Tomas Bata University in Zlín
Faculty of Management and Economics

Doctoral Thesis

# Determinants of Stock Returns in Colombo Stock Exchange

# Determinanty výnosů z cenných papírů na colombské burze

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# ABSTRACT

Although determinants of stock returns are the central theme of research in finance since 1960s, this aspect has not been sufficiently addressed in emerging markets. Therefore, the main purpose of this study is to identify which factors are important for explaining the variation in stock returns in Colombo Stock Exchange (CSE).

The study uses 266 stocks from January 1995 to December 2008. Further, the sample period is divided into two sub periods as down-market and up-market. The study examines five financial market anomalies which have been proved in the financial literature to be correlated with stock returns mainly in developed markets. Market anomalies are used to form mimicking factors and they are used together with excess market return factor as independent variables in multiple regressions to generate asset pricing models in full period as well as in sub periods.

The study finds that earnings-to-price, book-to-market and momentum anomalies persist in CSE. However, they are market state dependent. In addition, size and trading volume anomalies do not exist in the CSE. The study finds that determinants of stock returns are also varying from down-market to up-market.

Due to the lack of literature in emerging markets, the findings of this study generate practically as well as theoretically valuable knowledge base. Market anomalies can be used to formulate better trading strategies subject to market conditions in which anomaly exists. Furthermore, time varying asset pricing models should be considered in computation of cost of capital as well as measurement of portfolio performance. Theoretically, existence of market anomalies rejects the validity of Capital Asset Pricing Model (CAPM). Further, non-existence of size anomaly suggests that famous Fama and French (1993) three factor model is not applicable to the CSE. Finally, the study suggests that risk factor models formulated based on developed markets may not generate same results in emerging markets.

# ABSTRAKT

Přestože jsou determinanty výnosů akcií již od roku 1960 ústředním tématem výzkumu v oblasti financí, na rozvíjejících se trzích zatím nebyly dostatečně zohledněny. Proto je hlavním účelem této studie zjistit, které faktory jsou důležité pro vysvětlení změn výnosů z akcií na Colombské burze (CSE).

Studie využívá 266 akcií od ledna 1995 do prosince 2008. Dále je vybrané období rozděleno do dvou dílčích period, tzv. „down-market“ a „up-market“. Studie zkoumá pět finančních tržních anomálií, které byly ve finanční literatuře prokázány coby souvztažné s výnosy akcií převážně na rozvinutých trzích. Tržní anomálie jsou zvyklé napodobovat faktory a jsou používány společně s faktorem přemíry výnosu trhu jako nezávislé proměnné ve vícenásobných regresích k výrobě modelů oceňování aktiv v plném rozsahu periody, stejně jako v dílčích periodách.

Studie zjistila, že P/E, BTM a anomálie hybné síly na CSE přetrvávají. Nicméně, jsou závislé na situaci trhu. Kromě toho, anomálie velikosti a objemu obchodů na CSE neexistují. Studie zjistila, že determinanty výnosů akcií se také pohybují od „down-market“ po „up-market“.

Vzhledem k nedostatku literatury v rozvíjejících se trzích, jsou závěry této studie vytvořeny prakticky stejně jako teoreticky cenná báze znalostí. Tržní anomálie mohou být použity k sestavení lepších obchodních strategií podléhajících tržním podmínkám, ve kterých anomálie existuje. Kromě toho by různé modely oceňování aktiv měly být zváženy při výpočtu ceny kapitálu, stejně jako měření výkonnosti portfolia. Teoreticky vzato, existence tržních anomálií odmítá platnost modelu oceňování kapitálových aktiv (CAPM). Dále, neexistence anomálie velikosti naznačuje, že známý třífaktorový model dle Fama a French (1993) se na CSE nevztahuje. A konečně, studie naznačuje, že modely rizikového faktoru formulovány na základě rozvinutých trhů nemusí vytvářet stejné výsledky na rozvíjejících se trzích.

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| | |
|---|---|
| AC | Aggregate Coefficient |
| ACSG | Asia-Pacific Central Security Group |
| AMEX | American Stock Exchange |
| NYSE | New York Stock Exchange |
| ANOVA | Analysis of Variance |
| APT | Arbitrage Pricing Theory |
| ASPI | All Share Price Index |
| B/M | Book-to-Market |
| CAPM | Capital Asset Pricing Model |
| CBA | Colombo Brokers’ Association |
| CDS | Central Depository System |
| CML | Capital Market Line |
| CSE | Colombo Stock Exchange |
| CVS | Concurrent Versions System |
| E/P | Earnings-to-Price |
| HE/P | High Earnings-to-Price |
| HB/M | High Book-to-Market |
| HmLB/M | High minus Low Book-to-Market |
| HmLE/P | High minus Low Earnings-to-Price |
| HTML | Hyper Text Mark-up Language |
| HV | High Volume |
| ICAPM | Intertemporal Capital Asset Pricing Model |
| LB/M | Low Book-to Market |
| LE/P | Low Earnings-to-Price |
| LO | Loser |
| LS | Large Size |
| LTTE | Liberation Tigers of Tamil Eelam |
| LV | Large Volume |
| MDH | Mixture of Distribution Hypothesis |
| NASDAQ | National Association of Securities Dealers Automated Quotation |
| OLS | Ordinary Least Squares |
| SAFE | South Asian Federation of Exchanges |
| SBL | Stock Borrowing and Lending |
| SEC | Securities Exchange Commission |
| SML | Security Market Line |
| SmLS | Small minus Large Size |
| SS | Small Size |
| TRI | Total Return Index |
| WFE | World Federation of Exchanges |
| WI | Winner |
| WmL | Winner minus Loser |

# ROZŠÍŘENÝ ABSTRAKT

Přestože jsou determinanty výnosů akcií již od roku 1960 ústředním tématem výzkumu ve oblasti financí, na rozvíjejících se trzích zatím nebyly dostatečně zohledněny. Proto je hlavním účelem této studie zjistit, které faktory jsou důležité pro vysvětlení změn výnosů z akcií na colombské burze (CSE).
CSE má 240 společností uvedených na burze ke konci prosince 2010 s tržní kapitalizací kolem 20 miliard amerických dolarů.

Studie využívá všechny uvedené akcie (266), včetně cenných papírů vyřazených z CSE od roku 1995 do 2008 coby výběrovou studii. Studie je rozdělena na dvě dílčí periody. Perioda od ledna 1995 do září 2001 je označena jako tzv. „down-market“ a perioda od října 2001 do prosince 2008 je označena jako tzv. „up-market“. Analýza dat se provádí ve dvou krocích. Za prvé, je zkoumáno pět tržních anomálií, které byly v literatuře prokázány coby souvztažné s výnosy akcií. Zkoumanými tržními anomáliemi jsou ***poměr*** P/E, poměr BTM, velikost, hybná síla a objem obchodů. Za druhé, tržní anomálie, které existují na CSE, slouží k vytvoření napodobování rizikových faktorů a jsou používány společně s přemírou výnosu trhu ($R_m$-$R_f$) jako nezávislé proměnné pro určení modelů nejlepšího faktoru za celé období, na tzv. „down-market“ a „up-market“. Proto tato studie využívá jednoduché i vícenásobné regresní techniky jako hlavní analytické nástroje.

V prvním kroku analýzy dat studie zjistila, že poměr P/E, poměr BTM a anomálie hybné síly na CSE existují. Poměr P/E existuje pouze v plném rozsahu periody a „down-market“ periodě. Poměr BTM existuje pouze v plném rozsahu periody a „up-market“ periodě a anomálie hybné síly existuje v plném rozsahu periody a „down-market“ periodě. Proto tržní anomálie závislé na situaci trhu a anomálie velikosti a objemu obchodů na CSE neexistují. Ve druhém kroku analýzy dat studie zjistila, že faktory, které vysvětlují variabilitu výnosů akcií na Srí Lance, jsou proměnné v čase. V plném rozsahu periody jsou určeny nadměrné tržní výnosy a „vysoký mínus nízký“ poměr BTM (HmLB/M) faktor. V „down-market“ periodě jsou identifikovány nadměrné tržní výnosy a „vítěz mínus poražený“ (WmL) faktor hybné síly a v „up-market“ periodě nadměrné tržní výnosy spolu s faktorem HmLB/M jsou identifikovány jako faktory, které vysvětlují variabilitu výnosů akcií. Dále, absence vlivu velikosti v datech CSE ukazuje, že známý třífaktorový model dle Fama a Frenche (1993) na CSE není použitelný. Proto tato studie odmítá dřívější zjištění Nanayakkara (2008) který zjistil, že třífaktorový model dle Fama a Frenche (1993) je pro Srí Lanku dobře použitelný.

Vzhledem k tomu, že CSE je malý a na světě se rozvíjející trh, a důkazy o chování akciových výnosů na malém trhu ve finanční literatuře jsou značně omezené, výše uvedená zjištění jsou důležitá z teoretického i praktického hlediska. Za prvé, studie zjistila, že některé anomálie na trhu existují a jsou závislé na situaci trhu. Navíc, existence tržních anomálií znamená, že model oceňování kapitálových aktiv (CAPM) není věrný, co se týče CSE. Dále studie přidává nové poznatky tím, že určuje dva různé faktorové modely ve dvou různých situacích trhu. Kromě toho, konstatování nepoužitelnosti faktorů Fama a French (1993) vyvolává otázku, zda model Fama a Frenche (1993) není použitelný na malých trzích. To by mělo být dále prozkoumáno.

Výsledky této studie jsou důležité prakticky v několika směrech. Za prvé, dostupnost tržních anomálií může být použita pro tvorbu investiční strategie při dosahování zisku. Doporučuje se nakupovat akcie s vysokým poměrem P/E v uplynulém období a vysoké výnosy z předešlého období zvláště v „down-market“ periodě. Dále by se neměly finanční rozhodovací pravomoci ve firmách spoléhat na tradiční CAPM, místo toho by měly věnovat pozornost faktorovým modelům proměnným v čase. Investoři mohou využít faktorové modely proměnné v čase pro měření výkonnosti portfolia, které jsou průměrnou mírou efektivity. Pokud investoři používají nové modely, aby předpověděli výkonnost portfolia, automaticky zvýší efektivní mobilitu omezených zdrojů v ekonomice.

Nakonec autor navrhuje, aby rizikové faktory modelů formulovaných na základě vyspělých trhů nebyly používány na rozvíjejících se trzích, jak je stanoveno, aniž by byla potvrzena jejich použitelnost na rozvíjejících se trzích.

# EXTENDED ABSTRACT

Although determinants of stock returns are the central theme of research in finance since 1960s, this has not been sufficiently addressed in emerging markets. Therefore, the main purpose of this study is to identify which factors are important for explaining the variation in stock returns in Colombo Stock Exchange (CSE). The CSE has 240 listed companies as at the end of December 2010 with market capitalization around 20 billion U.S. Dollars.

The study uses all the listed stocks (266) including delisted securities in the CSE from 1995 to 2008 as sample of the study. The full study period is divided into two sub periods. Period from January 1995 to September 2001 is identified as down-market and period from October 2001 to December 2008 is identified as up-market. Data analysis is done in two steps. First, five market anomalies which have been proved in literature to be correlated with stock returns are examined. The market anomalies examined are, earnings-to-price (E/P), book-to-market (B/M), size, momentum and trading volume. Second, market anomalies which exist in the CSE are used to create mimicking risk factors and they are used together with excess market return ($R_m$-$R_f$) as independent variables to determine the best factor models in the full period, down-market as well as in the up-market. Therefore, this study uses single as well as multiple regression techniques as main analytical tools.

In the first step of data analysis, study finds that E/P, B/M and momentum anomalies exist in the CSE. E/P anomaly exists only in full period and down market period. B/M anomaly exists only in full period and in up-market period and momentum anomaly exists in full period and down-market period. Therefore, market anomalies are market state dependent and size and trading volume anomalies do not exist in the CSE. In the second step of the data analysis, study finds that factors which explain the variability of stock returns in Sri Lanka are time varying. In the full period, excess market returns and high minus low book-to-market (HmLB/M) factor are identified. In the down-market period, excess market returns and winner minus loser (WmL) momentum factor are identified and in the up-market period excess market returns together with HmLB/M factor are identified as factors which explain the variability of stock returns. Further, absence of the size effect in the CSE data reveals that famous Fama and French (1993) three-factor model does not operate in the CSE. Therefore, this study rejects the earlier finding of Nanayakkara (2008) who found that Fama and French (1993) three-factor model well applicable to Sri Lankan data.

As CSE is a small emerging market in the world and small market evidence on behavior of stock returns are extremely lacking in the financial literature, the above findings are theoretically as well as practically important. First, the study finds that several market anomalies exist and they are market state dependent. Additionally,

the existence of market anomalies implies that Capital Asset Pricing Model (CAPM) is not true in the CSE. Next, study adds new knowledge by identifying two different factor models in two different states of markets. Furthermore, finding of inapplicability of Fama and French (1993) factors raises a question whether the Fama and French (1993) model does not applicable to the small markets. This should be further researched to come to a conclusion.

The findings of this study are important practically in several ways. First, availability of market anomalies can be used to form investment strategies to make profits. It is advisable to buy stocks with high E/P ratio and past period high returns specially in the down-market period. Further, financial decision makers in firms should not further to rely upon traditional CAPM, instead they should pay attention on the time varying factor models. Investors can use the time varying factor models to measure the portfolio performance which are mean variance efficient. If investors use new models to predict portfolio performance, it will automatically increase the efficient mobility of scarce resources in the economy.

At last, the author suggests that the risk factor models formulated based on developed markets should not be used in emerging markets as prescribed without confirming their applicability in emerging markets.

# CHAPTER ONE
# INTRODUCTION

## 1.1 Background and statement of the problem

The relationship between risk and return is the most predominant theme of research in finance since 1960s. Sharpe, Lintner and Mossin introduced first asset pricing model known as Capital Asset Pricing Model (CAPM) in 1964, 1965 and 1966 respectively. CAPM states that, in equilibrium, beta (β) measured by the market index has a positive linear relationship with cross-section of expected returns. Though early studies supported the positive relationship between β and expected returns, studies after Fama and MacBeth (1973) have seriously challenged it.

Merton (1974) has constructed a generalized Intertemporal Capital Asset Pricing Model (ICAPM) in which a number of sources of uncertainty would be priced. Unlike the CAPM, ICAPM assumes that risk is multi dimensional rather than the uncertainty arises on the future value of security. Moreover, Ross (1976) has developed Arbitrage Pricing Theory (APT) which also holds that risk comes from multi sources and the returns on any stock be linearly related to a set of indices. Contrasting to CAPM the APT does not specify one factor which explains cross-section of stock returns but it can be many factors. However, the theory is silent about the number of factors. Hence, APT is open and valid for any period.

As risk arises from multi sources, researchers tended to find out what characteristics of firms are associated with excess returns. These characteristic effects are contrary to the CAPM and commonly known as market anomalies. Studies among the problems in CAPM (market anomalies), outperformance of value stocks against glamour stocks came first. Value stocks with (i) high earnings-to-price (E/P) ratio by Basu (1977), (ii) high book-to-market (B/M) by Stattman (1980) and Rosenburg, Reid and Lanstein (1985) and (iii) high cash flow-to-price (CF/P) ratio (Jacobs and Levy, 1988) outperformed their counterparts. (iv) Banz (1981) found that small stocks earn higher average returns than large stocks. (v) Later, Jegadeesh and Titman (1993) uncovered momentum effect. They found that stocks with high returns in the past 6 months continued to outperform low return stocks in the next 6 months. They named this pattern of stock price behavior as price momentum effect. (vi) Apart from the price related variables, technical analysts trust that share volume plays a key role in predicting future share price variations (see, e.g., Karpoff, 1987; Murphy, 1999).

Some researchers have found that market anomalies behave differently on different market conditions. It means relationship between firm characteristics and stock returns is different from up-market to down-market. (see, e.g., Kim and Burnie, 2002; Rutledge, Zhang and Karim, 2008; Muga and Santamaria, 2009 and Athanassakos, 2009).

Based on the market anomalies and in the spirit of the APT, Fama and French (1993, 1996) developed their three-factor model. The model includes the factor in the CAPM, i.e., excess market return, plus HML(High Minus Low book to market value ratio) and SMB (Small Minus Big market capitalization) which address the CAPM anomalies related to the B/M ratio and size anomaly respectively. Fama and French found that the three-factor model was an improvement on the CAPM as it explained all the CAPM anomalies except price momentum effect. Later, Carhart (1997) developed Fama and French (1993) model by adding momentum factor. Both of these models were developed based on the United State (U.S.) market and in unconditional market setting.

Even though four factor model (Carhart, 1997) is available to explain the variability of stock returns, still most famous and world wide used model is Fama and French (1993) three-factor model. Therefore, the present stage of research in this regard is the Fama and French (1993) three-factor model. However, literature revealed the following knowledge gaps related to the predictability of stock returns. Firstly, most of the proxy variables which have been proved in literature to be correlated with stock returns are market state dependent. However, these proxy variables have not been sufficiently tested based on emerging markets and specially in conditional market states. Secondly, there is no single pricing model which included all these factors to explain the cross-section of stock returns. Although, many researchers tend to use Fama and French (1993) model to explain the cross-section of expected returns, the Fama and French model has been developed based on the findings of Fama and French (1992) and because of that the factor mimicking portfolios created by Fama and French (1993) model would not be applicable for each market as it is. This view is shared by Malin and Veeraraghavan (2004) who stated that “the usefulness of multifactor models may not be fully known until sufficient new data becomes available to provide a true out-of-sample check on their performance”. Therefore, a problem arise as whether there is a possibility to add or remove any of the factor known to affect stock returns to create a better model to explain variability of stock returns in emerging markets. Thirdly, the conditional behavior of stock returns has not been sufficiently tested in multifactor models.

Therefore, this study is to develop a new asset pricing model based on the Colombo Stock Exchange (CSE) to explain the variability of stock returns in emerging markets. This study is going to be different from past studies in several aspects. Firstly, it examines all the (E/P, B/M, size, volume and momentum) market anomalies which assumed to be related with stock returns using CSE data. Moreover, momentum and trading volume anomalies are analyzed for the first time in the CSE. Secondly, it attempts to include all the five variables mentioned above in the asset pricing model. Thirdly, it examines market anomalies as well as factor models in conditional form (up-market and down-market). Sri Lanka is an unique market to examine the robustness of market anomalies and factor model as on the one hand, it is a fast growing market in the world and on the other hand, market reflects a bear market and bull market periods during the last 15 years to examine the conditional behavior of market anomalies and factor models.

## 1.2 Research questions

As explained in the previous section, the above knowledge gaps can be formulated into a broad research question as follows.

*What are the factors which affect on stock returns in Sri Lanka and how do they affect stock returns during the up-market and down- market?*

The above broad research question can be simplified into several sub-research questions as follows.

I. What market anomalies are persisting in Colombo Stock Exchange? This study examines the E/P, B/M, size, trading volume and momentum anomalies.

II. Whether the above market anomalies persist in the same manner both in up-market and down-market?

III. What is the best set of factors (factor model) that explain stock returns in CSE?

IV. How do the above factors affect on stock returns in up-market and down-market?

## 1.3 Purpose and objectives of the study

As discussed in the problem statement, risk factor models developed based on developed markets may not suitable to explain the variability of stock returns in emerging markets. Therefore the broad purpose of the study is to identify risk factors which explain variability of stock returns in emerging markets. In order to achieve the purpose of the study four research questions were formulated and the above research questions are simplified into two research objectives and the first objective is divided into five sub-objectives. Hence, the objectives of the study are;

I. To analyze market anomalies in CSE

Under this objective five market anomalies are analyzed in the full period as well as in both up-market and down-market states. Therefore, five sub-objectives are developed as follows.

i. To analyze the E/P anomaly in the CSE
ii. To analyze the B/M anomaly in the CSE
iii. To analyze the size anomaly in the CSE
iv. To analyze the trading volume anomaly in the CSE
v. To analyze the momentum anomaly in the CSE

II. The second objective is to formulate new asset pricing models to explain stock returns in CSE. Under this objective different asset pricing factor models are tested in order to determine the best asset pricing factor model that explains the portfolio of stock returns. Further, each asset pricing factor model is tested under up-market and down-market states.

## 1.4 Significance of the study

This study basically examines market anomalies and finally develops factor models to explain stock returns. The study conducts in unconditional market (full period) as well as in conditional markets (down-market and up-market). Therefore, findings of the study are important theoretically as well as practically as follows.

I. **Efficient allocation of resources**

In a capitalist economy, decisions are taken at the individual level and they are regulated by market, that is, by forces of demand and supply. Resources move out of loss making enterprises and into the profit making activities, and from low utility consumption to high utility ones. Such a system has been prevailed in developed economies like those in U.S. and Great Britain (U.K). However, in order to facilitate such a system, investors should be able to predict the true profitability of the firm. In developed countries; multifactor asset pricing models have been developed to identify the deterministic factors of stock returns. However, in Sri Lankan capital market, like most of the other emerging markets, such a return generating model has not yet been identified. Therefore, this study has an importance on increasing the efficiency of financial resource allocation in the economy.

II. **Computing cost of capital**

For more than 40 years financial theorists generally have favored the notion that using the CAPM is the preferred method to estimate the cost of equity capital (see. Pratt, 2002, P. 70). However, CAPM has not been empirically proved and therefore the beta measure using CAPM model is inappropriate to compute cost of equity capital because CAPM beta does not show the correct level of systematic risk. Hence, a better asset pricing model is necessary to compute the systematic risk accurately. This study develops multifactor models to estimate the systematic risk of stocks and it would be a better model to estimate the cost of equity capital than traditional CAPM. Therefore, indirectly the risk models identify in this study will help to make better capital budgeting decisions.

III. **Computation of abnormal returns**

It is necessary to compute abnormal returns in some financial studies like event analysis studies. Abnormal returns are computed by deducting expected returns from actual returns of stocks. Therefore, new asset pricing models developed under this study may useful in computing expected returns more accurately than computing expected returns based on traditional CAPM.

IV. **The performance of market anomalies in CSE**

It is evident that the lack of an in-depth study to examine the market anomalies in CSE. Therefore, this study aims to examine whether value stocks (high E/P and high B/M) outperform their counterparts (glamour stocks). Further, the study examines whether the size anomaly, volume anomaly and momentum anomaly are visible in the CSE. Such findings facilitate investors to form better portfolios of stocks to make investment decisions.

V. **Theoretical significance**

The main purpose of the study is to develop new asset pricing models using CSE data. Since CSE is a small emerging market, findings may add new knowledge to the financial literature. This study will further contribute to examine the five market anomalies (E/P anomaly, B/M anomaly, size effect, volume anomaly and momentum anomaly) conditionally as well as unconditionally. Such findings would be very important for practitioners to make better investment strategies. Moreover, test of market anomalies in conditional markets at CSE is a new experience to the financial literature because CSE is a small fast growing emerging market. Additionally, some researchers argue that observed market anomalies arise as a result of data mining (Lo and MacKinlay, 1990). Jagedeesh and Titman (2001) report that "…data mining is typically hardest to address because empirical research in non-experimental settings is limited by data availability". Therefore, out of sample findings are necessary to counter the data mining argument. Further, Malin and Veeraraghavan (2004) report that out of sample tests are needed to validate the Fama and French three-factor model. Since this study carries out at CSE findings will add theoretical significance.

## 1.5 Data and research methods

The data comes from secondary data sources. Stock prices, market capitalization and trading volume data were obtained from electronic data library of CSE. E/P and

B/M data are obtained from “Handbook of listed companies” annually published by CSE. Treasury bill rates were obtained from Central Bank reports of Sri Lanka. Stock prices were converted into returns and necessary adjustments were made for cash dividends, stock dividends and right issues. Further, maximum efforts are taken to minimize the effects of survivorship bias problem and thin trading problem.

Using the data, 3 portfolios were made taking extreme ends (highest and lowest 1/3) based on characteristics assumed to be affected on stock returns. These characteristics are, E/P, size, B/M, trading volume and momentum). The study period is ranged from January 1995 to December 2008 and the total period was divided into two sub periods as down-market state and up-market state.

Ordinary Least Square (OLS) regression (single) is used to test the market anomalies. Multiple regression model and correlation matrix are used to develop asset pricing models. The best asset pricing model or the best combination of factors is determined by comparing two models at one time until the best model is identified. The incremental adjusted coefficient of determination ($\Delta\bar{R}^2$) is used together with *F*-statistic to identify the best asset pricing model which explain stock returns.

## 1.6 Structure of thesis

The thesis begins with the introduction and rest of the chapters are organized as follows.

In Chapter 2, the Colombo Stock Exchange is introduced. Under this chapter, historical evolution, new development, price indices, trading activities and a brief comparison of CSE index with indices of few selected world stock exchanges are presented.

In Chapter 3, review of literature is presented. The chapter starts with the theoretical background of the study and it includes portfolio theory, CAPM, APT and multifactor models are discussed. Next, literature on five market anomalies and multifactor models are presented. Finally, literature related to CSE is presented.

In Chapter 4, data and methodology are discussed. This chapter starts with development of hypothesis. Next sample, data, and variables used in the study are described in detail. Also this chapter explains test of descriptive statistics. Methods of testing market anomalies and tools used to select best asset pricing models are explained at last.

In Chapter 5, findings are discussed in relation to market anomalies. The chapter is started with descriptive statistics. This chapter presents the results of earnings-to-price, book-to-market, size, trading volume and momentum anomalies.

In Chapter 6, findings are discussed in relation to the development of factor models. First, factor creations are described and next, factor models are explained under full period, down-market and up-market.

In Chapter 7, discussed how the findings of the study contribute to the existing literature and how findings can be used in practice are discussed. Limitations to the study and future directions are also explained in this chapter.

The Chapter 8, concludes the study.

# CHAPTER TWO
# THE COLOMBO STOCK EXCHANGE

This chapter aims to introduce the CSE from its historical developments to the present. The chapter reviews, historical evolution, new era of CSE, price indices of CSE, trading activities and comparison between recent behavior of CSE with few selected stock markets of developed and developing countries.

## 2.1 Historical evolution

Share trading has been taking placed in Sri Lanka since 1896. Share trading up to June 1984, was done under the auspices of the Colombo Brokers Association (CBA) and the activities of the primary and secondary market were governed by the rules and bye-laws of the CBA. On 2nd July 1984, a trading flow was established by the CBA and trading commenced under the "open outcry system" where both sellers and buyers had to bid and ask their prices very loudly. A public gallery was also made available. Trading continued under the patronage of the CBA. On 2nd December 1985, the operations of CBA were handed over to the Colombo Securities Exchange (Gte) Ltd. In March 1990, the Registrar of Companies granted the Colombo Securities Exchange (Gte) Ltd the approval to use the name 'Colombo Stock Exchange'.

While the period 1896 to 1984, would be of great historical interest, unfortunately calendar of events and stories did not exist for reference during this period. However, there are few points to be written as important events took place during the historical period of 1896 to 1984.

I. Colombo Stock Exchange shows off one of the oldest Exchanges in the world. Only privileged few stock exchanges in the world goes back to a full century.

II. Share trading did play a key role in the economic development of Sri Lanka by sourcing funds for the development of the plantation industry. It again played a role in the nation's economic development by sourcing funds for the hotel industry.

III. In addition to being one of the oldest stock markets, Colombo has been one of the first equity markets to raise capital for overseas investment. Money was raised in Colombo to open plantations in Malaysia.

When exchange controls were introduced in 1948, 140 rupee companies were listed on the Exchange and this included 16 Malaysian plantation companies.

Nineteen of the 140 companies were commercial companies and the balance 121 companies were plantations.

However, the situation became changing after the independency of the country from British Colonialism in 1948. State involvement in industries was the main ideology of the governments elected after the independency. As a result, activities of the private sector were curtailed. As far as share trading was concerned, number of listed companies dropped to a low of 76 in the year 1976. Trading activities were limited to private close door ‘call over’ between few brokers of five stock brokering companies.

## 2.2 New era of the Colombo Stock Exchange

In 1984 there was a big change in share market activities due to introduction of trading floor. With this introduction, investors got opportunities to meet in the same floor with brokers in their trading activities. Further going forward in 1985 December the Colombo Brokers Association and Stock Brokers Association has been combined together and formed Colombo Securities Exchange. Later, secondary activities of Colombo Stock Exchange were opened to general public as well. The secondary transactions were taken place through the open outcry system. The key milestones of the transformation process of the CSE are as follows.

I. Establishment of Securities Exchange Commission (SEC) under the parliamentary Act no 36 of 1987 to regulate the trading activities in the country. The activities of the SEC are: reviewing the information disclosures of listed firms, supervision of the activities of market intermediaries, conducting investigations to protect the rights of investors, reviewing and imposing new regulations for the smooth functioning of the CSE and monitoring trading activities of CSE to see whether the activities are in accordance with the Act.

II. One of the most important mile-stone in 1990 was the evolution of share trading in Sri Lanka. During the year stock market was opened for foreign investors by removing 100% transfer of property tax on share purchase of foreigners. Further, government relaxed exchange controls on inward remittances for shares purchases and outward remittances of surpluses on dealings on listed shares.

III. Establishment of Central Depository System (CDS) to automate the trading activities of CSE took place in 1991 and commenced its operation from June 1992. The central depositary system offers the following services and facilities.

   i. Opening of client accounts
   ii. Deposit and withdrawal of shares

iii. Transfer of shares
iv. Clearing and settlement of transactions
v. Record keeping
vi. Handling of new and subsequent issues
vii. Securities borrowing and lending

IV. Taxes on capital gains were abolished in 1992

V. In 1995 the activities of CSE was fully automated by computerizing operations of CSE which was another achievement in its history. With the automation of the trading system of CSE, investors were really benefited and all transactions were recorded then and there.

VI. In the year 1997 a Settlement Guarantee Fund and a Compensation Fund were established to safeguard the settlement of trading transactions.

VII. During the year 1998 CSE was admitted as the 52nd member of the World Federation of Stock Exchanges and the CDS gained membership in the Asia-Pacific Central Securities Group (ACSG).

VIII. Sensitivity Price Index (SPI) was replaced with the Milanka Price Index (MPI). MPI represents the largest and most liquid 25 stocks and annually composition on the index is revised based on last 4 quarter facts of each company. The base year of the index was 1999 and the base value of the index was 1000 rupees. The next important event occurred during the year was to establish the first regional branch of the CSE at Matara in Southern Province of the Island.

IX. Formation of the South Asian Federation of Exchanges (SAFE) took place in 2000. CSE played the key major role to establish SAFE.

X. Initially, CSE introduced Stock Borrowing and Lending system (SBL) in September 2001. The objective of the system was to provide an instrument to investors to hedge risk and profit from adverse movements in the market. But, until 2003 only one SBL transaction took place as the system was so complicated. However, in 2003 CSE took measures to simplify the process. According to that investors could offer to borrow or lend securities through a dedicated screen based automated trading system of CSE. Further, during the year CSE opened its second regional branch at Kandy in Central province.

XI. The Total Return Index (TRI) was introduced in 2004 in addition to the price indices (All Share Price Index-ASPI and MPI). The TRI reflects return due to price changes and dividend income. Therefore, the TRI is a good indicator in respect of investor’s point of view. For the computation purpose it is assumed that dividends earned are reinvested in the market.

XII. CSE opened its third regional branch at Kurunegala in North-Western province in 2005.

XIII. Five new trading members were admitted to the CSE in 2006 being the total number of trading members 21. CSE opened its forth regional branch at Nigambo in 2007. Further, CSE launched its new website www.cse.lk in September 2007. The new web site facilitates investors to get access to a wide range of online, real time data and information such as information of order book, charts and graphs of traded securities, news announcements and company profiles including quarterly and annual financial statements. With the introduction of the new website, it has become the primary communication channel for CSE. Most of the information is in downloadable facilities with the formats of Excel, Concurrent Versions System (CVS) and Hyper Text Markup Language (HTML). With the introduction of this new website the annual financial reports of listed accompanies are provided online for investors. Before the introduction of this facility, investors received annual reports of listed Companies long time after the financial year. Further, under the new information technology adoption, investors can access to financial information of all the listed companies even if they do not have invested money in shares of these companies.

XIV. Securities Exchange Commission introduced a new sophisticated electronic market based surveillance system in 2010 to instantaneously catch up price manipulations of investors or broker firms. As a result of the new system SEC has taken measures to suspend the trading of few securities. For an example, in August it was suspended the trading of Environment Resources Investment (ERI) group, and Blue Diamond Jewellery World, Touchwood Investments just before the share warrant and right issues. Further, the CSE introduced its fifth regional branch at Jaffna in the North province in April 2010.

## 2.3 Price indices of CSE

The CSE has two main price indices, All Share Price Index (ASPI) and the Milanka Price Index (MPI). These indices are market capitalization weighted indices where the weight of any company is taken as the number of ordinary shares listed in the market.

### 2.3.1 All Share Price Index

The ASPI indicates price fluctuations of all the listed companies and covers all the traded companies during a market day. It is computed in the following manner.

$$ASPI = \frac{Current\ \ market\ \ capitaliza\,tion}{Base\ \ market\ \ capitaliza\,tion}$$

Where, the current market capitalization is the sum of the market capitalization of each company. Market capitalization for a company is computed as the multiplication of current market price of the share by number of shares outstanding. The base market capitalization is also computed in the same manner but the values are base period values.

Base values are established with average market value on year 1985. Hence the base year becomes 1985.

### 2.3.2 Milanka Price Index (MPI)

The Milanka price index is another index which calculated by the Colombo Stock Exchange to show the most frequently traded largest 25 companies' performance in the share market. This index was introduced in 1998 by taking only 25 companies based on their performance on last four quarters. The base year was 1998 and the base index value was 1000. However, the CSE reviewed and revised the companies to be included in the MPI annually up to 2004 and there after it is reviewed and revised quarterly. However, The CSE has changed policy again from 2007 to review and revise it annually.

## 2.4 Trading activities at CSE

In this section the author intends to give a general understanding about the key indicators of trading activities from 1995 to date.

The CSE is the main avenue for quoted companies to raise capital for their investment requirements. Currently 240 companies are listed in the CSE representing twenty (20) business sectors with a market capitalization of Rs. 2308.75 billion (approx. US $ 20.68 billion) as at 30$^{th}$ September 2010.

### 2.4.1 Composition of listed companies in CSE

All the listed companies in the CSE have been categorized into one of the 20 sectors and all the sectors have performed extremely well during the year 2009 when compared to the year 2008. The following table shows the relative market capitalization of each sector as at June 2010 and growth of the sector indices during the year 2009.

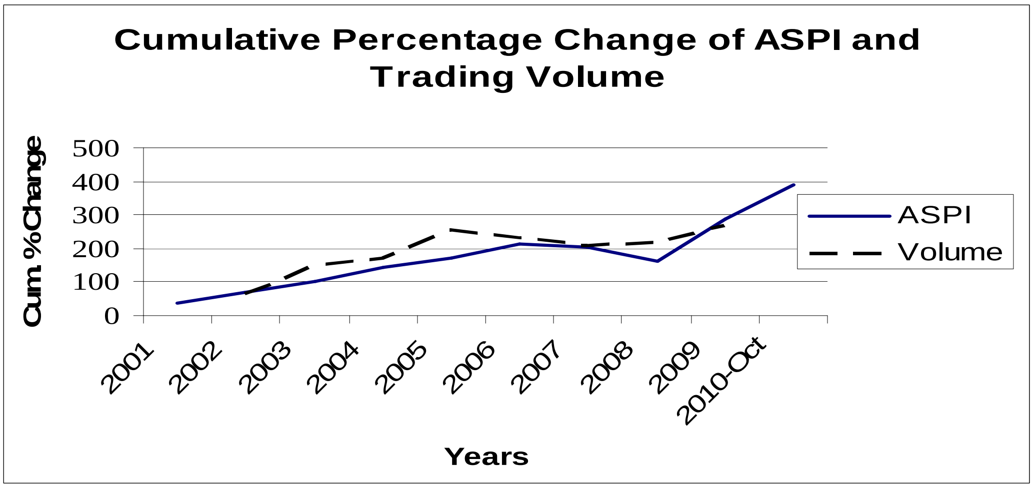
**Table 2.1 Trading sectors of CSE**

| Sector | % Market capitalization | Change of sector index (%) |
|---|---|---|
| Banks Finance and Insurance | 20.39 | 133.6 |
| Beverage Food and Tobacco | 13.39 | 113.7 |
| Chemicals and Pharmaceuticals | 1.43 | 155.2 |
| Construction and Engineering | 1.11 | 356.5 |
| Diversified Holding | 20.63 | 211.7 |
| Footwear and Textiles | 0.39 | 38.1 |
| Health Care | 10.47 | 89.7 |
| Hotels and Travels | 1.90 | 198.7 |
| Information Technology | 2.37 | 39.3 |
| Investment Trusts | 0.02 | 322.9 |
| Land and Property | 2.00 | 94.4 |
| Manufacturing | 5.84 | 110.8 |
| Motors | 1.24 | 130.7 |
| Oil Palms | 3.76 | 254.4 |
| Plantations | 1.38 | 71.8 |
| Power and Energy | 1.91 | 25.6 |
| Services | 0.43 | 105.0 |
| Stores and Supplies | 0.32 | 37.4 |
| Telecommunications | 9.72 | 35.5 |
| Trading | 1.23 | 239.6 |

Source: CSE annual report 2009

### 2.4.2 ASPI and trading volume

The following figure shows how cumulative ASPI returns and trading volume change have behaved after the new millennium at CSE. At a glance, it is clear that both variables have changed upward during the period. ASPI index returns have decreased by 6.6 percent and 8.1 percent in the years 2007 and 2008 respectively. This may be the impact of world economic crisis and heavy fighting between government army and Liberation Tigers of Tamil Eelam (LTTE) who engaged in violations in the country for last 3 decades. However, The ASPI returns have tremendously increased during the year 2009 and 2010 by 125.25 percent and 102 percent respectively. This is the outcome of finishing 30 years old war and massive investment programs launched by the government and private sectors after the war. Trading volume also has increased every year except in the years 2006 and 2007. This may be the outcome of the measures taken to uplift the trading and operational activities at CSE. Even though cumulative lines show that ASPI and trading volume are moving to same direction, the annual figures show a low positive correlation between the two series (r = 0.31).

