02	0.03	-0.03	-0.02	0.08	0.03	-0.08
4142	-0.08	-0.01	-0.05	0.03	-0.02	0.05	-0.04	0.09	0.01	-0.03
4145	0.07	0.01	-0.02	0.01	-0.02	-0.03	-0.04	-0.02	-0.03	
4151	0.01	0.00	-0.02	0.04	0.01	0.01	0.01	0.00	0.00	0.04
4158	0.06	0.03	-0.04	-0.02	0.01	0.00	-0.01	0.00	0.01	0.00
4241	0.00	-0.01	0.03	0.00	-0.02	0.00	-0.01	0.00	0.01	-0.01
1222	0.04	-0.09*	0.00	0.00	-0.04	-0.06	0.08	0.05	0.00	0.02
3104	-0.07	-0.07	0.09	-0.07	0.00	0.04	-0.01	0.00	-0.01	-0.03
3117	0.02	0.02	0.06	-0.02	0.04	-0.03	-0.02	0.02	0.04	-0.03
3121	-0.02	0.02	-0.03	-0.07	-0.04	-0.02	0.01	-0.05	-0.02	0.00
4106	-0.02	-0.07	0.01	0.08	0.06	-0.04	-0.07	0.06	0.06	0.03
4108	0.01	-0.01	0.01	0.02	0.01	-0.01	-0.02	0.03	0.00	-0.02
4113	0.01	-0.05	0.05	0.04	-0.04	-0.07	0.06	-0.04	-0.03	0.03
4112	-0.03	-0.01	-0.02	0.01	0.07	0.00	-0.03	-0.03	-0.01	-0.03
4109	0.08	-0.06	-0.02	0.09	0.02	0.03	-0.10	0.02	0.03	0.02
4111	-0.02	-0.14*	0.05	0.05	0.04	0.01	-0.06	0.01	0.06	-0.01
Average	**0.01**	**-0.03**	**0.01**	**0.02**	**0.00**	**-0.02**	**0.00**	**0.00**	**0.01**	**-0.01**

Table (**A5.6**)

