Factor models, risk management and investment decisions

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Abstract

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The recent extending empirical evidence regarding the power of factor models versus the traditional CAPM has motivated the research in the current thesis. Substantial controversy has been raised over two issues: 1) Are the new factors, market value and book-to-market equity, the most important sources of risk? and 2) Is it time to consider CAPM as a useless model? Effectively, these are the main questions we attempt to address in the current research within a unified framework of firm attributes and more aspects of the econometrical applied approaches.

The main findings of the empirical research in this thesis show that, firstly the beta portfolio returns exhibit the highest volatility, confirming thus the beta as the most significant risk source. Secondly, the market portfolio absorbs the excess returns of the majority of value-weighted factor portfolios which is partly attributed to the mitigation of the January effect. In the seasonality area, we identify a strong October effect with high volatility but not high returns, a phenomenon that cannot be explained with a rational story. The re-examination of the Fama and French 1992 model with corrections of econometrical problems and the application of panel data methodology reveals that the sole significant factor over all the candidate variables is the price variable. Yet, even the power of the price factor is eliminating with the application of non-linear systems where the CAPM constraints are directly validated but with a negative sign. However, the presence of negative risk premium is consistent with the valid application of CAPM in a financial world where the occurrence of bad states of world is more frequent than the presence of up markets.

Overall, the results of this thesis contribute to a thorough understanding of the factor models' performance which plays a key role in the financial investment decisions. The implication is that the CAPM should be still regarded as the basic financial model in the risk-return management process.

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Chapter 1

Introduction

In modern financial theory the central area of consideration and extensive research is the development of profitable strategies in the field of the investors' portfolio management decisions. Currently, the bulk of the transactions in financial markets is rarely implemented on the basis of simplistic views for the underpricing position of specific stocks. In recent years, complicated techniques and advanced approaches have been adopted to model the framework of the management strategy towards the execution of investment decisions. In addition, the evolution of major stock market exchanges and, thus, the feasibility of introducing an immense number of stocks for direct trading have primarily altered the direction of investment decisions towards the structure of stock portfolios. The advantages of this approach are derived from the benefits of hedging against adverse movements of individual stocks. The aggregation of stocks in selective portfolios substantially eliminates diversifiable risk and reduces the default risk.

The introduction of these new trends in financial markets would not be feasible without the development of the Capital Asset Pricing Model. In the early stages of financial theory, the prevalent approach for the assets' pricing was based on the measurement of total risk and the common sense that risky stocks would yield higher return than risk-free investments. Within this elementary framework, the introduction of the CAPM can be considered as a breakthrough for the financial theory and practice as it established the quantification of the tradeoff between risk and expected return. Investors and financial analysts were able to quantify the risk inherent in stocks and, in addition, to measure the magnitude of the return expected to be rewarded for bearing any specific amount of risk.

The groundwork for the development of the CAPM was formulated by *Markowitz (1959)* who showed that investors would optimally hold portfolios with the highest return for a certain level of variance i.e. mean-variance efficient portfolios. The extension of the mean-variance efficiency framework to the CAPM is attributed to *Sharpe (1964)* and *Lintner (1965)* who argued that all investors in a frictionless market would hold the market portfolio which is a mean-variance efficient portfolio. On this basis, the primary intuition behind the CAPM is that the only source of priced risk should be the undiversifiable risk inherent in the market portfolio. Any other kind of unsystematic risk is specific to individual stocks and can be diversified away by aggregation. In technical terms, the sole origin of priced risk is the beta i.e. the covariance of the stock return with the market portfolio return over the variance of the market portfolio return whereas the price of beta is the risk premium.

Although on a theoretical basis the CAPM seemed robust and well defined, its direct implication remained the mean-variance efficiency of the market portfolio, a statement surrounded by much controversy because of the unobservability of the market portfolio (*Roll, 1977*). Subsequent to this criticism, many tests have been conducted for the impact of different compositions of the market portfolio and the results seem quite sensitive to different approaches. However, the prevailing empirical literature employs the market portfolio of all stocks in major stock exchanges to empirically test the CAPM, as inferences are still robust with this traditional approach.

The appealing theoretical formulation of the CAPM does not share the same enthusiasm with its empirical verification. The basic implications of the CAPM on the empirical basis are the elimination of excess beta-risk-adjusted returns and the fact that beta completely captures the cross-sectional variation of expected excess returns. The first hypothesis was tested by *Black, Jensen and Scholes, BJS (1972)* with time-series models to test the insignificance of the constant in the market model i.e. the regression of realised stock returns to the market portfolio returns over a time period. Cross-sectional tests were conducted by *Fama and MacBeth, FM (1974)* to examine the significance of the beta price and the assumption that beta is the sole determinant of stock returns. We should mention that a major innovation in both studies was the employment of portfolios instead of individual stocks, a methodology that has been widely adopted in subsequent research as it mitigates the error-in-variables problem with pre-estimated betas and it moderates the undiversifiable risk of individual stocks with the aggregation procedure.

The results from the previous tests were not very supportive of the traditional CAPM. However, the evidence supported the less restrictive *Blank's (1972)* version of CAPM which replaced the risk-free rate with a zero beta portfolio in the absence of unrestricted lending and borrowing with a given risk-free rate. The appealing quantification of the risk and its reward with the theoretical CAPM and the favourable initial empirical tests established the CAPM as a powerful model in financial practice. However, the acceptance of this model was not unanimous among empirical researchers and a lot of controversy has been raised for its robust validation.

Although the criticism against the CAPM has many dimensions, the primary debate for the power of the CAPM has been concentrated on evidence that it is feasible to trade on stocks with specific attributes and achieve excess returns. This argument is devastating for the CAPM as it contradicts the basic assumption of zero beta-risk adjusted excess returns for any kind of trading. Furthermore, the evolution of empirical evidence surrounding the power of additional to beta factors as determinants of the cross-sectional variation of common stock returns challenged the notion of beta as the sole source of priced risk and introduced more risk factors. The re-examination of these aspects of controversy is the principal objective of this thesis.

The preliminary analysis concerning the presence of profitable opportunities from specific strategies adopted the term 'anomaly' as reference to this area of research. This term was employed to describe evidence against CAPM since this model was established as the robust paradigm in the financial theory and deviations from it were referred as anomaly patterns. In the current thesis, the procedure for the selection of the factors with potential patterns against the CAPM is limited to the area of specific firms' characteristics that transmit vital information for the company's future prospects. The basic methodology to examine the factors' power is to form portfolios with low and high values of the particular attribute and examine the performance of these portfolios over a period of time.

The first factors that were examined under this approach were the earnings/price (EP) and the dividend yield (DY) variable by *Basu (1975)* and *Litzenberg (1977)*. The rationale was that the trend of these factors reveals information for the direction and magnitude of future expected stock returns. Subsequent tests were extended to accommodate even more factors inherent with important information such as the market value (*Banz, 1981*), book-to-market equity (*Rosenberg, 1985*), debt (*Bhandari, 1985*), past returns (*DeBondt, 1985*) e.t.c. The plethora of the factors that were sequentially verified as risk sources was immense.

Within this framework, the focus of the current thesis will be directed towards the attempt to address several existing in addition to new issues in the area. More specifically, some of the questions this study will attempt to give answers to are the following:

- Is the evidence for the profitability of the factor models unanimously verified under divergent approaches of investment decisions? Can the CAPM be rejected in favour of a new risk model within a multivariate framework that takes into account more aspects of portfolio decisions?
- Which is the exact structure of the seasonality patterns present in the factor models and what is its impact in the pricing process?
- Given the enormous number of factors as potential new risk sources, how we can eliminate the strong correlation among these variables and effectively infer on the common risk factor inherent in all the variables?
- What are the inferences for the future of the CAPM as a valid financial model subsequently to the conclusions drawn from the previous issues and within a framework that mitigates some of the econometrical problems and introduces time-varying parameters?

To address the issues more analytically, preliminary examination of portfolios constructed from individual factors was based on reports for the magnitude of return and volatility across portfolios and the factor importance was inferred from the presence of high spread. However, this evidence cannot be considered an anomaly as the CAPM asserts the absence of high *risk-adjusted* returns. This is the area of research where the bulk of controversy is concentrated. Sequential papers were published with different approaches in the examination of the CAPM over the alternative models and a concrete conclusion could not be drawn. Furthermore, the likelihood of correlation among some variables and the effort to limit the number of robust factors initiated an even more increased speed of empirical search.

The groundwork of these issues is examined in the subsequent chapters of this study. The motivation for the current research is the presence of divergences in conclusions over the CAPM failure as a valid model. The bulk of research has been conducted separately over individual factors and inferences were drawn quite easily for the CAPM rejection. In order to substitute a theoretically robust model with an empirical model, even in the absence of theoretical background, the empirical findings should be robust to the level of basic details. Otherwise, it is very dangerous for the financial practice to introduce a model with power solely based on a particular approach.

One of the primary areas of examination in this thesis is the unification of factor portfolio strategies under the same approach. In other words, whereas up to the current empirical literature many studies have been performed for the profitability of individual factor strategies, there is a strong consensus that the examination should be conducted unanimously for all the candidate variables (e.g. market value, earnings/price ratio, cash flow, e.t.c.) and not to reach different conclusions merely because of methodological divergences. The data sample employed throughout the empirical research is compatible with all the studies where patterns were identified and it includes the common shares that are traded in the major U.S. stock exchanges of NYSE, AMEX and NASDAQ. The latter stock market has not been widely employed to previous research mainly because of restrictions in data availability.

However, it is a common argument that under the current complexity of financial markets the inclusion of the large, in terms of number of shares traded, NASDAQ market is critical for successful portfolio management decisions. In cases where we introduce the NASDAQ market to extend any previous research on the NYSE and AMEX markets, we gain the advantage of locating any significant changes generated with the inclusion of the new market.

The selection of the factors under scrutiny is based on results for their significance from prior empirical research and the presence of a rational framework for the information that these specific variables transmit for the firms' prospects and could indeed be considered as possible sources of priced risk. The initial tests in the first empirical chapters are concentrated on the evidence that portfolios with low or high specific attributes could earn risk-adjusted excess returns. This examination is conducted within the framework of the traditional CAPM and it employs the value-weighed market portfolio of all the stocks traded in the three major stock exchanges to absorb any possible excess returns. This methodology is rather common in most of the studies and it has formed the basis for rejecting the power of the CAPM. However, a shortcoming of previous studies is that explicitly and rather quickly conclude on violations of the basic CAPM implications. The current objective is to identify possible sources of divergences that could cast doubts on previous evidence. The justification is that in order to qualify a factor's excess performance as an anomaly we should conclude on the presence of risk-adjusted excess returns on a unified basis.

In the empirical literature of financial practice there is another area that has been referred to an anomaly issue. It is the presence of seasonality patterns in the performance of factor portfolios. More specifically, it has been argued that the portfolio excess returns cannot be achieved on a regular basis as they could be considered only a manifestation of the January effect. The evidence of this phenomenon asserts that there are substantially excess returns in the month of January with so high magnitude that the exclusion of this month eliminates the excess profits. Once more, this pattern has been referred as an anomaly since the

January excess returns are not accompanied by evidence of higher risk. Although the bulk of research in the seasonality issues has been concentrated on the January high returns, we re-consider the evidence of *risk-adjusted* excess returns. Furthermore, we attempt to examine more thoroughly the factor portfolios' performance across months and provide some more detailed descriptions of the present seasonality patterns.

The shortcoming with the application of the factor portfolios and the examination of their performance is that inferences are quite sensitive to methodological approaches. However, the empirical procedure cannot be side-stepped as it is necessary for the verification and application of a theoretical model. The main concern that has to be strongly considered is that the complexity of the financial markets has been widely increased in the latest years. This also introduces complications in the empirical examination as more parameters have to be included and estimated in the econometrical models. Thus, we consider some methodological approaches not widely employed in factor models that take into account more aspects of the microstructure effects in stock returns and the strong financial interrelations.

More specifically, the structure of this thesis is as follows. The literature review of the majority of previous studies in the area of the Capital Asset Pricing Model and the factor portfolio performance is presented in Chapter 2. There is a vast number of studies in this research field as the subject is very important for the financial practice and it directly affects investment decisions. The layout of this chapter is consistent with the structure of the rest of the thesis as we present the main issues that have been examined in the empirical literature and will be re-examined and extended in the current empirical research. Although the number of the factors that have been explored is quite large, we present some rationale behind the specific set of factors selected in the present study. We start the empirical examination in Chapter 3 with the analysis of the factor mimicking portfolio performance, represented by specific factors' return and volatility measures. Although the econometrical analysis of the factor mimicking portfolios has not been widely applied in the empirical literature, it is shown in this chapter that very important inferences can be drawn from a preliminary presentation. In Chapter 4 we proceed to a more robust analysis of the factor portfolios performance as we present evidence for the power of the CAPM to fully adjust for any present excess returns. At this stage, we also introduce some evidence for the new model that has been employed in previous tests as a substitution to the CAPM, the three-factor model with the additional risk portfolios of market value and book-to-market equity. Although a preliminary study for seasonality issues is present in Chapter 3, in this chapter we look more thoroughly into this part of the asset pricing model analysis. Subsequent to the evidence for the basic assumption of the CAPM about the absence of risk-adjusted excess returns, we turn in Chapter 5 to examine the other major CAPM implication of the beta as the sole determinant of the common stock returns. The methodology based on cross-sectional tests is employed in this chapter in order to infer not only on the power of beta but the pricing of other factors as well. As one of the main concerns among the empirical researchers is the different results between the time-series and the cross-sectional models, in Chapter 6 we employ the combined methodology of panel data in relation with the recently applied in asset pricing models non-parametric methodology of General Method of Moments estimation. The advantages of this approach have been presented in many studies but its application in the factor models is limited. However, the employment of this methodology allows the direct test of the validity of the CAPM constraints i.e. the presence of a unanimous positive risk premium in all the subsets of stocks and the introduction of a time-varying environment with non-linear models. Finally, in Chapter 7 we present the conclusions drawn from the current study and we identify some issues for future research.

Chapter 2

Review of the Literature

2.1 Introduction

The central paradigm in the financial markets has remained over decades the revolutionary for its contemporary time period Capital Asset Pricing Model. The introduction of this model altered the direction of the financial markets' management towards a robust approach for the quantification of the financial risk and the appraisal of investment decisions. The most appealing feature of the CAPM was and still remains its vigorous theoretical background on the establishment of portfolio theory in the mean-variance portfolio efficiency framework.

The robust theoretical background of the CAPM was initially as well verified by effective empirical evidence for the application of the model with realised stock returns. However, subsequent research placed CAPM under attack as evidence about the model's inadequacies appeared in the literature. The main opponent was the multifactor model which could take either the form of the Arbitrage Pricing Theory or the International-CAPM model where more factors in addition to the market portfolio were included as risk sources. In the first model, either unidentified factors extracted with factor analysis or macroeconomic variables are considered as the sources of priced risk inherent in common stock returns. However, the divergences in the testable implications of the APT model among different groups of assets and the vague framework surrounding the true nature of the risk sources extracted from return eigenvalues establish a primary drawback for this model's wide application in the pragmatic investment portfolio management. Instead, the more representative group of applied patterns for the disposition of security investment strategies constitutes of firm-attribute models which is the main focus of the current research.

Thus, the primary subject of the current literature review in this chapter is the motivation, the application and the empirical evidence behind the research for the misspecification of the CAPM and the introduction of more powerful factor models. In the context of factor models, we refer to firm-attribute models where information about the firm's prospects contributes to achievement of excess returns that the traditional CAPM cannot justify.

More specifically, in the first part of the literature review we present the basic intuition behind the CAPM and the initial empirical tests in combination with the most prevailing methodologies applied in these tests. Furthermore, we proceed to the presentation of some preliminary evidence about the CAPM misspecification and the introduction of a new multifactor model. In section 2.3 we examine in distinct areas the problems identified around the application of the CAPM and the new models as well. The bulk of the evidence in the first two sections of this chapter is based on the traditional methodologies of cross-sectional or time-series tests. In section 2.4, we present a more contemporary approach in the estimation of factor models which has not been widely employed, the panel data in combination with the General Method of Moments methodology. Finally, a brief summary is present in the section 2.5.

2.2 CAPM - Tests - Extensions

2.2.1 The first steps

Sharpe & Lintner in 1965 almost simultaneously developed an economic model at an attempt to deal with risk inherent in the marketable stocks in a quantifiable fashion. In order to accurately measure the quantity and price of a single asset's risk, determining thus the equilibrium rates of returns on the risky assets, they developed the **Capital Asset Pricing Model** (CAPM) which asserts that

$$E(R_i) = R_f + [E(R_m) - R_f][\frac{\sigma_{im}}{\sigma_m^2} = \beta] \qquad (1)$$

where

$E(R_i)$ =the expected return of the *i-th* security

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

R_f = the risk-free rate

σ_{im} = the covariance between the *i-th* security and the market return

σ_m^2 = the variance of the market return

This model shows that the portion of an asset's risk that is uncorrelated with the market can be diversified away at no cost. Consequently, the appropriate measure of a single asset' s risk is its beta (β). In a world where investors cannot borrow or lend unlimited amounts at the risk-free rate, it can be substituted by the expected return on a zero-beta portfolio uncorrelated with the market portfolio (the Black's version of CAPM).

The basic principles of the CAPM are: i) Higher risk should be associated with higher return, ii) there is a positive and linear relationship between risk and return and iii) bearing non-market risk adds no return. For the empirical examination of the CAPM, two traditional methodologies have been prevailed in the literature:

- ***two-stage cross-sectional tests:***

1st: $R_{it} = a_i + \beta_i R_{mt} + e_{it}$ (market model) (2)

where the betas are estimated and

2nd: $R_i = a_0 + a_1 \hat{\beta}_i + e_i$ (3)

where the estimated betas from the first step are employed to estimate the intercept and the slope and to compare the estimates with the hypothesised risk-return equilibrium relationship implied by the CAPM.

- ***time-series tests:***

$$R_{it} - R_f = a_i + \beta_i [R_{mt} - R_{ft}] + e_{it} \quad (4)$$

If the CAPM is a valid representation of the way in which markets value securities, the estimate of the intercept in the risk premium form of the market model should not be significantly different from zero.

After the formulation of the theoretical background for the CAPM risk-return relation, the model should be tested empirically so that inferences to be made whether is a valid representation of the actual risk pricing in the financial markets. *Black, Jensen and Scholes (BJS) (1972)* tested the CAPM using the time-series methodology with portfolio returns to reduce the bias introduced by measurement errors in the betas of individual stocks. The security's beta in a prior to test time period was employed as the instrumental variable for the ranking procedure as it is highly correlated with the true beta and can be observed independently. The regressions of 10 NYSE[1] beta portfolio returns on the market index over the period 1926 through 1966 supported the Black's version of the CAPM with evidence of a linear and positive risk-return relation. *Fama and MacBeth (FM) (1974)* employed the two-step methodology to test the CAPM, focusing the research on the presence of any non-linearities in the risk-return relationship and the impact of unsystematic risk on the return. The CAPM properties were verified in the regression results.

Despite the empirical verification of the CAPM, *Roll's critique (1977)* claimed that since the only valid empirical hypothesis is the ex ante efficiency of the market portfolio, the CAPM is not testable as the use of an efficient market portfolio presupposes its exact identification which is unattainable. Yet, *Gibbons (1982), Stambaugh (1982) and Shanken (1987)* showed that the inferences about the CAPM were not sensitive to alterations in the market index composition and that the testability of CAPM can be just depended on how well the proxy replicates the true but unobserved market portfolio.

2.2.2 Empirical Evidence of CAPM misspecification

Although Roll's critique seemed devastating for the CAPM validity, the model application in the stock pricing process was not restrained. What really brought up doubts about the validity of the CAPM for determining the equilibrium rates of returns was the violation of the beta as the only source of a stock's risk. Generally,

[1] NYSE = New York Stock Exchange

the empirical examination of the CAPM is based on the following formula

$$R'_{pt} = \gamma_0 + \gamma_1 \beta_p + \varepsilon_{pt} \qquad (5)$$

where $\gamma_1 = R_{mt} - R_{ft}$ *and* $R'_{pt} = R_{pt} - R_{ft}$ (6)

If CAPM is valid then the following propositions should be evident: a) the intercept term, γ_0, should not be significantly different from zero. If it is different from zero, there may be something "left out" of the CAPM that is captured in the empirically estimated intercept term and, b) beta should be the only factor that explains the rate of return on a risky asset. If other terms such as dividend yield, earnings/price ratios, firm size are included in an attempt to explain return, they should have no explanatory power.

Subsequent to the initial CAPM tests revealed violations in these propositions. *Basu (1977)* reported a reverse relationship between stock returns and price/earnings (P/E) ratios for the period 1958-1971, with significantly positive intercepts in the CAPM model for stocks with low P/E ratios and negative intercepts for high P/E ratios. *Ball (1978)* argued that the earnings variable might proxy for omitted variables from the two-factor CAPM, so it tends to explain differences in securities' rates of return in addition to market beta.

While all the research was focused on the earnings' power, *Banz (1981)* introduced another factor important for explaining the variation of expected stock returns, the firm size (MV). With monthly returns, prices and number of shares outstanding data for all NYSE stocks between 1926-1975, the empirical test was based on a asset pricing model which allowed the expected return of a common stock to be a function of risk β and an additional factor ϕ, the market value of the equity

$$E(R_i) = \gamma_0 + \gamma_1 \beta_i + \gamma_2 [(\phi_i - \phi_m) / \phi_m] \qquad (7)$$

where ϕ_i =market value of the security ϕ_m =average market value

The results from the regression showed a significant negative estimate for γ_2 for the overall time period as low market value stocks could earn higher returns than large firms. The CAPM appeared to be misspecified, yet it seemed unclear whether size *per se* was the missing factor or just a proxy for another risk factor. The joint relationship between earnings' yield (E/P) ratios, firm size and returns on the NYSE firms was examined by *Basu(1983)* where MV portfolio returns were constructed free from E/P confounding effects. The tests showed that the size effect was clearly more significant than the E/P effect and it subsumed the latter.

Adding another piece in the puzzle, *Rosenberg, Reid & Lanstein (1985)* found a positive relationship between stock returns and the book-to-market (BE/ME) ratio. The argument was based on inferences about the returns on a "book/price" strategy. This strategy buys stocks with a high ratio of book value of common equity to market price per share and sells stocks with a low book/price ratio, where 'book value' is common equity per share, including intangibles. A good performance would indicate market inefficiency. Regressions of the BE/ME portfolio returns on the market index revealed significantly superior performance for the strategy and a positive correlation between the variable and subsequent returns.

In an attempt to find a more appropriate and robust measure of risk, *Bhandari (1988)* examined the relationship between stock returns and the debt/equity (DER) ratio as a proxy for beta. Cross-sectional regressions showed that the expected returns on common stocks were positively related to the DER ratio, controlling for beta and size. Analysing the effects of inclusion or exclusion of the previously examined explanatory variables from the regression, there were slight upward or downward movements in the relevant coefficients but the major result was that excluding any one of the other variables seemed undesirable.

A paper that addressed the issue of justifying a link between economic background and the significance of the size effect was by *Chan & Chen (1991)* who argued that small firms are riskier because they are marginal firms i.e. have poor performance and their prices are more sensitive to changes in the economy. In order to empirically prove the hypothesis, two portfolios mimicking the return behaviour of marginal firms were constructed: i) DIV= difference between the return on a dividend-decrease portfolio and a matching portfolio smaller in MV with no dividends cuts, and ii) LEV= difference between the return on a high leverage portfolio and a matching portfolio smaller in size from a lower leverage quintile. In the time-series regressions of the returns of twenty size-ranking portfolios on the value-weighted NYSE index and the LEV and DIV indices, all the coefficients were statistically significant, indicating that the two indices captured some return variation along with the market index. In the cross-sectional tests the size factor lost its explanatory power when the new factors were included in the regression.

The major results from all the above papers signified the beginning of an endless controversy over the applicability of the CAPM in the determination of equilibrium returns. There were strong indications that the beta could not be considered as the only source of priced risk as other factors were found significant in the empirical process. The main question was should CAPM be abandoned as a valid model and substituted by another factor model.

2.2.3 Towards a Multifactor Pricing Model

The persisting introduction of additionally significant risk sources in the common stock returns seemed confusing and overwhelming. Thus, the next rational stage would be to isolate the most important variables with power that could be not be attributed to common sources of correlation. This was the objective of the paper by *Fama & French (FF) (1992)* i.e. to evaluate the joint roles of market beta, size, E/P, leverage, and book-to-market equity in the cross-section of average returns on NYSE, AMEX and NASDAQ[2] stocks and identify those with the higher explanatory power. The purpose was to test whether the risk inherent in the stocks is multidimensional in a rational pricing process.

[2] AMEX = American Stock Exchange

Each year in the period 1963-1990, all common stocks were assigned to 100 size-beta portfolios where the preranking betas were estimated with the five-year return market model before year *t*. Post-ranking returns for the portfolios were calculated for the next 12 months and betas were estimated using the full sample as the sum of slopes in the regressions of a portfolio's return on the current and prior month's market return, to adjust for nonsynchronous trading. For the beta-size relation, the following results were present: i) when portfolios were formed on size alone, the familiar strong negative relation between size and average return was evident, ii) the β-sorted portfolios did not support the CAPM as the risk-return relation was negligent and iii) the size-beta portfolios showed that variation in beta unrelated to size was not compensated in the average returns.

In a second stage, the post-ranking portfolio betas were assigned to individual stocks and the Fama-MacBeth regressions resulted in an insignificant beta coefficient and robust MV and BE/ME effects. In the case of leverage, using two different measures - A/ME and A/BE where A is total assets- the results were consistent with the BE/ME effect since the average slope of the latter in the regressions was close in absolute value to the slopes of the two measures, based on the fact that the difference between market and book leverage is the BE/ME equity. The E/P effect was found insignificant after size and BE/ME were included in the regressions because of the presence of negative earnings and the correlation between positive E/P and BE/ME. The final result was that two easily measured variables, size and book-to-market equity, provided a simple and powerful characterisation of the cross-section of average stock returns for the 1963-1990 period.

In a subsequent paper, *Fama & French (1993)* tested the significance of the new factors on bonds since a single model should be widely used in integrated markets. A time-series approach was employed to give direct evidence for the identification of the variables as proxies for risk factors. Monthly stock returns were employed to construct six portfolios from the intersections of two MV and three BE/ME groups

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NASDAQ = National Association of Security Dealers Automated Quotations and twenty-five portfolios from successive ranking on size and BE/ME. In the bond category, returns for government bond portfolios in two maturity stages and corporate bond portfolios in five rating groups were calculated. In the period 1963-1991, the twenty-five stock portfolios, the bond portfolios, E/P and D/P (dividends/price) portfolio returns were regressed on the stock market portfolio and mimicking portfolios for risk factors related to size, BE/ME, shifts in interest rates and shifts in economic conditions[3]. The time-series regression slopes on the mimicking portfolios could be considered as factor loadings that, unlike size or BE/ME, have a clear interpretation as risk-factor sensitivities for bonds as well as for stocks.

In a nutshell, the empirical results indicated that:

bond-market factors: TERM and DEF[3], used alone as the explanatory variables in the time-series regressions of stocks and bonds, resulted in significant slopes and high R^2 values, yet the intercepts left strong size and BE/ME effects in average returns.

stock-market factors: the three-factor model, RM-SMB-HML[3], performed far better than the market portfolio alone and captured strong common variation in stock returns.

stock-market and bond-market factors: in the five-factor regressions for stocks, the tracks of TERM and DEF were eliminated with the excess market return RM-RF. Stock returns shared three stock market factors and the links between stock and bond returns came largely from two shared term-structure factors. The authors concluded that the three-factor model should be used in any application that requires estimates of expected stock returns.

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[3]SMB = the difference between the average of the returns on the three small-stock and two big-stock portfolios

HML= the difference between the average of the returns on the high-BE/ME and on the low-BE/ME stock portfolios

TERM = the difference between the monthly long-term government bond return and the one-month bill rate

DEF = the difference between the return on a market portfolio of long-term corporate bonds and the long-term government bond return.

To complete the missing economic story behind the argument that size and BE/ME proxy for sensitivity to common risk factors in returns, *Fama and French (1995)* studied whether the behaviour of stock prices, in relation to size and BE/ME, reflects the behaviour of earnings. The basic intuition was that if the size and BE/ME risk factors in the returns are the result of rational pricing, they must be driven by common factors in shocks to expected earnings (EI) that are related to size and BE/ME. By employing as a measure of profitability the ratio EI(t)/BE(t-1), the high BE/ME stocks (relatively distressed) were found less profitable (lower earnings) than low BE/ME (growth) stocks. These differences in profitability associated with the BE/ME ratio persisted four years before and five years after the portfolio formation. For the size effect, small stocks tended to have lower earnings on book equity than big stocks. The chronological examination of the profitability ratio revealed the same patterns. Regressions of the earnings yield on the market, size and book-to-market variables also revealed strong relations between the regressors.

A review of the three-factor model and the identification of its weaknesses were the contents of the *Fama & French (1995)* paper. The purpose was to test the power of the model in portfolios constructed on the basis of other variables apart from size and BE/ME in the regression format

$$R_i - R_f = a_i + b_i(R_m - R_f) + s_i SMB + h_i HML + \varepsilon_i \qquad (8)$$

b_i = *the beta* s_i = *the size premium* h_i = *the book – to – market premium*

In the 25 size-BE/ME portfolios, the empirical results were supportive as almost all the intercepts in the time-series estimates of the equation were close to zero. In addition, FF tested the three-factor model on the portfolios that *Lakonishok, Shleifer and Vishny (LSV) (1994)* had constructed, namely 10 sets of deciles formed from sorts on BE/ME, E/P, C/P (cash flow/price), and five-year sales rank. The economic background of the empirical results is that low BE/ME, low E/P, low C/P, and high sales growth are typical of strong firms and have negative HML slopes which reduce expected returns. LSV attributed this pattern of market overreaction to strong past performance that turned out to be weaker in the future. The market does not understand that performance tends to regress toward the mean and so is surprised when firms improve. Yet, the zero intercepts in the FF tests proved that the excess returns constitute compensation for the three-factor risk structure rather than market overreaction. The same result was also evident in the double classification portfolio scheme with the sales growth as the common variable to overcome correlation because of the common price deflator.

Another anomalous pattern in the cross-section of stock returns is the *DeBondt & Thalers' (1985)* reversal in long-term returns; stocks with low past long-term returns tend to have higher future returns while the opposite appears for stocks with high past returns. The market portfolio and the two risk mimicking portfolios could also absorb the excess returns on the past loser portfolios. Yet, a serious weakness of the model was its failure to capture the continuation effect in the *Jegadeesh & Titman (1993)* paper where it was proved that when the portfolios are formed on the basis of short-term (up to one year) past returns, losers continue to be losers.

The main objective of this long series of papers by Fama and French was to establish the power and the robustness of the proposed three-factor model. The new model passed the empirical tests and performed well in the determination of the stock returns and the striking suggestion was that its superiority over the traditional CAPM should mark its adoption in the financial practice. However, the proposed model was not widely accepted as a flawless one and a lot of controversy was raised over the CAPM rejection and the validation of the new model.

2.3 Considerations of the new model

2.3.1 Contrarian Strategies

One of the basic assumptions for the stock market functional form is the investors' rational behavior in the context of costless available information. In such a rational environment, investors would bear higher risk only in return of higher return where risk could be traditionally measured by beta or with the FF three-factor model. Yet, research in cognitive psychology has revealed departures from perfect rationality and tendency to "overreaction" to unexpected and dramatic events that results in excessive price depreciation compared to the actual value implied by the nature of the event.

Perhaps the most influential paper on the overreaction hypothesis is by *DeBondt & Thaler (1985)* which presented evidence of economically important return reversals over long intervals. The purpose was to test whether the overreaction hypothesis was predictive by studying the investment performance of long-term past winner and loser portfolios. Using the methodology of Cumulative Average past Returns (CAR) to identify winner and loser stocks, the examination of future returns revealed excess profits for the loser portfolios even on a risk-adjusted basis. Yet, *Chan (1988)* found that the abnormal returns of an arbitrage portfolio calculated as the difference between loser and winner portfolios were not significant after controlling for changes in risk after the portfolio formation period.

Although the overreaction hypothesis was initially tested with past returns, the subsequent research turned the direction to the contrarian strategies on factor models. Variables such as size and BE/ME could be used as fundamental pieces of information to form trading strategies (value strategies) to outperform the market. The excess returns that investors could achieve were considered as compensation of the higher risk inherent in these strategies in a rational framework. However, *Lakonishok, Shleifer and Vishny (LSV) (1994)* seemed to contradict to this explanation for the success of the value strategies. The excess returns could be just the result of contrarian strategies as an extrapolation of information that naive investors use to form traditional ways of trading e.g. buy stocks that have performed well in the past recent months.

To empirically test the contrarian hypothesis, annual buy-and-hold returns of portfolios formed on the basis of past growth rates of sales, earnings and cash flow were used to identify glamour (winner) and value (loser) strategies. Two main points were put forward to prove the extrapolation story. The first one was the evidence that for all portfolios consisting of glamour stocks the actual growth rates were less superior than they were expected to be on the basis of the fundamental variables. The aim of the second point was to reject the allegation of higher risk of the value strategies that could justify the excess returns. The magnitude of the annual risk of the value and glamour strategies revealed that the value strategies did not underperform the glamour strategies in any state of economic conditions and thus did not expose investors to greater downside risk. In addition, the standard deviation and the systematic risk of the value strategies were not higher than the equivalent measures of the glamour strategies.

The argument in the Fama and French 1995 paper model was that, in a rational pricing environment, the high returns of the low size and high BE/ME stocks should be connected and used as signals for the earnings prospects of the firms. If the extrapolation story was true, the strong earnings growth of low BE/ME stocks during the portfolio formation period should decrease in the year after the realisation of incorrect prediction. Yet, the earnings ratio remained almost intact in the long-term future period. In addition, when the 1996 three-factor model with the SMB and HML as the factor mimicking portfolios was tested on the LSV two-way classification portfolios on a variable and the sales growth, the abnormal returns were found insignificant.

MacKinlay (1995) developed a framework in order to discriminate between the risk-based (multifactor models) and nonrisk-based (various forms of bias) explanations of the CAPM deviations with an ex ante analysis. On an ex post basis one could always find a set of risk factors that will make the asset pricing model intercept zero. Without a specific theory identifying the risk factors, one would constantly be able to explain the cross-section of expected returns with a multifactor asset pricing model, even if the real explanation could lie in one of the nonrisk-based categories.

The basic intuition behind the discrimination of the two categories is the property of the mean-variance efficient set mathematics which states that when deviations from the CAPM are the result of omitted risk factors there is an upper limit on the distance between the null distribution of the test statistic and the alternative distribution. A similar bound is present in the maximum squared Sharpe measure for the risk-based alternatives whereas there are no such bounds for the non-risk categories. Based on this proposition, he examined the importance of data-snooping bias and investor irrationality (LSV 1994) against the multifactor model (FF 1993) and he concluded that the first alternative is more likely.

In the context of the controversy whether the higher performance of value stocks is due to higher risk or to investors' systematic errors, *LaPorta (1996)* employed survey data from the IBES (Institutional-Brokers-Estimates-System) to test the overreaction hypothesis as the analysts' earnings forecasts E{g} provide a clean proxy for investors' expected growth rates. The analysts' earnings forecasts portfolio returns supported the errors-in-expectations hypothesis since the stocks with high earnings expectations were overpriced with low subsequent returns. The cross-sectional regressions resulted in a significant expected earnings growth variable and the inclusion of other factors or the annual beta could not reverse the strong relation. The Dimson beta estimates showed that the high E{g} stocks have higher risk than the low E{g} stocks but the differences in the directions and magnitudes of the betas during bull and bear markets provided no evidence for a uniformed risk consistent pattern.

Supportive of the irrational explanation, *LaPorta, Lakonishok, Shleifer and Vishny (1997)* provided new evidence on the hypothesis that the superior returns on the value stocks is the result of expectational errors made by investors and not compensation for higher risk. Applying the usual portfolio classification, annual buy-and-hold returns were computed every quarter after earnings announcements to form a portfolio event return over a three-day window as the extrapolation hypothesis asserts that the market slowly realises that earnings growth rates for value stocks are higher than initially expected. The results indicated that event returns over the 5 years after the formation period were substantially higher for the value portfolio than for the glamour portfolio but they died out slowly towards the end of the five year period. The risk explanation of the return differences would assert that, for both glamour and value stocks, event returns should be higher than nonevent returns. Regression of daily stock returns on the value weighted market portfolio and a dummy variable for whether the day belongs to the (-1, +1) window around that quarter's earnings announcement did not support the risk premium explanation.

Yet, *Harris and Marston (1994)* also employed the mean of financial analysts' forecasts of long-term (five-year) growth in earnings per share data from IBES data to proxy for the firm's growth and showed that the superior performance of the value strategies is driven from the BE/MV variable and not the growth effect. Starting from the discount price model (substituted the cash flow by rate of return times book value of share), they developed a regression model with the BE/ME as the dependent variable and the beta and growth as the regressors. The results showed a positive relationship between beta and BE/ME once growth is controlled for, providing thus the evidence that higher BE/ME returns are compensation for higher beta. By examining BE/ME portfolio returns, the irrational explanation of the effect could not be fully confirmed as portfolios based purely on differences in analysts' growth forecasts had no return advantages.

A review of the literature in the controversial subject of the risk hypothesis for the value stock excess returns against the extrapolation hypothesis was presented by *Fama (1997)*. The main arguments against the rejection of market efficiency were the evidence of symmetry in the presence of under-reaction and over-reaction patterns and the mixed inferences for the long-term return anomalies with different models and different statistical approaches. A major disadvantage of the tests for market inefficiency is that they don't respond to a clear alternative hypothesis but they study a vast range of different anomalies. The major question is whether the evidence for the contrarian strategies is so overwhelming to reject the market efficiency. The answer given in this paper is negative based on the arguments of chance and prior evidence for additional risk sources.

Connor (1995) employed the methodology of APT models to compare the three types of factor models: the macroeconomic factor models (observable economic time series as measures of the pervasive factors in security returns), statistical factor models (maximum-likelihood and principal-components factor analysis procedures to identify the pervasive factors in returns) and fundamental factor models (company attributes explain a substantial proportion of common return). Similarly to Connor and Koracjzyk's principal components analysis of determining the number of factors in the APT model, this type of test was used to compare the models. The intuition behind the test was that if the five-factor statistical model is adequate in explaining the pervasive comovements in returns, the addition of either the macroeconomic or the fundamental factor model should add ~~not~~ no extra explanatory power. The results showed that the fundamental factor model slightly outperformed the statistical and the macroeconomic models since the latter had no marginal explanatory power when it was added to the former. This result could suggest that the attributes could be combined to equate the betas of economic market forces.

Under the review of the above studies, a definite concluding point about the accuracy of either the extrapolation or the risk hypothesis for the justification of the value strategies excess returns would not be adequate. The bulk of the overreaction research has employed analysts' forecast data where the noise factor cannot be ignored and, as Fama pointed out, inferences depend only on specific methodologies.

2.3.2 Rationale for the factor selection - Intersections

The introduction of additional factors in the determination of common stock returns has not been supported only on the basis of empirical tests. There was also some rationale for the choice of the particular variables which could be proved either as the actual missing factors or as correlated variables with some unknown risks. The intuition behind a multifactor CAPM is that securities' returns are functions of various independent parameters of their return distributions. Thus, if some known variables proxy for possible omitted factors from the model, then these variables should be included as additional independent regressors to increase the explanatory power of the model. Many of the candidate variables are financial ratios from individual firms' accounts adjusted for size as clarified information could be hidden when individual numbers are observed (*Barnes, 1987*).

As pointed out by *Ball (1978)*, because securities' earnings yield are unlikely to be independent of securities' risks, failure to control for differences in relative risks will allow earnings yield to proxy for them. Consequently, there will be apparent excess returns from the analysis of earnings yields. The stocks' yields such as high earnings/price (E/P) and dividend yield (D/P) ratios were employed as indicators of growth firms i.e. firms that enter the stock market with fairly low capitalisation but are expected to grow over time and they seem promising. The initial low capitalisation of small firms would be an indication of higher risk for these firms and this relation prompts the introduction of the market value factor. As less information is available for small firms, investors will not hold these securities because of estimation risk. Thus, investing in these stocks will yield higher risk and higher returns due to greater uncertainty about the true parameters of the return distribution.

Several studies attempted to economically justify the size effect, including that by *Chan, Chen and Hsieth (1985)* who found that the risk differences between small and large firms arise from the greater exposition of the small firms to production risk and changes in the risk premium. Furthermore, *Chan and Chen (1991)* argued that the excess returns of the small firms could be attributed to a distress factor. Small firms tend to be marginal firms that have lost market value because of poor performance, are inefficient producers and have high financial leverage and cash flow problems. This low pace of growth causes their different reaction to macroeconomic news than the large firms. The indication of a marginal firm was the substantial cut in dividends.

The empirical failure of the beta as the only source of firm risk justified the introduction of the debt (non-common equity liabilities) to equity (DER) ratio as a risk indicator. Further support for its inclusion as a risk source was its availability on a more current basis than the beta which was estimated with error. In addition, the book-to-market equity ratio (BE/ME) was introduced on the basis of its correlation with the pricing error in the process of the price evaluation in an inefficient market. From the investor's point of view, the BE/ME ratio could constitute an additional risk source, as it is an indicator of the excess value of the firm. Since BE is the book value of the equity and ME is the current market value of the firm, the lower the ratio the higher is the return value of the firm.

Fama and French in a series of papers attempted indirectly to economically justify the importance of the size and the BE/ME effects by showing their significance in a model explaining the bond returns and the earnings. Furthermore, size and BE/ME were found related to systematic patterns in relative profitability and growth that confirmed the Chan and Chen's argument of the common distress risk source factor in returns. The significance of size and BE/ME was also confirmed by *Dennis, et al (1995)* who examined the FF model taking into account some other factors such as transaction costs and different rebalancing periods.

Lakonishok, Sleifer and Vishny (1994) pointed out that the BE/ME variable is not clearly connected with a specific missing risk factor as it may represent firms from different categories, either marginal or healthy, depending upon the incorporation or not of specific information about the firm's characteristics. In contrast, the CF/P and the E/P might be more clear indications of a firm's prospects as they are connected with the Gordon's formula for the expected growth. To eliminate variable collinearity in the presence of the price scaling factor, the sales growth variable was tested as it transmits information about the firm's financial evolution and strength. In addition, even in a ratio format, the sales/price (S/P) appeared as a more reliable indicator of a firm's long-term profit potential and a reflection of a company's relative popularity in the investment community. This is why, *Barbee, et al (1996)* examined the FF model including also the S/P ratio and the DER variable. With some changes in the model aspects (e.g. using only December fiscal-year-end firms), S/P and D/E absorbed the role of MV and BE/ME with the S/P having the greatest explanatory power.

A fundamentally different approach towards the relation between market value and risk was followed by *Berk (1995)* who argued that MV does not proxy for any risk.

Size-related regularities should not be considered as an anomaly as, regardless of the return generating process, the empirically demonstrated relation between size and expected return should always be observed. A simple cross-sectional regression of a stock's expected return on the logarithm of market value showed that, even if size (measured by expected cashflow) and risk are unrelated, the log of market value always measures the firm's discount rate i.e. the market value will be inversely correlated with realised return. Thus, there is no factor that market value "proxies" for. Market value is inversely correlated with unmeasured risk, so the type of risk it will "proxy" for is entirely determined by the asset pricing model that is being tested.

Furthermore, *Berk (1996)* provided evidence that market value is not a risk source by examining the significance of alternative measures of firm size highly correlated to market value (such as the book value of assets or the book value of undepreciated property). The market value effect was found present even when the size effect (measured with other variables) was controlled for. These findings were interpreted as evidence of an endogenous inverse relation of the stock returns with the market value through the connection with the discount rate and the absence of a direct negative return-firm size relation.

The main implication of the literature was that factor strategies could earn returns above the expected risk-adjusted returns. A specific area of research attempted to examine the magnitude of the excess returns in the presence of transaction costs. *Stoll and Whaley (1983)* showed that the excess small size portfolio returns were absorbed by the transaction costs measured by the bid-ask spread that the investor pays to the stock's dealer. The bid-ask spread has an inverse relation with the stock's price and the trading volume and a positive relation with the stock's risk as it conveys information about a stock's liquidity. *Amihud and Mendelson (1991)* argued that the lower the liquidity of an asset (i.e. the higher the bid-ask spread), the lower is its price, the higher the return for compensating the investors for the risk of nonliquidation in a sale event. Yet, the bid-ask liquidity spread was criticized as a noisy representation of transaction costs and a loose liquidity factor. The strong correlation between the bid-ask spread and the trading volume introduced the latter as a better alternative liquidity factor in the paper by *Datar, Naik, Radcliffe's* (1996). Trading volume shows the bulk of a stock's trading in the stock exchange, how strong is the demand and therefore how liquid is the stock and it can be easily obtained from databases without biases and missing data.

This summary of the rationale behind the examination of the mentioned factors provides some insight into aspects related with risk sources. All these variables transmit vital information for the firm's prospects and thus are strongly linked with the risk inherent to the firm's stock. Yet, the main question remains whether these factors represent the real sources of risk or are they just correlated with unknown more fundamental missing variables.

2.3.3 Controversy over Survivor bias

An area of great debate around the factors significance and mostly for the BE/ME ratio is the presence of survivorship bias. Most of the studies have related accounting and price data using the COMPUSTAT database as the data source. Whereas COMPUSTAT could be considered as a convenient, sufficient and quick data source, *Banz and Breen (1986)* revealed some serious problems connected with COMPUSTAT which could cause substantial changes in empirical results. COMPUSTAT database suffers from *ex-post selection* and *look-ahead* bias. According to the authors, the ex-post selection bias arises because COMPUSTAT contains only survivor firms and companies merged, filed for bankruptcy or ceased to exist are excluded. Furthermore, new surviving companies often enter the database with a full history, which introduces data not available on the file at an earlier time. The look-ahead bias is due to a timing problem since data reported for a particular point in time are not actually available to the investor until much later.

The suggestions for mitigating the ex-post selection bias in the COMPUSTAT tapes were to use the 'research' version with data for the non-survivors firms and the examination of the December fiscal-year end firms to mitigate the look-ahead bias. Yet, the latter suggestion is not appropriate for asset pricing tests as it arbitrary excludes a significant sample of firms.

Under the presence of survivor bias, *Fama and French* have posed some additional requirements for the inclusion of stocks in the tests. Data only after 1962 were selected because pre-1962 COMPUSTAT data are titled toward big historically successful firms and firms were not included until they had appeared on the database for two years as COMPUSTAT rarely includes more than two years of historical data when it adds firms. Similarly, *Lakonishok, Shleifer and Vishny (1994)* included stocks with 5 year history as the major COMPUSTAT expansion in 1978 added up to 5 prior years of data for NASDAQ firms.

In *Kothari, Sloan and Shanen 's (KSS) (1995)* paper, the rejection of the three-factor model was primarily based on the argument that there were strong selection biases in the collection of the data. The research was mainly concentrated on the effect of the biases to the positive relationship between returns and the BE/ME ratio. To explore the bias connected with the inclusion of surviving firms' financial data, results were reported on different firm samples on the CRSP[4] tape, on COMPUSTAT, and on CRSP but not on COMPUSTAT (the CRSP - COMPUSTAT sample). Consistent with the bias story, the average annual return on the COMPUSTAT sample exceeded that on the CRSP-COMPUSTAT sample, revealing thus the dominance of failing stocks in the latter sample. The evidence of upward bias in the average returns for the high B/M portfolios and the additional indication that the positive relation between B/M and returns was only period specific (it wasn't present over the post-1962 period and using data from the S&P Analyst's Handbook) cast serious doubts on the three-factor model.

The main effect of the survivorship bias has been focused on the questionable significance of the BE/ME variable. As *KSS (1995)* and *LaPorta (1994)* have showed, the survivorship bias are less severe in the large firms where the BE/ME effect loses its high explanatory power. *Davis (1994)* used a different test period (1940-1962) and a database free of survivorship bias (the Moody's Industrial

Manuals) to examine the BE/ME effect as well as the explanatory power of the MV, E/P and the ratio of cash flow per share to stock price (CF/P). From univariate and multivariate regressions, a significant BE/ME, CF/P and E/P effect was found, but no power for the market value and the beta. In a subsequent paper, *Davis (1996)* examined also the significance of the stock market anomalies in a current database where the missing COMPUSTAT data were replaced with Moody's observations. The cross-sectional regressions resulted in significant factor coefficients, yet, with a relative attenuation compared with the original COMPUSTAT database. A similar correction for missing data was included in the *Kim's (1997)* dataset where, although the selection bias pattern was present, the positive monotonic relation between returns and BEMV in the COMPUSTAT sample was further verified after the addition of missing data from the Moody's sample. These results provided evidence supporting the hypothesis that survivorship bias is not the sole cause of the observed explanatory power of the variables under study. The same conclusion was present in the paper by *Barber and Lyon (1996)* where the FF factors were tested in the holdout sample of financial firms with the additional restriction of 5 year history.

Chan, Jegadeesh and Lakonishok (1995) focused the research in mechanical aspects that cause the differences in the number and the performance of stocks included in the biased COMPUSTAT database and the unbiased CRSP file. Detailed analysis of the way that COMPUSTAT and CRSP present accounts after mergers or changes in firms' structure and the exclusion of nonprimary firms, REITs, ADRs[5] e.t.c showed that purely technical reasons rather than ex post selection bias result in negligible discrepancies between the databases, supporting thus the insignificance of the survivor bias.

Yet, *Brown, Goetzmann and Ross (1995)* formally established the survival problem through diffusion models applied directly to stock prices. Survival could induce a substantial spurious premium over the differences (returns) of a set of prices that survive, where the ex ante probability of survival at one date t depends on the level

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[4] CRSP = Centre for Research in Security Prices

[5] ADR = American Depository, REIT = Real Estate Investment Trusts

of prices at date *t*. Thus, the conditioning on the security surviving into a sample can induce a spurious relationship between observed return and total risk.

Breen and Korajczyk (1995) employed COMPUSTAT data collected month by month from January 1974 to December 1992 where firms that actually had data on the file, at the portfolio formation date, were eligible for inclusion in the tests. No back-filled data were used in portfolio construction or tests. With monthly portfolio rebalancing, the cross-sectional regressions resulted in a significant but with a lower magnitude BE/ME coefficient as a result of the exclusion of NASDAQ stocks from the sample.

The survivorship bias controversy could cast serious doubts over the originality of the factors significance from important risk connections or just sample disposition to biases. A definite answer could not be provided as a result of the research over this subject. Although the problem is present, any corrections and further considerations seems to attenuate the magnitude of the effects without eliminating it.

2.3.4 Beta estimation

The introduction of factors in asset pricing models was initiated by the failure of beta as the sole risk determinant. However, the research around the reasons of this failure brought in the surface problems in the beta estimation procedure which might account for it. Whereas the accounting variables in a multifactor model are measured without error, a pre-estimated beta inherent with measurement errors enters the post-regression model. However, one of the serious problems in this procedure is what *Scholes and Williams (1977)* present as the infrequent trading biases. Since many securities trade infrequently accurate calculation of returns over any fixed interval is difficult. Nonsynchronous trading of securities might induce spurious positive serial dependence in portfolio returns and the proposed solution by *Dimson (1977)* was an extended market model where the stock return is regressed on the current and lagged market return. A more precise estimate of beta is then the sum of all the coefficients in the model.

The same point was put forward by *Ibbotson, Kaplan and Peterson (1996)* who showed that this problem is more severe for small firms as they have higher transaction costs, are traded less frequently and a smaller number of analysts acquire information for them. Having estimated the traditional CAPM and the Dimson betas for ten equally-weighted size and beta portfolios, it was shown that whereas the simple beta was insignificant when used alone or with the size variable, the summed beta had some explanatory power over the realised returns and even over the size factor.

Another issue in the beta estimation procedure is the choice of adequate time spread for the market model. The bulk of the studies have used the prior to the test period five-year returns to obtain a beta estimate. Instead of this methodology, *Chan and Chen (1988)* computed beta as the time average of the five-year portfolio betas and held these average betas constant throughout all the cross-sectional regressions. Thus, the mean betas are estimated with higher precision since random errors of the five-year unconditional betas for each portfolio tend to cancel out each other in their time averages. After this correction, the firm-size variable was not longer significant.

Handa, Korthari and Wasley (1989) showed why the time interval plays an important role in estimating the beta. Instead of compounding returns, buy-and-hold equally-weighted portfolio returns were calculated and used in the market model for the beta estimation over many intervals up to one year. Mean returns and beta results proved that beta is sensitive to the return interval because the covariance with the market and the variance of the market (the two beta components) do not change proportionately as the return interval is changed. Monthly cross-sectional regressions of either monthly or annual portfolio returns on monthly or annual betas showed that the annual betas explained a greater percentage of the cross-sectional return variation. Adding the size variable in the regressions and employing the annual betas, the size effect became insignificant.

Annual buy-and-hold returns for the estimation of annual betas were also used by *Kothari, Sloan and Shanken (1995)* to replicate the FF (1992) research and the beta was found statistically significant. The use of annual returns was justified in the presence of a longer time investors' horizon, the elimination of possible bias due to non-synchronous trading and the exclusion of significant seasonal components. However, the replication of the FF 1992 model by *Breen and Korajczyk (1995)* with three methods of post-ranking portfolio betas i.e. the full period monthly market model, the full post-ranking period Dimson method and the market model with annual returns did not substantially change the beta insignificance.

Apart from the nonsynchronous trading bias that mitigates the beta effect, an additional puzzle with similar effects on beta significance is the Errors-In-Variables (EIV) problem which biases downwards the beta coefficient because of measurement errors aggregation. The suggested solution was the use of portfolios since the residual variance from the portfolio time-series regression will incorporate the cross-interdependencies in the individual residuals through elimination of the diversifiable risk and the EIV bias would be less severe in aggregate level than in individual securities. However, the advantage of aggregating individual errors can, at the same time, be considered as a disadvantage since the residuals from each individual stock might contain important information about effects not considered in the regression but influential in the risk-return process.

The hazard with forming portfolios is that a popular grouping procedure based on arbitrary firm characteristics might provide unjustifiable power to some variables irrelevant to the true risk-return relation, as pointed out by *Lo and MacKinlay (1990)*. The problem emerges from the construction of portfolios on the basis of some empirically motivated securities' characteristics which causes the data-snooping bias. If the choice of a variable is based on the data, then the sampling distribution of the test statistic concerning the significance of this variable is not the same as the null distribution of a well-determined variable based on economic theory. This kind of data snooping could lead to rejections of the null hypothesis even when it is true.

For the correction of the EIV bias, *Shanken (1992)* suggested an adjustment to the estimated coefficients of the second-pass procedure. The modified estimator is based on the observation that inconsistency of the second-pass estimator is driven by systematic bias in the lower right element of the $\hat{X}'\hat{X}$ matrix. Let $\hat{\Gamma} \equiv (\hat{\gamma}_0, \hat{\gamma}_1, \ldots, \hat{\gamma}_k)$ be the vector of the time-series means of the second-step estimators and $s^2(\gamma_k)$ be the variance of each estimator. The EIV-adjusted standard error of each estimates is given by the square root of $[s^2(\gamma_k) - s_k^2](1+c) + s_k^2$ where s_k^2 is the variance of the mean for the variable k and $c \equiv \hat{\Gamma}' S_F^{-1} \hat{\Gamma}$ with S_F the sample covariance matrix of the factors (*Shanken and Weinstein, 1990*).