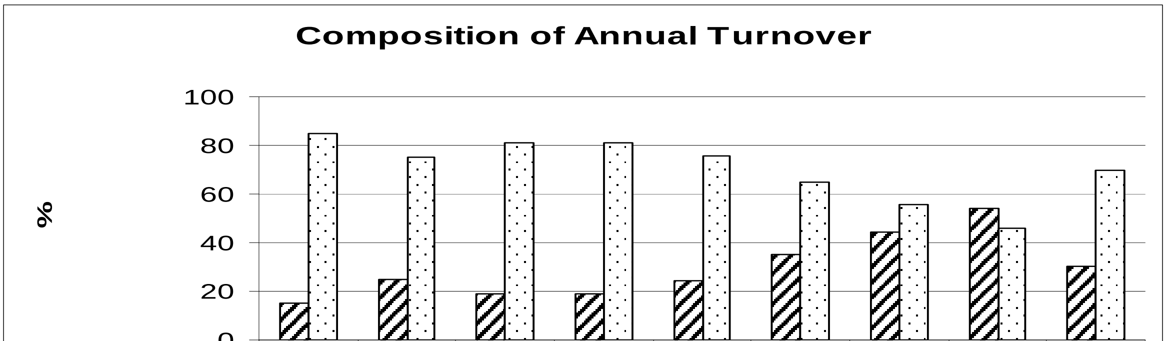



*Source: CSE data library 2009 and Yahoo finance data*

Figure 2.1 Behavior of ASPI returns and trading volume

### 2.4.3 Equity turnover

The figure 2.2 shows that distribution of total annual equity turnover between foreign investors and domestic investors. The total turnover has increased during the period from Rs. 13905 million in 2001 to Rs. 142,462.6 million in 2009. Percentage of foreign turnover did not exceed 25% until year 2005. After year 2005 it gradually increased and in the year 2008 foreign turnover outperformed the domestic turnover by 4% and in the year 2009 it was 31%. There were two reasons for this declining of percentage of foreign turnover. One was the increase of domestic inventors' activities in the capital market. The other reason was the more selling of shares by foreign institutional investors to rebalance their portfolio investments.




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|
| Foreign | 15 | 25 | 19 | 19 | 24 | 35 | 45 | 54 | 31 |
| Domestic | 85 | 75 | 81 | 81 | 76 | 65 | 55 | 46 | 69 |

*Source: CSE data library 2009 and Yahoo finance data*

Figure 2.2 Composition of annual turnover

### 2.4.4 Other market statistics

Table 2.2 provides facts about average turnover of equity, classification of CDS accounts, companies listed, companies traded, number of shares traded and market capitalization for a period of 16 years.

As shown in the earlier section, average turnover has increased significantly during the period concerned. The most eye catching feature is the distribution of CDS accounts among investors. Ninety seven percent of the CDS accounts are held by local individual investors. It indicates that there are lots of small investors in the market.

Companies traded have gradually increased from 209 to 231from first period to end of 2009. This indicates that market efficiency has gradually increased during the period.

**Table 2.2 Other market statistics**

| | 2009 | 2008 | 2003-2007 | 1998-2002 | 1993-1997 |
|---|---|---|---|---|---|
| Average turnover (Rs.million.) | 142,463 | 110,454 | 91,557 | 17,744 | 18,013 |
| % of accounts held by | | | | | |
| Local Individuals | NA | 97 | 97 | 97 | 97 |
| Foreign individuals | NA | 1 | 1 | 1 | 1 |
| Local Firms | NA | 1 | 1 | 1 | 1 |
| Foreign firms | NA | 1 | 1 | 1 | 1 |
| Companies traded | 231 | 232 | 236 | 227 | 209 |
| Companies listed | 231 | 235 | 239 | 239 | 219 |
| Shares traded (million) | 4,762.7 | 3,154.9 | 3,397 | 707 | 382 |
| Market capitalization (billion) | 1,092.1 | 488.8 | 540.3 | 111.9 | 115.2 |
| ASPI | 3,385.6 | 1,503.0 | 773.8 | 566.7 | 1,874.1 |
| MPI | 3,849.4 | 1,631.3 | 2,685.3 | 1,010.4 | NA |

*Source: CSE data library 2009 and Yahoo finance data*

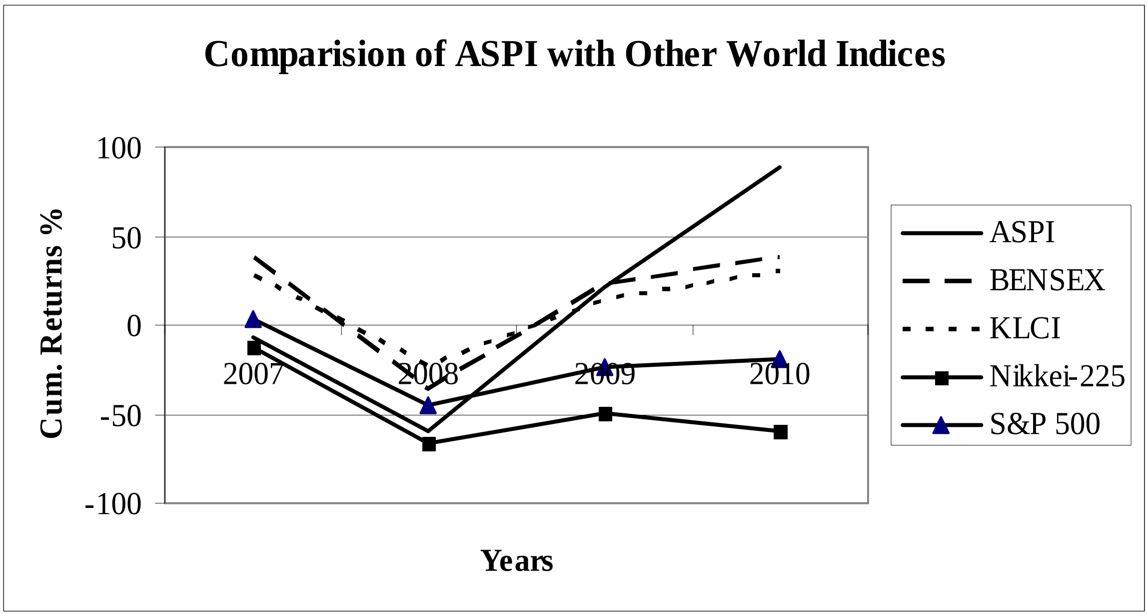
Trading volume (number of shares traded) has increased gradually over the period of time. Average number of shares traded during the period 1993-1997 was million 382 but it has improved to million 4762.7 by 2009.

The most important facts are the market capitalization and the behavior of market indices during the period. Market capitalization has increased to Rs. 1,092.14 billion (approx. US $ 9.48 billion) as at 30th December 2009. The All Share Price Index (ASPI) and the Milanka Price Index (MPI) have recorded the highest ever annual increase of 125 percent and 136 percent and closed at 3,385.6 and 3,849.4 points, respectively. However, the recent evidence shown that both ASPI and MPI have sky rocketed to 6833.16 and 7466.29 at 8th October 2010. Based on the exceptional performance of the All Share Price Index, the CSE was ranked the best performing exchange amongst the 52 member exchanges of the World Federation of Exchanges (WFE).

### 2.4.5 Comparison of present CSE performance with other markets

The graph 2.3 shows cumulative annual returns of indices for selected five, developed and emerging capital markets from 2007-2010 October. The indices are ASPI-Sri Lanka, BENSEX-India, KLIC-Malaysia, Nikkei 225-Japan and S&P 500-U.S.

BENSEX 30 is the sensitivity index of Bombay Stock Exchange (BSE). The BENSEX 30 is a value weighted index with 30 largest and most actively traded stocks. These 30 companies represent around 50 percent of the market capitalization of the BSE. The Kula Lampur Composite Index (KLCI) is a value weighted index composed of largest 30 companies listed at Kula Lampur Stock Exchange (KSE). Nikkei 225 is a price weighted index at Tokyo Stock Exchange composed of largest and well traded 225 companies of the TSE. S&P 500 is a value weighted index composed of largest actively traded 500 stocks in U.S.




*Data Sources: Yahoo finance data*

Figure 2.3 Comparison of ASPI with other world indices

The graph shows that cumulative returns of all the indices have declined drastically in the year 2008 reporting negative cumulative returns rang from -22.34 percent for KLCI to -66.49 percent for Nikkei 225. During the year 2009, all the indices are seemed to be recovering and the recovery of the three emerging markets (CSE, BSE and KSE) is more gigantic than that of the two developed markets (U.S. and Japan). The highest cumulative returns records by BENSEX (-23.64) and the lowest is the NIKKEI-225 (-49.06).

The ASPI of CSE is continuing the up-market trend reporting cumulative returns of 88.96 by the mid of October 2010. Except for Nikkei-225, cumulative returns of the other three market indices also have increased but the rate of increment is lower than the rate of increment in the previous year. Therefore, the graph reflects that the CSE is one of the best performing markets in the world at present.

## *Summary*

This chapter explained the CSE form its inception to current situation. It introduced historical evolution of the market and key milestones passed in the development process. Further, trading statistics including sector break downs of the CSE were presented. At last, the recent past behavior of ASPI was compared with the market indices of few key stock markets in the world to conclude that CSE is one of the best performing markets in the world.

# CHAPTER THREE
# REVIEW OF LITERATURE

This section is devoted to explain the theoretical background of the study and its empirical findings. Therefore, this chapter has following major sub sections.

3.1 Portfolio theory and CAPM
3.2 Reasons for failure of CAPM
3.3 Market anomalies
3.4 Multifactor asset pricing models
3.5 Empirical evidence from CSE

## 3.1 Portfolio theory and CAPM

### 3.1.1 Portfolio theory

Before 1950s investors mostly relied on technical analysis tools of chartings to make their investment decisions. Technical analysts believe that history repeats again and again. But, in 1940s investors realized that past performance of stocks was no longer giving a guarantee of future results. Hence, Harry Markowitz in 1952 developed the portfolio theory to guide future investment decisions.

The most primitive inputs used in portfolio theory are the risk and returns of future outcomes of an asset. The most commonly used returns measurement for individual asset is the ex-post price relative (see, equation 3.1) and risk is measured by variance or standard deviation (see, equation 3.2).

$$R_i = \frac{P_{it} - P_{it-1}}{P_{it-1}} \qquad (3.1)$$

Where,
$R_i$ = ex-post return of the asset *i*
$P_{it}$ = current closing price of the asset *i*
$P_{it-1}$ = previous closing price of the asset *i*

Variance ($\sigma^2$) and standard deviation of returns ($\sigma$) for asset ($i$) is computed as follows.

$$\sigma_i^2 = \frac{1}{n}\sum_{i=1}^{n}(R_i - \overline{R}_i)^2 \quad \text{or} \quad \sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(R_i - \overline{R}_i)^2} \qquad (3.2)$$

Where,

$n$ = total number of assets or time period
$\overline{R}_i$ = mean return for asset $i$

The most important discovery of the portfolio theory is the risk reduction of individual assets when they are added together. This means keeping assets together as a portfolio reduce risk. This phenomenon is called the diversification effect. Markowitz pointed out that rational investors would like to keep portfolio of assets because it reduces the systematic portion of risk associated with total risk of an individual asset. Therefore, the relevant variables for rational investor's decisions are portfolio returns and portfolio risk.

Next, it is important to understand as how to compute the portfolio return ($R_p$) and portfolio risk ($\sigma_p$). Portfolio return is the weighted average return of individual assets in the portfolio. The following formula shows the equally weighted portfolio return.

$$R_p = \frac{1}{n}\sum_{i=1}^{n} R_i \tag{3.3}$$

Where,
n = total number of stocks in the portfolio

The portfolio risk measured by standard deviation ($\sigma_p$) which depends on the correlation matrix of assets in the portfolio. According to Markowitz (1952), general equation for the standard deviation of portfolio returns is as follows.

$$\sigma_p = \sqrt{\sum_{i=1}^{N} X^2\sigma^2 + \sum_{i=1}^{N}\sum_{\substack{j=1 \\ i \neq j}}^{N} X_i X_j \sigma_{ij}} \tag{3.4}$$

Where,
$X$ = represent weight on asset $i$
$\sigma_{ij}$ = the covariance of returns between asset $i$ and $j$.

The above equation has two risk components. The first part of the equation 3.4 is the sum of the variances on individual assets multiplied by square of the proportion of investment in each asset. This part of the risk does not co-vary with the risk of other assets. Therefore, this part of the risk represents the firm specific risk contribution to total risk of the portfolio. Elton and Gruber (1997, pp. 61-62) precisely explain that when the number of assets in the portfolio increased, this component of risk is decreased. The second part of the equation is the covariance of returns of particular asset with the returns of other assets in the portfolio. As perfectly negatively correlated assets are not available in the world, this part of the risk can not go to zero but can be much less than the variance of individual asset returns. This part of the risk is called systematic risk. Brigham (2004, p. 187) points out this as follows.

> *Thus, almost half of the riskiness inherent in an average individual stock can be eliminated if the stock is held in a reasonably well-diversified portfolio, which is one containing 40 or more stocks. Some risk always remains, however, so it is virtually impossible to diversify away the effects of broad stock market movements that affect almost all stocks.*

Since the unsystematic risk can be diversified away by keeping a well diversified portfolio, and systematic risk can not be diversified away, the relevant part of the risk for an investor is systematic risk.

The common assumption in portfolio theory is the rational behavior of investor. It means investors aim to maximize their wealth while minimizing risk (risk averse). As the risk and return have a positive linear relationship these two objectives are appear to be contradictory. However, Markowitz (1952) developed the "Portfolio Theory" to answer for this issue. Markowitz's portfolio selection model aims to maximize the returns under given level of risk or to minimize the risk under given level of return.

Markowitz's portfolio theory deals with the investor's portfolio selection as a problem of utility maximization under the condition of uncertainty. According to the Markowitz portfolio theory, an investor can maximize his wealth by investing in an efficient portfolio which satisfies one of the following criterion.

I. Select the portfolio which has the highest return when the risk is equal to other portfolios' risk.
II. Select the portfolio which has the lowest risk when the return is equal to other portfolios' returns.

Thus, the Markowitz's portfolio theory deals with identifying efficient portfolios. Markowitz had set of assumptions in developing his theory of portfolio selection as follows.

I. Investors maximize the one period expected utility and have utility curve which demonstrates diminishing marginal utility of wealth.
II. Investors consider each investment alternative as being represented by probability distributions of expected returns over some holding period.
III. Investors make decisions solely based on expected returns and variance (standard deviation) of returns.

IV. For a given level of return, investor prefers to lower risk portfolio and vice versa. The portfolio which satisfied these conditions are called “mean-variance efficient portfolio”.

The selection of mean-variance efficient portfolio is depicted in figure 3.1. The curve ABC represents all the efficient portfolios and portfolios on the curve as well as in the curve are all attainable portfolios to an investor. However, portfolios in the curve are not efficient but the portfolios on the curve of ABC are efficient. If one compares portfolio of $X_1$ or $X_2$ with portfolio B on the curve ABC, the latter is efficient than the former. Portfolios on the curve ABC generate either higher expected return when risk is equal or lower risk when the expected returns are equal to other portfolios’ expected returns.

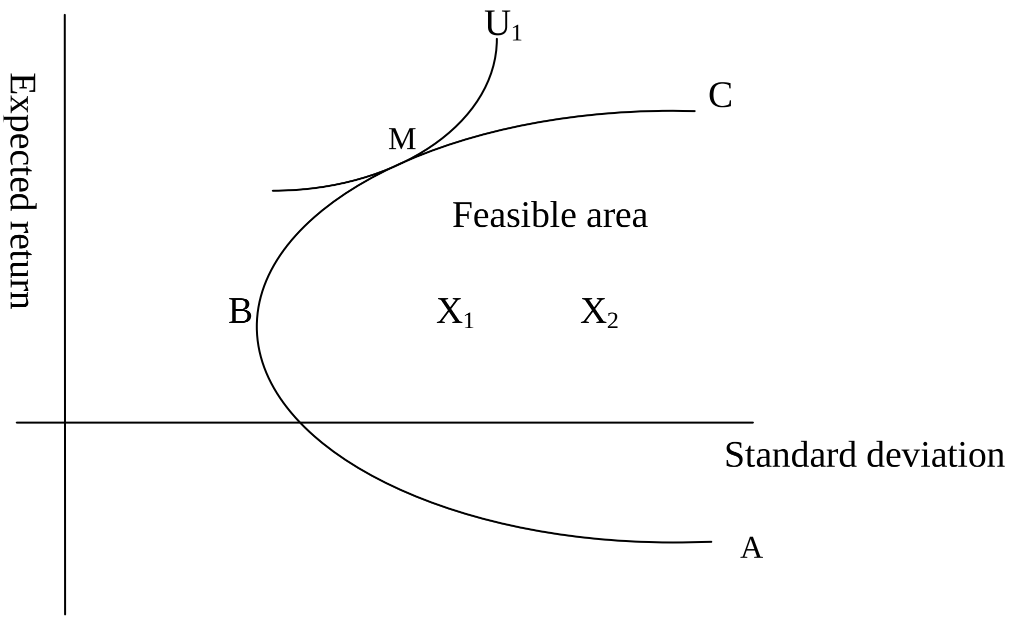



Figure 3.1 Markowitz’s efficient portfolio

However, all the portfolios along the curve ABC are not equally efficient. Portfolios above the point B on the curve are more efficient than the portfolios bellow the point B. Therefore, only the portfolios above point B are mean-variance efficient and this part of the curve is called the “efficient frontier”. Therefore, an investor who maximizes the expected return at a given level of risk will hold portfolios on B-C portion of the curve ABC. An investor selects the best portfolio to invest along the curve B-C on their utility and tolerance of risk. An investor’s utility curve (U) shows the trade-offs of he/she willing to make between expected return and risk. When we add the utility curve to the efficient frontier, the equilibrium portfolio which investor prefers can be determined. An investor who is a risk lover may select the portfolio C while a very risk averse inventor may select the portfolio B. Thus, the optimal portfolio is the portfolio on the B-C part of the efficient frontier which tangent with the highest indifference curve. According to the figure 3.1, the portfolio M is the optimum portfolio. Where as, the portfolio B is the global minimum portfolio which has the lowest variance among all the available portfolios.

Even though, selecting efficient portfolios are not difficult according to the graphical elaboration, however, computation of risk and expected return is not so easy. If portfolio consists of 200 stocks, it needs to compute 200 expected returns and 200 standard deviations. The most difficult part is the computation of correlation coefficients. Under the portfolio theory one has to estimate $N(N-1)/2$ (19900) number of correlation coefficients to have a 200 stock portfolio.

### 3.1.2 CAPM

In order to mitigate the above computational problem, Capital Market Theory (CMT) was developed. CMT extends on the work of Markowitz (1952) and develops asset pricing models to price risky assets whether they are efficient or not.

There are several asset pricing models as Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), Mossin (1966) later modified by Black (1972), Inter-temporal Capital Asset Pricing Model (ICAPM) of Merton (1973), Arbitrage Pricing Theory (APT) and three factor model of Fama and French (1993).

Based on the findings of Markowitz's mean-variance efficient portfolio theory, Sharpe, Lintner and Mossin developed the CAPM independently. The CAPM shows the way in which assets are priced in financial markets and the relationship between risk and return.

CAPM has been developed under set of assumptions and they are as follows.

I. There are no transaction costs. This means there is no cost (friction) of buying or selling any asset.
II. Assets are indefinitely divisible. This means that investors could take any portion in an investment, regardless of size of their asset.
III. Absence of personal income tax. This means investor is indifferent to the form (dividend or capital gains) in which the return on investment is received.
IV. An individual can not affect the price by his buying or selling action. This means there is a perfect capital market.
V. Investors are expected to make decisions entirely based on expected values and standard deviations of the returns on their portfolios.
VI. Unlimited short sales are allowed. The individual investor can sell short any amount of any asset.
VII. Unlimited lending and borrowing at the risk free rate. The investor can lend or borrow any amount of money at the risk free rate.

VIII. Investors are assumed to be concerned with the mean and variance of returns and all investors are to be having identical expectations with respect to inputs to the portfolio decision.
IX. All assets are marketable. This means all assets including human capital can be sold and bought on the market.

Derivation of the CAPM can be better explained using diagrams. Without riskless lending and borrowing, each investor faces an efficient frontier as shown in figure 3.2. In this figure, section B-C represents the efficient frontier while ABC represents the set of minimum variance portfolios. Under this situation investor select the best investment portfolio at the tangency point (M) of his highest indifference curve.

The introduction of risk-free assets to figure 3.2 allows developing a generalized theory of capital asset pricing under condition of uncertainty from the Markowitz portfolio theory. This is depicted in the figure 3.2.

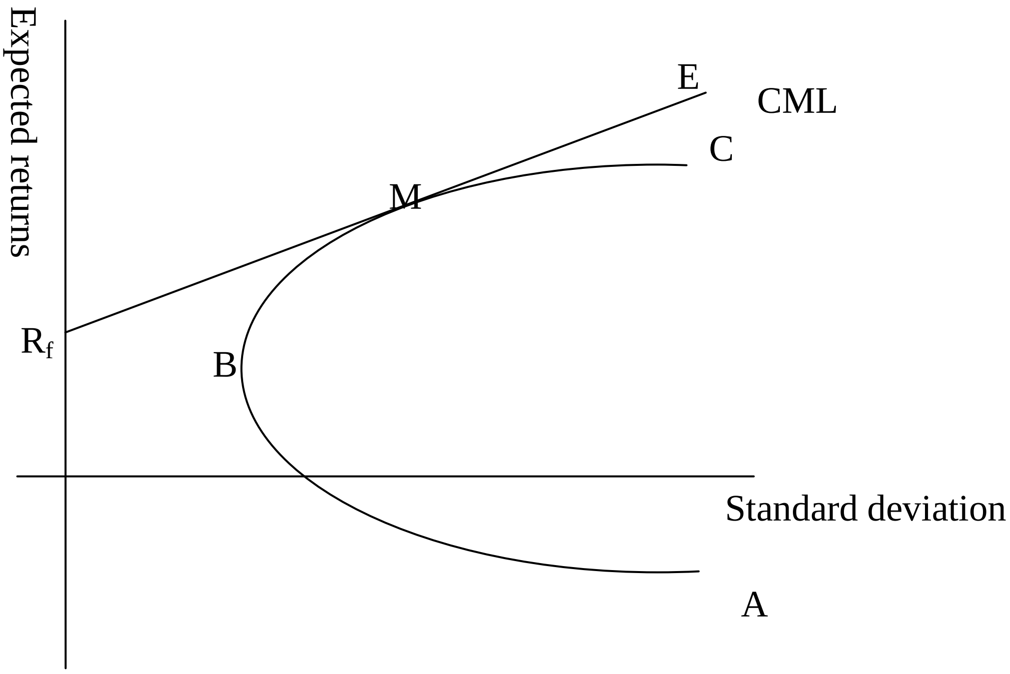



Figure 3.2 Capital Market Line

The risk free asset which has zero correlation with risky asset portfolio generates risk free rate of return and would lie on the vertical axis of the figure 3.2. To identify how the efficient portfolio changes with the introduction of $R_f$ to risky portfolio, one has to draw a line from $R_f$ in figure 3.2 up to the right as far as possible to the tangency portfolio M. Then the new efficient frontier shift from B–C curve to $R_f$ –M curve. And, all the portfolios on the line $R_f$ –M are superior to the portfolios on the curve B–C. If all the investors have homogeneous expectations about expected return, risk and covariance of assets and their indifference curves are equal, then tangency portfolio becomes the market portfolio. Therefore, when the capital market is efficient investor keep a portfolio of risk free assets and risky market portfolio.

Investor can lend as well as borrow money at risk free rate. In order to show the lending and borrowing portfolios at risk free rate, one has to continue the line $R_f$ – M to the point E. The new curve is called the Capital Market Line (CML).

The CML explains the linear relationship between expected return and standard deviation of the efficient portfolios with the risk free assets. The equation 3.5 states the mathematical relationship of the CML. All the portfolios alone the CML line are efficient portfolios and they combine the risk free assets and risky assets. The portfolios on the part of the $R_f$ – M of the CML are called lending portfolios because investors make their portfolios by lending certain portion of funds on risk free assets and balance in risky portfolio M. The portfolios from M - E are called as borrowing portfolios since investor borrows funds at $R_f$ and place their original capital plus the borrowed funds in portfolio M. If all investors have same (homogeneous) expectations about expected returns, variance of asset returns and covariance of asset returns and when they all face the same lending and borrowing rate, then they will each face a diagram such as figure 3.2 and, all investors' diagrams will be identical. If all the investors held the same portfolio of risky assets held by any other investor then in equilibrium it must be the market portfolio.

Thus, the CML leads all investors to invest on same risky asst portfolio, M and investors differ only regarding the position of the indifferent curve which depends on the risk preference of the individual investor.

$$E(R_e) = R_f + \frac{E(R_m) - R_f}{\sigma_m} \sigma_e \qquad (3.5)$$

Where,

$E(R_e)$ = expected return of an efficient portfolio *e*
$R_f$ = risk free rate of return
$\sigma_e$ = standard deviation of the returns of efficient portfolio *e*
$E(R_m)-R_f$ = market risk premium
$\sigma_m$ = standard deviation of the market portfolio

Where the subscript *e* denotes an efficient portfolio. The term $E(R_m - R_f)/\sigma_m$ can be thought of as the market price of risk for all efficient portfolios. The first term is simply the price of time or the return that is required for delaying potential consumption. The second term represents the element of required return that is paid to risk. Therefore, the expected return on an efficient portfolio can be expressed as follows.

(Expected return) = (Price of time) + (Price of risk) x (amount of risk)

CML is the equation which explains the relationship between expected returns and risk of an efficient portfolio. However, it does not show the risk-return trade-off of an inefficient portfolio or individual asset.

Portfolio theory holds that when a security is added to a well diversified portfolio part of the total risk of an asset can be eliminated and what is remaining is the systematic risk. In the derivation of CML line, it is shown that if all the investors have homogeneous expectations, they all keep the market portfolio. Therefore, when a new security is added to the efficient market portfolio the only relevant risk to be considered is the portion of the risk which co-varies with the market portfolio. That part of the risk is measured by beta (β) and by definition market β=1. Therefore, we can draw the risk-return relationship for any risky asset or any efficient or inefficient portfolio using Security Market Line (SML) as shown in the figure 3.3.

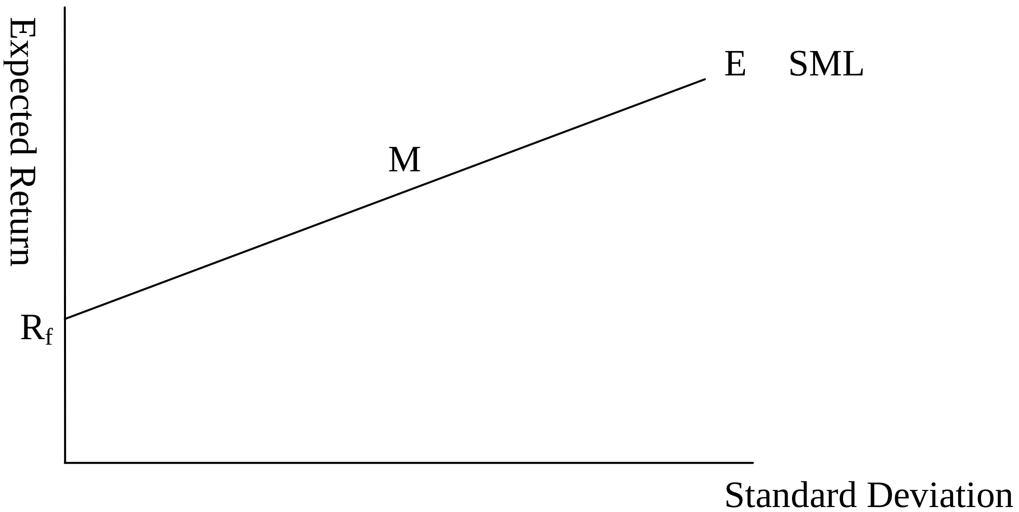



Figure 3.3 Security Market Line

Securities that are from $R_f$ to M in the figure 3.3 have lower risk (β<1) than risk of the average market portfolio. And, from the point M to up-wards have higher risk than the market portfolio (β>1). The equilibrium risk-return relationship is shown in the equation 3.6.

$$E(R_i) = R_f + (E(R_m - R_f)\beta_i \qquad (3.6)$$

and:

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

Where:

$E(R_i)$ = the expected return on asset $i$

$E(R_m)$ = the expected return on market portfolio

$R_f$ = the risk free rate

$Cov(R_i, R_m)$ = the covariance between the returns on asset $i$ and market portfolio

$\sigma_m^2$ = the risk of the market portfolio

The equation 3.6 states that there is a linear positive relationship between security return and its sensitivity to the market risk premium. In equilibrium, the expected return of security $i$ is determined by risk free rate, market risk premium ($E(R_m-R_f)$) and its beta. The beta of an individual security measures the covariance of the security returns with that of the market divided by the variance of the market returns.

### 3.1.3 Empirical test of CAPM

There has been a huge amount of empirical testing of the CAPM. However, this section is restricted to some key findings. If the CAPM is true following hypotheses should be hold.

I. Beta should be positively and linearly associated with a higher level of return.
II. There should not have any added return for bearing non market risk.

Black, Jensen, and Scholes (1972) (BJS) were the first to conduct an in-depth time series test of CAPM. They took the following as their basic time series model.

$$R_{it} - R_{ft} = \alpha_i + (R_{mt} - R_{ft})\beta_i + \varepsilon_{it} \qquad (3.7)$$

When this equation is estimated on the time series data the regression coefficient $\alpha_i$, should be equal to zero if the CAPM describes returns of company ($R_i$).

BJS employed five years of monthly data to estimate betas and rank stocks into deciles (from highest to lowest). Each decile was then considered the portfolio in the next (sixth) year. Then data for the second through sixth year were used to rank stocks and form deciles that were considered portfolios for the seventh year. This was done until deciles and the return for each decile was computed for whole period. Each of decile portfolios could then be regressed against market and found that CAPM is true.

Fama and MacBeth (1974) used an interesting methodology to test the CAPM. They formed 20 portfolios of stocks to estimate betas from a first-pass regression. They estimated betas for portfolios based on previous period data and then regress them in the second-pass regression against the portfolios' average returns of the next period. In that manner they separated the beta estimation period from the average return computation period which could enable them to make the beta estimation independent from the second-pass regression. Similar to BJS, Fama and MacBeth showed supportive evidence to CAPM. However, subsequent studies showed week relationship between stock returns and data (see for details Galagedara, 2007).

## 3.2 Reasons for failure of CAPM

This subsection is devoted for the discussion of various problems which cause to fail beta in explaining stock returns. Problems associated with CAPM can be broadly categorized into three (Chae and Yang, 2008).

I. Inaccurate estimation of true CAPM parameters ($R_f$, $R_m$ and beta)
II. Inventor irrationality
III. Missing risk factors

The above problems and possible causes of actions to avoid them are described bellow.

### 3.2.1 Inaccurate estimation of true CAPM parameters

One of the reasons for the failure of the CAPM is the inaccurate measure of the parameters: $R_f$, $R_m$ and beta. However, according to the past studies most challenging task is the beta estimation because it is subject to interval period (daily, weekly, monthly etc), aggregation methods (individual or portfolio beta) and sample and data bases.

The second controversial factor is the market returns ($R_m$). Theoretically, market portfolio should include all types of assets (Roll, 1977). However, in empirical studies, indexes which represent a subset of world equity markets have been used (e.g., S&P 500, Nikkei 225). When market indexes are used to measure beta, errors in the estimation of $R_m$ will indirectly cause errors in the estimation of beta.

***Beta and return measurement interval***

Number of days, months or years chosen to compute betas affect beta estimation and stability. Failure to accept account for these biases might result in appearance of the CAPM anomalies. Kotari, Shanken and Sloan (KSS) reported that annual return data is preferred to monthly return data due to several reasons.

I. True betas them-selves vary systematically and non-linearly with the length of the interval used to measure returns.
II. Beta estimates are biased due to trading frictions and non-synchronous trading

III. There appear to be a significant seasonal component to monthly returns. Using annual returns is one way to side stepping the statistical application that arises from seasonality in returns.

***Instability of individual asset beta compared to portfolio beta***

CAPM clearly specify that there should be a direct positive relationship between expected returns and beta. However, it does not give any guidelines as how to test the relationship empirically. Therefore, there is no common agreement among researchers as how to measure the beta. Hence, researchers have continuously paid attention on improving the measurement of beta.

There are many past studies concluding that individual betas are inferior to the portfolio betas. Among others the most popular study on beta measurement problem is the one done by Fama and French (1992). To deal with the problem of instability of individual stock betas, the authors used portfolio betas for individual stocks. Fama and French ranked individual stocks based on size and then beta and assigned them to 100 size-beta portfolios. They then recalculated the portfolio betas based on returns over the next five years after the portfolio formation. The calculated portfolio betas for each size-beta portfolio were then used as the individual stock betas for all the stocks under the respective size-beta portfolio.

***Impact of thin or infrequent trading***

Returns for shares are computed based on their last traded prices. Then there will be a mismatch between the returns of infrequently traded shares and the market index returns. The index used as a proxy of market portfolio usually changes every day because at least one company in its basket of companies trades and change price. When the return of the infrequently traded security is regressed against return of the index that changes every day, the covariance between the returns of market and the individual stock returns seems to be low. In other way, infrequently traded stocks are likely to have low betas, as the covariance between the returns of the securities and the market returns is underestimated. The opposite is true for the frequently traded shares whereby their betas tend to be higher as the covariance of their returns with the market returns tends to be higher. Fisher (1966) was the first to point out this problem. As he noted, a stock index constructed from infrequently traded shares caused positive, serial correlation in return estimates of the index that means, return on a day was correlated with return of the day before. This, in turn, caused a downward bias in the variance of returns.

However, researchers have shown that the bias with the beta of infrequently traded shares is less problematic as the interval used to calculate returns is increased. The average beta calculated against a value-weighted index increased almost consistently as the return measurement interval was extended. Roll (1981) pointed out that the beta calculated based on infrequently traded shares using ordinary least square (OLS) be likely to increase as the measurement interval increased from daily to semi-annually.

Dimson (1979) has proposed three methods to correct the bias in the beta of infrequently traded shares.

I. In addition to the contemporary market index, use lag market index in computing beta.

II. Use Dimson's Aggregate Coefficient (AC). Where, betas were computed using lag, contemporary and leading market returns.

III. Trade-to-trade basis. Where calculate returns for individual securities only when they were traded and use the same array of market returns to run the regression.

***Impact of market proxy***

The research of BJS, Fama and MacBeth provided much support for the CAPM. However, their empirical tests of CAPM were severely attacked by what is generally known as "Roll's critique". Roll (1977) pointed out that equilibrium theory is not testable unless the exact composition of the true market portfolio is known and used in the tests. Therefore, the true test of the CAPM is whether the market portfolio is mean-variance efficient. According to Roll, CAPM is never testable model because true market portfolio contains all risky assets. These include not only traded assets like stocks, bonds and preferred stocks, but assets on which data are not as readily available, such as diamond, gold, old coin and even human capital.

A number of studies have challenged Roll's critique and shown that the CAPM is in fact, empirically testable. However, in spite of the expansion of the test to include a broader range of assets, Shanken (1987) as referred in Elton and Gruber (1997, p. 360) recognized that the test of CAPM would still be valid even if a proxy portfolio such as market index is used. The CAPM still does not appear to hold. Therefore, many researchers release the assumptions and extend the model, as well as to investigate alternative asset pricing models. The alternative asset pricing models are discussed under missing risk factors in the next section.

***Sample and data biases***

The tests of CAPM largely depend on the sample of data and sources of data. Past studies have shown that there are two major data and sample related biases such as survivorship bias and look-ahead bias.

Kothari, Shanken and Sloan (1995) reported that market anomalies reported by Fama and French (1992) are biased because Fama and French (1992) used COMPUSTAT data base and it has data of more survived companies than the CRSP data file.

Look ahead bias arises when use data which are not yet available but assumed to be available. when computing P/E, B/M ratios, earnings and book value information will go to investors when they receive the annual report and not at the last date of the financial year. Ignorance of this fact causes to bias in regression parameters (Banz & Breen, 1986).

Blume and Stanburg (1983), and Mackinlay (1995), proposed an extreme view on this data-bias hypothesis and argued that many reported anomalies were simply the end results of extensive, collective data snooping exercises.

***Measures taken to improve the beta estimates***

Basically three methods can be used to improve the estimation of beta.