4 Day Serial Correlation Coefficients for Lags r = 1, 2,...,10. (Previous Prices)

Code	*Lag 1*	*Lag 2*	*Lag 3*	*Lag 4*	*Lag 5*	*Lag 6*	*Lag 7*	*Lag 8*	*Lag 9*	*Lag 10*
2109	-0.06	0.03	0.06	-0.09	0.04	0.01	-0.01	0.00	0.03	0.08
1323	-0.26*	0.09	-0.03	-0.01	-0.02	-0.01	-0.03	-0.05	0.09	-0.07
1101	0.02	0.01	-0.07	-0.04	-0.05	-0.02	0.04	-0.01	-0.09	-0.06
1102	-0.07	-0.02	0.03	-0.04	-0.01	-0.13	-0.05	-0.05	-0.05	0.01
1104	0.05	-0.08	0.10	0.00	-0.12	0.05	0.00	-0.04	-0.01	-0.02
1107	-0.06	0.06	-0.05	-0.04	0.01	0.05	-0.05	0.11	-0.03	0.01
1113	-0.09	0.15	-0.05	0.00	-0.04	-0.06	0.00	-0.08	0.08	-0.04
1114	-0.0	0.12	0.05	-0.03	0.04	-0.11	-0.01	-0.10	0.01	-0.04
4118	0.09	0.09	0.02	-0.02	0.02	-0.03	-0.04	0.07	-0.04	0.11
4119	-0.05	-0.08	0.02	0.03	0.00	-0.12	0.16	0.00	-0.04	0.12
4123	0.06	0.19	-0.03	0.01	0.04	0.10	0.18	-0.03	0.05	-0.01
4126	0.07	0.04	0.01	-0.03	-0.03	0.03	-0.04	0.01	0.04	-0.05
4127	-0.04	-0.01	0.03	-0.03	0.01	0.05	0.02	-0.01	-0.02	-0.04
4128	-0.02	0.08	0.05	0.06	0.02	0.07	0.03	-0.05	-0.06	-0.06
4132	-0.00	0.05	0.00	0.12	0.02	-0.01	-0.01	0.08	0.03	0.06
4135	-0.08	0.11	0.07	-0.03	0.02	0.05	0.08	-0.01	0.05	-0.02
4139	-0.02	0.01	0.00	-0.06	0.04	0.01	-0.01	-0.04	-0.01	-0.03
4140	-0.06	0.10	0.08	-0.04	0.01	0.04	0.14	-0.02	0.08	0.02
4142	-0.13	0.01	0.07	0.01	0.11	-0.09	-0.01	-0.04	-0.02	-0.03
4145	-0.00	-0.03	0.04	0.03	0.02	0.00	0.02	0.10	0.03	
4151	0.00	0.01	0.02	0.04	-0.05	0.01	-0.02	0.03	-0.01	-0.06
4158	-0.16*	-0.07	0.03	-0.02	-0.03	0.06	-0.01	-0.08	0.03	0.01
4241	-0.03	0.01	-0.02	0.00	0.04	-0.01	-0.01	0.00	-0.01	-0.01
1222	0.11	-0.12	-0.19	-0.04	-0.01	0.06	0.00	0.03	0.01	0.02
3104	-0.17	0.08	0.02	-0.05	-0.01	0.01	0.01	-0.10	0.11	0.01
3117	0.14	0.22	0.05	0.09	0.08	-0.10	0.00	-0.02	-0.09	-0.06
3121	-0.07	0.03	-0.06	0.08	-0.08	0.03	-0.11	-0.02	-0.05	0.08
4106	-0.09	0.08	0.05	-0.07	-0.05	0.01	0.05	0.01	0.04	0.02
4108	-0.02	0.03	0.01	-0.04	0.01	-0.06	0.06	0.00	0.05	0.00
4113	-0.07	0.02	-0.02	0.02	-0.04	0.01	0.05	0.00	0.00	-0.01
4112	-0.10	0.07	0.03	0.02	-0.08	0.03	0.04	-0.08	0.05	-0.04
4109	0.03	-0.01	0.02	-0.04	-0.01	0.02	0.08	0.03	-0.01	-0.02
4111	-0.19*	0.06	0.13	-0.08	0.04	0.06	0.02	0.10	0.05	-0.05
Average	**-0.04**	**0.04**	**0.01**	**-0.01**	**0.00**	**0.00**	**0.02**	**-0.01**	**0.01**	**0.00**

Table (A5.7)