Kim (1997) applied a different EIV correction in the coefficients of the cross-sectional regressions of individual securities' monthly and quarterly returns on beta, size, BEMV and E/P. The Fama-MacBeth estimation procedure is

$$R_t = \gamma_{0t} + \beta_t \gamma_{1t} + B_{t-1} \Gamma_{2t} + \varepsilon_t \quad (9)$$

Since the cross-sectional estimated regressors are T (time period) -consistent but not N (number of assets) -consistent, the MLE N-consistent estimation of all the coefficients was obtained by correcting the idiosyncratic error variance with additional information for the measurement error variance of the pre-estimated betas. The relationship between true betas and estimated betas is: $\hat{\beta}_{t-1} = \beta_t + \xi_{t-1}$. The last term which denotes the measurement errors of asset's estimated beta is represented with past idiosyncratic errors prior to each CSR:

$$\xi_{t-1} = \sum_{s \in S'} \varepsilon_{is} (R_{ms} - \overline{R}_m) / \sum_{s \in S'} (R_{ms} - \overline{R}_m)^2 \quad (10)$$

In order to obtain the MLE of $\vartheta = (\gamma_{0t}, \gamma_{1t}, \Gamma_{2t}, \beta_t)$ we should also take into account the additional information from the ratio:

$$\delta_{it} = \mathrm{Var}(\varepsilon_{it}) / \mathrm{Var}(\xi_{it-1}) = \sum_{s \in S^i} (R_{ms} - \overline{R}_m)^2 \qquad (11)$$

The MLE estimate is obtained by minimising the quadratic function $L = n'_t \Omega^{-1} n_t$ conditional on the ratio where Ω is the covariance matrix of $n_t(\varepsilon_t, \xi_{t-1})$. The new model application showed that the WLS estimate of the beta coefficient remained statistically significant even with the inclusion of the size. The same applied even when BEMV and E/P ratios were also included in the regressions, yet the BEMV effect was still present whereas the size and the E/P ratio turned out insignificant.

On an ex ante analysis, *Pettengill, Sundaram and Mathur (1995)* provided evidence for the beta significance during up and down markets. The basic notion of the Sharpe-Lintner-Black model is that there is a positive expected risk-return relation in the presence of an expected market return higher than the risk-free rate. However, in states when a negative relation is present, a reverse risk-return relationship might be inferred. Cross-sectional regressions with 20 pre-ranking beta portfolio returns were estimated to test the beta significance with the additional inclusion of dummy variables when the market portfolio was higher or lower than the risk-free rate. The estimated coefficients showed a significant beta-return relation for the whole year, yet, the relation was positive during up markets and negative during down markets, as implied by an ex-ante CAPM.

An additional problem that has received attention in the beta estimation procedure is the presence of outliers. *Chan and Lakonishok (1992)* considered this problem in the distribution of stock returns and its effect in beta estimation. Empirical research has suggested that stock returns follow a "fat-tailed" distribution relative to normal distribution, resulting in outliers which seriously affect the OLS beta estimate in studies of abnormal or cross-sectional returns. The problem is that when normality of the error term cannot be assumed, OLS will provide the best unbiased estimator of the parameters of the linear model only if attention is restricted to those parameters that are linear functions of the dependent variable. In many situations, however, this aspect may be unnecessarily restrictive. As an alternative to least squares estimator, the minimum Absolute Deviations (MAD) method has been suggested as it gives less weight to outlier observations by minimising the sum of absolute deviations instead of the sum of squared residuals. Another alternative is the trimmed regression quantile (TRQ) where the estimator is analogous to a trimmed mean where the trimming proportion is calculated from the "extreme" quantiles with the higher number of outliers. Simulated and actual returns data from 50 randomly selected NYSE firms supported the potential efficiency gains from robust methods, relative to least squares.

On the subject of outliers and irregularities in the beta estimation, *Draper and Paudyal (1995)* reported more tests on two samples of data from the FTSE100 index, seasoned and unseasoned stocks. With the outliers problem present, the return distribution departed from normality and produced inefficient estimated parameters as it exhibited fatter tails than a normally distributed series. With 400 daily observations, the first method was the classical CAPM with dummy variables for the day of the week effects and the impact of observations with more than 3 standard errors away from the mean. The second procedure was the robust estimator that is less influenced by extreme observations as the sum of absolute deviations is minimised. The third method was the Vasicek estimation procedure which attempts to reflect the regression of beta towards the mean and adjusts beta according to the size of the sampling error about beta. The differences between these methods were substantial.

The major piece of information transmitted from the review of the above identified problems with the beta estimation procedure is that inferences are sensitive to different approaches. The beta failure could be the result of just one estimation problem or a complex combination. On the other hand, beta could be rejected as the sole risk determinant even after controlling for any measurement error. A final conclusion should be reached under careful scrutiny of many dimensions and interrelations.

2.3.5 Return measurement problems

Another area of research with a similar assignment of identifying drawbacks in current methodologies was the problem inherent in the measurement procedures of the common stock returns. The impact of different measurement methods for abnormal returns was examined by *Barber and Lyon (1997)* in a paper focused on cumulative (CAR) and buy-and-hold (BAH) returns. The usual methodology in estimating the magnitude of high stock return performance is to calculate the abnormal stock return (AR) as the difference between realised and expected return and then to sum these ARs over a period to determine whether they are different from zero or not. The alternative methodology is to test for the significance of the difference between the stock's and a control portfolio's BHA returns. Preliminary tests between the mean difference of CAR and BHA returns showed that CARs ignore compounding effects, cumulate the measurement errors, are prone to new listing bias and exhibit positive skewness in return distribution in greater level than the BAH returns.

On the contrary, problems with buy-and-hold returns were presented in the *Fama's (1997)* review of the studies in abnormal performance. While the long-term returns were initially calculated with CAR, the introduction of BAH method was justified on the argument that long-term investor experience is better captured by compounding short-term returns to obtain long-term BAH returns. Yet, it was argued that the long-term BAH returns are not very useful since the estimation of stock performance is more relevant in short intervals because of normality problems and the fact that BAHR grow with the return horizon and exhibit extreme skewness by compounding monthly returns. Using annual buy-and-hold returns in forming the past winners and loser portfolios and examining their subsequent performance, *Ball, Kothari and Shanken (1995)* reported even more anomalies and measurement problems in the magnitude of excess returns.

The bulk of the asset pricing models research in the specific area of grouping stocks into portfolios calculated equally-weighted returns. The returns of the individual stocks in each portfolio are summed and divided by the number of the stocks in the portfolio and this average is the equally-weighted portfolio return. The alternative is the value-weighted returns where the individual stock returns are multiplied by the ratio of their market value to the sum market value of all the stocks in the portfolio and the sum of the adjusted returns represent the value-weighted return of the portfolio. With value-weighted returns, a portfolio will be less risky than an equally-weighted portfolio since small stocks in the latter are not weighted by their market value and influence more the final portfolio beta.

Some of the papers that make a distinction between equally- and value- weighted portfolios are by *Loughran (1997)* and *Daniel and Titman (1995)*. The former reports the vast difference when the returns within the size and book-to-market portfolios are value-weighted as the results are reversed and the growth firms outperform the value stocks. In the second paper, the use of value-weighted portfolios completely altered the previous findings as it was found that there is no return difference between the small and large firms. The justification for this finding was based on the argument that the smallest firms have larger returns but these returns are not heavily weighted in the value-weighted portfolios. *Breen and Korajczyk (1995)* found significant Jensen alphas in time-series regression for size, beta and B/M equally- but not for the value-portfolios. In addition, *Fama (1997)* presented some studies in areas of stock return performance where the long-term post-event returns become lower when value-weighted returns are used instead of equally-weighted. The argument behind this result is that value-weighted returns capture more accurately the total wealth effects experienced by investors[6].

Another important subject is the problem of delisting and data non-availability as it might introduce bias in econometric tests because the number of observations and degrees of freedom decrease substantially. In the area of finance research, this subject is not often addressed as the length of observations is so wide and some missing data could not affect the final results. Yet, there is always some concern in the influence of these problems in econometric tests. The high-risk stocks are more likely to be delisted from an exchange because of bankruptcy or failure reasons.

Thus, the weighted portfolio return would be higher than the case where those small firms' returns were also included.

The delisting problem appears in the stage where a stock is assigned in a portfolio and is delisted from the exchange during a subsequent period. *Kothari, Shanken and Sloan (1995)* noted that if a firm did not survive the 12-month period, the return until the delisting month plus any liquidating dividend reported in CRSP tape was used for the rest of the period. *Chan, Jegadeesh and Lakonishok (1995)* included the delisting return for the delisting months if this was available, otherwise they replaced the missing returns with the returns on a corresponding size portfolio. *Breman and Berry (1995)* excluded the company from the portfolio if some monthly returns were missing, although they mentioned that the replacement of the missing returns with a -100 return did not alter the results.

Shumway (1994) argued that significant delisting biases are present in the CRSP monthly return datafiles. After the delisting month, the usual procedure is to include the delisting value of the firm plus any liquidating dividends. Although this is the official CRSP regulation, it was rarely followed in practice. The alternative method proposed by Shumway is that a return of –100 after the delisting date should be reported. Replication of various studies with the additional incorporation of –100 delisting returns resulted in lower impact of most of the reported excess returns. Another method mentioned in the CRSP regulations is that zero returns should be reported after the delisting data that was also not implemented in the files.

The divergences in measurement methodologies for common stock returns should be expected and justified on the grounds of specific tests and approaches towards application of the asset pricing models. The striking point is the magnitude of the differences that such deviations could have on vital conclusions for specific models.

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[6] Fama (1997), "*Market efficiency, long-term returns and behavioral finance", p. 15*

2.3.6 Seasonality

A scenario against the validity of a multifactor model is the presence of seasonality patterns in the overall significance of the size and other effects. *Keim* has reported in a series of articles that the size effect is present only in the month of January and the level of significance is so high that is the driving force behind the effect. The exclusion of the January completely eliminates the power of the size anomaly whereas the same also applies in the BE/ME effect, yet without strong elimination. *Loughran (1997)* reported that the FF's empirical results were driven by two features of the data: a January seasonal in the book-to-market effect and exceptionally low returns on small, young, growth stocks. Preliminary statistics of MV-BE/ME annual buy-and-hold portfolio returns revealed that the NYSE sample has a large overall percentage of the total market value and the lowest percentage of newly listed firms and the Nasdaq is heavy weighted toward small growth firms. A similar to FF procedure for examining the equally-weighted returns of the B/M portfolios confirmed the book-to-market effect. However, a closer look at the results revealed that the B/M effect is stronger only for the smaller firms and non-existent outside of January for large firms. With value weighted portfolio returns, growth firms had higher annual returns than value firms outside the 1974-1984 period. Cross-sectional individual stock return regressions on size and B/M showed that the size effect was significant only in the month of January, whereas the B/M effect appeared with different seasonal patterns across different exchanges. Moreover, when the price variable was included in the regressions, the size and the B/M effect were greatly lowered in the month of January. The inclusion of a dummy variable according to whether the firm is in the top or low quintile, empowered the observation that the B/M effect is much stronger in the smaller firms.

Rogalski and Tinic (1989) examined the seasonality in betas and market value portfolio returns and found highly significant returns in the month of January whereas the null hypothesis of equal returns during the rest of the months and the January was strongly rejected. The variance of the smaller portfolios was also larger in January than in other months. To identify the source of the higher variance and returns in the small portfolios, a market model with daily returns was employed to estimate the beta which indeed was found larger in January and unstable during all months. Thus, the small firm effect should not be considered as an anomaly but rather as a manifestation of higher risk and higher transaction costs in the month of January.

The controversy over the seasonality subject seems quite devastating for the risk hypothesis story where the size and BE/ME factors are considered as new missing risk sources. It is evident that in the case where the seasonality presence is powerfully and undoubtedly accepted, the new multifactor model cannot be applied outside the January month. However, the issue remains whether the evidence is strong enough to reject the new risk mimicking factors.

2.3.7 Portfolio efficiency

We have already mentioned the Roll's critique which asserts that the beta is the sole risk determinant only if the market portfolio is ex ante mean-variance efficient. On a similar basis, *Roll & Ross (1994)* attempted to save beta with the argument that any other variable that happens to be cross-sectionally related to expected returns is building its empirical power on the fact that the index proxy is ex ante inefficient.

Yet, the surprising thing in the FF 1992 tests was the completely flat beta-return relation. This empirical result was the authors' motivation to test for possible connection between selected index proxies and beta-return relation. As it was pointed out[7]:

"The FF paper made us wonder where an index would have to be located to produce a set of true betas that had no relation whatever to true expected returns. We soon discovered that such indices exist and that they lie within a set whose boundaries can be directly calculated from basic parameters (expected returns and covariances of returns). More generally, for any arbitrary cross-sectional slope coefficient between betas and expected returns, there is a bounded set of possible indices. "

[7] Roll, Ross (1994): *Cross-sectional relation between expected returns and betas, p. 103*

The mathematics of the efficient set portfolios could show that there are market index proxies, located within a restricted region of the mean-variance space, that produce betas having no relation to expected returns. On the other hand, a market proxy very close to the efficient market portfolio could produce a zero beta relation. In addition, there is the possibility to produce a particular cross-sectional relation between expected returns and betas when the market index proxy lie within a closed region of the mean-variance space bounded by K value ellipses (where K is the cross-sectional covariance between beta and expected return). Thus, the flat risk-return relation and the evidence about additional cross-sectional determinants of expected returns could be attributed to the choice of specific market index proxies.

Kandel and Staumbaugh (1995) also provided similar evidence concerning the irrelevance in the direct relation between the beta-return relation and the market portfolio efficiency. The methodology to prove this statement was the repackaging of a set of risky assets into alternative subsets that generate the same portfolio opportunities. This repackaging does not change the location of the efficient portfolio in the mean-variance space but does change the relation between asset's expected returns and their betas with respect to the efficient portfolio. Thus, the employment of an inefficient portfolio could result in a positive beta-return relation with just a repackaging of a given sample of assets.

Shanken (1996) reviewed all the statistical methods employed for testing the mean-variance efficiency of a portfolio. A portfolio is characterised as minimum-variance efficient if the expected stock returns are a linear function of their betas on the portfolio return i.e.: $r_i = \gamma_{0p} + \beta_i (r_p - \gamma_{0p})$ where the betas are the slope coefficients from the market model. A minimum variance portfolio is efficient only if $r_p > \gamma_{0p}$. Comparing the two equations, we can derive the joint restriction

$$H_o: \ a_i = \gamma_{0p}(1 - \beta_i)$$

When $\gamma_{0p} = r_f$, the simple univariate test with a riskless asset is derived and an example is the BJS study for the mean-variance efficiency of the CRSP equally-weighted index. In the case of multivariate efficiency, Gibbons, Ross and Shanken (GRS) developed an F-test for the hypothesis that all the intercepts are zero. The test is $Q \equiv T\hat{a}'\sum^{-1}\hat{a}/[1+\overline{R}_p^2/s_p^2]$ which is large when the portfolio p is far from the ex post minimum-variance frontier. Yet, since the residual covariance matrix must be invertible for the implementation for the F-test, the number of assets should be lower than the length of time that leads to the portfolio formation procedure. The F-test with an additional White correction in the covariance matrix can also be used in the case of variation in betas and risk premiums measured with instrumental variables.

When the riskless asset is unknown, γ_{0p} has also to be estimated. The first methodology is the two-pass FM procedure where the coefficients are estimated in time-series regressions and then the estimates are entered in the cross-sectional regressions. The significance of the regressors is assessed with the t-statistics of their time-series means that does not take into account the cross-dependence problem. In addition, a correction term for the EIV problem should always be included in the estimated coefficients.

The different inferences about the beta validity drawn from the employment of ex post inefficient market proxies might establish the most serious argument against the empirical tests that prove the beta failure. However, the fact remains that CAPM is a model applied in the financial practice and it should constitute the best alternative among other models with the available data.

2.3.8 Multifactor models

The application of the multifactor models requires the construction of Factor Mimicking Portfolios (FMP), as the loadings of these portfolios represent the response of the common stock returns to new risk sources. *Fama and French (1993)* introduced the factor mimicking portfolios as independent regressors in tests of multibeta models. After the evidence that the size and book-to-market equity variables play a significant role in the cross-sectional determination of asset returns, they constructed factor mimicking portfolios based on these variables so as their factor loadings would have a clear interpretation as risk-factor sensitivities.

Kothari and Shanken (1998) reviewed the evidence on the beta and size-B/M effects and examined whether betas or other firm characteristics completely capture cross-sectional variation in expected returns. This examination was based on the magnitude of average residuals from regressions in order to test the incremental significance of e.g. size to the determination of expected returns. The average residuals from either monthly or annual returns showed that the incremental effect of size on expected return (fitted value), given that beta is already considered, is small.

Daniel & Titman (1995) strongly criticized the FF three-factor model with a completely different approach. The questions addressed in this paper were 1) whether there are pervasive risk factors associated with size and book-to-market and 2) whether there are risk premia associated with these factors. To test whether the covariance structure is a determinant of average returns, they examined three different return generating models. In the first one, there existed a "distressed" factor with a positive risk premium. In the second model, risk premia associated with the factors change as stocks loading on those factors move towards distress and in the third model, firm characteristics rather than loadings determine expected returns.

The intuition for the third model's testability was that test portfolios should be formed in such a way that book-to-market ratios within the portfolios and the covariances with the book-to-market sorted portfolios are not too highly correlated. Thus, it would be possible to distinguish which model better represents the return generating process. In the cross-sectional regressions, the results showed no relationship between factor loadings and expected returns. The intercepts from the regressions of the new portfolios to the three factors were different from zero. In a nutshell, what Daniel & Titman proved was that characteristics like size and book-to-market explain average returns rather than covariances with the FF factor portfolios. The distress factor portfolio may be priced as it might covary with other factors (e.g. the oil factor) at certain periods of time.

In the area of factor consideration, *Chan, Karceski and Lakonishok (1997)* evaluated the performance of various proposed factors in capturing return comovements. The goal was to develop a parsimonious set of observable variables that do a good job in capturing the systematic components of stock return covariances. For this purpose, factor mimicking portfolios were constructed since the presence of large return volatility of a mimicking portfolio would reveal its underlying factor as a substantial component to return movements. The main focus was in four factor categories: accounting characteristics, technical factors (past returns), macroeconomic factors, statistical factors (principal component analysis) and the market factor.

The standard deviation analysis revealed the higher figure for the size portfolios in combination with low mean spread, which shows that a variable with strong patterns of comovement need not be associated with a large return premium. From the macroeconomics factors, the term premium and the default premium portfolios were found to have the highest deviation, confirming the FF 1993 results, although the rest of the factors were also found significant. The problem faced with the high volatility of the macroeconomics factors is that the basis-factor is an estimated loading which can result in shared variation patterns even when the explanatory variable is not a true factor. The alternative procedure of random resample of macroeconomic variables' time-series realisations, breaking thus up any structural relation between past returns and any pseudofactor, resulted in lower significance for the factors apart from TERM and DEF. The statistical factors were important up to the second factor, together with the market indices.

Hawawini and Keim (1997) offered a literature review of all the research and the results from the cross-sectional relation between returns and many ad hoc variables in the U.S. and international markets. The portfolio mean returns and betas confirmed the previous evidence of excess returns with magnitude not justified by the beta spread. The reported Spearman rank portfolio correlations revealed a high correlation between these variables and the price variable. Forming portfolios on book-to-market and past-returns and adjusting the stock returns for size effects, they concluded that the high average returns for high B/P stocks may reflect some underlying relation between returns and low price. A concrete conclusion on which variables are finally important seems impossible due to the absence of theory for these variables and data-snooping biases.

Although the three-factor model appeared to explain best the variation of expected stock returns, its direct application lacked the CAPM notion of efficiency and simplicity. To overcome this drawback, *Fama (1997)* 's paper offered the link between the three-factor model and the Merton's ICAPM (1973). Like CAPM investors, ICAPM investors dislike wealth uncertainty and they use Markowitz' MVE (Mean Variance Efficient) portfolios to optimise the tradeoff of expected return for general sources of return variance. But ICAPM investors are also concerned with using their portfolio choices to hedge more specific aspects of future consumption-investment opportunities. As a result, the typical multifactor-efficient portfolio in the ICAPM combines an MVE portfolio with hedging portfolios, s=1,2,...,S, that mimic uncertainty about the S future consumption-investment state variables of concern to investors.

The ICAPM risk-return relation is

$$E(r_i)-r_f=\beta_{iM}[E(r_M)-r_f]+\sum_{s=1}^{S}\beta_{is}[E(r_s)-r_f] \qquad (12)$$

where apart from beta there are *s* more factors affecting the expected return. The joint normality of returns and the state variables implies that, given a choice of c_{t-1}, the optimal portfolio for an investor depends only on $E(r_p), \sigma^2(r_p)$ *and* B_p*(the* cov *vector)*. The three-factor model is based on the ICAPM model if we substitute the two variables of size and book-to-market equity as proxies for risk factors.

Fama argued that MV (Minimum Variance) optimal portfolios in the CAPM are replaced with MMV (Multifactor Minimum Variance) portfolios in the ICAPM and the MVE with ME (Multifactor Efficient) portfolios. In the ICAPM world, the MMV portfolios have two important properties which are equivalent of the MV portfolios: 1) all portfolios of MMV portfolios are MMV, and 2) if S is the number of state variables, any S+2 linearly independent MMV portfolios span all MMV and MVE portfolios. However, the key point of these properties is that in the ICAPM, the expected returns for any spanning set of MMV portfolios can explain the expected returns on all the securities and portfolios. Thus, the ICAPM risk-return relation is hardly unique. This means that empirical tests need not identify the market portfolio, the specific state variables of concern to investors, or the mimicking portfolios for the state variables. To test the ICAPM, it suffices to specify a) S, the number of state variables and b) S+2 candidate MMV portfolios that can be used to test the model's implications about expected returns.

However, *Fama and French (1995)* pointed out that a serious weakness of the three-factor model is that SMB and HML are not unique in explaining returns. If the three-factor model is valid, the market portfolio, the two components of the SMB and the two components of the HML must be among the MMV portfolios. Yet, different triplets of their components - S, H, L - in combination with the market M component could work equally well in explaining returns. All combinations of three of them provided similar and good explanations of the returns on other portfolios (those formed on other factors such as E/P, C/P, e.t.c.). Thus, there are ambiguous signals about the nature of the two underlying state variables of special hedging concern to investors, yet, one of them must be related to relative distress.

Based on the new evidence towards the factor-mimicking portfolios, *Fama (1997)* posed the research questions of identifying whether the number or the actual state variables is of special hedging interest to the ICAPM investors. The ICAPM equilibrium conditions state that in order to identify priced state variables we must find the smallest list L of state variable mimicking portfolios that, along with the riskfree asset, describe expected returns on all assets. The list L of priced state variables could be identified when: 1) the market portfolio and the mimicking portfolios for the state variables in L can explain the premiums (expected excess returns) on the mimicking portfolios for all state variables not in L. 2) the market portfolio and the other state variable mimicking portfolios in L cannot explain the premium on the mimicking portfolio for any state variable in L. Yet, when the number of state variables is known but not their names, definite conclusions about even the number of them that are priced are unlikely, unless the ICAPM collapses to the CAPM.

The above discussion provides some insights in the economic background of the market value and book-to-market effects as additional risk sources in a multivariate ICAPM. The current complexity of the financial markets could induce investors to base their decisions in multidimensional risk vectors. However, the problem remains that the new multifactor model is not unique in the return generating process and small divergences could alter substantially any inferences.

2.4. Panel Data and General Method of Moments

2.4.1 Introduction

As it was mentioned in a previous section, a problem present in the traditional CAPM tests is the error-in-variables (EIV) problem as the incorporation of pre-estimated betas introduces additional measurement errors and biases the postbeta coefficient downwards. *Gibbons (1982)* argued that the EIV problem could be mitigated in the procedure of simultaneous estimation of the beta and its coefficient. This can be achieved using the methodology of pooled time-series and cross-sectional data. In this model the stock returns can be represented with the form of a panel dataset across individual securities and time. Suppose that the model consists of m linear equations written as

$$y = X\beta + u \qquad i=1,2,....,M \text{ stocks} \qquad t=1,2,.....,T \text{ periods} \qquad (13)$$

where **y** is a (MT x 1) vector of M stock returns, **x** is a (MT x K) matrix of the K variables, β is a (K x 1) vector of the coefficients and **u** a (MT x 1) vector of disturbances.

The two-way error component regression model for the disturbances could be represented by

$$u_{it} = \mu_i + \lambda_t + \nu_{it} \tag{14}$$

where μ_i denotes the unobservable individual specific effect, λ_t denotes the unobservable time effect and ν_{it} denotes the remainder disturbance. Based on this disturbance model, we can further test the return equation with either the *fixed effects* estimation where μ_i is correlated with the regressors or the *random effects* estimation where the individual effect is uncorrelated with the regressors. The first estimator might seem more appropriate in the asset pricing tests where the residuals contain unmeasured effects that are possible to be connected with the variables included in the tests. We should take into consideration the fact that the error components GLS estimator will suffer from omitted variables bias if the individual and time effects are correlated with the explanatory variables. The strict assumption of uncorrelation between residuals and regressors would completely overlook the omitted variables problem and the presence of individual stock and industry interrelations with significant effects on the final results. In addition, the employment of finite sample stocks in asset pricing models does not make any specific assumptions about the distribution of the μ_i with the fixed effects model and thus it can be used for a wider range of problems.

2.4.2 CAPM alternative methodology

The Seemingly Unrelated Regression Methodology (SURM) is a fixed effects model where the coefficients are allowed to vary only over individual and not over time i.e. $\beta_{kit} = \beta_{ki}$. The two main violations in the OLS assumptions are homoskedasticity of the error term and independence of the explanatory variables from the error term. Homoskedasticity is lost when the error term's variance changes either across time or across categories. Independence of the explanatory variable from the error term could be lost when the equation being estimated is part of a larger set of equations. Thus, the additional assumption in the SUR model is that the residuals are contemporaneously correlated i.e.

$$\mathrm{cov}(u_{it}, u_{jt}) = \sigma_{ij} \quad t = 1,2,\ldots,T \quad whereas \ for \ s \neq t \ \mathrm{cov}(u_{it}, u_{js}) = 0$$

This means that there is no serial correlation and no serial cross-correlation (no correlation between disturbances to difference equations with different observation numbers) but there is correlation between disturbances with the same time observation number.

Gibbons (1982) introduced the advantages of SURM in the CAPM tests. The basic intuition was that the Black's version of CAPM places non-linear restrictions in the constant of the market model to be equal to $a_i = \gamma(1 - \beta_i)$ where γ is the return on the zero-beta portfolio. Because of cumbersome calculations of iterations in the case of non-linear restrictions, Gibbons used the Gauss-Newton algorithm to linearize the restrictions and to estimate the model with the linear SUR model (SURM). Further advantages of this methodology were that the estimator is consistent and asymptotically efficient with a normal distribution and the precision of the estimator is improved since a full contemporaneous covariance matrix for the residuals is incorporated. The likelihood ratio test statistic on the difference in explanatory power between the constrained and unconstrained regression rejected the validity of the CAPM. Yet, *Stambaugh (1982)* showed that the LR test may reject the null hypothesis too often when the number of market-model equations is increased and that with the Langrance Multiplier (LM) test the Black's CAPM was accepted.

2.4.3 Seemingly Unrelated Regression methodology

Despite the alleged advantages of the SURM, the bulk of the subsequent research over the beta significance adopted the traditional two-stage methodology, accompanied with some comments for the SURM. *Banz (1981)* mentioned that it creates problem in the time-series model since it is strongly depends on the market model as the correct specification of the return generating process. *Chan and Chen (1988)* argued that the SURM is a special case of a panel data construction with a fixed effects representation where correlation between the disturbance and the regressors is incorporated in the estimation procedure. In their paper, the presented model resembled to a random coefficient model where constants were allowed to vary over individual and time and residuals were uncorrelated with the regressors. *Bhandari (1988)* criticised the Gibbons' methodology on the grounds that it is not applied in one-tail tests, it cannot be corrected for non-synchronous trading and it is more susceptible in the presence of non-normality in the errors which is more severe for individual stocks.

The strongest criticism to Gibbon's procedure was posed by *Shanken (1992)* for the EIV bias problem. Although the use of individual stocks in the one-step methodology should avoid the EIV bias as beta and risk premia are estimated simultaneously, Shanken argued that when a covariance estimate is embodied in the second-pass GLS estimator, the latter becomes equivalent to the SUR Gauss-Newton MLE estimator. Thus, the EIV biases are also present in the MLE estimator as a result of the system's linearization with the Gauss-Newton algorithm. Furthermore, as N (=number of assets) increases, the true variability of the GLS estimator might be seriously understated as the asymptotic standard errors for the risk-return parameters do no reflect the noise in the covariance estimates[8].

Thus, most of the research that has revealed additional risk sources in the risk-return relation and weakened the beta power was based on the two-pass methodology. Yet, there is a part of research where the beta and the risk premia were estimated simultaneously and inferences were compared with previous methodologies. *Brown, Kleidon and Marsh (1983)* presented some new evidence on the nature of size-related anomalies in stock prices and their persistence over time. The dataset consisted of 566 firms where the size anomaly was proven present and the regression format was:

$$\widetilde{R}_{it} - R_{ft} = \gamma_{0i} + \beta_{iM}(\widetilde{R}_{Mt} - R_{ft}) + \gamma_{1i}\overline{S}_i + \widetilde{\varepsilon}_{it} \quad i=1,.....,N \quad t=1,.....,T \qquad (15)$$

where $\overline{S}_i$ = measure of size for asset i applicable to the period (1,T)

γ_{0i}, γ_{1i} = scalar parameters.

The size measure was assumed constant for each asset during the time period but varying across equations i.e. different assets. With these properties a common γ_0 and γ_1 could be estimated using the SURM where the residuals are assumed unautocorrelated but cross-correlated. The SUR model was tested in size portfolios instead of individual securities, a methodology that does not fully exploit its capabilities. Yet, the use of individual securities would be econometrically justified only in the case where the number of securities is less than the number of the generated parameters out of the simultaneous equations. Otherwise, there are more parameters than observations and the covariance matrix becomes singular. When the number of stocks is large and the singularity problem is evident, the possible solution is to reduce the number of observations by forming portfolios. The final SURM tests resulted in different inferences for the size effect from the FM approach, revealing an instability of the size effect based on different approaches and time periods.

Jaffe, Keim and Westerfield (1989) re-examined the relation between earnings yields, market values and stock returns to test for the presence of seasonality in the month of January. The survivorship biases were mitigated with the inclusion of the COMPUSTAT research file and firms with fiscal years ending December 31. The SUR model for 25 portfolios formed on size and E/P ratio was:

$$\widetilde{R}_{pt} - R_{ft} = a_0 + \beta_{pr}(\widetilde{R}_{mt} - R_{ft}) + a_1 (E/P)_{pt} + a_2 LMVE_{pt} + \widetilde{u}_{pt} \qquad (16)$$

[8] Shanken and Weistein (1990), "*Macroeconomic variable and asset pricing: Further results*", *p.12*

where $p = 1,2,\ldots,25$ and $t = 1,2,\ldots,T$

The overall results showed a significant E/P effect whereas the size had a significant negative impact only in January. The same methodology was also employed by *Keim (1985)* in the examination of the dividend-yield variable where tests on DY portfolios revealed that the excess returns were the result of a non-linear relation between DY and long-run stock returns in the month of January. Furthermore, two-way sorted portfolios on size and DY with additional dummies for the month of January exhibited higher returns in January, yet the excess returns were also significant in the rest of the months.

For comparison reasons between the two competing methodologies, *Amihud, Christensen and Mendelson (1993)* tested the FF 1992 model with the SUR approach and some corrections for survivorship bias. Instead of the FM two-stage methodology, a pooled time-series-cross-sectional model was given as

$$r = (I_Y \otimes e)\gamma_0 + X\gamma_1 + \varepsilon \quad (17)$$

It was argued that the OLS pooled joint estimation of this model is more powerful than the OLS estimator of the FM methodology as the variance of the first estimator is lower than the second's and the efficiency is higher. Yet, the optimality of the OLS joint estimator is based on the homoskedastic and uncorrelated residuals. Since these assumptions are very restrictive and difficult to be justified, the more efficient estimator is given by the GLS methodology where both sides of the model are premultiplied with *W* [var(e)=V and V=W'W].

The dependent variable in the regressions was annual buy-and-hold returns of size and beta NYSE portfolios in the period 1953-1990. To address the survivorship bias problem arising from the delisting of a stock for a whole year if returns were not reported for some months, they adjusted the sample by substituting the returns of these firms for the subsequent months with the market return. In addition, the GLS procedure is an effective way to mitigate the survivorship bias because effectively standardizes the observations by the variance-covariance matrix which reflects both the residual dispersion and their cross-sectional dependence (*Brown,* *Goetzmann, Ibbotson, 1992*). The GLS procedure requires an estimation of the variance-covariance matrix $V_y = \sigma_y^2 V$. The two estimators used are $\hat{\sigma}_y^2 = \frac{1}{P}\hat{\varepsilon}'_y \hat{\varepsilon}_y$ from the residuals of the OLS estimation and $\hat{V}^J = \frac{1}{Y}\sum_{y=1}^{Y} \hat{\upsilon}_y^J \hat{\upsilon}'^J_y$. From the relation $(\hat{V}^J)^{-1} = W'W$, the transformed model is derived by multiplying the regressors with W and divide with the variance estimator.

The joint-pooled estimator proved to be more efficient than the time-series average of the FM second-pass estimator, since its variance was less than that of the time-series average. The OLS estimation of the four datasets, the unadjusted and adjusted model with raw and excess returns, resulted in an insignificant coefficient for the beta, whereas its coefficient was significant with the OLS and the GLS estimation in the pooled model.

Datar, Naik and Radcliffe (1997) attempted to shed light on the relation between liquidity and asset returns using a different proxy for the liquidity, the turnover rate defined as number of shares traded as a fraction of the number of shares outstanding. This variable was included as an independent regressor together with the size, BEMV and beta in the cross-sectional procedure for determining the expected returns. The estimation procedure employed was the WLS of the pooled cross-sectional and time-series observations. The empirical model was of the pooled form:

$$R_{it} = \gamma_{0t} + \sum_{k=1}^{k} \gamma_{kt} X_{it} + \varepsilon_{it} \quad i=1,2,.....N \quad t=1,2,....T \qquad (18)$$

If the monthly estimators are serially uncorrelated, the pooled GLS estimator of $\hat{\gamma}_k$ is found as the weighted mean of the monthly estimates where the weights are inversely proportional to the variances of these estimates:

$$\hat{\gamma}_k = \sum_{t=1}^{T} Z_{kt}\gamma_{kt} \qquad \text{where} \qquad Z_{kt} = \frac{[\mathrm{Var}(\hat{\gamma}_{kt})]^{-1}}{\sum_{t=1}^{T}[\mathrm{Var}(\hat{\gamma}_{kt})]^{-1}}$$

and $\text{Var}(\hat{\gamma}_k) = \sum_{t=1}^{T} Z_{kt}^2 \text{Var}(\hat{\gamma}_{kt})$

The GLS estimator with both individual stocks and beta portfolios returns proved a negatively significant trading volume variable in all months which was not subsumed by size, BEMV or beta.

Brennan, Chordia and Subrahmanyam (1997) introduced tests for the risk-return relationship of portfolios formed on a wide set of variables including size, price, turnover, bid-ask spread, analyst forecast, dispersion of analyst opinion, book to market ratio, institutional holdings, membership in the S&P500 index, dividend yield and lagged returns. The basic model under estimation is:

$$E[\tilde{R}_j] - R_F = c_0 + \sum_{k=1}^{5} \lambda_k \beta_{jk} + \sum_{m=1}^{M} c_m Z_{mj} \qquad (19)$$

where R_j is the return on security j, β_{jk} is the loading of security j on factor k, λ_k is the risk premium associated with factor k, Z_{mj} is the value of (non-risk) characteristic factor k , and c_m is the premium per unit of characteristic m. The main hypothesis is that the non-risk characteristics have no explanatory power in the model.

The data consisted of NYSE firms for the period 1977-1989 and the sources varied from CRSP to IBES, S&P and COMPUSTAT depending on the variable's nature. The methodology used for estimation procedure varied as well, employing both portfolios and individual securities for the tests. The first test implemented the FM procedure of forming 25 portfolios first on size and then in various variables and regress the monthly equally-weighted returns on firm characteristics. The main difference was that the monthly portfolio returns were adjusted for the Connor-Korajczyk (C-K) five pervasive factors obtained with the principal components analysis. The only variable found significant was the institutional ownership.

The second methodology employed to avoid the EIV problem and the cross-sectional correlation in the residual returns was the SUR estimation. The excess but not adjusted returns on the two-way sorted portfolios were used as the dependent variables and the same characteristics with the C-K factor loadings as the independent regressors. The following pooled time-series-cross-section regression was estimated by OLS:

$$R = X\beta + \varepsilon \qquad (20)$$

where R is the vector of the 25 portfolios' returns over time, X consisted of the coefficients of the 5 C-K factors for the portfolios, the constant term and the 14 security characteristics and ε is the vector of errors. The GLS beta estimate of this equation is:

$$\hat{\beta} = (X'\hat{\Omega}^{-1}X)*(X'\hat{\Omega}^{-1}Y) \qquad (21)$$

where $\hat{\Omega}$ is the estimation of the errors covariance matrix from the OLS procedure. The results were somehow different from the FM results. Some of the characteristics were found significant with the important observation that there were conflicting inferences between different sorting criteria.

Thus, the safe way to conclude on some variables' significance was to avoid the portfolio grouping confusion and to use individual securities. First, the excess returns on securities were regressed on the previous 24 to 60 months for estimating the factor loadings on the C-K factors:

$$\widetilde{R}_{jt} - R_{ft} = \sum_{k=1}^{5} \beta_{jk} \widetilde{F}_{kt} + \widetilde{e}_{jt} \qquad (22)$$

Then the adjusted for these factor returns defined from:

$$\widetilde{R}'_{jt} = \widetilde{R}_{jt} - R_{ft} - \sum \hat{\beta}_{jk} \widetilde{F}_{kt} \qquad (23)$$

were regressed on characteristics each month :

$$\widetilde{R}'_{jt} = c_{0t} + \sum_{m=1}^{14} c_{mt} Z_{mjt} + \widetilde{e}_{jt} \qquad (24)$$

This methodology has the advantage of using individual securities to address the problems of spurious conclusion induced by portfolio grouping and loosing valuable information induced by aggregation procedure. At the same time, it avoids the EIV problem since the error-hidden factor loading estimates are impounded in the dependent variable of the regression.

The OLS estimation procedure resulted in significance of many variables even when the characteristics were regressed on the factors but not for the BEMV and the price variable. Yet, the inclusion of lags for some of these variables to avoid the problem of correlation resulted in the final conclusion of the dollar volume of share trading and the S&P membership being the only significant variables.

2.4.4 Non-linear systems

The main criticism of the Gibbon's SUR estimation was focused on the equivalence between the one-step estimator and the GLS second-pass estimator. The loss in the one-step estimator efficiency comes from the Gauss-Newton logarithm that linearizes the non-linear restriction. *McElroy, Burmeister and Wall (1985)* employed the NLSUR estimation to directly test the non-linear restrictions and to regain the loss in efficiency. The main difference with the Gibbon's SUR estimation is that all non-linear parameter constraints are incorporated (exactly) into the model specification whereas they are only linearly approximated in Gibbons. Although in their paper the NLSUR was employed to test for the number of factors priced in the APT model, the test can be easily extended in the CAPM case.

The CAPM tests in the two-stage methodology are mainly being undertaken with the OLS method. A major OLS assumption for the estimates to be efficient is that the variance-covariance matrix of the returns is diagonal which precludes any contemporaneous correlation between different individuals at the same point of time. Yet, this assumption is extremely restrictive especially in the multifactor asset pricing models where some of the variables-regressors strongly depend on characteristics or industry specifications which affect many companies at a contemporaneous period. The alternative method used by McElroy, Burmeister and Wall was a non-linear seemingly unrelated regression technique (NLSUR) which is asymptotically efficient when the variance-covariance matrix of returns is not diagonal. The basic rationale behind the NLSUR test in the APT pricing models is that the restriction of equal risk price irrespective of stocks' different beta sensitivities to each factor should be valid for every stock.

This methoodology was employed by *Clare, Priesltey and Thomas (1995)* in U.K 100 securities from the London Stock Exchange between 1980 and 1993 and the comparison between the one- and two-step estimators resulted in a highly significant beta using the NLSUR estimation. To examine further the risk-return relation, they also considered the FF accounting variables as candidate determinants of the U.K. stock returns. The methodology employed for this test was to regress the residuals from the NLSUR estimation on the accounting variables to examine the incremental power that these variables have on the return part unexplained by the market factor. As it was shown, the variables cannot be directly tested in the one-step estimation. If we extend the model to incorporate the MV variable, we get:

$$E_t = \lambda_m \beta + \gamma \ln(MV)_{t-1}$$
$$R_t = \lambda_m \beta + \gamma \ln(MV)_{t-1} + \beta RM_t + v_t \qquad (25)$$

From the second equation, we get the restrictions that the prices (risk premium) of beta and MV are equal across all the securities[9]. This is not the test in FF procedure. The time-series averages from the auxiliary regressions resulted in non-significance of the variables' coefficients.

An extension to the NLSUR estimation is the Iterated Non Linear Seemingly Unrelated Regression (ITNLSUR) procedure where the estimators may be calculated by iterating the NLSUR steps until the covariance matrix stabilises. *McElroy and Burmeister (1988)* employed the suggested extension to the APT factor model on monthly returns of 70 stocks. An important issue raised in this paper concerned the assumed exogeneity of the market portfolio. The market portfolio should be considered as an endogenous variable if this is used to proxy for the individual security returns that are already proxying for the unobserved factors[10]. In that case, the model estimation should follow the NL3SLS procedure with the introduction of instruments for the three stages. This is the methodology

[9] The restriction represented by γ tests the equality of asset sensitivities over time to past values of own market value, this is a consequence of the fact that the NLSUR procedure is a time-series estimator augmented by non-linear restrictions. *(Priestley, Claire, Thomas 1995 :p.16)*

followed by *Antoniou, Garrett, Priestley (1993)* in testing the APT and the CAPM in the U.K. market. Although both models seemed to perform well with U.K data, a comparison distinguished APT as a superior model as it explained residual variation from the CAPM model.

Burmeister and McElroy (1988) extended the NLSUR framework to allow the market portfolio to enter the regression as an endogenous variable by using non-linear three stage least squares (NL3SLS) estimator which can provide joint estimates of λ and B that solve the minimisation problem

$$\min\ e'(\hat{\Sigma}^{-1} \otimes \{Z(Z'Z^{-1})Z'\})e \qquad (26)$$

where $\hat{\Sigma}^{-1}$ is the residual variance-covariance matrix and Z is a matrix of instrumental variables. The instruments employed for the NL3SLS were the exogenous macro factors and the squared exogenous factors: the returns and the squared returns of the S&P 500 index: the fitted values and the squared fitted values from a regression of the excess return from the market portfolio on the macroeconomic factors. The NL3SLS with a strict covariance matrix showed no significance for any of the factors whereas with an approximate structure five factors plus a proxy for the market portfolio were priced. The same methodology was used the test the CAPM in the U.K. market and it was found that the NL3SLS revealed a statistically significant beta risk premium

We have seen that the state variables with significant power in a multi-beta CAPM were the market value, the BE/ME ratio, the E/P ratio and the dividend yield, with the first two as the most dominant, even upon the market beta. One possible explanation for the failure of the market beta to explain the cross-section of average returns is that stock risks are multi-dimensional instead of one-dimensional as described by the CAPM. *Mei (1993)* attempted to provide answers in two important questions: a) Can a multi-factor asset pricing model, such as the APT, offer a comprehensive explanation of the cross-section of average returns? b) That is, can the multiple betas from a multi-factor model absorb the role of size and book-to-

[10] Antoniou, Garrette, Priesltey (93), "*The APT vs. CAPM in the UK stock market*", *p.5*

market equity so that asset returns are still determined ultimately by systematic risks instead of firm-specific variables?

To address these questions, a simple autoregression approach was used with the additional advantages of using a linear combination of historical returns to proxy for the unobservable betas, taking into account the fact that expected returns vary over time and also including firm-specific effects. A 3SLS instrumental estimation was performed in the autoregressive model

$$R_{it} = \psi_{0t} + \sum_{j=1}^{K} \psi_{jt} R_{i,t-j} + \pi_t C_{i,t-1} + n_{it} \tag{27}$$

where $\psi_{0t} = \lambda_{0t} - \sum_{j=1}^{K} \psi_{jt} \lambda_{0,t-j}$ $\qquad n_{it} = \varepsilon_{it} - \sum_{j=1}^{K} \psi_{jt} \varepsilon_{i,t-j}$

and $C_{i,t-1}$ represents a firm-specific variable such as B/M, DY, E/P and size.

This model implies that if the returns are generated by a K-factor APT model, then lagged returns from t-1 to t-K should be sufficient in explaining the cross-sectional variation in returns at time t via a K-lag autoregresion. The methodology was first to estimate the unrestricted model (which includes the APT factors and the firm-specific variables) and the restricted model (the restriction was imposed on the significance of the state variables) and then calculate the difference in their sum of squared residuals. If the restriction does not hold, then the difference would be large, indicating a rejection of the hypothesis. The "size anomaly" was due to an "omitted factors" problem, but not the B/M and the E/P effect. They noted that the B/M and the E/P ratio variables must possess some unique information besides exposure to systematic risks, which can help explain the cross-sectional variation in stock returns.

Zhou (1997) examined the FF three factor model using an estimation that avoids the EIV problem, the maximum likelihood estimation as it is a one-step methodology. In addition, the likelihood ratio test is used to test the restrictions of the model together with the pricing significance of a given factor. Gibbons (1982) was the first to use the MLE in a multivariate framework, but his analysis was focused on the zero-beta CAPM. This paper uses the MLE in an analytical rather than a numerical framework that makes the methodology more appealing to testing procedures. Assuming that the asset returns are governed by a multifactor model

$$r_{it} = a_i + \beta_{i1} f_{1t} + \ldots + \beta_{iK} f_{Kt} + \varepsilon_{it} \qquad (28)$$

the asset pricing restriction can be written as

$$H_0: \ a_i = \gamma_0 1_N + \gamma_1 \beta_1 + \ldots. + \gamma_K \beta_K \qquad (29)$$

where the gammas represent the risk premiums of the factors. So the model (28) should be estimated under the restrictions in the equation (29), yet since the parameters enter the restrictions by multiplications the constraints are nonlinear. It was shown that the LRT could be used to test these restrictions in the MLE procedure. This combination can be used even when the factors are portfolio returns, adding new restrictions to the model. The application of this methodology in the FF three factor model resulted in a contradictory piece of evidence, a negative market risk premium. Furthermore, the LRT rejected the model in a 5% significance level.

The introduction of the non-linear systems in the estimation procedure of asset pricing models in combination with the consideration of instrumental variables initiated the application of the General Method of Moments (GMM) methodology. The advantages of this approach are summed up to its non-parametric nature about specific distributions and the feasibility to introduce time-variation in the model parameters through conditional expectations with the instruments' history.

An adequate description of the GMM tests application in asset pricing models is present in the paper by *Zhou (1994)* where the finite sample properties of the GMM estimation were derived so it can be used through analytical instead of mathematical cumbersome procedures. The main problem in the GMM procedure was to solve the GMM optimisation problem which includes a large parameter space. The paper's solution to this problem was presented in a framework of independent and identically distributed model residuals. The general approach of GMM introduced by Hansen (1982) is to use sample moment conditions to replace those of the model. Then, the parameter estimators $\hat{\theta}$ are obtained by minimising a those of the model. Then, the parameter estimators $\hat{\theta}$ are obtained by minimising a weighted quadratic form of the sample moments:

$$\min Q \equiv g_T(\theta)' W_T g_T(\theta) \qquad (30)$$

where

$$g_T(\theta) = \frac{1}{T}\sum_{t=1}^{T} f_t(\theta) \qquad f_t(\theta) \equiv U_t(\theta) \otimes Z_{t-1} \qquad E[(f_t(\theta)] = 0$$

$U_t(\theta)$ = the vector of model disturbances

Z_{t-1} = the vector of instruments

and W_T is a weighting matrix that is positive definite. Many solutions were proposed to the problem of choosing the right weighting matrix. Hansen proposed that $W_T = S_T^{-1}$ where S_T is the *Newey-West* consistent estimator of the covariance matrix of the model's moment conditions.

If N is the number of assets, L is the number of instruments and q is the number of parameters, then the number of moment conditions is NL > q and there are (NL-q) overidintification restrictions in the model. The Hansen test statistic tests these overidentification restrictions $H_0 = T g_T(\hat{\theta}) W_T g_T(\hat{\theta}) \sim \chi^2(NL-q)$. Yet, the estimator from the minimisation problem should be used in the null hypothesis and this is the point where the numerical procedures create the problems. The difficulty of the optimal weighting matrix can be overcome if we consider a weighting matrix of i.i.d. residuals like a covariance matrix based on such residuals.

The alternative test proposed was $H_Z \equiv T(M_T g_T)' V_T (M_T g_T)$ where V_T is a diagonal matrix of positive eigenvalues of a semidefinite matrix and M_T is a matrix of which the *i*th row is the standardized eigenvactor corresponding to the *i*th largest eigenvalue. As an application to an asset pricing model, consider the multivariate regression model

$$R_{it} = \theta_1 Z_{t-1,1} + \dots + \theta_{Li} Z_{t-1,L} + u_{it} \qquad (31)$$

and the pricing relation is

$$E(R_{it} \backslash Z_{t-1}) = b_{1i}\lambda_1(Z_{t-1}) + \dots\dots + b_{Ki}\lambda_K(Z_{t-1}) \qquad (32)$$

Then the pricing restriction $E(R \backslash Z) = \lambda(Z)B$ is valid if and only if the multivariate regression coefficient matrix θ has rank K. The Hansen covariance matrix estimator is given by $S_T = \frac{1}{T}\sum_{t=1}^{T}(U_t U'_t \otimes Z_{t-1} Z'_{t-1})$. In the less cumbersome assumption of i.i.d. residuals, the consistent matrix can be written as $S_T = (\frac{1}{T}\sum_{t=1}^{T} U_t U'_t) \otimes (\frac{1}{T}\sum_{t=1}^{T} Z_t Z'_t)$, based on the orthogonality conditions $E(U_t \backslash Z_{t-1}, U_{t-1}, Z_{t-2}, \ldots..) = 0$. If the model residuals are not only i.i.d. but also normally distributed with mean zero and a constant nonsingular covariance matrix, a MLE procedure may be also used. To empirically verify the new test, 46 industry portfolios of monthly stock returns from the CRSP file together with two sets of instrumental variables were used. The estimation procedure included tree steps: an estimator was computed using the identity matrix as the weighting one, the residuals based on this estimator were used to estimate the covariance matrix and then weighting matrix $W_T = S_T^{-1}$ was used to obtain a second-round estimator. It was found that a two-factor model passed all the tests. Simulation tests verified the convergence between the distributions of the null hypothesis based on i.i.d residuals and the suggested new test.

In the research area for the CAPM validity with GMM tests, *Jagannathan and Wang (1996)* examined the ability of not the static but the conditional CAPM - where betas and expected returns are allowed to vary over the business cycle - to explain the cross-sectional variation in average returns. The motivation for this test was that the FF evidence of the flat beta-return relation is against the static CAPM but not necessarily against the conditional CAPM which is more representative of the real financial world.

The starting point for the derivation of the new model was to distinguish between the two forms of CAPM:

$$E(R_{it} \backslash I_{t-1}) = \gamma_{0t-1} + \gamma_{1t-1}\beta_{it-1} \text{ with} \tag{33}$$

$$\beta_{it-1} = \text{cov}(R_{it}, R_{mt} \backslash I_{t-1}) / \text{var}(R_{mt} \backslash I_{t-1}) \quad \text{Conditional CAPM} \tag{34}$$

$$E(R_{it}) = \gamma_0 + \gamma_1 \overline{\beta}_i + \operatorname{cov}(\gamma_{1t-1}, \beta_{it-1}) \qquad \text{Unconditional CAPM} \quad (35)$$

To derive the model employed in the cross-sectional tests, the starting point was a CAPM holding in a market where investors' expectations are formed on previous available information and conditional betas were decomposed into components consisted of unconditional betas and extra variables that vary over time. Thus, the conditional CAPM leads to a model for unconditional expected returns through a linear two-factor model, the conditional beta and the beta-prem sensitivity i.e. the sensitivity of conditional beta to the market risk. In addition to this new testing model, they also included human capital in the value-weighted market portfolio in order to test whether an insufficient market portfolio is the cause for the rejection of the CAPM in the FF tests. The model - basis for the empirical tests is

$$E[R_{it}] = c_0 + c_{vw}\beta_i^{vw} + c_{prem}\beta_i^{prem} + c_{labor}\beta_i^{labor} \qquad (36)$$

The yield spread between BAA and AAA rated bonds was used as a proxy for the market risk premium and the return on the human capital was proxied by the growth rate in per capita labour income (the latter is the difference between the total personal income and the dividend income). To examine the explanatory power of the three betas in this model (Premium-Labour model), the most common method is to also include an additional variable - usually the firm size - and test whether it has the ability to explain the part of expected returns left unexplained from the betas.

The model was tested on similar to FF portfolios from NYSE and AMEX stocks using the GMM for the moments

$$E(R_{it}(\delta_0 + \delta_{vw} R_t^{vw} + \delta_{prem} R_t^{prem} + \delta_{labour} R_t^{labour})] = 1 \qquad (37)$$

where δ is the a stochastic discount factor such that , as long as the financial market satisfies the law of one price, $E[R_{it}\delta_t] = 1$

The weighting matrix used for he GMM estimation is $A = (E[R_t R'_t])^{-1}$

The GMM estimation of the model parameters revealed devastated results for the firm size effect. The inclusion of the APT macroeconomic factors also failed to decrease the explanatory power of the P-L model. The same failure of the FF two factors suggested that they may proxy for the risk associated with the return on human capital and beta instability.

He, Kan, Ng and Zhang (1996) employed the GMM procedure in asset pricing models allowing for both time-varying covariances between stock returns and marketwide factors and time-varying reward-to-covariabilities. More specifically, the size and B/M factors were tested in a conditional multifactor CAPM. Since the functional form of the relation between return and various risks can be the source of rejecting the single beta model, the GMM procedure was used as it admits a general structure for conditional covariances between stock returns and marketwide factors. To introduce time variation in covariances, the multifactor model can be written as

$$\mu_t = E_t[(r_{t+1} - \mu_t)(f_{t+1} - \phi_t)']\gamma_t \qquad (38)$$

where $\mu_t = E_t r_{t+1}$ *and* $\phi_t = E_t f_{t+1}$ f = a k-vector of marketwide factors.

By assuming $\mu_t = D z_t$ *and* $\phi_t = C z_t$ where D and C are constants, the model is tested by examining the moment conditions:

$E_t[r_{t+1} - D z_t] = 0$ *and* $E_t[r_{t+1} - C z_t] = 0$ z = the vector of instruments

With this model, the CAPM was rejected and the failure reason was placed on the strict assumption of constant γ_t. The introduction of time-varying γ_t, a prespecified functional form and the consideration of only the market factor was not adequate to save the CAPM and the reason was to found between the two latter assumptions. The problem was addressed by placing $\gamma_t = A z_t$. The basic approach was to test asset pricing models with economic variables as factors in a one-step approach.

The empirical model for expected returns is $E[r_{i,t+1} \backslash x_{it}, z^*_t] = d' x_{it} + h'_i z^*_t$ while the introduced conditional model is

$$E(r_{i,t+1}(f_{t+1} - C z_t)' A z_t \backslash x_{it} z^*_t] = \delta' x_{it} + n' z^*_{ti} \qquad (39)$$

Therefore, if the asset pricing model is properly specified, it should $h_i = n_i$ *and* $d = \delta$ where x are the economic variables and z the marketwide factors. The adequacy of the specified asset pricing model was tested with variance ratios where the denominator is the variance of the predicted returns and the numerator is the variance of the expected return.

The dataset was similar to FF1993 and it consisted of 25 ME-BE stock portfolios from NYSE, AMEX and NASDAQ firms. Five portfolios were used as inputs, the value-weighted portfolio, the DEF and TERM portfolio and the SMB and HML portfolios and the instrumental variables included the S&P 500 index, TB's, DY and rated bonds' yields. The conditional model was estimated with GMM and z instrumental variables. Comparing the expected return under the asset pricing restrictions with different sets of factors, they found that the magnitude and the significance increased with the number of factors. The results from the variance ratios indicated that the marketwide information can predict asset returns better than firm-specific information but still the power of asset pricing models is very low.