I. Fama and French (1992) estimated beta based on portfolio returns to minimize the problem with instability of individual stock betas while maintaining the richness of individual stock variations compared to that of portfolios.

II. As mentioned earlier Dimson (1979) has proposed three methods to adjust returns for thin trading problem. In addition to that thin trading problem can be minimized in formation of trading strategies by ignoring companies which have not traded above some predetermined benchmark level of non trading (for example three months) with a trading horizon (for example 6 months) for both formation period as well as for the holding period. Further, some researchers ignore infrequently traded securities completely from the sample (Nanayakkara, 2008). However, this method is not appropriate if the sample has limited number of stocks.

III. Survivorship bias problem can be addressed by taking even delisted securities for the sample (Chen, Jegadeesh and Lakonishok, 1995). Further look ahead bias has been addressed by Basu (1979, p. 665).

> …*Although the P/E ratio was computed as of December 31, it is unlikely that investors would have access to the firms financial statements, and exact earnings figures at that time, even though Ball and Brown [1] among others indicates that the market reacts as though it possesses such information. Since over 90% of firms release their financial reports with in three months of the fiscal year-end (see[1]), the P/E portfolios were assumed to be purchased on the following April.*

### 3.2.2 Investor irrationality

Capital market theory assumes that investors always behave rationally. This means every one makes decisions based on fully available information and they are trying to maximize their utility. If the investor subject to irrational decisions he does not necessarily invest in Markowitz's efficient frontier or in other words he does not have common homogeneous expectations. The study of this topic comes under the subject called behavioral finance. Behavioral finance suggests investors biased behaviors cause to explain specific market anomalies. Two major bias behaviors which affect to come out market anomalies are market under-reaction and over-reaction.

There are many behavioral theories which explain under-reaction and over-reaction. One is the self deception theory of Daniel, Hirshleifer and Subrahmayam (1998). Their theory is based on investor overconfidence and variations in confidence arising from biased self-attribution. According to the self attribution bias, investor overestimates his ability to generate information and underestimate his forecast errors. If the investor is more over confidence about signals or assessments with which he has greater personal involvement and he will tend to be overconfident about the information he has generated but not the public information. Thus overconfidence investor over-reacts to personal information and under-react to public information.

Barberis, Shleifer, and Visny (1998) explained a model which talks about investor under-reaction. Their model explains that representative investor who suffers from conservatism bias and who does not update his beliefs sufficiently when he observes new public information. If investors act in this way, prices will tend to slowly adjust to information but once information is fully incorporated in prices, there is no further predictability in stock returns that means post holding period returns will be zero.

There are number of alternative explanations for the P/E anomaly of Basu (1977). Among the other explanations, (misspecification of the CAPM, small size effect) an alternative behavioral clarification for the anomaly is based on investor over-reaction. Accordingly, companies with very low P/E are under valued due to continuous bad earnings reports and companies with very high P/E are over valued.

There are empirical evidences supporting that some market anomalies are due to investor irrational behaviors. DeBondt and Thalar (1985) attributed that their finding of contrarian strategies where returns over 3 to 5 years reversed back in the subsequent period of 3 to 5 years as investor over-reacted to formation period information and price correction in the subsequent period. Debondt and Thalar attributed their findings of 3 to 5 years period losers turned out to be winners in the next 3 to five years, as over-reaction effect.

They argued that investors gradually over-react to the new information and it takes share prices extremely high and decline in the subsequent period. The opposite is true for the losers. However, Zarowin (1990) pointed out that contrarian effect was due to size effect and January effect. He pointed out that in most of the ranking period's loser portfolios likely to be smaller size than that of the winners. Hence, when the losers were small size firms they outperformed the winners. However, Ball and Kothari (1989) refused both of the over-reaction and size explanations to returns reversal effect. They pointed out that time varying beta is the reason for the reversal of returns. They pointed out that beta of the winner portfolio was decreased by 49 percent from the first year of the formation period to first year of the holding period and opposite was true for losers.

Although over-reaction hypothesis for long term contrarian or reversal effect of returns are refused, there are no strong evidence to reject the delayed reaction effect of momentum.

Jegadeesh & Titman (1993) examined the relative strength strategies called the momentum strategies in the NYSE. The main hypotheses in the momentum strategies are that past period winners having above average returns in the medium 3 to 12 months also will have higher returns in the next period. On the other hand past period losers have below average returns in the medium 3 to 12 months also will have lower returns in the next period. Jegadeesh and Titman (1993) pointed out that their momentum effect was due to under-reaction to formation period information. But according to Conrad and Kaul (1998) there could be a momentum profit due to the cross–sectional variance of expected returns. Momentum profits can be achieved by buying high mean securities using the proceeds from sale of low mean securities because losers and winners on average reflect lower and higher average returns respectively. However, Jegadeesh and Titman (2001) has strongly rejected this hypothesis. Jegadeesh and Titman (2001) found that cumulative momentum profits were continuously negative through 13–60 months post holding period. Hence, they refused the Conrad and Kaul (1998) hypothesis that momentum profits are due to cross-section variation of expected returns.

### 3.2.3 Missing risk factors

The CAPM model was developed under restrictive assumptions and it explains the behavior of total capital market in macro level. However, CAPM is not true in the real world because of their restricted conditions. Most of investors keep portfolio of risky assets. However, they are not resembled to market portfolio. Therefore, researchers have developed alternative multifactor asset pricing models by releasing some of the assumptions held by the CAPM. The most important multifactor asset pricing models are Intertemporal Capital Asset Pricing Model (ICAPM), Arbitrage Pricing Model (APM) and Fama and French three factors model because these three models provide basic frame-work for the analytical model in this study. The section 3.4 discusses multifactor models in details. Since some of the multifactor models emerged out of market anomalies, next section is devoted for the discussion of market anomalies.

## 3.3 Market anomalies

This section is devoted to examine the firm characteristics and returns. This means relationship between firm characteristics and excess returns are examined. Financial literature revealed that a number of firm characteristics such as E/P, size, B/M value, trading volume and momentum were related to excess returns. On the one hand, CAPM holds that beta is the sole factor which explains the cross-section of expected returns. On the other hand, the above characteristics are related with the excess returns. Therefore, the above mentioned characteristics are known as market anomalies. In this section above mentioned five market anomalies are addressed.

### 3.3.1 The size anomaly

Banz (1981) published one of the most often quoted empirical articles on the size effect. The size effect refers to the negative relationship between stock returns and market value of common equity of the firm. Banz (1981) was first to uncover this phenomenon based on NYSE. Employing the methodology similar to Fama and MacBeth (1974) Banz documented that small firms earn significantly higher excess returns (Alfa) than other size based portfolios during the period from 1936 – 1977. Further, he pointed out that the returns difference of buying small firms than the very large firms was 12 percent per month (19.8 percent per annum).

After the discovery of size effect by Banz many researchers have tried to find reasons for the size effect based on U.S. data. Reinganum (1981) analyzed the size effect in a shorter period of 1975 to 1977 with a sample of 566 NYSE and AMEX firms over the period 1975-1977. He found that the largest 10 percent of the firms underperformed the smallest 10 percent of the firms by 1.6 percent per month. The smallest 10 percent of size portfolios had a beta roughly equal to 1 and also a return of about 1 percent per month above the return on the equally-weighted market index. The largest size portfolio had a beta of 0.83 and underperformed the market by roughly 0.6 percent per month. Brown, Keim, Kleidon and Marsh (1983) reexamined the size effect using the same data used by Reinganum over a longer sample period of 1967 to 1979 using the Fama MacBeth approach. They found that there was an approximately linear relation between the average daily return on 10 size-based portfolios and the logarithm of the mean size of all firms in the portfolio.

They also showed that the size effect was unstable over time and was reversed in the period 1967 to 1975.

Keim (1983) reported an average excess return of small stocks of 2.4 percent per month in a sample of NYSE and AMEX firms over the period 1963-1979. Evidence was provided that daily abnormal return distributions in January had large means relative to the remaining eleven months.

Kim and Burnie (2002) reported that mean rate of return on stocks decrease as firm size increase. Their sample period was from January 1976 to December 1995 and number of sample firms varied among years from 680 to 835. They reported that small size portfolio had a mean return of 2.32 percent and it was doubled that of large size portfolio.

More recently Al-Rjoub, Varela and Assan (2005) examined size effect using all NYSE, AMEX and NASDAQ operating firms for over the period 1970–1999. They reported that average returns of small size firms outperformed the average returns of large size firms during the total sample. However, during the ten year period from 1980–1989 size effect was reversed and in the next decade it again appeared.

In addition to the U.S. findings a large number of research studies has been done based on other developed and developing markets. Some of the important findings are summarized as follows.

Levis (1985) examined the size effect in London Stock Exchange (LSE) from 1958–1982 using all the stocks in LSE. He formed 10 equally weighted portfolios and found that small size portfolio had average returns of 1.33 percent while the large size portfolio had 0.94 percent. However, small firms had lower risk (beta equal to 0.64) than large firms (beta equal to 1.02). Mills and Jordanov (2000) also found that small size portfolios outperformed the large size portfolios in LSE from 1985 to 1995 inclusive of both years.

Wahlroos and Berblund (1986) examined the size anomaly at Helsinki Stock Exchange from 1970–1981 period. Using the Fama MacBeth cross-sectional regression method, the risk adjusted mean annual returns for the small size portfolio was 8.7 per year while it was negative (-2.2 percent) for the large size portfolio.

Elfakhani, Lockwood, and Zaher (1998) examined the size effect based on nearly 2000 stocks traded in two stock markets exist in Canada: Toronto Stock Exchange and Montreal Stock Exchange from June 1975 through December 1992. Using the Fama-MacBeth methodology they found that average stock returns decreased with the increase of firm size. This evidence was true even after controlling for the beta variation.

Herrera and Lockwood (1994) examined the size effect on Mexican Stock Market using data from January 1987 to December 1992. They found that average returns increased with increases (decreases) in beta (size), using the portfolios segmented on size alone. For example, for Mexican size sorted portfolios low, medium, and high, size sorted portfolios earned, average monthly returns of 5.80 percent, 3.46 percent, and 1.64 percent, and betas were 1.31, 1.12, and 0.79.

In another study the relationship between cash flow risks, firm size and returns were examined by Gomez, Hodoshima, and Kunimura (1998) from 1957 to 1994 in TSE. They found negative relationship between firm size and cash flow risk. It means when firm size decrease cash flow risk increase. Further, smaller firms reflected positive excess returns. Thus, firm size may proxy for cash-flow risk and this risk was not captured by beta in explaining the excess returns of small firms over large firms.

Among the other studies Maroney and Protopapadakis (2002) examined the size effect on seven markets namely, Australia (AUS), Canada (CAN), Germany (DEU), France (FRA), the U.K. (GBR), Japan (JPN), and the U.S. (USA). The sample period for USA and CAN was November 1983 to October 1994 and for AUS, FRA, DEU, GBR, and JPN is November 1986 to October 1994. They found that small size portfolio returns outperform large size portfolio returns for all the markets.

Holle, Annaert, Crombez, Bart (2002) examined the size anomaly over 15 European country stocks of 2866 from January 1973 until December 2000. Every stock in the sample belonged to one of the following countries: Austria, Belgium, France, Germany, Denmark, Finland, Ireland, Italy, Netherland, Norway, the U.K., Switzerland, Spain, Portugal or Sweden. According to the value weighted portfolio returns, small European stocks earned a monthly return of more than 2.6 percent per month, which was much higher than the 1.2 percent per month for the largest stocks. This result was found after excluding the 20 percent smallest stocks of each country from the sample. They found a significant size premium of 1.45 percent per month, or about 19 percent on an annual basis by employing the Fama and French (1993) three factor model.

There are number of studies of size effect done based on Athens Stock Exchange (ASE). Leledakis, Davidson and Karathanassis (2003) examined the cross-sectional variation of stock returns for the 1990-2000 period using the Fama French portfolio grouping procedure. They used size, beta, B/M equity, leverage, E/P, dividend yield and sales-to-price as independent variables in the model. However, they found that only size had a significant explanatory power in explaining cross-sectional variation of stock returns. Further, Theriou, Maditinos, Chadzoglou and Anggelidis (2005) and Kousenidis (2005) also found that size had a negative relationship with stock returns at ASE.

The above findings reveal that size effect is visible in the international markets. For most of the studies size effect is not captured by beta. Most studies in agreement that some risk factors not included in traditional asset pricing models is captured by size effect.

Several studies have examined the size effect in bull versus bear markets. Generally these studies found that size effect was different depending on the primary condition of the market. Bhardwaj and Brooks (1992) examined the size effect in bull and bear market using Dual-beta market model for NYSE and AMEX stocks from 1926 to 1988. The study classified as either a bull month or bear month if the market return in that month was higher or lower than the median market returns over the entire period. They found that for the whole period, monthly average returns decreased with the size increased but small firm stocks under-performed large firm stocks in bear months but out-performed them in bull months.

Kim and Burnie (2002) found a different findings to Bhardwaj and Brooks (1992) taking a sample of 680 to 835 surviving firms from 1976 to 1995. They found that average monthly returns of portfolios were negatively related with size. They found that size effect was true in the up-market but not in the down-market period.

Rutledge et al. (2008) examined the size anomaly in Chinese market from 1998-2003 on conditional markets. They recognized the bull market period as the up-market of Shanghai A-share monthly index level and bear market as the down ward trend of the index. They reported that in the bullish market average daily excess returns were a monotonically decreasing function of market value of the firm. However, in the bear market small firm recorded negative returns while large firms reported positive returns.

In summary of this sub section, studies found that during bull markets small firms have returns higher than large firms. However, during bear markets, returns of small firms did not significantly outperform that of large firms. Therefore, it can be concluded that size effect is visible only in bull market conditions.

### 3.3.2 Earnings-to-price (E/P) anomaly

Basu (1977) was the pioneer for uncovering the first market anomaly called Earnings-to-price effect. Basu selected 1400 firms including 300-400 delisted securities traded at NYSE from 1956-1971 in order to examine E/P effect. Basu used the reciprocal of the E/P that means P/E ratio to examine the E/P effect.

$$P/E = \frac{Market\ value\ of\ common\ stock}{Annual\ earnings\ before\ extra\ ordinary\ items}$$

Basu computed the numerator of the above ratio as at 31st December every year. However, the denominator was taken as the market value of equity as at 1st April. Therefore, his study did not suffer the look-ahead bias problem. Afterwards, all stocks in the sample were sorted into five portfolios based on their rankings. The lowest return portfolio was computed in two ways, with negative P/E securities and without negative P/E securities. Average returns of each portfolio were computed for the next 12 months and that process was continued throughout the whole study period. Basu employed the following time series regression equation suggested by BJS (1972) in order to see whether P/E sorted portfolios were related with the excess returns.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p (R_{m,t} - R_{f,t}) \qquad (3.8)$$

Where,

$R_{pt}$ = continuously compounded logarithm returns on 5 P/E portfolios in month t
$R_{mt}$ = continuously compounded logarithm returns of the market portfolio
$R_{ft}$ = risk free rate of return.
$\alpha_p$ = intercept of the equation which is the Jensen's differential Alfa.
$\beta_p$ = is the slope estimation of the equation.

Basu found that average annual portfolio returns were gradually increasing from highest P/E portfolio (9.5 percent) to lowest P/E return portfolio (16.3 percent). Further, the risk adjusted excess returns measured as α also reflected the same momentum across the portfolios. Annual excess return of the highest P/E portfolio was 2.65 percent (t=2.01) and annual excess return lowest P/E portfolio was 4.67 percent (t=3.98). Statistically significant excess returns revealed that CAPM failed to fully capture all the systematic risk associated with the extreme P/E portfolios.

Recently, Chen, Kim and Zheng (2008) re-examined the P/E anomaly based on all the stocks listed at NYSE, AMEX and NASDAQ. Their sample period was from April 1986 to March 2003. As similar to the Basu (1977) and Banz and Breen (1986) they also included even the delisted securities to the sample in order to avoid the survivorship bias problem. The authors adopted exactly the same method used by the Basu (1977) to form portfolios and to compute portfolio returns. Their findings reflected some inconsistencies with the findings of Basu (1977). Basu found that annual returns of lowest P/E portfolio outperformed the high P/E portfolio. However, this study found that average annual returns of the highest P/E portfolio were 35.5 percent and which was higher than that of the lowest P/E portfolio (25.1). However, the findings of risk adjusted excess returns (Jensen's Alfa) were similar to the Basu (1977). The lowest P/E portfolio showed higher excess returns than the highest P/E portfolio (-1.69) for the entire sample period.

Further, authors analyzed P/E effect based on conditional markets. They identified April 1986 to March 2000 as bull market period and April 2000 to March 2003 as bear market period. Average annual returns of the highest P/E stocks portfolio (48.44 percent) clearly outperformed the lowest P/E portfolio (25.33 percent) during the bull market period. The pattern was same for the excess returns also. The highest P/E portfolio showed annual excess returns of 2.99 percent and the lowest P/E portfolio reported just 0.1 percent annual excess returns during the bull market period. However, during the bear market condition it reversed. Annual average returns and excess returns were -15.67 percent and -0.23 percent respectively for highest P/E portfolio. However, the corresponding values were 24.23 percent and 14 percent respectively for lowest P/E portfolio.

Other than U.S. findings, few other international findings are reported as follows.

Anderson and Brooks (2006) examined the P/E anomaly based on London Stock Exchange data from 1975 to 2003. They computed 8 P/E statistics for each company. Empirical findings reflected that the average returns of the lowest P/E portfolio were higher than that of the highest P/E portfolio by 11.62 percent.

Stanley and Samuelson (2009) examined the P/E effect and B/M value effect based on Australian Stock Exchange (ASE). Their sample period was very short to 5 years from 2003 to 2007 and number of stocks taken for the sample varied from 129 in 2003 to 96 in 2007. They formed 5 portfolios based on the both criterion mentioned and portfolios were rebalanced every year. Portfolios were created in the way that it avoided the look-ahead bias and survivorship bias. Findings showed that average monthly returns of low P/E portfolio (31.72) were higher than the average monthly returns of high P/E portfolio (24.99). However, opposite results were found after adjusting for risk using Sharpe ratio. Risk adjusted returns of the lowest P/E portfolio was 1.98 percent but risk adjusted returns of the highest P/E portfolio was little higher than that (2.28 percent).

The conclusion of this section is that, for most of the studies there was a negative (positive) relationship between P/E (E/P) ratio and average portfolio returns. Therefore, it reveals that CAPM has failed to capture the excess returns of extreme P/E (E/P) portfolios. At last, P/E (E/P) effect seems to be market state dependent.

### 3.3.3 Book-to-Market (B/M) anomaly

Stattman (1980) provided another piece of evidence against the CAPM by showing that the average returns are positively related to B/M effect. Rosenburg, Reid, and Lanstein (1985), also found that high B/M stocks have higher return than low B/M stocks. Further, Fama and French (1992), Lakonishok, Shleifer, and

Vishny (1994) and Chen, Hamao, and Lakonishok (1991) have all examined the relationship between B/M value and excess returns.

For example, Lakonishok, Shleifer, and Vishny (1994) examined returns on portfolios of stocks bought on the basis of a stock's B/M. To control for size effect they first classified stocks into five size categories. Within each of the five size categories they classified stocks into ten equal-size groups on the basis of B/M value. The average difference in returns between the high B/M firms and the low B/M firms was 7.8 percent per year. They attempted to examine whether this difference could be explained by risk and for that purpose they used a different and interesting approach. They separated good market periods and bad market periods. They argued that if a stock is risky, it is because it gives its good outcomes when it is needed most, namely, in bad markets. They found that high B/M did not give a higher return when markets are poor, and thus argued that the higher return on high B/M firms is not due to compensation for risk.

As referred in Griffin and Lemmon (2002) one of the explanations given by Fama and French (1995) and Chen and Zhang (1998) for the B/M effect was that the equity premium in returns was higher for high B/M firms because they have relatively high risk of distress. The researchers have found that high B/M firms have relatively low earnings as well as earning uncertainty is high. As a result they tended to cut dividends compared with other firms. Further, high B/M firms have high financial risk or they have high debt ratios in their capital structures.

### 3.3.4 B/M and E/P anomaly

Kwag and Lee (2006) examined the value and growth strategies for E/P, B/M, CF/P and dividend yield for Korean Stock Exchange. Their sample period was 1954 to 2002. They created value weighted quantile portfolios under each factor. They used Sharpe ratio and Treyner ratio to measure the risk adjusted portfolio returns of quartile portfolios. Further, value and growth strategies were compared under economic contraction period and economic expansion period. Both Sharpe measure and Treyner measure revealed that in the total sample period value portfolio investing (high B/M and high E/P) generated higher risk adjusted returns than their counter parts. In the economic contraction period excess returns of growth investment became negative while excess returns of value investment became positive. However, in the expansion period excess returns for both value and growth investments became positive but again the value investments outperformed the growth investment. But authors concluded that relative returns difference between value and growth investments was high in the contraction period than in the expansion period.

In another study value premium of investment was examined using data from Toronto Stock Exchange, Canada, (Athanassakos, 2009). The sample period of the study was from 1984 to 2005. Value and growth strategies were formed based on P/E and P/BV ratios. Stocks with negative P/E ratios as well as P/BV ratios were excluded from the sample. Further, outliers were removed from the sample and for P/E ratio in excess of 200 and for P/BV in excess of 20 were recognized as outliers. Every year June, stocks were ranked and grouped into 4 portfolios under both criterion. Further, portfolios were rebalanced every year. Unadjusted average monthly returns revealed that value strategies of P/E and P/BV significantly higher than their counter parts in the total sample period (6.30 percent and 4.25 percent respectively). Their sub-sample analysis of value premium on bull and bear market states revealed that both value premiums were positive and statistically significant in the bull market condition as well as in bear market condition. However, value premiums were steeper in the bear market than in the bull market.

In summary, both E/P and B/M anomalies are market state dependent and both anomalies are true mainly in the contraction period than in the expansion period.

### 3.3.5 Momentum anomaly

Return reversals as well as continuations are the latest patterns of anomalies in stock market that empirical researchers have uncovered. Many researchers both in developed markets as well as in developing markets have tested these two anomalies in detail. However, this section mainly examines the momentum strategies and possible reasons for the momentum strategies.

De Bondt and Thaler (1985, 1987) found that stocks that were the most extreme losers have abnormally high subsequent performance and stocks that have been the biggest winners had subsequent poor performance. Hence, they created contrarian strategies by buying past 3 to 5 years worse performing stocks and selling past 3 to 5 years best performing stocks. They pointed out that such strategy could create zero investment profits.

Starting a new research paradigm to the long-term contrarian strategies, Jegadeesh and Titman (1993) examined the relative strength strategies called the momentum strategies in the NYSE. The main hypotheses in the momentum strategies are that past period winners having above average returns in the medium 3 to 12 months also will have higher returns in the next period. On the other hand past period losers have below average returns in the medium 3 to 12 months also will have lower returns in the next period. They employed the daily return data of NYSE from 1965 to 1989 for their study. They examined 16 different momentum strategies based on 1 to 4 quarters as holding period (J) and in the same way 1 to 4 quarters as the formation period (K). In addition, they examined a second set of 16 strategies that skip one week between portfolio formation period and holding period. They skipped a one week between the formation period and holding period in order to avoid bid–ask spread, price pressure, and lagged reaction effects. In order to test the momentum anomaly they ranked securities in to descending order in each month t on the bias of their formation period returns. Based on these rankings, 10 equally weighted portfolios were created as top decile, second decile and so on. The top decile portfolio was called the winner portfolio and the bottom decile was called the loser portfolio. In each month *t* strategy sold the loser portfolio and bought the winner portfolio and holds it for the next *J* period. To increase power of the test, the portfolios were rebalanced every month to maintain the equal size. Their initial findings of momentum strategy reflected that highest return strategy was the 12 months 3 months strategy (0.0131) when there was no one week lag between portfolio formation and holding. That figure was increased to 0.049 when there is a one week time lag between portfolio formation and holding periods. On average 6 months formation and holding 3, 6, 9 & 12, respectively showed 1 percent level relative strength profits.

Conrad and Kaul (1998) examined the profits of momentum and contrarian strategies using the monthly and weekly returns data of NYSE and AMEX from 1926 to 1989. They divided the sample period into two sub periods as before World War II and after World War II. Their portfolio formation and profit calculations were as same as, Jegadeesh & Titman (1993). They found that after second world War period momentum profits were significant in 3-12 months. One week strategy from 1962 to 1989 was contrarian and highly significant.

Jegadeesh and Titman (2001) further examined the profitability of momentum strategies documented in Jegadeesh and Titman (1993). The previous paper of the same authors was conducted the analysis from 1965 to 1990 and this paper extended the sample period for another 8 years up to 1998. In this paper, they examined whether the profitability of momentum strategies documented by Jegadeesh and Titman (1993) could be recognized to data mining bias. But, this sample was different from the Jegadeesh and Titman (1993) by including NASDAQ stocks. Additionally, this study excluded all stocks priced bellow 5$ at the beginning of the holding period and all stocks with the market capitalization that would fall to the smallest NYSE decile.  This further extended study revealed that from 1990-1998 momentum profits in 6 months strategy was 1.39 percent per month. The original paper of the same authors in 1993 showed that on average momentum profit was 1.17 percent per month. Therefore, this was a good source of evidence that momentum profits were not due to data mining.  Lee and Swaminathan (2000) also found momentum effects for NYSE and AMEX from January 1965 to December 1995.

In addition to U.S. findings there are many international findings on momentum anomaly and some of them are presented as follows.

Rouwenhorst (1998) examined momentum strategies in 12 European countries from 1978 through 1995. These countries and number of stocks were Austria (60 firms), Belgium (127), Denmark (60), France (427), Germany (228), Italy (223), Netherlands (101), Norway (71), Spain (111), Sweden (134), Switzerland (154), and the United Kingdom (494). The momentum portfolios were constructed as in the Jegadeesh and Titman (1993). The average monthly returns on the combined portfolio strategies of all countries showed that the past three months losers showed positive returns of 1.16 percent per month in the next three months period. Top winners in the last three months performed 1.87 percent returns in the next three months. The excess returns of buying winners and selling losers increased by 0.71 percent.

Chui, Titman and Wei (2000) examined the profitability of momentum strategies in eight different Asian countries namely Hong Kong, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand. The sample included all the listed companies in 8 Asian markets. They included only the stocks which have size data as well as return history of at least 8 months. Sample period started in late 1970s for most markets and end in February 2000. For all markets, in contrast to Jegadeesh and Titman (1993) they formed three value weighted portfolios. In addition, to minimize the effect of bid-ask effects, they skipped a month between the ranking period and the holding period. They found all but two countries (Indonesia and Korea) exhibited positive momentum profits for the entire sample period. The momentum profits however were statistically significant only in Hong Kong (0.94 percent per month). For the period before the financial crisis, momentum profits were significantly positive in Malaysia, Singapore, Thailand and Hong Kong.

Nijman, Laurens and Marno (2002) examined the momentum effect in 15 developed European markets. Their sample period was January 1990 to November 2000. Based on Jegadeesh and Titman (1993) procedure they formed three value weighted portfolios as well as three equally weighted portfolios. In order to reduce micro structure effect the first month was skipped between portfolio formation and investment. According to their findings, all the sample countries showed a momentum effect except Sweden and Austria. Momentum effect was significant for Denmark, U.K. and France. The country neutral momentum strategy on average (average over each of countries) yielded a significant 0.63 percent momentum profit.

Shen, Szakmany and Shaima (2005) examined value (high B/M), growth and blended momentum strategies in international markets. Their sample included country indices of 18 developed capital markets. In evaluating momentum and contrarian strategies, they used the methodology of Jegadeesh and Titman (1993 and

2001). They formed 3 portfolios in the way that one portfolio included 6 country indices. The profitability patterns in the overall blended equity indices agree with the findings from Jegadeesh and Titman (1993), i.e. momentum profits were found for medium time horizons (3-12 month holding periods) while contrarian profits were observed for long holding periods of two to five years.

When the existence of momentum or contrarian anomaly is confirmed, it is important to understand its causes. Although the existence of momentum or contrarian does not seem to be controversial, it is much less clear what might be driving it. Researchers have examined momentum effect in relation to overreaction, underreaction, size and risk etc.

Barberis, Shleifer, and Visny (1998) tended to explain momentum profits as investors underreact to ranking period information which was gradually incorporated in stock prices causing a momentum in stock returns. When investors response to new information in the above manner, prices will have a propensity to slowly adjust to information but once information is fully included in prices, there is no further predictability in stock returns that means post holding period returns will be zero.

Daniel, Hirshleifer and Subrahmayam (1998) presented a behavioral model that is based on the idea that momentum profit arise because of inherent bias in the way that investors interpret information. Their model was based on investor over confidence bias. According to over confidence bias, investors over estimate his ability to generate information and underestimate the forecasting errors. If the present signals of stock prices are in accordance with information he gathered, investor over-react on that information. This overreaction to personal information will cause short term auto correlation in stock returns. Jegadeesh and Titman (2001) examined post holding period behavior of cumulative momentum profits over 60 months. They found that cumulative momentum profits declined after the month 12. This finding is consistence with the overreaction hypothesis.

***Momentum and market states***

Moreover, the empirical results have shown that momentum profits are related to the market states. Cooper, Gutierrez and Hameed (2004) examined the impact of market states on momentum profits in order to test the overreaction hypothesis. According to them, stock market was defined as in down (up) market if the portfolio formation period market returns were negative (positive). They found that average monthly momentum profits following up-market was significantly positive (0.93 percent) and the average monthly momentum profits in the down-market was negative (-0.37 percent). They interpreted that up-market momentum was due to the overreaction to market signals by investors in the up-market.

More recently, Wang, Jiang and Huang (2009) examined momentum profits in up-market and down-market states using weekly data from the Taiwan Stock Exchange from 1997-2006. Up (down) market states were recognized if 6 months market index returns prior to holding period was positive (negative). The authors found negative relationship between momentum profits and market states. This means momentum profits were negative in up-markets and positive in down-markets.

Further, Profitability of momentum effect following bull and bear markets using data from the London Stock Exchange was examined by Antonios and Patricia (2006). They found that momentum profits were more evident following bear markets.

Muga and Santamaria (2009) examined the momentum effect in Spanish market from 1973 to 2004. They tested the disposition hypothesis where investor's under reaction to past period information leads to momentum profits. They examined up-market and down-market momentum effects in order to test the disposition hypothesis. In the up-market disposition prone investor is declined to sell the stock and on the other hand if loser portfolio generates negative returns such investor declined to keep loser portfolios and it creates momentum in the up-market. However, if both loser and winner are positive, the momentum effect may very small in the up-market. The authors found significant momentum profits for all the 16 strategies tested and they found momentum profits both in up-market and down-market.

### 3.3.6 Trading volume anomaly

Volume is number of units traded during the time period under study. Technical analysts use volume as well as price trend to predict the future movements of stock prices. Murphy (1999, p. 162) explains the relationship between volume and stock price as "volume should increase or expand in the direction of the existing price trend. In an up trend, volume should be heavier as the price moves higher, and should decrease or contract on price dips". Therefore, trading volume and share price is seemed to have a positive correlation. This sub section examines the theoretical background as well as empirical evidences on volume–price relationship.

***Sequential arrival of information theory***

As referred in Karpoff (1987), Copeland (1976) has developed this model to explain the positive correlation between trading volume and absolute change in price. There is a one strong assumption behind the theory. It assumes that information is disseminated to only one trader at a time, further, information causes to one time upward shift in the demand curve of "optimists" by X amount and one time down ward shift in the demand curve of each "pessimist" by same X amount. Further, any uninformed trader does not infer the content of the information from informed traders' actions. Copeland says that trading volume generated by a optimist is higher than the trading volume generated by a pessimist because of short sales.

According to the theory, price change and trading volume of the next informed trader is depending on two factors.

I. trading pattern of the previous informed trader
II. whether the subsequent trader is an optimist or pessimist

Simulation test pointed out that the trading volume was highest when all the traders were optimists or pessimists. Therefore, change in price and volume has a positive correlation.

There are some unrealistic points in the theory. It assumes that uninformed investors can not learn the information from the acts of informed traders. However, practically, most of the uninformed traders follow the informed traders and they are passive investors.

***Mixture of Distribution Hypothesis (MDH)***

MDH has many forms. Epps and Epps (1976) have derived a model and according to that variance of the price change on a single transaction is depend on the volume of that transaction. Hence, price and volume has a positive correlation. The information sequential hypothesis (ISH) and MDH are mostly similar. However, according to ISH information comes to market one after another. However, MDH assumes that information can come even simultaneously.

Recent empirical findings of the relation between change in stock price (return) and trading volume are as follows.

Ciner (2002) examined the simultaneous and lags relationships between daily stock returns and trading volume on Toronto Stock Exchange using TSE 300 index from 1990 to 2002. There sample period included 7 years pre-automation period and 5 years post automation period. They employed the following vector autoregressive (VAR) model to test the lag relationship between trading volume and index returns.

$$R_t = a_r + \sum_{i=1}^{l} b_{r,i} R_{t-1} + \sum_{i=1}^{m} c_r V_{t-1} + \sum_{i=1}^{k} D_i + U_{r,t} \qquad (3.9)$$

Where,
$R_t$ = index returns
$V_t$ = volume measured by number of shares traded

$D_i$ = dummy variables to capture the day of the week and month of the year effect.
$U_{r,t}$ = error term
l,m,k = autoregressive lag lengths

Further the contemporaneous relationship between returns and trading volume established by the following Generalized Method of Moments (GMM) approach.

$$R_t = b_0 + b_1 V_t + b_2 V_{t-1} + b_3 R_{t-1} + U_t \quad (3.10)$$

The study found that there was a negative relationship between contemporaneous returns and trading volume ($b_1$ =-0.009, p =0.09). However, that relationship was no more significant after the automation. Results were same for lag return model also.

Chen, Firth and Rui (2001) examined the dynamic relations between returns, volume and volatility of stock indices of nine national markets from 1973 to 2000. Using daily returns, they found that non-absolute return-volume relationship (contemporary) as significant for five countries but the relationship between absolute return and value was significant for all the nine countries. Further, their Ganger causality test revealed that in the presence of current and past returns, past trading volume has significant (5 percent lave) relationship with current returns only for Switzerland and Netherland. Therefore, for most of the countries trading volume does not add significant predictive power for future returns.

Khan and Rizwan (2001) examined the casual relationship between trading volume and daily stock returns in Karachi Stock Exchange. The study found that there was a significant lag relationship between trading volume and stock returns and they concluded that information content on volume affect stock returns.

Lee and Rui (2002) examined the individual as well as cross-country relationships between daily index returns and daily trading volume. They selected S&P 500, Tokyo Stock Exchange Price Index (TOPIX) and Financial Times – Stock Exchange (FT-SE 100) as data for the study. The study found that there was a contemporaneous positive relationship between trading volume and stock returns in all the 3 countries. Further, they found that S&P 500 index returns and trading volume has an explanatory power on returns of FT-SE 100 and TOPIX.

Pisedtasalasai and Gunasekarage (2008) examined the relationship between trading volume and stock returns in 5 East Asian countries, namely, Indonesia, Malaysia, Philippine, Singapore and Thailand. They used daily index data and corresponding trading volume for their analysis. The relationship between returns and trading volume was examined using VAR. They used 7 volume lag variables as independent variables in the model. Their study was based on the sequential information arrival model and according to that lag trading volume may contain information to predict the future stock returns. Therefore, contemporaneous trading data was not added to the VAR model. The empirical evidence showed mixed results. They found significant relationship between trading volume and stock returns for Singapore (lag 2=1.6108, $F$ =2.27) and a weak relationship for Indonesia (lag 5 = -0.1412, $F$ = 1.00). For other countries there was no significant relationship between stock returns and trading volume.

Nowbutsing and Naregadu (2009) examined the contemporaneous relationship between stock returns and trading volume at Mauritius Stock Exchange (MSE) taking 36 companies from 2002 to 2008 as the sample of the study. They examined the MDH by taking trading volume as the independent variable which represents the arrival of new information. The study found that there was no relationship between trading volume and stock returns on the MSE. The authors justify the above results as a consequence of few securities registered at MSE.

***Visibility hypothesis***

Taking a new approach to volume–return relationship, some researchers have tested visibility hypothesis. Gervars, Kaniel and Mingelgrin (GKM) (2001) developed visibility hypothesis based on viewpoints of Miller (1977) and Mayshar (1983). Visibility hypothesis holds that when investors have diverse opinions about the value of a stock, the traders who bought the stock are optimistic about its value. Further, when the stock’s supply is limited by short selling or margin trading then the opinion of the pessimistic investors will not incorporate into the stock price and the stock price will be bias. GKM pointed out that under such situation, any positive shock in number of traders giving attention to the stock (GKM named as increase in the stock’s visibility) will increase demand for the stock (because number of buyers increase). However, supply for the stock will remain constant (no excess in sales). Hence, volume and price move positively. Therefore, the visibility hypothesis suggests that under market constraints, if more traders’ attention is attracted on a stock its trading volume and price will increase.

Visibility hypothesis was first tested by GKM (2001) and subsequently by Huang and Heian (2010). GKM examined the relationship between current trading volume with future returns for NYSE from 1963 to 1996 for both daily and weekly data. Number of shares traded is used as the measure of trading volume. Portfolios were formed in accordance with the Jegadeesh and Titman (1993) approach. They formed high, medium and low volume portfolios based on daily and weekly data and without rebalancing kept these portfolios for 1, 10, 20, 50 or 100 trading days. Study found that portfolios with high trading volume tended to be followed by high returns and vice versa. This high-volume return premium was true when the formation period was day or a week. It lasted at least 20 trading days and at most 100 trading days.