4 Day Serial Correlation Coefficients for Lags r = 1, 2,...,10. (Actual Prices)

Code	*Lag 1*	*Lag 2*	*Lag 3*	*Lag 4*	*Lag 5*	*Lag 6*	*Lag 7*	*Lag 8*	*Lag 9*	*Lag 10*
2109	0.01	0.07	-0.01	-0.07	-0.05	0.02	-0.01	0.05	0.08	0.00
1323	-0.12	0.07	-0.02	-0.07	0.00	-0.03	0.00	0.00	0.01	-0.07
1101	0.04	-0.08	0.01	-0.11	-0.04	-0.03	0.01	0.05	-0.06	0.05
1102	-0.14*	-0.04	0.04	-0.04	-0.10	-0.05	0.01	-0.06	0.05	-0.01
1104	-0.01	-0.09	0.08	-0.04	-0.06	-0.05	-0.04	0.01	-0.06	-0.06
1107	0.00	0.02	-0.13	-0.01	0.01	0.03	0.03	-0.12	0.06	-0.04
1113	-0.13	0.06	-0.03	-0.03	0.08	-0.07	-0.03	0.04	0.01	-0.12
1114	0.04	0.09	-0.16	0.00	0.01	-0.08	-0.07	0.04	0.12	0.06
4118	0.01	0.07	-0.01	-0.07	-0.05	0.02	-0.01	0.05	0.08	0.00
4119	-0.06	-0.04	0.16	0.01	-0.04	0.02	0.07	0.03	0.06	-0.02
4123	0.07	0.15	-0.08	0.05	-0.06	0.06	0.11	-0.05	0.01	-0.02
4126	0.02	0.08	-0.07	0.08	-0.09	-0.02	0.04	-0.06	-0.07	-0.20
4127	0.05	0.06	0.10	0.08	0.01	0.01	0.10	0.02	0.00	0.01
4128	0.02	0.01	-0.02	0.11	0.05	-0.01	-0.01	-0.11	-0.08	-0.01
4132	-0.04	0.03	0.02	0.13	0.05	-0.06	-0.03	0.10	-0.04	0.07
4135	0.04	0.06	-0.06	-0.06	0.11	0.05	0.10	0.05	-0.02	-0.03
4139	0.04	0.07	0.05	-0.12	-0.04	0.03	0.01	-0.04	-0.03	-0.02
4140	-0.07	0.07	0.08	-0.03	-0.01	0.04	0.01	0.04	0.05	-0.05
4142	-0.02	-0.04	0.02	0.02	0.02	-0.03	-0.04	-0.06	-0.03	-0.09
4145	0.02	0.02	-0.01	0.04	0.03	-0.01	-0.01	0.02	0.11	0.05
4151	0.03	-0.02	0.08	0.10	0.10	-0.08	-0.06	0.06	-0.08	-0.08
4158	0.16*	-0.09	-0.11	-0.08	-0.01	-0.06	0.04	-0.03	0.04	-0.08
4241	-0.12	-0.01	0.04	-0.09	-0.09	0.07	-0.06	-0.06	0.08	-0.05
1222	-0.27*	-0.02	0.08	-0.04	0.06	-0.05	0.00	0.00	-0.02	0.06
3104	-0.13	-0.05	0.00	0.05	0.00	-0.03	-0.03	-0.03	0.11	0.10
3117	0.20*	0.13	0.14	0.06	0.05	-0.01	-0.04	-0.01	-0.08	-0.13
3121	0.06	0.07	-0.10	0.13	-0.07	0.06	0.05	0.01	-0.01	0.02
4106	-0.03	0.07	0.00	-0.08	-0.06	0.05	0.05	0.02	-0.01	0.02
4108	0.02	-0.03	-0.06	-0.03	-0.03	-0.07	0.07	-0.03	-0.02	0.05
4113	0.00	0.02	0.03	0.02	-0.06	-0.01	0.10	-0.02	-0.05	0.01
4112	-0.16*	0.02	0.03	-0.07	0.05	-0.06	-0.06	0.08	-0.06	0.09
4109	0.04	-0.02	-0.02	-0.01	0.04	-0.04	0.04	0.00	-0.04	0.00
4111	-0.19*	0.13	0.01	-0.07	0.13	0.09	0.01	-0.01	-0.01	0.01
Average	**-0.02**	**0.03**	**0.00**	**-0.01**	**0.00**	**-0.01**	**0.01**	**0.00**	**0.00**	**-0.02**

Table(**A5.8**)
Actual, Expected Number of Runs & Percentage Differences
(Actual Two Day Price changes)

Code	*Actual Number of Runs*	*Expected Number of Runs*	*R-M/M*
2109	445	451	-0.01
1323	518	555	-0.07
1102	500	540	-0.08
1101	405	438	-0.08
1113	468	499	-0.07
4127	454	470	-0.03
4132	485	501	-0.03
4135	525	546	-0.04
4139	495	538	-0.09
4140	488	514	-0.05
4142	574	625	-0.09
4145	473	516	-0.09
4241	525	558	-0.06
3104	533	584	-0.10
4104	441	443	-0.01
4106	529	567	-0.07
4113	547	553	-0.01
4112	420	498	-0.19
Average	**490**	**522**	**-0.07**

Table(**A5.9**)
Actual, Expected Number of Runs & Percentage Differences
(Previous Prices Two Day Price changes)

Code	*Actual Number of Runs*	*R-M/M*	*Expected Number of Runs*
2109	517	630	-0.22
1323	560	589	-0.05
1102	570	613	-0.08
1101	560	643	-0.15
1113	556	639	-0.15
4127	543	598	-0.10
4132	582	621	-0.07
4135	561	597	-0.06
4139	534	596	-0.12
4140	525	571	-0.09
4142	589	630	-0.07
4145	544	603	-0.11
4241	551	585	-0.06
3104	559	640	-0.14
4104	545	642	-0.18
4106	540	580	-0.07
4113	553	576	-0.04
4112	525	612	-0.17
Average	**551**	**609**	**-0.11**

Table (A6.1)
Descriptive Statistics of the Average Logarithmic
& Discrete Monthly Returns