Velu and Zhou (1997) tested the efficiency of the market portfolio and the FF three factor model using the GMM estimation. The first approach was to test a K-beta model by using N assets and K reference portfolios. The multi-beta model and the restriction are

$$\begin{aligned} r_{it} - r_{ft} &= a_i + \beta_{i1}(R_{p1t} - r_{ft}) + \ldots + \beta_{iK}(R_{pKt} - r_{ft}) + \varepsilon_{it} \\ H_0 &: a_i = 0 \end{aligned} \tag{40}$$

Since there are differences in the lending and borrowing rates, the risk-free rate could be written differently to incorporate this difference $\gamma_t = r_{ft} + c_0$ and the null hypothesis changes to $H_0 : a_i = c_0(1 - \beta_{i1} - \ldots - \beta_{iK})$. With the assumption of normally distributed residuals, it was shown that the null hypothesis could be examined with the LR test. If we replace the assumption of normality with i.i.d. residuals, the test can be conducted with GMM estimation. If we consider the K-factor APT model:

$$r_{it} = E[r_i] + \beta_{i1} f_{1t} + \ldots + \beta_{iK} f_{Kt} + \varepsilon_{it} \tag{41}$$

the restriction becomes

$$E[r_t] = \lambda_{0t} 1_N + \beta \lambda_t \qquad (42)$$

which in the case of non-normal residuals can be estimated with GMM procedure.

Empirically, 10 size NYSE portfolios returns were employed to test the efficiency of a weighted market portfolio consisted of equally- and value-weighted indices. The LRT and the GMM tests could not reject the efficiency of a portfolio of the two indices. In addition, the three FF factor model was estimated with the GMM test and whereas it was rejected using the traditional risk-free rate, it was accepted under the more general assumption of a risk-free rate plus a constant.

It is evident that this new approach of panel data employment in the empirical tests of asset pricing models could substantially alter the traditional views in the current literature. The advantages inherent in the examination of simultaneous effects between returns and factors and the allowance of modifications for various kinds of biases enhances the quality of the inferences for the explanatory power of the model.

2.5 Summary

The structure of the current chapter is based on a review of the literature in the area of factor models and it has been divided in three distinct sections. At the first stage, a brief introduction of the CAPM framework was accompanied by the description of the prevailing methodologies for the empirical verification of the model. Briefly, these are the time-series approach which tests the CAPM implication of zero risk-adjusted realised returns and the cross-sectional methodology which tests the hypothesis that the beta is the sole cross-sectional determinant in a positive risk-return relation. Subsequent to the verification of these CAPM implications by *BJS (1972)* and *FM (1974)*, evidence about the CAPM misspecification was raised by many researchers who presented evidence that firm attributes can beat the CAPM such as the firm market value, the debt ratio, the earnings/price ratio, e.t.c. A unification of the most powerful factors in the influential paper by FF 1992 resulted in the devastating conclusion of a flat risk-return relation and the introduction of the powerful cross-sectional determinants of market value and book-to-market factors. These factors were subsequently employed to form the additional to the market portfolio size and financial distress risk portfolios in order to examine the time-series properties of the factor portfolios and to establish the three-factor model as a substitution to the CAPM.

In the second part of the literature review, we present some motivation behind the isolation of the specific factors upon which we build empirical research of this thesis. Furthermore, we separate the issues identified in the various estimation procedures of the asset pricing models according to mis-measurement problems in stock returns, the betas and the values of the factors. More specifically, we examine the empirical evidence about the contrarian strategies as a counterpart argument to the risk story by FF. This part of research supports the argument that the excess returns achieved by factor models cannot be simply attributed to higher risk implied by the three-factor model but they are manifestation of investors' overreaction to unfavourable news that is corrected gradually. Furthermore, we present a summary of the research conducted until recently on specific topics in factor portfolios such as the seasonality patterns and the survivor bias problem which strongly influence the magnitude and the stability of the factors' performance. As concluding remarks, we present some evidence concerning the debate around the efficiency of the market portfolio and its effect in the risk-return relation and more general points about the construction and the utilisation of the multifactor models.

In the last section we introduce a more robust empirical methodology for the estimation of the factor models, the employment of panel data which combines the time-series and the cross-sectional properties of the stock returns and the factors. The empirical literature that employs the panel data for the estimation of the factor models is not as extensive as the previous methodologies. However, there are many dimensions of this approach towards the empirical applications, the initial of which is the simultaneous estimation of the beta and the factor coefficients. Furthermore, we can extend the panel data approach to accommodate non-linear systems in the

CAPM estimation in order to test either the Black version of the CAPM or its major implications about the unique risk premium. The bulk of the research with non-linear constraints has been applied in the APT models and not widely in the CAPM literature. Even more importantly, this empirical approach leads to the application of the GMM estimation which is non-parametric and robust to measurement and econometrical problems. In addition, we can introduce the instrumental variables function that tests the CAPM conditionally to past information and thus we include a component of time-variation in the model.

In sum, the stages in the empirical literature review establish also the structure of the empirical research in the current thesis. The first stage would be the analysis of factor portfolios performance that has directed the misspecification of the CAPM in order to proceed to the examination of the CAPM power taking into account the identified problems and weaknesses. Having conducted the analysis with the prevailing methodologies, we then move on the employment of the panel data in the factor models.

Chapter 3

Identification of the risk factors with Factor Mimicking Portfolios

3.1 Introduction

One of the main disputable subjects in the current empirical financial research area remains the question whether beta is the sole component of priced risk. The controversy has been raised after evidence that factors transmitting information for firms' specific characteristics have additional power over beta as determinants of stock returns. The purpose of this thesis is to re-examine the relationship between stock returns and an adequate set of factors that contain vital information for the firm's growth prospects and have been empirically supported as significant sources of risk inherent in the stocks. Although many individual tests have been performed with these variables, the presentation of a complete and integral examination of all the factors under the scrutiny of the beta risk and the defects of prevailing methodologies is appealing for future directions of financial portfolio management.

The examination of portfolios constructed to mimic the return from strategies investing in stocks with high or low values of specific attributes is a first critical stage for a subsequent focus on particular factors. The performance of these portfolios provides indications of profitable opportunities and sources of excess return volatility. Furthermore, a vital element in the examination of various portfolios is the validity and homogeneity of their performance trends over different approaches. In addition, the analysis of the factor mimicking portfolios performance provides, even on a preliminary basis, very useful insights of the widely examined seasonality patterns of the factor portfolios. We examine the well-known January effect and we proceed to identify more specific trends across the months over an extended time period. Thus, a complete presentation of the factor mimicking portfolio return and volatility patterns under considerations of additional issues and divergent methodologies is the scope of this chapter.

The paper is structured as follows. In the next section we present some of the issues concerning the employment of factor mimicking portfolios in the identification procedure of risk sources. In section 3.2, we describe the data employed in the tests of the current and following chapters. The methodology of constructing the factor mimicking portfolios and the formation of the hypotheses under examination are presented in section 3.4, whereas the empirical results are reported in section 3.5. Finally, the conclusions of this chapter are presented in section 3.6.

3.2 Factor Mimicking Portfolio Issues

The procedure of forming portfolios has the purpose of maximising the spread in betas across portfolios so the effect of beta in return could be examined more thoroughly. This spread is appealing in the current broad use of factor models for the determination of the stock returns' driving forces. The base of the factor models is the factor mimicking portfolios. The introduction of the factor mimicking portfolios (FMP) in asset pricing tests was presented in APT models and subsequently it was incorporated in CAPM tests. *Lehmann and Modest (1988)* argued that there exists a well-diversified mean-variance efficient portfolio of K basis portfolios that with the riskless asset spans the mean-variance efficient frontier of the individual assets[11]. These basis portfolios are perfectly correlated with the determinant factors for the asset returns and their construction could mimic the realisations of the common factors. The loadings of the factors abstracted from either a factor or a principal component analysis are estimated at a first stage and the estimates are employed to form the portfolios.

This evidence was further supported by Huberman, *Kandel and Stambaugh (1987)* and *Grinblatt and Titman (1987)* where it was shown that it is possible to construct

[11] Lehmann, Modest (1988), "*The empirical foundations of the APT*", *p.216*

K factor reference portfolios that are correlated with the factors in a K-factor generating model. The *k*th factor mimicking portfolio will be the one that is perfectly correlated with the *k*th common factor[12]. *Huberman, Kandel and Stambaugh* argued that, assuming a K-factor structure, the maximum-likelihood factor analysis asymptotically identifies K portfolios of riskless and risky assets with returns that can replace the factors in pricing the subset's assets if and only if exact arbitrage pricing holds. In that case, the APT linear pricing relation can also be expressed in terms of the multiple-regression coefficients obtained by regressing the N asset returns on the payoffs of the K mimicking portfolios.

The drawback with the construction of the FMP with factor analysis is the difficulty in the identification of specific and unique risk sources across different subsets of stocks. The alternative procedure is the *Fama and French (1993)* suggestion where a specific variable of interest is converted to a return concept by constructing a portfolio to capture its influence. Although there are differences between the two approaches, the purpose is to capture the common risks as the fundamental driving forces of the stock returns through the construction of portfolio returns that mimic any present risk-return pattern.

Generally, the factor mimicking portfolios, according to *Connor (1995),* are designed to capture the marginal returns associated with a unit of exposure to each factor. The advantage of the factor mimicking portfolios is that they provide a significant first benchmark for the evaluation of risk factors and whether this strategy can earn excess returns. The adequate spread in the risk-return relation achieved with sorting the stocks according to a factor can give a first sight for which factors are important, indicated by high volatility in the return between the two extreme portfolios. The difference between this approach and the asset pricing models is that the factors that exhibit large dispersion in the returns might not coincide with the factors priced in the regressions. The main reason of turning to the solution of factor mimicking portfolios is the failure of the traditional asset

[12] *Grinblatt, Titman (1987),* "The relation between mean-variance efficiency and arbitrage pricing", *p.110*

pricing models to unanimously identify the risk determinants of the stock returns due to problems in the process of empirical verification.

In the application of factor mimicking portfolios in asset pricing models with stock attributes in relation with the CAPM beta-return relation, the main work has been undertaken by *Chan, Karceski and Lakonishok (1997)* and *Hawanini and Keim* (1997) as described in the previous chapter. In the following sections, we employ a dataset similar to the above papers' data selection, yet we expand it with more common stocks and additional attributes. The inferences drawn from the re-examination shed new light to the beta's and other factors' power.

3.3 Data Description

The datasources of the annual accounting data for the empirical work are the COMPUSTAT CD-ROM database for the period 1975-1995 and the COMPUSTAT Backdata tapes for the years 1962-1975 which are comprised of the Primary-Supplementary-Tertiary (PST) data file for the stocks quoted on the major exchanges like NYSE, AMEX and the Full Coverage file which contains NASDAQ firms. The monthly variables in the tests are retrieved from the monthly COMPUSTAT tapes for prices, dividends and earnings (PDE file) for the years 1962-1995. All these sources of data exist for two broad categories of firms, the active firms which continue to trade up to 1995 and are included in the Active file and the firms that have been delisted from the major exchanges at one point in time during 1962 and 1995 due to bankruptcy, mergers and acquisitions (Research file). The research file is also included in conjunction with the database for the active firms to mitigate the survivor bias problem. The firms that are listed on the NYSE, AMEX, or NASDAQ over the counter (OTC) exchanges up to 1995 and the firms that were listed to one of these exchanges but ceased their listing during that period, form the database for the empirical tests.

Since all the annual data for the firms were split in two files, the tapes database up to 1975 and the CD-ROM database from 1975 up to 1994, we had to match the firms and their relevant information in one single file. The problem raised in this procedure was the COMPUSTAT warning that some changes might occur in the basic identifiers of the firms in the two sources. So, the matching of the firms was based firstly on their stock ticker (SMBL) and the CUSIP[13] identifier and, for greater safety, we also conducted a careful scrutiny through the company name, industry name and industry classification with the SIC[14] identifier. Thus, we were able to match all the information for firms for the longer period of 1962-1994. The same procedure was followed to match the firms with available data on both the monthly and the annual files. The market portfolio employed in the regressions is a value-weighted portfolio of all the stocks in the monthly COMPUSTAT file and not just the firms in the intersection. This provides a wider selection of stocks and corresponds more closely to the CRSP market portfolio. In order to sustain a higher degree of comparability with the CRSP file, we included NASDAQ firms after the year 1973.

So, from the monthly database, we calculated the monthly returns as the percentages of the current month close price plus dividends (adjusted for all stock splits and dividends that occurred during the month) and cash equivalent distributions, minus the previous month close price i.e.

$$MR_t = \frac{(P_t + D_t + C_t) - P_{t-1}}{P_{t-1}} * 100 \qquad (43)$$

MR_t = the market return of stock i in the month t

P_t = the price of stock i in the month t

D_t = any dividends that the stock i pay in month t

C_t = any cash equivalents that the stock i pay in month t

P_{t-1} = the price of stock i in the month t-1

[13] CUSIP = Committee on Uniform Security Identification Procedures ⇒ It is a nine-digit code: the first six digits identify the issuer, the seventh and eighth digit identify the issue, and the ninth digit is the check digit.

[14] SIC = Standard Industry Classification ⇒ is a four-digit system of classification under which a firm may be identified according to its activity. The first digit shows the general industry and the following digits the subdivisions.

The monthly market value was calculated as

$$MV_t = P_t \, X \, CSHO_t \quad (44)$$

where $CSHO_t$ = number of shares outstanding at month t

Where the monthly shares outstanding were not available for some months of the year and we still had prices for these months, we substituted the missing observations with the number of shares outstanding in the preceding or subsequent months. In the case where we had prices during a year but no availability of shares outstanding in any of the months, we multiplied the monthly prices with the equivalent annual number of shares outstanding for this particular firm and year.

In the empirical tests, only common equity firms are considered i.e. ADRs, REITs[15] etc. firms are excluded as many of these stocks concern investments in foreign corporations and mainly they are closed-end funds. Furthermore, these categories of stocks are excluded from the tests under the evidence by *Chan and Jegadeesh (1992)* that they constitute the main sources of differences between the CRSP and COMPUSTAT files. Next, the firms in the intersection of the annual and monthly files from both the active and the research database were included in the return tests from July of year *t* to June of year *t+1* for the annual tests. The choice of July as the starting month for the tests was to give a minimum 6 month gap between the release of the accounting information and the return tests in order to examine any possible influence on the following returns. Most firms have fiscal year-end at December and the 6-month gap between the fiscal-year and the return tests applies directly. In cases where the fiscal year ends between June and December of year *t-1* the fiscal year coincides with the calendar year and these data are used for the return tests of July of year *t* to June of year *t+1*. When the fiscal-year ends between January and May, the reported year in the annual data is the previous calendar year e.g. for fiscal-year end in May of 1979 the reported fiscal year in the data is 1978 and these information are used for the returns tests starting in the next year. A suggested procedure in the empirical literature is to consider only stocks with December year-ends to avoid the look-ahead bias. However, as mentioned in the

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[15] ADR = American Depository Receipts REIT = Real Estate Investment Trusts

previous chapter, this is a very restricted solution as it arbitrary eliminates a wide selection of common stocks.

For all the tests that employ ratios, the nominator is the accounting figure in the calendar year *t-1*. The scaling factor in the ratios is either the market value or the price variable measured for the annual tests in December of year *t-1* and for the monthly tests the prior to the return tests month figure. For example, for the cross-sectional regression of the stock return in month July of 1968, for the annual tests the book-to-market ratio is measured as the ratio of the book-to-market variable in year 1967 over the market value in December 1967 whereas for the monthly tests the ratio is measured as the book-to-market variable in year 1967 over the market value in month June 1968. For individual variables, the monthly returns are regressed on the previous month's variables.

More specifically, the factors employed in the tests are:

- BEMV: the natural logarithm (ln) of common equity[16] plus deferred taxes (balance sheet) at year t-1 divided by the market value
- TAMV: the ln of total assets at t-1 divided by the market value
- TABE: the ln of total assets at t-1 divided by the book equity[16] at year t-1
- EP: income before extraordinary items plus deferred taxes (income account) minus preferred dividends at t-1 divided by the market value. It takes the value of zero in case of negative earnings.
- EN: based on the previous variable with the value of zero in case of positive earnings and one otherwise.
- CFLP: EP plus depreciation at t-1 divided by the market value. It takes the value of zero in case of negative cash flow.
- CFLN: based on the previous variable with the value of zero in case of positive cash flow and one otherwise.
- SALE: ln of Sales (Net) at t-1 divided by the market value
- GR: a weighted average of sales GR based on five years

[16] common equity = defined as the common capital stated in the balance sheet
book equity = defined as the book value of common capital stated in the balance sheet

$$= \sum_{j=1}^{5} (6-j) \times \ln\left(\frac{Sales(t-j)}{Sales(t-j-1)}\right)$$

- DIVCOM: dividends common at t-1 divided by the market value
- DIVSUM: the sum of the previous 12 monthly dividends per share divided by the previous price.
- CSHO: the ln of the number of shares outstanding at June of year t (or monthly)
- TR: trading volume: the average of the previous 3 monthly number of shares traded divided by the previous month shares outstanding.
- BETA: the estimated beta from a market model where 24 to 60 individual stock returns are regressed on a value-weighted portfolio of all the stocks.
- DEBT: the ln of (total assets - common equity) divided by the market value
- MV: the ln of market value at June of year t (or monthly)
- PRICE: the ln of price at June of year t (or monthly)
- CAR12: the cumulative market-adjusted returns ($R_{it} - R_{mt}$) over the previous 12 months
- CAR60: the cumulative market-adjusted returns ($R_{it} - R_{mt}$) over the previous 60 months

The description of the components in the above ratios is present in the literature review chapter in the relevant papers. Most of the ratios are presented in a logarithm format because of skewness problems in their distributions. The CAR12 and CAR60 variables are reported with one month and one year lag respectively to avoid contemporaneous effects between current returns and returns over previous time periods. For the portfolio construction procedure we consider only positive EP, CFLP and BEMV ratios following the argument by *Lakonishok, Shleifer and Vishny (1994)* that negative ratios cannot interpreted in terms of expected growth rates.

The selection of the COMPUSTAT database as the input source raises the question about the selection bias problem. The survival issue is a major subject of criticism in the empirical verification of any model that employs stock market returns. Although the survivorship bias problem is present in the COMPUSTAT database, the same argument can be put forward for any data source. However, COMPUSTAT remains a reliable and complete source of accounting data for an extensive category of firms and over a wide period of time. Furthermore, the majority of the studies in the area of factor models employ the COMPUSTAT database and it is vital for comparability reasons to adopt the same input source. For comparability reasons with other studies, we also follow the suggestion by *Fama and French (1995)* that only firms with accounting data in COMPUSTAT for two years before the returns rests should be eligible for inclusion. This requirement mitigates the survivorship bias as COMPUSTAT rarely includes more than two years past history information for firms that are subsequently added to its database. In some of the tests, we also impose the more restrictive requirement by *Lakonishok, Shleifer and Vishny (1994)* that firms should have data for at least five years before they are eligible for inclusion in tests.

Over a vast number of potential factors as determinants of stock return risk sources, the selection of the particular variables was based on the arguments provided in the relevant subsection of the literature review chapter. We included the factors that have been prevailed in the empirical research as the dominated figures and also the factors whose significance has been questioned under different approaches. The focus of the research is on the accuracy of the additional variables derived from specific firm characteristics as important risk sources over the beta risk. Alternative models have focused the research on factors extracted from the stock returns with factor or principal component analysis and on macroeconomic factors. This is a different approach to risk measurement procedure that contains serious problems in the uniqueness of a return generating process across all assets and it does not constitute a part of the present research.

3.4 Methodology and Hypothesis Formation

For the construction of the FMP, monthly returns data are employed for all the NYSE, AMEX and NASDAQ common stocks. The bulk of the research in factor mimicking portfolios have considered only NYSE and AMEX stocks because the collection of data for these two exchanges is implicit and available from a more convenient database. However, the current wide expansion of the NASDAQ stock exchange has introduced the inclusion of NASDAQ firms in the majority of financial decisions on portfolio management. Thus, the consideration of NASDAQ firms would provide a more representative status of the portfolio performance in current financial markets.

The prevailing methodology in the rebalancing procedure of the factor mimicking portfolios is on an annual basis, as in *Chan, et.* where only NYSE and AMEX stocks were included. The accounting data are considered on a calendar basis in year $t-1$ so they can be matched with the returns from July of year t to June of year $t+1$. In comparison with the papers by *Chan, et.* and *Hawanini, et.*, in addition to the dataset expansion with NASDAQ firms, a further confinement that has been lifted in the current methodology was to include only firms with December year-end with all the inherent previously mentioned problems.

For annual rebalancing, each June for the period 1964-1994 we calculate the breakpoints for ten portfolios based only on the NYSE stocks. The rationale for this restriction for the breakpoints is that the NYSE sample is consisted basically of large firms and the cut off points would evenly assign the firms into deciles, as pointed out in *Fama and French, FF (1992)*. The inclusion of the other exchanges in the breakpoints calculation would result in deciles consisted primarily of small firms. In addition to annual rebalancing, we also considered rebalancing on a monthly basis to take into account the complexity of the financial practice where frequent rebalancing is necessary in a dynamically changing environment. With monthly rebalancing, the breakpoints for the construction of the portfolios are calculated every month only for the NYSE firms.

The structure of the portfolios is based on each factor individually. For the factors TAMV, TABE, CFLP and DEBT we exclude the financial firms (SIC code beginning with 6) for the different interpretation that these leverage variables have for the financial firms. More specifically, the financial firms have high leverage ratios because of the nature of their transactions and, thus, they may appear to have a problem of financial distress that is not obviously the case. In addition, we consider only positive and non-zero values for the EP, CFLP and dividend-based factors. The purpose for this restriction is that the interpretation of performance for firms with negative earnings is quite troublesome and the inclusion of stocks with zero dividends would bias the results towards elimination of any present dividend-return relation. On an annual basis, firms from the three exchanges that have available data on the ranking factor are allocated each June into ten portfolios and the equally-weighted returns (the sum of the stock returns over the total number of stocks in the portfolio) are calculated for the next 12 months. For the monthly rebalancing, the stocks are assigned to portfolios each month and the equally-weighted returns are calculated for the next month. In addition, we also calculate the value-weighted returns of the portfolios where each stock's return is multiplied with the ratio of its market value over the aggregate market value of all the stocks in the specific portfolio.

For the monthly rebalancing procedure, the problem of missing returns is not present since the delisting of a firm from an exchange at a specific month will automatically exclude the firm from the monthly portfolio. However, the missing returns is a serious issue in the case of annual rebalancing where the portfolio returns are calculated for a period of twelve months during which a firm might be delisted or merged. The common practice in this case is to calculate the average returns of all the firms assigned to the portfolio in June and to ignore missing returns during a subperiod. An alternative is to substitute the missing returns with zero or –100 values, assuming that for the rest of the year the stock can be traded at the last price or at no current price which gives the value of –100. However, the substitution of delisting returns with the very low value of –100 for all the missing months would actually lower the average returns dramatically and it could not provide clear indications of any other effects. In our annual portfolios, if a stock has missing returns for more than 6 months during one year, we exclude that firm from this year's portfolio. Otherwise, we consider both the cases of either substitution with zero returns or just calculate the average returns up to the last reported month. However, the inferences are not substantially altered with any option, as the cases where we face the missing return problem are limited to a very low percentage of 10%.

The construction of the factor portfolios follows the *Fama and French (1993)* methodology where the return of the highest minus the lowest portfolio is employed to mimic the underlying factor. So, the first step would be to identify the factors that are possible sources of risk by examining the magnitude of the return volatility between the highest and the lowest portfolio. Subsequently, the factors present with significant volatility could be tested in the asset pricing models to examine whether these factors are also priced. In addition, the mean returns, percentiles and seasonality patterns are also presented for a more thorough examination of factor portfolio strategies. In the seasonality examination, we also estimate a general model where the factor mimicking portfolio returns are regressed on dummies constructed for each month of the year. Then, for every month we test the restriction that the dummy coefficient is zero and we report the p-value of the F-test whether the restriction is valid or not. A p-value greater than 0.05 or 0.01 indicates failure to reject the null hypothesis of zero coefficient at the 5% or 1% level of significance.

The inferences drawn from the descriptive examination of factor mimicking portfolios establishes an introductory framework for the subsequent investigation. For robust results, regression analysis should also be employed. The factor mimicking portfolio returns are regressed on a constant and the hypothesis tested is whether the constant is statistically significant from zero. A positive significant constant would indicate that the average performance of the high portfolios is greater than the average performance of the low portfolios, whereas a significant negative constant would indicate that the low portfolios outperform the high portfolios. In the regression analysis, we also report the results after correction for outliers in the model by removing any observations with residuals from a preliminary regression deviating 3 and 2 standard errors away from the mean.

Although the basic rationale behind the construction of the factor mimicking portfolios is similar to previous empirical tests, the divergences are present in the broader employment of factors, the procedure of rebalancing the portfolios and the examination of robust return premia.

3.5 Empirical Results

3.5.1 Factor mimicking portfolio examination

The construction of the factor mimicking portfolios (FMP) resembles the *Chan, Karceski and Lakonishok's (1997)* methodology where each of the proxy factors is the return on a zero investment strategy that goes long in high attribute stocks and short in low attribute stocks. However, the stocks are divided into ten portfolios for each factor according to *Hawanini and Keim's (1997)* paper, mainly because, in contrast with the above papers, we also include NASDAQ firms and the number of stocks with available data is increased substantially. Furthermore, we examine more factors that have been prevailed in the empirical literature in order to expose possible interrelations.

In the preliminary stage, the performance of the factor mimicking portfolios is presented with certain introductory statistics that provide some first insights into the factors' importance. Initially, the autocorrelation coefficients for all the portfolios are reported in Table 3.1, starting from lag one up to the 10^{th} lag. From the autocorrelations pattern we can infer relations in the factor mimicking portfolio returns across time and dependence with lag returns. Evidence about any specific reversion or time correlation patterns could be useful for the investment strategy formulation.

In almost all of the cases, the first lag is the significant one and afterwards the autocorrelation dies out. Low first order autocorrelation is present in the EP and CAR12 portfolios. The highest first order autocorrelation appears in the price portfolios followed by the beta and the market value portfolios. The autocorrelation pattern and magnitude are not substantially altered with value-weighted portfolios. From the empirical view of autocorrelation presence in time-series models, we correct the subsequent regression analysis for first order autocorrelation.

In Table 3.2, we report the mean returns (calculated as averages for the overall period of 372 months), standard deviation and the percentiles of all the equally-weighted FMP. The mean returns examination would reveal the factors with the highest performance in portfolio management, as a high FMP mean return would signify increased investment in low attribute stocks in case of negative mean return or in high attribute stocks where there is positive mean return. In addition to the overall performance, we report the magnitude of various percentiles in order to present a general view of the realisation of mean returns across time subperiods which provides a thorough understanding for the time stability of the factor profitability.

The calculation of the mean returns in Table 3.2 confirms the prevailing evidence for the direction of the return-factor relation i.e. negative relation between returns and the factors CSHO, MV, PRICE, GR, TR and CAR60 and positive relation for the rest of the factors. Comparing the results with the *Chan, et.* paper, the most striking contrast is the return of the BETA portfolio where they found a negative mean return with the employment of the value-weighted market portfolio. In our tests, the anticipated positive return on the BETA portfolio is present, as stocks in high portfolios are riskier than low portfolio stocks and, thus, they achieve higher returns. There is also the exception of the DIV portfolios where we find negative mean return for the FMP in contrast with the positive DIV effect in the paper by *Chan, et.* The possible source of this difference is the inclusion of the NASDAQ stocks as they are primarily small firms with low dividend distributions. The negative mean dividend FMP return could be another manifestation of the growth firms' high performance as the low dividend firms outperform the high dividend firms.

More vital information for the factor importance is transmitted from the standard deviation of the factor mimicking portfolio returns, as it is possible a high return volatility not to be priced in terms of high performance. As *Chan, et.* pointed out, if a mimicking portfolio exhibits large return volatility, this is consistent with the underlying factor contributing a substantial common component to return movements. In Table 3.2, the highest standard deviation is present in the beta portfolios even though they have low mean returns. The same applies in the trading volume portfolios where high standard deviations are not accompanied by high returns. The second highest standard deviation is revealed for the market value portfolios, in contrast with *Chan et.* results where MV was found with a more pronounce volatility effect than beta in a sample of NYSE and AMEX stocks. This establishes a robust argument for beta as the factor which captures best and highly the systematic components of stock return variation even in the inclusion of NASDAQ stocks which would be expected to boost the size effect.

High mean returns are confirmed in the price, market value and BEMV mimicking portfolios that also have high volatility whereas the GR and TABE portfolios exhibit the lowest standard deviations. Using value-weighted portfolios in Table 3.3 the same patterns are present but even with higher mean returns and standard deviations for the beta, shares traded, market value and price portfolios. The striking evidence with the value-weighted portfolios is the reversion in the sign of the TR portfolio returns where we observe a positive effect, in contrast with *Datar, Naik, Radcliffe (1997)* where the trading volume variable was found with a significant negative effect. When the portfolio returns are weighted with their market values, the stocks with the highest trading volume are expected to yield higher returns even though they are argued to face lower risk than the low trading volume shares. Thus, the trading volume effect could be the unsteady result of the small firm effect which disappears with the employment of returns more balanced between large and small firms.

Although the FMP standard deviations indicate sources of volatility initiated from the underlying factor, some of these sources might be attributed to common factors which are highly correlated with each other. To examine this possibility, Tables 3.4 and 3.5 report correlations between the factor mimicking portfolio returns. Even though it is difficult from the magnitude of the correlations to definitely conclude which one is the most important, we could gain some insight of common effects. The higher correlations are present in the factors that have the same accounting source i.e. earnings and cash flow, debt and market book value, common dividends and summed dividends, market value and shares outstanding. High correlations are also present between market value and price, debt and book-to-market whereas the correlation between market value and beta is –0.647 and between CAR60 and BEMV is -0.716. The correlation patterns in the value-weighted portfolios are similar with a higher magnitude. These inferences are quite appealing for the subsequent research where we focus the interest on uncorrelated factors.

3.5.2 Sesonality Patterns

The seasonality issue has been widely examined and documented in any pricing model of assets. The main emphasis is given in the January effect which has raised much controversy as the driving force behind the abnormal performance of strategies formed on the basis of various factors. The high excess returns of value portfolios i.e. portfolios constructed of small, distressed or low growth firms are appeared to be mainly present in January. In the case where the significance of the value strategies' overall performance can be justified only by the January excess returns, the relevant factor cannot be considered as a robust risk source but as a manifestation of a seasonal phenomenon.

Examining the mean returns and standard deviations during every month of the year in Tables 3.6 and 3.7, interesting patterns emerge in the seasonality issue for the factor mimicking portfolios. In almost all the cases, the highest values of return and volatility are present in the month of January. However, a more thorough examination of performance across months in Figure 3.1 reveals more aspects in the seasonality issue.

Following the high volatility in the January month, a sudden drop occurs after January and the descending course continues until April when we observe a slight and temporary increase in volatility. During the beginning of the summer there are not extreme movements until a decline in August following with an upward trend in September. The striking evidence appears in October where volatility reaches a high peak point that tends to be very close to the January's magnitude. The upward trend drops just before the beginning of the new year. In a substantial number of portfolios we also observe higher October volatility than January. In the beta portfolios, the reversal pattern reaches the peak in the month of October where the mean returns are negative. Although the standard deviation of the FMP portfolios increases in October just like in January, the October mean returns do not exhibit high returns and are presented with the opposite sign than the January returns in most of the portfolios. This is a very interesting seasonality pattern that is also confirmed in Figure 3.2 where the value-weighted portfolios are employed. The only striking difference in this Figure is present with the trading volume portfolios where we report a much higher January volatility than equally-weighted portfolios.

Thus, this is the general pattern we observe in Figures 3.1 and 3.2 for all the portfolios, although each factor mimicking portfolio experiences its own distinctive return trends along the year period. In order to obtain a closer look in separate portfolios, in Table 3.8 we present the p-value of the F-test for the mean return's significance for individual months. In the BEMV, BETA and EP portfolios, we observe a strong January and October effect. In the CFL, CSHO, DEBT, DIVCOM, DIVSUM and CAR12 portfolios a January and November effect is present whereas we also observe temporarily powerful effects after the January month. Even though the null hypothesis is marginally rejected in October for these portfolios, the November effect is stronger as we examine mean returns. From the Figure 3.1, we infer that the strongest October effect is present in the volatility patterns which might be incorporated in the November monthly returns. We could thus deduce that the BETA portfolios appear to react more quickly to changes in volatility. For the SALE, CAR60 and TAMV portfolios, the significance is present in January and the immediate following months.

The most powerful evidence in this table is revealed in the MV and PRICE portfolios where the significance of distinctive monthly returns is constantly present in the PRICE portfolios and substantially increases with the value-weighted MV portfolios. Surprisingly, the January effect is not present in the equally-weighted TR portfolios whereas January is the most significant month in the value-weighted TR portfolios. This evidence could be the source of differences between the two rebalancing portfolios.

In sum, although the January is the month that has attracted the bulk of the research in the seasonality area, the previous evidence suggests that October is also a month with considerably important effects in return volatility. The possibility that October 1987 was the driving force behind the extreme movements was further examined and the elimination of this particular month did not alter the seasonal effect in October over the whole time period.

3.5.3 Robustness of the return premia magnitude

The standard deviation was introduced as a first indication of an important risk factor in the determination of the stock returns. The construction of the return factor premia was based on the factor mimicking portfolio returns calculated as the difference between the returns of highest and lowest portfolios. Another strongest indication of the factor importance would be to examine the significance of this return premia in a regression context. The sheer report of the FMP mean returns could not provide evidence of the spread's magnitude significance. In Table 3.9 we present the results from an analysis where return premia is regressed on a constant and the statistical significance of this constant is examined. The test has been performed with the actual and the excess to risk-free rate returns with no substantial change in the results.

With this test, there are some factors eliminated as unimportant on a preliminary basis such as the dividends common, the dividend yield, the book leverage and the past short-term cumulative return variables for both the equally- and value-weighted portfolios. The GR portfolios are a special case where the significance is present in equally-weighted portfolios but marginally disappears in value-weighted returns. Marginally insignificant is also the return premia in the CFLP and the TR portfolios where we confirm the previous evidence of constant reversal with value-weighted returns. The results are not altered when we include a dummy for October 1987, correct for extreme observations and re-estimate the model with correction for first order autocorrelation.

What is striking evidence in this table is the indication that whereas the beta is rejected as an important factor in the equally-weighted portfolios, it becomes significant in the value-weighted portfolios. It is a well documented evidence (*Fama and French 1992*) the inability of the beta factor to produce substantial spread in returns in contrast with market value and other factors. However, it is evident that this devastating for the beta result is not unanimously present in the portfolio management. The employment of value-weighted portfolios reveals adequate return spread across beta portfolios. In the rest of the cases, the factors appear to be significant and the signs of the constants are consistent with the prevailing evidence about the directions of the each factor's influence.

The contradictory results for individual factor's significance between the two procedures of equally- and value-weighted calculation of the portfolio returns can be presented graphically to get a visual representation of the different patterns. In Figure 3.3, we plot the cumulative returns of the factor mimicking portfolio mean returns with equally- and value-weighted rebalancing methodology against the market portfolio cumulative returns. We can observe clearly the important divergences in the beta and trading volume portfolios.

In sum, the empirical tests in this subsection have revealed quite significant indications for the performance of the factor mimicking portfolio returns. Similarly to the main paper in the area of the factor mimicking portfolio examination by

Chan, Karceski, Lakonishok (1997), we found high volatility present in the market size and book-to-market portfolios which was also related with high return performance. However, contrary to this paper, we located the highest source of volatility in the beta portfolios which was not significantly priced in terms of high return, yet we should mention that the return spread was substantially increased in value-weighted rebalancing procedure. For the other factor portfolios, we also observe sufficient volatility, however there are diverse results for the return premia significant. In the Appendix we report the performance of the most important factor portfolios with monthly rebalancing. The results are not substantially altered.

3.6 Concluding Remarks

The main area under scrutiny in the empirical research of this chapter is the examination of the factor mimicking portfolio returns. Factor mimicking portfolio returns are calculated as the difference between the returns of high and low portfolios on the basis of individual factors. The selected factors are firm specific attributes that accommodate vital information for the firms' prospects and profitable opportunities could be raised from investment strategies based on these factors. The principal dispute is centred to the isolation of a limited number of important factors that unambiguously affect the determination of stock returns and it is not the result of interrelation patterns or defective inferences. Furthermore, the controversy continues over the beta power to justify the high performance of factor portfolios and the possible role that these variables could play as new risk sources.

The analysis of the factor mimicking portfolio performance identified interesting patterns that have not been thoroughly examined in the empirical literature. As a confirmation to previous studies, a high return performance was present in market value and book-to-market portfolios whereas the price portfolios exhibited the highest mean returns. This result is a strong indication of interrelation presence between the market value and price factors and it constitutes the leading evidence towards a closer investigation in the following chapters. However, the vital information gained from factor mimicking portfolios is the spread of the return volatility as a high spread is consistent with the factor's significant contribution to the portfolio's performance. In contrast with previous studies in factor mimicking portfolios, we report the highest volatility for the beta factor followed by market value, price and trading volume. Furthermore, we present interesting issues over the seasonality subject after confirming the January effect. It becomes evident that there is also a powerful October effect where we observe high volatility and opposite effect in return than the January month.

Following the statistical analysis, the regression framework provides the means for examining the robustness of portfolio return premia. Once more, the striking evidence is present in the beta portfolios where we observe a highly significant return premia i.e. the regression constant when the rebalancing of the portfolios is based on a value-weighted procedure. The divergences of results based on equally- or value-weighted returns are quite substantial and sufficient to alter some of the findings in the empirical literature. The most important difference is with the beta portfolios where the value-weighted returns exhibit high beta volatility. Another significant variation in results is present with the trading volume portfolios where the empirical evidence of a negative effect disappears in the value-weighted portfolios.

Although the conclusions from the empirical tests in the previous sections are quite devastating for some of the factors that have gained power in the empirical literature, they have to be examined more thoroughly to be consistent with the directions in current research. More specifically, an area of debate in strategies constructed on the basis of firms' specific attributes is the achievement of risk-adjusted excess returns. The main approach towards this examination is the application of time-series models where present excess returns are reviewed under the inclusion of risk sources and their stability is presented over long periods of time. This area of research is the focus of the subsequent chapter.

TABLE 3.1

AUTOCORRELATION COEFFICIENTS OF THE FMP

The autocorrelation coefficients are estimated for the mimicking portfolio returns calculated as the difference between the highest and lowest decile portfolio returns. Both equally- and value-weighted returns are considered. Autocorrelations are reported up to the 10^{th} lag.

FACTOR		Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
BEMV	EQL	0.1499	0.1069	-0.0548	-0.0592	0.0289	0.0827	0.0431	-0.0184	-0.0348	0.0607
	VWG	0.1766	0.0478	-0.0481	-0.0016	0.0195	0.0859	0.0016	0.0091	-0.0586	0.0599
BETA	EQL	0.1798	-0.0028	-0.0448	-0.0321	-0.0755	-0.0285	0.0116	-0.0542	0.0210	0.0440
	VWG	0.1918	0.0128	-0.0539	-0.0562	-0.0803	-0.0416	0.0401	-0.0602	-0.0083	0.0198
CFL	EQL	0.1319	0.0244	-0.0561	0.0965	0.0630	0.1485	0.0199	0.0098	-0.0324	0.0299
	VWG	0.0654	-0.0006	-0.0161	0.0637	0.0191	0.1170	0.0043	-0.0738	-0.0511	0.0096
CSHO	EQL	0.1039	0.0346	-0.1126	0.0492	0.0219	0.0702	0.0256	0.0209	-0.1187	0.0649
	VWG	0.1328	0.0631	-0.1050	0.0890	0.0165	0.1154	0.0017	0.0270	-0.1009	0.0530
DEBT	EQL	0.1192	0.0455	-0.1138	-0.0579	0.0542	0.0519	0.0012	-0.0539	-0.0490	0.0708
	VWG	0.1307	0.0684	-0.0570	0.0402	0.0184	0.1200	0.0377	-0.0286	-0.0258	0.1144
DIVCOM	EQL	0.1467	0.0128	-0.0274	-0.0448	-0.0209	0.0771	0.0386	-0.0348	0.0363	-0.0267
	VWG	0.1527	-0.0024	0.0001	0.0339	-0.0004	0.0350	0.0002	-0.0430	0.0318	0.0388
DIVSUM	EQL	0.1010	-0.0150	-0.0652	-0.0010	-0.0320	0.0500	0.0050	-0.0076	0.0478	0.0139
	VWG	0.1091	-0.0146	-0.0570	-0.0090	0.0223	0.0679	0.0091	-0.0607	0.0251	0.0676
EP	EQL	0.0590	0.0211	-0.0658	0.1007	-0.0123	0.1339	0.0070	0.0462	-0.0223	-0.0002
	VWG	0.0536	0.0442	-0.0244	0.0575	0.0375	0.1631	0.0305	-0.0622	-0.0527	-0.0531
MV	EQL	0.1543	0.0318	-0.0768	0.0557	0.0037	0.0555	0.0004	0.0211	-0.0961	0.0529
	VWG	0.1592	0.0169	-0.0653	0.0686	0.0492	0.0262	0.0108	-0.0164	-0.0504	0.0468
PRICE	EQL	0.1853	0.0596	0.0175	0.0268	-0.0356	0.0214	0.0526	-0.0321	0.0035	0.0716
	VWG	0.2127	0.0532	0.0492	0.1650	0.0390	0.0146	0.0047	0.0689	0.0854	0.0991
SALE	EQL	0.1977	0.0735	0.0347	0.0204	0.0869	0.0304	0.0138	-0.0032	0.0133	0.0835
	VWG	0.1416	0.0432	-0.0739	0.0498	0.0126	0.0766	0.0281	-0.0019	-0.0101	0.0641
GR	EQL	0.1414	0.0431	-0.0740	0.0495	0.0128	0.0767	0.0282	-0.0019	-0.0103	0.0643
	VWG	0.1414	0.0431	-0.0740	0.0495	0.0128	0.0767	0.0282	-0.0019	-0.0103	0.0643
TR	EQL	0.0862	0.0565	0.0175	-0.0047	0.1289	-0.0105	0.0394	-0.0625	-0.0569	0.1610
	VWG	0.1217	0.0268	-0.0488	0.0151	0.0456	0.0782	0.0182	0.0022	-0.0016	0.0514

TABE	EQL	0.1710	0.0628	-0.0574	-0.0348	0.1171	0.1489	0.1037	-0.0099	-0.0482	0.0851
	VWG	0.1139	0.0703	-0.0376	0.0630	0.0199	0.1209	0.0364	0.0372	0.0371	0.1932
TAMV	EQL	0.1101	0.0273	-0.0545	0.0468	0.0438	0.1136	-0.0276	-0.0416	-0.0333	0.0428
	VWG	0.1101	0.0273	-0.0545	0.0468	0.0438	0.1136	-0.0276	-0.0416	-0.0333	0.0428
CAR12	EQL	0.0105	-0.0700	-0.0574	0.0228	-0.0005	-0.0489	-0.0048	-0.0415	-0.0725	-0.0133
	VWG	0.0351	-0.0405	-0.0316	-0.0116	0.0760	-0.0227	0.0158	-0.0326	0.0110	0.0280
CAR60	EQL	0.1726	0.0638	-0.1075	-0.0053	0.0316	0.0906	-0.0122	-0.0018	-0.0661	0.1010
	VWG	0.1090	0.0328	-0.0433	0.1095	0.1239	0.0777	0.0757	0.0789	0.0331	0.0311

TABLE 3.2

STATISTICS FOR EQUALLY-WEIGHTED FACTOR MIMICKING PORTFOLIO RETURNS

For every year from July 1964 to July 1994, NYSE, AMEX and NASDAQ firms are allocated to 10 portfolios according to: BEM, TAMV, TABE, EP, CFLP, SALEMV, GR, DIVCOM, DIVSUM, CSHO, TR, BETA, DEBT, MV, PRICE, CAR12, CAR60. The factor mimicking portfolio returns are calculated as the difference between the highest and the lowest equally-weighted portfolio returns. The statistics are for the average returns over the whole period of 372 months.

FACTOR	MEAN RETURN	STANDARD DEVIATION	MIN	5th Percentile	25th Percentile	MEDIAN	75th Percentile	95th Percentile	MAX
BEMV	1.1982	4.1045	-14.4053	-4.6694	-1.2059	0.9868	3.2701	6.8459	19.2886
BETA	0.1592	5.5480	-16.4432	-7.6078	-3.1752	-0.1124	2.9143	9.0472	23.9358
CFLP	1.1268	3.7458	-13.9670	-3.9014	-1.0132	0.9606	2.8518	6.5022	31.3466
CSHO	-0.1504	4.2439	-18.0962	-7.0028	-2.1830	-0.0183	2.1986	6.3887	11.8118
DEBT	1.0415	3.8873	-8.9457	-4.2380	-1.1825	0.6963	2.8927	7.0684	22.6892
DIVCOM	-0.0753	4.2796	-18.1713	-7.1687	-2.4430	-0.2744	2.4420	6.5075	13.8178
DIVSUM	-0.1639	4.4497	-14.6907	-7.4675	-2.6785	-0.2932	2.3265	6.0934	17.9499
EP	0.9023	3.5214	-12.5780	-3.4751	-0.9875	0.6735	2.3519	6.3341	33.6608
MV	-1.3203	5.3564	-26.1737	-10.1952	-3.6804	-0.7669	1.7271	6.1124	13.4477
PRICE	-2.7961	3.6831	-26.4012	-8.7458	-4.9163	-2.3313	-0.4736	1.8095	6.7126
SALE	1.2672	3.9581	-13.0344	-3.8998	-1.0668	0.8943	3.1770	7.9588	25.0243
GR	-0.8997	2.9855	-16.4784	-5.7056	-2.4732	-0.8551	0.6125	4.2539	8.1441
TR	-0.6344	5.0818	-16.4596	-8.6000	-3.5149	-1.0008	2.1785	8.0579	19.6242
TABE	0.1971	2.2193	-5.1804	-2.8166	-1.1796	-0.0705	1.3605	4.0103	10.7696
TAMV	1.4937	4.8248	-9.1922	-4.9990	-1.3233	1.1850	3.5761	9.2803	33.9263
CAR12	0.0104	4.3885	-21.4971	-6.8212	-1.8989	0.3260	2.2857	6.3943	14.1570
CAR60	-0.9571	3.8666	-16.7973	-6.6752	-2.9210	-0.7352	1.1660	4.5853	12.5683

TABLE 3.3

STATISTICS FOR VALUE-WEIGHTED FACTOR MIMICKING PORTFOLIOS RETURNS

For every year from July 1964 to July 1994, NYSE, AMEX and NASDAQ firms are allocated to 10 portfolios according to: BEM, TAMV, TABE, EP, CFLP, SALEMV, GR, DIVCOM, DIVSUM, CSHO, TR, BETA, DEBT, MV, PRICE, CAR12, CAR60. The factor mimicking portfolio returns are calculated as the difference between the highest and the lowest value-weighted portfolio returns. The statistics are for the average returns over the whole period of 372 months.

FACTOR	MEAN RETURN	STANDARD DEVIATION	MIN	5th Percentile	25th Percentile	MEDIAN	75th Percentile	95th Percentile	MAX
BEMV	0.7762	4.6722	-13.6435	-5.9431	-2.1259	0.5098	3.4942	8.6503	23.8070
BETA	1.0328	6.6113	-21.9788	-8.9959	-3.0471	0.6826	5.0100	13.2013	29.1471
CFLP	0.5172	4.8394	-20.3851	-6.7041	-2.2768	0.4632	3.0746	8.4852	28.1609
CSHO	-0.7988	4.0276	-18.5198	-7.5207	-3.0999	-0.5041	1.7490	5.2517	11.2569
DEBT	0.7183	4.4559	-9.6433	-6.2180	-2.2781	0.5498	3.3118	7.3723	23.5324
DIVCOM	-0.3064	5.0637	-28.1616	-8.1073	-3.2326	-0.0770	2.6697	7.7439	19.5745
DIVSUM	-0.4535	5.1226	-26.2640	-8.1382	-3.3428	-0.3482	2.4236	7.5764	23.0684
EP	0.6790	4.7450	-15.4061	-6.2095	-1.8957	0.4067	3.1305	7.5543	33.8647
MV	-2.8165	5.9789	-32.4430	-13.4140	-5.3607	-2.0570	0.7833	5.1783	13.3669
PRICE	-3.1398	4.7194	-38.1700	-10.0938	-5.1361	-2.5905	-0.5931	2.5736	9.7370
SALE	1.0684	4.8334	-14.7720	-5.6908	-2.1126	0.9204	3.3686	9.0674	23.5877
GR	-0.3669	3.4721	-10.8087	-6.3328	-2.4716	-0.3277	1.9137	5.0198	14.4441
TR	0.7704	6.0890	-17.9011	-7.1578	-2.7589	0.5335	3.9206	10.1340	53.8416
TABE	0.2641	3.0501	-11.3105	-4.7682	-1.7188	0.2186	2.3001	5.0357	11.5044
TAMV	0.9724	5.0116	-9.3950	-6.4488	-2.3984	0.7913	3.7709	8.4978	28.5824
CAR12	0.4100	5.5087	-22.8501	-9.1066	-2.3133	0.7673	3.8086	8.5747	22.0685
CAR60	-0.7721	5.1674	-45.6398	-6.7078	-3.0219	-1.0262	1.9767	6.5998	14.5510

TABLE 3.4

CORRELATIONS BETWEEN RETURNS OF THE FACTOR-MIMICKING PORTFOLIOS EQUALLY-WEIGHTED

The correlations are estimated between the equally-weighted factor mimicking portfolio returns.

	BEMV	BETA	CFLP	CSHO	DEBT	DIVCOM	DIVSUM	EP	MV	PRICE	SALE	GR	TR	TABE	TAMV	CAR12
BETA	-0.167															
CFLP	0.763*	-0.194														
CSHO	-0.348	-0.581	-0.208													
DEBT	0.878*	0.017	0.700	-0.465												
DIVCOM	0.653	-0.594	0.598	0.055	0.513											
DIVSUM	0.611	-0.573	0.550	0.049	0.459	0.931*										
EP	0.649	-0.218	0.900*	-0.156	0.591	0.587	0.544									
MV	-0.338	-0.647	-0.230	0.970*	-0.464	0.093	0.087	-0.182								
PRICE	-0.393	-0.498	-0.324	0.777*	-0.501	-0.025	-0.018	-0.298	0.860*							
SALE	0.727*	0.168	0.730*	-0.502	0.806*	0.345	0.306	0.689	-0.544	-0.594						
GR	-0.623	0.224	-0.444	0.308	-0.532	-0.485	-0.404	-0.362	0.293	0.383	-0.461					
TR	-0.514	0.700	-0.434	-0.199	-0.310	-0.706*	-0.675	-0.426	-0.244	-0.051	-0.144	0.561				
TABE	0.331	0.365	0.306	-0.554	0.614	0.061	0.013	0.236	-0.575	-0.558	0.526	-0.184	0.106			
TAMV	0.849*	0.007	0.825*	-0.458	0.894*	0.520	0.476	0.741*	-0.476	-0.551	0.859*	-0.575	-0.340	0.506		
CAR12	-0.390	-0.131	-0.324	0.324	-0.380	-0.294	-0.417	-0.323	0.343	0.421	-0.378	0.183	0.289	-0.253	-0.479	
CAR60	-0.700	0.124	-0.560	0.285	-0.677	-0.556	-0.469	-0.473	0.304	0.425	-0.569	0.667	0.477	-0.366	-0.682	0.217

* = indicates high correlation > 0.700

TABLE 3.5

CORRELATIONS BETWEEN RETURNS ON THE FACTOR-MIMICKING PORTFOLIOS VALUE-WEIGHTED

The correlations are estimated between the value-weighted factor mimicking portfolio returns.

	BEMV	BETA	CFLP	CSHO	DEBT	DIVCOM	DIVSUM	EP	MV	PRICE	SALE	GR	TR	TABE	TAMV	CAR12
BETA	0.063															
CFLP	0.809*	-0.129														
CSHO	-0.376	-0.627	-0.181													
DEBT	0.884*	0.063	0.788*	-0.419												
DIVCOM	0.602	-0.468	0.650	0.049	0.569											
DIVSUM	0.528	-0.503	0.584	0.074	0.519	0.941*										
EP	0.723*	-0.098	0.874*	-0.220	0.708	0.592	0.544									
MV	-0.354	-0.563	-0.211	0.832*	-0.418	0.019	0.044	-0.232								
PRICE	-0.222	-0.481	-0.175	0.539	-0.284	0.062	0.100	-0.245	0.717*							
SALE	0.790*	0.230	0.730	-0.488	0.828*	0.433	0.379	0.717	-0.542	-0.506						
GR	-0.499	0.267	-0.447	0.029	-0.441	-0.474	-0.451	-0.323	0.114	0.018	-0.346					
TR	-0.075	0.706	-0.153	-0.401	-0.057	-0.476	-0.506	-0.076	-0.357	-0.336	0.130	0.410				
TABE	0.480	0.093	0.450	-0.346	0.644	0.242	0.221	0.402	-0.293	-0.151	0.535	-0.191	-0.036			
TAMV	0.878*	0.124	0.816*	-0.435	0.938*	0.530	0.478	0.757*	-0.492	-0.410	0.884*	-0.455	0.015	0.593		
CAR12	-0.217	0.010	-0.201	0.054	-0.217	-0.306	-0.360	-0.134	0.145	0.249	-0.247	0.193	0.258	-0.036	-0.259	
CAR60	-0.518	0.142	-0.503	0.049	-0.541	-0.549	-0.496	-0.462	0.299	0.280	-0.463	0.448	0.286	-0.280	-0.547	0.203

* = indicates high correlation > 0.700

TABLE 3.6

MEAN RETURN AND STANDARD DEVIATION OF THE EQUALLY-WEIGHTED FMP EVERY MONTH OF THE YEAR

The mean returns and standard deviation statistics are reported as the averages for every individual month during the whole period for the factor mimicking portfolios.