Huang and Heian (2010) examined the risk adjusted high value premium based on all firms listed on NYSE and AMEX from August 1963 to December 2005. They used the conventional method widely used by momentum literature (Jegadeesh and Titman 1993) to test the strategy. Formation period was 26 weeks and the holding period varied from 1 week to 52 weeks. They found statistically significant abnormal returns for high volume minus low volume portfolio for holding periods 1-4 weeks. However, as the holding period increased beyond 8 weeks, abnormal returns fallen below 4 percent.

In summary of this sub section, most of the early studies on volume-return relationships examined sequential arrival of information theory or HMD. Using daily returns most studies hold that daily stock returns relate with contemporary trading volume. Few studies found that there is a lead-lag relationship between stock returns and trading volume. More recently, Huang and Heian (2010) found that weekly trading volume has an explanatory power on weekly stock returns.

## 3.4 Multifactor asset pricing models

### 3.4.1 Intertemporal Capital Asset Pricing Model (ICAPM)

Merton (1973) as referred in Elton and Gruber (1997, p. 330-331) has constructed a generalize ICAPM in which number of sources of uncertainty would be priced. One of the major limitations of the CAPM is that it is valid only for a one single period. However, investors invest in assets for multiple periods and they rebalance their investment portfolios continuously. Under such circumstances standard CAPM is not valid. Merton has constructed ICAPM, where holding periods were allowed to change through time and face with multiple sources of uncertainty. Merton showed that investors would take into account not only systematic risk, but also the uncertainty of economy in their current economic decisions. This suggested that investors would form portfolios to hedge away each of these risks. If sources of risks are a general concern to investors, then these sources of risk will affect the expected returns of securities. Therefore, according to the Merton model multiple betas are needed to explain expected returns; and that the number of betas include, one broad market factor plus other state variables which affect investors investment opportunities. The form of the expected returns according to ICAPM is:

$$R_i - R_f = \beta_m(R_m - R_f) + \beta_{I1}(R_{i1} - R_f) + \beta_{I2}(R_{i2} - R_f) + \ldots\ldots\ldots\ldots \quad (3.11)$$

Where, $R_i$ is the expected return of the model, $R_m$ is the market factor and $R_{i1}$ and $R_{i2}$ represent other risk factors.

### 3.4.2 Arbitrage Pricing Theory (APT)

Since, CAPM does not hold, Ross (1976) has proposed a new approach to explain the pricing of assets. Arbitrage assumes that certain risk free profits can be achieved by simultaneously buying and selling identical assets. The theory has a strong assumption as if assets do not correlate and fully reflect their risk characteristics, arbitrage opportunities may arise and these will be quickly eliminated by the act of arbitragers and equilibrium price will be restored. The main difference of the APT and CAPM is that there are several systematic risk factors that affect on security returns, APT presents in theoretical form as follows.

$$R_i = E_i + b_{i1} + b_{i2} + \dots\dots\dots.\dots. + b_{kn}\delta_k + \varepsilon_i \qquad (3.12)$$

$E_i$ = the expected return on asset i
$\delta$ = the common factor that affect all asset returns
$b_{ij}$ = sensitivity measure of asset $i$ 's returns to the change in the common factor.
$\varepsilon_i$ = the firm specific error term.

The common operational form of the APT is,

$$R_{i,t} - R_{f,t} = \beta_{j1,t}(R_{f1,t} - R_{f,t}) + \beta_{j2,t}(R_{f2,t} - R_{f,t}) + \dots. + \beta_{jk,t}(R_{nk,t} - R_{f,t}) + \varepsilon_i \qquad (3.13)$$

The above two models study that asset returns equal to returns that uncorrelated with ($\varepsilon_i$ or $R_f$) with risk factors and sensitivity to changes in other risk factors. As APT does not specify any factors, it can never be falsified and researchers who want to test the model would have to propose viable factors. However, one thing should be noted here, APT does not necessarily contrast the CAPM, in the extreme case it consistent with the single index market risk factor ($R_m$- $R_f$) (Elton and Gruber, 1995, p. 387). The coming part of this section explains the empirical findings of APT.

Roll and Ross (1980) were the pioneers of APT tests. They used individual equity data of NYSE and American Stock Exchange (AMEX) over the period 1962-1972. Their final conclusion was that five factors were more than enough to explain the variability of stock returns. However, they pointed out that at least 3 factors needed to load in APT model. Subsequently, Chen, Roll and Ross (1986) attempted to identify these factors. They used macroeconomic variables to test the effect of economic forces within an APT model. They found that following macroeconomic variables systematically explain stock market returns: the spread between long and short interest rates, expected and unexpected inflation, industrial production, and the spread between high and low grade bonds. However, most noting has the finding that market index did not have significant impact on stock returns. This further concludes the failure of CAPM.

Dhrymes, Friend and Gultekin (1984) found that number of factors concluded by Roll and Ross (1980) were depending on number of securities in the sample. For example, if the group consists 15 securities, only one or two factors may enough to explain the returns. For an example, if the number of securities in the sample reaches 60, five or six factors could be enough to explain the variation of returns. Therefore, the findings suggest that number of factors needed in the APT model is not certain. Based on APT approach, Fama and French (1993) has developed the " Fama and French three factor model".

### 3.4.3 Fama and French three-factor model

The paper written by Fama and French (1992) made a turning point in assets pricing models. They made the first empirical investigation to evaluate the joint effect of market beta, size, E/P, leverage and B/M in explaining the cross-sectional average returns of all non-financial NYSE, AMEX and NASDAQ stocks from the period 1962-1989.

Fama and French first sorted all the stocks based on market capitalization and grouped into 10 portfolios and subsequently they sorted stocks under each size deciles and formed 10 portfolios based on past 24-60 month beta estimates. They used Fama and MacBeth (1973) cross-sectional regression to regress the portfolio returns on the specified explanatory variables individually as well as jointly. Their findings were as follows.

I. Beta was not statistically significant when used as a single explanatory factor.
II. Even though leverage and E/P effects were significant when they were used as explanatory variables individually, when used jointly their effects were subsumed by size and B/M factors.
III. They concluded that, if assets were priced rationally risks of stock are multidimensional. This means one dimension of risk was provided by size and the other dimension of risk was proxy by B/M.

Based on the findings of the previous paper, Fama and French (1993) further examined the relation between dependent variables of stock and bond returns and independent variables of firm common risk factors. They used three stock market factors and two bond market factors as independent variables. The stock market factors were size, B/M factor and market index. Two bond market factors were the term structure of rates and default risk. They used the time series regression approach of BJS (1972), monthly returns on stocks and bonds were regressed on the returns to market portfolio of stocks and mimicking portfolio of size, B/M and term structure risk factors. The time series slopes were treated as factor loadings and size and B/M had a clear interpretation as risk factor sensitivities of securities.

Sample of the study included NYSE, AMEX and NASDAQ stocks and U.S. corporate and treasury bonds over the period 1963-1991.

In this study Fama and French created B/M and size mimicking portfolios by taking the returns difference between the bottom 30 percent and top 30 percent of the ranked values of B/M and size portfolios. B/M mimicking portfolio was created in the way that neutralize the size effect and size mimicking portfolio was created in the way that neutralize the B/M effect. The interest rate change represented the bond risk and default risk was coming form the changes in economic conditions.

They used excess returns of 25 portfolios formed on size and B/M as dependent variables. The 25 portfolio excess returns were regressed on the following model.

$$R_{it} - R_{ft} = \alpha_i + \beta_m (R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i TERM_t + d\ \ DEF_t + \varepsilon_{it} \quad (3.14)$$

Where:

$R_{it}$-$R_{ft}$ = the portfolio excess return at time *t*

$R_{mt}$-$R_{ft}$ = the market excess return at time *t*

$SMB_t$ = the mimicking portfolio return difference between the 30 percent smallest and largest stocks (SMB: Small Minus Big)

$HML_t$ = the mimicking portfolio return difference between the 30 percent highest and lowest B/M portfolios. (HML: High Minus Low)

$TERM_t$ = the spread between long-term government bond and one-month Treasury bill

$DEF_t$ = the portfolio return difference between long-term corporate bonds and long-term government bonds.

$E_{it}$ = the portfolio specific error term.

This model was used to answer for two specific asset pricing issues.

I. If assets are priced rationally, variables that are related to average returns, such as size, B/M must proxy for sensitivity to common risk factors in returns. This was measured by $R^2$ value of the model.

II. The model used excess returns (portfolio returns minus risk free returns) as dependent variable and either excess returns or zero investment portfolios as explanatory variables. In such regressions, a well specified asset pricing model produce intercepts that are equal to 0. This implies that there are no excess returns left unexplained by the model.

The results indicated that both size and B/M factors provided significant explanatory power for the stock returns and market beta was also found to be significant and it was not subsumed in size and B/M factors. When three stock market factors were added to the time series regressions, the intercept term was very close to zero. Only 2 out of 25 intercepts in the three factor regression differed from 0 by more than 0.2 percent per month. Intercepts close to 0 said that the regressions that included $R_m$-$R_f$, SMB and HML to absorb common time series variation in returns do a good job explaining cross-sectional variation in stock returns. When the two other bond market factors added to the time series regression of stocks, there was no effect on the intercept term produced by the three stock market factors. The results suggested that Fama-French three factor model has the following specification.

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i (R_{m,t} - R_{f,t}) + s_i SMB_t + h_i HML_t + \varepsilon_{i,t} \tag{3.15}$$

Fama and French (1996) provided further empirical evidence on three-factor model, using NYSE, AMEX and NASDAQ stocks over the period 1963–1993. The model appeared to capture a number of anomalies not captured by the CAPM. The three factor model captured the patterns in returns observed when portfolios were formed on E/P, cash-flow-to price (CF/P) and sales growth and long term contrarian strategies documented by DeBondt and Thaler (1985). However, the three-factor model did not explain the medium term momentum strategy of Jegadeesh and Titman (1993).

Fama and French (1996) reveled that their three factors were unable to explain the momentum effect of Jegadeesh and Titman (1993). Therefore, Carhart (1997) expanded the Fama and French three-factor model by introducing momentum factor. The momentum factor was calculated by taking the difference of equal weighted, average returns of firms with the lowest 30 percent last year returns and the highest 30 percent last 12 months returns. Carhart found that the proposed four factors explain most of the cross-sectional variation of stock returns in mutual fund portfolios created from 1963 to 1993.

More recently, Simlai (2008) re-examined the three factor model of Fama and French (1993) using NYSE, AMEX and NASDAQ stocks from July 1926 to June 2007. He used the generalized autoregressive conditional hetroskdastic model and found that B/M played a stronger role in explaining average stock returns and the empirical results strongly supported the findings of Fama and French (1993).

Now, Fama and French three factor model has become the bench mark model in explaining variation of stock returns. As a result, this model has tested on other international markets also.

Drew and Veeraraghavan (2002) examined the ability of Fama and French (1996) model capturing cross-section of average stock returns for the Malaysian setting from December 1992 to December 1999. They found that the two mimic portfolios of SMB and HML generated a return of 17.70 percent and 17.69 percent per annum respectively. However, the market factor generates a return of 1.92 percent per annum. They concluded that the Fama and French (1993) model was a good representation of the risk factors for Malaysia. They also found that the average coefficient of determination ($R^2$) for size and B/M portfolios was 0.90.

Wang and Xu (2004) examined the three-factor model to A-shares in the Chinese equity market. The sample period was from July 1996 through June 2002. Size factor was found to explain the cross-sectional differences in returns, but contrary to U.S. findings B/M was not helpful. Additional factor, free float (ratio of shares in a public company that are freely available to invest to public) served as a proxy for omitted risk factors. Therefore, three-factor model of market, size and free float significantly increased the explanatory power of the market model from 81 percent to 90 percent. This study uncovered a new asset pricing model which was unique to the Chinese markets.

Malin and Veeraraghavan (2004) examined the Fama and French model for three European markets. They found that size anomaly was true for France and Germany and reversed in UK. Rather than a value premium they found a growth premium for all the three markets. The model explained 69 percent, 82 percent and 83 percent for France, Germany and UK respectively.

In another study by Drew, Naughton and Veeraraghavan (2003) compared the explanatory power of a single index model with the multifactor asset-pricing model of Fama and French (1996) for Hong-Kong, Korea, Malaysia and the Philippines. Their findings suggested that the CAPM beta alone was not sufficient to describe the cross-section of expected returns. The explanatory powers of single index models were 40 percent, 51 percent, 71 percent and 42 percent for Hong Kong, Korea, Malaysia and Philippines respectively. When the size and B/M factors added to the model, explanatory powers increased to 62.5 percent, 79.3 percent, 89.3 percent and 65.3 percent respectively.

Bahl (2006) studied the Fama and French (2003) three factor model of stock returns along with its variants. Including the one factor CAPM for 79 stocks listed on the BSE-100 stock market index for India. There were strong evidence for the market factor, size and B/M. There was strong evidence for the market factor in all the portfolios, having highest explanatory power. The study confirmed that the three factor model captured better the common variation of the stock returns than the CAPM.

Konstantinos (2008) examined the significance of the size, B/M and momentum risk factors in explaining portfolio returns in the Australian Stock Market (ASM). Overall findings confirmed existing evidence that there was a strong size effect and a weaker B/M effect in the ASM. Further, momentum returns have limited power in explaining realized returns. Additionally, they reported that average B/M factor returns were positive in both good and bad market states while momentum factor showed counter results. The size factor showed positive average returns in the up-market and negative average returns in the down-market.

Bundoo (2008) examined the Fama and French model for Stock Exchange of Mauritius from January 1998 to December 2004. Based on sample of 40 stocks they found that the time variation in betas was priced, but the size and B/M equity effects were still statistically significant. The Fama and French model was therefore robust after taking into account the time-variation in beta.

Misirli and Elper (2009) investigated the impact of coskewness on the variation of portfolio excess returns in Istanbul Stock Exchange (ISE) over the period July 1999 to December 2005. The findings revealed that coskewness was able to explain the size premium in ISE. Hence, the basic two-moment CAPM without the coskewness factor would under estimate the return of size portfolios. Cross-sectional analysis uncovered that coskewness has a significant additional explanatory power over CAPM, especially for size and industry portfolios. However, coskewness did not have a significant incremental explanatory power over Fama-French factors in ISE.

### 3.4.4 Other factor models

Chen, Hamao, and Lakonishok (1991) examined the relationship between cross-sectional difference in expected returns with four fundamental variables, namely, E/P, size, B/M and cash flow-to-price ratio based on Tokyo Stock Exchange data from 1971-1981. They employed a multivariate CAPM model with both value weighted and equally weighted index return premiums to control for systematic risk. The multivariate test revealed that both size and B/M ratios have a positive, statistically significant relationship with the cross-section of stock returns.

Mobarek and Mollah (2005) studied the relationship between firm specific factors and stock returns in Bangladesh. Their study included 123 non-financial companies listed on the Dhaka Stock Exchange (DSE) from 1988 to 1997. First, betas for individual companies were computed using univariate regression and in the second stage multivariate pooled regression was run including variables: beta, size, ratio of B/M, volume, dividend yield, positive earnings yield, negative earnings yield, positive cash flow yield, negative cash flow yield, leverage, growth and industry dummy. The study did not support the CAPM of a positive relationship between share return and beta. However, they found that variables such as size, B/M, and volume of shares traded, earnings yield and cash flow yield have a significant influence on share returns.

Using monthly data from Shanghai and Shenzhen stock markets from 1994 to 2002, Wang and Iorio (2007) found that neither the OLS beta nor the time-varying beta was related to stock returns in A-shares. Further, there was no evidence that the A-share market has become increasingly integrated with either the world market or the Hong Kong market over the sample period. They did find, however, that the B/M ratio and size were important factors in explaining variations in A-share returns.

Another study examined 207 firm-specific attributes using the Fama and MacBeth (1973) approach from June 1994 to May 2004 in ASE (Rensburg and Janari, 2008). The study found that 27 variables have displayed evidence of the ability to explain the cross-sectional variation in share returns beyond that explain by beta. Then they used all the 27 time series variables to create a multivariate model. The sets of multivariate regressions were started with the most univariately significant characteristics, and thereafter characteristics were included in the regression one at a time (in order of the statistical significance of univariate test). Until the least significant variable displayed an insignificant mean (the student's (1908) t-test at 5 percent level was taken as the cut-off point) of the time-series of controlled slopes. The variable was then removed and then the process of incorporating more variables in the regressions continued until all variables have been tested. Finally, a five factor characteristic based model for the ASE was empirically derived, which comprised: (a) prior 12 month returns, (b) B/M value, (c) two-year percentage change in dividends paid, (d) CF/P, and (e) two year percentage change in M/B value as explanatory variables.

Gharghori, Lee and Veeraraghavan (2009) provided new evidence on market anomalies and the ability of Fama and French (2003) model and other anomalies in explaining cross-section of expected returns. Their findings supported with prior research and found evidence of a size effect, a B/M effect and an E/P effect. Further, they found a new anomaly for Australia, a CF/P effect and an E/P and CF/P effect in firms that report negative earnings and cash flows, respectively. However, they did not find evidence of leverage or liquidity effects. But they have not adjusted risk when test the anomalies. Their asset pricing tests showed that the Fama–French model failed to explain the returns of their test portfolios and is thus less than satisfactory in pricing assets in Australia.

## 3.5 Empirical evidence from CSE

Although CSE in its present form goes back to early 1985, few studies have been carried out about the behavior of stock returns. Among them Nimal (1997) Samarakoon (1996, 1997), Banadara (2001), Nanayakkara (2008) Pathirawasam (2010a and 2010b) are important.

### 3.5.1 CAPM and factor models

Nimal (1997) investigated relationships between stock returns and selected fundamental variables (beta, size, E/P and B/M) using yearly data for the period 1991 to 1996. He tested the CAPM to see the relationships of the above variables with stock returns. A simple and multiple regression models were used for the analysis. The study found that average stock returns and β were not related. However, E/P ratio showed a strongly positive relation with average returns. B/M and leverage did not relate to average returns in any significant manner.

However, Samarakoon (1997) found different results from Nimal (1997). Using daily stock returns from 1991 to 1997 period, he found that average stock returns and β were strongly related. However, E/P ratio showed a strong positive relation with average returns. Size, B/M and leverage did not relate to average returns in any significant manner.

Nanayakkara (2008) examined the company size, B/M and market factor in explaining cross-section of expected stock returns in Sri Lanka. Sample of the study covered 101 listed companies which were selected based on availability of at least eight years of accounting and market data from January 1998 to December 2005. Another criteria to select a company for the study was to have traded at least once a month during the sample period. Only capital gains yield has been considered in computing stock returns.

In the methodology, each year June all the companies in the sample have been allocated to five groups based on market capitalization from small to big portfolios. Similar method was used for B/M portfolios. He found that there was an evidence of 1.45 percent monthly difference of returns between the smallest size stocks and largest size stocks. Similarly, B/M sorted portfolios showed a difference of 2.09 of monthly return between stocks of largest B/M and lowest B/M stocks. However, he has not adjusted risk to see whether the excess returns show similar results. He has used the Fama and French (1993) approach to develop portfolios in order to analyze the explanatory power of variables on portfolio of stock returns.

They found that Jensen Alfa of each regression close to zero and they concluded that the three factor model is capable to capture a cross-section of stock returns in the Sri Lankan stock market ($R^2$=87 percent). However, the author was silent about the incremental explanatory power of each factor individually.

Even though the author was silent, the table 6.3 of his study revealed that there was no size effect when stocks were sorted into three portfolios and the B/M effect was controlled. The B/M effect adjusted small size portfolios generated average returns of 0.73 percent and the corresponding value for large size portfolio 0.70

percent. Therefore, the small size portfolio outperformed the large size portfolio by 0.03 percent. Hence, application of Fama and French three factor model to Sri Lankan data is irrational.

In another study, very recently Pathirawasm (2010a) investigated the value relevance of earning based accounting information to see how value relevance has changed with the introduction of new information technology in the CSE. Sample of the study included 129 companies selected from 6 major sectors at CSE. Cross-sectional and time series cross-sectional regression were used for the data analysis. Study found that earnings per share and returns on equity have a significant impact on market price. However, the explanatory power of combined variables was below average. Further, value explanatory power of earnings has considerably improved after the new information technology adoption at CSE. Further, Pathirawasam (2010b) found that both earnings per share and book value per share are economically and statistically related with stock prices in the recent years.

### 3.5.2 Efficient market hypotheses

There are few studies coming under weak form and semi-strong form efficient market hypotheses.

Samarakoon (1996) examined first-order-autocorrelation of daily, weekly and monthly returns of the (CSE) in 1985–1995 sample period using data from two market indices and sector indices. The study found significant autocorrelation value of 0.50 and $R^2$ of about 0.30 in the daily market returns for the 1991–1995 period. Further, autocorrelation values of monthly and weekly were 0.27 each with an explanatory power of 0.07. Thus the evidence rejected random walk model of stock returns for market indices.

Bandara (2001) examined two well known phenomena in financial economics known as the January effect and monthly seasonality using ASPI returns of the CSE from 1985-1998. Results of both parametric and non parametric tests confirmed the non-existence of a January effect or a monthly seasonality on the CSE.

Further, Pathirawasm (2009) examined the market reaction to Sri Lankan stock dividends from 1998 to 2007 using the event analysis methodology. The positive abnormal returns in Sri Lanka (CSE) were much higher than any other international findings on the announcement day. Even after controlling the contaminated information, abnormal returns for pure stock dividends were positively significant on the announcement day. Further, announcement day abnormal returns were positively related with the size of the stock dividend announcement. Therefore, these findings, based on CSE expand the empirical evidence on the signaling hypothesis of stock dividends.

Pathirawasam (2010c) re-examined the autocorrelations of index returns of CSE in order to provide latest evidence on predictability of short-horizon returns. Further, he examined whether predictability of short–horizon returns in CSE was due to infrequent trading behavior of stock. This study used the two market indices of the CSE; ASPI and MPI from February of 1985 to June 2009. Study used the univariate time series regression to test the first-order-autocorrelation of index returns. Residual adjusted returns were used to adjust for the infrequent trading behavior of stocks. The study found that CSE returns were, to a certain degree, predictable based on previous returns for ASPI and MPI on daily, weekly and monthly basis during the period 1985-2009. Further, study revealed that the first-order-autocorrelation of ASPI and MPI for daily weekly and monthly returns has completely removed when returns were adjusted for the infrequent trading. Hence, it showed that the rejection of the random walk model of ASPI and MPI returns was due to potential bias in infrequent trading of CSE stocks.

***Summary***

This chapter explained in to details the theoretical aspects of asset pricing models and their empirical investigations. Literature pointed out that CAPM was empirically failed due to some weakness of the model. As a result, many market anomalies emerged. Literature relating to five market anomalies, namely E/P, B/M, size, trading volume and momentum were discussed. However, very few studies were found on market anomalies on conditional markets. Mostly, anomalies were true in bear market than in bull market. Further, chapter outlined literature on asset pricing models. Literature revealed that Fama and French three factor model outperformed the CAPM. At last, literature relation to Sri Lankan market was considered. It is evident that there is no an in-depth study relating to determination of stock returns in Sri Lankan context. Nanayakkara (2008) has attempted to apply Fama and French three-factor model to Sri Lankan data but in the absence of a size anomaly, its validity for Sri Lankan data is in question.

# CHAPTER FOUR

# RESEARCH METHODOLOGY

## 4.1 Introduction

This chapter describes the research methodology used to achieve research objectives. The following flow chart shows the steps followed under the research methodology.

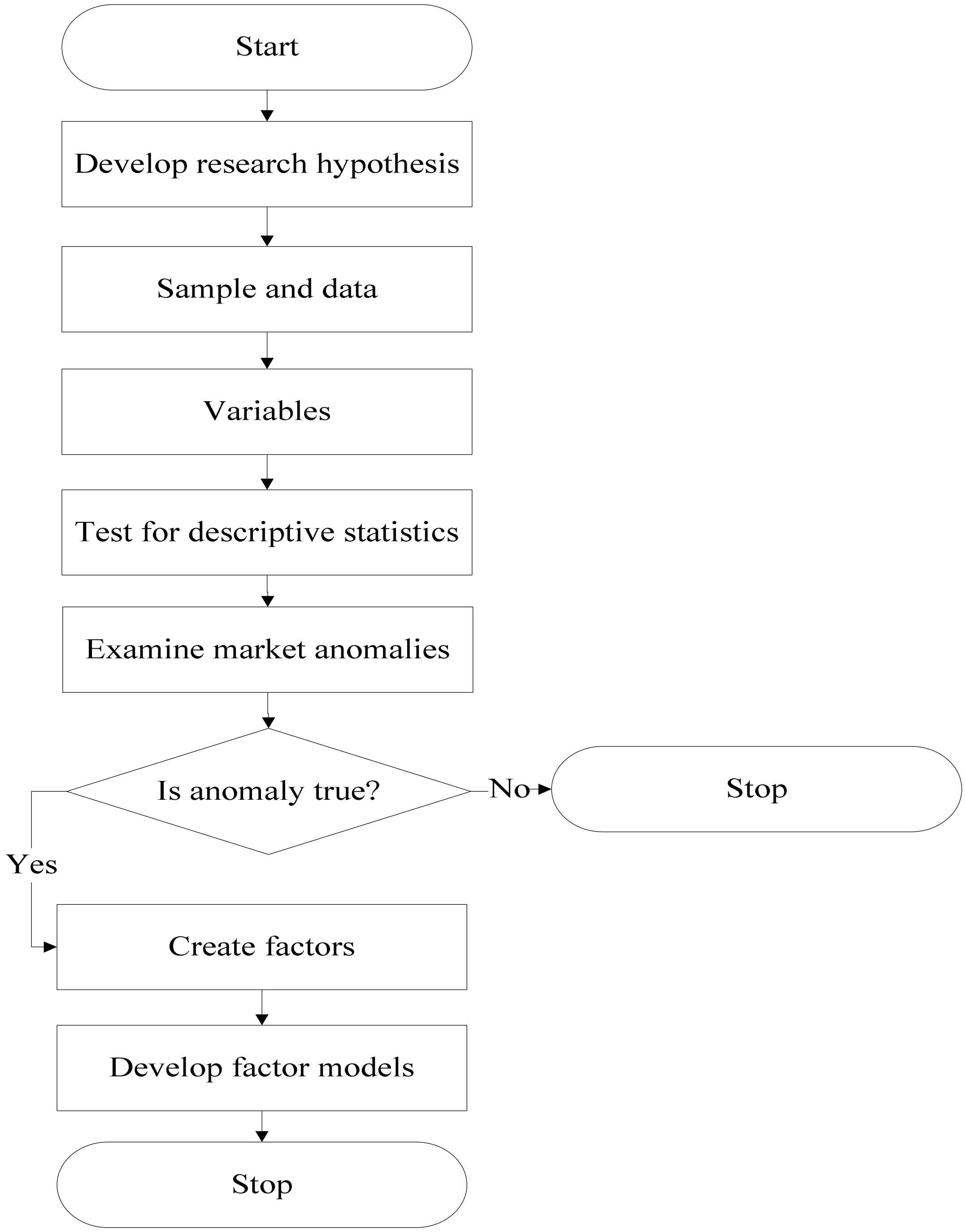



Figure 4.1 Overview of research methodology

As shown in the flow chart the methodology consists of several steps. Research methodology was begun with developing hypotheses. Next, sample and data were described. As the third step, collected data were converted into variables. Next, before use the data in regression analysis descriptive statistics were calculated in order to ensure their reliability. As the next step market anomalies were tested. If the anomaly exists, that variable was used for the next step. The next step was to create factors and finally, each factor was added to a factor model in order to decide the best combination of factors which explain the variability of stock returns.

## 4.2 Research hypotheses

The following hypotheses were developed to address the research objectives reported in the chapter one. As reported in chapter one, all the objectives were also tested in conditional markets (up-market and down-market) in addition to unconditional market (full period).

Following alternative hypotheses ($H_1$) were developed in order to achieve the research objectives. All the hypotheses were developed based on past empirical studies reported in the previous chapter.

***Hypothesis one: E/P anomaly***

Two alternative hypotheses were developed to test the E/P anomaly in the CSE. The first alternative hypothesis was developed to test the E/P effect in the CSE. If the following alternative hypothesis is accepted then E/P effect persists in the CSE.

$H_{1.a}$: The average monthly return of high E/P (HE/P) portfolio is different from the average monthly return of low E/P (LE/P) portfolio.

The second alternative hypothesis was developed to test the E/P anomaly in the CSE. If the CAPM fails to explain the average returns of HE/P or LE/P portfolio, then the E/P anomaly persists in the CSE. Therefore, the following alternative hypothesis was developed to test the E/P anomaly in the CSE.

$H_{1.b}$: Monthly excess return ($\alpha$) of HE/P portfolio or LE/P portfolio is not equal to zero.

If $H_{1.a}$ is accepted and one of the HE/P or LE/P portfolios has significant excess return, then the E/P anomaly persists.

The above hypotheses were tested in full period as well as in conditional periods also.

***Hypothesis two: B/M anomaly***

Second hypothesis was developed to test the B/M anomaly in the CSE. Two alternative hypotheses were developed to test the B/M anomaly in the CSE. The first alternative hypothesis was developed to test the B/M effect in the CSE. If the following alternative hypothesis is accepted then B/M effect persists in the CSE.

$H_{2.a}$: The average monthly return of high B/M (HB/M) portfolio is different from the average monthly return of low B/M (LB/M) portfolio.

The second alternative hypothesis was developed to test the B/M anomaly in the CSE. If the CAPM fails to explain the average returns of HB/M or LB/M portfolio, then the B/M anomaly persists in the CSE. Therefore, the following alternative hypothesis was developed to test the B/M anomaly in the CSE.

$H_{2.b}$: Monthly excess return (α) of HB/M portfolio or LB/M portfolio is not equal to zero.

If $H_{2.a}$ is accepted and one of the HB/M or LB/M portfolios has significant excess return, then the B/M anomaly persists.

The above hypotheses were tested in full period as well as in conditional periods also.

***Hypothesis three: Size anomaly***

Third hypothesis was developed to test the size anomaly in the CSE. Two alternative hypotheses were developed to test the size anomaly in the CSE. The first alternative hypothesis was developed to test the size effect in the CSE. If the following alternative hypothesis is accepted then size effect persists in the CSE.

$H_{3.a}$: The average monthly return of large size (LS) portfolio is different from the average monthly return of small size (SS) portfolio.

The second alternative hypothesis was developed to test the size anomaly in the CSE. If the CAPM fails to explain the average returns of LS or SS portfolio, then the size anomaly persists in the CSE. Therefore, the following alternative hypothesis was developed to test the size anomaly in the CSE.

$H_{3.b}$: Monthly excess return (α) of LS portfolio or SS portfolio is not equal to zero.

If $H_{3.a}$ is accepted and one of the LS or SS portfolios has significant excess returns, then the size anomaly persists.

The above hypotheses were tested in full period as well as in conditional periods also.

***Hypothesis four: Momentum anomaly***

Forth hypothesis was developed to test the momentum anomaly in the CSE. Two alternative hypotheses were developed to test the momentum anomaly in the CSE. The first alternative hypothesis was developed to test the momentum effect in the CSE. If the following alternative hypothesis is accepted then momentum effect persists in the CSE.

$H_{4.a}$: The average monthly return of winner (WI) portfolio is different from the average monthly return of loser (LO) portfolio.

The second alternative hypothesis was developed to test the momentum anomaly in the CSE. If the CAPM fails to explain the average returns of WI or LO portfolio returns, then the momentum anomaly persists in the CSE. Therefore, the following alternative hypothesis was developed to test the momentum anomaly in the CSE.

$H_{4.b}$: Monthly excess returns (α) of WI portfolio or LO portfolio is not equal to zero.

If $H_{4.a}$ is accepted and one of the WI or LO portfolios has significant excess return, then the momentum anomaly persists.

The above hypotheses were tested in full period as well as conditional periods also.

***Hypothesis five: Trading volume anomaly***

Fifth hypothesis was developed to test the trading volume anomaly in the CSE. Two alternative hypotheses were developed to test the trading volume anomaly in the CSE. The first alternative hypothesis was developed to test the trading volume effect in the CSE. If the following alternative hypothesis is accepted then trading volume effect persists in the CSE.

$H_{5.a}$: The average monthly return of high-volume (HV) portfolio is different from the average monthly return of low-volume (LV) portfolio.

The second alternative hypothesis was developed to test the trading volume anomaly in the CSE. If the CAPM fails to explain the average returns of WI or LO portfolio, then the trading volume anomaly persists in the CSE. Therefore, the following alternative hypothesis was developed to test the trading volume anomaly.

$H_{5.b}$: Monthly excess return (α) of HV portfolio or LV portfolio is not equal to zero.

If $H_{5.a}$ is accepted and one of the HV or LV portfolios has significant excess return, then the trading volume anomaly persists.

The above hypotheses were tested only in the up-market condition.

***Hypothesis six: Factor models***

The main objective of the study is to develop a factor model to explain the variation of stock returns. The factor model was developed step wise. Starting from the market model (market factor), other factors were added one by one to the model. The incremental adjusted $R^2$ and regression coefficient of new factor were used to test the statistical explanatory power of the new factor. Therefore, alternative hypotheses of adding a new factor to the model were developed as follows. The alternative hypotheses were same for conditional markets also.

$H_{6.a}$: The incremental adjusted $R^2$ of the new factor entered to the model is positive

$H_{6.b}$: The regression coefficient of the new factor is not equal to zero

## 4.3 Sample and data

### 4.3.1 Sample of the study

The sample of the study included all the voting stocks (266 companies including delisted companies) listed in the CSE from January 1995 to December 2008. The appendix A presents company codes and names of companies used for the study. The selection of the beginning period of the study on January 1995 was due to the liberalization of CSE. In 1991 the CSE was opened for foreign transactions and since 1995 the post liberalization period was started (Jaleel and Samarakoon, 2009).

This study was carried out for both unconditional as well as conditional market situations. Unconditional means for the total period and conditional means the total period is divided into two sub periods as down-market and up-market. In accordance with Rutledge et al.(2008) two sub periods have been identified by examining the behavior of cumulative returns of the ASPI. As shown in the figure 4.2, from June 1995 to August 2001 was identified as the down-market and from September 2001 to December 2008 was identified as the up-market. The conditional markets were added as a moderating variable to the figure 4.3 and figure 4.4 reported in section 4.6 and 4.8.

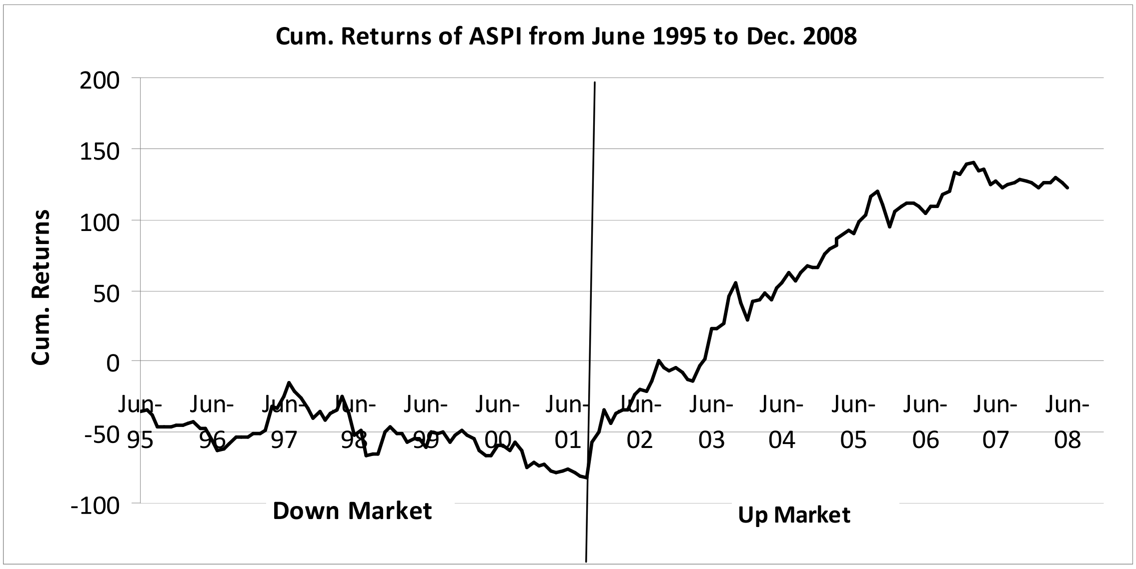



Figure 4.2 Cumulative returns of ASPI from June 1995 to December 2008

### 4.3.2 Data used for the study

Share prices, number of shares outstanding and trading volume of each stock came from the CSE data library 2008. Other accounting data of each company was gathered from the 'Hand Book of Listed Companies' published by the CSE and annual reports of respective companies. Short term interest rate data was collected from the annual reports of Central Bank of Sri Lanka. The trading volume data was available only after year 2000. Six kinds of raw data were used in the analysis. Definitions of the raw data are as follows.