Log Return		*Discrete Return*	
Mean	0.010	Mean	0.026
Standard Error	0.001	Standard Error	0.004
Median	0.013	Median	0.024
Standard Deviation	0.009	Standard Deviation	0.027
Sample Variance	0.000	Sample Variance	0.001
Kurtosis	0.482	Kurtosis	2.582
Skewness	-0.829	Skewness	1.394
Range	0.041	Range	0.124
Largest(1)	0.026	Largest(1)	0.114
Smallest(1)	-0.015	Smallest(1)	-0.010
Confidence Level (95%)	0.003	Confidence Level (95%)	0.007

Table (A7.1)

Measuring Beta using Marsh adjusted Trade-To-Trade Logarithmic Returns

Code	*Beta*	*R squared*	*Residual Variance*	*t*	*Observations*
1107	1.09	0.34	0.0002	6.38	84
4123	1.46	0.37	0.0003	6.10	69
4119	0.99	0.35	0.0001	6.66	94
2109	1.00	0.20	0.0003	4.48	85
1323	1.09	0.72	0.0000	15.13	94
1101	1.35	0.44	0.0002	8.38	94
1102	1.06	0.37	0.0001	7.30	94
1104	0.86	0.33	0.0001	6.66	93
1113	0.70	0.22	0.0001	5.06	94
1114	0.95	0.32	0.0001	6.24	93
4118	0.95	0.34	0.0001	6.87	94
4126	0.76	0.15	0.0003	3.94	91
4127	1.28	0.29	0.0003	5.95	94
4128	0.93	0.21	0.0003	4.61	92
4132	1.35	0.32	0.0003	6.39	92
4135	0.93	0.32	0.0003	4.23	94
4139	1.49	0.32	0.0003	6.45	94
4140	1.20	0.28	0.0003	5.92	94
4142	0.68	0.28	0.0001	5.86	94
4145	1.51	0.27	0.0005	5.59	94
4151	1.20	0.15	0.0007	3.19	63
4158	1.52	0.32	0.0003	5.47	66
4241	0.43	0.24	0.0000	5.39	94
1222	0.59	0.16	0.0001	3.52	75
3104	0.71	0.21	0.0001	4.95	94
3112	0.86	0.19	0.0002	4.49	94
3115	1.15	0.18	0.0006	3.18	70
3117	1.14	0.22	0.0004	4.44	81
3119	0.87	0.31	0.0002	5.50	92
3120	0.86	0.12	0.0005	2.94	88
3121	1.43	0.22	0.0006	4.45	77
4103	1.00	0.13	0.0006	3.08	88
4104	0.78	0.22	0.0002	5.00	93
4106	1.14	0.32	0.0002	6.53	94
4108	1.07	0.33	0.0002	6.55	94
4109	1.10	0.24	0.0003	5.34	94
4110	1.29	0.29	0.0003	5.81	93
4111	0.57	0.14	0.0001	3.82	94
4112	1.44	0.56	0.0001	10.31	94
4113	1.46	0.41	0.0002	7.89	94
4115	0.76	0.23	0.0002	4.80	94
3118	1.45	0.37	0.0003	5.53	59
4114	0.91	0.24	0.0003	3.81	87
4117	0.70	0.27	0.0001	5.37	91
4130	0.33	0.06	0.0003	1.29	68
4138	0.83	0.20	0.0003	3.80	83
1106	0.63	0.16	0.0001	4.11	92
2104	0.49	0.20	0.0001	3.68	70
2117	0.47	0.14	0.0001	3.69	92
3105	0.85	0.18	0.0003	3.58	71
4167	1.07	0.14	0.0006	2.97	64