		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
BEMV	Return	4.9862	2.5132	1.7866	1.5745	0.4292	1.1547	1.5148	0.3357	0.7073	-0.2375	-0.8530	0.4662
	s.d.	6.5187	4.6944	2.8754	3.6877	2.6986	3.2141	3.2141	2.9996	3.3091	4.2790	4.1000	3.8221
BETA	Return	5.3533	0.3488	0.5156	0.1068	-0.4243	-0.6948	-0.6948	0.2042	-0.0837	-1.8853	-0.1139	0.3862
	s.d.	7.3152	4.6662	4.6615	4.6045	4.6103	5.9488	5.9488	5.2003	5.7279	6.6415	5.6390	4.3041
CFLP	Return	3.1147	2.0090	1.5390	0.9852	0.0778	1.8134	1.8134	0.9480	0.3384	1.4321	-0.4344	0.3787
	s.d.	4.4370	4.1003	2.6327	3.2336	2.1440	3.0214	3.0214	2.5053	3.3677	6.8141	3.6853	2.6320
CSHO	Return	-6.2513	-1.6060	-0.4985	0.4523	0.5808	0.3029	0.3029	1.0347	-0.8671	2.3472	1.0312	1.2532
	s.d.	5.4662	4.1644	2.9336	2.9911	4.2663	3.0729	3.0729	3.4761	3.1917	4.1555	3.4325	4.0644
DEBT	Return	5.5451	2.4654	1.2624	1.2028	0.4067	1.4552	1.4552	-0.0259	0.0090	-0.6247	-0.7254	0.3763
	s.d.	6.0320	4.5207	2.2682	2.7109	2.8127	2.9975	2.9975	2.5311	2.5214	3.0621	3.3400	5.2211
DIVCOM	Return	2.4686	0.0233	-0.4112	-0.1209	-0.4672	0.5576	0.5576	-0.4945	-0.4467	0.5482	-1.3990	-1.4816
	s.d.	4.6520	4.5178	3.6618	4.0478	2.8346	5.0170	5.0170	4.4392	3.8110	5.4976	4.7805	3.3201
DIVSUM	Return	2.2826	-0.5425	-0.5525	0.0600	-0.4894	0.2830	0.2830	-0.5262	-0.1465	0.8653	-1.6166	-1.9989
	s.d.	5.2305	4.5837	4.0275	4.2476	3.0000	4.6227	4.6227	4.5629	3.6815	6.2358	4.8105	3.4224
EP	Return	2.0981	1.1961	1.3869	0.6950	-0.0712	1.3314	1.3314	0.3775	0.9049	1.4088	-0.2232	0.4842
	s.d.	4.2441	2.9817	2.8211	2.7279	2.1717	2.6396	2.6396	2.3514	2.7975	7.1424	3.5746	2.2408
MV	Return	-9.3274	-2.7481	-1.7792	-1.0490	-0.5025	-0.7807	-0.7807	0.3051	-1.8490	1.5515	0.7341	0.1018
	s.d.	7.1185	5.3038	3.9704	3.6907	5.0350	3.8572	3.8572	4.2123	3.7662	5.3352	4.3799	5.0875
PRICE	Return	-8.3047	-3.7225	-3.3587	-3.2307	-2.5151	-2.6728	-2.6728	-1.1727	-2.3156	-1.6684	-0.5218	-1.4149
	s.d.	5.0242	3.2080	3.2291	2.5074	2.9198	2.6368	2.6368	2.3254	2.2005	3.7023	3.6614	3.1661
SALE	Return	5.1232	2.8837	1.7084	1.6658	0.1138	1.0705	1.0705	0.2811	0.4736	0.4969	-0.5057	0.5448
	s.d.	5.5056	4.0516	2.5978	2.9660	2.8666	2.8456	2.8456	2.1654	2.9349	5.7487	3.9012	3.7364
GR	Return	-3.5162	-1.8294	-1.1814	-1.7991	-0.4688	-0.7264	-1.1210	-0.4110	-0.6770	0.4401	0.3648	0.1294
	s.d.	3.9304	2.8242	2.2571	3.3998	2.0332	2.3802	2.7654	2.9575	2.6284	2.2472	2.7682	3.2719

TR	Return	-0.2122	-1.5038	-1.0335	-1.1773	-0.9099	-1.9577	-1.6649	0.4747	-0.4938	-1.3382	1.3305	0.8729
	s.d.	5.9747	4.8538	4.1328	4.8212	3.8004	4.9974	5.4094	4.5599	5.3317	6.5455	5.4768	4.0603
TABE	Return	2.3112	0.8120	0.1899	0.0085	-0.2216	0.6484	0.4003	-0.2424	-0.2543	-0.4150	-0.1916	-0.6808
	s.d.	3.6285	2.5312	1.8424	1.8127	1.5311	1.8518	1.7783	1.7870	1.6838	2.0985	1.8608	2.1432
TAMV	Return	7.0544	3.0466	1.7874	1.8832	0.4177	1.5950	1.9146	0.0545	0.6490	0.4239	-1.0743	0.1723
	s.d.	6.4673	4.8511	2.7129	3.7260	3.3377	3.8492	3.4755	2.9903	2.9219	7.3678	4.0111	5.1602
CAR12	Return	-5.1870	-1.1141	-0.7644	0.0578	-0.2213	-0.5290	0.7384	0.5501	0.6672	0.4067	3.4487	2.0716
	s.d.	6.2492	3.2598	2.9835	2.6645	2.4110	3.0763	3.2260	3.9335	3.7352	5.8556	4.2490	4.0960
CAR60	Return	-4.4320	-1.5203	-2.1709	-1.1667	-0.4568	-1.1775	-1.5130	0.1553	-0.1853	0.3453	0.1463	0.4900
	s.d.	5.6615	4.2678	3.5233	3.9304	2.4629	3.6707	3.3011	3.7013	3.5442	3.5161	2.6808	3.0658

TABLE 3.7

MEAN RETURN AND STANDARD DEVIATION OF THE VALUE-WEIGHTED FMP EVERY MONTH OF THE YEAR

The mean returns and standard deviation statistics are reported as the averages for every individual month during the whole period for the factor mimicking portfolios.

		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
BEMV	Return	5.3310	1.6929	1.0801	0.7015	-0.4585	0.8615	0.8615	0.6640	0.7287	-1.8084	-0.7782	1.2314
	s.d.	6.8113	5.5376	3.8745	3.8174	3.2579	3.6197	3.6197	3.8451	4.5106	4.1922	4.9053	4.0285
BETA	Return	4.7452	1.7088	1.6512	0.2824	0.1241	-0.1484	-0.1484	2.1666	0.3025	-1.6687	2.3006	1.7884
	s.d.	9.2681	6.3800	5.5390	5.0691	5.5338	7.4252	7.4252	5.6437	7.3398	8.0077	6.6401	4.4450
CFLP	Return	3.5228	0.6189	0.7941	0.2650	-0.6402	1.1227	1.1227	0.4593	0.9923	-1.0552	-2.0148	0.9266
	s.d.	6.5668	5.5058	3.3782	3.7267	3.3632	3.8201	3.8201	4.3090	4.7071	5.6701	4.5709	3.6901
CSHO	Return	-4.9732	-1.3211	-1.0608	0.0541	-0.4173	-0.5024	-0.5024	0.1265	-1.4954	1.6487	-1.1314	-0.3594
	s.d.	5.1962	4.0018	3.4377	3.3786	4.3294	3.5686	3.5686	3.1567	3.4441	4.1860	3.6877	3.6751
DEBT	Return	4.7276	1.5045	1.1304	0.6653	-0.1616	1.1549	1.1549	0.0605	0.7916	-1.0409	-0.7301	0.4779
	s.d.	6.6733	5.0529	3.8670	4.0199	3.1726	3.7531	3.7531	3.6805	4.1225	3.8587	4.2661	3.8927
DIVCOM	Return	2.6660	-0.4530	-0.6318	-0.1824	-1.3016	0.7327	0.7327	-0.0632	0.0272	-0.5456	-2.5099	-0.5462
	s.d.	6.2255	5.3395	3.9664	4.7474	3.4530	4.9963	4.9963	4.3147	4.3537	7.1809	6.2080	3.7449
DIVSUM	Return	2.3275	-1.0720	-0.7274	-0.8506	-1.3941	0.5507	0.5507	-0.0779	0.3411	0.0612	-2.5651	-1.4179
	s.d.	6.2821	5.0161	3.9637	4.7461	3.6431	4.9090	4.9090	4.5007	4.0207	7.3913	6.2060	4.5848
EP	Return	3.3296	0.7816	0.9667	0.4233	-0.3398	1.0480	1.0480	0.5160	1.1116	-1.4107	-1.3375	1.2038
	s.d.	6.9590	4.5840	3.4889	3.5759	4.0815	3.4818	3.4818	3.6682	4.0101	5.5246	4.1569	3.6987
MV	Return	-9.7503	-3.4906	-3.1920	-2.9079	-1.8185	-1.8688	-1.8688	-1.0779	-2.9951	-0.3962	-1.3057	-2.2601
	s.d.	7.3325	5.4354	4.4435	6.2506	5.4738	4.2345	4.2345	4.3506	3.9463	7.7273	4.8493	5.0164
PRICE	Return	-6.0561	-2.9243	-3.9298	-3.2150	-3.5493	-2.6748	-2.6748	-1.6313	-2.9093	-1.7592	-2.3799	-2.2698
	s.d.	5.8675	4.1314	3.7184	5.0671	3.4849	3.5312	3.5312	2.5644	3.5521	6.1545	3.9627	2.4636
SALE	Return	5.6178	1.8445	1.8727	0.8892	-0.3676	1.1350	1.1350	0.0089	1.3267	-0.8793	-0.3946	0.3103
	s.d.	7.1948	5.4288	3.6357	3.1029	3.1937	4.1338	4.1338	2.8749	4.4260	5.7774	4.6876	3.2944
GR	Return	-1.7593	-0.8163	-1.2183	-1.2860	0.4716	0.5946	-0.7113	-0.7157	-0.3342	1.3341	0.4289	-0.3911
	s.d.	4.0320	3.2491	3.2216	3.3798	2.9422	3.3274	3.4583	3.1257	3.0907	3.7243	3.4285	3.8800
TR	Return	3.9390	0.3871	-0.1174	0.7650	-0.1901	-0.1671	-0.2760	1.5837	0.5735	-0.1829	2.1748	0.7546
	s.d.	10.8732	4.7732	4.6836	5.2586	4.8575	5.3540	5.6456	4.6076	5.6643	7.1362	6.2623	4.7201

TABE	Return	1.1873	0.2588	0.6712	0.2666	0.2698	0.5917	0.5039	-0.5523	0.0964	-0.3459	0.4555	-0.2336
	s.d.	3.2130	3.5690	2.7448	3.4127	2.8578	2.6823	2.6633	2.5691	3.3609	3.4873	3.1523	2.7824
TAMV	Return	5.9676	2.0808	1.3717	1.3347	-0.5094	0.7641	1.1872	0.0043	0.9451	-1.2031	-0.7450	0.4705
	s.d.	7.3371	5.1416	3.8519	4.2832	3.6689	5.7608	3.6885	3.7822	4.1521	5.3692	4.5196	4.1498
CAR12	Return	-3.3506	0.6330	0.4170	-0.2485	0.0218	0.4098	0.3895	0.1174	1.0405	0.3846	3.4838	1.6214
	s.d.	6.8627	5.2146	3.9660	4.7810	3.7179	4.4252	5.7460	5.3958	5.5208	6.6363	6.9356	4.1462
CAR60	Return	-3.1591	-1.3671	-2.1000	-1.1113	0.8658	-1.4384	-1.5622	0.0207	-0.8539	1.1866	0.1658	0.0874
	s.d.	7.1118	4.3895	3.7385	4.6909	3.7961	9.5801	3.4997	4.6487	4.3355	4.6837	3.7001	3.6604

TABLE 3.8

P-VALUES OF THE F-TEST FOR RETURN SIGNIFICANCE OVER INDIVIDUAL MONTHS

In this Table, we report the p-values of the F-test on an unrestricted model of factor mimicking portfolio returns on dummies created for each month of the year. The subsequent restrictions are tested for every month that the coefficient of this particular month is zero.

		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
BEMV	EQ	0.0000	0.0050	0.0733	0.1409	0.8903	0.3733	0.1570	0.7806	0.8134	0.2753	0.0491	0.9304
	VW	0.0000	0.1462	0.4871	0.8385	0.2170	0.5630	0.6681	0.8677	0.8143	0.0035	0.1007	0.3772
BETA	EQ	0.0000	0.8482	0.9911	0.6545	0.3256	0.0162	0.2091	0.7350	0.5176	0.0128	0.5040	0.8837
	VW	0.0004	0.3172	0.3383	0.8269	0.7321	0.2375	0.5693	0.1642	0.8386	0.0618	0.1326	0.2832
CFL	EQ	0.0001	0.0267	0.1275	0.5014	0.4993	0.2339	0.0518	0.5300	0.7594	0.1740	0.1458	0.8224
	VW	0.0005	0.9203	0.7531	0.7475	0.1712	0.4212	0.4790	0.9326	0.5966	0.0634	0.0029	0.6393
CSHO	EQ	0.0000	0.0015	0.1265	0.8968	0.9348	0.8654	0.7459	0.4524	0.0359	0.0069	0.4561	0.2788
	VW	0.0000	0.0066	0.0200	0.4757	0.1659	0.3153	0.1333	0.5517	0.0029	0.1003	0.0148	0.1926
DEBT	EQ	0.0000	0.0030	0.2558	0.3055	0.8536	0.3367	0.1489	0.3894	0.4107	0.0753	0.0526	0.8152
	VW	0.0000	0.2080	0.4331	0.8699	0.3722	0.5250	0.4099	0.5410	0.7455	0.0421	0.1019	0.9486
DIVCOM	EQ	0.0109	0.5003	0.2161	0.3836	0.1901	0.7820	0.9603	0.1760	0.1924	0.9798	0.0111	0.0083
	VW	0.0179	0.2719	0.1973	0.4215	0.0423	0.1198	0.8126	0.5077	0.5666	0.2315	0.0008	0.2319
DIVSUM	EQ	0.0264	0.1712	0.1702	0.5420	0.1966	0.8848	0.7630	0.1788	0.3813	0.6686	0.0065	0.0014
	VW	0.0484	0.0773	0.1674	0.1261	0.0348	0.2064	0.9729	0.5019	0.8250	0.6061	0.0007	0.0325
EP	EQ	0.0137	0.2952	0.1740	0.8053	0.3451	0.2622	0.1998	0.8077	0.5656	0.1646	0.2328	0.9453
	VW	0.0009	0.7668	0.5984	0.8897	0.3007	0.1133	0.5276	0.9854	0.4955	0.0208	0.0259	0.4188
MV	EQ	0.0000	0.0001	0.0064	0.0599	0.2223	0.2218	0.1230	0.7881	0.0047	0.2251	0.8102	0.6132
	VW	0.0000	0.0001	0.0002	0.0007	0.0200	0.0013	0.0178	0.1097	0.0005	0.3572	0.0679	0.0058
PRICE	EQ	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031	0.0000	0.0001	0.0663	0.0008
	VW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0095	0.0000	0.0061	0.0005	0.0008
SALE	EQ	0.0000	0.0006	0.0812	0.0964	0.5423	0.2252	0.4158	0.7115	0.9200	0.9621	0.1256	0.9796
	VW	0.0000	0.1161	0.1065	0.6742	0.2835	0.2653	0.4602	0.5304	0.3460	0.0914	0.2662	0.7942

GR	EQ	0.0000	0.0000	0.0017	0.0000	0.0632	0.0198	0.0024	0.0766	0.0234	0.8347	0.7241	0.4411
	VW	0.0005	0.0383	0.0079	0.0054	0.9055	0.9512	0.0570	0.0544	0.1729	0.2387	0.8453	0.1548
TR	EQ	0.4144	0.0260	0.0878	0.0604	0.1160	0.0067	0.0170	0.9505	0.2566	0.0412	0.3815	0.7049
	VW	0.0020	0.8934	0.5565	0.8365	0.5130	0.5247	0.4672	0.3366	0.9768	0.5155	0.1339	0.8356
TABE	EQ	0.0000	0.4716	0.3840	0.1701	0.0535	0.7578	0.7570	0.0458	0.0399	0.0149	0.0617	0.0019
	VW	0.2344	0.6173	0.7923	0.6204	0.6414	0.9096	0.9768	0.0495	0.4186	0.1125	0.8895	0.1672
TAMV	EQ	0.0000	0.0020	0.1184	0.0961	0.8931	0.1867	0.0842	0.5543	0.8939	0.8963	0.0469	0.6595
	VW	0.0000	0.0713	0.3236	0.3530	0.2268	0.7838	0.4358	0.5382	0.6374	0.0436	0.1363	0.9469
CAR12	EQ	0.0000	0.0219	0.0722	0.5017	0.2972	0.1402	0.7603	0.9791	0.8608	0.8644	0.0001	0.0317
	VW	0.0001	0.9186	0.9103	0.4171	0.6033	0.9020	0.8931	0.6697	0.6072	0.8817	0.0025	0.2599
CAR60	EQ	0.0000	0.0042	0.0002	0.0168	0.1631	0.0169	0.0044	0.5705	0.2935	0.7668	0.5644	0.9282
	VW	0.0002	0.0548	0.0084	0.0939	0.7538	0.0469	0.0349	0.5865	0.1542	0.5308	0.6917	0.6402

TABLE 3.9

REGRESSION OF THE FACTOR MIMICKING PORTFOLIO RETURNS ON A CONSTANT

The individual factor mimicking risk premia is regressed on a constant with the standard OLS estimation and further correction for outliers in excess of 3 and 2.5 standard deviations from the estimated residuals.

FACTOR		COEFF	T-STAT	P-VALUE	3 S.E.	COEFF	T-STAT	P-VALUE	2.5 S.E.	COEFF	T-STAT	P-VALUE
BEMV	EQL	1.1982	5.6302	0.0000		1.0239	5.6043	0.0000		0.9598	5.5202	0.0000
	VWG	0.7762	3.2042	0.0015		0.6602	3.0244	0.0027		0.6602	3.0244	0.0027
BETA	EQL	0.1592	0.5536	0.5802		-0.0697	-0.2615	0.7938		-0.0696	-0.2778	0.7813
	VWG	1.0328	3.0130	0.0028		0.8906	2.7893	0.0056		0.8448	2.6663	0.0080
CFLP	EQL	1.1268	5.8019	0.0000		1.0488	6.4262	0.0000		0.9910	6.4197	0.0000
	VWG	0.5172	2.0611	0.0400		0.4074	1.8003	0.0726		0.4006	1.8890	0.0597
CSHO	EQL	-0.1504	-0.6836	0.4947		0.0647	0.3227	0.7471		0.1634	0.8814	0.3787
	VWG	-0.7988	-3.8253	0.0002		-0.6429	-3.2857	0.0011		-0.5197	-2.8375	0.0048
DEBT	EQL	1.0415	5.1676	0.0000		0.7597	4.5219	0.0000		0.7251	4.4897	0.0000
	VWG	0.7183	3.1092	0.0020		0.5314	2.4967	0.0130		0.4640	2.2246	0.0267
DIVCOM	EQL	-0.0753	-0.3394	0.7345		-0.1318	-0.6479	0.5175		-0.0319	-0.1659	0.8683
	VWG	-0.3064	-1.1671	0.2439		-0.1779	-0.7519	0.4526		-0.2149	-0.9168	0.3598
DIVSUM	EQL	-0.1639	-0.7102	0.4780		-0.2264	-1.0976	0.2731		-0.1955	-0.9773	0.3291
	VWG	-0.4535	-1.7076	0.0886		-0.3944	-1.6775	0.0943		-0.3567	-1.5329	0.1262
EP	EQL	0.9023	4.9418	0.0000		0.7879	5.5178	0.0000		0.8399	6.0534	0.0000
	VWG	0.6790	2.7600	0.0061		0.6105	2.8480	0.0046		0.5806	2.8774	0.0042
MV	EQL	-1.3203	-4.7541	0.0000		-0.9894	-4.0202	0.0001		-0.9115	-3.9475	0.0001
	VWG	-2.8165	-9.0857	0.0000		-2.4042	-9.0941	0.0000		-2.3564	-9.2450	0.0000
PRICE	EQL	-2.7961	-14.6423	0.0000		-2.6253	-15.3585	0.0000		-2.6150	-16.2983	0.0000
	VWG	-3.1398	-12.8317	0.0000		-2.7962	-14.6354	0.0000		-2.7952	-15.0554	0.0000
SALE	EQL	1.2672	6.1750	0.0000		1.0427	6.0400	0.0000		1.0403	6.2048	0.0000
	VWG	1.0684	4.2635	0.0000		0.7861	3.6961	0.0003		0.6810	3.3126	0.0010
GR	EQL	-0.8997	-5.4243	0.0000		-0.8488	-5.4874	0.0000		-0.8251	-5.3811	0.0000
	VWG	-0.3669	-1.9022	0.0580		-0.3805	-2.0486	0.0413		-0.4092	-2.2230	0.0269
TR	EQL	-0.6344	-2.4079	0.0165		-0.7375	-2.9652	0.0032		-0.8063	-3.4248	0.0007
	VWG	0.7704	2.4402	0.0151		0.6173	2.2642	0.0241		0.6606	2.5201	0.0122

TABE	EQL	0.1971	1.7126	0.0876	0.0416	0.4138	0.6793	0.0068	0.0695	0.9447
	VWG	0.2641	1.6702	0.0957	0.2650	1.7335	0.0838	0.2636	1.7541	0.0802
TAMV	EQL	1.4937	5.9712	0.0000	1.1092	5.4138	0.0000	1.1099	5.7264	0.0000
	VWG	0.9724	3.7422	0.0002	0.7057	3.0357	0.0026	0.7027	3.0931	0.0021
CAR12	EQL	0.0104	0.0457	0.9636	0.2207	1.1474	0.2520	0.1563	0.8320	0.4060
	VWG	0.4100	1.4355	0.1520	0.4828	1.9030	0.0578	0.5651	2.2760	0.0234
CAR60	EQL	-0.9571	-4.3724	0.0000	-0.7663	-4.1912	0.0000	-0.7337	-4.0648	0.0001
	VWG	-0.7721	-2.6394	0.0087	-0.4983	-2.0784	0.0385	-0.4533	-2.0522	0.0410

APPENDIX

DESCRIPTIVE STATISTICS FOR MONTHLY REBALANCING FMP

Equally-weighted

FACTOR	MEAN RETURN	S.D.	MIN	5th Perc.	25th Perc.	MEDIAN	75th Perc.	95th Perc.	MAX
BEMV	1.5986	5.0652	-14.8267	-5.6393	-1.3770	1.2923	4.0912	8.6654	39.0544
BETA	0.3219	5.4849	-16.4846	-7.3713	-2.8983	-0.0059	3.5652	9.0785	20.2197
MV	-1.4471	5.5631	-32.9271	-10.1667	-3.8454	-0.9361	1.7425	6.0385	12.7577
PRICE	-3.0880	4.3217	-31.7194	-10.6080	-4.9281	-2.2500	-0.4558	1.9656	6.8536
TR	-0.4199	5.1643	-19.0569	-8.7285	-3.4470	-0.9374	2.1564	9.0091	15.9662

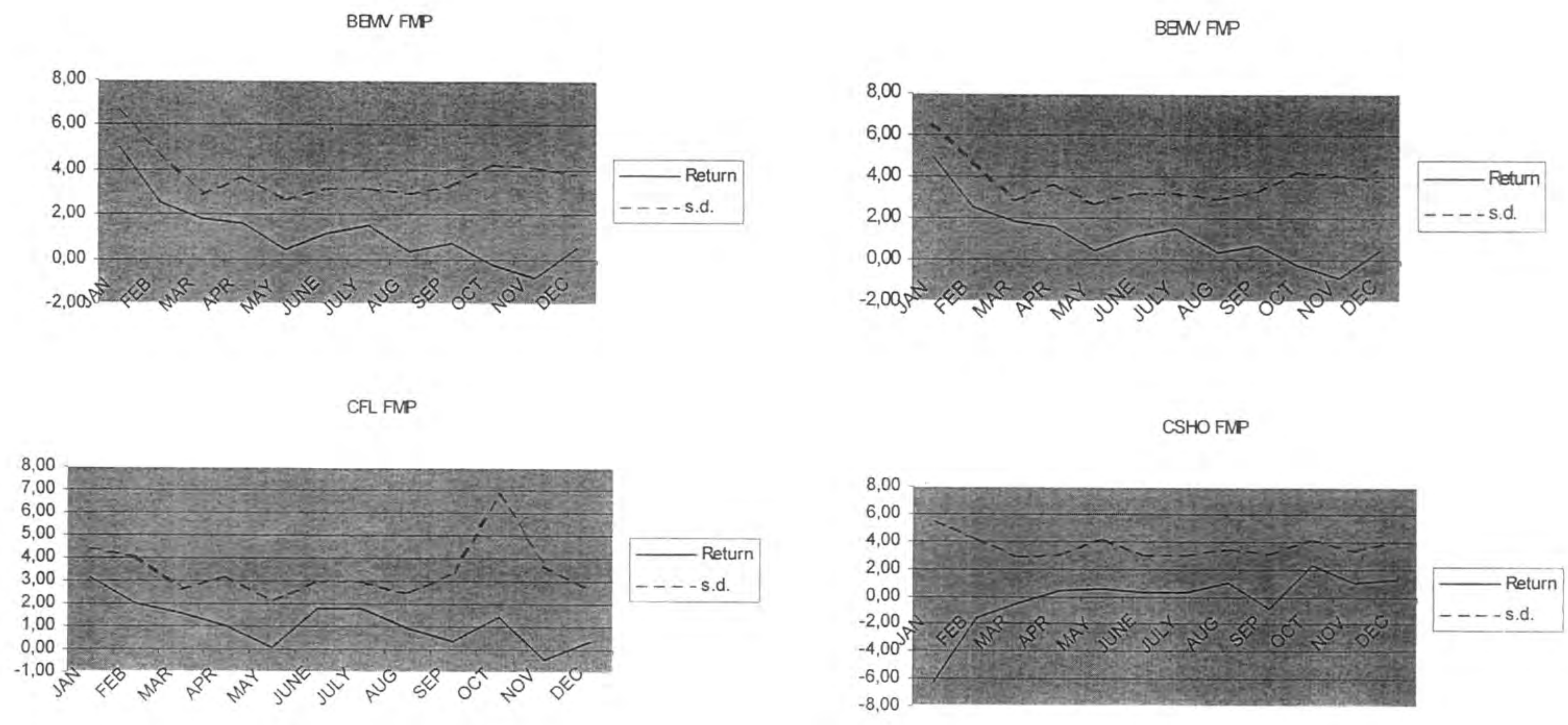
Value-weighted

FACTOR	MEAN RETURN	S.D.	MIN	5th Perc.	25th Perc.	MEDIAN	75th Perc.	95th Perc.	MAX
BEMV	0.7534	5.3728	-19.7182	-6.4558	-2.3805	0.5554	3.2376	9.3183	40.4972
BETA	1.1711	6.5225	-22.7053	-8.1448	-2.9686	0.9150	4.7393	13.7124	21.9851
MV	-3.1558	6.7908	-49.5765	-13.9040	-5.3834	-2.1437	0.6662	4.7403	12.0636
PRICE	-3.4423	5.4092	-40.4758	-10.4196	-5.1557	-2.7224	-0.4882	2.4972	10.5506
TR	0.9750	5.9395	-16.1512	-6.8833	-2.5151	0.6037	3.7978	10.4331	49.1408

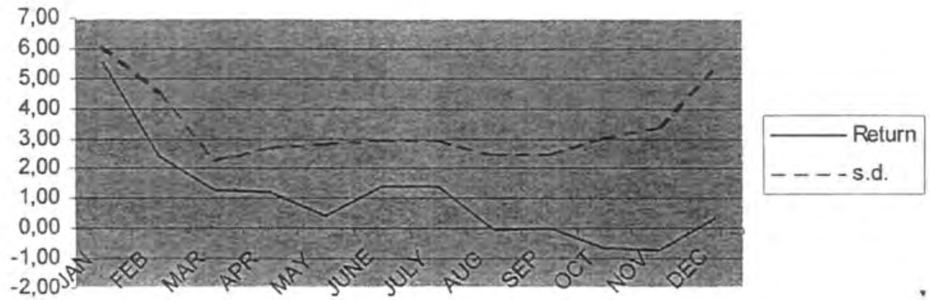
REGRESSIONS OF MONTHLY REBALANCING FMP IN A CONSTANT

FACTOR		COEFF	S.E.	T-STAT	P-VALUE	3 S.E.	COEFF	S.E.	T-STAT	P-VALUE
BEMV	EQL	1.5986	0.2626	6.0872	0.0000		1.4613	0.2264	6.4542	0.0000
	VWG	0.7534	0.2786	2.7046	0.0072		0.5461	0.2378	2.2968	0.0222
BETA	EQL	0.3219	0.2844	1.1320	0.2584		0.1610	0.2649	0.6079	0.5436
	VWG	1.1711	0.3382	3.4629	0.0006		1.1234	0.3251	3.4555	0.0006
MV	EQL	-1.4471	0.2884	-5.0172	0.0000		-1.1304	0.2533	-4.4620	0.0000
	VWG	-3.1625	0.3517	-8.9927	0.0000		-2.5737	0.2740	-9.3914	0.0000
PRICE	EQL	-3.0880	0.2241	-13.7814	0.0000		-2.8431	0.1873	-15.1820	0.0000
	VWG	-3.4423	0.2805	-12.2740	0.0000		-2.9186	0.2018	-14.4618	0.0000
TR	EQL	-0.4199	0.2678	-1.5683	0.1177		-0.5449	0.2516	-2.1661	0.0310
	VWG	0.9750	0.3080	3.1660	0.0017		0.7308	0.2694	2.7128	0.0070

FIGURE 3.1
RETURN AND S.D. OF THE EQUALLY-WEIGHTED FMP ACROSS MONTHS

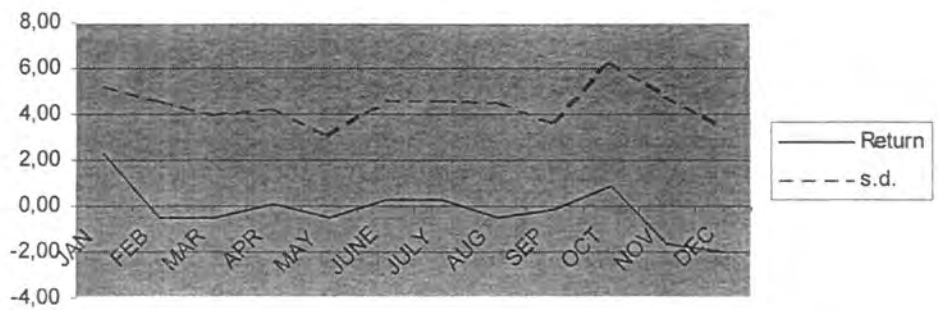


DEBT FMP

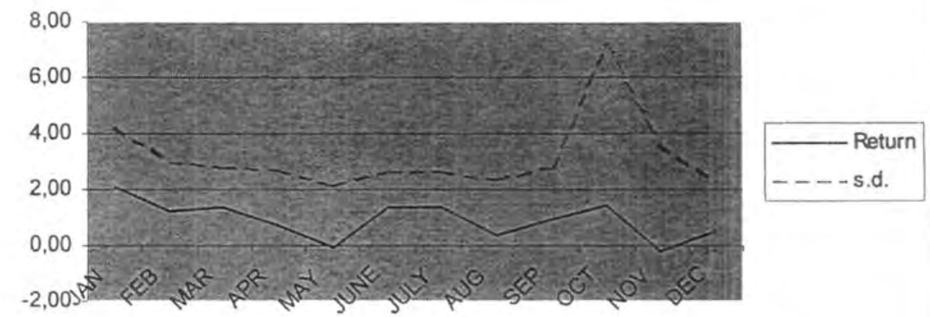


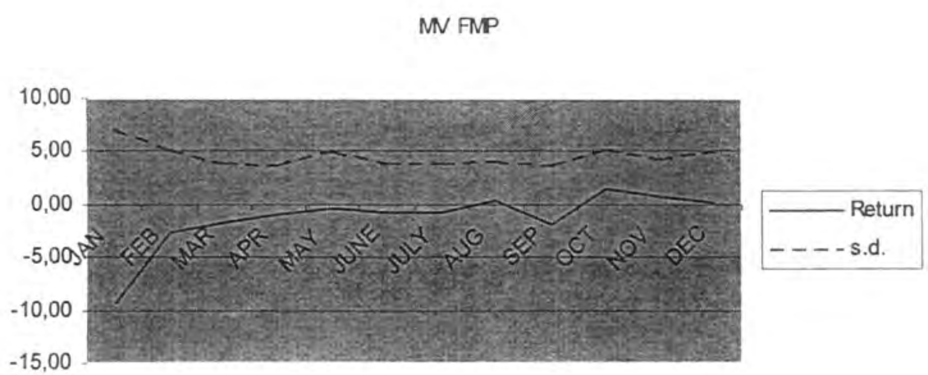
DIVCOM FMP

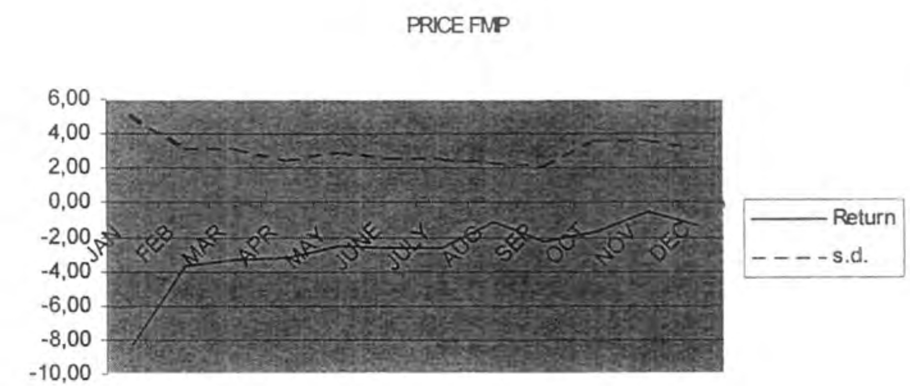
DIVSUM FMP

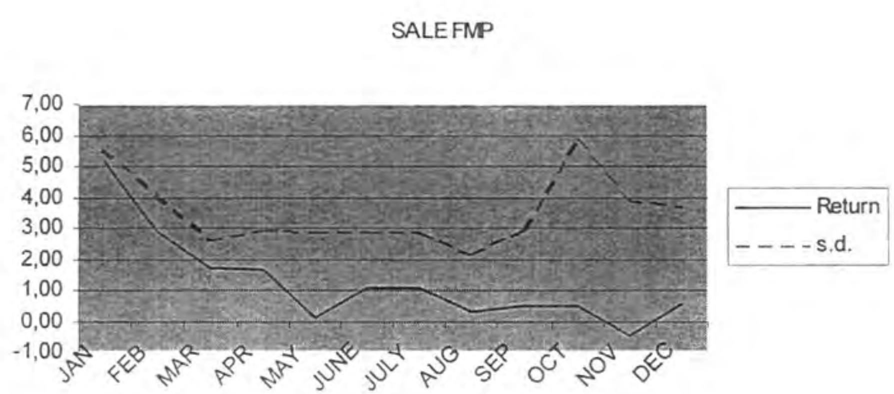


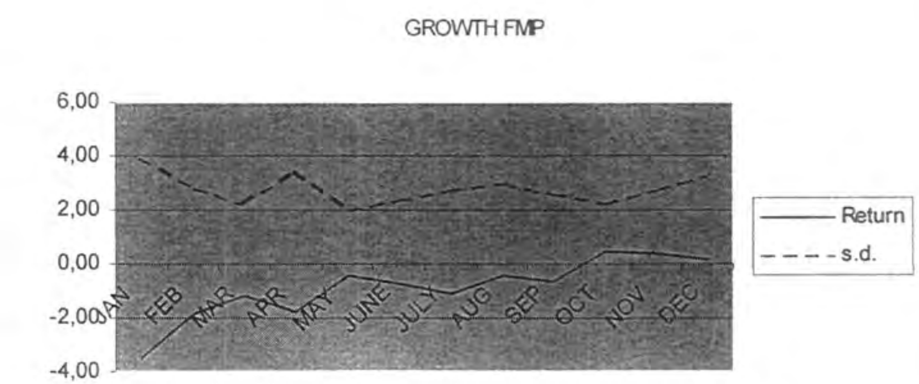
EP FMP

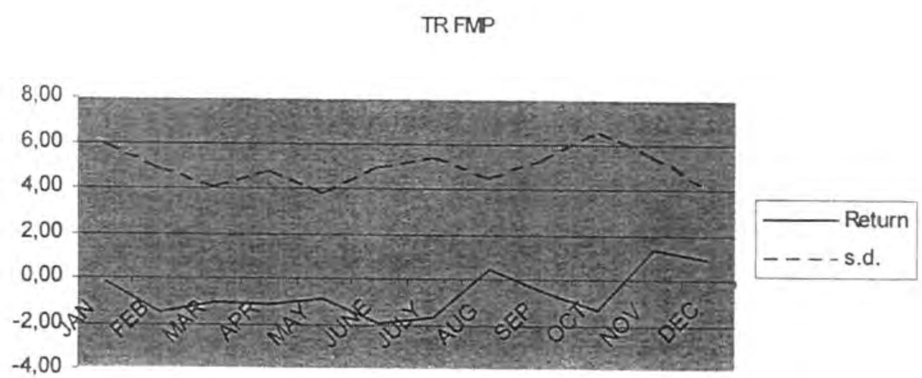


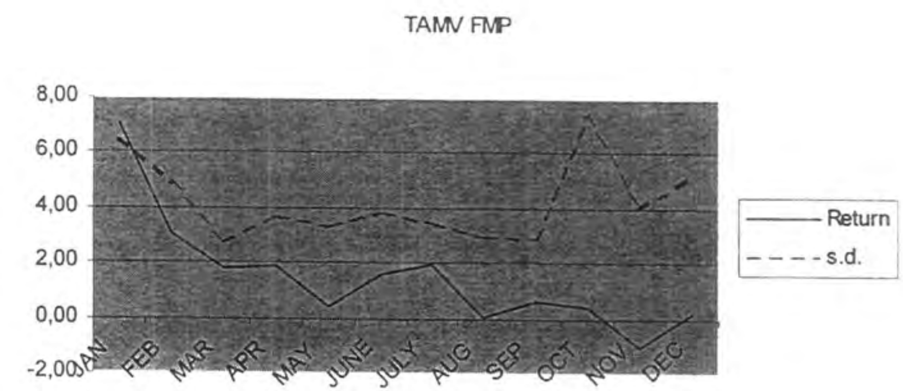

MV FMP
10,00
5,00
0,00
-5,00
-10,00
-15,00
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
Return
s.d.

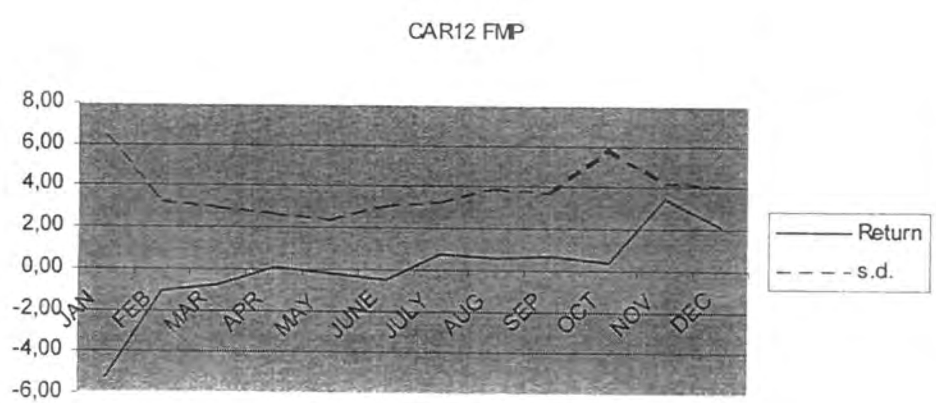

PRICE FMP
6,00
4,00
2,00
0,00
-2,00
-4,00
-6,00
-8,00
-10,00
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
Return
s.d.


SALE FMP
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
-1,00
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
Return
s.d.


GROWTH FMP
6,00
4,00
2,00
0,00
-2,00
-4,00
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
Return
s.d.


TR FMP
8,00
6,00
4,00
2,00
0,00
-2,00
-4,00
JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC
Return
s.d.


TAMV FMP
8,00
6,00
4,00
2,00
0,00
-2,00
JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC
Return
s.d.


CAR12 FMP
8,00
6,00
4,00
2,00
0,00
-2,00
-4,00
-6,00
JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC
Return
s.d.

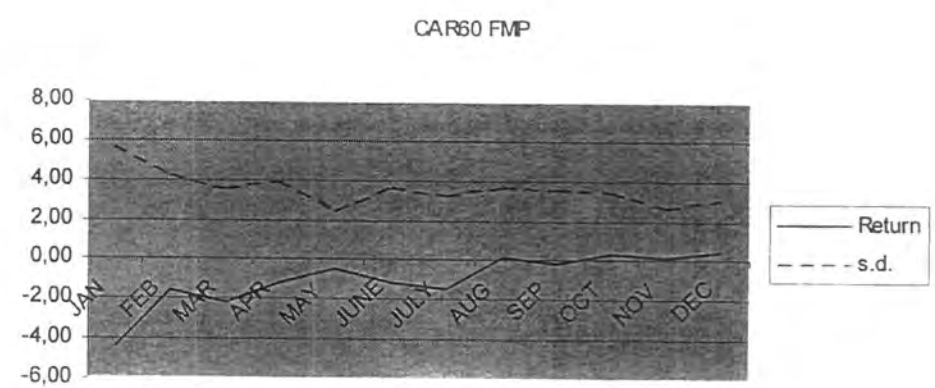
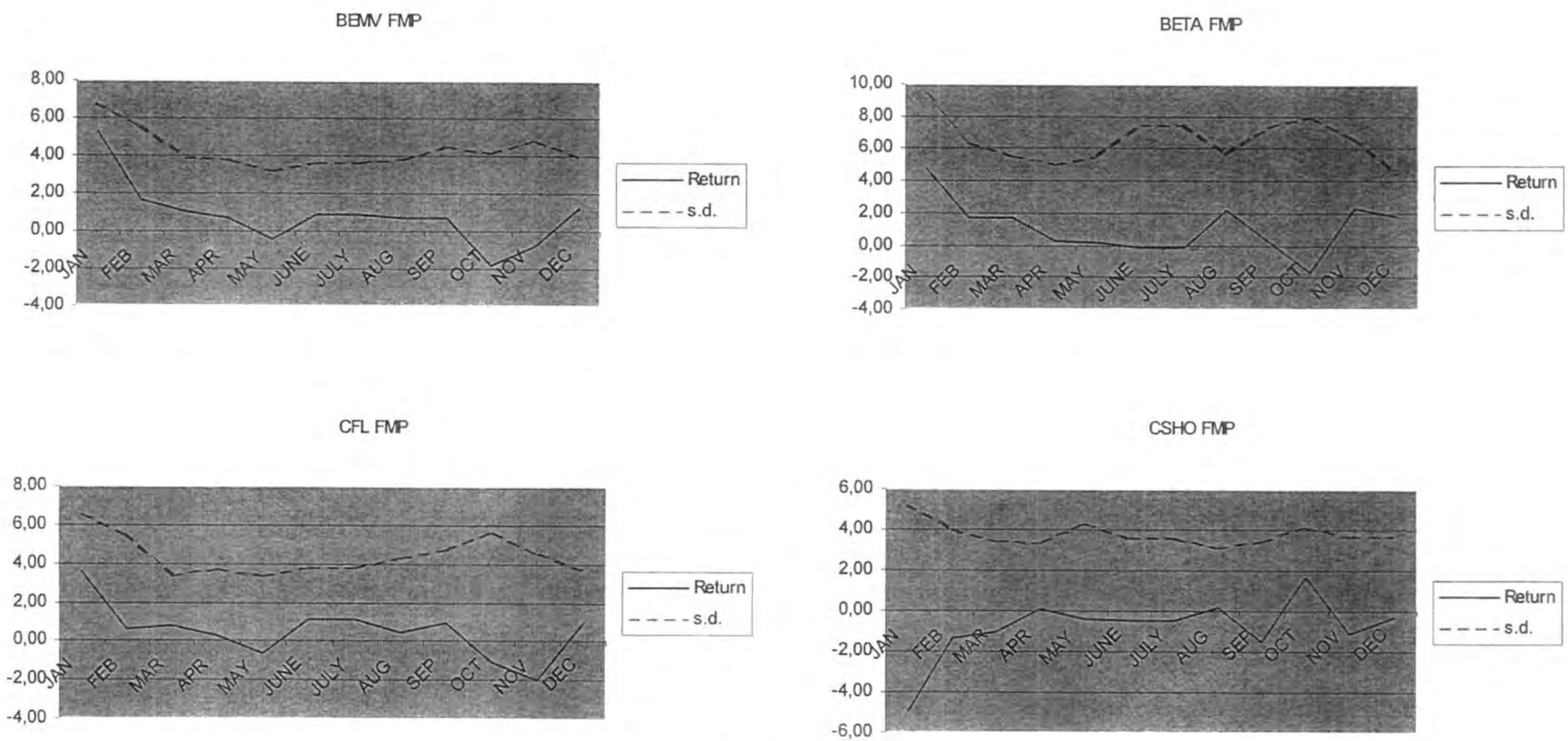
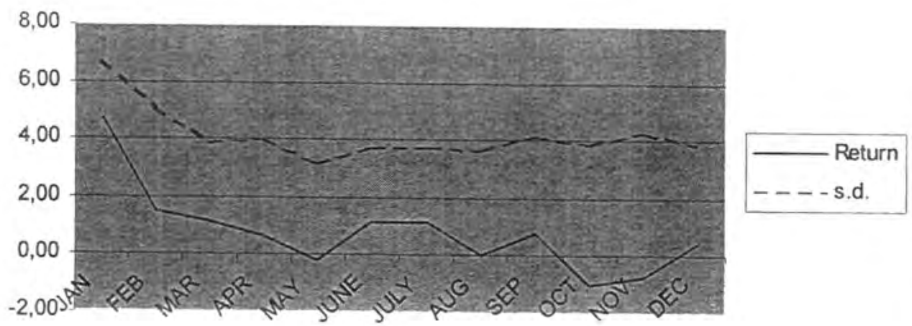

CAR60 FMP
8,00
6,00
4,00
2,00
0,00
-2,00
-4,00
-6,00
JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC
Return
s.d.

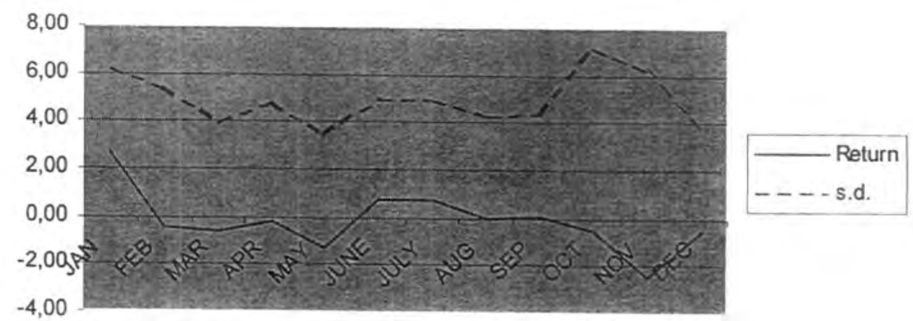
FIGURE 3.2
RETURN AND S.D. OF THE VALUE-WEIGHTED FMP ACROSS MONTHS



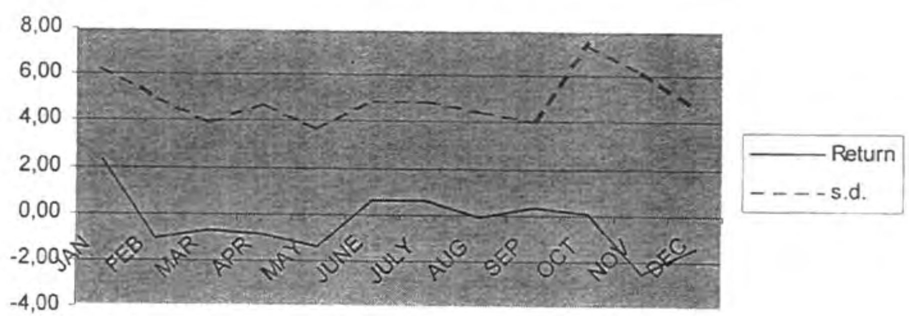
DEBT FMP



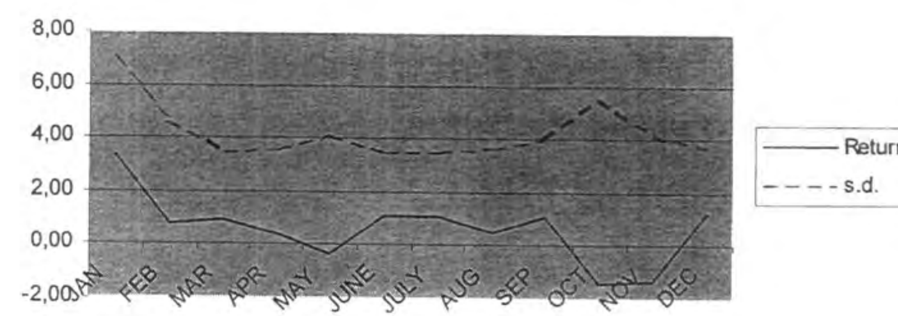
DIVCOM FMP



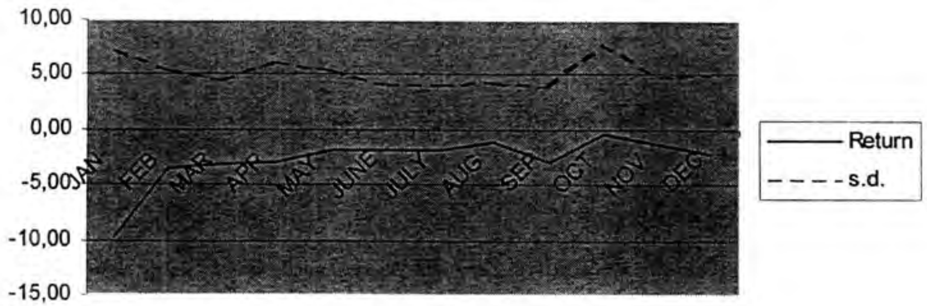
DIVSUM FMP



EP FMP

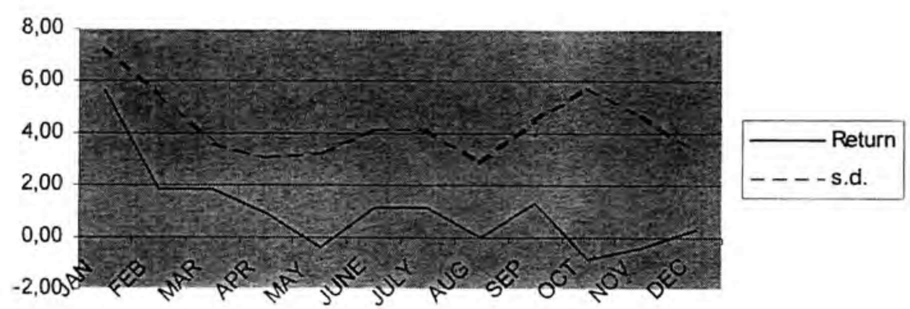


MV FMP



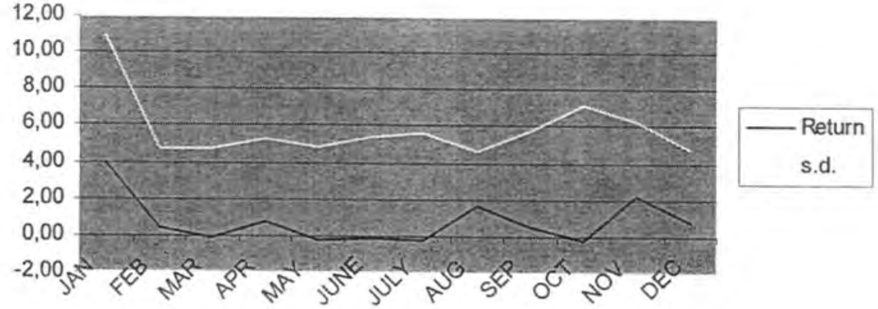
PRICE FMP

SALE FMP

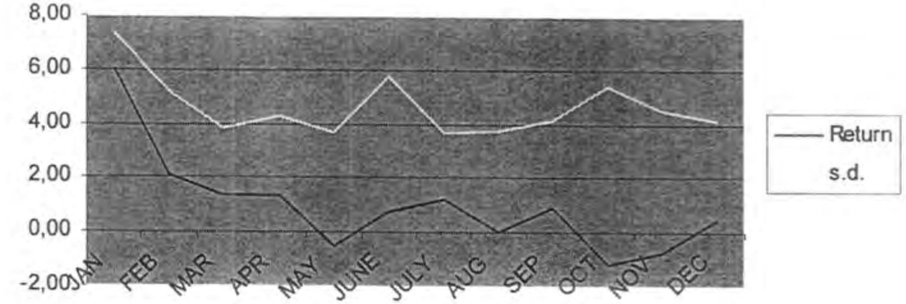


GROWTH FMP

TR FMP



TAMV FMP



CAR12 FMP

CAR60 FMP

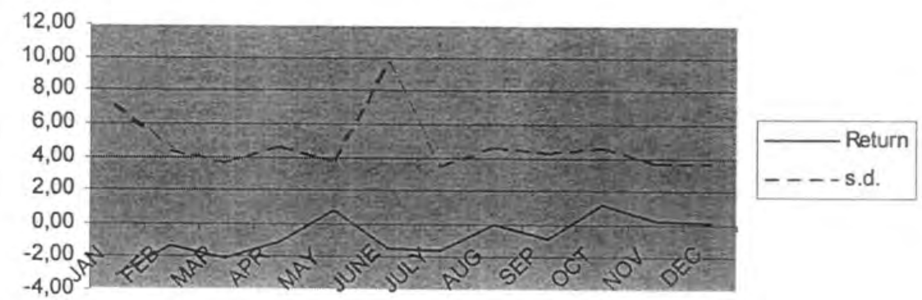
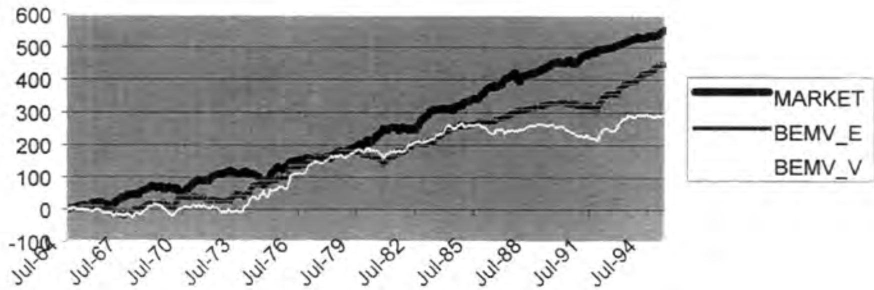
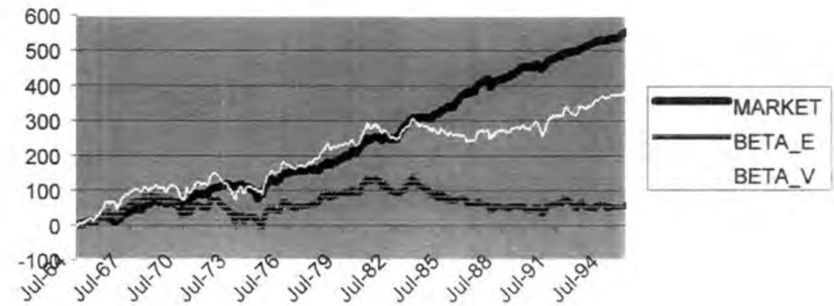