**Table 4.1 Data used for the study**

| Raw data | Data description |
|---|---|
| I. Monthly stock prices | Monthly stock price is the closing price of stock on the last day of the month at which stock is traded |
| II. Earnings | Net profit attributable to ordinary share holders |
| III. Shares outstanding | Shares outstanding are the number of ordinary shares outstanding as at end of June in each year |
| IV. Book value | Share holder equity |
| V. Trading volume | Number of shares traded |
| VI. Three month Treasury bill rate | Rate of interest for three months Treasury bills in Sri Lanka[1] |

[1] This study used the three month Treasury bill rate as the risk free rate because it has lower inflation risk than the 12 months Treasury bill rate. Further, the three month Treasury bill rate was converted to monthly yields because stock returns were computed on monthly basis. This is also similar to the other previous studies (see, Fama and French, 1993; Simlai, 2008).

### 4.3.3 Issues in data and measurements

As all the data were secondary, financial data, there was no major concern over the ethical issues as one would have if he or she used data that are related to human. However, following issues were considered in order to increase the quality of the data.

***Survivorship bias***

It means inclusion of only surviving companies in the sample of the study. Kotari, Shanken and Sloan (1995) pointed out that survivorship bias significantly affect on the CAPM anomalies. Therefore, this study included even delisted securities to the sample until the company was delisted. By the end of 2008 there were 235 companies listed in the CSE. However, this study considered 266 companies for the analysis including delisted companies up to the date of delisting.

***Thin trading problem***

Pathirawasam (2010c) found that most of the stocks at CSE are not traded everyday. Further, thin trading induces autocorrelation in the time series of returns for a series would other wise exhibit serial independence. This issue was controlled by taking monthly returns instead of daily returns and removing the stock from the sample, if it has not traded half (6) of the months in an investment horizon (12). However, it was re-included to the sample if it satisfied the above condition in the subsequent investment horizon.

***Look-ahead bias***

It is a bias caused by using data which are not yet available but assumes to be available. When computing the P/E and B/M ratios, earnings and book value data will come to investors' hand when they receive the annual report of the company and not at the last date of financial year. In order to address this issue, earnings and book values were divided with June $30^{th}$ price of the stock. Therefore, it was assumed that annual reports of the companies would reach to the hands of share holders before the end of June each year.

***Portfolio returns***

Individual stock beta is instable than portfolio beta. Therefore this study considered portfolio returns instead of individual stock returns for the analysis.

### 4.3.4 Data Preparation

Under this sub heading, computation of monthly stock returns, return adjustments, adjustment for outliers, and computation of E/P, size, B/M and change in trading volume ratios were discussed. Following steps were followed in preparation of the data.

***Step 1: Computation of monthly stock returns for each company***

Monthly stock returns were computed for each of the 266 stocks in order to make the price series stationary. Monthly log returns were computed for each company as follows.

$$R_{i,t} = \ln(P_{i,t} / P_{i,t-1}) \quad (4.1)$$

Where,

$P_{i,t}$ = the closing price of company *i* for month *t*

$P_{i,t-1}$ = the closing price of company *i* for previous month

***Step 2: Adjustments to returns***

Monthly returns were adjusted for the various benefits received to the investor. They were cash dividends, stock dividends and right issues. The following formulas were used to adjust the individual company returns for the benefits.

**Adjustment for cash dividends**

The cash dividend adjustment was made on the month at which ex-dividend date was occurred.

$$R_{i,t} = \ln((P_{i,t} + D_i) / P_{i,t-1}) \quad (4.2)$$

Where, $D_i =$ Cash dividend of company *i*.

During the period from January 1995 to December 2008, 2769 dividend announcements had been made by the companies in the sample and all of them were adjusted to the returns computed in the equation 4.1 using the equation 4.2.

**Adjustment for right issues**

The right issue adjustment was made on the month at which ex-right date was occurred.

$$R_{i,t} = \ln(((1+RR)*P_{i,t})/(RR*P_r + P_{i,t-1}) \quad (4.3)$$

Where, RR is the rights ratio, $P_r$ is the per share price of rights

During the period from January 1995 to December 2008, 167 right issue announcements had been made by the companies and all of them were adjusted to the returns computed in the equation 4.1 using the equation 4.3.

**Adjustment for stock dividends**

The stock dividend adjustment was made on the month at which ex-dividend date was occurred.

$$R_{i,t} = \ln(((1+BR)*P_{i,t})/(P_{i,t-1}) \quad (4.4)$$

Where, BR is the bonus ratio

During the period from January 1995 to December 2008, 256 stock dividend announcements had been made by the companies in the sample and all of them were adjusted to the returns computed in the equation 4.1 using the equation 4.4.

If all cash dividend, stock dividend and right issue ex- dates were on the same month for a company, the adjustment was done as follows.

$$R_{i,t} = \ln(((1+RR+BR)*(P_{i,t}+D_i))/(BR*P_r + P_{i,t-1})) \quad (4.5)$$

***Step 3: Controlling for Outliers***

Data quality is important for any type of statistical test. When it is taken a large array of data it is common to find at least a few data components are extremely higher than others or *vice versa* and those are called "outliers". An outlier can be the outcome of either:

I. Share price data entered to the computer was incorrect.
II. Outlier is a result of omission to adjust stock returns for cash dividends, stock dividends, right issues, or stock splits.
III. Outlier is not an error in data but it is a reflection of true behavior of investors.

No one can be sure as how outliers come. There are no statistical packages to detect the sources of the outlier. Therefore, best option is to delete the outliers.

This study used the Grubbs' (1954) Extreme Studentized Deviate (ESD) method for identifying outliers. This test statistic shows whether that a value is come form the same Gaussian population as the other variables in the sample. Following formula was computed to identify how far the outlier from other variables.

$$Z = \frac{\left|\overline{X} - X\right|}{\sigma_X} \tag{4.6}$$

Where,

$\left|\overline{X} - X\right|$ = the absolute value difference between the outlier and the mean value

$\sigma_X$ = standard deviation of the X variable.

Next, it is vital to find out that a critical level of confidence to determine whether the data item is with in the confidence level or out side. If Z is large, the value is far from others. This study used Z=3 as the critical value which holds that the value is a outlier at 99 percent of confidence level.

***Step 4: Computation of E/P, B/M, size and change in trading volume***

**E/P ratio**

E/P ratio was computed as follows

$$\frac{Earnings\ \ per\ \ share\ \ before\ \ extra\ \ ordinary\ \ items}{Monthly\ \ stock\ \ price\ \ end\ \ of\ \ June}$$

**B/M ratio**

Book-to-market ratio was computed as follows

$$\frac{Book\ \ value\ \ per\ \ share}{Monthly\ \ stock\ \ price\ \ end\ \ of\ \ June}$$

**Size (market capitalization)**

Size of a company was computed on a monthly basis as follows.

*Price of the stock X number of shares outstanding*

Fama and French (1993) defined book value as follows. Book value of share holder’s equity plus balance-sheet deferred taxes and investment tax credit (if available), minus the book value of preferred stock.

**Change in trading volume**

$$\ln((Vol_{i,t} - Vol_{i,t-1}) / Vol_{i,t-1}) \qquad (4.7)$$

Where,

$Vol_{i,t}$ = the trading volume of company *i* for month *t*

$Vol_{i,t-1}$ = the trading volume of company *i* for previous month

## 4.4 Variables

This sub section focused on variables that were used in testing the market anomalies. Therefore, this section was devoted for explaining formation of portfolios and computation of market returns.

***Portfolio formation***

Formation of portfolios was based on criterion that have been reported to affect returns or known as CAPM anomalies. Portfolios were formed using the following variables in order to test the market anomalies.

**E/P portfolios**

End of June every year stocks were ranked from the lowest to highest E/P ratio and divided into three groups. Then, average return of each portfolio was computed for next 12 months and that process was continued throughout the whole study period. Portfolios were rebalanced every year. The highest and the lowest E/P portfolios were used to test the E/P anomaly.

**Size portfolios**

Size portfolios were formed by ranking stocks based on market capitalization of stocks at the end of June each year and divided into 3 groups. Then, average return of each portfolio was computed for next 12 months and that process was continued throughout the whole study period. Portfolios were rebalanced every year. Portfolios used to test the anomaly were the lowest 1/3 of market capitalization and the highest 1/3 of market capitalization.

**B/M portfolios**

End of June every year stocks were ranked from the lowest to highest B/M ratio and divided into three groups. Then, average return of each portfolio was computed for next 12 months and that process was continued throughout the whole study period. Portfolios were rebalanced every year. The highest and the lowest B/M portfolios were used to test the B/M anomaly.

**Six months trading volume portfolios**

At the end of each month, from September 2001 to June 2008, all eligible stocks in the sample were ranked based on their past 6 months trading volume change, and the ranked stocks were divided into three portfolios that have the highest, middle and lowest volume changes over time. Then, average return of each trading volume portfolio was computed for the next 6 months. The portfolios were rebalanced every month. The portfolios taken for the test of trading volume anomaly were the highest one third of volume change and the lowest one third of the volume change.

**Six months momentum portfolios**

At the end of each month, from January 1995 to June 2008, all eligible stocks in the sample were ranked based on their past 6 months returns, and then grouped the stocks into three equally weighted portfolios based on these ranks. Then, average return of each portfolio was computed for the next 6 months. Portfolios were rebalanced every month. Portfolio with the highest returns is the winner portfolio and portfolio with the lowest returns is called the loser portfolio. Winner and the loser portfolios were considered for the test of the momentum anomaly.

## 4.5 Tests for descriptive statistics

This study mainly depended on regression analysis techniques. Linear regression method will generate unbiased coefficients only if data inputs are free from defects. Before present descriptive statistics, it is better to examine the basic assumptions of the regression model. The regression model has following assumptions as per Gujarati (2005, p. 192).

I. The stochastic disturbance or stochastic error term is having zero mean value, or

$$E(u_i / X_{i,t}) = 0$$

II. The stochastic error term is serially uncorrelated

$$Cov(u_i, u_j) = 0 \qquad (i \neq j)$$

III. Homoscedasticity or equal variance of error terms

$$Var(u_i) = \sigma^2$$

This means variance of $u_i$ for each factor $X_i$ (conditional variance of $u_i$) is some constant positive number equal to $\sigma^2$. This means $u_i$ is having equal variances.

IV. No exact co-linearity between X variables.

This means no exact liner relationship between $X_1$ and $X_2$.

### 4.5.1 Normality test

As stated above, linear regressions assumes that each error term ($u_i$) is distributed normally with,

Mean: $E(u_i) = 0$

Variance: $E(u_i^2) = \sigma^2$

Cov ($u_i$,$u_j$): 0 $i \neq j$

Even though this study use the population rather than a sample, the normality test was done for the time series of portfolio returns: high E/P (HE/P), low E/P (LE/P), high E/P minus low E/P (HmLE/P), high B/M (HB/M), low B/M (LB/M), high B/M minus low B/M (HmLB/M), large size (LS), small size (SS), large size minus small size (LmS) winner (WI), loser (LO), winner minus loser (WmL), high volume (HV), low volume (LV), high volume minus low volume (HmLV) and market returns portfolio. The study followed two steps to assure the normality of time series data.

I. Study used (skeletal) box plot diagram to identify any outliers in the time series.

II. As the second step, identified outliers were replaced with time series mean and Kolmogorov-Smirnov (K-S) D test and Shapiro-Wilk Statistic (S-W) was tested using the SPSS package to test statistically the normality of the data series.

### 4.5.2 Homoscedasticity

Homoscedasticity states that the variance of $u_i$ for each $X_i$ is some positive constant number equal to $\sigma^2$. In other words, the Y population corresponding to X values have the same variance. In contrast where the conditional variance of the Y population varies with X is known as heteroscedasticity. If the heteroscedasticity is present the confidence intervals can not be computed correctly for hypothesis testing because, variance of estimated slope $\lfloor Var(\hat{\beta}_2) \rfloor$ is biased in the presence of heteroscedasticity. Gujarati (2005 p. 366) express as,

> *The bias arises from the fact that $\hat{\sigma}^2$, the conventional estimator of $\sigma^2$, namely, $\sum \hat{u}_i^2 /(n-2)$ is no longer an unbiased estimator of the latter when heteroscedasticity is present. As a result, we can no longer rely on the conventionally computed confidence intervals and the conventionally employed t and F statistics.*

This study used the Eviews soft-ware package to run all the regressions. Eviews has the facility to compute t-statistics and F-statistics which are corrected for heteroscedasticity. Therefore, all the t-statistics and F-statistics are corrected for heteroscedasticity problem (White heteroscedasticity consistent standard errors and covariance).

## 4.6 Examine market anomalies

Testing of market anomaly was a two steps process as follows.

**Step 1: Test of effects**

This step examined whether characteristics have an effect on stock returns. The difference between high and low portfolios of E/P, size, B/M, trading volume and momentum should be statistically significant. Even though the direction of each anomaly is clear two tail t-test is employed to test the hypotheses because Malin and Veeraraghavan (2004) reported that growth effect was true for France, Germen and United Kingdom data.

**Step 2: Test of anomalies**

Under the second step, it was examined whether the returns of extreme portfolios of each characteristic were explained by systematic risk (CAPM). In order to test each anomaly, high and low return portfolios were used under each characteristic. The market index returns were used as the independent variable and the conditional markets (up-market and down-market) were used as moderating variables. It is shown in the following theoretical framework in figure 4.3.

In order to identify the explanatory factors of Sri Lankan stock returns the market anomalies in the model (figure 4.3) were tested one by one, using the following CAPM equation suggested by BJS (1972).

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p (R_{m,t} - R_{f,t}) + \varepsilon_{p,t} \quad (4.8)$$

Where,

$R_{p,t}$ = Return of portfolio P in month t. The portfolio P represents the portfolios of HE/P, HB/M, LS, WI, HV, LE/P, LB/M, SS, LO and LV.

$R_{f,t}$ =Monthly risk free rate at time t and this is represented by the monthly yield of 3 months Treasury bill.

$R_{mt}$ = Return on value weighted market portfolio in month t.

$\alpha_P$ = The intercept of the regression to measure excess returns (Jensen's alpha) of portfolio P. If the risk explains anomalies, $\alpha_P$ should not be statistically different from zero.

$\beta_p$ = The beta of portfolio P.

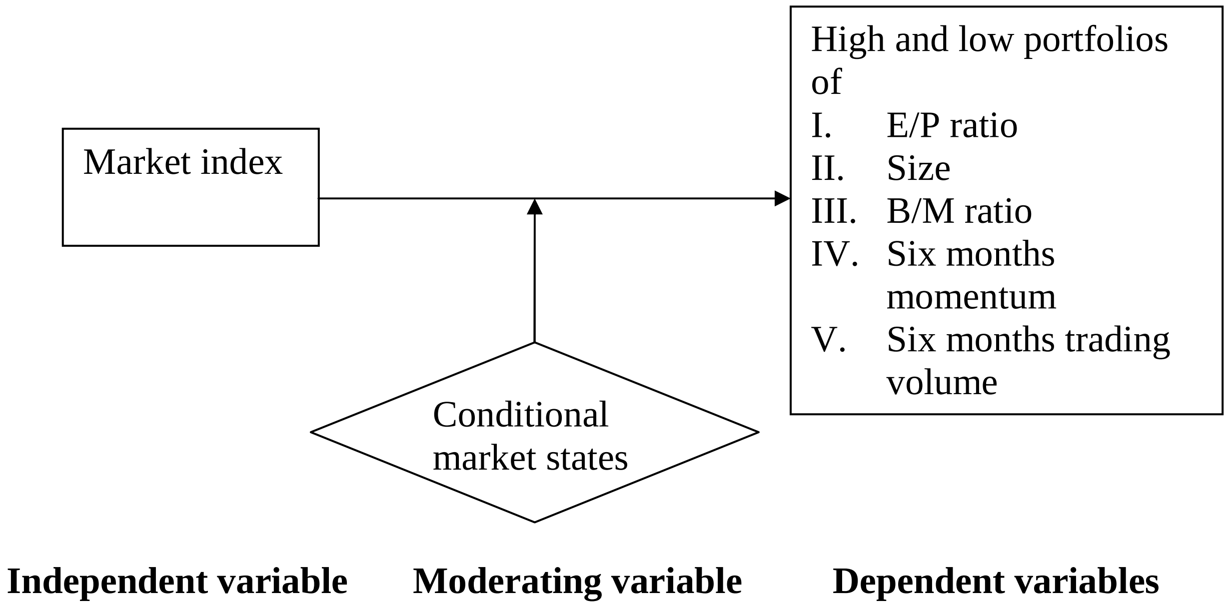



Figure 4.3: Test of market anomalies

## 4.7 Creating factors

Three market anomalies (E/P, B/M and momentum) were identified in the above step. Once the market anomalies identified, factor mimicking (representative) portfolios (HmLE/P, HmLB/M and WmL) were created in order to develop a factor model to explain variability of stock returns. Factor mimicking portfolios were formed based on the Fama and French (1993) approach. For an example if at least one of the E/P portfolios (HE/P or LE/P) shows significant excess returns after adjusting for market risk, then E/P factor mimic portfolio (HmLE/P) is created as follows.

$$HmLE/P_t = HE/P_t - LE/P_t \quad (4.9)$$

Where,

HE/P = Earnings to price portfolio with the highest returns
LE/P = Earnings to price portfolio with the lowest returns

Similar method was applied to form the other factor mimicking portfolios also (HmLB/M and WmL).

## 4.8 Develop factor models

This section addressed the second main objective of the study. Study used the time-series regression approach which is the spirit of Merton (1974) and Fama and French (1993). Monthly excess returns of stocks were regressed on the excess returns to market portfolio and mimicking (HmLE/P, HmLB/M and WmL) portfolios of factors. The factor loadings must proxy for sensitivity to common factors. As the model used excess returns for dependent as well as independent variables, if the combination of common factors captures the variability of portfolio returns, intercept of the regression model should be indistinguishable from zero (Merton, 1974 quoted from Elton and Gruber, 1997, p. 330).

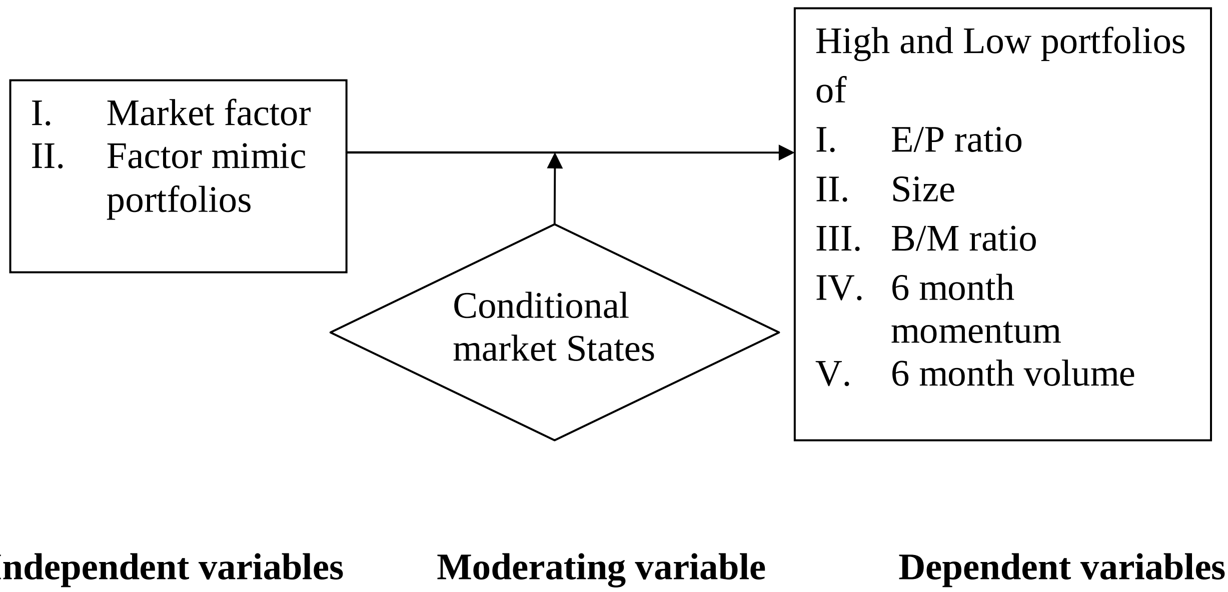



Figure 4.4 Test of asset pricing models

### 4.8.1 Multicollinearity test

Before determining the final form of a multiple regression equation, multicolinearity problem was dealt with. Multicolinearity problem occurs when two explanatory variables are highly correlated.

Multicolinearity has several consequences as follows (Gujarati, 1995, p. 327).

I. Because of the high multicolinearity between regressors, the confidence intervals tend to be much wider, leading to the acceptance of the "zero null hypothesis" more readily.

II. Because of the high multicolinearity, the t-ratio of one or more coefficients tends to be statistically insignificant.

III. Even though t-ratios of one or more coefficients are satisfactorily insignificant, the coefficient of determination can be high.

The correlation matrix was prepared for all the pairs of independent variables in the factor model 4.10 in order to detect the multicolinerity problem. If two explanatory variables say $X_1$ and $X_2$ are highly correlated, then Y (dependant) variable will be explained about equally well by any equation containing only $X_1$ or $X_2$ as it will by an equation containing both $X_1$ and $X_2$. Therefore, if two independent variables are linearly correlated, one of them is enough to add to the regression model.

The following correlation equation was used to compute the correlation coefficients ( r ) between each of the two independent variables.

$$r = \frac{n\sum X_1 X_2 - (\sum X_1)(\sum X_2)}{\sqrt{n(\sum X_1^2) - (\sum X_1)^2}\sqrt{n(\sum X_2^2) - (\sum X_2)^2} \quad (4.10)$$

After identifying factor mimicking portfolios they were loaded to a multi-beta CAPM model as suggested by Merton (1974) referred in Elton and Gruber (1997, p. 330) to determine the explanatory power of each factor in determining the variability of independent variables. The procedure of testing the relationship between the independent and dependent variables in the model 2 is as follows.

$$R_{p,t} - R_{f,t} = \alpha_p + b_p\left(R_{m,t} - R_{f,t}\right) + \sum_{i=1}^{n} b_i f_{i,t} + \varepsilon_{p,t} \quad (4.11)$$

Where,

$R_{p,t}$ = Returns of portfolio P in month t. The portfolio P represents the portfolios of HE/P, HB/M, LS, HV, WI, LE/P, LB/M, SS, LV and LO

$R_{f,t}$ = Monthly risk free rate at time t measured as 3 months Treasury bill rate

$b_i$ = Sensitivity of the portfolio to each factor

$f_{i,t}$ = Factor mimic portfolios

$n$ = Number of factors

Step wise regression was used to determine the best regression model. The first step of step-wise regression was to find the best model that uses one independent variable. The excess market return ($R_m$-$R_f$) was the best independent variable that explained the portfolio returns. The first two parts of the above equation equal to the BJS (1972) CAPM model (see equation 3.7) which is commonly known as market model. Therefore, the analysis of the multifactor model was started from the following market model.

$$R_{p,t} - R_{f,t} = \alpha_p + b_p\left(R_{m,t} - R_{f,t}\right) + \varepsilon_{p,t} \qquad (4.12)$$

The next step is to find the best of the remaining independent variables to add to the market model (4.12). If the second entered variable did not have significant incremental coefficient of determination, this variable would be removed and next best variable was entered.

### 4.8.2 Explanatory power of the model

Coefficient of determination ($R^2$) and adjusted coefficient of determination ($\overline{R}^2$) measure the proportion of the total variation in Y explained by the regression model. This study used $\overline{R}^2$ instead of $R^2$ to measure the appropriateness of the model. As referred in Gujarati (1995, p. 208), Theil notes: "… it is good practice to use $\overline{R}^2$ rather than $R^2$ because $R^2$ tends to give overly optimistic picture of the fit of the regression, particularly when the number of explanatory variables is not very small compared with the number of observations".

Not like in $R^2$, $\overline{R}^2$ takes into account the number of independent variables present in the model. The computation of $R^2$ and $\overline{R}^2$ are as follows.

$$R^2 = 1 - \frac{\sum_{i=1}^{n} \hat{u}_i}{\sum_{i=1}^{n} Y_i^2} = 1 - \frac{RSS}{TSS} \; or \; \frac{ESS}{TSS} \qquad (4.13)$$

Where,
RSS = residual sum of squares
TSS = total sum of squares
ESS = explained sum of squares

$$\overline{R}^2 = 1 - \frac{\sum_{i=1}^{n} \hat{u}_i /(n-k)}{\sum_{i=1}^{n} Y_i^2 /(n-1)} \qquad (4.14)$$

Where, n is the number of observations and k is the number of parameters in the model including the intercept term.
Now it is visible that $R^2$ and $\overline{R}^2$ are related. Therefore,

$$\bar{R}^2 = 1 - (1 - R^2)\frac{n-1}{n-k} \quad (4.15)$$

Therefore, when (parameters) k >1, $\bar{R}^2 < R^2$. That means when number of X (independent) variables increase, the $\bar{R}^2$ less than the $R^2$. In order to increase the robustness of the study, this study used $\bar{R}^2$ instead of $R^2$.

However, according to Gujarati (1995, p. 211) no one can decide whether the estimated model is good or bad just looking at the $R^2$ values. The objective is to obtain a high $R^2$ value together with dependable estimates of the true regression coefficients and draw statistical inferences about them. Gujarati has says:

> *…in empirical analysis it is not unusual to obtain a very high $\bar{R}^2$ but find that some of the regression coefficients either are statistically significant or have signs that are contrary to a priori expectations. Therefore, the researcher should be more concerned about the logical or theoretical relevance of the explanatory variables to the dependent variable and their statistical significance. If in this process we obtain a high $\bar{R}^2$, well and good, on the other hand, if $\bar{R}^2$ is low, it does not mean bad.*

Therefore testing the overall significance of the multiple regressions is important.

### 4.8.3 Testing overall significance, *F*- test

In a partial or multiple regression analysis, usual t-test can not be used to test the joint hypothesis of $\beta_1$ and $\beta_2$ are jointly or simultaneously equal to zero. This is expressed by Fomby, Hill and Johnson (1984) as reffered in Gujarati, 1995 p. 245).
"… testing a series of single (individual) hypothesis is not equivalent to testing those same hypothesis jointly. The intuitive reason for this is that in a joint test of several hypotheses any single hypothesis is "affected" by the information in the other hypotheses".

Therefore, the author used analysis of variance (ANOVA) technique to test the joint hypothesis. Under the assumption of normal distribution for $u_i$, the null hypothesis, $\beta_1 = \beta_2 = \ldots\ldots = \beta_n = 0$ (the alternative hypothesis, $\beta_1 \neq \beta_2 \neq \ldots\ldots \neq \beta_n \neq 0$) is tested using following *F* statistic.

$$F = \frac{ESS/df}{RSS/df} = \frac{ESS/(k-1)}{RSS/(n-k)} \quad (4.16)$$

Where,
k = total number of parameters to be estimated including intercept
n = number of observations

There is a direct relationship between $\overline{R}^2$ and $F$ statistic. Gujarati (1995 p. 249) says, "When $R^2 = 0$, F is zero ipso facto. The larger the $R^2$, the greater the $F$ value. In the limit, when $R^2 = 1$, $F$ is infinite. Thus the F-test, is also a test of significance of $R^2$".

Gujarati (1995, p. 249) has derived $F$ test in terms of $R^2$ as follows.

$$F = \frac{R^2 / k}{1 - R^2 / n - k} \tag{4.17}$$

### 4.8.4 Incremental power of explanatory variables

The basic criteria used to determine the increase of explanatory power of adding a new variable was its $\overline{R}^2$ contribution to the existing model. Therefore, when adding a new variable to the model, answers have to be found for 3 questions.

I. What is the marginal, or incremental, contribution of new variable knowing that existing variables are significantly related to dependent variable Y?
II. Is the incremental contribution statistically significant?
III. What is the criterion for adding variables into the model?

All the above questions are answered by using ANOVA technique.

Answer for the first question can be given by using incremental $\overline{R}^2$ ($\Delta\overline{R}^2$) as follows.

$$\Delta\overline{R}^2 = \left[\overline{R}^2_{new} - \overline{R}^2_{old}\right] \tag{4.18}$$

This study tested a one set of independent variables with several dependent variables (factor portfolios as shown in figure 4.3). Incremental $\overline{R}^2$,s were computed for each test portfolio separately and their average $\Delta\overline{R}^2$ was computed to summarize the findings.

The significance of the value increment of the above equation 4.17 was determined using $F$- statistics (see, Gujarati, 1995, p. 253).

$$F = \frac{(\overline{R}^2_{new} - \overline{R}^2_{old}) / df}{(1 - \overline{R}^2_{new}) / df} \tag{4.19}$$

$$F = \frac{(\overline{R}^2_{new} - \overline{R}^2_{old}) / df \ (number\ of\ new\ regressors)}{(1 - \overline{R}^2_{new}) / df \ (= n - number\ of\ parameters\ in\ the\ new\ \mathrm{mod}\,el)}$$

The researchers generally and frequently choose the model that gives highest $\overline{R}^2$. Therefore, when entering a variable to the model, it should be considered when $\overline{R}^2$ is increased. Gujarati (1995, p. 254) expresses:

> *… $\overline{R}^2$ will increase if the t value of the coefficient of the newly added variable is greater than 1 absolute value. When the t value is computed under the hypothesis that the population value of the said coefficient is zero ($\beta_1$=0). … $\overline{R}^2$ will increase with the addition of an extra explanatory variable if the F (= $t^2$) value of that variable exceeds 1.*

Therefore, explanatory factors which added to the model 4.11 were prioritized based on the t values of each factor in univariate regression model given below.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p (R_{m,t} - R_{f,t}) + \varepsilon_{p,t} \tag{4.20}$$

The dependent variables in the above regression were, HE/P, LE/P, HB/M, LB/M, LS, SS, WI, LO, HV and LV portfolios return. Independent variables were mimicking factors (HmLE/P, HmLB/M, WML and Rm-Rf). Each mimicking factor was regressed on dependent variables separately to compute the t-values of β coefficients. The average t-value was used to rank the factors which were entered to the factor model.  Factor with the highest average t-value was ranked as first variable entered to the model and the factor with second highest average t-value was ranked as second and so on.

## *Summary*

This chapter outlined hypotheses, data sources and detailed methodologies used in the analysis. The data set covered the period January 1995 to December 2008. However, trading volume data was used since April 2001. The analysis was done on unconditional market as well as on conditional markets.

This study followed BJS (1972) CAPM formula to test the market anomalies. Merton (1973) and Fama and French (1993) methods were used to develop the factor models. Outliers free data were used for the analysis. Before the regression analysis, normality and homoscedasticity of data series were assured. The $\overline{R}^2$ was used to test the explanatory power of the factor model and *F*-statistic was used to measure the statistical significance of the model.

# CHAPTER FIVE
# RESULTS AND DISCUSSION-MARKET ANOMALIES

## 5.1 Introduction

Previous chapter explained the hypotheses, data, variables and statistical methods and this chapter explains the application of those in order to find evidence in the CSE. This chapter starts with the descriptive statistics. The analysis was carried out in accordance with the hypotheses developed. Therefore, this chapter examines, five market anomalies namely, E/P, B/M, size, momentum and trading volume.

## 5.2 Descriptive statistics

This study mainly used regression technique to analyze the data. The accuracy of the regression is highly depending on the quality of the data input. Therefore, outliers, normality and heteroscedasticity of data variables used in the regression model are three of the important matters to be considered.

### 5.2.1 Outliers

An outlier is a data component which is extremely higher or extremely lower than others. This study identified outliers of data in two stages.

First, all the outliers in the monthly stock return data sheet were identified and removed. This study used 44688 observations for 266 companies through 14 years. Out of the total observations, 7682 represent non-trading observations (no return values for those observations) which is 17.19% of the total observations. According to the computations there were 415 outliers which was a 0.931% of the total number of observations. These outliers were deleted in the data sheet.

**Table 5.1 Data outliers of test variables**

| Test variable | Number of outliers | Percentage |
|---|---|---|
| SS | 08 | 0.051 |
| LS | 07 | 0.044 |
| SmLS | 07 | 0.044 |
| HV | 02 | 0.024 |
| LV | 02 | 0.024 |
| HmLV | 00 | 0.000 |

Secondly, this study used Box-plot diagrams to identify any outliers in the time series portfolios of small size (SS), large size (LS), small size minus large size

(SmLS), high volume (HV), low volume (LV), and high volume minus low volume (HmLV hereafter). Number of outliers and their percentages out of total observations in the series are given in the table 5.1. Total number of observations are 156 for first 3 variables (size) and it is 81 for the last three (volume) variables. According to the table number of outliers reported for size portfolios are 5 percent, 4 percent and 4 percent of the total observations for SS, LS and SmLS portfolios respectively. The box-plot diagrams are presented in the appendix B.

### 5.2.2 Normality test

The main statistical tools used to analyze data are simple and multiple regression techniques. As stated in the methodology, linear regression assumes that each error term ($u_i$) is distributed normally with,

Mean: $E(u_i) = 0$
Variance: $E(u_i^2) = \sigma^2$
Cov ($u_i$,$u_j$): $0 \quad i \neq j$

**Table 5.2 Normality test results of the data variables**

| Test variable | Df* | Kolmogorov-Smirnov[a] | | Shapiro-Wilk test | |
|---|---|---|---|---|---|
| | | Statistic | Sig. | Statistic | Sig. |
| HE/P | 156 | 0.065 | 0.200 | 0.979 | 0.016 |
| LE/P | 156 | 0.058 | 0.095 | 0.993 | 0.647 |
| HmL E/P | 156 | 0.057 | 0.200 | 0.983 | 0.051 |
| HB/M | 156 | 0.049 | 0.200 | 0.983 | 0.051 |
| LB/M | 156 | 0.066 | 0.095 | 0.984 | 0.072 |
| HmLB/M | 156 | 0.055 | 0.200 | 0.988 | 0.192 |
| SS | 156 | 0.055 | 0.200 | 0.974 | 0.226 |
| LS | 156 | 0.068 | 0.071 | 0.984 | 0.008 |
| SmLS | 156 | 0.074 | 0.037 | 0.978 | 0.001 |
| WI | 156 | 0.048 | 0.200 | 0.988 | 0.191 |
| LO | 156 | 0.065 | 0.100 | 0.990 | 0.310 |
| WmL | 156 | 0.042 | 0.200 | 0.985 | 0.099 |
| HV | 81 | 0.065 | 0.200 | 0.988 | 0.031 |
| LV | 81 | 0.097 | 0.056 | 0.981 | 0.227 |
| HmLV | 81 | 0.114 | 0.011 | 0.982 | 0.019 |

**Degrees of freedom*
*[a]Lilliefors Significance Correction*

Even though this study use the population rather than a sample, the normality test was done for the time series of portfolio returns of high E/P (HE/P), low E/P (LE/P), high E/P minus low E/P (HmLE/P), high B/M (HB/P hereafter), low B/M (LB/M), high B/M minus low B/M (HmLB/M), SS, LS, SmLS, winner (WI), loser (LO hereafter), winner minus loser (WmL), HV, LV, HmLV and market returns portfolio. Appendix C shows the results for the normality test. Appendix C includes Kolmogorov-Smirnov (K-S) D test and Shapiro-Wilk (S-W) test. The normality test of data was done using SPSS statistical package. The K-S and S-W tests results for the data normality are presented in table 5.2.

If the significance levels of S-K and S-W tests are greater than 0.05 ($p>0.05$) then normality can be assumed. According to the table 5.2 for all the E/P, B/M and momentum portfolios except HE/P, significance levels are greater than 0.05. Therefore, all the variables are assumed to have a normal distribution. HE/P portfolio does not have normality according to S-W test but it is normally distributed according to S-K test. However, it does not make a significant impact to the findings because normality of one portfolio (HE/P or LE/P) is sufficient for the market anomaly test.

When consider the size sorted portfolios, both SS portfolio returns and SmLS portfolio returns do not satisfy the normality condition according to both tests. Further, HV and HmLV portfolio returns also did not normally distribute. Therefore, Box-plot diagrams were used to identify outliers of the above variables (see table 5.1). Once the outliers were identified they were replaced with mean value of each series using SPSS package. Normality test results after controlling for outliers are reported in table 5.3 below.

**Table 5.3 Normality test results for outliers controlled variables**

| Test variable | Df* | Kolmogorov-Smirnov[a] | | Shapiro-Wilk test | |
|---|---|---|---|---|---|
| | | Statistic | Sig. | Statistic | Sig. |
| SS | 156 | 0.085 | 0.008 | 0.986 | 0.107 |
| LS | 156 | 0.044 | 0.200 | 0.994 | 0.776 |
| SmLS | 156 | 0.092 | 0.003 | 0.959 | 0.000 |
| HV | 81 | 0.049 | 0.200 | 0.988 | 0.676 |
| LV | 81 | 0.084 | 0.200 | 0.981 | 0.278 |
| HmLV | 81 | 0.078 | 0.200 | 0.982 | 0.297 |

**Degrees of freedom*
[a]*Lilliefors Significance Correction*

According to the table 5.3 after controlling the outliers, returns of the volume portfolios and LS and SS portfolios became normally distributed according to S-W test. The appendix B presents the new Box-plot diagrams of after controlling outliers. However, the non-normal behavior of portfolio returns of SmLS portfolio does not make a significant impact on the final finding of the study as size anomaly is not true in the CSE (see, section 5.3.3).

### 5.2.3 Test of the heteroscedasticity

Another key assumption in linear regression is the heteroscedasticity or equal variance of disturbance term which is conditional on explanatory variables. This study used the Eviews soft-ware package to run all the regressions. Therefore, all the t-statistics and *F*-statistics reported in the study are White heteroscedasticity-consistent standard errors and covariance.

## 5.3 Test of market anomalies

The first main objective of this study is to test the market anomalies in the CSE. The first five alternative hypotheses developed are related to the anomaly tests. Therefore, this section reports the results for following market anomaly tests.