Table (A7.2)
Measuring Beta using Marsh Adjusted Trade-To-Trade
Discrete Returns

Code	*Beta*	*R squared*	*Residual Variance*	*t*	*Observations*
1107	1.09	0.32	0.00019	6.17	84
4123	1.43	0.33	0.00033	5.53	69
4119	1.01	0.33	0.00015	6.42	94
2109	0.97	0.19	0.00028	4.39	85
1323	1.14	0.72	0.00004	15.12	94
1101	1.37	0.42	0.00018	8.18	94
1102	1.08	0.37	0.00014	7.25	94
1104	0.96	0.33	0.00015	6.61	93
1113	0.73	0.21	0.00014	4.91	94
1114	0.99	0.32	0.00015	6.21	93
4118	0.94	0.33	0.00014	6.62	94
4126	0.76	0.15	0.00028	3.81	91
4127	1.25	0.26	0.00034	5.55	94
4128	0.93	0.18	0.00034	4.20	92
4132	1.36	0.30	0.00031	6.10	92
4135	0.87	0.33	0.00035	3.75	94
4139	1.45	0.28	0.00040	5.84	94
4140	1.14	0.22	0.00033	5.08	94
4142	0.70	0.27	0.00009	5.82	94
4145	1.43	0.23	0.00052	5.02	94
4151	1.08	0.12	0.00068	2.85	63
4158	1.63	0.30	0.00042	5.14	66
4241	0.42	0.24	0.00004	5.32	94
1222	0.59	0.15	0.00016	3.37	75
3104	0.72	0.21	0.00014	4.86	94
3112	0.84	0.17	0.00027	4.14	94
3115	1.11	0.17	0.00057	3.13	70
3117	1.13	0.19	0.00043	4.05	81
3119	0.83	0.29	0.00016	5.21	92
3120	0.81	0.09	0.00064	2.51	88
3121	1.39	0.20	0.00067	4.18	77
4103	1.04	0.10	0.00085	2.71	88
4104	0.76	0.20	0.00017	4.77	93
4106	1.10	0.28	0.00022	5.97	94
4108	1.10	0.33	0.00018	6.54	94
4109	1.07	0.22	0.00030	4.99	94
4110	1.30	0.27	0.00035	5.52	93
4111	0.57	0.14	0.00015	3.75	94
4112	1.43	0.54	0.00014	9.88	94
4113	1.43	0.38	0.00025	7.27	94
4115	0.78	0.22	0.00018	4.72	94
3118	1.41	0.37	0.00026	5.37	59
4114	0.88	0.21	0.00037	3.40	87
4117	0.71	0.27	0.00011	5.35	91
4130	0.31	0.05	0.00030	1.16	68
4138	0.87	0.19	0.00033	3.72	83
1106	0.66	0.18	0.00014	4.28	92
2104	0.50	0.21	0.00010	3.75	70
2117	0.50	0.14	0.00012	3.76	92
3105	0.80	0.15	0.00032	3.22	71
4167	1.08	0.12	0.00083	2.63	64

Table (A7.3)
Measuring Beta using Trade-To-Trade Monthly
Logarithmic Returns

Code	Beta	R squared	Residual Variance	t	Observations
1107	1.02	0.256	0.00699	5.32	84
4123	1.43	0.362	0.00837	6.17	69
4119	1.02	0.336	0.00422	6.83	94
2109	0.70	0.071	0.01395	2.52	85
1323	1.10	0.722	0.00098	15.46	94
1101	1.35	0.445	0.00486	8.59	94
1102	1.04	0.360	0.00406	7.20	94
1104	0.95	0.349	0.00379	6.99	93
1113	0.70	0.220	0.00358	5.09	94
1114	1.03	0.315	0.00456	6.46	93
4118	0.93	0.337	0.00398	6.84	94
4126	0.70	0.136	0.00747	3.75	91
4127	1.30	0.293	0.00920	6.17	94
4128	0.93	0.192	0.00860	4.62	92
4132	1.35	0.321	0.00821	6.53	92
4135	0.90	0.165	0.00872	4.26	94
4139	1.49	0.317	0.01012	6.54	94
4140	1.20	0.274	0.00814	5.89	94
4142	0.68	0.277	0.00254	5.94	94
4145	1.51	0.260	0.01378	5.68	94
4151	1.18	0.145	0.01998	3.22	63
4158	1.41	0.318	0.01097	5.46	66
4241	0.42	0.235	0.00122	5.31	94
1222	0.56	0.136	0.00434	3.38	75
3104	0.71	0.211	0.00394	4.95	94
3112	0.90	0.199	0.00692	4.78	94
3115	1.21	0.157	0.01677	3.56	70
3117	1.11	0.228	0.01076	4.84	81
3119	0.88	0.254	0.00500	5.53	92
3120	0.50	0.033	0.01715	1.72	88
3121	1.17	0.132	0.02248	3.38	77
4103	0.85	0.061	0.02332	2.37	88
4104	0.76	0.206	0.00492	4.86	93
4106	1.14	0.324	0.00580	6.64	94
4108	1.08	0.326	0.00508	6.67	94
4109	1.09	0.238	0.00832	5.35	94
4110	1.28	0.279	0.00904	5.93	93
4111	0.58	0.141	0.00424	3.89	94
4112	1.43	0.530	0.00384	10.19	94
4113	1.47	0.411	0.00657	8.01	94
4115	0.77	0.198	0.00504	4.77	94
3118	1.43	0.316	0.00852	5.28	59
4114	0.86	0.116	0.01195	3.33	87
4117	0.71	0.258	0.00328	5.56	90
4130	0.47	0.092	0.00822	2.58	68
4138	1.06	0.230	0.00884	4.91	83
1106	0.63	0.169	0.00413	4.27	92
2104	0.55	0.192	0.00307	4.02	70
2117	0.53	0.175	0.00340	4.37	92
3105	0.86	0.169	0.00857	3.74	71
4167	1.11	0.142	0.01903	3.20	64