FIGURE 3.3
CUMULATIVE RETURNS OF THE FMP PORTFOLIOS AND THE MARKET PORTFOLIO

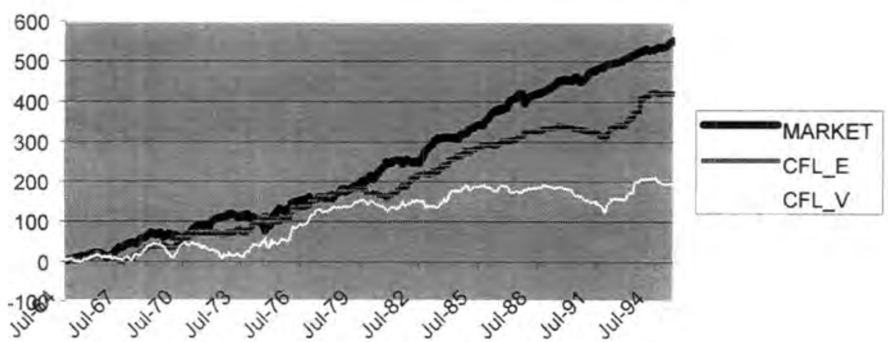
CUM RETURNS OF THE BEMV FMP



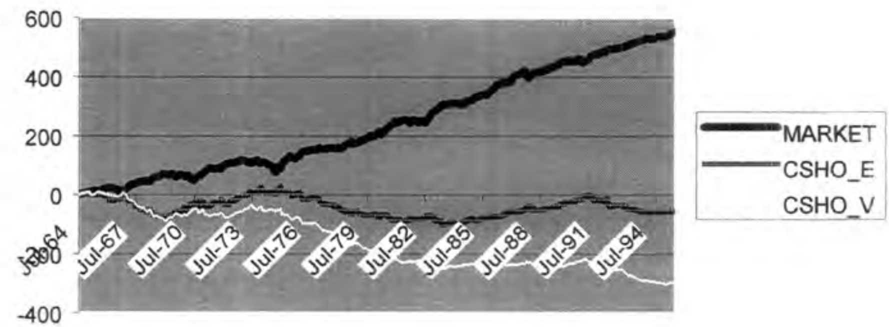
CUM RETURNS OF THE BETA FMP



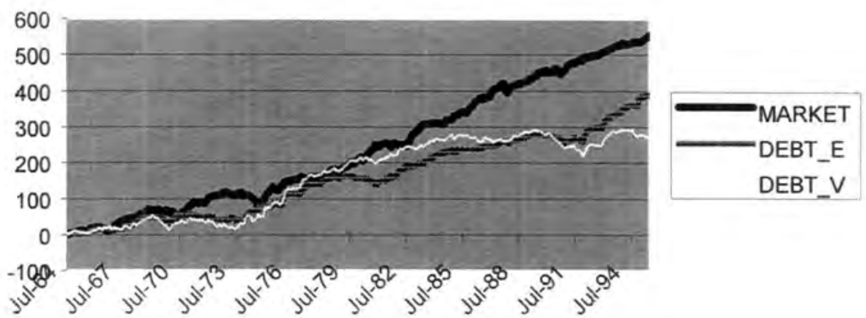
CUM RETURNS OF THE CFL FMP



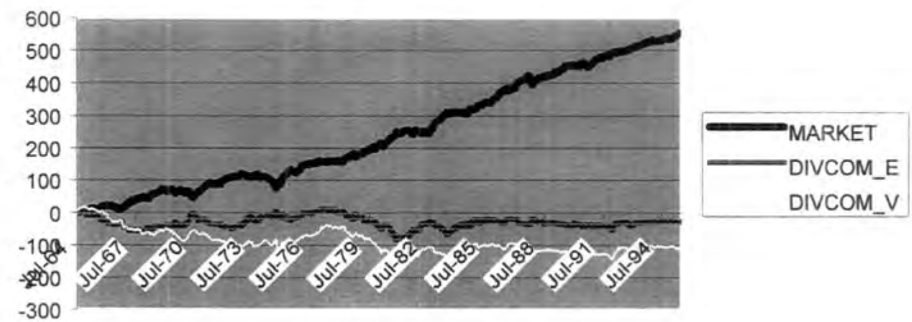
CUM RETURNS OF THE CSHO FMP



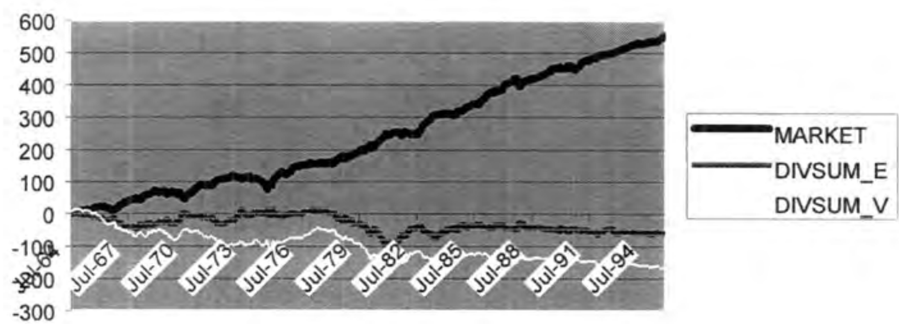
CUM RETURNS OF THE DEBT FMP



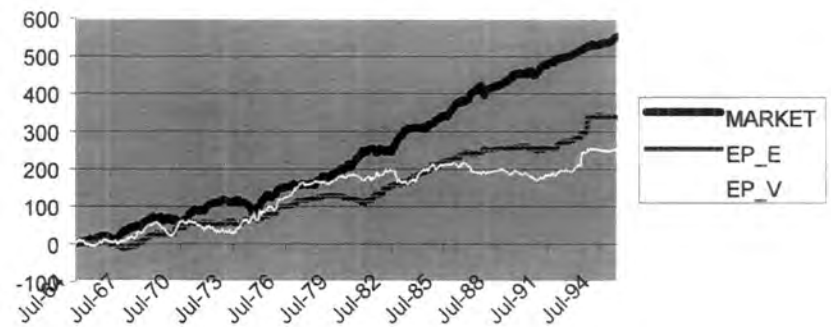
CUM RETURNS OF THE DIVCOM FMP



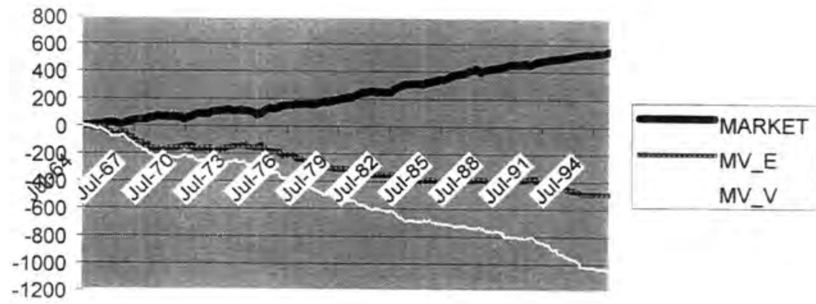
CUM RETURNS OF THE DIVSUM FMP



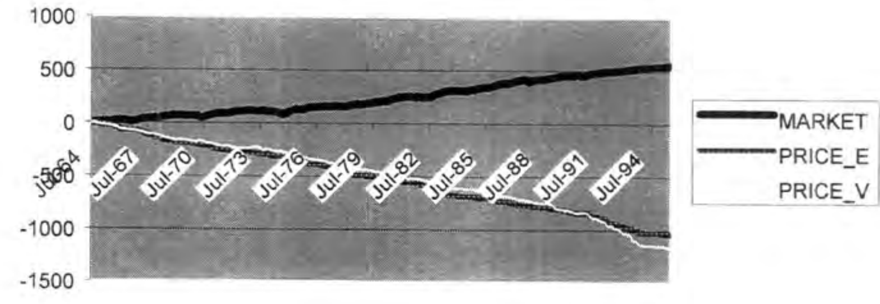
CUM RETURNS OF THE EP FMP



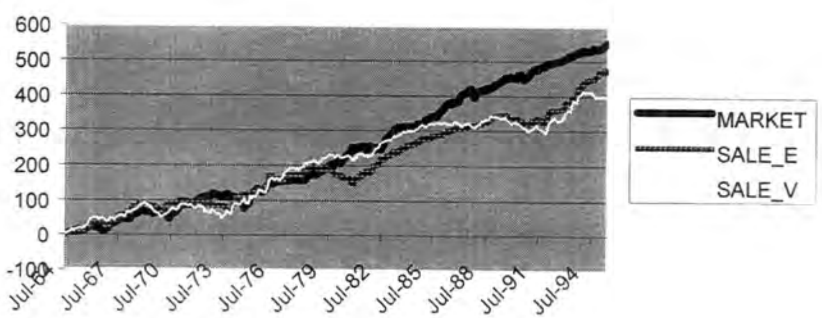
CUM RETURNS OF THE MV FMP



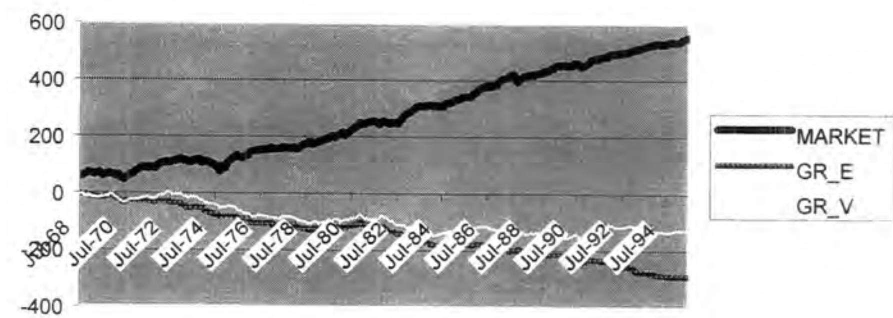
CUM RETURNS OF THE PRICE FMP



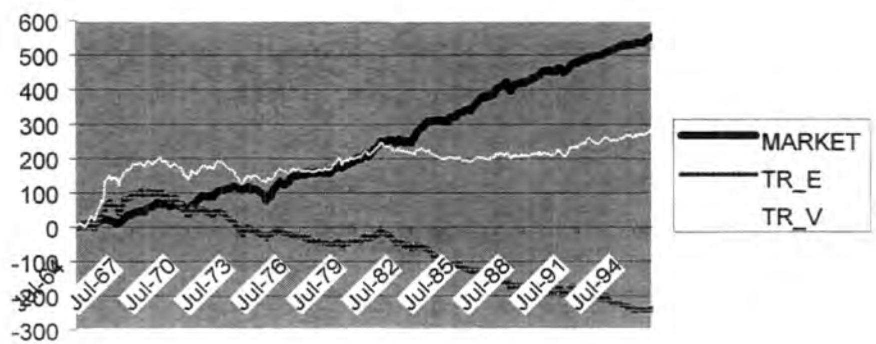
CUM RETURNS OF THE SALE FMP



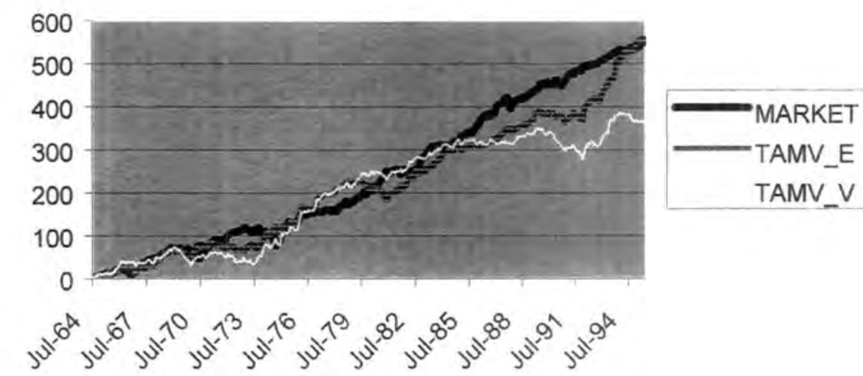
CUM RETURNS OF THE GROWTH FMP



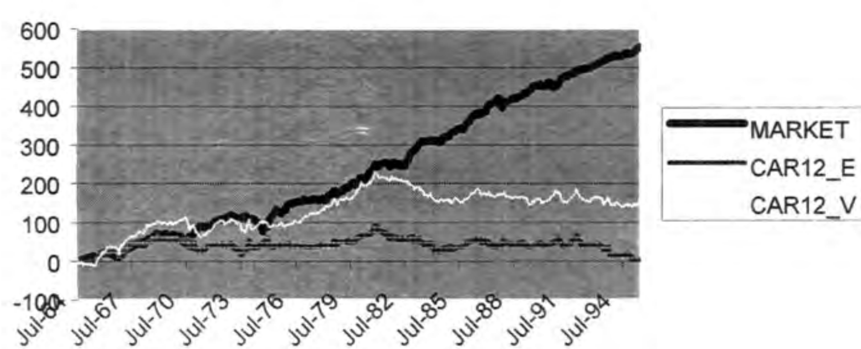
CUM RETURNS OF THE TR FMP



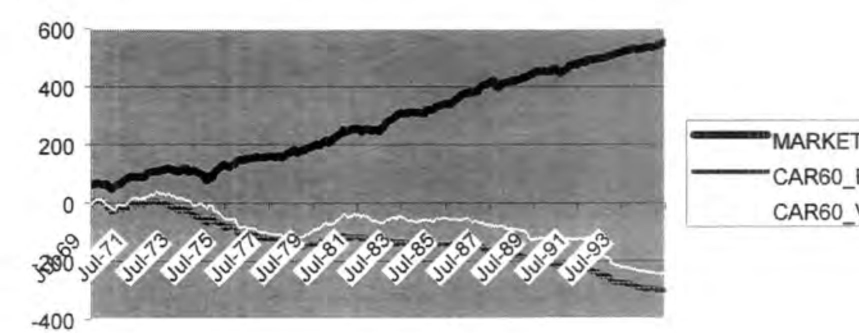
CUM RETURNS OF THE TAMV FMP



CUM RETURNS OF THE CAR12 FMP



CUM RETURNS OF THE CAR60 FMP



Chapter 4

Time-Series Properties of the Factor Portfolios Risk-Adjusted Expected Returns

4.1 Introduction

The identification of the risk factors through the employment of factor mimicking portfolios establishes the first stage towards the isolation of the important factors for the determination of expected stock returns. This specific examination in the previous chapter revealed the variables that introduce high volatility in return spread across portfolios of the same factor. The presence of this high volatility is evidence that the particular factor captivates the systematic components of stock return variation. Furthermore, we also presented the factor portfolios that achieve the highest performance in terms of realised mean returns which transmits important information for portfolio management.

However, a simple presentation of the overall performance is not sufficient for an explicit conclusion over a factor's significance. Important issues arise for the risk-adjusted excess returns of specific strategies and the persistence of these excess returns over long periods of time. The bulk of the debate in the financial empirical research is concentrated on the power of the market portfolio to absorb the excess return on any specific strategy. Evidence in the empirical literature for the failure of the market portfolio to introduce the sole source of priced risk, the beta, has initiated the exploration of additional sources of risk.

A preliminary approach towards the examination of the beta power to capture the magnitude of the high returns accommodates a general trend to justify the power of a factor by comparing the spread between the returns of extreme portfolios and the corresponding risk spread measured with the market model. In cases where there is no adequate beta spread to account for high return spread, an explicit conclusion is reached for the failure of the capital asset pricing model. In some of the cases an even more restricted procedure has been adopted where the performance of factor portfolios was examined with the magnitude of market adjusted returns where the adjustment was calculated as the difference between the actual portfolio returns and the market portfolio returns. The problem with this analytical technique is that it does not take into account the dimension of the systematic risk effect. Furthermore, the comparison of absolute differences between return and risk spread is not adequate to powerfully infer on the empirical failure of the capital asset pricing model.

However, this simplistic risk-return examination of individual factor portfolios is sufficient to analyse another important topic in this area of research, the seasonality issue. Although some first insights into this subject were presented with the analysis of the factor mimicking portfolio returns, a more robust approach is adopted with the employment of decile portfolios as it makes feasible the isolation of the seasonality patterns into specific subsets of assets. In addition, we are able to test the significance of the return-risk relation and its stability across separate months.

In terms of empirical methodology, the most common approach towards the examination of the market portfolio power is the test of the constant significance in the market model with the portfolio returns as the dependent variable. One of the basic assumptions of the CAPM is that there is no excess return after adjusting for market risk i.e. the constant should be zero. This is the rationale behind the initial time-series tests of the CAPM according to *Black, Jensen and Scholes, BJS (1972).* Subsequent research applied this methodology to test the significance of additional factors as earnings/price ratio (*Basu, 1977*), dividend payout (*Litzenberg and Ramaswamy, 1979*), market value (*Banz, 1981*) and book-to-market ratio (*Rosenberg, et., 1985*). However, the initial results for the excess risk-adjusted performance of portfolios on the basis of these variables were inferred from univariate t-tests on the constants' significance. This raises the problem of unanimous conclusion over a factor's significance.

The evidence based on the previous tests for the inadequacy of the CAPM initiated the introduction of additional risk sources. *Fama and French (1992)* strongly verified the failure of the beta to capture the cross-sectional dispersion of stock returns and the power of two other factors, the market value and the book-to-market variables, to absorb what beta left unexplained. This proof led to the construction of two portfolios which present additional risk sources that should be priced, the small size and the distress factor. The first risk factor is presented with the Small-Minus-Big (SMB) portfolio and the second risk source with the High-Minus-Low (HML) portfolio, as described in *Fama and French (1993)*. The argument is that the inclusion of these two portfolios with the market portfolio absorbs any excess returns reported in specific factor portfolios. This has been empirically supported with the consideration of time-series models and the familiar test for the null hypothesis of zero constant.

In the following sections, we re-consider the evidence for the failure of the market portfolio as the sole source of priced risk. More specifically, we present evidence about the time-series properties of the factor portfolio risk-adjusted excess returns over a long period of time where the adjustment for risk procedure includes the market portfolio as well as the new risk portfolios on the basis of market value and book-to-market variables. The portfolios are formed from the initial factors that have been introduced in the empirical literature and their examination is extended to consider more recent factors. The methodology employed to test the CAPM and the three-factor model is also extended to accommodate more issues for the rebalancing procedures as well as new evidence from multivariate tests for the constant significance that bear advantages over the previously described traditional examinations for the market portfolio power.

The chapter is structured as follows. In section 4.2 we describe the methodology of constructing the factor portfolios on the basis of one-way and doubled-sorted procedures and we present the formation of the hypothesis for insignificant risk-adjusted excess returns with the employment of time-series models. The empirical results from the examination of decile factor portfolio returns and the time-series tests are reported in section 4.3 and the conclusions of this chapter are presented in section 4.4.

4.2 Methodology and Hypothesis Formation

The empirical research in the following section employs the univariate factor portfolios whose structure has been described in the methodology section of the previous chapter. However, the basic examination is not applied in factor mimicking portfolios but it is based on ten portfolios constructed from individual factors with annual rebalancing and equally- and value-weighted return calculation procedures. Some of the empirical studies have included in the portfolios only the stocks with available data for all the factors under examination, which reduces substantially the number of firms in the empirical tests. We choose to follow the more general approach in the empirical literature where the individual factor portfolios consist of the firms that have available data on the specific factor. The rationale for this approach is that the introduction of these factors as priced risk sources has been based on empirical tests with available data for the particular factor. Thus, the restriction in the number of eligible firms according to the availability of all factors introduces biases in the significance of individual factors and presents results which are not directly comparable with initial tests. Furthermore, the restricted approach introduces look ahead biases as only firms with specific valid information are included. However, for comparability reasons with some of the leading papers in this area of research we also examine the performance of factor portfolios where we impose the restriction of availability in a subset of factors before we include stocks in the portfolio.

Thus, the first approach in the current methodological issues is the division of stocks into ten portfolios on the basis of individual factors in order to examine the spread in return across the deciles. The presence of high return differences between extreme portfolios is an indication of excess performance for the specific factor. Then, we move on to examine the spread in volatility and the risk of the portfolios where the risk is measured as the beta from the market model over the whole time period. In addition, we report the Dimson beta which is corrected for nonsynchronous bias as it is the sum of the coefficients on the current and the lagged one period market portfolio. The purpose is to infer whether the spread in risk on the CAPM basis is adequate to justify the return spread in the powerful factors.

The risk-return analysis of the factor portfolios provides some indications about the factors' power but not a definite argument for the failure of the CAPM. Prior to a more robust approach towards this direction, it is very useful to employ the decile portfolios in order to facilitate the examination of seasonality patterns as we can test more thoroughly the magnitude of the January and the October effects. The formation of the hypothesis for the empirical tests is similar to the proposition by *Rogalski and Tinic (1986)* where the following regression model is estimated

$$R_{pt} = \sum_{i=1}^{12} a_{pi} D_{it} + e_{pt} \qquad (45)$$

The dummies are set for individual months and we report the p-values from the F-test that the mean returns in each of the ten portfolios are equal across the months. In the case where we reject the hypothesis of equal monthly returns, we proceed to test whether we can justify the return inequality on the basis of different volatility as well. The equality of the portfolio's standard deviations across the months is tested with the Bartlett's test

$$M = \frac{(T-m)\ln\hat{\sigma} - \sum_{i=1}^{m}(T_i - 1)\ln\hat{\sigma}}{1 + [1/3(m-1)][\sum_{i=1}^{m} 1/(T_i - 1) - 1/(T-m)]} \sim \chi^2_{m-1} \qquad m = 1,2,\ldots,12 \text{ months}$$ [17]

(46)

The equality tests are also performed for the beta variables. These empirical tests in combination with chi-square tests for the significance of volatility across months are sufficient in order to reach a clear view of the seasonality patterns.

Up to this stage of the current thesis, the focus of the research has been concentrated on the performance of univariate factor portfolios. However, the vast

[17] *Judge, G. et.*, "The Theory and Practice of Econometrics", Ch. 11

evidence in the empirical literature concerning the importance of an immense number of factors raised serious doubts about the presence of strong interrelations between them. A suggested approach by *Jegadeesh (1992)* to partially examine this possibility is the subdivision of the stocks in each portfolio on the basis of a second criterion. The justification of this procedure is that if there isn't adequate return spread within the subdivided portfolios, the first grouping factor is more significant than the second criterion. To examine this scenario, we divide the stocks to five market value portfolios according to NYSE breakpoints and within each group we subdivide stocks to five portfolios according to NYSE breakpoints for PRICE, TR, GR or BEMV factors. The choice of the second sorting factor is based on evidence from the factor mimicking portfolio examination and previous results in the empirical literature for these factors' significance. Thus, in June of every year we construct the 25 portfolios and the equally- and value-weighted returns are calculated for the following twelve months and, thus, at the end we present results for the overall performance during the whole period of 372 months.

Although the above procedure of subdivision is the common methodology in order to mitigate the correlation between factors, we apply another approach for portfolio construction which has not been considered in recent research. The initial paper that employed this methodology was by *Basu (1983)* who argued that the control of confounding effects raised from factors' association could be lifted with randomised portfolios. More specifically, after the first sorting according to the market value variable and the subdivision according to the second criterion, we form five portfolios from the lowest BEMV, GR, PR or TR groups relative to the five market value classes. Thus, the resulting new five portfolios on the basis of the second factors are free of market value effects and their time-series properties can be examined more objectively.

Although the primary investigation in the empirical section is the re-examination of the evidence against the CAPM implication for zero risk-adjusted excess returns, we cannot ignore the popular FF 1993 three-factor model which asserts that the CAPM inadequacy can be restored with the consideration of a multifactor model. Thus, another set of portfolios constructed for the empirical tests in this chapter consists of the two portfolios that have been suggested in the literature as additional to market portfolio risk sources. These portfolios are the SMB and HML risk portfolios that are constructed to mimic the risk variables of market value and book-to-market ratio. The formation procedure follows the suggestions by *Fama and French (1993)* and the more detailed presentation of *Daniel and Titman (1997)*. Every June in the period 1964-94, we rank the NYSE stocks into two market value deciles and three book-to-market deciles. After determining the breakpoints according to these deciles, we assign the NYSE, AMEX and NASDAQ firms into the two MV deciles designated as S for small firms and L for large firms. We also place the firms into the three BEMV deciles where the portfolio below the 30% book-to-market breakpoint is designated as L, the middle 40% of the firms as M and above 70% as H. Six value-weighted portfolios are resulted from the interaction of these portfolios, HB, MB, LB, HS, MS and LS. The formula for the calculation of the SMB portfolio returns is: SMB = ((HS+MS+LS)-(HB-MB-LB))/3 and for the HML portfolio returns: HML = ((HB+HS)-(LB-LS))/2. With this set of portfolios we complete the methodological part devoted to the description of the applied dataset in the empirical tests.

The inferences drawn from the examination of one-way and doubled-sorted factor portfolios establishes an essential framework for the subsequent investigation. Following the description for the portfolios' construction and the framework for the their performance and the seasonality examination, we proceed to the direct CAPM test. Thus, the next vital question for the factors' significance is whether their portfolios can achieve abnormal returns where the term abnormal refers to performance above the risk-adjusted returns with the inclusion of the market portfolio. The time-series regression methodology is the common procedure towards this direction.

The general model of the CAPM is $f_i = E(R_i) = R_f + \beta_i E(R_m)$. To test against an alternative e.g. the significance of the size effect in the determination of the expected returns as an additional source of risk, we could also include the specific factor in the above specification of the model $E(R_i) = f_i + \gamma_3 MV_i$. Then the null hypothesis tested is that $\gamma_3 = 0$. Instead of testing the null hypothesis in the cross-sectional regressions (a test conducted in the subsequent chapter), the equivalent methodology (BJS) is to sort the stocks into portfolios according to the factor under scrutiny (e.g. market value), calculate the portfolio returns and regress the time-series of monthly excess (over the TB) returns on the market index[18]

$$R_{pt} - R_{ft} = a_{pt} + \beta_p (R_{mt} - R_{ft}) + e_{pt} \quad (47)$$

Thus, the counterpart test is whether the intercepts of the decile regressions are all jointly zero. This hypothesis can be tested with the simple t-test for zero coefficients. The problem with this test is that a concrete and definite rejection of all the constants for all the 10 decile portfolios is not feasible and we obtain mixed conclusions as the CAPM failure is generally restricted in subsets of portfolios.

The limitations of the univariate t-tests direct the empirical research into multivariate tests for the constants' significance. Thus, a more appealing test statistic is the Loglikelihood Ratio Test (LRT) for the joint constant significance of all the 10 portfolios. With this test, we estimate the initial regression and subsequently a restricted version of the model with the restriction of zero constants for all the portfolios. The test statistic is $LRT = T[\log[|\hat{\sum}_r| - \log|\hat{\sum}_u|] \sim \chi^2_n$ where $|\hat{V}_r|$, $|\hat{V}_u|$=the determinants of the variance-covariance residual matrix from the restricted and the unrestricted model and n = number of restrictions. Thus, the power of the CAPM is confirmed if the LRT accepts the null hypothesis of valid constraints.

However, much controversy has been raised over the tendency of the LRT to reject or accept the null hypothesis too often and it is under criticism for its weakness. Thus, for robustness check of the results we also employ the alternative F-test suggested by *Gibbons, Ross and Shanken (1989)* (GRS) for the multivariate joint constant significance that provides evidence as well for the mean-variance

[18] *Breek, Korajczyk (1995)*, "On selection biases in book-to-market based tests of asset pricing models", p. 18

efficiency of the value-weighted market index. Thus, for each of the ten factor portfolios we estimate the familiar regression

$$r_{pt} = a_{pt} + \beta_p r_{mt} + e_{pt} \qquad (48)$$

From this regression results we calculate the test statistic

$$W = \hat{a}_p' \hat{\Sigma}^{-1} \hat{a}_p / (1 + \theta_m^2) \qquad (49)$$

where $\hat{a}_p$ = the vector of estimated constants for all the 10 portfolios

Σ = estimated variance-covariance matrix of the residuals and $\hat{\theta}_m = \bar{r}_m / \sigma_m$

The adjusted test statistic follows a F-distribution i.e. T(T-N-1)/N(T-2)W ~ F with N, (T-N-1) degrees of freedom where T is the number of observations and N is the number of portfolios. Testing the significance of this statistic is a robust examination of the hypothesis of zero constants.

Following the empirical tests for the CAPM rejection or confirmation as a valid model in the financial practice, we proceed to estimate and, thus, examine the power of the popular FF 1993 three-factor model with the additional consideration of the two new risk sources in the model

$$R_{pt} = a_{pt} + \beta_p (R_{mt} - R_{ft}) + s_p SMB_t + h_p HML_t + e_{pt} \qquad (50)$$

The zero abnormal performance i.e. zero constant is tested as well with the employment of the two familiar LRT and the modified GRS F-test with the corresponding formats of

$LRT = -(T - N/2 - K - 1)[\log|\hat{\Sigma}_U| - \log|\hat{\Sigma}_R|] \sim \chi_N^2$ where K = number of factors

and

$\frac{T}{N} * \frac{T-N-L}{T-L-1} * (1 + \bar{r}'_L \hat{\Omega}^{-1} \bar{r}_L)^{-1} * \hat{a}'_p \hat{\Sigma}^{-1} \hat{a}_p \sim F_{N,T-N-L}$ where

r_L = vector of sample means = $(r_{1t}, r_{2t}, \ldots, r_{Lt})$

$\hat{\Omega}$ = sample variance-covariance matrix of the L (=3) explanatory portfolios

Thus, this is the general framework for testing the absence of time-series excess risk-adjusted returns as an important implication of a valid asset-pricing model, which is applied in the traditional CAPM and the more recent three-factor model.

The above methodology of constructing the portfolios and the tests for estimating the time-series properties of the factor portfolio returns are primary issues for consideration in current trends of financial research. However, a great deal of confusion has been raised on the importance of either the one- or three-factor model in their role to absorb the abnormal returns. In the following section we will clarify some major points over the joint constant significance and we will discuss upon sources of divergences for various portfolios.

4.3 Empirical Results

4.3.1 Return and Risk Spread

In the first part of the current empirical research, in addition to the examination of the factor mimicking portfolio performance in the previous chapter, we complement the analysis with a more thorough study of the return-risk spread within the 10 portfolios for each factor. In Table 4.1 we present the mean returns, standard deviations and betas of each of the 10 portfolios for all the factors. We also report the Dimson corrected beta for nonsynchronous bias under the variable with the name SUMBETA. The purpose is to compare between the magnitude in the return differences across the low and the high portfolios and their risk differences. The main difference between this table and previous evidence for factor portfolio returns, *as in Fama and French (1997)*, is the magnitude of the returns. In Table 4.1 we observe higher mean returns between the lowest and the highest portfolio and the source of this magnitude is the relaxation of the restriction for data availability in all the factors. However, the evidence is consistent with relevant studies that have also relaxed the above restriction as in *Hawanini and Keim* (1997). Furthermore, the returns reported are time-series mean returns whereas the excess returns over the one-month Treasury Bill rate are closer in magnitude to the excess returns reported in FF.

The important point about this table is not the magnitude of the returns but the differences in returns and risk between extreme portfolios which are consistent with previous empirical studies. The last column in the Table presents the difference between the figures of the highest and the lowest portfolios. The patterns in MV and EP portfolios are very similar to previous evidence by *Keim (1990)* where lowest MV and highest EP portfolios have highest return than the opposite extreme portfolios. However, the high returns of the low MV portfolios could be explained in terms of highest beta whereas the same does not apply for the EP portfolios. Equivalent to the MV portfolios performance is the risk-return relation in the PRICE and DIV portfolios. On the other hand, the pattern present in the EP portfolios applies also in the CFLP, BEMV and CAR12 portfolios, evidence consistent with *Fama and French (1997)*. On the contrary, the high returns of the large SALE, DEBT and TAMV portfolios could be a justification of higher risk. Finally, another distinctive pattern is present in the GR, CAR60 and TR portfolios where the return difference is negative whereas the risk difference is positive.

The previous examination confirms the evidence from the factor mimicking portfolios and the empirical literature about the direction of each factor's influence on the return performance. The mixed and contradictory results are present in the beta spread where in almost all the cases is not adequate to justify the return spread whereas in some cases does not even follow the return direction. However, the beta spread increases substantially with the Dimson beta, evidence consistent with *Ibbotson, et. (1997)* for better results obtained for the beta power when we correct for nonsynchronous bias. Specifically with the MV portfolios, the sumbeta increases substantially in the low portfolios as the infrequent trading problem is more severe for the small market capitalisation firms. et, even this increase in risk spread's magnitude with the Dimson beta is not sufficient to save the beta power.

With the BETA portfolios, we confirm the evidence by *Chan, Lakonishok (1994)* that there is a positive relation between betas and average returns. Confirming the evidence with the factor mimicking portfolio return regressions on a constant, the striking evidence in the BETA portfolios is the fact that there is no return spread in the equally-weighted portfolios in contrast with the value-weighted portfolios. On the contrary, in the majority of the rest of the portfolios we observe a decrease in return spread with the value-weighted procedure. Two additional points that are noteworthy from this examination is once again the reverse in the TR effect between the two rebalancing functions and the immense difference in the returns between low and high PRICE portfolios in contrast with the low spread in their betas.

Although there is evidence of return spread within most of the ten portfolios constructed on individual factors, there is also the possibility of interrelation between some of these factors. The conventional method for isolating the factors whose significance cannot be attributed to presence of correlation with other factors is the application of cross-sectional tests, which is examined in the subsequent chapter. In the current section, we take into account the correlation matrix of the factor mimicking portfolios in Table 3.4 and we form multivariate portfolios where the correlation is mitigated with subdivision procedures. Thus, we chose to form market value portfolios because of the persistent evidence of this factor's significance and further subdivide each portfolio on the basis of the additional factors of PRICE, TR, GR and BEMV in the spirit of *Lakonishok, Shleifer and Vishny (1994)* and *Fama and French (1997)*. The higher magnitude of returns is also present in the multivariate sorting of the portfolios and the rationale is the same for the one-way sorted portfolios.

The presence of adequate spread across MV portfolios and the absence of sufficient return differences within each MV portfolio could provide evidence of the power of the MV factor over the second sorting criterion. In Table 4.2 we can observe that within each MV equally-weighted portfolio there is substantial return spread to justify the importance of the second criterion in addition to the market value significance. With value-weighted returns we detect lower spread within each MV portfolio according to BEMV and TR factors. The highest return spread is present in the PRICE subdivision procedure which remains strongly substantial in both rebalancing procedures and in all the portfolios. However, for the rest of the multivariate portfolios the high return differences occur within the lowest market value portfolios whereas we observe a substantial decrease in higher portfolios.

Evidently, the primary advantages gained from the application of multivariate portfolios are the mitigation of factor interrelation problems and the achievement of higher return spread. Thus, the more thorough examination of these portfolios' volatility and betas would not provide additional useful insights for the factors' power over the CAPM.

In sum, the preliminary analysis of the return-risk spread across the factor decile portfolios confirms, even with the inclusion of NASDAQ stocks, evidence in the empirical literature for the high returns of low or high attribute stocks and the failure of the CAPM beta to justify the magnitude of the return differences across extreme decile portfolios. However, some more specific points have been identified which are examined more thoroughly in subsequent section after an analysis of seasonality patterns.

4.3.2 Seasonality Issues

A first look in seasonality patterns was presented in the previous chapter with the factor mimicking portfolio returns. However, the introductory notes for this subject were quite preliminary, as the seasonality issue has been proven present in subsets of factor portfolios. More specifically, it has been argued that the January effect is the driving force behind the excess returns of factor portfolios of stocks with growth prospects e.g. small market value. As the January high performance is not present in large stock returns, the whole issue of profitable factor strategies could be a mere representation of a January seasonal pattern in certain portfolios.

The primary test in this area of research is the examination of the January returns' magnitude in comparison with the rest of the months. Although the bulk of research has been concentrated in the MV portfolios, we extend the test to accommodate all the factors. Thus, in the Table 4.3 we present the results from the F-tests for the examination of the equality or the presence of specific patterns in the factor portfolio returns across months. Under the ALL column we report the p-values of the F-test that the mean returns are equal for all the months whereas under the JAN column we report the results from a similar test excluding the month of January. The tests are performed for both the equally- and value-weighted returns.

From the examination of return equality across all the months, it is evident that the null hypothesis is not accepted for all the ten portfolios. More specifically, the p-values are quite low for the subsets of portfolios that exhibit high growth prospects i.e. high BEMV, CFL, EP, DEBT, SALE, TAMV and low MV, PRICE and GR characteristics. The portfolios with homogeneous results of unequal returns for all the months are the equally-weighted BETA and TR returns, confirming the evidence by *Data, Naik and Radcliffe (1993)* for the presence of the liquidity effect throughout the year. More generally, the common result in all the cases is that with the exclusion of the January month we strongly accept the null hypothesis of equal returns across the rest of the months. Thus, we cannot evade the presence of the highest performance for all the strategies in the month of January.

Although these results are not contradictory to previous evidence, the unexplored patterns are present with the value-weighted returns. Under the corresponding JAN column, the number of p-values higher than 0.05 that accept the null hypothesis of equal returns is substantially increased for most of the portfolios. This evidence is quite important for the interpretation of the presence of high return premia for a very limited number of factor portfolios as proved in the previous chapter and for the risk-adjusted excess returns evidence in the subsequent sections. More specifically, with value-weighted rebalancing procedure the cases where we observe unequal monthly seasonal returns consist of the lowest portfolios of each factor. Thus, with the equally-weighted portfolios at least the five smaller of larger portfolios exhibited January seasonal whereas with the value-weighted procedure the evidence is confined the most to two portfolios. Quite evidently, the January effect seems to be a manifestation of the small size effect as its alleviation strongly mitigates this specific seasonal pattern. The same argument has been put forward by *Ritter and Chopra (1989)* who found elimination and not mitigation of the January seasonal with MV value-weighted returns and only NYSE firms. The suggested points for justifying the high January equally-weighted returns were the tax-loss selling hypothesis and the managers' 'window dressing' engagement in the end of year rebalancing decisions.

Additional noteworthy conclusions from Table 4.3 are the patterns in the PRICE, BETA and TR value-weighted portfolios. The January effect is evidently present in the equally-weighted portfolios and it is eliminated with the value-weighted returns. However, evidence in the previous chapter and subsequent research shows that the value-weighted PRICE portfolios exhibit high return premia that cannot be attributed to the January effect. The same argument cannot be drawn for the MV and SALE portfolios.

The next step in the analysis of the seasonality issues is the examination of variance and portfolio betas across the months. The rationale for this approach is to examine whether the high January returns are just compensation of higher risk. With this scenario, the January effect cannot be considered as an anomaly as it can be explained in the current framework of risk-adjusted returns. The Bartlett's test described in the methodology section is employed to examine the hypothesis of equal variance and betas for all the months. The results are homogeneous and robust for all the cases and can be easily described without a corresponding table. The null hypothesis of equality is strongly rejected for all the portfolios and in both scenarios for the exclusion or not of the January month. Thus, the direct evidence is that the volatility and the systematic risk of the factor portfolios are not stable across months even without January. The open issue in this case that cannot be sufficiently explored is whether the inequality in the variances and betas between the January and the rest of the months is adequate to explain the high January returns. Thus, the feasible conclusion that can be drawn from this examination is that the January effect could be a justification of high betas, as we cannot accept the hypothesis of equal risk across the months. Moreover, we cannot adequately examine the issue of whether the failure to justify the January high returns by means of higher risk is just a manifestation of the risk mismeasurement hypothesis.

As the focus of the seasonality examination was centred on the high January returns, any subsequent research was also conducted towards this direction.

However, in the previous chapter we reported another seasonality issue which has not been adequately pursued in factor models. More specifically, in Tables 4.4 and 4.5 we present the p-values of a chi-squared test for the significance of portfolio volatility across individual months. As anticipated, the January column contains very low p-values as in this month the volatility is very high and it is also priced in terms of returns. The innovative result in these Tables is the high volatility in the month of October. As shown, in the rest of the months the p-values accept the null hypothesis of insignificant volatility whereas in October we fail to accept this hypothesis. An argument to justify this result could be the fact that it is driven from the October 1987 crash. Nevertheless, we have already taken into account this possibility and the results in the Tables are free of the October 1987 large increase in volatility. Indications about the October effect have been also presented by *Glosten, Jagannathab and Runkle (1993)* in the framework of a GARCH-M model and with emphasis on the NYSE stock market index. The puzzle surrounding the presence of the October high volatility pattern is that it is not rewarded with sufficiently high returns and at the same time the October returns have always the opposite sign than the January returns. Furthermore, the January effect is accompanied by some rational explanations for its existence whereas there has not been any logical or risk stories behind the October effect. The employment of the value-weighted returns in Table 4.5 results in mitigation of the January and October effects but still the magnitude is considerable.

To sum up the seasonality results, the thorough examination of the January effect was based on evidence for the presence of the highest returns at this particular month that was strongly confirmed in the current research. The part that remains unanswered is whether these high returns are compensation for risk and there is a great deal of debate over the characterisation of the January effect as an anomaly pattern, mismeasurement hypothesis or a risk story. However, this seasonality pattern is substantially mitigated with the employment of value-weighted returns. In addition, we report another significant seasonality pattern present in the October month where there is high return volatility not highly priced in terms of returns.

4.3.3 Time-series Analysis of the one- and three-factor models

4.3.3.1 Univariate Sorting Portfolios

The analysis in the previous chapter was concentrated on the performance of the factor mimicking portfolio returns and the regression analysis was based on these returns to examine the robustness of the return premia. However, as it was mentioned in the methodology section, to test the validity of CAPM over the beta-return relation and the significance of additional variables, the regression analysis should be extended to include all the ten portfolios from individual factors. Then, the testable hypothesis is that all the constants from the ten portfolio return regressions on the market index are zero. The easiest way is the t-test for zero constants as are reported in Table 4.6. However, the t-test is performed in each of the 10 portfolios and, as it is evident from the Table, we reach mixed results as only some of the constants are zero. As far as the BETA portfolios are concerned, we observe that generally the constants' t-statistics lead to the acceptance of the null hypothesis for zero excess returns. This result is consistent with the evidence by BJS (1972) in addition with the observation that constants are positive for betas lower than one and the reverse. As it was mentioned in the literature review, this evidence is consistent with the Black's version of the CAPM which will be further examined in a subsequent chapter.

The more robust test for the constant significance in the time-series regression of the ten factor portfolio returns on the market index is based on the GRS F-test and the results are reported in Table 4.7. We present the value of the W statistics and the p-value of rejecting or accepting the null hypothesis of zero constants. Although the F-test is quite appealing for time-series models in testing the CAPM, it has not been widely performed for one-way factor portfolios. In the equally-weighted portfolios the factors found insignificant were the CSHO, TABE and CAR12. In the value-weighted portfolios the number of the insignificant factors increases to include the CFL, DEBT, EP, GR, CAR60 and TR variables at the 5% level of significance and at the 1% level the BEMV, DIVS, DIVP and TAMV factors. The factors that retain their power with the GRS test are the MV, PRICE and SALE variables where the constants are significantly different from zero. The results for the MV portfolios are contradictory to *Gibbons, Ross and Shanken' s (1989)* empirical results where a zero constant was found for ten value-weighted market value portfolios. However, the methodology employed in their paper for the construction of the MV portfolios was quite divergent as they included only NYSE stocks and a buy-and-hold strategy without rebalancing for five years was adopted. The relaxation of these strict restrictions in the present methodology revealed violation of a zero constant in the MV portfolios.

Furthermore, the significance of the F-test results is confirmed with the examination of the LRT results in Table 4.8. The p-values of the LRT verify the previous results and confirm that the significance of all the factors is rejected apart from MV, PRICE and SALE value-weighted portfolios. Comparing the results with *Breen, Korajczyk (1995)*, we confirm the reversion in the results between equally- and value-weighted BEMV portfolios. However, they found a significant constant with equally-weighted MV and BETA portfolios and a zero constant with value-weighted portfolios. In BETA portfolios, we also confirmed a zero constant for both portfolios which is consistent with the capital asset pricing model where the market portfolio is the source of priced risk. Nevertheless, the presence of excess risk-adjusted returns in MV portfolios is not rejected and it appears to be quite strong.

Thus, we have shown that the employment of value-weighted portfolio returns functions quite well for the acceptance of the CAPM. However, a substantial part of the current research in asset pricing models has applied the three-factor model so we attempt as well an examination of this model in order to infer on any present divergences from our previous results. In the univariate factor portfolios, *Fama and French (1993)* verified the presence of abnormal performance of the high EP and DIVSUM portfolios with the market model and showed that the constants' significance was substantially lowered with the three-factor model. In a subsequent paper (1997), they employed the F-test and a zero constant was found present in the CFL, GR and CAR60 return portfolios with the three-factor model whereas the failure of the three-factor model was present in the CAR12 portfolios. To replicate and extend the tests, these ten univariate portfolio returns are employed to time-series regressions where the explanatory variables are the excess returns of the market portfolio and the returns of the two additional risk portfolios, the SMB and HML. The results are presented in Table 4.9 where in Panel A we report the p-values for the GRS F-test and in Panel B the p-values of the modified LRT for both the equally- and value-weighted procedures.

The results are quite puzzling as we reach different conclusions than FF. With the F-test we reject the null hypothesis of zero constant for all the equally-weighted portfolios whereas we confirm the Fama and French results for the BEMV, CFL, EP, GR and CAR60 portfolios but with the value-weighted returns. The double check of the results with the employment of the LRT was sufficient to verify the same conclusions with the F-test. To examine the possibility that FF' tests accepted the null hypothesis with the F-test and equally-weighted portfolios on the grounds of data availability restrictions, we re-performed the tests with modified portfolios. More specifically, we imposed the restriction of data availability for the FF factors i.e. BEMV, GR, EP, CFL and we re-calculated the individual factor portfolio returns including only the firms that meet the requirements. We also failed to verify the p-values of the F-test in their paper with equally-weighted returns.

Thus, the re-examination of the factor portfolio returns with the three-factor model has some important implications for the controversy over the power of the inclusion of the two new risk portfolios in addition to the market portfolio. In the empirical results from the time-series tests of the one factor model the inferences were quite devastating for all the factors apart from the market value, price and sale portfolios. However, it is evident from the Table 4.9 that even the employment of the alleged powerful three-factor model was not sufficient to absorb the excess returns of these portfolios. In sum, the results from the time-series tests of the univariate factor portfolios in combination with the replication of the FF three-factor model tests provides some indications that the inclusion of the additional risk SMB and HML portfolios might be unnecessary as the small firm and distress factor effects could be simply absorbed by the consideration of value-weighted returns.

4.3.3.2 Multivariate Sorting Portfolios

The introduction of multivariate portfolios i.e. portfolios constructed on the basis of two factors is credited to *Lakonishok, Shleifer and Vishny (1994)* who argued that strategies are formed on a more complicated basis than assuming single factor portfolios. In practice, investors seek to exploit stocks that, according to evidence, have achieved excess returns based on information about low past growth history and high expected future growth. Thus, the investment strategies are based on portfolios of stocks that bear characteristics confined to specifically illustrate all the aspects of firms' growth prospects. Thus, the common methodology is to sort stocks into portfolios according to one factor and further re-assign each portfolio's stocks to more portfolios on the basis of a second criterion.

A technical aspect for the employment of multivariate portfolios is the presence of higher spread in risk and return and the diversification of unsystematic risk from the aggregation of individual stock returns. Furthermore, a common argument for the construction of multivariate portfolios is the elimination of possible correlation between the two sorting criteria that could be the driving force behind a present factor effect. The most frequently applied set of multivariate portfolios in the empirical literature is the MV-BEMV portfolios after the FF evidence that these two factors are the cross-sectional determinants of the stock returns. In Table 4.2 we presented the return spread in this set of portfolios as well as in additional double-sorted portfolios.

Although the employment of multivariate portfolios was introduced to support the extrapolation story by *LSV (1994), Fama and French (1997)* presented evidence in favour of the risk story behind the excess returns of these portfolios. More specifically, they reported the F-test for the multivariate significance of the constant in regressions with the three-factor model and accepted the null hypothesis of zero constants i.e. zero excess returns after we account for the two additional SMB and HML risk portfolios. On a first stage, we tested the one-factor model of the market portfolio with the equally- and value-weighted double-sorted portfolio returns and we failed to accept the null hypothesis of zero constants. Thus, we confirmed the presence of excess returns from strategies formed from multivariate portfolios. The results were unaltered for both rebalancing procedures and for the F-test as well as the LR test. However, we also examined the three-factor model and tested the multivariate constant significance but we failed to confirm the FF results. For all the multivariate portfolios we strongly rejected the null hypothesis of zero constants with all the possible tests. We further attempted to alter the portfolio construction procedure where, instead of subdivision, we replicated the FF methodology and form the portfolios from intersections between subsets. We also failed to support the three-factor model with the double-sorted portfolios.

However, the strong rejection of the constant insignificance in the double-sorted portfolios with all the possible combinations and the one- or three-factor model seemed quite puzzling so we moved on to the examination of an alternative construction of the multivariate portfolios, the randomised portfolios as suggested by *Basu (1983)*. On a rational basis, the two suggested methodologies should not substantially altered inferences about the presence of excess returns as the justification behind both approaches is the elimination of correlation sources. In Table 4.10 we report the p-values of the LRT and the F-test for the significance of the excess returns in the one-factor model with the randomised portfolio returns. Surprisingly enough, we find evidence for the strong acceptance of the CAPM with multivariate portfolios and the value-weighted procedure apart from the MV-PRICE portfolios. Thus, it is evident that even in the case of double-sorted portfolios where are sources of divergences that could work very well towards the confirmation of the CAPM power.

In sum, the empirical research of the previous subsections was focused on the examination of the achievement of risk-adjusted excess returns from factor portfolios. A detailed presentation of the factor portfolio mean returns, standard deviations and market betas revealed and confirmed previous evidence for the presence of high returns of subsets of stocks with low or high specific attributes. Although the beta magnitude was not sufficient to justify the high return differences, the multivariate tests for the constant significance in time-series models revealed divergent results. Confirming existent evidence, the market portfolio was not evidently adequate to absorb the excess returns of factor strategies with the equally-weighted rebalancing procedure. However, the striking evidence was that a simple substitution of this prevailing methodology with the more representative of the investors' portfolio management decisions value-weighted procedure eliminated the importance of all the factors apart from the market value, price and sale variables. Similar remarks were issued as well for the multivariate portfolios.

4.4 Concluding Remarks

The empirical research of this chapter could be separated into two distinctive areas. In the first field, the examination of the returns achieved from portfolios constructed on the basis of individual factors is the main area of interest. We examine the magnitude of differences in returns between high and low portfolios, as the lack of spread in returns is evidence against the importance of the corresponding factor. In our portfolios, we find in almost all the cases an adequate spread in returns between extreme portfolios and the direction of highest return is consistent with previous evidence in the empirical literature that introduced the importance of the specific factors.

In addition to the presentation of factor portfolio return performance, we present patterns in the corresponding standard deviations, current market betas and betas corrected for nosynchronous trading bias. The purpose of this report is to infer on a preliminary basis on the power of the capital asset pricing model. The high performance of portfolios with high or low specific attributes is not controversial under the paradigm of CAPM as long as the excess spread can be justified as compensation for excess risk. More specifically, if the CAPM is the model that explains best the expected stock returns, the spread in beta should be similar in magnitude with the return spread. Apart from the DIVCOM, DIVSUM, TR, TABE and value-weighted GR portfolios where the difference in betas is matching the return differences, in the rests of the cases there is no alignment between betas and returns to justify high performance. However, we also present evidence that the correction for infrequent trading is necessary in the beta adjustment procedure as the magnitude in the beta spread is sufficiently increased to justify the return spread.

An additional important conclusion drawn from the presentation of the factor portfolios performance is the evidence of seasonality patterns. The well known January effect has been proven present in all the portfolios as the highest returns are achieved during the specific month and the return equality across the rest of the months is not rejected. However, we cannot either reject the hypothesis that the variances and systematic risks are unequal across the months which could justify the high January returns as risk compensation. Although there is the scenario that could result in the characterisation of the January effect not as anomaly but as a manifestation of measurement problems in the risk adjustment procedure, we could not rationally explain the significant October effect. As shown in a previous subsection, in addition to high January volatility we observe increased volatility in the month of October whereas we accept the hypothesis of insignificance volatility in the rest of the months. What is more puzzling for this seasonality pattern is the absence of high returns to price the high volatility and the fact that the sign of the October returns is always in the opposite direction than the high January returns.

At the second stage, we examine the performance of portfolios formed with individual factors on a risk-adjusted basis. More analytically, we employ regression analysis to test whether the portfolio excess returns could be absorbed by the inclusion of the market portfolio i.e. the beta risk. The GRS F-test results for the hypothesis of joint zero constants for individual factor portfolios present more clearly the contradiction between equally- and value-weighted portfolios. In the first case, only some of the factors are rejected as insignificant as there are many cases of risk-adjusted excess returns. However, with value-weighted returns the number is substantially increased to accommodate all the factors apart from market value, price and sale variables. Even the well-documented book-to-market effect is dissolved with the employment of returns that are less influenced by the small firm effect. We should mention the fact that the significance of the value-weighted price portfolios cannot be attributed to the special seasonality patterns such as the January effect as it is the only case where we have rejected the hypothesis of highest January returns for all the decile portfolios.

From evidence concerning the univariate portfolios we have proceed to examine another prevalent approach in asset pricing models, the performance of multivariate portfolios. The rationale for this approach is that substantially mitigates strong interrelations among factors and that investment decisions are based on restrictive subsets of stocks with more specific characteristics. The employment of the common subdivision procedure for the construction of double-sorted portfolios resulted in evidence against the CAPM with the multivariate tests for the constant's significance. However, we applied another approach of randomised multivariate portfolios and we showed that a simple re-consideration of the portfolios methodology resulted in the CAPM power with value-weighted returns apart from the MV-PRICE portfolios whose unanimous significance is thoroughly examined in subsequent chapters.

Although in this chapter we presented evidence that shed light on the alleged importance of many factors the evidence should be complemented with additional research in the framework of the capital asset pricing model power. The importance of the beta factor as well as other variables cannot be inferred merely over the presence of high volatility. Additionally, the power of the market portfolio cannot be solely confirmed with the time-series zero constant significance. An approach that simultaneously proves that these factors are also priced should be employed. Therefore, a more extensively applied empirical application in the asset pricing models is the cross-sectional methodology where the determinants of the stock returns are examined at specific points of time with the absence of tautological effects.

TABLE 4.1

MEAN RETURN, STANDARD DEVIATION AND BETA OF EACH OF THE 10 PORTFOLIOS

Equally- and value-weighted returns are reported for each of the 10 portfolios constructed on the basis of individual factors. The returns are calculated as averages over the whole period of 372 months and we also report the standard deviations of the return series. The portfolio betas are obtained from the market model where the portfolio returns are regressed on the market portfolio over the whole period of 372 months. The SUMBETA stands for the nonsynchrounous bias-adjusted beta as the summation of the coefficient of the current market portfolio and the coefficient on the market with a lag.