I. Earnings-to-price anomaly
II. Book-to-market anomaly
III. Size effect
IV. Momentum anomaly
V. Trading volume anomaly

### 5.3.1 Earnings-to-price anomaly

Financial literature suggests that value strategies outperform the growth strategies[2]. The first value strategy was uncovered by Basu (1979). Basu argues that if investors buy stocks with high E/P ratios and hold those stocks for a long term, then they could enjoy better investment performance than buying and holding stocks with low E/P ratios. However, there are some evidence that the above notion might not be applicable universally. Cheh, Kim and Zheng (2008) found that LE/P portfolios performed significantly better than HE/P portfolios. Therefore, a specific direction of relationship between E/P and return was not targeted in developing alternative hypothesis for examining E/P effect in this study.

***Hypotheses***

The E/P anomaly, in this study, was tested under two steps. First, the E/P effect on returns was examined without taking into consideration any adjustments for risk. Therefore, the following alternative hypothesis was developed to test the E/P effect.

$H_{1.a}$: The average monthly return of HE/P portfolio is different from the average monthly return of LE/P portfolio.

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[2] A firm that has high accounting fundamentals relative to price is considered a value firm where as a firm with low accounting fundamentals relative to price is considered as a growth firm.

E/P anomaly exists only if there is an excess return after adjusting returns of portfolios for risk. Therefore, excess returns of HE/P portfolio and LE/P portfolio were examined to determine whether the E/P anomaly exists for Sri Lankan data. The equation 4.8 was used to compute the excess returns for each portfolio. Therefore, the second alternative hypothesis was developed as:

$H_{1.b}$: Risk adjusted average monthly excess returns of E/P based portfolios are not equal to zero.

If $H_{1.a}$ is accepted and one of the HE/P or LE/P portfolios has statistically significant excess returns, then the E/P anomaly exists.

**Table 5.4 Average monthly percentage returns: Firms categorized by E/P**

| Period | Mean return | | |
|---|---|---|---|
| | HE/P | LE/P | HmLE/P |
| Full period | 1.586 | 0.729 | 0.856 (3.644)*** |
| Down-market | 0.391 | -0.511 | 0.902 (3.052)*** |
| Up-market | 2.677 | 1.863 | 0.813 (2.254)** |

***significant at 5% level. ***significant at 1% level.*

In order to examine the hypothesis $H_{1.a}$, every year June, all the stocks were ranked based on E/P ratio and divided into 3 portfolios as HE/P, medium E/P and LE/P portfolios. Next each portfolio's average monthly returns was computed for next 12 months and portfolios were rebalanced every year. Table 5.4 reports the average monthly portfolio returns of HE/P portfolio, LE/P portfolio and HmLE/P portfolio together with associated t-statistics in parentheses. The table reports returns for full sample period (1995–2008), for the down-market period (January 1995–August 2001) as well as for the up-market period (September 2001–December 2008).

When compare monthly average returns of high and low E/P portfolios, HE/P portfolios exhibit better performance than LE/P portfolios. Therefore, HmLE/P portfolios for the full period, down-market as well as up-market display positive average monthly returns of 0.856 (t = 3.644) percent, 0.902 (t = 3.052) percent and 0.813 (t = 2.254) percent respectively. Interestingly, even in down-market HE/P portfolio reflects positive average returns. This finding accepts the first alternative hypothesis and hence, E/P effect exists in the CSE. According to the findings it is advisable to invest in high E/P stocks rather than in low E/P stocks.

**Table 5.5 Estimated abnormal returns: Firms categorized by E/P**

| Period | Excess returns (α) | |
|---|---|---|
| | H/EP | L/EP |
| Full period | 0.573 (2.235)** | -0.284 (-1.291) |
| Down-market | 0.550 (1.894)* | -0.277 (-1.415) |
| Up-market | 0.308 (0.730) | -0.281 (-0.733) |

*Notes: The regression model for sub-periods and full period is based on E/P portfolios. The model is:* $R_{p,t} - R_{f,t} = \alpha_p + \beta_p (R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$. *The regression coefficient Alfa is White heterroscedasticity-consistent standard errors and covariance. t-statistics in parentheses. *significant at 10% level. **significant at 5% level.*

The above comparison of monthly average returns between different E/P portfolios would not be fair because of the ignorance of risk inherent to E/P portfolios. Therefore, risk-adjusted E/P portfolio returns were examined to see whether E/P portfolios reflect better risk-adjusted returns. The CAPM equation 4.8 was used to compute risk-adjusted average returns (α) for each portfolio and the findings are reported in the table 5.5. When average risk-adjusted monthly return of HE/P and LE/P portfolios are compared, as shown in table 5.5, as being consistent with Basu (1977), the HE/P portfolio shows better average risk-adjusted return (α) of 0.573 percent (t = 2.235) than that of LE/P portfolio -0.284 percent (t = -1.291) for the full sample period. This finding is consistent with Kwag and Lee (2006) and Athanassakos (2009). In the down-market period average risk-adjusted return of HE/P portfolio is 0.550 and it is statistically significant at 10 percent level. However, the LE/P portfolio generates negative average risk-adjusted return and it is not statistically significant. As excess returns of HE/P portfolio is significant, E/P anomaly exists in the down-market period.

The average risk adjusted excess return is positive for HE/P but it is negative for LE/P portfolio in the up-market. As excess returns of both HE/P and LE/P portfolios are not statistically significantly different from zero, it can be concluded that E/P anomaly does not exist in the up-market period.

***Discussion***

This study finds that E/P effect exists in the CSE for all the test periods. This positive relationship between E/P ratio and stock return is similar to the findings of Basu (1977) in U.S. market and the Pthirawasam (2010 a) in CSE. Pathirawasam (2010 a) found that earnings per share has a positive relationship with market price per share.

Risk adjusted excess returns of HE/P portfolios are always greater (positive) than the risk adjusted returns (negative) of LE/P portfolios. However, E/P anomaly exists only in the down-market. This implies that the time varying CAPM is able to capture returns of HE/P and LE/P portfolios in the up-market. The down-market value effect of this study is consistent for several past studies (see, Chen, Kim and Zheng, 2008; Kwag and Lee, 2006 and Athanassakos, 2009).

This study finds that there is no earnings based value premium in the up-market period and it is contradictory with both Kwag and Lee (2006) and Athanassakos (2009). Further, Chen, Kim and Zheng (2008) found that there is a significant growth effect in the up-market period.

The findings of the full period are similar to the previous CSE findings by Samarakoon (1997) and Nimal (1997).

There are two views about the outperformance of value portfolios than growth. Fama and French (1996) pointed out that superior performance of value portfolios could potentially be a reward for distress risk. Second, Lakonishok (1994) argued that investors over-extrapolate (over priced) the performance of growth stocks and under extrapolate (under priced) the performance of value stocks and that cause for value-growth effect.

### 5.3.2 Book-to-market anomaly

Stattman (1980) provided another piece of evidence against the CAPM by showing that the average returns are positively related to B/M effect. However, value premiums were steeper in the bear market than in the bull market (Athanassakos, 2009). Therefore, a specific direction of relationship between B/M ratio and return was not targeted in developing alternative hypothesis for examining B/M effect.

***Hypotheses***

B/M anomaly, in this study, was tested in two steps. First, the B/M effect on returns was examined without taking into consideration any adjustments for risk. Therefore, the following alternative hypothesis was developed to test the B/M effect.

$H_{2.a}$: The average monthly return of high B/M (HB/M) portfolio is different from the average monthly return of low B/M (LB/M) portfolio.

B/M anomaly exists only if there is an excess return after adjusting portfolio returns for risk. Therefore, excess returns of HB/M portfolio and LB/M portfolio were examined to determine whether the B/M anomaly exists for Sri Lankan data.

The equation 4.8 was used to compute the excess returns for each portfolio. Therefore, the second alternative hypothesis was developed as:

$H_{2.b}$: Risk adjusted average monthly excess returns of B/M based portfolios are not equal to zero.

If $H_{1.a}$ is accepted and one of the HB/M or LB/M portfolios has significant excess returns, then the B/M anomaly exists.

**Table 5.6 Average monthly percentage returns: Firms categorized by B/M**

| Period | Mean return | | |
|---|---|---|---|
| | HB/M | LB/M | HmLB/M |
| Full period | 1.112 | 0.640 | 0.472<br>(2.013)** |
| Down-market | -0.358 | -0.276 | -0.082<br>(-0.247) |
| Up-market | 2.455 | 1.477 | 0.978<br>(3.022)*** |

***significant at 5% level. ***significant at 1% level.*

In order to examine the hypothesis $H_{2.a}$, every year June, all the stocks were ranked based on B/M ratio and divided into 3 portfolios as high B/M (HB/M), medium B/M and low B/M (LB/M) portfolios. Next each portfolio's average monthly returns was computed for next 12 months and portfolios were rebalanced every year. Table 5.6 reports the average monthly portfolio returns of HB/M portfolio, LB/M portfolio and HmLB/M portfolio together with associated t-statistics in parentheses. The table reports returns for full sample period, for the down-market period as well as for the up-market period.

The table 5.6 reports that the average monthly returns of HB/M and LB/M portfolios are 1.112 percent and 0.640 percent respectively. Therefore the B/M premium is 0.472 percent and it is economically and statistically significant (accept the alternative hypothesis $H_{2.a}$). However, the down-market scenario is quite different. In the down-market both portfolios generate negative average returns and LB/M portfolio outperforms HB/M portfolio by 0.082 percent (t = 0.247) and this is not economically and statistically significant. However, in the up-market HB/M portfolio outperforms LB/M portfolio by 0.978 percent and this is statistically and economically significant (accept the $H_{2.a}$). Therefore, the table 5.6 reveals that B/M effect exists in the CSE in the full period as well as in the up-market period.

The above findings are not sufficient to determine the existence of B/M anomaly. Therefore, the table 5.7 provides evidence on the risk adjusted returns of the B/M portfolios. The table 5.7 presents average monthly excess returns (α) on the two B/M sorted portfolios.

According to the table, excess return on HB/M portfolio is positive but not statistically distinguishable from zero in the full sample period. However, the corresponding value on LB/M portfolio is negative (-0.373 percent) and it is statistically significantly different from zero. Therefore, accept the second alternative hypothesis and B/M anomaly exists for the full sample period. As positive excess return of HB/M portfolio is not statistically significant, it is not advisable to invest on high B/M portfolios.

**Table 5.7 Estimated abnormal returns: Firms categorized by B/M**

| Period | Excess returns (α) | |
|---|---|---|
| | HB/M | LB/M |
| Full period | 0.098<br>(0.372) | -0.373<br>(1.706)* |
| Down-market | -0.438<br>(-1.498) | -0.338<br>(-1.273) |
| Up-market | 0.145<br>(0.343) | -0.625<br>(-1.723)* |

*Notes: The regression model for sub-periods and full period is based on B/M portfolios. The models is:* $R_{p,t} - R_{f,t} = \alpha_p + \beta_p (R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$ . *The regression coefficient Alfas are White heterroscedasticity-consistent standard errors and covariance. t-statistics in parentheses. *significant at 10% level.*

For the down market excess returns on both HB/M as well as LB/M portfolios are negative and statistically not distinguishable from zero. Therefore, the second null hypothesis is rejected and as a result of that B/M anomaly does not exist in the down-market.

In the up-market analysis, similar to the full period, excess return of HB/M portfolio is positive but statistically not significant. However, the excess return is negative (-0.625) and statistically distinguishable from zero on the LB/M portfolio. This accepts the second null hypothesis, B/M anomaly is true for the up-market period. The existence of the anomaly is due to the underperformance of LB/M portfolio rather than significant outperformance of HB/M portfolio. Therefore, B/M ratio is not a sound basis to create investment portfolios in practical sense.

***Discussion***

This study finds that value stocks outperform the growth stocks in the full sample, and up-market period. Moreover, the B/M anomaly is true in the above two periods due to the negative excess returns of LB/M stocks. Therefore, B/M ratio is not a good criteria to make investment portfolios.

However, the outperformance of HB/M than LB/M is consistent with the Stattman (1980). The appearance of B/M anomaly in the CSE is market state dependent. This is contradictory with the findings of Kwag and Lee (2006) who found that value stocks outperform the growth stocks irrespective of economic conditions. Further, this finding is different from Athanassakos (2009) who also reported that value premium is not market state dependent but more steeper in the down-market.

Further, findings in this study are not consistent with previous Sri Lankan findings. Both Samarakoon (1997) and Nimal (1997) found that B/M ratio did not relate with stock returns. Nimal's sample period was 1991-1996 and he used yearly data. Samarakoon used daily stock returns from 1991-1997 with 75 companies. However, this study used 266 companies from 1995-2008. Further, methods of testing were quite different. Further, Pathirawasam (2010b) also found that B/M ratio is significantly relate to stock price in the recent period. Therefore, value relevance of accounting information on book value might have changed in the recent decade.

The outperformance of HB/M portfolio and underperformance of LB/M portfolio may be due to over pricing of LB/M stocks and under pricing of HB/M stocks.

### 5.3.3 Size effect

As stated in the literature, size effect refers to the negative relations between stock returns and market value of common equity. This means small size firms have higher average returns than large size firms. However, there are instances where the size-return relationship has reversed (Malin and Veeraraghavan, 2004; in their U.K. sample). Therefore, a specific direction of relationship between size and return was not targeted in developing alternative hypothesis for examining size effect.

***Hypotheses***

The following alternative hypothesis was developed to test the size effect.

$H_3$: The average monthly return of small market capitalization portfolio is different from the average monthly return of large capitalization portfolio.

Size effect exists if the above null hypothesis is accepted.

In order to examine the hypothesis $H_3$, every year June all the stocks were ranked and divided into 3 portfolios. Next each portfolio's monthly average returns was computed. Table 5.8 reports the average monthly returns for LS portfolio, SS and SmLS portfolio together with associated t-statistics parentheses. The table reports returns for full sample period (1995–2008), the down market period (January 1995–August 2001) as well as for the up-market period (September 2001–December 2008).

According to the table 5.8 LS stocks achieve higher returns than SS stocks with a difference of 0.249% (t = 0.930) per month in the full sample period. In the down market period, both portfolios generate negative monthly average returns of -0.141 percent and -0.080 percent for LS and SS respectively. Therefore, the SmLS portfolio return is 0.061 percent but it is not statistically significant. In the up-market, both LS and SS portfolios record positive average monthly returns of 1.913 percent and 1.858 percent respectively being the SmLS portfolio returns equal to -0.055 percent and it is also not statistically significant. Therefore, the above findings reject the alternative hypothesis $H_3$ beyond any doubts and findings revel that there is no size effect in Sri Lankan data.

**Table 5.8 Average monthly percentage returns: Firms categorized by firm Size**

| Period | Mean return | | |
|---|---|---|---|
| | LS | SS | SmLS |
| Full period | 0.998 | 0.749 | -0.249<br>(-0.930) |
| Down-market | -0.141 | -0.080 | 0.061<br>(0.145) |
| Up-market | 1.913 | 1.858 | -0.055<br>(-0.137) |

***Discussion***

This study finds that firm size has no relationship with stock returns in conditional or unconditional markets. This fining is contradictory with most of the international findings (see, Banz, 1981 and Rutledge et al. 2008). However, this finding is consistent with few local studies. Samrakoon (1997) as well as Nimal (1997) also found the similar results during the period 1991 to 1997.

However, this finding is not consistent with Nanayakkara (2008) who found a negative relationship between size and returns in CSE. Nanayakkara (2008) found that there was an evidence of 1.457 percent monthly difference of returns between smallest and largest stocks in CSE. There are, number of reasons for the inconsistency between findings. First, Nanayakkara (2008) used 101 companies for the sample. However, this study used 266 companies for the sample. Nanayakkara formed five portfolios to test the size effect where as in this study three portfolios were formed to test the size effect. Nanayakkara (2008) has considered only capital gains for the analysis, but this study considered in addition to capital gains, cash dividends, stock dividends and right issues. Finally, it can be concluded that there is no size effect in the CSE when all the companies are considered.

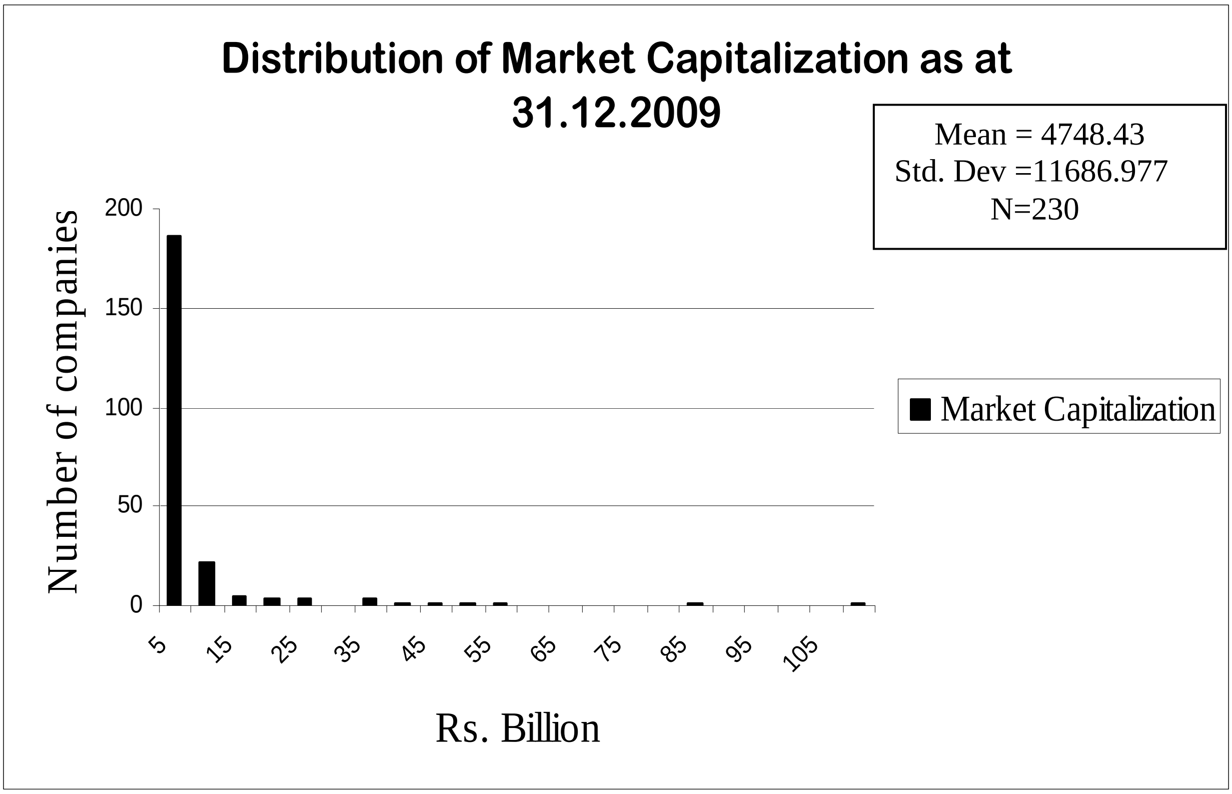


Figure 5.1 Distribution of market capitalization as at 31.12.2009.

Next, it is worth to examine reasons for the non existence of size effect/anomaly in Sri Lanka. The figure 5.1 helps to understand the distribution of company market capitalization (size) for all the companies listed in CSE as at 31 December 2009. According to the histogram, mean market capitalization of all the companies is 4748.43 Rs. millions. However, the standard deviation is extremely high (11686.97). According to the histogram 183 firms have market capitalization below the mean value and only 47 firms have market capitalization above the mean value. The largest 10 companies contribute for the 46 percent of the total market capitalization. This shows that there is a great dispersion in the distribution of market capitalization. It is further evident by the normality test results of the market capitalization distribution reported in the table 5.9. The normality test statistics of S-W test is 0.403 at $P < 0.001$. This rejects the normality assumption of market capitalization distribution even at 0.999 percent confidence level.

**Table 5.9 Normality test results for market capitalization**

| | Kolmogorov-Smimov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Market Capitalization | 0.342 | 230 | 0.000 | 0.403 | 230 | 0.000 |

[a] *Lilliefors Significance Correlation*

The size effect was examined by comparing the average returns of LS and SS portfolios. The untabulated results found that number of stocks included in these portfolios were varied from 50 in 1995 to 70 in 2008. Therefore, even in 1995, 80 percent of the stocks in the LS portfolio were small size companies (If largest 10 companies are considered as the largest companies). The corresponding percentage was 86 percent in a LS portfolio in 2008. Therefore, the reason for non-existence of size effect may be greater unequal distribution of market capitalization of listed companies. Sometimes, size effect may be visible if 5 portfolios are formed instead of 3 portfolios. However, if 5 portfolios are formed, one portfolio will consist only 30 companies in 1995 and according to Brigham (2004) one portfolio should consist 40 companies to considerably eliminated the non-systematic risk.

### 5.3.4 Momentum anomaly

The momentum effect refers to a phenomenon whereby stocks that perform well (badly) in the past tend to outperform (underperform) over a certain period in future. In other words, winners (losers) tend to remain winners (losers). However, there are instances where momentum effect has reversed (Cooper, Gutierrez and Hameed (2004). Therefore, a specific direction of momentum profit was not targeted in developing alternative hypothesis for examining momentum effect in this study.

***Hypotheses***

Momentum anomaly, in this study, was tested in two steps. First, the momentum effect on returns was examined without taking into consideration any adjustments for risk. Therefore, the following alternative hypothesis was developed to test the momentum effect.

$H_{4.a}$: The average monthly return of winner portfolio is different from the average monthly return of loser portfolio.

Momentum anomaly exists only if there is an excess return after adjusting portfolio returns for risk. Therefore, excess returns of winner portfolio and loser portfolio were examined to determine whether the momentum anomaly exists for Sri Lankan data. The equation 4.8 was used to compute the excess returns for each portfolio. Therefore, the second alternative hypothesis was developed as:

$H_{4.b}$: Risk adjusted average monthly returns of winner or loser portfolios are not equal to zero.

If $H_{4.a}$ is accepted and one of the winner or loser portfolios has significant excess returns, then the size anomaly exists.

In order to examine the hypothesis $H_{4.a}$, each month stocks were ranked and grouped into three portfolios on the basis of their returns over the previous 6 months. The highest return portfolio was termed as "winner" and the lowest return portfolio was termed as "loser". The table 5.10 reports the monthly returns of winner and loser portfolios formed based on past 6 month returns and held for next 6 months. The WmL is the momentum portfolio and t-statistics are presented in parenthesis. The full period sample includes all the stocks traded on the CSE from January 1995 to December 2008. The down-market sub-sample includes all the stocks traded on the CSE from January 1995 to August 2001. The up-market sub-sample includes all the stocks traded on the CSE from September 2001 to December 2008.

**Table 5.10 Average monthly percentage returns: Firms categorized by past returns**

| Period | Mean return | | |
|---|---|---|---|
| | Winner | Loser | WmL |
| Full period | 1.119 | 0.521 | 0.598<br>(5.362)*** |
| Down-market | 0.827 | -0.342 | 1.169<br>(6.751)*** |
| Up-market | 1.359 | 1.259 | 0.100<br>(0.844) |

****significant at 1% level.*

According to the table 5.10, the 6 month/6 month momentum strategy yields 0.598 percent return per month for the full sample period and it is statistically significant at 1 percent level of significance (t = 5.362). Therefore, alternative hypothesis $H_{4.a}$ is accepted. Winner portfolio yields an average monthly return of 1.119 percent per month while the corresponding value for the loser portfolio is 0.521 percent. This indicates that momentum profit for the full sample period is clearly due to the outperformance of winner portfolio.

Table 5.10 further to report momentum effects for the two sub periods. The table shows that momentum effect in the down-market is extremely high. The momentum effect is 1.169 (t = 6.751) percent per month for the 6 month/6 month strategy. Further, the average monthly returns of winners and losers reveal that momentum effect is a product of positive average monthly returns of winners and the negative average monthly returns of losers. Average monthly return on winner is 0.827

percent and average monthly return of loser portfolio is -0.342 percent per month. Therefore, alternative hypothesis $H_{4.a}$ is accepted and momentum effect exists in the down-market.

Conversely, the table shows that momentum effect in the up-market is relatively low. The momentum effect in the up-market is 0.100 percent per month and it is not statistically significant. This rejects the alternative hypothesis $H_{4.a}$.

Therefore, the above analysis reveals that momentum effect exists only in the full period and down-market period.

**Table 5.11 Estimated abnormal returns: Firms categorized by past returns**

| Period | Excess returns (α) | |
|---|---|---|
| | Winner | Loser |
| Full period | 0.155<br>(1.538) | -0.437<br>(-4.354)*** |
| Down-market | 0.677<br>(7.131)*** | -0.385<br>(-2.769)*** |
| Up-market | -0.220<br>(-1.368) | -0.336<br>(-2.370)** |

*Notes: The regression model for sub-periods and full period is based on momentum portfolios. The model is:* $R_{p,t} - R_{f,t} = \alpha_p + \beta_p (R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$. *The regression coefficient Alfa is White heterroscedasticity-consistent standard errors and covariance. t-statistics in parentheses. **significant at 5% level. ***significant at 1% level.*

The table 5.11 reports the excess returns of the winner and loser portfolios estimated by regressing their monthly excess returns (after deducting the risk-free rate) on the monthly excess returns of the market portfolio. The CAPM alphas (see equation 4.8) for loser portfolios are negative but statistically significantly different from zero for all the three test periods reported in the table. However, CAPM alpha of the winner portfolio is positive and significantly different from zero only for the down-market period and it is negative but not statistically significant in the up-market period. Even though up-market loser portfolio has statistically significant excess returns, it is not sufficient to conclude that momentum anomaly is true in the up-market because table 5.10 reports that there is no momentum effect in the up-market. Therefore, it is clear CAPM has unable to explain the momentum effect only in down-market period. The momentum anomaly is well preserved in full sample period as well as in down-market period. Therefore, momentum anomaly in CSE is market state dependent.

***Discussion***

Momentum effect exists only in the down-market period. In the down-market, winners outperform losers while in the up-market both winners and losers generate positive returns and therefore momentum profits are not significant. This indicates that a practical investor should buy high return stocks in the down market. In the up-market momentum is not a good criteria to make investment strategies.

The full sample findings are much similar to the finings in other markets (i.e. Jegadeesh and Titman, 1993; Rouwenhorst, 1998). Further, the results indicate that states of the market in the formation period are rather negatively associated with the profitability of the momentum strategies. The momentum profits are significantly positive in the down market. In contrast, momentum profits appear to be positive but not significant in up-market. The reason for the non existence of momentum profits in the up-market is the high positive returns of the formation period losers in the holding period. This finding is contradictory with that of Cooper et al. (2004) but confirms the findings of Antonios and Patricia (2006) and Wang et al. (2009).

The non existence of momentum effect in the up-market condition may be due to asymmetrical reaction of investors to prior period winners and losers. If the market turns out to be bullish in the holding period, price reversal may be more likely for losers. Investors may think that losers were under valued in the formation period and correct their price in the holding period. However, in the bearish period investors may think that price decline may continue for the losers. If the market is bullish some investors may think that winners are performing well and continue trading. At the same time if the market is bearish some investors may hesitate to adjust their positive assessment of the winner stocks. Hence price continuation is slow for winners. Therefore existence of momentum profits in the down market and non existence of momentum profits in the up-market may be due to the investor asymmetrical reaction to prior winners and losers in the holding period.

### 5.3.5 Trading volume anomaly

Gervais et al. (2001) found that stocks with large (small) trading volume over periods of a day or a week tend to experience large (small) returns over the subsequent month. However, most of the volume-return relationships have been examined for very shorter time horizons. As this study examines volume-return relationship for six month period, a specific direction of volume-return was not targeted in developing alternative hypothesis for examining volume effect in this study.

***Hypotheses***

Trading volume anomaly, in this study, is tested in two steps. First, the volume effect on returns was examined without taking into consideration any adjustments for risk. Therefore, the following alternative hypothesis was developed to test the volume effect.

$H_{5.a}$: The average monthly return of high volume portfolio is different from the average monthly return of low volume portfolio.

Volume anomaly exists only if there is an excess return after adjusting portfolio returns for risk. Therefore, excess returns of high volume portfolio and low volume portfolio were examined to determine whether the volume anomaly exists for Sri Lankan data. The equation 4.8 was used to compute the excess returns for each portfolio. Therefore, the second alternative hypothesis was developed as:

$H_{5.b}$: Risk adjusted average monthly excess returns of high volume (HV) or low volume (LV) portfolios are not equal to zero.

If $H_{5.a}$ is accepted and one of the HV or LV portfolios has significant excess returns, then the volume anomaly exists.

In order to examine the hypothesis $H_{5.a}$, each month stocks were ranked and grouped into three portfolios on the basis of their trading volume over the previous 6 months. The highest trading volume portfolio is termed as HV and the lowest trading volume portfolio is termed as LV. The table 5.12 reports the monthly returns of HV and LV portfolios formed based on past 6 month trading volume and held for next 6 months. The HmLV is the volume premium portfolio and t-statistic is presented in parenthesis. The sample includes stocks traded on the CSE from September 2001– December 2008 (up-market).

**Table 5.12 Average monthly percentage returns: Firms categorized by trading volume**

| Period | Mean return | | |
|---|---|---|---|
| | HV | LV | HmLV |
| Up-market | 1.158 | 1.571 | -0.413<br>(-4.621)*** |

****significant at 1% level.*

Table 5.12 reveals that average monthly excess returns of both HV portfolio and LV portfolio are positive but LV portfolio outperforms the HV portfolio by 0.413 percept at t = 4.621. This accepts the alternative hypothesis ($H_{5.a}$) and indicates that past 6 months trading volume is negatively relate with the stock returns.

The table 5.13 reports risk-adjusted average returns on the HV portfolio and LV portfolio. Excess return of HV portfolio is negative and not statistically significantly different from zero. The excess return on LV portfolio is positive but again not statistically and economically different from zero. This rejects the second alternative hypothesis and indicates that there is no medium term volume anomaly in the CSE.

**Table 5.13 Estimated abnormal returns: Firms categorized by trading volume**

| Period | Excess returns (α) | |
|---|---|---|
| | HV | LV |
| Up-market | -0.178<br>(-0.864) | 0.280<br>(1.330) |

*Notes: The regression model for up-market is based on trading volume portfolios. The model is:* $R_{p,t} - R_{f,t} = \alpha_p + \beta_p(R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$ . *The regression coefficient Alfa is White heterroscedasticity-consistent standard errors and covariance. t-statistics in parentheses.*

***Discussion***

The outperformance of low volume portfolio than the high volume portfolio is contrary to the previous findings (see, Gervars et al., 2001; Huan and Heian 2010). Further, the finding is not in accordance with the sequential arrival of information theory of Copeland (1976) and mixture of distribution hypothesis of Epps and Epps (1976). The outperformance of HV portfolio returns by LV portfolio returns can be justified with two reasons.

First, the higher (lower) future returns of LV(HV) stocks can be due to investor misperceptions about future earnings. Lee and Swaminathan (2001) found negative relationship between trading volume and returns and they pointed out that:

*… analysts provide lower (higher) long-term earnings growth forecasts for low(high) volume stocks. However, low(high) volume firms experience significantly better (worse) future operating performance. Moreover, we find that short-window earnings announcement returns are significantly more positive (negative) for low(high) volume firms over each of the next eight quarters.*

The same pattern is observed in this study also and as Lee and Swaminathan (2001) pointed out that this can be due to investor misperceptions about future earnings of low volume firms. As a result of that market is “surprised” by the systematically higher (lower) future earnings of low (high) volume firms.

The second justification for the negative relationship between trading volume and return is the liquidity of the assets. Datar, Naik and Radcliffe (1998) found negative relationship between future stock returns and liquidity measured by stock turnover rate for all non financial firms on the NYSE from July 31, 1962 through December 31, 1991. Dater et al. (1998) pointed out the negative sign between stock return and trading volume is due to illiquid stocks that offer higher average returns than liquid stocks.

However, trading volume is not a good criteria to make investment portfolios since excess returns of LV portfolio is not statistically significant.

***Summary***

This chapter examined the five market anomalies in the CSE. The summarized findings are given in the table 5.14 below.

**5.14 Summary results of market anomalies**

| Anomaly | Does anomaly exist? | | |
|---|---|---|---|
| | Full period | Down-market | Up-market |
| E/P | Yes | Yes | No |
| B/M | Yes | No | Yes |
| Size | No | No | No |
| Momentum | Yes | Yes | No |
| Trading volume | Na | Na | No |

*Na = Data not available*

Three market anomalies, E/P, B/M and momentum exist in the full period while in the down-market; E/P and momentum anomalies exist. In the up-market only B/M anomaly exists. Therefore, the next part of the study is to develop factor models by creating factor mimicking portfolios using the anomalies which exist and to construct factor models for the three periods separately.

# CHAPTER SIX

# RESULTS AND DISCUSSION-FACTOR MODELS

Number of market anomalies was identified in the last chapter. The aim of this chapter is to develop asset pricing factor models to explain the variability of common stock returns in the CSE. The factor models were developed for full period, down-market and up-market separately. The following steps were followed in developing factor models in each sub-period.

6.1 Construction of factor mimicking portfolios
6.2 Multicolinearity test
6.3 Ranking factors
6.4 Developing factor models
6.5 Discussion of the findings

## 6.1 Construction of factor mimicking portfolios

The main objective of this study is to identify set of factors which explain the cross-section of portfolio stock returns. The previous section revealed that E/P, B/M and momentum anomalies exist in the CSE. Therefore, three factor mimicking portfolios were constructed based on these anomalies as HmLE/P, HmLB/M and WmL.

HmLE/P is the difference between the returns of HE/P portfolio and returns of LE/P portfolio.

HmLB/M is the difference between the returns of HB/M portfolio and returns of LB/M portfolio.

WmL is the difference between the returns of winner portfolio and returns of loser portfolio.

In addition to above, the excess returns of the market portfolio ($R_m$-$R_f$) were used as an independent variable.

## 6.2 Multicolinearity test

Before determine the final form of a multifactor regression model it should be assured that two independent variables are not highly correlated (the multicolineraity problem). Therefore, the table 6.1 reports the Pearson correlation coefficients computed for each pair of independent variables for full period, down-market and up-market.

The panel A of the table shows the Pearson correlation coefficient between variables in the full period. According to the table, there is no strong positive or negative correlation between any pair of variables.

The panel B of the table presents Pearson correlation coefficients between independent variables in the down-market period. Panel B also reveals that there is no strong correlation between variables.

**Table 6.1 Pearson correlation coefficients**

| **Panel A: Full period N=155** | | | | |
|---|---|---|---|---|
| | $(R_m-R_f)$ | HmLE/P | HmLB/M | WmL |
| $(R_m-R_f)$ | 1 | 0.165 | 0.223 | -0.027 |
| HmLE/P | | 1 | 0.252 | 0.051 |
| HmL/M | | | 1 | -0.020 |
| WmL | | | | 1 |
| **Panel B: Down-market period N=74** | | | | |
| $(R_m-R_f)$ | 1 | -0.104 | - | 0.062 |
| HmLE/P | | 1 | - | 0.036 |
| WmL | | | | 1 |
| **Panel B: Up-market period N=81** | | | | |
| $(R_m-R_f)$ | 1 | - | 0.340 | - |
| HmLB/M | | | 1 | - |

Similarly, the panel C of the table reveals that there is no strong correlation between variables in the up-market period.

Therefore, in conclusion, there is no multicilinearity problem between any pair of variables selected for the regression analysis.

## 6.3 Ranking factors

Before entering factors into a multiple regression model, each independent variable should be ranked as first, second and so on to enter into the factor model. For this purpose, univariate regressions were run (equation 4.8) for each independent variable on set of dependent variable portfolios separately for each test period. The criterion used to rank independent variable was the average t-statistics of univatriate regression slope coefficients. The variable with highest average t-statistics was entered into the model first and the variable with the second highest average t-statistic next and so on. A variable was selected (ranked) for the analysis only if it satisfied following criteria.

The average t-statistic on all the test portfolios should be greater than one.

### 6.3.1 Full sample period

The table 6.2 shows t-statistics relating to univariate regression slope coefficients run on eight dependent variables using four independent factor variables.

According to the table, the excess market return factor has highest average t-statistic (16.011) and for all the univariate regressions t-statistics are greater than 1. Therefore, market factor was ranked as the number 1 to be added to the final factor model. Next, HmLB/M factor reflects average t-statistic of 2.779. Therefore, the second rank was given to the HmLB/M factor. Next, the average t-statistics for HmLE/P factor is 1.467. Therefore, this factor was ranked as factor 3. Finally, WmL factor was selected because WmL factor also have t-statistics greater than 1. Therefore, in the full sample period, following four factors were selected for the final model.