Table (A7.4)
Measuring Beta using Trade-To-Trade Monthly Discrete Returns

Code	Beta	R squared	Residual Variance	t	Observations
1107	1.04	0.26	0.00722	5.426	84
4123	1.42	0.32	0.01024	5.610	69
4119	1.03	0.32	0.00489	6.584	94
2109	0.73	0.09	0.01217	2.899	85
1323	1.15	0.72	0.00114	15.460	94
1101	1.38	0.43	0.00547	8.409	94
1102	1.05	0.36	0.00444	7.144	94
1104	1.05	0.34	0.00472	6.895	93
1113	0.72	0.21	0.00429	4.934	94
1114	1.07	0.31	0.00531	6.337	93
4118	0.92	0.32	0.00425	6.600	94
4126	0.70	0.13	0.00824	3.645	91
4127	1.28	0.27	0.01068	5.782	94
4128	0.93	0.17	0.01075	4.223	92
4132	1.36	0.30	0.00950	6.236	92
4135	0.84	0.14	0.01002	3.800	94
4139	1.46	0.28	0.01226	5.940	94
4140	1.13	0.22	0.01020	5.071	94
4142	0.69	0.27	0.00278	5.889	94
4145	1.44	0.22	0.01603	5.124	94
4151	1.07	0.12	0.02083	2.900	63
4158	1.54	0.29	0.01555	5.126	66
4241	0.41	0.23	0.00123	5.248	94
1222	0.55	0.13	0.00485	3.250	75
3104	0.71	0.20	0.00436	4.860	94
3112	0.89	0.18	0.00822	4.460	94
3115	1.17	0.15	0.01747	3.414	70
3117	1.09	0.20	0.01313	4.441	81
3119	0.84	0.23	0.00533	5.227	92
3120	0.47	0.03	0.02045	1.531	88
3121	1.11	0.11	0.02688	2.989	77
4103	0.85	0.04	0.03700	1.943	88
4104	0.75	0.19	0.00540	4.671	93
4106	1.10	0.29	0.00668	6.076	94
4108	1.10	0.33	0.00560	6.661	94
4109	1.07	0.22	0.00942	5.023	94
4110	1.28	0.26	0.01047	5.625	93
4111	0.57	0.14	0.00456	3.824	94
4112	1.41	0.51	0.00428	9.785	94
4113	1.44	0.37	0.00777	7.395	94
4115	0.79	0.19	0.00573	4.717	94
3118	1.39	0.31	0.00878	5.068	59
4114	0.83	0.11	0.01305	3.184	87
4117	0.72	0.26	0.00351	5.571	90
4130	0.47	0.09	0.00944	2.600	68
4138	1.10	0.22	0.01049	4.821	83
1106	0.66	0.18	0.00431	4.440	92
2104	0.56	0.20	0.00320	4.115	70
2117	0.55	0.18	0.00363	4.474	92
3105	0.82	0.14	0.00979	3.376	71
4167	1.13	0.12	0.02578	2.842	64