FACTOR		POR1	POR2	POR3	POR4	POR5	POR6	POR7	POR8	POR9	POR10	
BEMV	RET-EQL	1.0464	1.1646	1.2100	1.2930	1.3564	1.4006	1.4706	1.5932	1.7433	2.2446	1.1982
	S.D.-EQL	6.8026	6.3407	6.1296	5.8260	5.6604	5.3818	5.2658	5.2567	5.5499	6.3437	-0.4590
	BETA	1.3819	1.3013	1.2479	1.1845	1.1293	1.0744	1.0379	1.0105	1.0180	1.0894	-0.2925
	SUMBETA	1.5644	1.4693	1.4176	1.3592	1.2943	1.2326	1.1892	1.1696	1.2236	1.3593	-0.2051
	RET-VWG	1.3761	1.3857	1.4225	1.3705	1.3486	1.3549	1.4978	1.5577	1.8068	2.1523	0.7762
	S.D.-VWG	5.4090	4.9563	4.9053	4.8345	4.4726	4.4984	4.3591	4.3467	4.7008	4.9898	-0.4192
	BETA	1.1250	1.0826	1.0705	1.0519	0.9518	0.9507	0.8997	0.8948	0.9582	1.1119	-0.0130
	SUMBETA	1.1522	1.0666	1.0637	1.0614	0.9223	0.9226	0.8517	0.8469	0.9729	1.1456	-0.0066
BETA	RET-EQL	1.3891	1.4268	1.3524	1.4106	1.4664	1.4474	1.4196	1.5419	1.6474	1.5483	0.1592
	S.D.-EQL	3.8525	4.1066	4.6163	4.9826	5.3764	5.6569	6.1650	6.5928	7.3855	8.1305	4.2780
	BETA	0.7147	0.8366	0.9576	1.0296	1.0815	1.1467	1.2185	1.2722	1.3776	1.5066	0.7919
	SUMBETA	0.7979	0.9283	1.0858	1.1681	1.2431	1.3019	1.3993	1.4653	1.5954	1.7942	0.9962
	RET-VWG	1.2465	1.2947	1.2329	1.4065	1.4337	1.4649	1.5313	1.7321	1.8841	2.2793	1.0328
	S.D.-VWG	3.5734	4.1472	4.3164	4.7098	5.0321	5.2915	5.6609	6.0577	6.6541	8.0723	4.4990
	BETA	0.6627	0.8657	0.9341	1.0334	1.1076	1.1635	1.2077	1.2955	1.3876	1.6327	0.9700
	SUMBETA	0.5900	0.8182	0.9351	0.9998	1.1247	1.1525	1.2472	1.3386	1.4785	1.7525	1.1625
CFL	RET-EQL	1.0764	1.1468	1.2884	1.3372	1.4645	1.5293	1.5383	1.5814	1.7702	2.2032	1.1268
	S.D.-EQL	6.7055	6.2917	6.0989	5.9026	5.7879	5.6879	5.5260	5.4696	5.6098	6.4274	-0.2781

	BETA	1.3567	1.2848	1.2408	1.1986	1.1579	1.1404	1.0982	1.0768	1.0635	1.1458	-0.2109
	SUMBETA	1.5454	1.4533	1.3983	1.3479	1.3346	1.3052	1.2546	1.2444	1.2469	1.3682	-0.1773
	RET-VWG	1.4516	1.3368	1.3943	1.4325	1.5286	1.4631	1.4763	1.5570	1.6701	1.9687	0.5172
	S.D.-VWG	5.7432	5.0155	5.0148	4.7856	4.8042	4.7980	4.5929	4.7611	4.6506	5.4764	-0.2667
	BETA	1.1858	1.0660	1.0946	1.0358	1.0173	1.0133	0.9756	0.9743	0.9390	1.0367	-0.1490
	SUMBETA	1.2210	1.0535	1.0973	1.0192	1.0618	0.9940	0.9357	0.9482	0.9189	1.0701	-0.1509
CSHO	RET-EQL	1.6163	1.4989	1.5053	1.5384	1.5826	1.5022	1.5653	1.4956	1.4966	1.4659	-0.1504
	S.D.-EQL	6.4641	6.5252	6.2643	6.1347	6.1755	5.5773	5.6008	5.2386	5.0906	4.6892	-1.7750
	BETA	1.1223	1.2406	1.2183	1.2240	1.2193	1.1699	1.1572	1.1530	1.0921	1.0511	-0.0712
	SUMBETA	1.4352	1.4875	1.4308	1.4195	1.3773	1.2806	1.2451	1.1922	1.1486	1.0380	-0.3972
	RET-VWG	2.1040	2.0231	1.9436	1.8569	1.8253	1.6424	1.5869	1.5197	1.4454	1.3052	-0.7988
	S.D.-VWG	6.0720	6.1844	5.8063	5.5128	5.4958	5.1285	5.0001	4.8816	4.7006	4.1720	-1.9000
	BETA	1.1883	1.2198	1.1974	1.1703	1.1716	1.1252	1.0979	1.0824	1.0513	0.9333	-0.2550
	SUMBETA	1.4022	1.3402	1.3057	1.2830	1.2433	1.1621	1.1255	1.0678	1.0383	0.8934	-0.5087
DEBT	RET-EQL	1.1700	1.2896	1.3424	1.4324	1.4848	1.4318	1.4857	1.4594	1.5592	2.2115	1.0415
	S.D.-EQL	6.1974	6.0034	5.9221	5.7859	5.8085	5.7474	5.6023	5.4282	5.4400	6.8140	0.6166
	BETA	1.2615	1.2217	1.2057	1.1764	1.1623	1.1466	1.1090	1.0451	1.0280	1.3697	0.1082
	SUMBETA	1.4390	1.4065	1.3749	1.3438	1.3355	1.3122	1.2810	1.2169	1.2005	1.4439	0.0049
	RET-VWG	1.3576	1.3916	1.3341	1.4275	1.5507	1.4635	1.3810	1.4514	1.4877	2.0760	0.7183
	S.D.-VWG	5.2296	4.8002	4.8472	4.7783	4.6352	4.5139	4.3752	4.2409	4.4679	5.6636	0.4340
	BETA	1.0832	1.0501	1.0592	1.0342	1.0000	0.9567	0.9236	0.8894	0.9044	1.1114	0.0281
	SUMBETA	1.1049	1.0505	1.0683	1.0116	0.9689	0.9145	0.9148	0.8414	0.8689	1.1626	0.0577
DIVCOM	RET-EQL	1.2490	1.2474	1.2703	1.3741	1.3682	1.3767	1.3854	1.4780	1.3300	1.1736	-0.0753
	S.D.-EQL	6.4027	5.8477	5.4649	5.3709	5.0865	4.9493	4.6969	4.5490	4.0067	4.4496	-1.9531
	BETA	1.3231	1.2300	1.1520	1.1169	1.0522	1.0228	0.9698	0.9331	0.7760	0.7443	-0.5788
	SUMBETA	1.4704	1.3573	1.2883	1.2478	1.1705	1.1146	1.0666	1.0111	0.8442	0.8480	-0.6224
	RET-VWG	1.5864	1.3442	1.3388	1.4851	1.2684	1.3609	1.4205	1.3842	1.3277	1.2800	-0.3064
	S.D.-VWG	5.7931	5.2675	4.8585	4.9235	4.7290	4.4766	4.3323	4.2943	3.8215	4.2496	-1.5435
	BETA	1.2138	1.1379	1.0605	1.0739	1.0271	0.9553	0.9193	0.8893	0.7394	0.7032	-0.5107
	SUMBETA	1.2596	1.1347	1.0563	1.0449	1.0124	0.9221	0.8637	0.8588	0.6865	0.6809	-0.5787
DIVSUM	RET-EQL	1.2943	1.3221	1.3826	1.3304	1.3690	1.4238	1.4244	1.3676	1.2519	1.1305	-0.1639
	S.D.-EQL	6.2459	5.7708	5.5495	5.2970	5.1496	4.8605	4.6887	4.3944	3.8985	4.3233	-1.9226

	BETA	1.3054	1.2129	1.1564	1.1022	1.0609	1.0041	0.9579	0.8833	0.7392	0.6975	-0.6079
	SUMBETA	1.4485	1.3352	1.2987	1.2374	1.1687	1.1113	1.0550	0.9677	0.8165	0.7868	-0.6617
	RET-VWG	1.6721	1.3716	1.4970	1.3417	1.2818	1.3379	1.2881	1.3931	1.2936	1.2185	-0.4535
	S.D.-VWG	5.7578	5.3140	4.9384	4.8360	4.8369	4.4971	4.4218	4.2087	3.8205	4.0366	-1.7212
	BETA	1.2094	1.1478	1.0814	1.0579	1.0456	0.9652	0.9329	0.8652	0.7215	0.6505	-0.5588
	SUMBETA	1.2425	1.1465	1.0656	1.0395	1.0083	0.9329	0.8807	0.8218	0.6814	0.6267	-0.6158
EP	RET-EQL	1.1604	1.2440	1.3178	1.3886	1.3840	1.4268	1.4510	1.5843	1.6816	2.0627	0.9023
	S.D.-EQL	6.6895	6.0879	5.9048	5.7893	5.6815	5.6312	5.4173	5.4583	5.5486	6.4164	-0.2731
	BETA	1.3349	1.2509	1.2185	1.1855	1.1612	1.1399	1.0899	1.0771	1.0789	1.1247	-0.2103
	SUMBETA	1.5392	1.3926	1.3543	1.3330	1.3180	1.2805	1.2314	1.2300	1.2538	1.3677	-0.1715
	RET-VWG	1.3427	1.3770	1.3592	1.5768	1.4850	1.4400	1.4956	1.5255	1.7529	2.0217	0.6790
	S.D.-VWG	5.7614	4.9593	4.7531	4.8670	4.7235	4.9889	4.4597	4.7696	4.7676	5.6464	-0.1150
	BETA	1.2016	1.0603	1.0293	1.0629	1.0197	1.0533	0.9608	1.0032	0.9567	1.0619	-0.1397
	SUMBETA	1.2407	1.0486	0.9985	1.0517	0.9935	1.0195	0.9548	1.0072	0.9717	1.0935	-0.1471
MV	RET-EQL	2.2210	1.3417	1.3086	1.1983	1.1905	1.1912	1.1156	1.1080	0.9714	0.9007	-1.3203
	S.D.-EQL	7.0189	6.3695	6.1950	5.9486	5.6178	5.3097	5.1681	5.0536	4.8149	4.4118	-2.6071
	BETA	1.1768	1.2209	1.2353	1.2164	1.1670	1.1282	1.1220	1.1204	1.0695	0.9914	-0.1854
	SUMBETA	1.5462	1.4204	1.3920	1.3488	1.2884	1.2087	1.1785	1.1383	1.0613	0.9533	-0.5929
	RET-VWG	3.9902	2.8267	2.4887	2.2493	2.1076	2.0178	1.8132	1.7447	1.4736	1.1737	-2.8165
	S.D.-VWG	7.6489	6.9036	6.2949	5.9371	5.6668	5.2813	5.1522	5.0409	4.7950	4.2028	-3.4462
	BETA	1.2911	1.2605	1.2624	1.2269	1.1852	1.1287	1.1257	1.1205	1.0681	0.9415	-0.3497
	SUMBETA	1.6400	1.4660	1.4116	1.3533	1.3004	1.1944	1.1698	1.1205	1.0438	0.9015	-0.7384
PRICE	RET-EQL	3.0325	1.9273	1.6119	1.3955	1.2286	1.0329	0.9748	0.7189	0.6011	0.2364	-2.7961
	S.D.-EQL	7.0489	6.4282	6.1002	5.8907	5.6894	5.3935	5.2384	5.2170	5.0591	5.2822	-1.7667
	BETA	1.2265	1.1993	1.1608	1.1575	1.1460	1.1111	1.0998	1.1109	1.0886	1.1354	-0.0911
	SUMBETA	1.5898	1.4639	1.3855	1.3378	1.2785	1.2169	1.1964	1.1809	1.1504	1.2368	-0.3530
	RET-VWG	4.0601	2.6903	2.2426	1.9389	1.7355	1.6599	1.5356	1.3109	1.1587	0.9203	-3.1398
	S.D.-VWG	6.8679	5.4671	4.9377	4.8062	4.7262	4.6358	4.4981	4.6064	4.6649	4.2871	-2.5808
	BETA	1.2716	1.1493	1.0686	1.0421	1.0404	1.0245	0.9959	1.0238	1.0401	0.9541	-0.3175
	SUMBETA	1.4376	1.2186	1.1122	1.0552	1.0214	1.0241	0.9822	0.9974	0.9867	0.9492	-0.4884
SALE	RET-EQL	1.0657	1.0519	1.1029	1.2409	1.4259	1.4919	1.6141	1.7240	1.8461	2.3330	1.2672
	S.D.-EQL	6.1450	5.4372	5.1573	5.4118	5.6455	5.7819	5.8816	6.1126	6.2438	6.9507	0.8057

	BETA	1.2314	1.1407	1.0845	1.1250	1.1469	1.1624	1.1630	1.1655	1.1503	1.3029	0.0715
	SUMBETA	1.3887	1.2574	1.1886	1.2572	1.3046	1.3330	1.3537	1.3642	1.4098	1.4854	0.0967
	RET-VWG	1.3110	1.3197	1.2023	1.3617	1.5642	1.5759	1.5929	1.8934	1.9836	2.3794	1.0684
	S.D.-VWG	5.1735	4.3761	4.3287	4.4020	4.5153	4.8590	5.0610	5.2593	5.4092	6.3196	1.1461
	BETA	1.0891	0.9516	0.9474	0.9654	0.9865	1.0573	1.0893	1.1091	1.1120	1.1983	0.1092
	SUMBETA	1.1152	0.9129	0.8914	0.9155	0.9593	1.0807	1.1186	1.1556	1.1625	1.3058	0.1906
GR	RET-EQL	1.8896	1.5684	1.5671	1.4433	1.3524	1.3817	1.3972	1.3678	1.2768	0.9899	-0.8997
	S.D.-EQL	6.6749	5.5170	5.7741	5.0076	5.1595	5.2193	5.4867	5.9183	6.2542	7.0874	0.4124
	BETA	1.1093	1.0164	1.0088	0.9775	1.0340	1.0381	1.1020	1.1738	1.2424	1.3704	0.2612
	SUMBETA	1.3830	1.1706	1.1303	1.0875	1.1439	1.1527	1.2187	1.3237	1.4149	1.5658	0.1828
	RET-VWG	2.0216	1.7343	1.5282	1.4059	1.3718	1.3103	1.3887	1.3930	1.4119	1.6547	-0.3669
	S.D.-VWG	5.4958	4.9543	4.7761	4.3573	4.3948	4.5232	4.7063	5.0163	5.3023	6.2022	0.7064
	BETA	1.0555	0.9905	0.9810	0.9108	0.9263	0.9464	1.0036	1.0658	1.1179	1.2941	0.2386
	SUMBETA	1.1171	0.9831	0.9222	0.8444	0.8690	0.9284	0.9873	1.0820	1.1539	1.3418	0.2246
TR	RET-EQL	1.7486	1.5981	1.6505	1.4482	1.4867	1.5459	1.3815	1.5094	1.3088	1.1142	-0.6344
	S.D.-EQL	4.6305	5.0962	5.2236	5.3820	5.6540	6.0669	6.3299	6.8782	7.1716	8.0015	3.3711
	BETA	0.8165	0.9388	1.0145	1.0713	1.1374	1.1986	1.2633	1.3499	1.4286	1.5583	0.7418
	SUMBETA	1.0439	1.1450	1.1822	1.2319	1.2956	1.3589	1.4451	1.5396	1.6091	1.7136	0.6697
	RET-VWG	1.3863	1.3531	1.3708	1.2879	1.4125	1.5313	1.4137	1.6334	1.7756	2.1566	0.7704
	S.D.-VWG	3.7231	4.0609	4.3141	4.4729	4.7403	5.3096	5.2770	5.5613	6.3781	7.9259	4.2027
	BETA	0.7740	0.8490	0.9314	0.9754	1.0412	1.0755	1.1504	1.1967	1.3617	1.4983	0.7243
	SUMBETA	0.8031	0.8296	0.9088	0.9466	1.0105	1.0830	1.1405	1.2175	1.3962	1.5536	0.7505
TABE	RET-EQL	1.4929	1.4789	1.5086	1.5040	1.4781	1.4370	1.5229	1.4395	1.4010	1.6899	0.1971
	S.D.-EQL	5.6596	5.6533	5.8850	5.7372	5.8689	5.9685	5.9654	5.9862	5.9096	6.8153	1.1557
	BETA	1.1180	1.1421	1.1761	1.1774	1.1799	1.1948	1.1784	1.1669	1.1251	1.2463	0.1282
	SUMBETA	1.3181	1.3106	1.3570	1.3351	1.3549	1.3747	1.3663	1.3593	1.2974	1.5527	0.2346
	RET-VWG	1.5473	1.3093	1.4168	1.3565	1.4895	1.3062	1.6038	1.4867	1.3603	1.8114	0.2641
	S.D.-VWG	5.0446	4.6242	4.6258	4.4836	4.6842	4.7430	4.5837	4.7572	4.6113	5.6089	0.5643
	BETA	1.0728	0.9992	1.0122	0.9705	1.0165	1.0378	0.9909	1.0370	0.9315	1.1854	0.1127
	SUMBETA	1.1175	1.0034	0.9975	0.9478	0.9898	1.0323	0.9692	1.0185	0.8985	1.2137	0.0962
TAMV	RET-EQL	1.0321	1.1743	1.3690	1.3543	1.4304	1.4991	1.5849	1.5610	1.7257	2.5258	1.4937
	S.D.-EQL	6.7126	6.1128	6.0817	5.7811	5.6538	5.6140	5.5155	5.3892	5.6263	7.3589	0.6463

	BETA	1.3642	1.2565	1.2282	1.1686	1.1394	1.1151	1.0659	1.0275	1.0547	1.5472	0.1830
	SUMBETA	1.5338	1.4291	1.4089	1.3388	1.3015	1.2936	1.2455	1.2047	1.2331	1.5612	0.0274
	RET-VWG	1.3454	1.3604	1.4464	1.4428	1.4121	1.4211	1.4753	1.5002	1.7207	2.3178	0.9724
	S.D.-VWG	5.2625	4.9110	4.7503	4.7444	4.4210	4.4770	4.3994	4.4112	4.5252	6.1834	0.9209
	BETA	1.0916	1.0770	1.0378	1.0183	0.9403	0.9503	0.9110	0.9101	0.9277	1.1625	0.0709
	SUMBETA	1.1082	1.0826	1.0272	1.0113	0.9129	0.9139	0.8749	0.8764	0.8929	1.2279	0.1197
CAR12	RET-EQL	1.7371	1.3349	1.2966	1.3126	1.3707	1.3439	1.4063	1.4196	1.5133	1.7475	0.0104
	S.D.-EQL	7.5109	5.8971	5.3869	5.0555	4.9436	4.9856	5.1782	5.4023	5.8054	6.9241	-0.5869
	BETA	1.2764	1.0930	1.0387	1.0089	1.0001	1.0251	1.0674	1.1118	1.1829	1.2034	-0.0730
	SUMBETA	1.6053	1.2954	1.1925	1.1478	1.1259	1.1508	1.1984	1.2575	1.3232	1.5540	-0.0514
	RET-VWG	1.7549	1.4214	1.4165	1.3074	1.3317	1.3045	1.3773	1.5285	1.7889	2.1649	0.4100
	S.D.-VWG	6.5562	5.2935	4.8798	4.4450	4.4192	4.3922	4.5559	4.9462	5.5177	6.4194	-0.1367
	BETA	1.2371	1.0624	1.0063	0.9394	0.9567	0.9526	0.9925	1.0609	1.1522	1.1707	-0.0664
	SUMBETA	1.3669	1.0975	0.9964	0.9349	0.9477	0.9086	0.9642	1.0326	1.1315	1.3278	-0.0391
CAR60	RET-EQL	2.0417	1.5572	1.4338	1.3880	1.4377	1.3217	1.4333	1.3441	1.1813	1.0846	-0.9571
	S.D.-EQL	6.7790	5.4562	5.0322	4.9082	5.2260	5.0471	5.2474	5.3961	5.8453	6.8745	0.1045
	BETA	1.1137	1.0092	0.9712	0.9627	1.0182	1.0000	1.0370	1.0931	1.1879	1.3246	0.2109
	SUMBETA	1.3147	1.1124	1.0482	1.0419	1.1183	1.0879	1.1531	1.1894	1.2871	1.4776	0.1628
	RET-VWG	2.3354	1.6253	1.6229	1.5105	1.5274	1.3620	1.4896	1.4689	1.6149	1.5632	-0.7721
	S.D.-VWG	6.3187	4.8595	4.6341	4.5217	4.7881	4.6949	4.7448	4.9681	5.3817	6.3342	0.0155
	BETA	1.0675	0.9543	0.9480	0.9421	0.9901	0.9750	0.9916	1.0400	1.1211	1.3005	0.2329
	SUMBETA	1.0891	0.9265	0.9348	0.8947	0.9588	0.9699	0.9940	1.0299	1.1318	1.3503	0.2612

TABLE 4.2

FACTOR PORFOLIOS WITH MULTIVARIATE SORTING

Every year, all common stocks are assigned to five market value portfolios according to NYSE breakpoints. Each MV portfolio is then subdivided into five further portfolios according to NYSE breakpoints for BEMV, PRICE, GROWTH or TR variables. The resulting twenty-five portfolios are rebalanced every year and their equally- and value-weighted returns are calculates for the following twelve months. The mean returns are the averages over the whole period of 372 months.

EQ		BEMV1	BEMV2	BEMV3	BEMV4	BEMV5	VW		BEMV1	BEMV2	BEMV3	BEMV4	BEMV5
	MV1	1.663	1.847	1.911	2.075	2.526		MV1	3.436	3.028	2.917	3.029	3.710
	MV2	1.046	1.247	1.374	1.461	1.583		MV2	2.466	2.309	2.306	2.308	2.559
	MV3	1.023	1.176	1.224	1.358	1.426		MV3	2.224	2.028	1.921	2.059	2.152
	MV4	1.020	1.041	0.951	1.182	1.425		MV4	1.917	1.665	1.471	1.675	1.957
	MV5	0.884	0.897	0.904	0.910	1.084		MV5	1.177	1.269	1.162	1.082	1.412

EQ		GR1	GR2	GR3	GR4	GR5	VW		GR1	GR2	GR3	GR4	GR5
	MV1	2.223	1.848	1.893	1.760	1.389		MV1	4.351	3.866	3.342	2.782	2.933
	MV2	1.181	1.225	1.256	1.208	0.941		MV2	2.271	2.017	2.109	2.183	2.297
	MV3	1.299	1.248	1.237	1.155	0.994		MV3	2.071	1.839	1.921	1.933	2.180
	MV4	1.235	1.134	1.096	1.250	0.862		MV4	1.804	1.620	1.626	1.883	1.718
	MV5	1.124	1.033	0.999	0.921	0.735		MV5	1.366	1.268	1.200	1.253	1.300

EQ		PR1	PR2	PR3	PR4	PR5
	MV1	3.640	2.244	1.756	1.290	0.589
	MV2	2.267	1.557	1.266	0.968	0.308
	MV3	2.182	1.596	1.260	0.813	0.325
	MV4	1.932	1.393	1.128	0.821	0.367
	MV5	1.514	1.061	0.841	0.790	0.414

VW		PR1	PR2	PR3	PR4	PR5
	MV1	3.697	3.981	3.407	2.734	1.922
	MV2	3.607	2.696	2.372	1.984	1.412
	MV3	3.161	2.505	2.080	1.612	1.290
	MV4	2.690	2.032	1.719	1.418	1.083
	MV5	1.894	1.389	1.236	1.154	0.837

EQ		TR1	TR2	TR3	TR4	TR5
	MV1	2.267	2.132	1.834	2.057	1.467
	MV2	1.316	1.420	1.301	1.220	1.004
	MV3	1.319	1.286	1.206	1.285	0.975
	MV4	1.055	1.267	1.214	1.069	1.030
	MV5	0.923	0.917	0.902	1.031	0.914

VW		TR1	TR2	TR3	TR4	TR5
	MV1	3.359	3.232	3.186	4.648	3.262
	MV2	2.108	2.243	2.213	2.431	2.618
	MV3	1.903	1.834	1.973	2.229	2.278
	MV4	1.477	1.676	1.752	1.728	2.117
	MV5	1.120	1.041	1.156	1.363	1.555

TABLE 4.3

P-VALUES FOR THE F-TESTS OF RETURN EQUALITY ACROSS MONTHS

We report the p-values of the F-test that the each portfolio's returns are equal across all the months with equally- and value-weighted procedure. We then exclude the month of January and we test the return equality across the rest of the months.

POR	BEMV				BETA				CFL			
	All		Jan		All		Jan		All		Jan	
	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW
1	0.1326	0.7353	0.9497	0.6803	0.0015	0.8658	0.8685	0.9162	0.0379	0.7158	0.9056	0.6684
2	0.0624	0.8215	0.8998	0.8297	0.0063	0.9487	0.9431	0.9666	0.0408	0.8186	0.8297	0.9028
3	0.0345	0.8660	0.9704	0.9151	0.0034	0.7618	0.8314	0.8410	0.0239	0.7412	0.8408	0.8166
4	0.0079	0.7334	0.8180	0.9453	0.0016	0.7002	0.7053	0.8530	0.0172	0.8920	0.8768	0.9191
5	0.0008	0.7813	0.7342	0.9592	0.0028	0.5252	0.5994	0.7381	0.0028	0.5554	0.7608	0.7506
6	0.0018	0.6254	0.9163	0.8883	0.0030	0.5107	0.8302	0.7375	0.0011	0.7873	0.6498	0.9628
7	0.0000	0.1746	0.7162	0.8441	0.0005	0.3784	0.6576	0.7388	0.0002	0.6860	0.6285	0.9443
8	0.0000	0.0227	0.6160	0.7890	0.0003	0.2645	0.6942	0.7489	0.0001	0.2484	0.6145	0.7325
9	0.0000	0.0057	0.3940	0.5812	0.0002	0.3716	0.8823	0.8723	0.0000	0.0184	0.5588	0.5976
10	0.0000	0.0001	0.2344	0.4433	0.0000	0.0788	0.7460	0.6461	0.0000	0.0346	0.8179	0.7948
POR	CSHO				DEBT				DIVCOM			
	All		Jan		All		Jan		All		Jan	
	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW
1	0.0000	0.0020	0.5277	0.7883	0.0333	0.5817	0.9066	0.5606	0.2411	0.8162	0.8285	0.8176
2	0.0000	0.0131	0.7282	0.7037	0.0112	0.8991	0.9112	0.9093	0.1135	0.7003	0.6293	0.6236
3	0.0001	0.0433	0.7670	0.8193	0.0058	0.8451	0.8968	0.9040	0.0312	0.6639	0.7733	0.6913
4	0.0005	0.0655	0.8235	0.7334	0.0033	0.7808	0.7410	0.9322	0.0249	0.9436	0.7178	0.9406
5	0.0365	0.4388	0.9688	0.9143	0.0005	0.5819	0.6578	0.8746	0.0308	0.7953	0.8000	0.8177
6	0.0266	0.2767	0.8517	0.8198	0.0012	0.3638	0.8445	0.5894	0.0047	0.6760	0.6516	0.8961

	7	0.1168	0.5089	0.8724	0.9161	0.0002	0.1607	0.6474	0.6579	0.0094	0.5390	0.5922	0.7007
	8	0.2035	0.5315	0.8349	0.7743	0.0002	0.2918	0.9129	0.9165	0.0044	0.4383	0.7904	0.9355
	9	0.3425	0.6010	0.9232	0.9078	0.0000	0.0987	0.6300	0.7696	0.0002	0.0754	0.9535	0.9286
	10	0.5389	0.7713	0.8238	0.8116	0.0000	0.0006	0.2624	0.6003	0.0000	0.0002	0.9254	0.7304
POR		DIVSUM				EP				MV			
		All		Jan		All		Jan		All		Jan	
		EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW
	1	0.2600	0.8075	0.7815	0.7931	0.0084	0.6155	0.9022	0.6347	0.0000	0.0000	0.5123	0.8795
	2	0.0704	0.7169	0.8119	0.6419	0.0799	0.8393	0.8855	0.8629	0.0001	0.0107	0.8818	0.9746
	3	0.0311	0.8720	0.6480	0.8664	0.0800	0.8803	0.9101	0.9040	0.0027	0.0066	0.7501	0.7586
	4	0.0305	0.6790	0.7252	0.6626	0.0421	0.9398	0.8967	0.9602	0.0104	0.0329	0.8441	0.8924
	5	0.0109	0.7762	0.7648	0.9372	0.0078	0.8232	0.7435	0.9022	0.0324	0.0592	0.7268	0.7851
	6	0.0064	0.6219	0.6650	0.6653	0.0053	0.5509	0.8604	0.7255	0.0863	0.1153	0.6295	0.6845
	7	0.0054	0.5770	0.7266	0.8092	0.0011	0.5007	0.4742	0.8901	0.2098	0.3203	0.7934	0.8776
	8	0.0032	0.4019	0.7110	0.9166	0.0002	0.2229	0.5740	0.9249	0.4539	0.4829	0.7816	0.8290
	9	0.0001	0.0283	0.9415	0.9221	0.0002	0.0171	0.6460	0.6483	0.5657	0.6251	0.8312	0.8798
	10	0.0000	0.0017	0.9986	0.9865	0.0001	0.0262	0.9320	0.7044	0.7641	0.7921	0.8121	0.8288
POR		PRICE				SALE				GR			
		All		Jan		All		Jan		All		Jan	
		EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW
	1	0.0000	0.1274	0.5768	0.9582	0.0218	0.6741	0.9836	0.6404	0.0000	0.0185	0.3921	0.3121
	2	0.0000	0.1672	0.6585	0.8422	0.1186	0.9024	0.9556	0.9053	0.0001	0.6158	0.5551	0.7919
	3	0.0000	0.4036	0.7893	0.9751	0.0195	0.5764	0.9045	0.7944	0.0474	0.6174	0.9879	0.7116
	4	0.0004	0.4167	0.8119	0.8287	0.0158	0.8802	0.8178	0.9412	0.0031	0.6212	0.6991	0.7821
	5	0.0009	0.6178	0.8264	0.9647	0.0025	0.4297	0.8621	0.9179	0.0088	0.4407	0.6383	0.6987
	6	0.0129	0.7270	0.9330	0.9045	0.0008	0.2763	0.6625	0.6099	0.0086	0.4561	0.6897	0.5929
	7	0.0148	0.5609	0.8125	0.8672	0.0003	0.3038	0.7067	0.8378	0.0267	0.6708	0.8310	0.7495
	8	0.0527	0.7057	0.7836	0.8068	0.0000	0.0154	0.5960	0.4257	0.0185	0.6838	0.7115	0.7659
	9	0.2071	0.8284	0.8195	0.8487	0.0000	0.0216	0.3459	0.3913	0.0196	0.5698	0.7891	0.6155
	10	0.1289	0.5711	0.7506	0.7713	0.0000	0.0023	0.6487	0.8323	0.0163	0.7603	0.9293	0.9265

POR	TR				TABE				TAMV			
	All		Jan		All		Jan		All		Jan	
	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW	EQ	VW
1	0.0000	0.6167	0.3167	0.8392	0.0000	0.3326	0.7165	0.5947	0.1376	0.5933	0.9021	0.5265
2	0.0000	0.6178	0.7634	0.8932	0.0009	0.4341	0.7596	0.4950	0.0365	0.9195	0.9090	0.9692
3	0.0000	0.8739	0.6275	0.9375	0.0004	0.7913	0.8444	0.8972	0.0058	0.6443	0.9027	0.7857
4	0.0000	0.6103	0.7383	0.8100	0.0014	0.6935	0.8027	0.8022	0.0028	0.9322	0.7790	0.9543
5	0.0002	0.8719	0.7680	0.9072	0.0017	0.3369	0.7750	0.7297	0.0015	0.4432	0.7448	0.8607
6	0.0006	0.4768	0.8123	0.9029	0.0010	0.7945	0.7833	0.8673	0.0003	0.5944	0.7436	0.8598
7	0.0005	0.5034	0.7757	0.7362	0.0007	0.7734	0.8773	0.9363	0.0003	0.1739	0.8230	0.7784
8	0.0047	0.5001	0.9630	0.7990	0.0002	0.8202	0.8090	0.9403	0.0000	0.0898	0.7489	0.8085
9	0.0024	0.3733	0.7227	0.6155	0.0001	0.3917	0.6802	0.9612	0.0000	0.0139	0.5379	0.6714
10	0.0111	0.1179	0.7394	0.7639	0.0000	0.2282	0.7045	0.7811	0.0000	0.0003	0.5143	0.5917

POR	CAR12				CAR60			
	All		Jan		All		Jan	
	EQ	VW	EQ	VW	EQ	VW	EQ	VW
1	0.0000	0.0185	0.5214	0.9530	0.0000	0.0607	0.1735	0.4683
2	0.0000	0.0828	0.9039	0.8564	0.0004	0.2308	0.4521	0.6255
3	0.0000	0.0929	0.9006	0.9425	0.0010	0.0994	0.3855	0.4280
4	0.0011	0.5777	0.8649	0.9153	0.0079	0.6667	0.5811	0.8604
5	0.0036	0.5985	0.8715	0.8048	0.0195	0.7214	0.5178	0.8400
6	0.0087	0.8920	0.8008	0.9292	0.0376	0.6727	0.6044	0.6418
7	0.0185	0.8725	0.8029	0.9152	0.0112	0.6246	0.8577	0.7750
8	0.0196	0.6378	0.7014	0.6449	0.1052	0.7378	0.7448	0.7129
9	0.0189	0.7050	0.6609	0.7364	0.0361	0.5741	0.7410	0.6843
10	0.0310	0.5602	0.6630	0.5692	0.0592	0.6333	0.7872	0.6517

TABLE 4.4

P-VALUES FOR THE CHI-SQUARED TEST FOR THE SIGNIFICANCE OF VOLATILITY ACROSS MONTHS (EQ)

We report the p-values of the chi-squared test for the significance of each portfolio's volatility in individual months.

POR BEMV	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0049	0.0128	0.0141	0.0073	0.0221	0.0241	0.0129	0.0095	0.0099	0.0014	0.0067	0.0280
2	0.0051	0.0152	0.0204	0.0131	0.0183	0.0318	0.0123	0.0124	0.0142	0.0025	0.0118	0.0348
3	0.0050	0.0209	0.0228	0.0161	0.0243	0.0321	0.0141	0.0127	0.0203	0.0031	0.0111	0.0331
4	0.0059	0.0268	0.0234	0.0233	0.0254	0.0378	0.0196	0.0169	0.0258	0.0036	0.0155	0.0303
5	0.0053	0.0331	0.0234	0.0261	0.0247	0.0401	0.0264	0.0170	0.0320	0.0055	0.0169	0.0359
6	0.0056	0.0342	0.0295	0.0346	0.0288	0.0432	0.0343	0.0231	0.0328	0.0057	0.0200	0.0442
7	0.0055	0.0330	0.0386	0.0326	0.0383	0.0469	0.0389	0.0242	0.0422	0.0076	0.0242	0.0379
8	0.0050	0.0361	0.0326	0.0349	0.0371	0.0430	0.0452	0.0294	0.0425	0.0087	0.0271	0.0347
9	0.0044	0.0298	0.0277	0.0416	0.0275	0.0428	0.0430	0.0266	0.0398	0.0068	0.0226	0.0282
10	0.0022	0.0168	0.0204	0.0323	0.0229	0.0414	0.0281	0.0218	0.0292	0.0047	0.0168	0.0188

POR BETA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0267	0.0565	0.0526	0.0556	0.0693	0.0725	0.1133	0.0506	0.0923	0.0176	0.0513	0.0877
2	0.0207	0.0578	0.0556	0.0650	0.0729	0.0662	0.0716	0.0452	0.0707	0.0105	0.0432	0.0741
3	0.0154	0.0544	0.0380	0.0490	0.0576	0.0627	0.0505	0.0309	0.0497	0.0060	0.0353	0.0688
4	0.0104	0.0341	0.0365	0.0450	0.0383	0.0518	0.0398	0.0248	0.0528	0.0062	0.0248	0.0516
5	0.0082	0.0282	0.0344	0.0335	0.0362	0.0229	0.0333	0.0236	0.0354	0.0054	0.0191	0.0402
6	0.0055	0.0282	0.0295	0.0310	0.0320	0.0437	0.0275	0.0171	0.0294	0.0035	0.0150	0.0383
7	0.0028	0.0214	0.0174	0.0267	0.0272	0.0361	0.0227	0.0133	0.0245	0.0035	0.0135	0.0253
8	0.0026	0.0163	0.0190	0.0118	0.0194	0.0170	0.0159	0.0135	0.0229	0.0028	0.0133	0.0205
9	0.0013	0.0141	0.0145	0.0132	0.0155	0.0195	0.0113	0.0084	0.0143	0.0008	0.0084	0.0171
10	0.0009	0.0093	0.0093	0.0079	0.0087	0.0159	0.0073	0.0057	0.0065	0.0010	0.0051	0.0132

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR CFL												
1	0.0049	0.0149	0.0183	0.0086	0.0212	0.0234	0.0132	0.0101	0.0100	0.0015	0.0080	0.0298
2	0.0047	0.0190	0.0217	0.0112	0.0188	0.0326	0.0129	0.0130	0.0152	0.0029	0.0129	0.0284
3	0.0045	0.0214	0.0249	0.0156	0.0230	0.0287	0.0149	0.0142	0.0192	0.0041	0.0117	0.0283
4	0.0049	0.0282	0.0205	0.0192	0.0241	0.0314	0.0208	0.0147	0.0268	0.0042	0.0142	0.0293
5	0.0048	0.0262	0.0227	0.0245	0.0258	0.0354	0.0202	0.0173	0.0277	0.0044	0.0186	0.0343
6	0.0050	0.0269	0.0269	0.0241	0.0286	0.0355	0.0251	0.0229	0.0283	0.0048	0.0166	0.0344
7	0.0053	0.0290	0.0266	0.0289	0.0299	0.0382	0.0297	0.0238	0.0323	0.0065	0.0213	0.0323
8	0.0055	0.0294	0.0329	0.0343	0.0367	0.0425	0.0327	0.0206	0.0336	0.0067	0.0219	0.0245
9	0.0039	0.0354	0.0236	0.0310	0.0252	0.0404	0.0336	0.0231	0.0337	0.0074	0.0208	0.0286
10	0.0031	0.0267	0.0217	0.0251	0.0208	0.0261	0.0282	0.0175	0.0263	0.0012	0.0161	0.0220

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR CSHO												
1	0.0035	0.0149	0.0232	0.0154	0.0168	0.0266	0.0232	0.0190	0.0191	0.0045	0.0156	0.0198
2	0.0026	0.0167	0.0167	0.0153	0.0203	0.0265	0.0211	0.0135	0.0209	0.0034	0.0131	0.0211
3	0.0033	0.0210	0.0189	0.0180	0.0230	0.0271	0.0208	0.0139	0.0222	0.0036	0.0149	0.0270
4	0.0033	0.0227	0.0198	0.0182	0.0208	0.0366	0.0250	0.0144	0.0241	0.0038	0.0136	0.0274
5	0.0045	0.0297	0.0226	0.0212	0.0233	0.0336	0.0211	0.0148	0.0277	0.0012	0.0131	0.0301
6	0.0062	0.0311	0.0322	0.0269	0.0292	0.0377	0.0247	0.0159	0.0275	0.0045	0.0173	0.0343
7	0.0063	0.0328	0.0290	0.0132	0.0328	0.0209	0.0312	0.0165	0.0299	0.0054	0.0172	0.0422
8	0.0090	0.0428	0.0355	0.0283	0.0332	0.0401	0.0276	0.0175	0.0321	0.0051	0.0193	0.0477
9	0.0091	0.0409	0.0451	0.0355	0.0351	0.0192	0.0324	0.0189	0.0418	0.0073	0.0220	0.0518
10	0.0139	0.0464	0.0608	0.0351	0.0425	0.0661	0.0309	0.0201	0.0419	0.0087	0.0290	0.0493

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR DEBT												
1	0.0069	0.0178	0.0199	0.0147	0.0252	0.0324	0.0150	0.0113	0.0151	0.0024	0.0110	0.0379
2	0.0051	0.0217	0.0245	0.0155	0.0236	0.0404	0.0193	0.0149	0.0205	0.0030	0.0159	0.0328
3	0.0058	0.0257	0.0248	0.0175	0.0233	0.0347	0.0193	0.0160	0.0250	0.0035	0.0130	0.0352
4	0.0050	0.0299	0.0253	0.0217	0.0264	0.0353	0.0201	0.0174	0.0228	0.0046	0.0165	0.0360

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5	0.0052	0.0230	0.0232	0.0251	0.0279	0.0425	0.0233	0.0190	0.0263	0.0042	0.0163	0.0296
6	0.0051	0.0276	0.0227	0.0258	0.0253	0.0407	0.0238	0.0194	0.0279	0.0044	0.0173	0.0321
7	0.0055	0.0298	0.0258	0.0341	0.0246	0.0407	0.0261	0.0204	0.0318	0.0058	0.0187	0.0324
8	0.0048	0.0312	0.0255	0.0310	0.0341	0.0395	0.0358	0.0276	0.0377	0.0065	0.0221	0.0372
9	0.0046	0.0276	0.0344	0.0354	0.0318	0.0472	0.0516	0.0246	0.0389	0.0060	0.0229	0.0308
10	0.0014	0.0135	0.0191	0.0286	0.0200	0.0331	0.0285	0.0170	0.0255	0.0039	0.0130	0.0112

POR DIVC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0060	0.0165	0.0198	0.0111	0.0217	0.0253	0.0137	0.0087	0.0139	0.0024	0.0087	0.0263
2	0.0080	0.0248	0.0221	0.0159	0.0284	0.0349	0.0194	0.0117	0.0239	0.0036	0.0144	0.0297
3	0.0078	0.0334	0.0316	0.0201	0.0327	0.0435	0.0240	0.0168	0.0289	0.0049	0.0208	0.0369
4	0.0065	0.0309	0.0301	0.0307	0.0352	0.0461	0.0273	0.0201	0.0306	0.0061	0.0187	0.0351
5	0.0091	0.0361	0.0354	0.0375	0.0368	0.0490	0.0277	0.0234	0.0380	0.0063	0.0252	0.0441
6	0.0085	0.0411	0.0421	0.0419	0.0448	0.0515	0.0401	0.0259	0.0517	0.0068	0.0246	0.0445
7	0.0107	0.0484	0.0448	0.0560	0.0418	0.0596	0.0592	0.0267	0.0523	0.0080	0.0295	0.0449
8	0.0116	0.0526	0.0456	0.0525	0.0485	0.0672	0.0520	0.0311	0.0573	0.0103	0.0304	0.0561
9	0.0157	0.0700	0.0618	0.0655	0.0648	0.0591	0.0782	0.0488	0.0735	0.0234	0.0454	0.0704
10	0.0074	0.0487	0.0702	0.0463	0.0569	0.0575	0.1082	0.0496	0.0630	0.0278	0.0442	0.0513

POR DIVS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0071	0.0166	0.0175	0.0129	0.0241	0.0278	0.0147	0.0101	0.0171	0.0024	0.0106	0.0269
2	0.0066	0.0288	0.0237	0.0161	0.0287	0.0364	0.0204	0.0139	0.0291	0.0036	0.0149	0.0364
3	0.0074	0.0264	0.0285	0.0200	0.0311	0.0412	0.0246	0.0171	0.0313	0.0051	0.0186	0.0286
4	0.0077	0.0327	0.0348	0.0308	0.0312	0.0442	0.0274	0.0200	0.0315	0.0059	0.0223	0.0356
5	0.0073	0.0372	0.0360	0.0325	0.0452	0.0523	0.0282	0.0245	0.0369	0.0064	0.0232	0.0412
6	0.0092	0.0462	0.0416	0.0479	0.0444	0.0503	0.0434	0.0246	0.0403	0.0092	0.0239	0.0450
7	0.0110	0.0443	0.0456	0.0554	0.0477	0.0527	0.0476	0.0285	0.0500	0.0096	0.0271	0.0495
8	0.0138	0.0515	0.0462	0.0587	0.0527	0.0700	0.0563	0.0353	0.0600	0.0117	0.0378	0.0562
9	0.0167	0.0761	0.0611	0.0630	0.0654	0.0632	0.0970	0.0489	0.0752	0.0290	0.0518	0.0754
10	0.0066	0.0695	0.0784	0.0470	0.0658	0.0548	0.1299	0.0432	0.0663	0.0352	0.0450	0.0523

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR EP												
1	0.0048	0.0176	0.0161	0.0097	0.0189	0.0230	0.0124	0.0122	0.0110	0.0016	0.0089	0.0277
2	0.0054	0.0197	0.0246	0.0139	0.0241	0.0289	0.0150	0.0145	0.0188	0.0030	0.0142	0.0285
3	0.0057	0.0238	0.0216	0.0150	0.0248	0.0334	0.0177	0.0153	0.0203	0.0043	0.0146	0.0308
4	0.0065	0.0278	0.0243	0.0191	0.0276	0.0358	0.0186	0.0146	0.0253	0.0044	0.0135	0.0288
5	0.0051	0.0269	0.0259	0.0263	0.0272	0.0344	0.0223	0.0173	0.0288	0.0058	0.0155	0.0317
6	0.0053	0.0278	0.0251	0.0262	0.0303	0.0407	0.0241	0.0175	0.0321	0.0052	0.0170	0.0323
7	0.0063	0.0333	0.0312	0.0286	0.0280	0.0407	0.0298	0.0237	0.0358	0.0061	0.0192	0.0371
8	0.0046	0.0322	0.0291	0.0307	0.0315	0.0434	0.0334	0.0245	0.0346	0.0076	0.0221	0.0269
9	0.0043	0.0306	0.0257	0.0300	0.0319	0.0400	0.0327	0.0226	0.0312	0.0063	0.0230	0.0318
10	0.0030	0.0269	0.0209	0.0227	0.0194	0.0238	0.0337	0.0165	0.0259	0.0012	0.0162	0.0215
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR MV												
1	0.0022	0.0115	0.0169	0.0130	0.0131	0.0237	0.0191	0.0146	0.0157	0.0033	0.0133	0.0142
2	0.0034	0.0204	0.0199	0.0156	0.0195	0.0254	0.0203	0.0167	0.0181	0.0030	0.0111	0.0271
3	0.0033	0.0232	0.0217	0.0165	0.0236	0.0253	0.0200	0.0141	0.0217	0.0034	0.0139	0.0260
4	0.0035	0.0311	0.0234	0.0203	0.0255	0.0370	0.0230	0.0133	0.0236	0.0044	0.0135	0.0269
5	0.0060	0.0281	0.0283	0.0254	0.0291	0.0351	0.0233	0.0161	0.0288	0.0051	0.0143	0.0377
6	0.0073	0.0391	0.0320	0.0262	0.0352	0.0401	0.0345	0.0162	0.0353	0.0058	0.0180	0.0387
7	0.0078	0.0388	0.0380	0.0280	0.0350	0.0426	0.0317	0.0175	0.0361	0.0065	0.0212	0.0433
8	0.0094	0.0426	0.0436	0.0323	0.0347	0.0491	0.0269	0.0180	0.0397	0.0068	0.0223	0.0368
9	0.0127	0.0437	0.0555	0.0371	0.0406	0.0455	0.0349	0.0193	0.0420	0.0069	0.0266	0.0498
10	0.0175	0.0508	0.0744	0.0456	0.0519	0.0741	0.0379	0.0229	0.0472	0.0091	0.0330	0.0627
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR PRICE												
1	0.0018	0.0139	0.0114	0.0130	0.0149	0.0300	0.0171	0.0133	0.0160	0.0024	0.0108	0.0185
2	0.0027	0.0155	0.0225	0.0190	0.0190	0.0293	0.0190	0.0144	0.0221	0.0037	0.0143	0.0203
3	0.0032	0.0216	0.0235	0.0209	0.0236	0.0373	0.0231	0.0164	0.0210	0.0046	0.0154	0.0285
4	0.0042	0.0253	0.0234	0.0212	0.0297	0.0370	0.0275	0.0139	0.0232	0.0049	0.0165	0.0282

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5	0.0048	0.0320	0.0304	0.0239	0.0288	0.0345	0.0314	0.0173	0.0268	0.0052	0.0181	0.0269
6	0.0070	0.0372	0.0337	0.0228	0.0321	0.0369	0.0253	0.0191	0.0314	0.0068	0.0209	0.0326
7	0.0074	0.0402	0.0382	0.0275	0.0358	0.0437	0.0344	0.0203	0.0312	0.0069	0.0195	0.0360
8	0.0078	0.0376	0.0413	0.0265	0.0405	0.0388	0.0273	0.0212	0.0319	0.0066	0.0205	0.0398
9	0.0105	0.0369	0.0384	0.0283	0.0324	0.0430	0.0310	0.0218	0.0466	0.0062	0.0223	0.0456
10	0.0089	0.0341	0.0353	0.0219	0.0346	0.0399	0.0324	0.0205	0.0284	0.0051	0.0202	0.0445

POR SALE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0078	0.0215	0.0184	0.0132	0.0224	0.0265	0.0182	0.0140	0.0142	0.0024	0.0149	0.0346
2	0.0092	0.0305	0.0310	0.0242	0.0333	0.0398	0.0214	0.0183	0.0293	0.0039	0.0182	0.0466
3	0.0096	0.0328	0.0434	0.0241	0.0378	0.0465	0.0319	0.0223	0.0299	0.0064	0.0214	0.0520
4	0.0075	0.0326	0.0320	0.0225	0.0302	0.0480	0.0279	0.0212	0.0289	0.0059	0.0166	0.0363
5	0.0047	0.0285	0.0308	0.0228	0.0268	0.0412	0.0258	0.0197	0.0257	0.0053	0.0162	0.0464
6	0.0050	0.0260	0.0241	0.0206	0.0269	0.0348	0.0249	0.0193	0.0260	0.0053	0.0149	0.0338
7	0.0039	0.0249	0.0221	0.0224	0.0266	0.0356	0.0261	0.0181	0.0265	0.0046	0.0174	0.0319
8	0.0032	0.0253	0.0187	0.0243	0.0255	0.0286	0.0266	0.0157	0.0294	0.0041	0.0136	0.0254
9	0.0033	0.0160	0.0256	0.0174	0.0196	0.0343	0.0254	0.0165	0.0256	0.0041	0.0156	0.0200
10	0.0017	0.0143	0.0172	0.0185	0.0185	0.0252	0.0233	0.0168	0.0240	0.0014	0.0147	0.0157

POR GR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0026	0.0141	0.0169	0.0139	0.0275	0.0328	0.0211	0.0200	0.0262	0.0024	0.0127	0.0238
2	0.0061	0.0329	0.0247	0.0475	0.0364	0.0264	0.0277	0.0266	0.0516	0.0045	0.0187	0.0357
3	0.0080	0.0335	0.0329	0.0514	0.0351	0.0576	0.0430	0.0284	0.0493	0.0004	0.0177	0.0486
4	0.0070	0.0405	0.0361	0.0425	0.0481	0.0542	0.0469	0.0255	0.0470	0.0069	0.0238	0.0484
5	0.0087	0.0337	0.0314	0.0377	0.0460	0.0494	0.0377	0.0203	0.0401	0.0057	0.0221	0.0416
6	0.0068	0.0315	0.0434	0.0421	0.0430	0.0461	0.0404	0.0239	0.0372	0.0046	0.0207	0.0425
7	0.0051	0.0288	0.0340	0.0327	0.0392	0.0467	0.0293	0.0204	0.0281	0.0044	0.0176	0.0350
8	0.0041	0.0232	0.0260	0.0269	0.0318	0.0327	0.0269	0.0162	0.0207	0.0034	0.0143	0.0237
9	0.0036	0.0225	0.0173	0.0215	0.0215	0.0315	0.0182	0.0148	0.0176	0.0028	0.0111	0.0228
10	0.0016	0.0142	0.0127	0.0150	0.0163	0.0207	0.0096	0.0094	0.0119	0.0016	0.0073	0.0189

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR TR												
1	0.0084	0.0382	0.0395	0.0660	0.0521	0.0835	0.0707	0.0468	0.0720	0.0133	0.0357	0.0493
2	0.0059	0.0342	0.0389	0.0517	0.0413	0.0654	0.0526	0.0302	0.0517	0.0055	0.0281	0.0435
3	0.0066	0.0426	0.0328	0.0415	0.0370	0.0546	0.0403	0.0248	0.0452	0.0067	0.0249	0.0310
4	0.0057	0.0331	0.0367	0.0330	0.0389	0.0517	0.0348	0.0217	0.0403	0.0064	0.0244	0.0344
5	0.0052	0.0307	0.0290	0.0305	0.0290	0.0380	0.0303	0.0169	0.0247	0.0047	0.0207	0.0359
6	0.0038	0.0222	0.0246	0.0177	0.0297	0.0166	0.0215	0.0160	0.0250	0.0039	0.0163	0.0345
7	0.0035	0.0218	0.0166	0.0165	0.0190	0.0237	0.0216	0.0105	0.0204	0.0035	0.0139	0.0273
8	0.0033	0.0165	0.0197	0.0145	0.0144	0.0208	0.0126	0.0108	0.0166	0.0009	0.0087	0.0206
9	0.0027	0.0126	0.0146	0.0107	0.0140	0.0169	0.0090	0.0073	0.0116	0.0016	0.0067	0.0182
10	0.0015	0.0102	0.0108	0.0066	0.0098	0.0095	0.0056	0.0056	0.0053	0.0008	0.0038	0.0135
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR TABE												
1	0.0067	0.0282	0.0256	0.0256	0.0291	0.0443	0.0261	0.0181	0.0324	0.0042	0.0201	0.0393
2	0.0065	0.0262	0.0266	0.0296	0.0312	0.0424	0.0236	0.0181	0.0266	0.0041	0.0169	0.0382
3	0.0040	0.0264	0.0218	0.0243	0.0252	0.0404	0.0218	0.0173	0.0278	0.0043	0.0163	0.0319
4	0.0043	0.0295	0.0269	0.0232	0.0294	0.0398	0.0245	0.0193	0.0259	0.0043	0.0191	0.0337
5	0.0053	0.0242	0.0256	0.0232	0.0287	0.0305	0.0218	0.0145	0.0213	0.0043	0.0168	0.0300
6	0.0043	0.0237	0.0216	0.0198	0.0204	0.0348	0.0246	0.0156	0.0220	0.0043	0.0174	0.0294
7	0.0036	0.0236	0.0245	0.0179	0.0286	0.0316	0.0212	0.0191	0.0223	0.0048	0.0153	0.0292
8	0.0037	0.0221	0.0260	0.0215	0.0240	0.0358	0.0221	0.0172	0.0289	0.0045	0.0130	0.0310
9	0.0039	0.0206	0.0253	0.0297	0.0271	0.0347	0.0354	0.0209	0.0298	0.0044	0.0172	0.0162
10	0.0021	0.0147	0.0133	0.0159	0.0180	0.0262	0.0218	0.0111	0.0186	0.0027	0.0120	0.0199
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR TAMV												
1	0.0046	0.0135	0.0175	0.0089	0.0222	0.0248	0.0115	0.0091	0.0108	0.0016	0.0069	0.0300
2	0.0061	0.0191	0.0231	0.0136	0.0215	0.0327	0.0163	0.0151	0.0179	0.0028	0.0121	0.0327
3	0.0058	0.0220	0.0222	0.0167	0.0219	0.0327	0.0152	0.0137	0.0190	0.0034	0.0139	0.0320
4	0.0054	0.0283	0.0245	0.0200	0.0287	0.0382	0.0212	0.0187	0.0253	0.0041	0.0166	0.0344

5		0.0061	0.0276	0.0219	0.0255	0.0265	0.0367	0.0228	0.0198	0.0292	0.0053	0.0183	0.0358
6		0.0054	0.0292	0.0267	0.0286	0.0292	0.0379	0.0278	0.0215	0.0311	0.0049	0.0186	0.0340
7		0.0051	0.0325	0.0231	0.0352	0.0233	0.0455	0.0290	0.0199	0.0368	0.0064	0.0208	0.0391
8		0.0050	0.0368	0.0356	0.0388	0.0302	0.0384	0.0393	0.0278	0.0386	0.0064	0.0227	0.0348
9		0.0046	0.0228	0.0312	0.0318	0.0261	0.0507	0.0461	0.0199	0.0422	0.0056	0.0236	0.0251
10		0.0011	0.0129	0.0172	0.0180	0.0182	0.0220	0.0246	0.0168	0.0235	0.0008	0.0129	0.0126
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR	CAR12												
1		0.0011	0.0130	0.0110	0.0139	0.0136	0.0290	0.0108	0.0126	0.0113	0.0018	0.0104	0.0156
2		0.0033	0.0344	0.0293	0.0233	0.0262	0.0393	0.0234	0.0183	0.0242	0.0062	0.0150	0.0372
3		0.0047	0.0389	0.0404	0.0322	0.0336	0.0474	0.0308	0.0255	0.0296	0.0090	0.0172	0.0373
4		0.0069	0.0378	0.0459	0.0401	0.0410	0.0529	0.0401	0.0269	0.0358	0.0085	0.0210	0.0408
5		0.0082	0.0427	0.0445	0.0476	0.0446	0.0551	0.0385	0.0276	0.0400	0.0080	0.0203	0.0444
6		0.0094	0.0387	0.0413	0.0354	0.0371	0.0486	0.0391	0.0284	0.0425	0.0071	0.0224	0.0454
7		0.0091	0.0317	0.0327	0.0338	0.0387	0.0431	0.0328	0.0213	0.0427	0.0053	0.0244	0.0408
8		0.0074	0.0279	0.0261	0.0261	0.0306	0.0414	0.0313	0.0195	0.0387	0.0048	0.0252	0.0349
9		0.0067	0.0200	0.0213	0.0178	0.0274	0.0303	0.0300	0.0160	0.0282	0.0030	0.0221	0.0304
10		0.0027	0.0127	0.0135	0.0073	0.0146	0.0189	0.0163	0.0096	0.0139	0.0015	0.0112	0.0186
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR	CAR60												
1		0.0013	0.0120	0.0165	0.0245	0.0279	0.0379	0.0205	0.0174	0.0517	0.0021	0.0103	0.0240
2		0.0037	0.0288	0.0323	0.0516	0.0452	0.0684	0.0358	0.0278	0.0492	0.0033	0.0206	0.0450
3		0.0063	0.0413	0.0379	0.0588	0.0476	0.0750	0.0510	0.0331	0.0587	0.0042	0.0253	0.0434
4		0.0081	0.0423	0.0396	0.0580	0.0483	0.0800	0.0503	0.0277	0.0577	0.0047	0.0264	0.0446
5		0.0067	0.0470	0.0356	0.0528	0.0440	0.0236	0.0335	0.0233	0.0451	0.0052	0.0213	0.0352
6		0.0077	0.0504	0.0248	0.0439	0.0398	0.0613	0.0384	0.0200	0.0521	0.0066	0.0239	0.0399
7		0.0057	0.0454	0.0314	0.0353	0.0396	0.0681	0.0304	0.0200	0.0364	0.0056	0.0211	0.0464
8		0.0077	0.0439	0.0224	0.0312	0.0325	0.0675	0.0239	0.0177	0.0315	0.0047	0.0149	0.0390
9		0.0056	0.0321	0.0211	0.0269	0.0268	0.0466	0.0229	0.0112	0.0287	0.0031	0.0124	0.0345
10		0.0042	0.0255	0.0126	0.0169	0.0182	0.0334	0.0097	0.0074	0.0150	0.0014	0.0085	0.0292

TABLE 4.5

P-VALUES FOR THE CHI-SQUARED TEST FOR THE SIGNIFICANCE OF VOLATILITY ACROSS MONTHS (VW)

We report the p-values of the chi-squared test for the significance of each portfolio's volatility in individual months.