I. Excess market returns factor ($R_m$-$R_f$)
II. HmLB/M factor
III. HmLE/P factor
IV. WmL factor

**Table 6.2 t-statistics of univariate regressions: Full period**

| Dependent variable | ($R_m$-$R_f$) | HmLE/P | HmLB/M | WmL |
|---|---|---|---|---|
| HE/P | 18.016 | 5.090 | 4.506 | 0.362 |
| LE/P | 15.872 | 0.142 | 3.366 | 0.043 |
| HB/M | 15.355 | 2.905 | 7.015 | 0.031 |
| LB/M | 15.151 | 1.726 | 0.590 | 0.161 |
| LS | 7.532 | 0.520 | 2.500 | 0.177 |
| SS | 8.200 | 0.258 | 4.035 | 0.531 |
| WI | 21.624 | 0.370 | 0.182 | 0.967 |
| Lo | 26.340 | 0.729 | 0.041 | 6.622 |
| **Average** | **16.011** | **1.467** | **2.779** | **1.104** |
| **Rank** | **1** | **3** | **2** | **4** |

### 6.3.2 Down-market period

The table 6.3 shows t-statistics relating to univariate regression slope coefficients run on eight dependent variables using three independent factor variables. The average t-statistic for market factor is 16.717 and it is greater than 1 for all the univariate regressions. Moreover, WmL variable has average t-statistic greater than 1. However, the HmLE/P variable has average t-statistic below 1 (t=0.932). Therefore, HmLE/P was rejected. Finally, following two variables were selected in the down market.

I. Excess market returns factor ($R_m$-$R_f$)
II. WmL factor

**Table 6.3 t-statistics of univariate regressions: Down-market**

| Dependent variable | ($R_m$-$R_f$) | HmLE/P | WmL |
|---|---|---|---|
| HE/P | 18.070 | 1.944 | 0.288 |
| LE/P | 18.431 | 2.001 | 0.121 |
| HB/M | 15.385 | 0.060 | 0.548 |
| LB/M | 13.029 | 0.031 | 0.203 |
| LS | 5.566 | 2.026 | 0.758 |
| SS | 10.197 | 0.400 | 0.769 |
| WI | 31.778 | 0.468 | 0.522 |
| Lo | 21.280 | 0.528 | 5.765 |
| **Average** | **16.717** | **0.932** | **1.121** |
| **Rank** | **1** | **-** | **2** |

### 6.3.3 Up-market period

The table 6.4 shows statistics relating to univariate regression slope coefficients run on ten dependent variables using three independent factor variables.

**Table 6.4 t-statistics of univariate regressions: Up-market period**

| Dependent Variable | ($R_m$-$R_f$) | HmLB/M |
|---|---|---|
| HE/P | 12.890 | 5.268 |
| LE/P | 10.680 | 3.247 |
| HB/M | 11.376 | 6.312 |
| LB/M | 11.024 | 1.871 |
| LS | 5.307 | 3.277 |
| SS | 7.710 | 2.809 |
| WI | 13.278 | 0.616 |
| LO | 15.992 | 0.204 |
| HV | 5.281 | 2.520 |
| LV | 6.560 | 1.752 |
| **Average** | **10.009** | **2.786** |
| **Rank** | **1** | **2** |

The average t-statistic for excess market return factor is 10.009 and it is greater than 1 for all the univariate regressions. As all the t-statistics reported are greater than 1, the excess market return factor was ranked as the number one to be entered to the final model. Next, important factor is the HmLB/M factor which shows average t-statistic of 2.786. Therefore, following two factors were selected for the final model building.

I. Excess market returns factor ($R_m$-$R_f$)
II. HmLB/M factor

## 6.4 Developing factor models

This study used the time series regression approach of BJS (1972) to develop asset pricing factor models. According to the factor rankings in the previous section, each period factor models were started with the market model. That means monthly returns on stock portfolios were regressed on the excess market returns ($R_m$-$R_f$). There in after other factor mimicking portfolios were entered step wise. The following two alternative hypotheses were developed to test each of the factor models developed in this chapter.

***Alternative hypothesis one***

$H_{6.a}$: The Incremental explanatory power ($\Delta\bar{R}^2$) of the new factor entered to the model is positive.

Fama and French 1993 and 1996 models were tested on large number of (25) test portfolios created by sorts on B/M and size characteristics. The Sri Lankan market is much smaller than U.S. market. Therefore in this study, factor models were tested on portfolios sorted under E/P, B/M, size, momentum and volume characteristics. The test portfolios on which each model tested were HE/P, LE/P, HB/M, LB/M, LS, SS, WI and LO. According to Fama and French (1993), the slopes and $R^2$ values were direct evidence on whether different risk factors capture common variations in stock returns. Therefore, this study used $\Delta\bar{R}^2$ to test the alternative hypothesis. The significance of the explanatory power is determined using *F*-statistic. As each model is tested 8 (10 in up-market) test portfolios, if *F*-statistics are significant at least 4 (5 in up-market) times, then the alternative hypothesis is accepted.

***Alternative hypothesis two***

$H_{6.b}$: Regression slope coefficients of the new factor are not equal to zero

The above alternative hypothesis is tested using t-statistics. As in the above, if regression slope coefficients of the new factor entered to the model are statistically significant at least for half of the test portfolios tested, then it would be assumed that the second alternative hypothesis is accepted.

Therefore, only if the above two alternative hypotheses were accepted for a factor mimicking portfolio, then that factor would be accepted as a proxy for the missing risk factors.

### 6.4.1 Factor models for the full period

This section examines the role of stock market factors in returns under four steps in accordance with the factor ranks in the table 6.2.

I. Regressions that use excess market return ($R_m$-$R_f$) to explain excess stock returns (market model).

II. Regressions that use HmLB/M mimicking returns together with $R_m$-$R_{f,}$ as explanatory variables. (two-factor model).

III. Regressions that use HmLB/M and HmLE/P returns together with $R_m$-$R_{f,}$ as explanatory factors (three-factor model).

IV. Regressions that use HmLB/M and WmL returns together with $R_m$-$R_{f,}$ as explanatory factors (Three-factor model).

***Market model***

The table 6.5 shows the excess returns of market model (α), slope coefficients ($\beta_m$) and $\overline{R}^2$ of the model. Similar to the Fama and French (1993), the excess returns on the market portfolio of stocks ($R_m$-$R_f$), capture more variation in stock returns of portfolios. Fama and French (1993) has taken $R^2$ = 90 percent as the benchmark satisfactory level of explanatory power of any variable(s). However, according to the table 6.5 none of the test portfolios record $\overline{R}^2$ value closer to 90 percent.

The highest $\overline{R}^2$ value reports for LO portfolio ($\overline{R}^2$= 80.8 at $F$= 647.74). At the same time the lowest $\overline{R}^2$ value reports for the SS test portfolio ($\overline{R}^2$= 49.8 at $F$= 153.83). Further, all the $\overline{R}^2$ values are statistically significant ($p < 0.001$) and all of the factor coefficients ($\beta_m$) are statistically significant at 1 percent level. Therefore, both alternative hypotheses ($H_{6.a}$ and $H_{6.b}$) are accepted. The average $\overline{R}^2$ value of the entire test portfolios is 71.7 percent and it implies that there are potentials to increase the explanatory power of the model by adding other factors to the market model. Therefore, in the next section, HmLB/M factor is introduced to the market model.

**Table 6.5 Regression of excess stock returns on excess market returns**

$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$

| Dependent variable | α | t(α) | β1 | t(β1) | $\overline{R}^2$ | *F* |
|---|---|---|---|---|---|---|
| HEP | 0.572 | 2.24** | 0.829 | 18.016*** | 77.2 | 521.69*** |
| LEP | -0.283 | -1.29 | 0.761 | 15.872*** | 79.5 | 597.28*** |
| HBM | 0.098 | 0.37 | 0.768 | 15.385*** | 73.1 | 418.56*** |
| LBM | -0.373 | -1.71* | 0.676 | 15.151*** | 75.5 | 475.08*** |
| LS | -0.081 | -0.30 | 0.612 | 7.532*** | 61.3 | 245.23*** |
| SS | -0.081 | -0.31 | 0.469 | 8.200*** | 49.8 | 153.83*** |
| WI | 0.154 | 1.54 | 0.686 | 21.624*** | 76.6 | 505.18*** |
| LO | -0.437 | -4.35*** | 0.777 | 26.340*** | 80.8 | 647.67*** |
| **Average** | | | | | **71.7** | |

*In June of each year t over the test period 1995-2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year and momentum portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variable included monthly excess returns of value weighted market index. F-statistics measure the statistical significance of* $\overline{R}^2$ *values while t-statistics measure the statistical significance of slope coefficient.*significant at 10% level. **significant at 5% level. ***significant at 1% level.*

### *Two factor model ($R_m$-$R_f$ and HmLB/M)*

The table 6.6 shows regression results of test portfolios when the independent variables are excess market returns and high minus low book-to-market (HmLB/M) mimicking portfolio returns. The table 6.6 shows excess returns of the model (α), slope coefficients of each factors, $\overline{R}^2$,s of the two factor model and the $\Delta\overline{R}^2$,s due to the new factor HmLB/M. The table shows that $\Delta\overline{R}^2$,s of the new factor HmLB/M are positive for all the test portfolios other than LS portfolio. The highest $\Delta\overline{R}^2$ records for HB/M ($\Delta\overline{R}^2$ = 10.1 at *F*= 91.32). The average incremental $\overline{R}^2$ of the new factor is 2.2 percent. Further, four of the test portfolios record $\Delta\overline{R}^2$,s which are statistically significant at $p < 0.01$ level. Further, slope coefficients associated with HmLB/M for all the test portfolios other than LS are statistically significant. Therefore, both alternative hypotheses ($H_{6.a}$ and $H_{6.b}$) are accepted.

The other important fact is that the inclusion of HmLB/M factor to the market model has not changed the slope coefficients of the market factor reported in table 6.5. The $\overline{R}^2$,s of the test portfolios reflect that none of the test portfolios comes to the cut-off level of $\overline{R}^2$ (90 percent). The highest $\overline{R}^2$ of 83.2 percent record for the HB/M test portfolio while the lowest $\overline{R}^2$ records for the SS portfolio ($\overline{R}^2$ = 52.2).

The average $\overline{R}^2$ of the two factor model is 73.9 percent which is an increment of 2.2 percent from the market model reported in table 6.5.

The excess returns measured by α shows that four test portfolios generate significant excess returns. It implies that the two factor model has failed to fully explain the variability of returns in these four test portfolios.

In conclusion, since $\Delta\overline{R}^2$,s are statistically significant for four test portfolios and seven of the factor coefficients ($\beta_2$) associated with HmLB/M factor are also statistically significant, the two factor model of excess market return and HmLB/M factor seems to explain the variability of test portfolio returns. However, four of the eight intercepts in the two factor regressions differ from zero by more than 10 percent level per month. Therefore, it can not be concluded that this model is the best possible factor model to be created to explain the variability of stock returns in the CSE.

***Three-factor model ($R_m$-$R_f$, HmLB/M and HmLE/P)***

The table 6.7 shows the three-factor multiple regression results for test portfolios when the independent variables are market excess returns, high minus low book-to-market (HmLB/M) and high minus low earnings-to-price (HmLE/P) portfolio returns. The table shows excess returns of the model (α), slope coefficients of each factor, $\overline{R}^2$,s of the three factor model and the $\Delta\overline{R}^2$ due to the new factor HmLE/P.

According to the table 6.7 the new factor HmLE/P generates positive $\Delta\overline{R}^2$,s for all the test portfolios except winner (WI) portfolio. The highest $\Delta\overline{R}^2$ is recorded for HE/P portfolio ($\Delta\overline{R}^2$ = 6.6 at $F$= 72.18). Four out of eight $\Delta\overline{R}^2$ values are statistically significantly different from zero. As a result, the average $\Delta\overline{R}^2$ due to new factor is 1.5 percent. Therefore, first alternative hypothesis is accepted.

Next, slope coefficients ($\beta_3$) of new factor are examined. The table 6.7 reveals that only three out of eight slope coefficients of new factor are statistically significantly different from zero. Since the slope coefficient of HmLE/P factor variable is not statistically significantly different from zero for majority (5) of test portfolios, second alternative hypothesis is rejected and the factor HmLE/P can not be considered as a factor which is capable of explaining variability of stock returns in the CSE.

**Table 6.6 Regression of excess stock returns on excess market returns and HmLB/M returns**

$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(HmLB/M_t) + \varepsilon_{p,t}$

| Dependent variable | α | t(α) | $\beta_1$ | t($\beta_1$) | $\beta_2$ | t($\beta_2$) | $\bar{R}^2$ | $\Delta\bar{R}^2$ | $F$ |
|---|---|---|---|---|---|---|---|---|---|
| HE/P | 0.39 | 1.69* | 0.795 | 18.270*** | 0.370 | 3.816*** | 79.6 | 2.4 | 17.71*** |
| LE/P | -0.35 | -1.67* | 0.748 | 15.947*** | 0.143 | 1.699* | 79.8 | 0.3 | 2.47 |
| HB/M | -2.37 | -1.17 | 0.702 | 16.322*** | 0.711 | 8.600*** | 83.2 | 10.1 | 91.32*** |
| LB/M | -0.23 | 0.165 | 0.702 | 16.322*** | -0.288 | -3.484*** | 77.6 | 2.1 | 14.14*** |
| LS | -0.10 | -0.40 | 0.607 | 7.269*** | 0.054 | 0.525 | 61.2 | -0.2 | -0.68 |
| SS | -0.20 | -0.80 | 0.444 | 7.871*** | 0.268 | 2.901*** | 52.2 | 2.4 | 7.48*** |
| WI | 0.18 | 1.80* | 0.689 | 22.671*** | -0.057 | -1.687* | 76.9 | 0.3 | 1.83 |
| LO | -0.41 | -4.10*** | 0.779 | 26.894*** | -0.054 | -1.643* | 81.0 | 0.2 | 1.48 |
| **Average** | | | | | | | **73.9** | **2.2** | |

*In June of each year t over the test period 1995-2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year and momentum portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables included monthly excess returns of market portfolio and high minus low book-to-market (HmLM/B) mimicking portfolio returns. F-statistics measure the statistical significance of $\Delta\bar{R}^2$ values while t-statistics measure the statistical significance of slope coefficients.*significant at 10% level. **significant at 5% level. ***significant at 1% level.*

**Table 6.7 Regression of excess stock returns on excess market returns, HmLB/M and HmLE/P returns**

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(HmLB/M_t) + \beta_3(HmLE/P_t) + \varepsilon_{p,t}$$

| Dependent variable | A | t(α) | $\beta_1$ | t($\beta_1$) | $\beta_2$ | t($\beta_2$) | $\beta_3$ | t($\beta_3$) | $\bar{R}^2$ | $\Delta\bar{R}^2$ | $F$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HE/P | -0.06 | -0.31 | 0.77 | 18.91*** | 0.23 | 2.93*** | 0.61 | 7.35*** | 86.1 | 6.6 | 72.18*** |
| LE/P | -0.06 | -0.31 | 0.75 | 18.91*** | 0.23 | 2.93*** | -0.39 | -4.72*** | 83.2 | 3.4 | 28.95*** |
| HB/M | -0.32 | -1.52 | 0.70 | 16.30*** | 0.69 | 8.36*** | 0.11 | 1.34 | 83.3 | 0.1 | 1.17 |
| LB/M | -0.32 | -1.52 | 0.70 | 16.30*** | -0.31 | -3.81*** | 0.11 | 1.34 | 77.7 | 0.2 | 1.35 |
| LS | 0.04 | 0.14 | 0.62 | 8.06*** | 0.10 | 0.89 | -0.19 | -1.44 | 61.9 | 0.7 | 2.57* |
| SS | -0.04 | -0.16 | 0.46 | 8.94*** | 0.32 | 3.38*** | -0.22 | -2.00** | 53.7 | 1.5 | 4.99* |
| WI | 0.19 | 1.90* | 0.69 | 21.89*** | -0.06 | -1.70* | -0.01 | -0.42 | 76.7 | -0.1 | -0.65 |
| LO | -0.38 | -3.78*** | 0.78 | 26.68*** | -0.04 | -1.29 | -0.04 | -1.30 | 81.0 | 0.0 | 0.16 |
| Average | | | | | | | | | **75.5** | **1.5** | |

*In June of each year t over the test period 1995-2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year momentum portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables included monthly excess returns of market portfolio, high minus low book-to-market (HmLM/B) mimicking portfolio returns and high minus low earnings-to-price (HmLE/P) mimicking portfolio returns. F-statistics measure the statistical significance of* $\Delta\bar{R}^2$ *values while t-statistics measure the statistical significance of slope coefficients. *significant at 10% level. **significant at 5% level. ***significant at 1% level.*

**Table 6.8 Regression of excess stock returns on excess market returns and HmLB/M, and WmL returns**

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(HmLB/M_t) + \beta_3(WmL_t) + \varepsilon_{p,t}$$

| Dependent variable | A | t(α) | $\beta_1$ | t($\beta_1$) | $\beta_2$ | t($\beta_2$) | $\beta_3$ | t($\beta_3$) | $\bar{R}^2$ | $\Delta\bar{R}^2$ | $F$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HEP | 0.25 | 1.04 | 0.80 | 18.78*** | 0.37 | 3.88*** | 0.25 | 1.83* | 79.7 | 0.1 | 1.00 |
| LEP | -0.43 | -1.91* | 0.75 | 16.07*** | 0.14 | 1.71* | 0.12 | 1.01 | 79.8 | -0.1 | -0.39 |
| HBM | -0.32 | -1.47 | 0.70 | 16.47*** | 0.71 | 8.64*** | 0.14 | 1.09 | 83.1 | 0.0 | -0.19 |
| LBM | -0.32 | -1.47 | 0.70 | 16.47*** | -0.29 | -3.48*** | 0.14 | 1.09 | 77.5 | 0.0 | -0.19 |
| LS | -0.19 | -0.62 | 0.61 | 7.29*** | 0.06 | 0.54 | 0.13 | 0.78 | 61.0 | -0.1 | -0.58 |
| SS | -0.16 | -0.58 | 0.44 | 7.79*** | 0.27 | 2.89*** | -0.09 | -0.48 | 51.9 | -0.3 | -0.79 |
| WI | -0.11 | -1.19 | 0.74 | 29.18*** | -0.06 | -2.22** | 0.50 | 8.46*** | 83.8 | 6.9 | 63.87*** |
| LO | -0.11 | -1.19 | 0.73 | 29.18*** | -0.06 | -2.22** | -0.50 | -8.49*** | 86.6 | 5.7 | 64.27*** |
| **Average** | | | | | | | | | **75.4** | **1.5** | |

*In June of each year t over the test period 1995-2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year and momentum portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables included monthly excess returns of market portfolio, high minus low book-to-market (HmLM/B) mimicking portfolio returns and winner minus loser (WmL) mimicking portfolio returns. F-statistics measure the statistical significance of* $\Delta\bar{R}^2$ *values while t-statistics measure the statistical significance of slope coefficients. *significant at 10% level. ** significant at 5% level. *** significant at 1% level.*

***Three factor model ($R_m$-$R_f$, HmLB/M and WmL)***

As the HmLE/P factor did not sufficiently affect on the variability of stock returns, instead of the HmLE/P factor, winner minus loser (WmL) factor was introduced to the two factor model reported in table 6.7.

According to the table 6.8 $\Delta\overline{R}^2$ is significant only for two test portfolios and for three portfolios' $\Delta\overline{R}^2$,s are negative and another two test portfolios' $\Delta\overline{R}^2$,s are almost zero. However, the overall $\Delta\overline{R}^2$ is 1.5 percent and it is mainly due to the high $\overline{R}^2$,s of WI and LO tests portfolios. The first alternative hypothesis is rejected as most of the test portfolios have negative or zero $\Delta\overline{R}^2$,s.

When consider slope coefficients associated with WmL mimicking portfolio, only three of the eight slope coefficients are statistically significantly different from zero. Therefore, the second null hypothesis is also rejected and as a result the WmL factor can not be entered to the two factor model recorded in the table 6.6.

***Summary***

According to the analysis following conclusions are arrived for the full sample period.

I. Similar to the Fama and French (1993), excess returns of market factor ($R_m$-$R_f$) captures more variation in common stocks in the CSE. The average explanatory power of the market factor is 71.7 percent.

II. When the two-factor model is created by adding the HmLB/M factor to the $R_m$-$R_f$ factor the average explanatory power of the model increase by 2.2 percent than that of the market model.

III. The HmLE/P factor as well as WmL does not significantly affect on the variability of returns of most of the test portfolios.

IV. Therefore, finally, it can be concluded that the only $R_m$-$R_f$ and HmLB/M factors proxy for risk factors in the CSE. However, the joint explanatory power of the two factors only 73.9 percent and this two factor model has failed to fully explain the variability of stock returns in four out of eight test portfolios ($\alpha$,s are significant). Therefore, more potential risk factors should be added to the two factor model of $R_m$-$R_f$ and HmLB/M. The best model selected can be shown in an equation as follows.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(HmLB/M_t) + \varepsilon_{p,t}$$

### 6.4.2 Factor models for the down-market

This section examines the role of stock market factors in returns under two steps in accordance with the factor ranks in the table 6.3.

I. Regressions that use excess market return ($R_m$-$R_f$) to explain excess stock returns (market model).

II. Regressions that use WmL mimicking returns together with $R_m$-$R_f$, as explanatory variables. (two-factor model).

***Market model***

**Table 6.9 Regression of excess stock returns on excess market returns**

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1 (R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$$

| Dependent variable | α | t(α) | $\beta_1$ | t($\beta_1$) | $\overline{R}^2$ | *F* |
|---|---|---|---|---|---|---|
| HE/P | 0.55 | 1.89* | 0.72 | 18.07*** | 77.0 | 244.75*** |
| LE/P | -0.28 | 1.42 | 0.76 | 18.43*** | 86.4 | 465.06*** |
| HB/M | -0.44 | -1.50 | 0.58 | 15.09*** | 67.5 | 152.80*** |
| LB/M | -0.34 | -1.27 | 0.59 | 13.03*** | 76.0 | 231.87*** |
| LS | -0.07 | -0.22 | 0.67 | 5.57*** | 65.0 | 136.44*** |
| SS | 0.35 | -1.18 | 0.48 | 10.20*** | 57.7 | 100.48*** |
| WI | 0.68 | 7.13*** | 0.78 | 31.78*** | 87.0 | 488.40*** |
| LO | -0.39 | -2.77*** | 0.87 | 21.28*** | 80.8 | 308.73*** |
| **Average** | | | | | **74.7** | |

*In June of each year t over the test period January 1995-August 2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next periods. E/P, B/M and size portfolios were rebalanced every year and momentum portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables included monthly excess market returns. F-statistics measure the statistical significance of $\overline{R}^2$ values while t-statistics measure the statistical significance of slope coefficients. *significant at 10% level. ***significant at 1% level.*

The table 6.9 presents the excess returns of market model (α), slope coefficients ($\beta_1$) and $\overline{R}^2$ of the model for eight test portfolios. Similar to the full period, the excess returns on market portfolio of stocks ($R_m$-$R_f$), capture more variation in portfolio of stock returns. The average explanatory power of the model is, $\overline{R}^2$=74.7 percent and it is 3 percent above the corresponding figure in the full period. The highest explanatory power records for the winner (WI) test portfolio ($\overline{R}^2$ = 87 percent at $F$=488.40). All the $\bar{R}^2$,s are statistically significant. Therefore, the first alternative hypothesis is accepted. The lowest explanatory power reflects for the small size (SS) test portfolio with $\bar{R}^2$ = 57.7 (F=100.48) percent. All the slope coefficients are highly statistically different from zero at 1 percent level. Therefore, the second alternative hypothesis is also accepted. However, three of the eight (for HE/P, WI and LO) excess returns (α) are statistically different from zero. This implies that market factor does not sufficiently explain the return variation of these test portfolios and there is a potential to add new factor(s) to the market model to increase explanatory power of the model. Therefore, in the next subsection WmL mimicking portfolio is introduced to the market model.

***Two factor model ($R_m$-$R_f$ and WmL)***

The table 6.10 shows regression results of test portfolios when independent variables are excess market returns and winner minus loser (WmL) mimicking portfolio returns. The table 6.10 presents excess returns (α), slope coefficients (β), $\bar{R}^2$ of the two factor model and the $\Delta\bar{R}^2$ due to new factor WmL. The table reports that $\Delta\bar{R}^2$,s of the new factor WmL are positive for five test portfolios and the highest $\Delta\bar{R}^2$ records for the test portfolio LO ($\Delta\bar{R}^2$=12.7 at F=140.60). Four test portfolios record statistically significant $\Delta\bar{R}^2$,s. Therefore, the first alternative hypothesis is accepted. At the same time, the new factor, WmL, has decreased the explanatory power of the market model reported in the table 6.9 for two test portfolios of HE/P and LE/P. However, the explanatory power decreases of these two test portfolios are very small, $\Delta\bar{R}^2$ =-0.3 percent ($F$=-0.88) and $\Delta\bar{R}^2$ =-0.3 percent ($F$=-0.77) respectively for HE/P and LB/M test portfolios. On average the new factor, WmL, has increased the explanatory power by 2.6 percent.

Interestingly, two of the eight test portfolios (WI and LO) show $\bar{R}^2$,s greater than 90 percent. The average $\bar{R}^2$ of the model is 77.3 percent which is 2.6 percent increase of the $\bar{R}^2$ of the market model reported in the table 6.9.

The next most important criteria is the significance of the slope coefficient. Interestingly, six of the eight slope coefficients of the new factor WmL are statistically significantly different from zero. Further, the inclusion of the new factor, WmL, has improved the slope coefficients of the market factor for some of the test portfolios. Therefore, the second alternative hypothesis is also accepted.

The table 6.10 shows that most of the excess returns except WI and LO test portfolios are statistically insignificant. This implies that the two factor model of $R_m$-$R_f$ and WmL sufficiently explain the variability of stock returns in all the test portfolios.

In conclusion, since $\Delta\bar{R}^2$,s are statistically significant for four test portfolios and most of the factor coefficients of the new factor are statistically significant, the WmL seems proxy for omitted risk in the CSE.

***Summary***

According to the analysis following conclusions are arrived for the down-market period.

I. Similar to the full sample period, excess returns of market factor $R_m$-$R_f$ captures more variation in common stocks in the CSE. The average explanatory power of the market factor is 74.7 percent.

II. When the two-factor model is created by adding the WmL factor to the $R_m$-$R_f$ factor the average explanatory power of the model increase by 2.6 percent than that of market model.

III. Therefore, finally, it can be concluded that the $R_m$-$R_f$ and WmL factors proxy for risk factors in the down-market period. However, the joint explanatory power of the two factors only 77.3 percent and this two factor model has failed to fully explain the variability of stock returns in two out of eight test portfolios (α,s are significant). Therefore, more potential risk factors should be added to the two factor model of $R_m$-$R_f$ and WmL. The best model selected is as follows.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(WmL_t) + \varepsilon_{p,t}$$

**Table 6.10 Regression of excess stock returns on excess market returns and WmL returns**

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 (WmL_t) + \varepsilon_{p,t}$$

| Dependent variable | α | t(α) | $\beta_1$ | t($\beta_1$) | $\beta_2$ | t($\beta_2$) | $\overline{R}^2$ | $\Delta\overline{R}^2$ | *F* |
|---|---|---|---|---|---|---|---|---|---|
| HE/P | 0.63 | 1.51 | 0.72 | 17.09*** | -0.06 | -0.27 | 76.7 | -0.3 | -0.88 |
| LE/P | -0.11 | -0.41 | 0.77 | 18.54*** | -0.14 | -0.59 | 86.4 | 0.0 | -0.11 |
| HB/M | -0.03 | -0.09 | 0.59 | 15.72*** | -0.34 | -1.73* | 68.5 | 1.0 | 2.18 |
| LB/M | -0.24 | 0.17 | 0.70 | 16.32*** | -0.29 | -3.48*** | 75.7 | -0.3 | -0.77 |
| LS | 0.53 | 1.11 | 0.68 | 5.86*** | -0.50 | -2.14** | 66.8 | 1.8 | 3.88* |
| SS | 0.11 | 0.30 | 0.48 | 9.94*** | -0.38 | - 1.66* | 59.4 | 1.7 | 3.03* |
| WI | 0.31 | 4.29*** | 0.82 | 38.89*** | 0.34 | 6.33*** | 91.4 | 4.5 | 36.84*** |
| LO | 0.31 | 4.29*** | 0.82 | 38.89*** | -0.66 | -12.25*** | 93.6 | 12.7 | 140.60*** |
| **Average** | | | | | | | **77.3** | **2.6** | |

*In June of each year t over the test period January 1995-August 2001, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year and momentum portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables include monthly excess returns of market index and winner minus loser (WmL) mimicking portfolio returns. F-statistics measure the statistical significance of incremental* $\overline{R}^2$ *values while t-statistics measure the statistical significance of slope coefficients. *significant at 10% level. **significant at 5% level. ***significant at 1% level.*

### 6.4.3 Factor models for the up-market

This section examines the role of stock market factors in returns under two steps in accordance with the factor ranks in the table 6.4.

I. Regressions that use excess market return ($R_m$-$R_f$) to explain excess stock returns (market model).

II. Regressions that use HmLB/M mimicking returns together with $R_m$-$R_f$, as explanatory variables. (two-factor model).

***Market model***

**Table 6.11 Regression of excess stock returns on excess market returns**

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \varepsilon_{p,t}$$

| Dependent variable | α | t(α) | $B_1$ | t($\beta_1$) | $\overline{R}^2$ | *F* |
|---|---|---|---|---|---|---|
| HE/P | 0.31 | 0.81 | 0.90 | 12.89*** | 77.2 | 271.58*** |
| LE/P | -0.28 | -0.81 | 0.76 | 10.98*** | 74.3 | 232.69*** |
| HB/M | 0.15 | 0.39 | 0.86 | 11.38*** | 75.5 | 247.62*** |
| LB/M | -0.62 | -1.90* | 0.73 | 11.02*** | 75.1 | 242.93*** |
| LS | 0.06 | 0.16 | 0.57 | 5.31*** | 56.3 | 104.00*** |
| SS | 0.20 | 0.45 | 0.45 | 7.71*** | 42.2 | 59.46*** |
| WI | 0.46 | 2.89*** | 0.62 | 13.28*** | 68.7 | 176.33*** |
| LO | 0.35 | 2.39** | 0.64 | 15.99*** | 73.5 | 223.31*** |
| HV | 0.18 | 0.96 | 0.36 | 5.77*** | 34.2 | 42.65*** |
| LV | 0.60 | 3.04*** | 0.32 | 5.46*** | 27.6 | 31.49*** |
| **Average** | | | | | **60.0** | |

*In June of each year t over the test period September 2001-December 2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year while momentum and trading volume portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables included monthly excess returns of market portfolio. F-statistics measure the statistical significance of $\overline{R}^2$ values while t-statistics measure the statistical significance of slope coefficients. *significant at 10% level. **significant at 5% level. ***significant at 1% level.*

The table 6.11 shows excess returns of market model (α), slope coefficients (β) and $\overline{R}^2$,s of the model for 10 test portfolios including high volume (HV) portfolio and low volume (LV) portfolio. Like in the previous two periods, ($R_m$-$R_f$) captures more variation in portfolio of stock returns. However, the average explanatory power is, $\overline{R}^2$ = 60.5 percent and it is 11.1 percent below the corresponding values in the full period. The main reason for the explanatory power difference is the low explanatory power of the market factor over the test portfolio returns of HV ($\overline{R}^2$=34.2 at $F$=42.65) and LV ($\overline{R}^2$=27.6 at $F$=31.29). The highest $\overline{R}^2$ reports for the test portfolio HE/P ($\overline{R}^2$=77.2 at $F$=271.58). Further, all the factor coefficients are positive and strongly significant. Therefore, both alternative hypotheses are accepted. However, four of the ten excess returns (α,s) are statistically significantly different from zero. It implies that new factors may play a role in explaining the variability of returns of these test portfolios. Therefore, in the next section HmLB/M factor is introduced to the market model.

***Two factor model ($R_m$-$R_f$ and HmLB/M)***

The table 6.12 shows regression results of test portfolios when the independent variables are excess market returns and high minus low book-to-market (HmLB/M) mimicking portfolio returns. The table 6.12 presents excess returns (α), slope coefficients (β) and $\overline{R}^2$ of the two factor model and the $\Delta\overline{R}^2$ due to the new factor HmLB/M.

The table shows that $\Delta\overline{R}^2$,s are positive for all the test portfolios except test portfolio of LE/P and SS. However, these two test portfolios' minus $\Delta\overline{R}^2$,s are very small and not statistically significant. The highest $\Delta\overline{R}^2$ reports for the test portfolio HV ($\Delta\overline{R}^2$ =7.7 at F= 10.40). Seven of the ten $\Delta\overline{R}^2$,s reported are statistically significant. Further, five of the ten test portfolios record statistically significant slope coefficient for the HmLB/M factor. Further, the addition of the new factor HmLB/M has not made a significant impact on the loadings of the excess market returns factor. Therefore, both alternative hypotheses can be accepted.

The two factor model explains on average 63 percent of the variability of stock returns in the up-market. The highest explanatory power records for the test portfolio HB/M ($\overline{R}^2$ =82.7 percent). The lowest explanatory power records for the test portfolio of LV ($\overline{R}^2$=30.5 percent).

The excess returns measured by the α shows that two test portfolios generate significant excess returns. Therefore, generally two factor model of excess returns and HmLB/M mimicking portfolio returns sufficiently explain the variability of returns in the test portfolios.

In conclusion, as incremental $\overline{R}^2$,s are statistically significant for seven test portfolios and factor loadings of HmLB/M factor is statistically significant for 5 of the ten coefficients, the two factor model of the excess market returns and HmLB/M seems to explain the variability of test portfolio returns in the up-market period.

***Summary***

According to the analysis following conclusions are arrived for the down-market period.

I. Similar to the full period and down-market, excess returns of market factor captures more variation in common stocks in the CSE. The average explanatory power of the market factor is 60.5 percent.

II. When the two factor model is created by adding the HmLB/M factor to the $R_m$-$R_f$ factor the average explanatory power of the model increase by 2.6 percent.

III. Therefore, finally, it can be concluded that the $R_m$-$R_f$ and HmLB/M factors proxy for risk factors in the up-market period. However, the joint explanatory power of the two factors only 63.1 percent and this two factor model has failed to fully explain the variability of stock returns in two out of ten test portfolios. The best factor model selected for the down-market is as follows.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(HmLB/M_t) + \varepsilon_{p,t}$$

**Table 6.12 Regression of excess stock returns on excess market returns and HmLB/M mimicking returns**

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 (HmLB / M_t) + \varepsilon_{p,t}$$

| Dependent variable | α | t(α) | $\beta_1$ | t($\beta_1$) | $\beta_2$ | t($\beta_2$) | $\bar{R}^2$ | $\Delta R^2$ | $F$ |
|---|---|---|---|---|---|---|---|---|---|
| HE/P | -0.09 | -0.28 | 0.83 | 12.56*** | 0.52 | 3.54*** | 80.4 | 3.2 | 12.64*** |
| LE/P | -0.36 | -1.04 | 0.75 | 10.14*** | 0.10 | 0.61 | 74.2 | -0.2 | -0.46 |
| HB/M | -0.43 | -1.37 | 0.77 | 11.11*** | 0.74 | 5.39*** | 82.7 | 7.2 | 32.20*** |
| LB/M | -0.43 | -1.37 | 0.77 | 11.11*** | -0.26 | -1.87* | 76.1 | 0.9 | 3.01* |
| LS | -0.08 | -0.20 | 0.55 | 4.78*** | 0.19 | 1.12 | 56.6 | 0.3 | 0.49 |
| SS | 0.10 | 0.24 | 0.43 | 4.76*** | 0.13 | 0.86 | 42.0 | -0.3 | -0.35 |
| WI | -0.19 | -1.18 | 0.67 | 15.00*** | 0.02 | 0.31 | 70.2 | 1.6 | 4.12** |
| LO | -0.29 | -1.93* | 0.70 | 17.12*** | -0.02 | -0.42 | 75.7 | 2.1 | 6.88** |
| HV | 0.03 | 0.14 | 0.40 | 6.14*** | -0.22 | -4.04*** | 42.0 | 7.7 | 10.40*** |
| LV | 0.42 | 2.10** | 0.35 | 5.64*** | -0.16 | -2.60*** | 30.5 | 2.9 | 3.28* |
| **Average** | | | | | | | **63.0** | **2.6** | |

*In June of each year t over the test period September 2001-December 2008, all the stocks were sorted into three portfolios based on various characteristics and equally weighted returns were computed for next period. E/P, B/M and size portfolios were rebalanced every year while momentum and trading volume portfolios were rebalanced every month. The time series of extreme portfolios of each characteristic were taken as dependent variable. Independent variables included monthly excess returns of market portfolio and high minus low book-to-market (HmLM/B) mimicking portfolio returns. F-statistics measure the statistical significance of* $\Delta\bar{R}^2$ *values while t-statistics measure the statistical significance of slope coefficients.*significant at 10% level. **significant at 5% level. ***significant at 1% level.*

## 6.5 Discussions of the findings

The main findings of this chapter are summarized as follows.

I. Excess market returns ($R_m$-$R_f$) and high minus low book-to-market (HmLB/M) mimicking factor explain most of the variation of stock returns in the full period.

II. Excess market returns ($R_m$-$R_f$) and winner minus loser (WmL) mimicking factor explain most of the variation of stock returns in the down-market period.

III. Excess market returns ($R_m$-$R_f$) and high minus low book-to-market (HmLB/M) mimicking factor explain most of the variation of stock returns in the up-market period.

The above findings are clearly different from the plethora of studies which examined Fama and French (1993) three factor model (see, Fama and French 1996; Drew and Veeraraghavan, 2002, 2003; Wang and Xu, 2004; Bahl 2008 and Simlai, 2008). These studies found that Fama and French three factor model explain the stock returns. However, this study finds that excess market returns sufficiently explain the returns of size sorted portfolios. Therefore, Fama and French (1993) three factor model is not applicable for CSE data. Moreover, this study has serious implications for the asset pricing in Sri Lanka.