Table (**A7.5**)
Test of the Capital Asset Pricing Model in Terms of Excess Logarithmic Returns
Second Pass Regression

$$\bar{r}_i = a_0 + a_1 b_i + a_2 \sigma^2 (e_i) + \eta_i$$

$\overline{R_i}$ =	a_0	a_1	a_2	ρ^2
Coefficient	0.001	0.005		0.023
Standard Error	0.004	0.004		**F**
t	0.267	1.083		1.17
Coefficient	0.007		-0.094	0.003
Standard Error	0.002		0.251	**F**
t	2.724		-0.375	0.14
Coefficient	0.002	0.005	-0.173	0.032
Standard Error	0.005	0.004	0.258	**F**
t	0.400	1.212	-0.670	0.80

Table (**A7.6**)
Test of the Capital Asset Pricing Model in Terms of Excess
Logarithmic Marsh Adjusted Betas
Second Pass Regression

$$\bar{r}_i = a_0 + a_1 b_i + a_2 \sigma^2 (e_i) + \eta_i$$

$\overline{R_i}$ =	a_0	a_1	a_2	ρ^2
Coefficient	0.002	0.004		0.015
Standard Error	0.004	0.004		**F**
t	0.474	0.872		0.76
Coefficient	0.006		-2.729	0.002
Standard Error	0.003		8.703	**F**
t	2.573		-0.314	0.1
Coefficient	0.002	0.005	-7.104	0.026
Standard Error	0.004	0.005	9.554	**F**
t	0.538	1.099	-0.744	0.65

Table (A7.7)
Test the Capital Asset Pricing Model in Terms of Excess
Discrete Marsh Adjusted Betas
Second Pass Regression

$$\bar{r}_i = a_0 + a_1 b_i + a_2 \sigma^2(e_i) + \eta_i$$

$\overline{R_i} =$	a_0	a_1	a_2	ρ^2
Coefficient	0.005	0.016		0.033
Standard Error	0.013	0.012		**F**
t	0.430	1.297		1.297
Coefficient	0.022		-3.821	0.0007
Standard Error	0.007		20.019	**F**
t	3.249		-0.191	0.036
Coefficient	0.006	0.019	-14.905	0.042
Standard Error	0.013	0.013	21.211	**F**
t	0.502	1.456	-0.703	1.08

Table (A7.8)
Number of Stocks in Portfolios

Portfolio	First	Second	Third	Fourth	Fifth
Number of stocks 1987	9	7	8	7	8
Excluded	4142	*	*	1323	*
# remaining	8	7	8	6	8
# stock 1988	9	9	8	8	7
Excluded	4142	4118	*	1323	*
# remaining	8	8	8	7	7
# of stock 1989	10	8	9	8	9
Excluded	4118,1323	4142	*	*	*
# remaining	8	7	9	8	9
# stock 1990	10	9	9	10	9
Excluded	4142	*	*	4118	1323
# remaining	9	9	9	9	8
# stock 1991	10	9	9	10	9
Excluded	4142	*	*	4118	1323
# remaining	9	9	9	9	8
# stock 1992	10	9	9	10	9
Excluded	4142	*	4118	1323	*
# remaining	9	9	8	9	9
# stock 1993	10	9	9	10	9
Excluded	4142	*	4118	1323	*
# remaining	9	9	8	9	9
# stock 1994	10	9	10	9	9
Excluded	4142	4118	*	1323	*
# remaining	9	8	10	9	9

Table (**A8.1**)
Mean and Standard Deviations of Betas Estimated using Varying Lengths of Time Series