POR BEMV	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0088	0.0253	0.0473	0.0233	0.0359	0.0462	0.0200	0.0183	0.0195	0.0048	0.0169	0.0318
2	0.0139	0.0394	0.0541	0.0254	0.0351	0.0556	0.0230	0.0192	0.0378	0.0063	0.0284	0.0372
3	0.0147	0.0464	0.0430	0.0363	0.0429	0.0581	0.0276	0.0175	0.0352	0.0067	0.0156	0.0571
4	0.0103	0.0464	0.0393	0.0430	0.0473	0.0446	0.0343	0.0214	0.0408	0.0082	0.0213	0.0480
5	0.0146	0.0593	0.0444	0.0541	0.0499	0.0547	0.0386	0.0258	0.0634	0.0121	0.0200	0.0592
6	0.0141	0.0404	0.0847	0.0543	0.0541	0.0607	0.0519	0.0267	0.0613	0.0114	0.0207	0.0296
7	0.0108	0.0584	0.0445	0.0502	0.0607	0.0619	0.0425	0.0198	0.0632	0.0184	0.0476	0.0726
8	0.0103	0.0698	0.0626	0.0494	0.0587	0.0499	0.0572	0.0229	0.0640	0.0190	0.0345	0.0728
9	0.0104	0.0502	0.0375	0.0361	0.0440	0.0554	0.0546	0.0240	0.0477	0.0132	0.0423	0.0361
10	0.0042	0.0301	0.0218	0.0360	0.0256	0.0418	0.0256	0.0136	0.0356	0.0065	0.0254	0.0272

POR BETA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0392	0.0597	0.0829	0.0653	0.0952	0.0860	0.0675	0.0436	0.0608	0.0245	0.0566	0.0924
2	0.0202	0.0559	0.0568	0.0532	0.0590	0.0745	0.0534	0.0323	0.0631	0.0157	0.0247	0.0685
3	0.0177	0.0638	0.0480	0.0400	0.0513	0.0694	0.0372	0.0299	0.0602	0.0128	0.0329	0.0639
4	0.0121	0.0499	0.0557	0.0481	0.0502	0.0636	0.0356	0.0205	0.0415	0.0064	0.0293	0.0462
5	0.0088	0.0463	0.0349	0.0325	0.0407	0.0601	0.0236	0.0163	0.0339	0.0078	0.0237	0.0440
6	0.0086	0.0407	0.0455	0.0276	0.0457	0.0509	0.0232	0.0176	0.0244	0.0044	0.0182	0.0300
7	0.0052	0.0303	0.0419	0.0299	0.0358	0.0337	0.0120	0.0170	0.0219	0.0055	0.0164	0.0179
8	0.0042	0.0175	0.0252	0.0144	0.0246	0.0286	0.0118	0.0124	0.0244	0.0046	0.0144	0.0243
9	0.0027	0.0180	0.0144	0.0141	0.0146	0.0227	0.0082	0.0077	0.0150	0.0028	0.0090	0.0268
10	0.0009	0.0084	0.0101	0.0082	0.0092	0.0126	0.0040	0.0046	0.0044	0.0010	0.0037	0.0157

POR CFL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0075	0.0206	0.0416	0.0186	0.0266	0.0423	0.0157	0.0123	0.0213	0.0031	0.0158	0.0347
2	0.0121	0.0351	0.0472	0.0301	0.0366	0.0565	0.0251	0.0198	0.0285	0.0063	0.0273	0.0332
3	0.0117	0.0445	0.0463	0.0238	0.0354	0.0491	0.0216	0.0151	0.0296	0.0075	0.0329	0.0474
4	0.0146	0.0459	0.0371	0.0339	0.0472	0.0516	0.0379	0.0216	0.0337	0.0078	0.0223	0.0493
5	0.0139	0.0373	0.0327	0.0337	0.0383	0.0636	0.0391	0.0212	0.0426	0.0091	0.0241	0.0456
6	0.0095	0.0481	0.0317	0.0409	0.0426	0.0584	0.0298	0.0279	0.0471	0.0088	0.0207	0.0532
7	0.0120	0.0536	0.0393	0.0408	0.0414	0.0650	0.0404	0.0246	0.0451	0.0107	0.0279	0.0600
8	0.0075	0.0470	0.0531	0.0482	0.0706	0.0617	0.0343	0.0245	0.0509	0.0173	0.0171	0.0211
9	0.0064	0.0617	0.0456	0.0391	0.0559	0.0477	0.0511	0.0215	0.0458	0.0192	0.0380	0.0474
10	0.0051	0.0380	0.0329	0.0434	0.0371	0.0112	0.0316	0.0130	0.0285	0.0102	0.0193	0.0369

POR CSHO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0053	0.0194	0.0252	0.0151	0.0203	0.0294	0.0199	0.0164	0.0220	0.0042	0.0121	0.0271
2	0.0043	0.0269	0.0218	0.0174	0.0282	0.0323	0.0238	0.0153	0.0288	0.0044	0.0172	0.0039
3	0.0045	0.0276	0.0212	0.0175	0.0280	0.0272	0.0251	0.0169	0.0255	0.0045	0.0159	0.0367
4	0.0072	0.0288	0.0323	0.0229	0.0265	0.0421	0.0267	0.0154	0.0336	0.0052	0.0154	0.0351
5	0.0089	0.0334	0.0282	0.0258	0.0309	0.0378	0.0243	0.0148	0.0310	0.0031	0.0199	0.0352
6	0.0092	0.0387	0.0377	0.0344	0.0390	0.0397	0.0295	0.0190	0.0396	0.0054	0.0205	0.0435
7	0.0102	0.0369	0.0380	0.0332	0.0427	0.0455	0.0312	0.0191	0.0423	0.0058	0.0241	0.0499
8	0.0130	0.0514	0.0394	0.0400	0.0418	0.0451	0.0341	0.0198	0.0458	0.0056	0.0251	0.0436
9	0.0119	0.0507	0.0504	0.0413	0.0440	0.0528	0.0399	0.0196	0.0465	0.0074	0.0289	0.0585
10	0.0213	0.0618	0.0729	0.0495	0.0606	0.0898	0.0427	0.0264	0.0544	0.0132	0.0331	0.0606

POR DEBT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0110	0.0280	0.0526	0.0286	0.0370	0.0460	0.0211	0.0178	0.0244	0.0052	0.0209	0.0348
2	0.0143	0.0491	0.0442	0.0386	0.0464	0.0557	0.0266	0.0195	0.0421	0.0064	0.0272	0.0450
3	0.0142	0.0416	0.0435	0.0348	0.0441	0.0492	0.0324	0.0220	0.0323	0.0077	0.0197	0.0462
4	0.0095	0.0525	0.0450	0.0345	0.0425	0.0560	0.0362	0.0206	0.0430	0.0093	0.0251	0.0445

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5	0.0123	0.0406	0.0368	0.0422	0.0527	0.0581	0.0347	0.0194	0.0661	0.0129	0.0231	0.0550
6	0.0134	0.0630	0.0431	0.0522	0.0576	0.0708	0.0300	0.0263	0.0466	0.0152	0.0223	0.0449
7	0.0118	0.0509	0.0620	0.0471	0.0671	0.0495	0.0535	0.0230	0.0512	0.0180	0.0361	0.0554
8	0.0148	0.0591	0.0813	0.0531	0.0607	0.0547	0.0523	0.0250	0.0640	0.0163	0.0320	0.0624
9	0.0105	0.0652	0.0814	0.0456	0.0517	0.0424	0.0722	0.0224	0.0616	0.0137	0.0338	0.0395
10	0.0042	0.0230	0.0246	0.0292	0.0282	0.0319	0.0329	0.0150	0.0396	0.0053	0.0259	0.0375

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR DIVC												
1	0.0082	0.0232	0.0319	0.0191	0.0302	0.0325	0.0177	0.0125	0.0179	0.0028	0.0130	0.0349
2	0.0116	0.0318	0.0460	0.0243	0.0407	0.0439	0.0245	0.0202	0.0258	0.0041	0.0185	0.0314
3	0.0127	0.0345	0.0588	0.0296	0.0400	0.0568	0.0288	0.0184	0.0460	0.0067	0.0312	0.0440
4	0.0112	0.0401	0.0422	0.0322	0.0458	0.0625	0.0246	0.0169	0.0326	0.0073	0.0286	0.0418
5	0.0097	0.0497	0.0492	0.0449	0.0445	0.0757	0.0310	0.0227	0.0386	0.0095	0.0280	0.0347
6	0.0169	0.0546	0.0656	0.0570	0.0493	0.0697	0.0377	0.0214	0.0550	0.0103	0.0187	0.0624
7	0.0194	0.0520	0.0482	0.0570	0.0551	0.0622	0.0555	0.0297	0.0609	0.0095	0.0269	0.0729
8	0.0131	0.0566	0.0519	0.0603	0.0561	0.0654	0.0469	0.0223	0.0695	0.0165	0.0328	0.0676
9	0.0219	0.0819	0.0835	0.0624	0.0677	0.0704	0.0722	0.0238	0.0795	0.0303	0.0462	0.0858
10	0.0110	0.0493	0.0970	0.0342	0.0610	0.0491	0.0576	0.0446	0.0631	0.0303	0.0428	0.0660

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR DIVS												
1	0.0090	0.0249	0.0308	0.0195	0.0306	0.0331	0.0194	0.0128	0.0192	0.0027	0.0132	0.0321
2	0.0100	0.0326	0.0385	0.0260	0.0393	0.0498	0.0215	0.0175	0.0258	0.0040	0.0210	0.0314
3	0.0137	0.0343	0.0515	0.0294	0.0358	0.0616	0.0260	0.0238	0.0361	0.0064	0.0221	0.0360
4	0.0119	0.0439	0.0454	0.0355	0.0452	0.0643	0.0300	0.0212	0.0363	0.0074	0.0342	0.0291
5	0.0134	0.0495	0.0472	0.0345	0.0560	0.0665	0.0232	0.0203	0.0418	0.0073	0.0181	0.0455
6	0.0124	0.0521	0.0722	0.0513	0.0531	0.0573	0.0517	0.0215	0.0476	0.0101	0.0272	0.0521
7	0.0172	0.0482	0.0586	0.0606	0.0558	0.0624	0.0445	0.0259	0.0491	0.0091	0.0236	0.0773
8	0.0220	0.0526	0.0527	0.0514	0.0552	0.0799	0.0538	0.0199	0.0677	0.0143	0.0365	0.0791
9	0.0175	0.0808	0.0757	0.0694	0.0752	0.0644	0.0633	0.0263	0.0851	0.0338	0.0584	0.0870
10	0.0125	0.0694	0.0915	0.0357	0.0637	0.0495	0.0746	0.0405	0.0639	0.0452	0.0494	0.0699

POR EP	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0067	0.0250	0.0355	0.0183	0.0291	0.0393	0.0188	0.0140	0.0190	0.0024	0.0170	0.0394
2	0.0128	0.0404	0.0501	0.0294	0.0394	0.0515	0.0248	0.0174	0.0378	0.0058	0.0286	0.0409
3	0.0129	0.0434	0.0482	0.0345	0.0385	0.0567	0.0340	0.0180	0.0373	0.0087	0.0340	0.0445
4	0.0133	0.0470	0.0415	0.0332	0.0395	0.0527	0.0245	0.0209	0.0360	0.0078	0.0230	0.0442
5	0.0114	0.0465	0.0482	0.0538	0.0416	0.0539	0.0364	0.0180	0.0364	0.0101	0.0227	0.0520
6	0.0137	0.0495	0.0353	0.0282	0.0387	0.0599	0.0255	0.0245	0.0426	0.0086	0.0172	0.0219
7	0.0109	0.0426	0.0561	0.0427	0.0549	0.0634	0.0418	0.0272	0.0484	0.0134	0.0329	0.0692
8	0.0066	0.0525	0.0393	0.0375	0.0365	0.0618	0.0441	0.0242	0.0431	0.0159	0.0246	0.0442
9	0.0067	0.0506	0.0341	0.0471	0.0642	0.0419	0.0432	0.0182	0.0398	0.0218	0.0278	0.0466
10	0.0039	0.0359	0.0355	0.0334	0.0289	0.0073	0.0334	0.0149	0.0304	0.0084	0.0272	0.0339

POR MV	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0020	0.0101	0.0121	0.0037	0.0101	0.0057	0.0162	0.0108	0.0147	0.0011	0.0102	0.0148
2	0.0038	0.0187	0.0171	0.0137	0.0175	0.0018	0.0178	0.0159	0.0164	0.0018	0.0105	0.0288
3	0.0032	0.0209	0.0183	0.0149	0.0195	0.0238	0.0184	0.0139	0.0201	0.0033	0.0125	0.0280
4	0.0045	0.0290	0.0223	0.0200	0.0215	0.0303	0.0222	0.0131	0.0238	0.0042	0.0137	0.0277
5	0.0060	0.0291	0.0233	0.0250	0.0266	0.0339	0.0208	0.0163	0.0297	0.0051	0.0131	0.0359
6	0.0080	0.0398	0.0290	0.0258	0.0355	0.0400	0.0334	0.0166	0.0376	0.0058	0.0187	0.0389
7	0.0082	0.0399	0.0344	0.0293	0.0357	0.0424	0.0301	0.0179	0.0367	0.0062	0.0219	0.0425
8	0.0101	0.0456	0.0406	0.0342	0.0365	0.0459	0.0262	0.0181	0.0427	0.0066	0.0213	0.0369
9	0.0129	0.0474	0.0503	0.0394	0.0411	0.0480	0.0348	0.0196	0.0449	0.0067	0.0285	0.0440
10	0.0195	0.0607	0.0719	0.0501	0.0611	0.0891	0.0431	0.0264	0.0540	0.0125	0.0323	0.0614

POR PRICE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.0033	0.0138	0.0179	0.0073	0.0164	0.0036	0.0172	0.0115	0.0205	0.0015	0.0127	0.0357
2	0.0068	0.0284	0.0340	0.0282	0.0231	0.0360	0.0224	0.0199	0.0346	0.0046	0.0166	0.0438
3	0.0109	0.0396	0.0486	0.0341	0.0402	0.0544	0.0278	0.0215	0.0366	0.0061	0.0230	0.0574
4	0.0129	0.0372	0.0528	0.0408	0.0491	0.0534	0.0324	0.0155	0.0425	0.0075	0.0284	0.0530

5	0.0138	0.0454	0.0500	0.0467	0.0396	0.0553	0.0288	0.0223	0.0426	0.0076	0.0293	0.0476
6	0.0160	0.0453	0.0428	0.0380	0.0429	0.0584	0.0270	0.0205	0.0567	0.0096	0.0331	0.0500
7	0.0176	0.0469	0.0543	0.0518	0.0513	0.0668	0.0486	0.0196	0.0344	0.0101	0.0303	0.0583
8	0.0185	0.0484	0.0540	0.0397	0.0510	0.0464	0.0321	0.0201	0.0459	0.0101	0.0275	0.0443
9	0.0146	0.0535	0.0512	0.0402	0.0552	0.0596	0.0320	0.0193	0.0489	0.0064	0.0337	0.0482
10	0.0173	0.0600	0.0684	0.0424	0.0653	0.0776	0.0483	0.0312	0.0559	0.0124	0.0256	0.0507

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR SALE												
1	0.0115	0.0271	0.0524	0.0294	0.0374	0.0554	0.0204	0.0184	0.0237	0.0046	0.0251	0.0440
2	0.0225	0.0594	0.0726	0.0467	0.0525	0.0671	0.0418	0.0248	0.0573	0.0080	0.0272	0.0547
3	0.0146	0.0542	0.0569	0.0441	0.0734	0.0620	0.0367	0.0300	0.0470	0.0149	0.0384	0.0511
4	0.0164	0.0605	0.0595	0.0400	0.0518	0.0633	0.0438	0.0266	0.0457	0.0125	0.0256	0.0544
5	0.0138	0.0513	0.0599	0.0392	0.0443	0.0693	0.0468	0.0201	0.0505	0.0103	0.0304	0.0647
6	0.0079	0.0429	0.0402	0.0372	0.0424	0.0497	0.0323	0.0214	0.0436	0.0136	0.0193	0.0502
7	0.0061	0.0508	0.0380	0.0408	0.0417	0.0432	0.0315	0.0186	0.0373	0.0091	0.0176	0.0407
8	0.0070	0.0430	0.0388	0.0284	0.0403	0.0346	0.0307	0.0160	0.0350	0.0066	0.0212	0.0461
9	0.0087	0.0369	0.0316	0.0235	0.0275	0.0426	0.0262	0.0186	0.0328	0.0062	0.0201	0.0235
10	0.0027	0.0194	0.0192	0.0278	0.0243	0.0134	0.0196	0.0127	0.0237	0.0027	0.0162	0.0275

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR GR												
1	0.0109	0.0353	0.0179	0.0168	0.0377	0.0368	0.0197	0.0224	0.0474	0.0046	0.0170	0.0400
2	0.0132	0.0571	0.0311	0.0529	0.0468	0.0235	0.0267	0.0156	0.0672	0.0052	0.0248	0.0550
3	0.0140	0.0567	0.0333	0.0594	0.0484	0.0617	0.0260	0.0224	0.0528	0.0069	0.0264	0.0286
4	0.0196	0.0598	0.0768	0.0403	0.0620	0.0737	0.0385	0.0258	0.0631	0.0080	0.0316	0.0633
5	0.0193	0.0480	0.0563	0.0574	0.0574	0.0815	0.0309	0.0281	0.0514	0.0098	0.0280	0.0629
6	0.0144	0.0556	0.0542	0.0432	0.0551	0.0565	0.0461	0.0254	0.0520	0.0105	0.0236	0.0458
7	0.0132	0.0455	0.0568	0.0389	0.0453	0.0697	0.0429	0.0225	0.0307	0.0070	0.0303	0.0443
8	0.0118	0.0396	0.0452	0.0526	0.0427	0.0590	0.0316	0.0182	0.0296	0.0052	0.0181	0.0340
9	0.0089	0.0352	0.0514	0.0330	0.0435	0.0414	0.0217	0.0159	0.0231	0.0048	0.0176	0.0308
10	0.0050	0.0177	0.0203	0.0167	0.0280	0.0265	0.0115	0.0130	0.0189	0.0030	0.0083	0.0194

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR TR												
1	0.0267	0.0718	0.0564	0.0639	0.0905	0.1070	0.0641	0.0382	0.0821	0.0196	0.0456	0.0963
2	0.0191	0.0580	0.0800	0.0508	0.0695	0.0783	0.0591	0.0317	0.0626	0.0112	0.0498	0.0768
3	0.0173	0.0609	0.0624	0.0474	0.0515	0.0619	0.0438	0.0240	0.0501	0.0126	0.0353	0.0569
4	0.0140	0.0623	0.0741	0.0382	0.0638	0.0496	0.0338	0.0229	0.0429	0.0120	0.0321	0.0555
5	0.0118	0.0630	0.0635	0.0334	0.0420	0.0609	0.0392	0.0210	0.0388	0.0078	0.0192	0.0465
6	0.0027	0.0446	0.0420	0.0269	0.0424	0.0412	0.0270	0.0166	0.0333	0.0078	0.0269	0.0436
7	0.0081	0.0267	0.0411	0.0210	0.0385	0.0386	0.0212	0.0166	0.0346	0.0063	0.0234	0.0427
8	0.0070	0.0276	0.0284	0.0212	0.0344	0.0307	0.0185	0.0145	0.0245	0.0046	0.0193	0.0394
9	0.0051	0.0184	0.0189	0.0111	0.0205	0.0239	0.0111	0.0125	0.0163	0.0027	0.0087	0.0223
10	0.0005	0.0125	0.0131	0.0064	0.0087	0.0111	0.0071	0.0072	0.0072	0.0009	0.0044	0.0141

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR TABE												
1	0.0138	0.0282	0.0456	0.0292	0.0425	0.0571	0.0255	0.0188	0.0370	0.0052	0.0239	0.0477
2	0.0192	0.0552	0.0559	0.0535	0.0540	0.0591	0.0316	0.0176	0.0395	0.0086	0.0267	0.0393
3	0.0152	0.0445	0.0436	0.0379	0.0474	0.0629	0.0436	0.0241	0.0441	0.0087	0.0260	0.0468
4	0.0124	0.0680	0.0496	0.0487	0.0559	0.0638	0.0361	0.0238	0.0470	0.0116	0.0250	0.0603
5	0.0128	0.0507	0.0410	0.0377	0.0458	0.0587	0.0317	0.0222	0.0471	0.0095	0.0350	0.0464
6	0.0113	0.0483	0.0676	0.0302	0.0410	0.0612	0.0261	0.0207	0.0387	0.0122	0.0263	0.0358
7	0.0138	0.0569	0.0511	0.0405	0.0524	0.0628	0.0308	0.0202	0.0431	0.0103	0.0274	0.0587
8	0.0140	0.0462	0.0501	0.0316	0.0643	0.0475	0.0276	0.0208	0.0417	0.0081	0.0252	0.0459
9	0.0123	0.0447	0.0680	0.0418	0.0513	0.0381	0.0583	0.0264	0.0586	0.0079	0.0282	0.0479
10	0.0080	0.0263	0.0264	0.0225	0.0268	0.0330	0.0252	0.0139	0.0360	0.0044	0.0144	0.0292

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR TAMV												
1	0.0093	0.0287	0.0551	0.0274	0.0369	0.0479	0.0208	0.0182	0.0236	0.0052	0.0217	0.0323
2	0.0163	0.0468	0.0385	0.0247	0.0438	0.0538	0.0278	0.0186	0.0359	0.0069	0.0221	0.0405
3	0.0148	0.0401	0.0442	0.0427	0.0523	0.0651	0.0339	0.0211	0.0379	0.0065	0.0239	0.0553
4	0.0105	0.0426	0.0383	0.0387	0.0422	0.0524	0.0337	0.0214	0.0449	0.0110	0.0233	0.0506

5	0.0142	0.0574	0.0435	0.0489	0.0539	0.0711	0.0366	0.0271	0.0692	0.0149	0.0214	0.0572
6	0.0110	0.0567	0.0677	0.0577	0.0675	0.0601	0.0317	0.0236	0.0519	0.0147	0.0241	0.0424
7	0.0117	0.0449	0.0444	0.0501	0.0592	0.0631	0.0560	0.0219	0.0476	0.0193	0.0348	0.0663
8	0.0110	0.0664	0.0729	0.0427	0.0586	0.0401	0.0616	0.0246	0.0559	0.0158	0.0373	0.0489
9	0.0128	0.0625	0.0641	0.0395	0.0459	0.0546	0.0545	0.0235	0.0621	0.0122	0.0356	0.0409
10	0.0028	0.0206	0.0233	0.0200	0.0241	0.0131	0.0305	0.0139	0.0314	0.0032	0.0226	0.0320

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR CAR12												
1	0.0030	0.0236	0.0300	0.0117	0.0247	0.0191	0.0069	0.0078	0.0106	0.0032	0.0101	0.0514
2	0.0113	0.0404	0.0597	0.0302	0.0354	0.0528	0.0141	0.0126	0.0197	0.0077	0.0131	0.0750
3	0.0115	0.0510	0.0758	0.0406	0.0436	0.0536	0.0250	0.0150	0.0305	0.0083	0.0206	0.0801
4	0.0179	0.0599	0.0800	0.0611	0.0530	0.0726	0.0356	0.0202	0.0382	0.0110	0.0248	0.0517
5	0.0259	0.0447	0.0640	0.0540	0.0476	0.0740	0.0300	0.0223	0.0408	0.0103	0.0292	0.0681
6	0.0231	0.0483	0.0509	0.0426	0.0456	0.0732	0.0307	0.0236	0.0570	0.0110	0.0328	0.0643
7	0.0192	0.0498	0.0477	0.0499	0.0561	0.0643	0.0323	0.0265	0.0371	0.0066	0.0288	0.0598
8	0.0110	0.0421	0.0316	0.0335	0.0571	0.0595	0.0283	0.0180	0.0504	0.0064	0.0224	0.0388
9	0.0064	0.0296	0.0300	0.0225	0.0404	0.0546	0.0316	0.0178	0.0318	0.0041	0.0102	0.0236
10	0.0047	0.0152	0.0157	0.0111	0.0215	0.0243	0.0158	0.0092	0.0156	0.0025	0.0099	0.0193

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
POR CAR60												
1	0.0029	0.0232	0.0373	0.0106	0.0219	0.0028	0.0187	0.0195	0.0492	0.0032	0.0225	0.0382
2	0.0066	0.0495	0.0415	0.0442	0.0373	0.0587	0.0304	0.0231	0.0685	0.0069	0.0309	0.0590
3	0.0102	0.0589	0.0497	0.0550	0.0534	0.0770	0.0428	0.0247	0.0496	0.0090	0.0201	0.0574
4	0.0118	0.0562	0.0704	0.0547	0.0690	0.0746	0.0448	0.0292	0.0546	0.0077	0.0203	0.0394
5	0.0077	0.0443	0.0591	0.0539	0.0467	0.0418	0.0396	0.0168	0.0479	0.0093	0.0240	0.0447
6	0.0094	0.0435	0.0477	0.0456	0.0445	0.0731	0.0376	0.0235	0.0514	0.0100	0.0193	0.0501
7	0.0124	0.0586	0.0310	0.0397	0.0449	0.0693	0.0319	0.0173	0.0490	0.0082	0.0244	0.0677
8	0.0099	0.0513	0.0367	0.0482	0.0470	0.0445	0.0303	0.0176	0.0279	0.0078	0.0222	0.0320
9	0.0104	0.0335	0.0281	0.0277	0.0407	0.0497	0.0204	0.0176	0.0280	0.0039	0.0147	0.0382
10	0.0057	0.0226	0.0186	0.0233	0.0267	0.0273	0.0099	0.0096	0.0165	0.0013	0.0104	0.0267

TABLE 4.6

T-STATISTICS TESTS OVER THE CONSTANT SIGNIFICANCE

Each of the 10 portfolio equally- and value-weighted returns of individual factors are regressed on the market portfolio. The constant value plus the t-statistic of significance hypothesis are reported.

		BEMV		BETA		CFL		CSHO		DEBT		DIVCOM	
		CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT
1	EQL	-0.8036	-4.6784	0.1761	1.4450	-0.7495	-4.3618	0.0142	0.0623	-0.5651	-3.6338	-0.5449	-3.5927
2		-0.6084	-3.9521	0.0974	0.9484	-0.6106	-3.9252	-0.2161	-1.0980	-0.4074	-2.7028	-0.4576	-3.5903
3		-0.5120	-3.3502	-0.0926	-0.8631	-0.4268	-2.7930	-0.1885	-1.0501	-0.3394	-2.2940	-0.3602	-3.0529
4		-0.3685	-2.5192	-0.1030	-0.8732	-0.3377	-2.2699	-0.1609	-0.9808	-0.2214	-1.5193	-0.2229	-1.8074
5		-0.2524	-1.6735	-0.0967	-0.6890	-0.1717	-1.1179	-0.1121	-0.6583	-0.1555	-1.0105	-0.1670	-1.3965
6		-0.1558	-1.0845	-0.1781	-1.2367	-0.0901	-0.6018	-0.1454	-1.1803	-0.1935	-1.2598	-0.1304	-1.1166
7		-0.0510	-0.3508	-0.2744	-1.6211	-0.0408	-0.2725	-0.0702	-0.5309	-0.1038	-0.6781	-0.0711	-0.6389
8		0.0977	0.6299	-0.2034	-1.0565	0.0227	0.1492	-0.1358	-1.6364	-0.0690	-0.4335	0.0565	0.5110
9		0.2407	1.3414	-0.1985	-0.8568	0.2242	1.3178	-0.0768	-0.7739	0.0471	0.2831	0.0585	0.5045
10		0.6738	2.9810	-0.4207	-1.6322	0.5786	2.6571	-0.0682	-1.1720	0.5798	2.3479	-0.0676	-0.4144
1	VWG	-0.2286	-1.8350	0.0831	0.7449	-0.2111	-1.5496	0.4388	2.5635	-0.2072	-1.6875	-0.1031	-0.8004
2		-0.1785	-2.1275	-0.0625	-0.6780	-0.2116	-2.0450	0.3279	1.9256	-0.1417	-1.7792	-0.2729	-2.7911
3		-0.1302	-1.5656	-0.1895	-2.4181	-0.1814	-2.1237	0.2698	1.9525	-0.2078	-2.5316	-0.2044	-2.4609
4		-0.1644	-1.9579	-0.1107	-1.4517	-0.0870	-1.0038	0.2090	1.8308	-0.0906	-1.0435	-0.0708	-0.8521
5		-0.0908	-0.9990	-0.1544	-1.9397	0.0267	0.2669	0.1761	1.5765	0.0654	0.7596	-0.2428	-2.8809
6		-0.0834	-0.8718	-0.1766	-2.0853	-0.0350	-0.3443	0.0375	0.4487	0.0194	0.2069	-0.0818	-0.9148
7		0.1082	1.0563	-0.1523	-1.3291	0.0142	0.1507	0.0080	0.0989	-0.0315	-0.3383	0.0122	0.1371
8		0.1728	1.6574	-0.0353	-0.2919	0.0962	0.8210	-0.0444	-0.6303	0.0716	0.7715	0.0045	0.0458
9		0.3613	3.1076	0.0287	0.1903	0.2429	2.0273	-0.0889	-1.4840	0.0936	0.8259	0.0912	0.8268
10		0.5601	3.4912	0.1899	0.9209	0.4483	2.6840	-0.1166	-2.1941	0.4842	3.0681	0.0780	0.4958

	DIVSUM		EP		MV		PRICE		SALE		GR	
	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT
1 EQL	-0.4826	-3.4261	-0.6447	-3.6000	0.5668	2.2023	1.3309	5.3916	-0.6405	-3.9466	0.2610	1.0279
2	-0.3665	-2.8961	-0.4809	-3.2667	-0.3546	-1.8780	0.2517	1.2487	-0.5679	-4.7273	0.0296	0.1669
3	-0.2521	-1.9916	-0.3762	-2.6816	-0.4014	-2.4191	-0.0271	-0.1471	-0.4632	-4.1080	0.0357	0.1740
4	-0.2526	-2.0721	-0.2739	-1.9316	-0.4937	-3.3735	-0.2402	-1.4601	-0.3638	-2.9201	-0.0580	-0.4202
5	-0.1744	-1.4161	-0.2553	-1.8250	-0.4543	-3.5053	-0.3962	-2.6787	-0.1998	-1.4052	-0.2034	-1.5789
6	-0.0654	-0.5691	-0.1921	-1.3390	-0.4165	-3.7960	-0.5586	-4.3193	-0.1485	-0.9852	-0.1780	-1.3251
7	-0.0209	-0.1801	-0.1203	-0.8546	-0.4863	-5.2329	-0.6059	-5.2297	-0.0270	-0.1672	-0.2244	-1.6503
8	-0.0064	-0.0557	0.0253	0.1678	-0.4924	-6.6766	-0.8724	-8.1968	0.0805	0.4388	-0.3231	-2.0974
9	0.0155	0.1315	0.1209	0.7607	-0.5803	-8.5115	-0.9688	-10.0226	0.2171	1.0841	-0.4805	-2.9733
10	-0.0661	-0.4025	0.4583	2.0589	-0.5766	-11.1454	-1.3783	-13.5181	0.6949	2.7123	-0.8911	-4.4375
1 VWG	-0.0132	-0.1044	-0.3351	-2.5537	2.2269	8.0119	2.3154	10.5919	-0.2594	-2.2995	0.4449	2.8075
2	-0.2548	-2.5793	-0.1660	-1.6786	1.0925	4.8583	1.0624	8.8605	-0.1196	-1.5658	0.2206	1.7647
3	-0.0660	-0.8127	-0.1541	-1.7846	0.7528	4.5459	0.6917	7.6432	-0.2328	-3.2664	0.0236	0.2246
4	-0.1989	-2.4594	0.0313	0.3839	0.5473	3.9050	0.4133	4.7645	-0.0907	-1.2715	-0.0308	-0.3605
5	-0.2471	-2.8007	-0.0193	-0.2211	0.4454	3.5192	0.2115	2.8494	0.0917	1.2033	-0.0799	-0.9775
6	-0.1142	-1.3194	-0.0963	-0.9095	0.4095	3.8959	0.1511	2.1731	0.0358	0.4229	-0.1608	-1.8139
7	-0.1332	-1.4134	0.0476	0.5678	0.2077	2.3707	0.0541	0.8123	0.0223	0.2306	-0.1377	-1.7751
8	0.0364	0.3638	0.0371	0.3581	0.1442	2.0378	-0.1972	-3.0405	0.3039	2.6782	-0.1936	-2.2608
9	0.0740	0.6372	0.3088	2.4593	-0.0768	-1.1848	-0.3650	-5.8897	0.3913	3.0027	-0.2250	-2.2987
10	0.0668	0.4368	0.4772	2.7373	-0.2558	-4.8978	-0.5212	-8.7311	0.7047	3.6721	-0.1526	-1.2345

	TR		TABE		TAMV		CAR12		CAR60	
	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT	CON	TSTAT
1 EQL	0.4384	2.7470	-0.1052	-0.6754	-0.8009	-4.7341	-0.0122	-0.0450	0.3558	1.3710
2	0.1712	1.0459	-0.1421	-0.9760	-0.5560	-3.7670	-0.2392	-1.2808	-0.0508	-0.2989
3	0.1513	1.0045	-0.1450	-0.9258	-0.3343	-2.1374	-0.2257	-1.4333	-0.0772	-0.5409
4	-0.1052	-0.7275	-0.1508	-1.0794	-0.2920	-1.9698	-0.1813	-1.3423	-0.1166	-0.9269
5	-0.1299	-0.8801	-0.1791	-1.1668	-0.1882	-1.2851	-0.1148	-0.9072	-0.2004	-1.4458
6	-0.1292	-0.7726	-0.2344	-1.4840	-0.0962	-0.6321	-0.1655	-1.3749	-0.2041	-1.5712
7	-0.3553	-2.0995	-0.1328	-0.8081	0.0366	0.2282	-0.1434	-1.1596	-0.2852	-2.2608
8	-0.3101	-1.6082	-0.2052	-1.2050	0.0494	0.3053	-0.1726	-1.3291	-0.3187	-2.7136
9	-0.5858	-3.0437	-0.2039	-1.1488	0.1881	1.0748	-0.1467	-1.0080	-0.5336	-4.0115
10	-0.9042	-3.9643	-0.0306	-0.1380	0.8675	3.0748	-0.0715	-0.3613	-0.8805	-5.3213
1 VWG	0.1166	1.3793	-0.0076	-0.0731	-0.2274	-1.8514	0.0432	0.2154	0.6470	2.9349
2	0.0118	0.1306	-0.1754	-2.0284	-0.1985	-2.4925	-0.1236	-0.8981	0.1075	0.8545
3	-0.0492	-0.6133	-0.0802	-1.0465	-0.0751	-0.9366	-0.0749	-0.6455	0.1654	1.5602
4	-0.1741	-2.2730	-0.1008	-1.2226	-0.0601	-0.6601	-0.1201	-1.2764	0.0402	0.4455
5	-0.1123	-1.4648	-0.0117	-0.1404	-0.0163	-0.1802	-0.1124	-1.4041	-0.0519	-0.5276
6	-0.0262	-0.1938	-0.2152	-2.7221	-0.0169	-0.1812	-0.1357	-1.7454	-0.1194	-1.3335
7	-0.2152	-2.3768	0.1271	1.5117	0.0749	0.7339	-0.1009	-1.2669	-0.1449	-1.5540
8	-0.0398	-0.3741	-0.0341	-0.4203	0.1007	0.9650	-0.0151	-0.1571	-0.1538	-1.6680
9	-0.0551	-0.4319	-0.0596	-0.5078	0.3043	2.7668	0.1582	1.2682	-0.0607	-0.5947
10	0.1955	0.8089	0.1490	1.2591	0.6772	3.5548	0.3898	2.3984	-0.3320	-2.4274

TABLE 4.7

GRS F-TEST FOR THE JOINT SIGNIFICANCE OF THE TIME-SERIES CONSTANT WITH THE ONE FACTOR MODEL

EQ																	
	BEMV	BETA	CFL	CSHO	DEBT		DIVS	EP	MV	PRICE	SALE	GR	TR	TABE	TAMV	CAR12	CAR60
W	0.2461	0.0451	0.1863	0.0457	0.1493	0.0831	0.0599	0.1501	0.6367	1.5494	0.2655	0.2497	0.1658	0.0287	0.2091	0.0415	0.1978
P-Value	0.0000	0.0976	0.0000	0.0921	0.0000	0.0012	0.0198	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4161	0.0000	0.1389	0.0000
VW																	
	BEMV	BETA	CFL	CSHO	DEBT	DIVC	DIVS	EP	MV	PRICE	SALE	GR	TR	TABE	TAMV	CAR12	CAR60
W	0.0638	0.0493	0.0347	0.0336	0.0493	0.0602	0.0641	0.0481	0.2380	0.5311	0.0904	0.5487	0.0338	0.0552	0.0592	0.0352	0.1599
P-Value	0.0127	0.0636	0.2587	0.2824	0.0635	0.0193	0.0123	0.0723	0.0000	0.0000	0.0005	0.1382	0.2795	0.0336	0.0217	0.2479	0.0599

TABLE 4.8

LRT F-TEST FOR THE JOINT SIGNIFICANCE OF THE TIME-SERIES CONSTANT WITH THE ONE FACTOR MODEL

EQ																	
	BEMV	BETA	CFL	CSHO	DEBT	DIVC	DIVS	EP	MV	PRICE	SALE	GR	TR	TABE	TAMV	CAR12	CAR60
P-Value	0.0000	0.0859	0.0000	0.0809	0.0000	0.0009	0.0163	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3925	0.0000	0.1242	0.0000

VW																	
	BEMV	BETA	CFL	CSHO	DEBT	DIVC	DIVS	EP	MV	PRICE	SALE	GR	TR	TABE	TAMV	CAR12	CAR60
P-Value	0.0103	0.0550	0.2382	0.2611	0.0549	0.0159	0.0100	0.0628	0.0000	0.0000	0.0004	0.1149	0.2583	0.0283	0.0179	0.2277	0.0502

TABLE 4.9

F-TEST AND LRT TESTS FOR THE JOINT SIGNIFICANCE OF THE TIME-SERIES CONSTANT OF UNIVARIATE FACTOR PORTFOLIOS WITH THE THREE FACTOR MODEL

Panel A:

F-Test	BEMV	CFL	DIVS	EP	MV	PRICE	SALE	GR	CAR12	CAR60
EQ										
P-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
VW										
P-Value	0.0838	0.5194	0.0219	0.6221	0.0000	0.0000	0.0020	0.1992	0.0587	0.0000

Panel B:

LRT	BEMV	CFL	DIVS	EP	MV	PRICE	SALE	GR	CAR12	CAR60
EQ										
P-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
VW										
P-Value	0.0881	0.5285	0.0199	0.6305	0.0000	0.0000	0.0022	0.2076	0.0795	0.0597

TABLE 4.10

F-TEST AND LRT TESTS FOR THE JOINT SIGNIFICANCE OF THE TIME-SERIES CONSTANT OF MULTIVARIATE RANDOMISED FACTOR PORTFOLIOS WITH THE ONE FACTOR MODEL

Panel A:

F-Test	MVBEMV	MVGR	MVPR	MVTR
EQ				
P-Value	0.0000	0.0000	0.0000	0.0000
VW				
P-Value	0.0532	0.1357	0.0000	0.0698

Panel B:

LRT	MVBEMV	MVGR	MVPR	MVTR
EQ				
P-Value	0.0000	0.0000	0.0000	0.0000
VW				
P-Value	0.0501	0.1256	0.0000	0.0610

Chapter 5

Cross Sectional Determinants of Common Stock Returns

5.1 Introduction

The main area under scrutiny in the previous chapter was the tests conducted to verify one of the basic implications of the CAPM that the time-series excess stock or portfolio returns are insignificant after we adjust for beta risk. The evidence in the empirical literature from the time-series performance of asset pricing factor models has revealed inconsistent with the adequate risk-return relation pattern in the determination of the common stock returns. Across portfolios formulated on the basis of candidate variables for a new risk role, significant return spread was present that could not be justified by adequate beta spread. However, we presented evidence that multivariate tests for the constant significance in the CAPM risk-return relation resulted in zero excess returns for the majority of value-weighted factor portfolios and the CAPM could not thus be easily rejected.

On the other hand, the time-series methodology has been criticised on the grounds of an overall aggregation procedure for the entire time period which could eliminate or overexpose specific time events with a limited likelihood to identify the sources. Furthermore, the evidence in the previous chapter is not adequate to conclude on the CAPM power as many papers in the empirical literature have reported a violation of the second vital CAPM implication for the power of beta as the unique determinant of the cross-sectional variation of the common stock returns.

To examine whether a factor is priced and to test for the significance of its risk premium taking into account time effects, the alternative methodological solution is the employment of cross-sectional tests. In this case, the factors enter the model as the independent regressors and, thus, determinants of the common stock returns at each specified point of time and then their coefficients are aggregated for the whole time period. These coefficients represent the average figure for the pricing of the factors whose significance can be tested. The advantage of this procedure is that specific time events can be easily identified as well as individual factor effects in separate portfolios.

In this chapter, the cross-sectional methodology is applied in tests where stock or portfolio returns are examined to identify the possible sources of risk across time and then to conclude on the overall significance. The first step in these tests would be to replicate the *Fama and French FF1992* multifactor model which was examined with the cross-sectional *Fama-MacBeth (FM)* methodology. The evidence for the validation of this model is crucial for the empirical research over the asset pricing models as it establishes the basis for the formulation of the new market value (MV) and book-to-market (BEMV) risk sources. A lot of controversy has been raised over this model and the replication procedure could provide some indications over the unquestionable efficacy or the presence of limitations due to sample selection bias or other problems. Apart from inferences drawn for the significance of these two factors, we also re-examine another issue in the centre of debate around this model, the alleged flat relation between risk and return.

Furthermore, we will consider other issues raised in the empirical research over the cross-sectional tests and the problems inherent in the introduction of new variables. In addition to the prevailing MV and BEMV factors, more variables that have been presented as candidate risk sources will be examined with the purpose of attempting to isolate the factors whose significance cannot be attributed to strong interrelation patterns. Although a substantial part of inferences concerning the significance of some of the asset pricing factor models has been based on cross-sectional tests, the framework of this methodology has not been adequately examined and some important issues that greatly affect the conclusions have not been taken into account. Thus, in the subsequent sections a more thorough approach is adopted before we reach conclusions that could alter the view towards the power of specific asset pricing models.

The structure of the chapter is as follows. In section 5.2 we describe the methodology for constructing the portfolios employed in this chapter and we form the framework for the cross-sectional tests. We also present the formation of the hypotheses that we test in the empirical subsection. In section 5.3 we present the empirical results from the cross-sectional tests with individual stock and portfolio returns on the beta and additional factors. Finally, the conclusions drawn from this chapter are reported in section 5.4.

5.2 Methodology and Hypothesis Formation

The basic methodology for the cross-sectional tests has been formulated by *Fama and MacBeth (1974)* as described in the literature review chapter. The first test in the cross-sectional regressions is applied in the Fama and French FF 1992 multifactor model with a limited number of variables. To be included in the return tests, the stock requirements are to have returns from 24 to 60 months before July of year *t*, price and shares outstanding at June of year *t*, price at December of year *t-1* and accounting data, book-to-market BE, total assets A and earnings E in any month of year *t-1*.

In June of each year, all stocks that are listed on NYSE are sorted by size on ascending order to determine the 10 decile breakpoints. The method used in the calculation of the breakpoints is that when the number n of the market values is not divided evenly into 10 deciles, the (n-integer(n/10)x10) smallest deciles contained integer(n/10)+1 market values and the remaining deciles contained integer(n/10) market values (*Stoll, Whale, 1983*). All the NYSE, AMEX and NASDAQ stocks that meet the requirements are then allocated into 10 portfolios based on the NYSE breakpoints. Each market value portfolio is further subdivided into 10 portfolios based on preranking betas. The reason for this subdivision is the presence of strong negative correlation between market value and beta in one-way market value sorted portfolios (*Jegadeesh, 1992*). The preranking betas are estimated on 24 to 60 monthly returns before July of year t and are the sum of the slopes in a regression of the current and the previous month market return:

$$r_{i,t} - r_{f,t} = a_i + \beta_{i,0}(r_{m,t} - r_{f,t}) + \beta_{i,-1}(r_{m,t-1} - r_{f,t-1}) + \varepsilon_{ii,t} \tag{51}$$

and the preranking beta for asset i is

$$\beta_{i,PRE} = \beta_{i,0} + \beta_{i,-1} \tag{52}$$

This Dimson estimate is employed to adjust for nonsynchronous trading. The risk-free rate employed to calculate the excess returns is the monthly return on the 3-month US treasure bill at the beginning of the month (taken from Ibbotson Associates).

The breakpoints for the preranking betas are also calculated only on the NYSE stocks to ensure that there are firms in each of the 100 portfolios of each year. So, at June of each year t we have 100 portfolios based on size first and then on preranking betas. From July of year t to June of year $t+1$, we calculate the equal-weighted monthly returns for the each of the 100 portfolios from the monthly stock returns that consist each portfolio at June of year t. In the end, we have 372 monthly returns (July of 1964 to June of 1994) for the 100 portfolios. Then, post-ranking betas are estimated using the 372 monthly returns for the 100 portfolios against the value-weighted market portfolio with the same Dimson market model so the post-ranking beta for portfolio i (i =1 to 100) is the sum of the current and lagged beta coefficient.

Finally, we have 100 post-ranking betas and we assign each of the 100 betas to all the firms that belong to each of the 100 portfolios at the end of June of year t. As FF pointed out, the precision of the full post-ranking portfolio betas, relative to the imprecise beta estimates that would be obtained from individual stocks, more than makes up for the fact that true betas are not the same for all stocks in a portfolio. Yet, a stock can move across portfolios due to changes in market values and preranking betas. Furthermore, this methodology is consistent with the evidence by

Chan and Chen (1988) that full period betas are more accurate measures of the beta effect than betas estimated with prior overlapping five-year periods.

Although most of the studies with cross-sectional tests have employed portfolio returns, FF argued that the performance of the tests with individual stocks is more informative. The cross-sectional model is

$$R_{it} = a_{0t} + a_{1t}\beta_{it} + a_{2t} f_{it} + e_{it} \qquad (53)$$

In this model, individual stock returns are regressed every month on the post-ranking betas that were assigned to at the end of each year and on the specific factors. Thus, at the end of the estimation procedure we have 372 estimated coefficients which represent the price of risk. The significance of the constant and the coefficients is based on a t-test calculated as

$$t_i = \frac{\bar{t}_{it}}{se(t_{it})/\sqrt{n}} \qquad n=372 \qquad (54)$$

where the mean in the nominator of the ratio is the average of the 372 estimated coefficients and the standard deviation in the denominator is estimated within the same sample. If the CAPM is a valid model then the beta coefficient should be highly significant in a univariate regression. Additionally, in a bivariate regression where we include the beta and another factor the t-statistic of the factor's coefficient should confirm the null hypothesis of zero risk premium for this factor as the beta should be the only determinant of cross-sectional variation. The common approach is to test the cross-sectional model with many combinations of the included factors and examine the magnitude of the t-statistics.

Although the FF 1992 model employed individual returns, we also replicate the model with portfolio returns as there are many arguments that the distributions of the individual returns are highly skewed and could seriously distort final conclusions. The employment of portfolio returns in cross-sectional tests has also been proposed in order to alleviate the EIV problem inherent in pre-estimated beta which enters the second pass FM regression with measurement errors. However, *Shanken (1992)* showed that even in the presence of portfolios the EIV bias is still a problem and he suggested a necessary adjustment to the variance in the denominator of the t-statistic. More specifically, the constant's variance is multiplied by the EIV adjustment term $c=(1+\hat{a}_1^2/s_m^2)$. The beta coefficient's variance is calculated as $[s^2(a_1)-s_m^2](1+c)+s_m^2$. The Shanken's correction is applied to the resulting coefficients from both individual and portfolio return regressions.

The motivation behind the wide controversy over the validity of the applied in the empirical literature cross-sectional models is the sensitivity of this methodology to econometrical problems. More specifically, a common problem in cross-sectional tests is the presence of heteroskedasticity which is not taken into account with the traditional OLS estimation. In the current chapter, we test for this problem in the FF regressions with the known White's test for heteroskedasticity where the squared residuals from the initial regression are regressed on the regressors, their squares and products. Furthermore, we test for the presence of the normality problem by examining the significance levels of the skewness and kurtosis tests in the regressions' residuals. The test conducted for the normality examination is the Bera-Jarque test with the second, third and fourth moments of the residuals and the stock returns.

It is a common argument that the problem of normality has not been adequately dealt with in the empirical literature of asset pricing models. The bulk of research assumes the presence of normal distribution in returns and residuals and the classical OLS methodology is employed for the estimation of the models. However, the effects of any departure from normality are specifically severe for the cross-sectional models as the presence of outliers affect the estimation in particular points of time and then the measurement errors are further accumulated with the employment of t-statistics for final inferences. On the other hand, it is barely mentioned that the t-statistic is basically formulated on the assumption of normality which is even more severely violated with individual stock returns. For comparability reasons, we also employ the t-test for inferences of a factor's significance as this is the conventional method but we further consider the problems raised when the underlying assumptions of the t-test are violated. Thus, after we perform tests to infer on whether the normal distribution can be safely assumed, we move forward to examine the cross-sectional models with the class of robust estimators which estimate the cross-sectional regressions in the cases of departures from normality.

The most familiar robust estimator is the Minimum Absolute Deviations (MAD) estimator where the model's vector of coefficients is estimated as

$$\hat{\beta} = \min_{\beta} \sum_{t} \left| y_t - X_t \beta \right| \tag{55}$$

in order to minimise the extreme deviations from the mean residuals. However, the computation of the MAD estimator is quite complicated and alternative solutions have been suggested that have the basic implications of the MAD but they can be more easily processed. In the current study we apply the Iterated Weighted Least Squares estimator that initially estimates the model, save the residuals, define a range of spread around the residuals which optimally minimise the deviations and then re-estimates the regression by weighting the parameters with the spread value. Furthermore, it iterates the procedure until the convergence level for a robust covariance matrix of the coefficients. Thus, we obtain a new vector of factor coefficients which is estimated by taking into account presence of non-normality.

In the light of the previous chapter's evidence that inferences are quite sensitive to the portfolio return measurement procedure, we also consider alternative calculation methods for the portfolio returns employed to estimate the post-ranking betas. Firstly, we average the 100 size-beta portfolio returns by a value-weighting procedure to mitigate the effect of small firms in the final conclusions. Furthermore, we calculate the annual buy-and-hold (BAH) returns of each portfolio by averaging the BAH returns of all the stocks comprising the portfolio as suggested by *Kothari, Sloan and Shanken (1995).* In response to this argument, FF repeated the procedure with BAH returns and they argued that the inferences remained unaltered. However, the BAH portfolio returns were differently calculated as they compounded the average monthly portfolio returns, an approach also considered in the current tests. At the end, the time-series of annual portfolio returns are employed in the market model to estimate the post-ranking betas.

After the evidence concerning the FF 100 portfolios and the beta power, we proceed to test the cross-sectional models with many combinations of the factors considered in the FF model as well as additional factors that have been examined in other papers. The cross-sectional regressions are estimated with individual and portfolio returns. In the latter case, the portfolio returns are regressed on the average factor values of all the stocks that comprise each of the 100 size-beta portfolios. The purpose of this section of research is to identify the variables with strong commonality effects and correlation patterns and to isolate thus the most important factors as cross-sectional determinants. This procedure will further assist us to combine the knowledge from the previous chapter about the inadequacy of the CAPM to justify the excess returns from specific factor portfolios with current evidence for consistency in results with cross-sectional models.

5.3 Empirical Results

5.3.1 FF 1992 multifactor model

The first step is to look into some preliminary statistics for the behaviour of the 100 size-beta portfolio returns. In Panel A of Table 5.1 we present the average returns for the 100 portfolios as the intersection of rows, the 10 size portfolios, and columns, the 10 beta portfolios within each size portfolio. The average returns are time-series averages of the monthly equally-weighted portfolio returns. Examining the returns across the size portfolios, we can clearly see the size effect as the average return decreases when we move from small- to large- size portfolios. In each size portfolio we cannot observe a similar in magnitude spread in average returns, a first indication of beta insignificance. The size effect seems even more robust after a look at Panel B where there is no spread in postranking betas to justify the spread in size return as proved by FF 1992.

In addition to the FF 1992 postranking betas, we also consider alternative estimation procedures for the post-ranking betas to identify possible sources of divergences due to different return measurement methods. In Panel C we report the post-ranking betas estimated from annual BAH portfolio returns to address the issue by *Kothari, e.t.c.* for longer horizon returns and in Panel D we present the beta values obtained with the different methodology by FF where monthly portfolio returns are compounding. However, neither method seems to increase the spread in betas to justify the size effect. The characteristics of value-weighted 100 size-beta portfolio returns are reported in Table 5.2 where we can observe a higher return spread but also an increase in postranking beta spread, especially with the BAH returns. The increase in the beta spread with the employment of BAH returns has also been verified by *Handa, et (1985).* However, the argument by FF against the employment of annual returns seems quite rational, as it is not a common approach in financial practice to invest with so long time horizons. Even in the case where we accept this argument, we show that a preliminary analysis with monthly returns and the slightly improved procedure of value-weighted returns substantially increases the beta spread.

To infer whether the beta spread is adequate to explain the return spread across the market value-beta portfolios, we should examine the magnitude of the beta coefficient in the cross-sectional regression framework. For comparison reasons, in Table 5.3 we reproduce the results from the FF 1992 paper for the cross-sectional tests. In Table 5.4, we report the current results from the FM cross-sectional regressions of monthly stock excess returns (over the Treasury Bill monthly rate) on variables and post-ranking betas. Not surprisingly, discrepancies from the FF results are expected as there are differences in data sources because we do not employ the CRSP return file. However, the primary problem is not the magnitude of the mean values and the t-statistics that is sensitive to selection procedures but the direction of the results. The main difference from the FF results is the higher average slope for the three most competitive variables the beta, BEMV, MV which gives higher t-statistics for their significance. The beta alone has a t-statistic of 1.58 and the size t-statistic is -5.45. The regression with the two variables together results in a beta's t-statistic of -1.68 and a size's t-statistic of -6.52 that evidently constitutes weak evidence against the CAPM. The results are not substantially altered when we correct the beta coefficient's variance with the Shanken's EIV adjustment term. Although the beta was estimated with full-period returns, the powerful for the beta results by *Chan and Chen (1988)* could not be confirmed as *Jegadeesh (1992)* argued that the source of the favourite results was the strong correlation between beta and market value and this is the reason why with the 100 size-beta portfolios the full-period betas are still insignificant.

The overall similarity with FF is that the t-statistics are of the same direction, confirming the significance of the size and BEMV and rejecting the beta significance at the 5% level of significance. Yet, the size retains in our results a higher value than the BEMV since in the bivariate regression the size has a t-statistic of -4.96 whereas the BEMV t-statistic is 3.18. The EP and EN variables are significant as independent regressors (t-statistics EP=3.21, EN=3.35), yet their power is eliminated when the market value is entered the same regression as an additional variable (EP=1.71, EN=1.30).

A noteworthy difference is apparent in the case of TAMV and TABE variables. In the FF paper, the leverage effect was interpreted as a decomposition of the BEME effect since the TAMV and TABE coefficients were opposite in sign but similar in magnitude in comparison with the BEMV (since ln(BEMV)=ln(TAMV)-ln(TABE)). In our tests, the TAMV variable is always significant whereas the t-statistic of the TABE is insignificant with a very small coefficient. However, we examined the possibility that the results are influenced by extreme outliers in the factors' values and, thus, the regressions were reestimated with trimming away the observations with 4 standard error deviations away from the mean values. In that case, the TABE and TAMV coefficients are close in absolute value (0.33 and –0.3) with the BEMV (0.35) but not their t-statistics (TAMV = 4.36, TABE = -2.67, BEMV = 4.66). We are able to obtain closer to FF results if we further correct for 3 standard error deviations. But still the inferences are not so strong as in the FF tables. The problem raised with these differences in results is whether we should correctly exclude the debt variable from the model in favour of the BEMV factor. The two accounting variables TAMV and TABE have been introduced by FF in the model instead of the DEBT ratio suggested by *Bhandari (1988)* and the results were quite robust in order to exclude the DEBT variable as less significant than the BEMV ratio. However, as shown with the replication, doubts are cast for this exclusion.