Firstly, risk factors are differs from down-market to up-market. Therefore studies in Sri Lanka should focus on time varying factor models. Secondly, with respect to Sri Lankan market there are few studies examining the role of multifactor models. Among them the most recent finding of Nanayakkara (2008) is important. Nanayakkara (2008) found that Fama and French (1993) three-factor model explains around 87 percent of variability of stock returns. However, according to this study, Fama and French (1993) three-factor model does not seem to work for the CSE data. The similar finding arrived by the Konstantinos (2008) for Australian Stock Market also.

The findings of the chapter have following practical significance also.

I. This study finds that risk factors are time varying in Sri Lankan market. Therefore, these time varying risk factors should be considered in computations of cost of capital.

II. The time varying factor models can be used for investors to measure their portfolio performance.

Further, none of the factor models came to the optimal level of explanatory power (90 percent). It implies that further research is necessary to improve these factor models.

# CHAPTER SEVEN
# GAIN FOR SCIENCE AND PRACTICE

Predictability of stock returns has been the central theme of research in finance since 1960s. The first asset pricing model was the CAPM which developed by Sharpe (1964), Lintner (1965) and Mossin (1966). However, there are vast numbers of research findings which show that CAPM is not an empirically true model. As a result, Fama and French (1993) developed a three-factor asset pricing model comprising of market, size and book-to-market factors which sufficiently explained the stock returns. Fama and French (1993) model was true mainly in developed markets especially in the U.S. market.

However, there are several knowledge gaps which have not been sufficiently addressed by researchers.

I. Most of the proxy variables of risk are market state dependent (see, Kim and Burnie, 2002; Rutledge et al. 2008; Muga and Santamaria, 2009; Athanassakos, 2009; Konstantinos, 2008). However, these proxy variables have not been sufficiently tested based on emerging markets and in conditional market states.

II. Even though Fama and French (1993) model was true mainly in developed markets especially in the U.S. market, there are instances where it has been failed in some other markets (Malin and Veeraraghavan, 2004; Konstantinos, 2008). Empirical verifications of three-factor models are extremely lacking in emerging small markets.

III. Multifactor asset pricing models have not been sufficiently tested in conditional market states.

This study was carried out based on CSE which is an emerging market to find answers for the above knowledge gaps. Therefore, this study has two main objectives.

I. To analyze market anomalies conditionally as well as unconditionally in the CSE.

II. To analyze which asset pricing model(s) better explain stock returns in CSE conditionally as well as unconditionally.

The outcomes of the research can be categorized under two headings.

## 7.1 Contribution for the literature

This study found number of market anomalies in CSE data. The appearances of market anomalies suggest that CAPM is not exist in the CSE. This confirms the earlier findings of Nimal (1997) and Samarakoon (1997).

This study finds that E/P, B/M and momentum anomalies exist in the CSE while size and trading volume anomalies do not exist. Colombo Stock Exchange is a fast growing small market. Therefore, analysis of market anomalies in CSE broaden the existing knowledge base in finance literature. These are explained as follows.

I. This study finds that E/P effect exists for all the test periods. This positive relation between E/P ratio and stock return is similar to the findings of Basu (1977) and Pathirawasam (2010a). However, after adjusting for risk, E/P anomaly persists only in down-market. This confirms several past findings (see, Chen, Kim and Zheng, 2008 and Athanassakos, 2009). Further, this study finds that there is no earnings based value premium in the up-market and this is contradictory with Kwag and Lee (2006) and Athanassakos (2009).

II. Both full period and up-market period, B/M anomaly persists in the CSE. Therefore, the appearance of the B/M anomaly in the CSE is market state dependent. This is contradictory with the findings of Kway and Lee (2006) who found that value stocks outperform the growth stocks irrespective of economic conditions. Further, finding of this study does not agree with previous Sri Lankan findings of Nimal (1997) and Samarakoon (1997).

III. This study further to find that firm size has no relationship with stock returns in conditional or unconditional markets. This finding is not in accordance with most international findings (see, Banz 1981; Rutledge et al. 2008) as well as Nanayakkara (2008) in the CSE data. One hundred and eighty three of 230 companies in the CSE are very small firms. Therefore, this study suggests that in small markets size anomaly may not exist.

IV. Next finding is that monthly trading volume is negatively related with monthly stock returns. However, risk adjusted excess returns do not show the same pattern. Therefore, this finding is different from Gervais et al. (2001) and Huan and Heian (2010). However, they used weekly data. Further, this finding rejects the sequential arrival of information theory of Copeland (1976) and Mixture of distribution hypothesis of Epps and Epps (1976).

V. Next contribution to the literature is the existence of momentum anomaly in the CSE. Momentum anomaly is persisting in the full market period and down market period. The full sample finding is similar to the (Jegadeesh and Titman, 1993, 2001; Lee and Swaminathan, 2000). The momentum anomaly exists only in the down market. This finding is contradictory with Cooper et al. (2004) but confirm the findings of Antonios and Patricia (2006) and Wang et al. (2009).

Next, the study finds that risk factor models which explain the variability of stock returns differ from full period and up-market to down-market.

In the full period and up-market excess market returns and high minus low book-to-market (HmLB/M) mimicking factor portfolio returns explain most of the variation in stock returns and it is shown below.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 (HmLB / M_t) + \varepsilon_{p,t}$$

In the down-market, excess market returns ($R_m$ - $R_f$) and winner minus loser (WmL) mimicking factor portfolio returns explain most of the variation in stock returns and it is shown below.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 (WmL_t) + \varepsilon_{p,t}$$

The above findings reject the plethora of international findings on Fama and French model (see, Fama and French, 1996; Drew and Veeraraghavan, 2002, 2003; Wang and Xu, 2004; Bahl, 2008; Simlai, 2008). At the same time these findings rejects the earlier Sri Lankan finding of Nanayakkara (2008) who found that Fama and French (1993) three-factor model was applicable for the CSE data.

## 7.2 Contribution for the practice

First, finding of market anomalies can be used to make profitable trading strategies. E/P anomaly exists in the down-market. Therefore, investing in high earnings-to-price stocks generate positive abnormal returns. Similarly, momentum anomaly also exists in the down-market. Investing in stocks with past six month high returns generate positive abnormal returns. Therefore, it is recommended to invest in stocks with high E/P and stocks with past six month high returns which will generate positive abnormal excess returns in down-market. In the up-market, it is recommended to invest in stocks with high E/P and high B/M ratios which will generate positive abnormal returns even though they are not statistically significant.

The identified time varying factor models also have some practical significance.

First, the time varying factor models should be considered in computation of cost of capital than traditional CAPM. Second, the time varying factor models can be used for investors to measure mean-variance efficient portfolio performance. This will cause to mobilize financial resources more efficiently because resources will move out from loss making enterprises into the profit making activities.

## 7.3 Limitations of the study

Some limitations have been identified that have affected to the results of the study.

I. **Sample period:** The sample period of the study was confined to 14 years which is a short period when compare with similar studies in developed markets. The main limiting factor to increase the sample period was unavailability of a comprehensive data base at the CSE. All the accounting data were obtained through published documents and it was very difficult to find accounting reports in the past.

II. **Sample size:** With delisted securities the study considered 266 stocks for the study. But, in developed market studies number of stocks taken was much larger and in most of the cases they formed 10 portfolios in testing market anomalies but this study confined to three portfolios.

III. **Unavailability of data:** due to unavailability of trading volume data, trading volume anomaly was tested only in the up-market period. Further, cash flow to price variable was not considered to the study due to unavailability of data.

## 7.4 Future directions

This study finds that famous Fama and French (1993) model does not work for Sri Lankan data. Further, Konstantinos, (2008) also found that Fama and French (1993) model does not work in Australian data. However, in order to come to a concrete conclusion about the applicability of Fama and French (1993) in small markets more and more tests should be done based on small markets.

Further more research is needed on which macro economic risks the B/M and momentum factors proxy for.

Trading volume anomaly was tested only in the up-market period. Therefore, it is better to test the trading volume anomaly in the down-market period also.

Further these models do not consider the macro economic variables; interest rate, exchange rate and inflation rate. Therefore, these macro economic variables can be considered as further research.

# CHAPTER EIGHT
# CONCLUSION

This study was carried out to achieve the following objectives.

I. To analyze the E/P anomaly in CSE
II. To analyze the B/M anomaly in CSE
III. To analyze the size anomaly in CSE
IV. To analyze the trading volume anomaly in CSE
V. To analyze the momentum anomaly in CSE
VI. To formulate new asset pricing models to explain the stock returns in CSE

Study used 266 listed stocks from 1995 to 2008. Further, the total period was divided into two sub-periods as down-market and up-market. The main statistical tool used for the analysis was univariate regression and multi-variate time series regressions. The findings or achievements for the research objectives are as follows.

This study finds that E/P effect exists in the CSE for all the test periods. However, E/P anomaly persists only in the down-market. This implies that the time varying CAPM was able to capture returns of HE/P and LE/P portfolios in up-market. The outperformance of HE/P portfolio than LE/P portfolio may be due to higher distress risk of HE/P portfolio or investors may over extrapolate the performance of LE/P stocks and under extrapolate the performance of HE/P stocks in the down market. It is recommended to invest in high earnings-to-price stocks in the down market.

This study finds that high B/M stocks outperform the low B/M stocks in the full sample, and up-market period. However, the B/M anomaly exists in the above two periods due to the negative excess returns of LB/M stocks. Therefore, B/M ratio is not a good criteria to make investment portfolios.

This study finds that firm size has no relationship with stock returns in conditional or unconditional markets. This finding is contradictory with most of the international findings as well as with Nanayakkara (2008) who found that there is a negative relationship between size and returns in CSE. There are, number of reasons for the inconsistency between findings. First, Nanayakkara (2008) used 101 companies for the sample. However, this study used 266 companies for the sample. Nanayakkara (2008) has considered only capital gains for the analysis, but this study considered in addition to capital gains, cash dividends, stock dividends and right issues. This study formed three portfolios to test the size effect where as Nanayakkara (2008) formed five portfolios. Further, extended analysis found that the reason for non-existence of size effect may be greater unequal distribution of market capitalizations of listed companies.

Trading volume is negatively related with monthly stock returns. However, risk adjusted excess returns do not show the same pattern. The outperformance of low volume portfolio than the high volume portfolio is not in accordance with the sequential arrival of information theory and mixture of distribution hypothesis. The outperformance of high volume portfolio returns by low volume portfolio returns can be justified with two reasons. The higher (lower) performance of low volume (high volume) stocks can be due to investor misspecification about future earnings. Or else, illiquidity of low volume stocks can be the reason for outperformance of low volume stocks. However, risk adjusted returns confirm that volume anomaly does not exist in the CSE

Momentum anomaly exists only in the down-market period. In the down-market winners outperform losers while in the up-market both winners and losers generate positive returns and therefore momentum profits are not significant. This indicates that a practical investor should buy high return stocks in the down-market. In the up-market momentum is not a good criteria to make investment strategies. The existence of momentum profits in the down-market and non existence of momentum profits in the up-market may be due to the investor asymmetrical reaction regarding prior winners and losers in the holding period.

Next the study finds that risk factor models which explain the variability of stock returns differ from down-market to up-market. In the down-market, excess market returns and winner minus loser (WmL) mimicking factor portfolio returns explain most of the variation in stock returns while in the up-market excess market returns and high minus low book-to-market (HmLB/M) mimicking factor portfolio returns explain most of the variation in stock returns. This confirms that Fama and French (1993) three factor model is not operational in the CSE.

In summary, the study finds that E/P, B/M and momentum anomalies are persisting in the CSE and they are market state dependent. Further, risk factors identified as capable of explaining variability of stock returns are also time varying. On the one hand, these findings have enhanced the existing body of knowledge in asset pricing and on the other hand, findings bring with some practical benefits to existing and potential investors.

Finally, this study suggests that risk factors which well operate in developed markets may not equally operate in emerging markets. Therefore, the author suggests that the risk factor models formulated based on developed markets should not be used in emerging markets as prescribed without confirming their applicability in emerging markets.

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# CURRICULUM VITAE

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## 2. Academic Qualifications

| Degree | Year | Institution | Medium |
|---|---|---|---|
| M.Sc (Management) | 2006 | University of Sri Jayewardenepura, Sri Lanka | English |
| MBA (Finance) | 2003 | University of Shiga, Japan | English |
| PG Pip in Accounting and Finance | 1999 | University of Sri Jayewardenepura, Sri Lanka | English |
| B.Sc (Business Administration) | 1996 | University of Sri Jayewardenepura, Sri Lanka | English |

### 3. Employment Records

| Post | Institution | From | To |
|---|---|---|---|
| Senior lecturer | University of Kelaniya, Sri Lanka | Jan. 2004 | To date |
| Lecturer | University of Kelaniya, Sri Lanka | Mar. 2003 | Jan. 2004 |
| Lecturer probationary | University of Kelaniya, Sri Lanka | Jan. 1999 | Mar. 2003 |
| Temporary lecturer | University of Kelaniya, Sri Lanka | Sep. 1996 | Jan. 1999 |

### 4. Scholarships won and Medals Awarded

- MONBUSHO Japanese Scholarship in 2000.
- Bank of Ceylon (Sri Lanka) Undergraduate scholarship in 1995
- Prof. R.A.A Perera memorial gold medal awarded to the best student in the English group of the department of Business Administration University of Sri Jayawardenapura in 1996.

### 5. Professional Qualifications

- Passed the Licentiate Part I, II and Professional Part I, Examinations of the Institute of Chartered Accountants of Sri Lanka.
- Successfully completed the NSE's certification in Financial Markets (NCFM) Derivatives Module in December 2005.

# APPENDICES.

## APPENDIX A-Listed companies used for the study

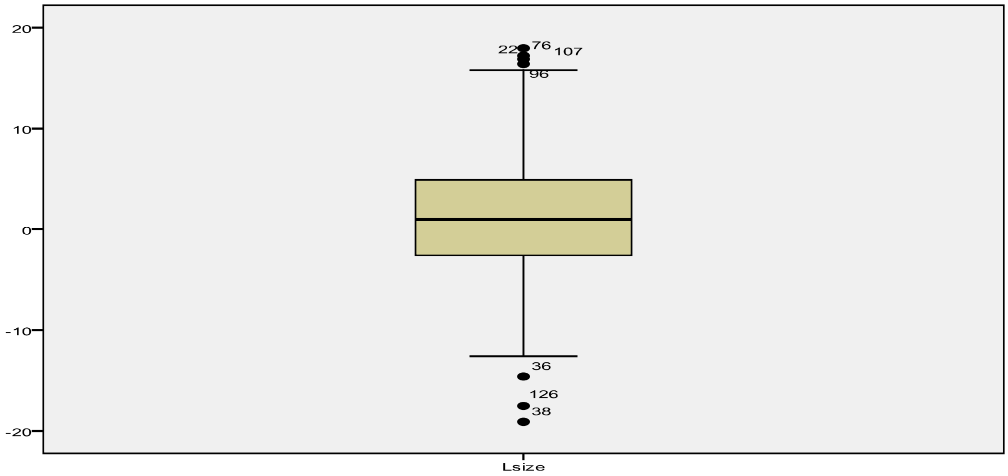
| | | | |
|---|---|---|---|
| AAIC | ASIAN ALLIANCE | JFIN | FINLAYS COLOMBO |
| ABAN | ABANS | JKH | JKH |
| ACAP | ASIA CAPITAL | JKL | JOHN KEELLS |
| ACL | ACL | KAHA | KAHAWATTE |
| ACME | ACME | KAPI | MTD WALKERS |
| AEC | AEC | KCAB | KELANI CABLES |
| AGAL | AGALAWATTE | KDL | KELSEY |
| AHPL | AHOT PROPERTIES | KFP | KEELLS FOOD |
| AHOT | ASIAN HOTELS | KGAL | KEGALLE |
| AHPL | ASIAN HOTELS & PROPERTIES PLC | KHC | KANDY HOTELS |
| AHUN | A.SPEN.HOT.HOLD. | KHL | KEELLS HOTELS |
| ALLI | ALLIANCE | KINN | KANDY WALK INN |
| ALUF | ALUFAB | KOTA | KOTAGALA |
| AMSL | ASIRI SURG | KREA | KOREA CEYLON |
| AMW | AMW | KTEX | KANDY TEXTILES |
| APDL | ASSOCIATED PROP. | KURU | KURUWITA TEXTILE |
| APLA | ACL PLASTICS | KVAL | KELANI VALLEY |
| ARPI | ARPICO | LALU | LANKA ALUMINIUM |
| ASCO | ASCOT HOLDINGS | LAMB | KOTMALE HOLDINGS |
| ASHA | ASIRI CENTRAL | LAND | LAND & BUILDING |
| ASHL | ASHA CENTRAL | LCEM | LANKA CEMENT |
| ASHO | LANKA ASHOK | LCEY | LANKEM CEYLON |
| ASIR | ASIR | LDEV | LANKEM DEV. |
| ASPH | INDUSTRIAL ASPH. | LFIN | LB FINANCE |
| ATL | AMANA | LHCL | LANKA HOSPITALS |
| AUTO | AUTODROME | LHL | LIGHTHOUSE HOTEL |
| BALA | BALANGODA | LION | LION BREWERY |
| BATA | BATA | LINV | LAKE HOUSE INV. |
| BBH | BROWNS BEACH | LIOC | LANKA IOC |
| BFL | BAIRAHA FARMS | LITE | LAXAPANA |
| BHR | RIVERINA HOTELS | LLUB | CHEVRON |
| BINN | BERUWELA WALKINN | LMF | LMF |
| BLUE | BLUE DIAMONDS | LPRT | LAKE HOUSE PRIN. |
| BOGA | BOGALA GRAPHITE | LOLC | LOLC |
| BOPL | BOGAWANTALAWA | LVEN | LANKA VENTURES |
| BREW | CEYLON BREWERY | LWL | LANKA WALLTILE |
| BRWN | BROWNS | MADU | MADULSIMA |
| BUKI | BUKIT DARAH | MAL | MALWATTE |
| CABO | CARGO BOAT | MARA | MARAWILA RESORTS |
| CARB | KABUL LANKA | MASK | MASKELIYA |
| CARE | PRINTCARE PLC | MBSL | MERCHANT BANK |
| CARG | CARGILLS | MGT | HAYLEYS - MGT |
| CARM | CARM | MIKE | MIKECHRIS |

| | | | |
|---|---|---|---|
| CARS | CARSONS | MILL | MILLERS 8/- |
| CCS | COLD STORES | MIRA | MIRAMAR |
| CDIC | CDIC | MLL | MLL |
| CERA | LANKA CERAMIC | MORI | MORISONS |
| CFI | CFI | MPAC | METAL PACKAGING |
| CFIN | CENTRAL FINANCE | MPEK | MPEK |
| CFLB | FORT LAND | MRH | MAHAWELI REACH |
| CFT | CFT | MRL | METAL RECYCLERS |
| CFVF | FIRST CAPITAL | MSL | MERC. SHIPPING |
| CHL | DURDANS | MULL | MULLERS |
| CHMX | CHEMANEX | NAMU | NAMUNUKULA |
| CHOT | HOTELS CORP. | NBL | NBL |
| CHOU | CEYLINCO HOUSING | NDB | NAT. DEV. BANK |
| CHR | CEYLON HOLIDAY | NEST | NESTLE |
| CIC | CIC | NTB | NATIONS TRUST |
| CIND | CENTRAL IND. | ONAL | ON'ALLY |
| CINS | CEYLINCO INS. | NAMU | NAMUNUKULA |
| CINV | CEYLON INV. | OSEA | OVERSEAS REALTY |
| CIT | CIT | OVL | OCEAN VIEW LTD |
| CLND | COLOMBO LAND | PALM | CONFIFI HOTEL |
| CNF | CNF | PARA | PARAGON |
| CLPL | CEYLON LEATHER | PARQ | PARQUET |
| CMAT | | PDL | PDL |
| COCO | COCO LANKA | PEG | PEGASUS HOTELS |
| COLO | COLONIAL MTR | PHAR | COL PHARMACY |
| COMB | COMMERCIAL BANK | PMB | PEOPLE'S MERCH |
| COMD | COMMERCIAL DEV. | PTEX | PUGODA TEXTILES |
| COML | COMM. LEASING | PURE | COCA-COLA |
| COMP | | RCL | ROYAL CERAMIC |
| CONN | AMAYA LEISURE | RECK | RECKITTS |
| COXY | CEYLON OXYGEN | REEF | REEFCOMBER |
| CPRT | CEYLON PRINTERS | REG | REGNIS |
| CSD | CEYLINCO SEYLAN | RENU | RENUKA CITY HOT. |
| CSEC | KSHATRIYA HOLD. | REXP | RICH PIERIS EXP |
| CSF | CEYLINCO FINANCE | RGEM | RADIANT GEMS |
| CSYN | SYNTHETICS | RHTL | FORTRESS RESORTS |
| CTC | CEYLON TOBACCO | RICH | RICHARD PIERIS |
| CTCE | EAGLE INSURANCE | RPBH | ROYAL PALMS |
| CTEA | TEA SERVICES | SAMP | SAMPATH |
| CTHR | CEY THEATRES | SAMS | SAMUELS |
| CTLD | C T LAND | SELI | SELINSING |
| CWM | C.W.MACKIE | SEMB | SEYLAN MERCHANT |
| DFCC | DFCC | SERV | HOTEL SERVICES |
| DIAL | DIALOG | SEYB | SEYLAN BANK |
| DIMO | DIMO | SHAW | SHAW WALLACE |
| DIPD | DIPPED PRODUCTS | SHOT | SERENDIB HOTELS |
| DIST | DISTILLERIES | SIDL | SIDL |
| DOCK | DOCKYARD | SIGV | SIGIRIYA VILLAGE |
| DPL | DANKOTUWA PORCEL | SIL | SAMSON INTERNAT. |

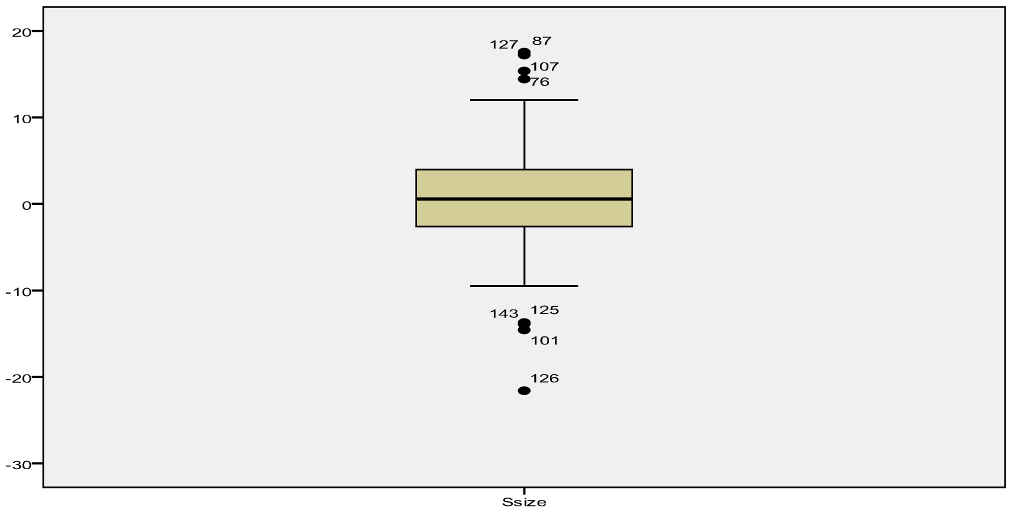
| | | | |
|---|---|---|---|
| EAST | EAST WEST | SING | SINGALANKA |
| EBCR | E B CREASY | SINI | SINGER IND. |
| ECL | E - CHANNELLING | SINN | CEY.STRAT. HOLD |
| EDEN | EDEN HOTEL LANKA | SIGV | SIGIRIYA VILLAGE |
| EHR | | SLND | SEREND LND |
| ELAS | ELASTOMERIC ENG | SINS | SINGER SRI LANKA |
| ELPL | ELPITIYA | SLTL | SLT |
| EMER | EASTERN MERCHANT | SMOT | SATHOSA MOTORS |
| EQIT | EQUITY | SOY | CONVENIENCE FOOD |
| ETWO | EQUITY TWO PLC | SPEN | AITKEN SPENCE |
| FERN | FERNTEA LTD | STAF | STAFFORD |
| FORB | FORBS CEYLON | STAT | STATCON |
| GEST | GESTETNER | SUGA | PELWATTE |
| GHLL | GALADARI | SUN | SUNSHINE HOLDING |
| GILB | GILB | SWAD | SWADESHI |
| GLAS | PIRAMAL GLASS | TAFL | THREE ACRE FARMS |
| GLAX | GLAXO | TAJ | TAJ LANKA |
| GOOD | GOOD HOPE | SUN | SUNSHINE HOLDING |
| GRAN | GRAIN ELEVATORS | TANG | TANGERINE |
| GREG | ENVI. RESOURCES | TESS | TESS AGRO |
| GUAR | CEYLON GUARDIAN | TFC | THE FINANCE CO. |
| HAPU | HAPUGASTENNE | TILE | LANKA TILES |
| HARI | HARISCHANDRA | TKYO | TOKYO CEMENT |
| HASU | HNB ASSURANCE | TPL | TALAWAKELLE |
| HAYC | HAYCARB | TRAN | TRANS ASIA |
| HAYL | HAYLEYS | TSML | TEA SMALLHOLDER |
| HDEV | HOTEL DEVELOPERS | TWOD | TOUCHWOOD |
| HDFC | HDFC | TYRE | KELANI TYRES |
| HEXP | HAYLEYS EXPORTS | UAL | UNION ASSURANCE |
| HHL | HEMAS HOLDINGS | UCAR | UNION CHEMICALS |
| HINN | HABARANA WALKINN | UDPL | UDAPUSSELLAWA |
| HINT | HINT | UML | UNITED MOTORS |
| HLOG | HABARANA LODGE | VANI | VANIK INCORP LTD |
| HNB | HNB | VTEX | VEYTEX |
| HOPL | HORANA | WALK | WALKERS TOURS |
| HPP | HAYL. PHOTOPRINT | VLL | VIDULLANKA |
| HSIG | HOTEL SIGIRIYA | VPEL | VPEL |
| HTEC | HAYTECH MARKET. | WATA | WATAWALA |
| HUEJ | HUEJAY | WMM | W.M.MENDIS |
| HUNA | HUNAS FALLS | YORK | YORK ARCADE |
| HUNT | HUNTERS | UPEN | UPEN |
| INDO | INDO MALAY | UPIN | UPALI INVESTMENT |
| ITH | INT. TOURISTS | WATA | WATAWALA |

## APPENDIX B-Box-plot diagrams

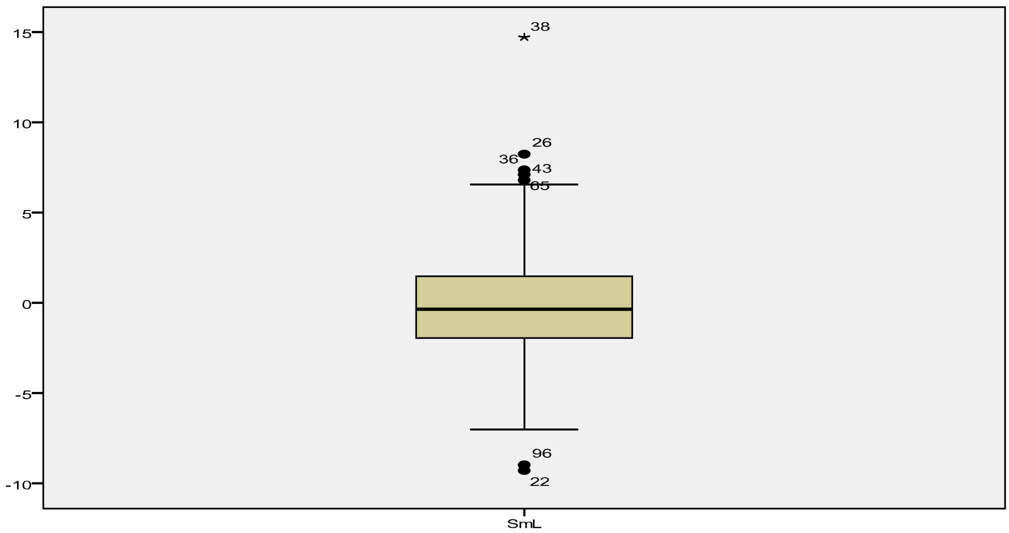
Large size before controlling outliers



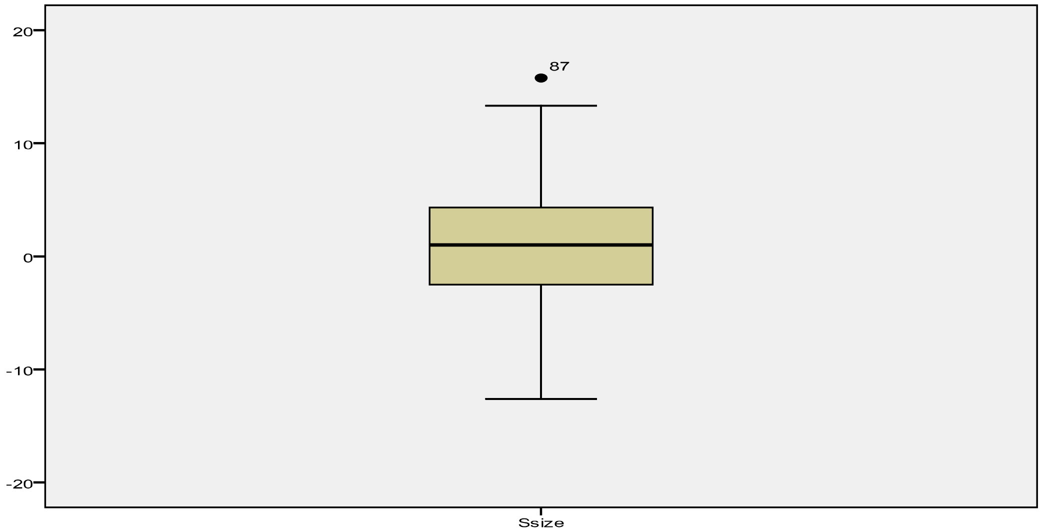

Small size before adjusting outliers



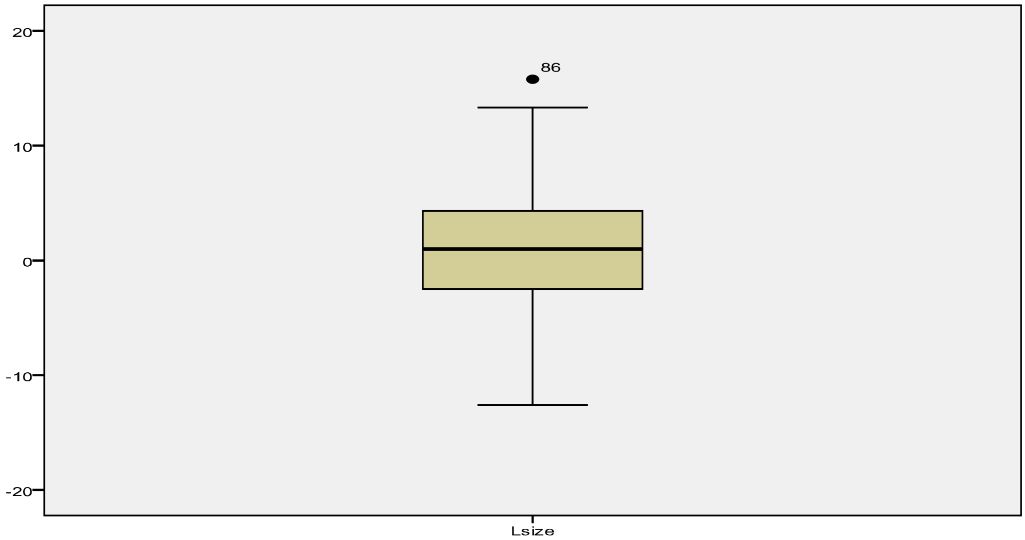

Small minus large size before adjusting outliers



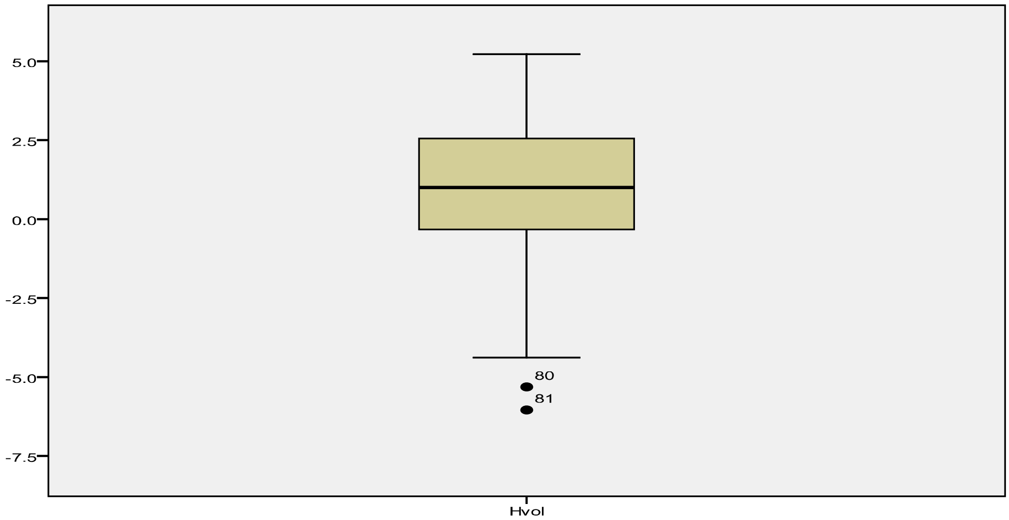
Small size after adjusting outliers



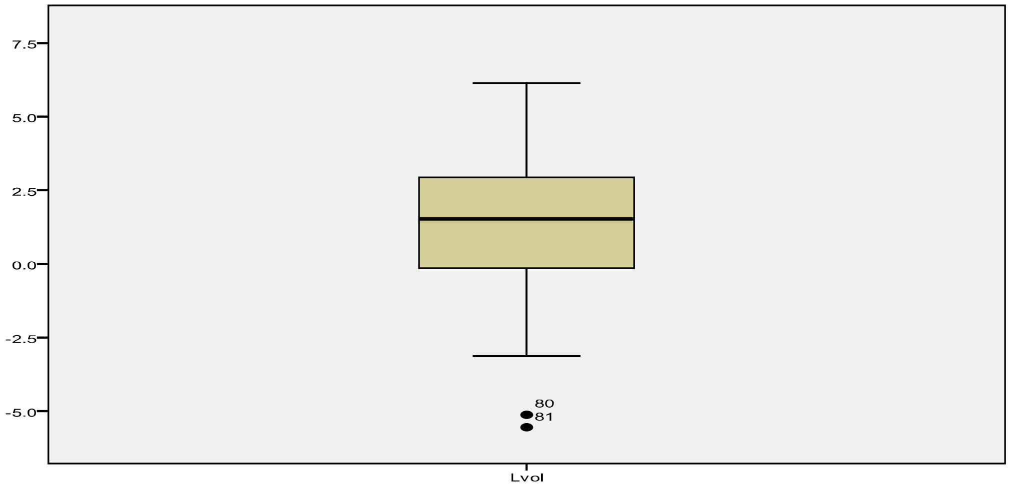

Large size after adjusting outliers




High volume portfolio before controlling outliers



Low volume before controlling outliers portfolio




# APPENDIX C - Normality test findings

## E/P portfolios

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| HE/P | .065 | 156 | .200* | .979 | 156 | .016 |
| LE/P | .058 | 156 | .200* | .993 | 156 | .647 |
| HmLE/P | .057 | 156 | .200* | .983 | 156 | .051 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

## B/M portfolios

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| HB/M | .049 | 156 | .200* | .983 | 156 | .051 |
| LB/M | .066 | 156 | .095 | .984 | 156 | .072 |
| HmLB/M | .055 | 156 | .200* | .988 | 156 | .192 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

## Size portfolio returns before adjusting outliers

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| LS | .055 | 156 | .200* | .988 | 156 | .226 |
| SS | .068 | 156 | .071 | .976 | 156 | .008 |
| SmL | .074 | 156 | .037 | .967 | 156 | .001 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

## Size portfolio returns after controlling outliers

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| LS | .044 | 155 | .200* | .994 | 155 | .776 |
| SS | .085 | 155 | .008 | .986 | 155 | .107 |
| SmL | .092 | 155 | .003 | .959 | 155 | .000 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

## Momentum portfolios

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| wl | .048 | 156 | .200* | .988 | 156 | .191 |
| LO | .065 | 156 | .100 | .990 | 156 | .310 |
| WmL | .042 | 156 | .200* | .985 | 156 | .099 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

## Volume portfolios before control outliers

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| HV | .065 | 81 | .200* | .966 | 81 | .031 |
| LV | .097 | 81 | .056 | .980 | 81 | .227 |
| HmLV | .114 | 81 | .011 | .963 | 81 | .019 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

## Volume portfolios after controlling outliers

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| HV | .049 | 81 | .200* | .988 | 81 | .676 |
| LV | .084 | 81 | .200* | .981 | 81 | .278 |
| HmLV | .078 | 81 | .200* | .982 | 81 | .297 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.