	Mean of 2	Standard	Mean of 3	Standard	Mean of 4	Standard	Mean of 5	Standard
Code	years Beta	Deviation	years Beta	Deviation	years Beta	Deviation	years Beta	Deviation
4114	0.79	0.26	0.82	0.21	0.81	0.17	0.80	0.07
4117	0.63	0.41	0.69	0.32	0.72	0.22	0.74	0.10
4130	0.40	0.27	0.37	0.22	0.33	0.17	0.30	0.01
4138	0.84	0.21	0.83	0.09	0.84	0.10	0.85	0.08
1106	0.71	0.53	0.70	0.43	0.66	0.29	0.65	0.12
2104	0.48	0.22	0.46	0.20	0.45	0.17	0.47	0.08
2117	0.53	0.20	0.47	0.17	0.45	0.12	0.44	0.06
3105	1.11	0.41	1.10	0.27	1.08	0.17	0.96	0.11
4167	1.14	0.36	1.13	0.16	1.06	0.10	1.02	0.08
4116	1.30	0.69	1.45	0.39	1.52	0.11	1.40	0.14
4106	1.16	0.33	1.16	0.25	1.17	0.17	1.15	0.06
4108	1.00	0.27	1.01	0.10	1.03	0.08	1.03	0.11
4109	0.99	0.54	0.96	0.41	0.95	0.30	0.93	0.11
4110	1.37	0.38	1.36	0.20	1.42	0.08	1.36	0.06
4111	0.56	0.45	0.52	0.22	0.58	0.11	0.52	0.08
4112	1.51	0.54	1.46	0.48	1.42	0.34	1.40	0.19
4113	1.48	0.58	1.54	0.34	1.63	0.14	1.59	0.11
4115	0.85	0.47	0.81	0.19	0.82	0.07	0.80	0.11
3118	1.40	0.32	1.41	0.16	1.36	0.06	1.33	0.05
1222	0.41	0.16	0.41	0.10	0.40	0.06	0.43	0.06
3104	0.69	0.50	0.63	0.44	0.62	0.34	0.58	0.19
3112	0.94	0.41	0.93	0.27	0.97	0.10	0.92	0.04
3115	1.20	0.34	1.20	0.26	1.19	0.11	1.17	0.07
3117	1.23	0.56	1.28	0.40	1.29	0.16	1.21	0.10
3119	0.90	0.47	0.98	0.31	1.02	0.12	0.99	0.07
3120	1.23	0.85	1.19	0.69	1.22	0.39	1.12	0.18
3121	1.54	0.82	1.66	0.59	1.69	0.15	1.50	0.10
4103	1.04	0.39	1.03	0.19	1.06	0.08	0.99	0.04
4104	0.77	0.35	0.78	0.19	0.82	0.09	0.80	0.12
4126	0.82	0.27	0.75	0.11	0.74	0.07	0.77	0.09
4127	1.31	0.39	1.29	0.19	1.36	0.11	1.31	0.08
4128	0.90	0.29	0.89	0.15	0.92	0.10	0.92	0.11
4132	1.31	0.43	1.37	0.32	1.44	0.21	1.42	0.14
4135	1.05	0.72	1.07	0.47	1.19	0.16	1.12	0.17
4139	1.52	0.74	1.57	0.46	1.64	0.21	1.56	0.07
4140	1.20	0.44	1.22	0.27	1.29	0.09	1.22	0.07
4142	0.66	0.35	0.63	0.31	0.62	0.23	0.60	0.11
4145	1.67	0.55	1.63	0.33	1.67	0.12	1.62	0.12
4151	1.51	0.76	1.43	0.52	1.38	0.07	1.17	0.01
4158	1.50	0.67	1.57	0.48	1.67	0.10	1.53	0.03
4241	0.45	0.21	0.42	0.19	0.43	0.15	0.40	0.08
1107	1.03	0.22	1.08	0.21	1.11	0.10	1.12	0.10
4123	1.45	0.33	1.49	0.16	1.44	0.11	1.37	0.06

Table (A8.1) Continued

Code	Mean of 2 years Beta	Standard Deviation	Mean of 3 years Beta	Standard Deviation	Mean of 4 years Beta	Standard Deviation	Mean of 5 years Beta	Standard Deviation
4119	0.97	0.24	0.98	0.13	1.03	0.06	0.99	0.04
2109	0.95	0.37	0.98	0.29	1.02	0.15	1.02	0.08
1323	1.09	0.30	1.11	0.25	1.10	0.18	1.13	0.08
1101	1.38	0.42	1.43	0.27	1.39	0.23	1.37	0.20
1102	1.09	0.53	1.19	0.30	1.23	0.21	1.17	0.19
1104	0.99	0.71	0.96	0.60	0.83	0.41	0.79	0.23
1113	0.71	0.67	0.65	0.55	0.56	0.38	0.55	0.24
1114	-	-	1.09	0.19	1.10	0.10	1.06	0.06
4118	-	-	0.90	0.16	0.95	0.13	0.94	0.10
Mean	***1.04***	***0.44***	***1.04***	***0.29***	***1.05***	***0.16***	***1.01***	***0.10***
St. Error	***0.34***	***0.18***	***0.35***	***0.14***	***0.37***	***0.09***	***0.34***	***0.05***

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