Further problems with the FF 1992 model that are not examined in the initial paper are the strong evidence for the presence of heteroskedasticity and normality problems. The p-values results from the White's test strongly reject the null hypothesis of homoskedasticity for all the regressions. Furthermore, a problem that is not easily removed even after the trimming of outliers in the independent variables is the normality problem as the residuals from all the regressions exhibit skewness and kurtosis problems. The p-values from the Bera-Jarque test for the normality assumption in the stock returns and the residuals are nearly all zero.

Under the light of evidence for significant departures from normality, we re-estimate the cross-sectional models with the robust procedure of iterated weighted least squares estimation. The results are reported in Table 5.5 and they are quite devastating for the power of the variables. Surprisingly enough, the market value variable is found insignificant even when it enters the model as the sole independent regressor and only the BEMV factors' t-statistic remains marginally significant. Furthermore, with these results we can confirm the FF argument about the relation between TAMV, TABE and BEMV. The main difference between previous correction for outliers and the current results is that the robust estimation procedure attempts to minimise extreme deviations from the mean residuals and, thus, the outliers not only of the independent variables but also of the excess returns. Therefore, it might be possible that the source of the increased market value power in the cross-sectional models is the presence of extreme outliers in the individual stock return distributions.

To obtain an overview of the factors' importance, the correlation matrix between the factors considered in the above regressions is reported in Table 5.6. The most significant correlation exists between return and size and it has the expected negative sign, whereas less significant is the correlation between return and beta which is actually increased with the value-weighted betas. The strong correlation between BEMV and TAMV indicates commonality in the two effects and could suggest redundancy of one variable in later tests.

All the previous regressions were estimated using monthly returns on annual variables. Yet, we could also construct a model for the investors' decisions where the accounting data are known on an annual basis whereas the ratios are revised monthly by dividing the annual variables with the changing monthly market values. The monthly returns then are regressed on monthly revised ratios with a lag of one month to adjust for delays in information. However, the two models provide the same results and we make no distinctions between them.

Quite different results we obtain when the postranking betas are estimated using value-weighted returns of the 100 size-beta portfolios. In that case, the beta coefficient value is 0.52 with a significant t-statistic of 2.79. Comparing the magnitude of this t-statistic with the corresponding of the market value's coefficient it is obvious that it is much smaller and it lowers further when we include the market value in a bivariate regression. However, the important point is that we refute the strong evidence by FF of the flat beta-return relation with the means of a simple change in the weighting portfolio procedure. Another very important issue in Table 5.4 that is missing from the corresponding FF table is the examination of the constant significance. If the CAPM is a valid model then the inclusion of the beta variable as independent regressor should absorb the excess returns i.e. the constant should be zero. As it is evident from the Table, only in the univariate regression with the beta variable the constant is insignificant, evidence consistent with the initial tests by *Fama and MacBeth (1974)*. This is even the case with the equally-weighted postranking beta whose coefficient is not statistically significant. Consistent with the time-series results in the previous chapter, we estimate a beta coefficient lower that the market risk premium which, as argued and confirmed by *FM,* leads to evidence for the Black's version of the zero beta CAPM. With all the other combinations of variables in the regression models the constant is highly significant which could mean that even though the new factors are important, there is always an effect unexplained.

As the CAPM is a model applied in individual stocks as well as in portfolios, we reproduce the above tests with the 100 portfolio returns in Table 5.7 with the most significant variables of MV and BEMV and additional calculated values for the beta variable. This approach has also been applied by *Jagannathan and Wang (1997)* where only the beta and market value factors were examined. In Panel A, we employ equally-weighted returns and in Panel B value-weighted returns. In Panel A we confirm the evidence by *Jagannathan and Wang* of a low t-statistic for the beta alone and a high t-statistic of the MV coefficient when examined simultaneously with the beta. One of the main points drawn from Panel A is the insignificant constants when beta is the only independent variable and the increase in beta significance with the BAH returns. With all the other combinations the constants' t-statistics are very high towards the rejection of the null hypothesis. In the tests with individual returns we showed that the BEMV and the MV variables are both significant in a bivariate model. With portfolio returns, the inclusion of the MV absorbs a big part of the BEMV factor' s significance whose t-statistic is lower than the corresponding MV coefficient. We should also mention that the inclusion of the beta increases the power of the MV and the constant's coefficients which could be considered as evidence of the presence of common components between the two factors. Apparently, we cannot argue that this common component is the strong correlation as this has already been removed from the 100 portfolio returns.

The employment of value-weighted returns in Panel B alters substantially the previous conclusions as it increases very significantly the beta's t-statistic to a level where we strongly reject the null hypothesis of zero risk premium. This evidence is consistent with *Kothari, Sloan and Shanken (1995)* who regressed monthly BAH portfolio returns on annual betas and found a significant coefficient. Although we employ monthly value-weighted returns we still find a significant beta, whereas the same result is not present with equally-weighted returns. What we failed to confirm is the evidence that beta is still significant after the inclusion of the market value. Replicating the tests with the robust estimation procedure and reporting the results in Table 5.8 we cannot infer any substantial changes in factors' significance.

Comparing the results from the regressions with individual returns and portfolio returns, we can draw some important conclusions for the validity of cross-sectional models. Firstly, we confirm previous empirical evidence that the problem of normality is far more severe for individual returns. We can clearly see how results for the market value power are negatively distorted with the robust estimation in individual returns. The employment of portfolio returns might be preferable when we examine cross-sectional models as we have already mentioned that this methodology is very sensitive to econometrical problems and portfolio returns exhibit less extreme patterns. Thus, the consistency of results between the traditional OLS and the robust estimation for the portfolio returns favours the consideration of the results from the portfolio return tests and not the conclusion of the individual tests for the insignificance of the market value variable. Yet, the strong BEMV significance in the cross-sectional tests with individual returns, which is also confirmed with portfolio returns when BEMV is the sole determinant, is decreased after the market value inclusion in the portfolio returns tests.

In sum, the thorough re-examination of the FF 1992 model reveals the presence of problems that seriously distort the final inferences. Firstly, the calculation of the post-ranking betas with value-weighted returns results in a significantly positive return-beta relation. On the other hand, we showed that the inferences drawn from the employment of individual stock returns is quite problematic due to normality problems and the application of portfolio returns results in a MV effect higher in magnitude that the BEMV effect.

5.3.2 Consideration of additional factors

After the damaging evidence against the beta significance, an overwhelming number of additional factors attracted the bulk of the research as determinants of stock returns. The focus in this section rests to the more significant factors in the literature and their performance in cross-sectional regressions. Initially, we estimate cross-sectional regressions with individual stock returns and factors to infer on isolated effects. From Table 5.9, we can see that the factors with no explanatory power are the CSHO, CAR12 and DIVSUM. We also repeated these tests with the additional restriction of simultaneous available data for all the variables. Although the coefficients and the t-statistics magnitude are lower, the insignificance of the above factors is still present.

From the Correlation Matrix in Table 5.10, we could observe the highly correlated variables and restrict the tests to a more limited number of variables. The high correlation of TAMV with SALE, DEBT and BEMV provides some justification for the exclusion of this variable and the similar TABE ratio from joint tests. Additionally, the EP-CFLP ratios and the MV-CSHO variables are also highly correlated and in following tests we consider only the EP and MV factors.

The variable that has attracted the bulk of the attention in the new direction of factor models is the market value variable. The FF 1992 tests eliminated the rest of the factors based on evidence that the inclusion of MV absorbed their power in the cross-sectional models. Thus, the next step is to examine the significance of the factors' coefficients in combination with the market value. In Table 5.11, we report the coefficients' values and t-statistics in regressions where the independent variables consist of the market value and an additional factor. We can see that the variable whose power is absorbed by the MV is the trading volume variable, evidence that confirms results in the previous chapter that the significance of this factor is merely attributed to the small firm effect, a possibility not examined within the same framework by *Datar, Naik and Radcliffe (1993).* The FF evidence about the MV impact on the earnings factor that is not confirmed in this Table motivated the examination of similar regression models with the additional restriction that the stocks have available data for all the factors. With this restriction, we are able to accept the argument that the inclusion of market value destroys the EP ratio power as shown in Table 5.12. The rest of the factors retain their significance even in the presence of the market value. However, the striking evidence present in both Tables is the insignificance of the MV factor after the inclusion of the PRICE variable. Thus, we could infer that the small firm effect might be just the result of price microstructure effects on common stock returns and this indication motivates the more thorough examination of the MV-PRICE relation in subsequent sections.

The previous divergences in the results from regressions with individual stock and portfolio returns emerged the necessity to replicate all factor regressions with the 100 portfolio returns as the dependent variable. In Table 5.13, we report the results from univariate regressions with individual factors and we confirm the insignificance only of the DIVS and CAR12 factors. The results are unaltered with value-weighted returns and the robust estimation procedure and consistent with the previous evidence that the TR factor becomes insignificant when we employ the value-weighted portfolio returns.

For robustness checks, we have re-estimated all the previous regressions with both the equally- and value-weighted portfolio returns and the results are quite interesting. With the equally-weighted returns we confirm all the results from the regressions with the individual returns and the factors. More specifically, we find that the inclusion of the MV or the PRICE variable is not sufficient to conclude on the insignificance of a substantial number of factors. However, the results are completely reversed when we employ value-weighted returns and they are reported in Table 5.14. Surprisingly enough, when we estimate the regressions with all the combinations of the factors, the additional restriction of availability for all the variables and the employment of value-weighted returns the only factor that retains its significance is the price variable. The importance of this evidence is twofold. Firstly, it is present in portfolio returns which we showed that significantly eliminate the problem of outliers and non-normality in returns and residuals. Secondly, the proof is consistent with the argument in the empirical literature that the cross-sectional tests should be performed with the restriction of availability of all the factors-regressors. We obtain same results when we estimate the regression models with randomised beta portfolios according to size with the methodology described in the previous chapter. Thus, we are able to confirm our inferences on the basis of another approach that was proved robust in the debate around the most efficient portfolio formation procedure.

In sum, the empirical results of this chapter cast serious doubts on the influential paper for the cross-sectional determinants of common stock returns by Fama and French 1992. Initially, a replication of the FF 1992 methodology and tests confirmed the flat beta-return relation and the significance of the MV and BEMV variables over a limited number of other factors in the cross-sectional tests. However, a more detailed examination of the issues concerning the application of the cross-sectional tests revealed critical problems of non-normality and outliers. The suggested correction of these problems substantially altered the results. Yet, a concrete conclusions could not be drawn with the employment of individual returns but with portfolio returns where we found a positive beta-return relation with value-weighted returns. In addition, the elaborate consideration of the most prevailed factors under the light of the cross-sectional tests requirements revealed only one significant factor, the price variable.

5.4 Concluding Remarks

In the empirical literature, the study of asset pricing models with the methodology of cross-sectional tests has cast the more serious doubts upon the validity of the CAPM. Subsequent to the influential introduction of this approach by Fama and MacBeth which was in favour of the CAPM, many research papers showed that the beta presence in models with additional variables as cross-sectional determinants was not adequate to conclude on zero risk premium for these factors. As evidence was accumulating, the examination of the time-series implications of the CAPM was put aside in support of the devastating for the CAPM cross-sectional evidence.

The most influential paper in the area of cross-sectional tests was by FF 1992 which initiated the employment of additional to the market portfolio sources of risk in time-series models. The striking points from this paper were the completely flat beta-return relation and the evidence in favour of the powerful new cross-sectional determinants of the common stock returns, the market value and the book-to-market variables. One of the main objectives of the current chapter was to challenge these strong conclusions drawn from the FF 1992 paper. Subsequently, more variables were examined within this framework and mixed results made more difficult the agreement over a unanimous set of important factors. A re-examination of this controversial area of research was also a significant part of the current empirical research.

At a first stage, we reconstructed the FF1992 100 size-beta portfolios and replicated their tests in order to identify any sources of divergences. Although there were some differences in the magnitude of the results from the cross-sectional models, we were able to confirm the basic results i.e. the insignificance of the market beta and the power of the MV and BEMV factors over the EP, TAMV and TABE variables. However, the first important divergence from their results emerged with the employment of value-weighted portfolio returns for the calculation of the postranking beta. When this beta entered the cross-sectional regressions was found highly significant as the sole cross-sectional determinant. However, this result was not adequate to save the CAPM as even this particular form of postranking betas was not powerful enough the absorb the power of the rest of the factors.

Subsequently, we examined more thoroughly the structure of the cross-sectional regresssion results and we found evidence of present heteroskedasticity and normality problems. The employment of a robust estimation procedure instead of the traditional OLS which does not take into account these problems revealed very different results as all the factors were found insignificant apart from the BEMV variable at a marginal level. However, this very strong rejection of all the t-statistics seemed quite suspicious and we chose to run some robustness tests to double check the results.

The employment of individual returns in the cross-sectional regressions has been based on the argument that additional information for individual firms can be more beneficial for the final conclusions. Although we do not refute the rationale for this argument, we argue that empirically the distribution of individual returns is clearly non-normal which creates even more problems in the empirical results. As the CAPM is a model for both stock and portfolio returns, we re-estimated the regressions with equally- and value-weighted portfolio returns. The positive effect of this procedure was the elimination of divergences between OLS and robust estimation procedures. Consistent with previous current research, we showed that with value-weighted returns the beta coefficient is significant and that the MV lowers the BEMV variable power.

At a second stage, we extended the limited set of factors considered in the FF 1992 model to accommodate a broader number of empirically significant factors. The estimation of cross-sectional models with individual returns and factors eliminated the CAR12, CSHO and DIVSUM factors. As the prevailing evidence is favour of the MV variable, the next step was to estimate simultaneously the MV with each factor to infer whether it is the dominant factor. Only the TR variable was found insignificant in the presence of the MV. When we moved further to add the restriction of data availability of all the factors, the EP ratio was added in the list of insignificant factors.

For robustness check, the employment of equally-weighted portfolio returns in the above regressions did not substantially alter the basic conclusions. However, the striking evidence was present once more with the inclusion of value-weighted portfolio returns as the independent regressors. We showed that the combination of the MV factor with each other factor individually resulted in the strong and sole significance of the MV variable. The elimination of all the rest factors was unanimous and very strong. Yet, more importantly, the MV factor itself was found inefficient with the inclusion of the PRICE variable. Thus, we were able to show that the results from the cross-sectional tests in the FF 1992 paper which formulated the basis for the inclusion of two additional risk portfolios were clearly a result of a sample specific methodology. The re-examination of the tests under the light of evidence for the presence of problems in cross-sectional tests revealed serious weaknesses in FF results.

The empirical research conducted up to this point in the current thesis has unveiled new evidence for the power of the so called factor anomalies against the power of the Capital Asset Pricing Model. We have already refuted previous evidence that the inclusion of the market portfolio is not adequate to justify the excess risk-adjusted returns of various factor portfolios. In the current chapter we also cast doubts in the controversial FF 1992 paper about the importance of the MV and BEMV variables as cross-sectional determinants of the stock returns. However, we also showed that the inferences crucially depend on methodological and econometrical issues. Combining the information we have about the properties of the time-series models and the importance, together with the problems, of the cross-sectional models seems very appealing for the confirmation or rejection of current results. This approach is followed in the subsequent chapter in combination with more advanced techniques applied in the current empirical literature.

TABLE 5.1

RISK-RETURN RELATION OF THE 100 EQ PORTFOLIOS

Portfolios are formed yearly. In June of each year t (1964 to 1994) all the NYSE firms determine 10 decile breakpoints based on market value at this month. All NYSE, AMEX and (after 1973) NASDAQ firms that meet the requirements are allocated to 10 portfolios based on the breakpoints. Each portfolio is then subdivided in 10 subportfolios based on preranking betas for the NYSE stock in each of the 10 portfolios. At the end, we have 100 portfolios in June of year t and post-ranking equal-weighted returns are calculated for the portfolio from July of year t to June of year t+1.
The 372 post-ranking portfolio returns are employed to estimate the 100 post-ranking betas each of which is assigned to firms that belong to correspondent portfolio at the end of June. The pre- and post-ranking betas are the sum of the slopes from the regression of returns to the value-weighted market portfolio of NYSE, AMEX and (after 1973) NASDAQ firms. In addition, we report the post-ranking betas obtained from the employment of annual buy-and-hold returns in the market model.

Panel A : Average monthly returns(in percent)

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	High-beta
Small-ME	2.22	1.87	1.84	2.47	1.86	2.35	1.84	2.22	2.25	2.07
ME-2	1.59	1.68	1.45	1.71	1.38	1.49	1.43	1.31	1.26	1.31
ME-3	1.23	1.37	1.42	1.22	1.19	1.69	1.49	1.28	1.42	1.38
ME-4	1.27	1.29	1.12	1.31	1.42	1.53	1.31	1.51	1.14	1.30
ME-5	1.59	1.82	1.11	1.57	1.31	1.09	1.16	0.99	1.31	0.81
ME-6	1.41	1.42	1.45	1.49	1.49	1.17	1.40	1.45	1.22	0.94
ME-7	1.28	1.42	1.37	1.21	1.23	1.19	1.32	0.96	1.11	0.79
ME-8	1.33	1.22	1.15	1.34	1.01	1.02	1.06	0.94	1.16	1.39
ME-9	1.13	1.01	1.00	1.28	1.21	0.96	1.03	1.11	0.93	0.68
Large-ME	1.16	1.03	1.00	0.93	0.98	0.94	0.84	0.84	0.69	0.64

Panel B : Post-ranking betas

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	high-beta
Small-ME	1.14	1.21	1.30	1.45	1.42	1.57	1.53	1.58	1.68	1.91
ME-2	1.05	1.15	1.22	1.29	1.34	1.38	1.40	1.58	1.59	1.83
ME-3	1.01	1.12	1.25	1.34	1.38	1.38	1.42	1.59	1.65	1.84
ME-4	1.02	1.12	1.25	1.32	1.38	1.35	1.50	1.56	1.60	1.88
ME-5	1.05	1.14	1.19	1.27	1.36	1.38	1.47	1.42	1.67	1.74
ME-6	0.83	1.07	1.19	1.15	1.27	1.34	1.38	1.52	1.49	1.66
ME-7	0.90	1.05	1.10	1.22	1.24	1.28	1.26	1.35	1.46	1.69
ME-8	0.85	0.96	1.07	1.09	1.29	1.21	1.25	1.38	1.43	1.63
ME-9	0.81	0.84	1.03	1.05	1.11	1.24	1.23	1.11	1.32	1.47
Large-ME	0.65	0.79	0.89	0.97	0.92	1.05	0.99	1.09	1.18	1.35

Panel C: Post-ranking betas (BAH)

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	high-beta
Small-ME	1.11	1.13	1.12	0.98	1.47	1.29	1.58	1.39	1.72	1.59
ME-2	0.77	0.98	1.33	1.17	1.07	1.29	1.68	1.40	1.22	1.57
ME-3	0.86	0.94	0.99	1.16	1.13	1.29	1.32	1.28	1.36	1.25
ME-4	1.04	1.01	1.00	1.38	1.28	1.10	1.39	1.12	1.31	1.70
ME-5	1.29	1.10	1.07	1.19	1.16	1.28	1.31	1.48	1.36	1.16
ME-6	0.96	1.11	1.02	1.03	1.22	1.06	1.14	1.06	1.42	1.19
ME-7	1.07	0.97	1.14	1.09	1.06	1.19	0.92	1.02	1.05	1.42
ME-8	0.94	1.05	1.03	0.92	1.17	0.96	1.12	1.16	1.01	1.38
ME-9	0.77	0.84	1.02	1.11	0.86	1.07	1.05	1.10	1.16	1.23
Large-ME	0.75	0.72	0.80	0.91	0.75	0.98	1.00	1.25	1.35	1.40

Panel D: Post-ranking betas (BAHFF)

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	high-beta
Small-ME	1.09	1.12	1.12	0.97	1.45	1.24	1.55	1.37	1.73	1.80
ME-2	0.81	0.94	1.26	1.19	1.06	1.32	1.63	1.26	1.30	1.74
ME-3	0.88	0.98	1.00	1.19	1.19	1.33	1.34	1.29	1.34	1.23
ME-4	0.98	1.04	1.03	1.26	1.23	1.10	1.32	1.17	1.35	1.69
ME-5	1.30	1.06	1.03	1.20	1.13	1.30	1.28	1.47	1.37	1.14
ME-6	0.97	1.13	1.03	1.02	1.21	1.03	1.16	1.10	1.41	1.16
ME-7	1.07	0.98	1.12	1.11	1.08	1.22	0.92	1.02	1.04	1.45
ME-8	0.93	1.07	1.04	0.96	1.16	0.96	1.18	1.19	1.03	1.33
ME-9	0.79	0.85	1.04	1.09	0.87	1.09	1.07	1.11	0.98	1.19
Large-ME	0.75	0.72	0.79	0.92	0.75	0.95	0.99	1.11	1.16	1.25

Panel E: Average market values

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	high-beta
Small-ME	2.13	2.34	2.27	2.25	2.27	2.26	2.27	2.28	2.18	2.13
ME-2	3.61	3.62	3.62	3.62	3.59	3.61	3.61	3.59	3.51	3.60
ME-3	4.09	4.09	4.09	4.08	4.08	4.11	4.09	4.09	4.08	4.08
ME-4	4.51	4.51	4.52	4.50	4.51	4.51	4.52	4.51	4.50	4.52
ME-5	4.95	4.94	4.95	4.93	4.94	4.94	4.93	4.93	4.93	4.92
ME-6	5.38	5.40	5.38	5.37	5.39	5.38	5.37	5.36	5.37	5.35
ME-7	5.84	5.84	5.83	5.84	5.85	5.85	5.84	5.83	5.83	5.84
ME-8	6.39	6.39	6.40	6.36	6.37	6.36	6.38	6.37	6.38	6.34
ME-9	7.03	7.01	7.01	7.02	7.00	7.01	7.01	7.01	7.00	6.97
Large-ME	8.33	8.44	8.31	8.24	8.23	8.22	8.22	8.01	8.08	7.84

TABLE 5.2

RISK-RETURN RELATION OF THE 100 VW PORTFOLIOS

Portfolios are formed yearly. In June of each year t (1964 to 1994) all the NYSE firms determine 10 decile breakpoints based on market value at this month. All NYSE, AMEX and (after 1973) NASDAQ firms that meet the requirements are allocated to 10 portfolios based on the breakpoints. Each portfolio is then subdivided in 10 subportfolio based on preranking betas for the NYSE stock in each of the 10 portfolios. At the end, we have 100 portfolios in June of year t and post-ranking value-weighted returns are calculated for the portfolio from July of year t to June of year t+1.
The 372 post-ranking returns of each portfolio are employed to estimate the 100 post-ranking betas each of which is assigned to firms that belong to correspondent portfolio at the end of June. The pre- and post-ranking betas are the sum of the slopes from the regression of returns to the value-weighted market portfolio of NYSE, AMEX and (after 1973) NASDAQ firms. In addition, we report the post-ranking betas obtained from the employment of annual buy-and-hold returns in the market model.

Panel A: Average monthly returns (in percent)

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	High-beta
Small-ME	3.38	3.05	2.83	3.82	3.22	3.72	3.26	3.66	3.76	3.91
ME-2	2.63	2.60	2.42	2.84	2.44	2.63	2.64	2.48	2.57	3.00
ME-3	1.97	2.06	2.30	2.03	2.08	2.58	2.43	2.37	2.62	2.89
ME-4	1.95	1.95	1.89	2.08	2.21	2.36	2.31	2.44	2.39	2.68
ME-5	2.23	2.49	1.77	2.23	2.14	1.90	1.96	1.88	2.30	2.01
ME-6	1.92	1.88	2.08	2.05	2.16	1.80	2.14	2.41	2.17	2.07
ME-7	1.77	1.89	1.86	1.70	1.68	1.72	2.00	1.64	1.96	1.76
ME-8	1.79	1.62	1.55	1.83	1.47	1.56	1.60	1.54	1.87	2.31
ME-9	1.45	1.31	1.42	1.65	1.61	1.41	1.49	1.53	1.58	1.39
Large-ME	1.28	1.31	1.10	1.16	1.06	1.03	1.08	1.18	1.04	1.18

Panel B: Post-ranking betas

	Low-beta	Beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	high-beta
Small-ME	1.19	1.25	1.34	1.46	1.58	1.62	1.61	1.75	1.87	2.02
ME-2	1.07	1.17	1.24	1.32	1.34	1.41	1.45	1.63	1.64	1.89
ME-3	1.03	1.12	1.26	1.37	1.40	1.41	1.40	1.58	1.69	1.89
ME-4	1.04	1.13	1.27	1.34	1.38	1.36	1.55	1.57	1.62	1.92
ME-5	1.03	1.17	1.18	1.27	1.38	1.38	1.49	1.44	1.64	1.80
ME-6	0.82	1.07	1.18	1.15	1.28	1.32	1.36	1.53	1.50	1.68
ME-7	0.89	1.06	1.09	1.19	1.24	1.25	1.25	1.32	1.47	1.69
ME-8	0.84	0.95	1.06	1.07	1.28	1.19	1.21	1.36	1.44	1.60
ME-9	0.79	0.82	1.01	1.03	1.09	1.23	1.20	1.11	1.30	1.43
Large-ME	0.59	0.79	0.84	0.97	0.90	1.01	0.94	1.06	1.14	1.30

Panel C: Post-ranking betas (BAH)

	Low-beta	beta-2	beta-3	beta-4	beta-5	beta-6	beta-7	beta-8	beta-9	high-beta
Small-ME	1.10	1.29	1.27	1.42	2.02	1.53	2.04	1.88	2.28	2.58
ME-2	0.92	1.13	1.53	1.39	1.20	1.63	1.93	1.67	1.57	2.12
ME-3	0.95	1.07	1.12	1.34	1.38	1.57	1.56	1.47	1.61	1.59
ME-4	1.13	1.12	1.12	1.47	1.36	1.24	1.82	1.27	1.54	1.99
ME-5	1.43	1.23	1.13	1.32	1.28	1.46	1.47	1.64	1.66	1.50
ME-6	0.97	1.20	1.15	1.07	1.32	1.10	1.29	1.22	1.60	1.44
ME-7	1.16	1.09	1.22	1.17	1.14	1.30	0.99	1.07	1.17	1.66
ME-8	0.95	1.09	1.07	1.04	1.26	0.96	1.25	1.26	1.14	1.62
ME-9	0.82	0.86	1.07	1.15	0.92	1.17	1.11	1.19	1.02	1.27
Large-ME	0.68	0.80	0.75	1.09	0.66	0.91	0.97	1.00	1.15	1.30

TABLE 5.3

REPRODUCTION OF THE FF 1992 RESULTS

The dependent variable is the monthly stock return of individual stocks for the period July 1964 to June 1994. The beta is the post-ranking beta of 100 portfolios formed on size and pre-ranking betas and it is assigned to each stock according to which portfolio the stock belonged to at the end of June of year t. The MV is the log of shares outstanding times the price in June t. The BE is the book value of common equity plus balance sheet deferred taxes, TA is the total assets and E is income before extraordinary items plus income-statement deferred taxes and minus preferred dividends. BEMV and TAMV are the log ratios of the corresponding variable in year t-1 to market value in June t. TABE is the log of the TA to BE. EP is the ratio of E of t-1 to MV in June and it has the value of 0 where the E are negative whereas EN is a dummy taking the value of 0 where E are positive and 1 otherwise.

The slope is the average value of the sum of the coefficients in each of the monthly regressions divided by 372 and the t-statistic is calculated by $t_j = \frac{\bar{t}_{jt}}{se(t_{jt}) / \sqrt{n}}$

BETA	MV	BEMV	TAMV	TABE	EP	EN
0.15						
(0.46)						
	-0.15					
	(-2.58)					
-0.37	-0.17					
(-1.21)	(-3.41)					
		0.50				
		(5.71)				
			0.50	-0.57		
			(5.69)	(-5.34)		
					4.72	0.57
					(4.57)	(2.28)
	-0.11	0.35				
	(-1.99)	(4.44)				
	-0.11		0.35	-0.50		
	(-2.06)		(4.32)	(-4.56)		
	-0.16				2.99	0.06
	(-3.06)				(3.04)	(0.38)
	-0.13	0.33			0.87	-0.14
	(-2.47)	(4.46)			(1.23)	(-0.90)
	-0.13		0.32	-0.46	1.15	-0.08
	(-2.47)		(4.28)	(-4.45)	(1.57)	(-0.56)

TABLE 5.4

FM CROSS-SECTIONAL REGRESSIONS WITH STOCK RETURNS AND THE FF FACTORS

The dependent variable is the monthly stock return of individual stocks for the period July 1964 to June 1994. The beta is the post-ranking beta of 100 portfolios formed on size and pre-ranking betas and it is assigned to each stock according to which portfolio the stock belonged to at the end of June of year t. The MV is the log of shares outstanding times the price in June t. The BE is the book value of common equity plus balance sheet deferred taxes, TA is the total assets and E is income before extraordinary items plus income-statement deferred taxes and minus preferred dividends. BEMV and TAMV are the log ratios of the corresponding variable in year t-1 to market value in June t. TABE is the log of the TA to BE. EP is the ratio of E of t-1 to MV in June and it has the value of 0 where the E are negative whereas EN is a dummy taking the value of 0 where E are positive and 1 otherwise.

The slope is the average value of the sum of the coefficients in each of the monthly regressions divided by 372 and the t-statistic is calculated by $t_j = \frac{\bar{t}_{jt}}{se(t_{jt}) / \sqrt{n}}$

CONSTANT	BETA	MV	BEMV	TAMV	TABE	EP	EN
0.32	0.48						
(1.31)	(1.58)						
2.13		-0.27					
(4.83)		(-5.45)					
2.93	-0.47	-0.31					
(8.52)	(-1.68)	(-6.52)					
1.05			0.44				
(3.59)			(5.68)				
0.80				0.44	-0.04		
(3.08)				(5.59)	(-0.34)		
0.61						2.56	0.81
(1.98)						(3.21)	(3.35)
2.14		-0.25	0.23				
(4.87)		(-4.96)	(3.18)				
1.94		-0.24		0.24	-0.01		
(4.89)		(-4.95)		(3.23)	(-0.06)		
1.99		-0.27				1.36	0.24
(4.51)		(-5.82)				(1.71)	(1.30)
2.05		-0.25	0.22			0.50	0.20
(4.81)		(-5.28)	(2.99)			(0.94)	(1.10)
1.89		-0.24		0.22	-0.01	0.54	0.12
(4.75)		(-5.25)		(3.05)	(-0.06)	(0.95)	(0.72)

TABLE 5.5

RE-ESTIMATION OF THE FF1992 MODEL WITH ROBUST ESTIMATOR

Re-estimation of the cross-sectional regressions of the FF' 92 model with stock returns and the robust Iterated Weighted Least Squares estimation. The mean coefficients and the t-statistics in the parenthesis are calculated as previously.

CONSTANT	BETA	MV	BEMV	TAMV	TABE	EP	EN
0.135	0.634						
(0.938)	1.010						
0.082		-0.044					
(1.203)		(-1.881)					
1.171	-0.637	-0.005					
(3.728)	(-1.942)	(-1.927)					
0.318			0.272				
(1.151)			(3.610)				
0.355				0.252	-0.283		
(1.445)				(3.335)	(-2.499)		
0.159						2.050	-0.332
(1.534)						(2.507)	(-1.414)
0.068		-0.070	0.282				
(1.171)		(-1.568)	(2.006)				
0.106		-0.070		0.265	-0.316		
(1.294)		(-1.614)		(1.758)	(-1.786)		
0.179		-0.010				1.629	-0.358
(1.434)		(-0.241)				(1.997)	(-1.928)
0.238		-0.035	0.252			0.719	-0.431
(1.603)		(-0.815)	(2.161)			(1.439)	(-1.456)
0.192		-0.038		0.236	-0.211	0.959	-0.414
(1.520)		(-0.905)		(1.508)	(-1.940)	(1.821)	(-1.467)

TABLE 5.6

CORRELATION MATRIX OF THE FF 1992 MODEL

Variable	StockReturns	Beta - Eql	Beta - Vwg	MV	BEMV	TAMV	TABE	EP
Beta - Eql	0.015							
Beta - Vwg	0.021							
MV	-0.030	-0.481	-0.543					
BEMV	0.026	-0.038	-0.013	-0.287				
TAMV	0.025	0.023	0.048	-0.309	0.861			
TABE	0.006	0.129	0.133	-0.117	-0.063	0.446		
EP	0.011	-0.098	-0.094	0.003	0.363	0.327	-0.001	
EN	0.002	0.172	0.188	-0.264	0.064	0.163	0.211	-0.414

TABLE 5.7

FM CROSS-SECTIONAL REGRESSIONS WITH THE 100 PORTFOLIO RETURNS

Replication of the FM cross-sectional regressions with the 100 size-beta portfolio returns as the dependent variable. The post-ranking betas are estimated for the whole period of 372 months. The MV and BEMV variables are the average values of all the stocks in each portfolio.

Panel A: Equally-weighted returns

CONSTANT	BETA	BAH	BAHFF	MV	BEMV
0.390	0.309				
(1.526)	(0.971)				
0.103		0.603			
(0.408)		(1.866)			
0.129			0.579		
(0.517)			(1.795)		
2.356	-0.387			-0.215	
(6.027)	(-1.258)			(-4.780)	
2.112		-0.274		-0.205	
(6.142)		(-1.037)		(-4.608)	
2.120			-0.279	-0.205	
(6.173)			(-1.043)	(-4.619)	
1.750				-0.176	0.250
(3.787)				(-3.031)	(2.668)
2.203	-0.293			-0.205	0.141
(5.969)	(-1.048)			(-4.389)	(2.853)

Panel B: Value-weighted returns

CONSTANT	BETA	BAH	BAHFF	MV	BEMV
0.395	1.509				
(1.633)	(2.972)				
0.554		1.861			
(1.206)		(3.580)			
0.294			1.432		
(1.365)			(3.301)		
2.790	-0.365			-0.337	
(6.178)	(-1.216)			(-5.664)	
2.962		-0.325		-0.350	
(6.488)		(-1.184)		(-5.104)	
2.613			-0.418	-0.316	
(5.921)			(-2.058)	(-6.426)	
3.492				-0.406	0.237
(6.437)				(-5.980)	(2.992)
2.841	-0.347			-0.354	0.017
(6.753)	(-1.263)			(-6.818)	(3.046)

TABLE 5.8

FM CROSS-SECTIONAL REGRESSIONS WITH THE 100 PORTFOLIO RETURNS AND ROBUST ESTIMATION

Replication of the FM cross-sectional regressions with the 100 size-beta portfolio returns as the dependent variable and the robust estimation. The post-ranking betas are estimated for the whole period of 372 months. The MV and BEMV variables are the average values of all the stocks in each portfolio.

Panel A: Equally-weighted returns

CONSTANT	BETA	BAH	BAHFF	MV	BEMV
0.480	0.275				
(1.908)	(0.963)				
0.123		0.515			
(0.481)		(1.711)			
0.132			0.506		
(0.519)			(1.686)		
2.234	-0.449			-0.190	
(5.857)	(-1.495)			(-4.355)	
1.910		-0.279		-0.177	
(5.656)		(-1.084)		(-4.112)	
1.910			-0.279	-0.177	
(5.668)			(-1.076)	(-4.110)	
1.499				-0.140	0.252
(3.313)				(-2.491)	(2.500)
2.065	-0.358			-0.178	0.118
(5.719)	(-1.297)			(-3.954)	(2.717)

Panel B: Value-weighted returns

CONSTANT	BETA	BAH	BAHFF	MV	BEMV
0.245	1.307				
(0.974)	(2.102)				
0.561		1.758			
(1.227)		(2.331)			
0.566			1.758		
(1.258)			(2.334)		
2.745	-0.239			-0.317	
(6.344)	(-0.786)			(-6.545)	
2.765		-0.274		-0.321	
(6.148)		(-1.029)		(-6.685)	
2.689			-0.323	-0.318	
(6.944)			(-1.198)	(-6.610)	
3.181				-0.365	0.224
(6.900)				(-6.467)	(2.645)
2.817	-0.190			-0.336	0.167
(6.869)	(-0.670)			(-6.682)	(2.993)

TABLE 5.9

CROSS-SECTIONAL REGRESSIONS WITH STOCK RETURNS AND INDIVIDUAL FACTORS

Examination of cross-sectional regressions of stock excess returns on individual factors.

CONSTANT	BEMV	TAMV	TABE	EP	EN	CFLP	CFLN	SALE	DEBT
1.091	0.421								
(3.767)	(5.383)								
0.977		0.427	-0.269						
(3.590)		(5.402)	(-2.985)						
0.572				4.354	1.178				
(1.772)				(2.966)	(4.971)				
0.533						2.751	1.341		
(1.634)						(3.115)	(4.611)		
0.865								0.317	
(2.880)								(5.675)	
1.008									0.188
(3.398)									(4.327)

CONSTANT	PRICE	MV	CSHO	CAR12	DIV_SUM	TR	GR	CAR60
2.750	-0.879							
(7.206)	(-12.430)							
2.407		-0.341						
(5.289)		(-6.371)						
1.067			-0.018					
(2.967)			(-0.413)					
0.951				0.001				
(3.263)				(0.620)				
1.170					-3.799			
(3.251)					(-1.289)			
1.194						-0.004		
(4.264)						(-2.089)		
1.144							-0.115	
(3.582)							(-4.927)	
0.885								-0.003
(2.878)								(-3.649)

TABLE 5.10

CORRELATION MATRIX

	ER	BEMV	TAMV	TABE	EP	EN	CFLP	CFLN	SALE	DEBT	CSHO	PRICE	MV	DIVSUM	GROWTH	TR	CAR12
BEMV	0.031																
TAMV	0.032	0.873															
TABE	-0.001	-0.122	0.373														
EP	0.006	0.330	0.245	-0.024													
EN	0.007	0.022	0.115	0.187	-0.291												
CFLP	0.020	0.432	0.399	0.099	0.767	-0.203											
CFLN	0.005	-0.051	0.033	0.150	-0.237	0.759	-0.234										
SALE	0.030	0.680	0.767	0.241	0.238	-0.012	0.337	-0.077									
DEBT	0.021	0.679	0.924	0.596	0.255	0.097	0.409	0.013	0.723								
CSHO	0.003	-0.183	-0.186	-0.058	-0.010	-0.186	-0.039	-0.160	-0.210	-0.128							
PRICE	-0.068	-0.143	-0.169	-0.053	0.005	-0.215	-0.043	-0.201	-0.169	-0.101	-0.062						
MV	-0.040	-0.241	-0.262	-0.085	-0.009	-0.286	-0.063	-0.254	-0.287	-0.175	0.790	0.550					
DIVSUM	0.001	0.230	0.176	-0.047	0.212	-0.151	0.170	-0.125	0.101	0.149	0.098	0.121	0.162				
GROWTH	-0.020	-0.249	-0.201	0.051	0.065	-0.183	0.021	-0.167	-0.110	-0.119	0.109	0.069	0.131	-0.094			
TR	-0.015	-0.231	-0.199	0.035	-0.080	0.018	-0.083	0.020	-0.147	-0.148	-0.020	0.112	0.032	-0.158	0.159		
CAR12	0.004	-0.340	-0.290	0.010	-0.220	0.030	-0.210	0.030	-0.210	-0.240	0.000	0.080	0.040	-0.110	-0.060	0.220	
CAR60	-0.030	-0.400	-0.400	-0.090	0.010	-0.200	-0.100	-0.150	-0.260	-0.320	0.040	0.090	0.080	-0.110	0.370	0.140	-0.050

TABLE 5.11

BIVARIATE CSR WITH STOCK RETURNS AND THE MARKET VALUE AS THE CONSTANT REGRESSOR

Cross-sectional regressions of stock excess returns in bivariate models where the constant independent variable is the market value in combination with a second factor.

CONSTANT	MV	BEMV	EP	EN	DEBT	SALE	PRICE	CAR12
2.239	-0.282	0.224						
(5.088)	(-5.356)	(2.955)						
1.991	-0.297		3.189	0.540				
(4.379)	(-6.079)		(2.191)	(3.084)				
2.227	-0.294				0.092			
(5.045)	(-5.718)				(2.283)			
2.182	-0.294					0.164		
(4.757)	(-5.628)					(3.473)		
2.856	-0.003						-0.952	
(6.191)	(-0.064)						(-12.524)	
2.225	-0.332							0.001
(5.147)	(-5.96)							(0.662)

CONSTANT	MV	DIVS	TR	GR	CAR60
2.455	-0.339	-0.244			
(5.161)	(-6.641)	(-0.092)			
2.442	-0.305		-0.003		
(5.456)	(-5.607)		(-1.732)		
2.019	-0.228			-0.082	
(4.281)	(-4.112)			(-3.683)	
1.693	-0.192				-0.002
(3.687)	(-3.662)				(-3.618)

TABLE 5.12

BIVARIATE CSR WITH STOCK RETURNS AND THE MARKET VALUE AS THE CONSTANT REGRESSOR DATA AVAILABILITY RESTRICTION

Cross-sectional regressions of stock excess returns in bivariate models where the constant independent variable is the market value in combination with a second factor and we impose the restriction that the stocks have available data for all the factors.

CONSTANT	MV	BEMV	EP	EN	DEBT	SALE	PRICE	CAR12
1.58	-0.146	0.275						
(3.281)	(-2.756)	(3.328)						
1.595	-0.184		0.846	0.155				
(3.365)	(-3.721)		(1.05)	(0.771)				
1.636	-0.167				0.132			
(3.492)	(-3.341)				(3.109)			
1.527	-0.165					0.131		
(3.151)	(-3.153)					(2.445)		
2.222	-0.076						-0.798	
(4.513)	(-1.567)						(-10.637)	
1.735	-0.189							0.001
(3.794)	(-3.716)							(0.804)

CONSTANT	MV	DIVS	TR	GR	CAR60
1.717	-0.193	1.955			
(3.386)	(-3.684)	(-0.821)			
1.927	-0.194		-0.004		
(4.247)	(-3.702)		(-1.993)		
1.766	-0.179			-0.059	
(3.723)	(-3.369)			(-2.359)	
1.641	-0.173				-0.002
(3.537)	(-3.374)				(-3.712)

TABLE 5.13

CSR WITH EQ 100 PORTFOLIO RETURNS AND INDIVIDUAL FACTORS

Examination of cross-sectional regressions with the equally-weighted 100 portfolio returns and individual factors.

CONSTANT	MV	BEMV	DEBT	SALE	PRICE	TR
1.236	-0.113					
(2.470)	(-2.156)					
0.766		0.650				
(2.442)		(3.322)				
0.713			0.394			
(2.182)			(2.957)			
0.350				0.465		
(1.119)				(3.283)		
1.824					-0.510	
(3.530)					(-3.784)	
1.066						-0.008
(4.351)						(-2.038)

CONSTANT	GR	EP	DIVS	CAR12	CAR60
1.130	-0.231				
(3.684)	(-2.851)				
0.209		7.964			
(0.532)		(3.625)			
0.433			-0.952		
(1.040)			(-1.807)		
0.688				0.001	
(2.241)				(0.149)	
0.646					-0.136
(2.093)					(-3.985)

TABLE 5.14

BIVARIATE CSR WITH VW PORTFOLIO RETURNS AND THE MARKET VALUE AS THE CONSTANT REGRESSOR DATA AVAILABILITY RESTRICTION

Cross-sectional regressions of the value-weighted portfolio returns in bivariate models where the constant independent variable is the market value in combination with a second factor and we impose the restriction that the stocks have available data for all the factors.

CONSTANT	MV	BEMV	DEBT	SALE	PRICE	TR
3.303	-0.354	0.137				
(6.047)	(-5.551)	(0.676)				
3.221	-0.333		0.033			
(6.438)	(-6.446)		(0.336)			
3.215	-0.330			0.092		
(5.544)	(-5.734)			(0.808)		
4.049	-0.083				-0.869	
(7.521)	(-1.533)				(-7.372)	
3.269	-0.346					0.003
(7.552)	(-6.636)					(0.682)

CONSTANT	MV	GR	EP	DIVS	CAR12	CAR60
3.098	-0.329	0.061				
(6.817)	(-5.890)	(0.752)				
3.137	-0.334		1.489			
(5.023)	(-6.225)		(0.744)			
3.350	-0.335			-0.394		
(5.288)	(-6.228)			(-0.092)		
3.269	-0.333				0.002	
(6.840)	(-6.808)				(0.610)	
3.237	-0.330					-0.001
(6.504)	(-6.291)					(-0.395)

Chapter 6

Panel Data and General Method of Moments

6.1 Introduction

Inferences for the validity of a single- or multi-factor asset pricing model are drawn from empirical tests where actual returns are examined to identify the risk sources. The ideal condition is the agreement on a specific model's significance of both the theoretical and empirical foundations of the model. The main drawback for this coherence is the contrast between the *ex ante* formulation of a theoretical model and the *ex post* empirical model. Although a model could be presented flawless in theory, its validity can only be tested with ex post data. On the other hand, the empirical examination of ex post data inherits problems related with sample specific selection bias and diversities in various methodological results.

One of the most important problems in the empirical practice is the presence of substantial differences between cross-sectional and time-series estimates. These two methodologies are designed to test the same hypothesis, the significance of a specific factor model. Although the hypothesis is the same and the structure of the methodologies is not fundamentally divergent, it is quite common to obtain different results. The source of these deviations is the distinct sphere of underlying assumptions in the empirical application of each methodology. Furthermore, the accumulation of extended data sources for thousands of stocks over a large time period has initiated complexity in the employment of ex post data. Thus, the introduction of empirical tests that take into account more aspects of this complexity is more appealing in current research.

A more rigorous approach towards the empirical verification of a model is the construction and examination of panel data. Panel data refers to the combination of time-series and cross-sectional stock data for market returns and the interaction of other factors as well. The advantage of this configuration is that it takes into account any interrelations between the cross-section and time-series properties of the dataset design and can be easily augmented to simultaneously accommodate further extensions of the model. Furthermore, the basic attributes of the tests for panel data seem appealing as they share the major properties and correct for the present weaknesses of the cross-sectional and time-series models.

The introduction of panel data has the additional advantage of allowing the consideration of various levels in the format of models, starting from simple linear models and stepping to more complex non-linear systems. In the area of linear panel data models there has been some applied empirical research, however the magnitude is not as intense as with the traditional approaches. What it has not been adequately explored in the field of factor models is the application of non-linear systems and the many issues that could be examined with this approach. Finally, an additional feature of the panel data tests which forms the basis for the new trend in the current empirical research direction is the application of the General Method of Moments methodology. The appealing primary characteristic of this function is that it strongly resembles a non-parametric approach towards the empirical verification of asset pricing models as it is not based on particular assumptions about distributions and suppositions about the absence of strong correlated patterns. More importantly, the GMM test employs instrumental variables selected from the economic market environment in order to introduce time-variation in the factor models' betas and risk premiums.

The current chapter has the following structure. In section 6.2 we describe the framework of the methodology adopted in the panel data approach, including linear models, non-linear systems, the GMM approach and the formation of the hypotheses we examine with these tests. The data set employed in the subsequent empirical tests is not different than prior chapters' description of the portfolio formation procedure as one of the main current objectives is to re-examine more thoroughly prior inferences. The empirical results from the application of the new approaches to the asset pricing factor models examined the previous chapters are reported in section 6.3. And finally, in section 6.4 we report a summary of the conclusions drawn from the empirical research section.

6.2 Methodology

The most appealing and relatively widely applied version of the panel data approach is the Seemingly Unrelated Regression Methodology (SURM). The basic intuition behind the SURM is the simultaneous estimation of the factor coefficients in the presence of the market portfolio, avoiding thus the two-step methodology that is susceptible to measurement errors and considering at the same time the time-series properties of the coefficients. Furthermore, it takes into account cross-correlation patterns between residuals from different equations at the same point of time which is rational to infer within a large set of securities where a significant number of stocks belong to the same industry groups.

Generally, the model is tested in the form of m linear equations written as

$$y_i = X_i \beta_i + u_i \qquad E(u_i) = 0 \qquad i = 1,2,\ldots\ldots,m \qquad n = 1,2,\ldots.372 \qquad (56)$$

where y_i is the (nx1) vector of observations on the endogenous and nonrandom variable of stock returns specific at equation i, X_i is the (nxk_i) matrix of regressors for equation i, β_i is the (k_ix1) vector of parameters for equation i and u_i is the (nx1) vector of disturbances for equation i. Now, we may introduce cross-correlation in the disturbances i.e. Cov $(u_i, u_j) = \sigma_{ij} I_n$ i,j=1,2,.......,m.

The feasible estimator for the coefficient vector would be

$$\beta_g = (X'\Sigma^{-1}X)^{-1} X'\Sigma^{-1} Y \qquad (57)$$

where the unknown variance matrix can be estimated using the following steps:

1) apply OLS separately to each equation, obtaining the vectors of sample residuals

$$u_i = [I - X_i (X'_i X_i)^{-1} X'_i] Y_i \qquad i=1,2,\ldots\ldots.,m \qquad (58)$$

2) the diagonal elements of Σ can be estimated by

$$s_{ii} = \frac{u'_i u_i}{n - k_i} \tag{59}$$

and the off-diagonal elements by

$$s_{ij} = \frac{u'_i u_j}{(n-k_i)^{1/2}(n-k_j)^{1/2}} \tag{60}$$

The gain in efficiency yielded by the SUR estimator over the OLS increases directly with the correlation between disturbances from the different equations and decreases as the correlation between the different sets of explanatory variables increases.

This methodology is applied to regression models of portfolio returns on the market return and portfolio factor values:

$$R_{pt} - R_{ft} = a_1 + \beta_p (R_{mt} - R_{ft}) + \sum_{i=1}^{k} a_i X_{pt} + e_{pt} \tag{61}$$

where

R_{pt} = the return of the portfolio

X_{pt} = the portfolio characteristics from i=1,2,.....,k

The portfolio characteristics are calculated as the average value of the stock variables that comprise each portfolio. The portfolio return at time *t* is regressed on the factor mean over the period *t-1* to allow for lags in the transmission of information. The SURM simultaneously estimate the factor coefficients and examine the statistical significance adjusted for the risk related with the market portfolio. Thus, it is not necessary to include a pre-estimated beta coefficient as independent regressor with all the familiar measurement problems.

One of the initial papers that employed the SUR methodology for testing the CAPM was by *Gibbons (1982)* as mentioned in the literature review chapter. However, the basic implication of the Gibbons' approach was a non-linear system whose complexity was overcome with the linearization of the restrictions, leading thus to the application of the linear SUR model. However, in the current chapter we will employ and test as well the approach of non-linear systems.

The basic structure of the non-linear systems can be extracted from the *Gibbons'* paper where actually the validity of the Black's version of CAPM was tested. Assuming a well specified 'market model', the implication is

$$E(R_{it}) = a_i + \beta_i E(R_{mt}) \quad (62)$$

The Black CAPM requires the following expected risk-return relationship

$$E(R_{it}) = \gamma \beta_i [E(R_{mt}) - \gamma] \quad (63)$$

In terms of this model, the Black model implies the following constraint on the intercept of the market model $a_i = \gamma(1 - \beta_i)$. Thus, the formal hypothesis becomes

$$H_0 : a = \gamma(\iota_N - \beta) \quad \text{i.e. CAPM is consistent with the data}$$
$$H_A ; a \neq \gamma(\iota_N - \beta)$$

where

$a' = (a_1, a_2, \dots\dots\dots, a_N)(1 \times N vector)$

$\iota_N' = (1,1,1,\dots\dots\dots,1)(1 \times N vector of ones)$

$\beta' = (\beta_1, \beta_2, \dots\dots, \beta_N)(1 \times N vector)$

γ = the return on the zero-beta portfolio uncorrelated with the market portfolio return.

Evidently, the CAPM places a nonlinear restriction on a system of N regression equations viewed as $R_i = a_i \iota_T + \beta_i R_m + n_i$ where all the notations indicate vectors. The validity of the restrictions is tested with the application of the likelihood ratio test statistic on the difference in explanatory power between the constrained and unconstrained regression LRT= $-2 \ln \lambda = T[\ln|\hat{\sum}_t| - \ln|\hat{\sum}_u|] \sim X^2_{N-1}$.

This is the framework for testing the Black version of CAPM in the case of absence of a risk-free rate. However, the non-linear systems methodology is far more general and can be easily extended to test the basic implications of the CAPM even with the employment of excess over the risk-free rate returns. The rationale for this structure is based on the *McElroy, Burmeister and Wall's (1985)* paper where the Non-linear SUR (NLSUR) methodology was employed to test the restrictions imposed by the APT model. However, the same approach could be applied to CAPM tests as well.

In the NLSUR model, the cross-sectional restriction on expected returns is incorporated into the time-series expression for returns:

$$R_t = E_t + \beta RM_t + v_t \tag{64}$$

$$E_t = \lambda_m \beta \tag{65}$$

and substituting (2) into (1)

$$R_t = \lambda_m \beta + \beta RM_t + v_t \tag{66}$$

where R_t is and Nx1 matrix of excess returns, E_t is an Nx1 matrix of expected returns, β is an Nx1 matrix of beta coefficients, λ_m and RM_t are scalars which represent the price of risk and the excess return on the market proxy and v_t is the NxN variance-covariance matrix[19].

According to McElroy e.t.c., if λ's were known, (66) would be a system of N seemingly unrelated linear regressions; since λ is unknown (66) is a system of seemingly unrelated non-linear regressions with (N-1)K cross-equations restrictions - where K is the number of factors included as regressors (in the case of CAPM there is one factor)- that the λ 's are the same for each of the N securities (i.e. the return generating process is unique). The NLSUR estimates are obtained in three steps: (1) OLS estimation is used in each of the N equations (with T observations for each equation) (2) the residuals from these regressions are used to estimate the variance-covariance matrix Σ and in (3) the vector (λ, β) is chosen to minimise the quadratic residual form. The basic difference with the previously described procedure for the SUR methodology is that the regressors enter the model in a non-

[19] Clare, Priestley, Thomas (1996), " Reports of beta's death are premature: Evidence from the UK", p.14

linear fashion and the model's estimation iterates the steps and computes derivatives with each iteration.

In general, the equation (3) places non-linear restrictions of the form $a = \lambda\beta$ and provides estimates of β and λ_m that solves the minimisation problem:

$$\min v'[\hat{\Sigma}^{-1} \otimes I_T]v \qquad (67)$$

where $\hat{\Sigma}^{-1}$ is the residual variance-covariance matrix. This is the estimate of the residual variance-covariance matrix of the OLS regression in each security equation. The validity of the restrictions is crucial for the CAPM as it confirms that the market risk premium λ should be the same across all assets or subsets of stocks.

As mentioned in the literature review, the next step after the NLSUR methodology was the introduction by *McElroy, Burmeister and Wall's (1987)* of the Non-Linear-3-Stage-Least-Squares approach as a more appropriate one when the market portfolio should be considered as endogenous variable. However, there are even more basic reasons for the application of the NL3SLS methodology in tests of the CAPM. The most fundamental is that the consideration of instrumental variables in the non-linear systems introduces the application of General Method of Moments estimation procedure. An introduction to the GMM estimation is present in the literature review chapter whereas in the current chapter we report the stages applied in the following empirical tests. Generally, the advantage of the GMM methodology is the non-parametric nature that encompasses deviations from the assumption that returns are jointly normal and identically independently distributed through time. Moreover, the procedure for the estimation of the regression coefficients accommodates corrections for heteroskedasticity and correlation in the residuals. We should also mention the introduction of time-variation in the model's coefficients with the GMM estimation as we employ instrumental variables that enter the regression with lags and, thus, we are able to examine the impact of previous vital information on current estimates.

More specifically, we define the general model as

$$y_t = f(X_t, \beta) + u_t \tag{68}$$

where $u_t = (u_{1t}, u_{2t}, \ldots\ldots, u_{nt})$ is the vector of residuals at time t. The innovation from the previous description of this model is that we further introduce a vector of instruments $Z_t = (z_{1t}, z_{2t}, \ldots\ldots, z_n)$. Following previous empirical research in the area of testing asset pricing models with the GMM estimation, we consider the five information variables[20] suggested by *He, Kan, Ng and Zhang (1996)*[21]:

1) the Standard and Poor 500 composite stock index
2) the difference between three-month and one-month Treasury Bill returns
3) the difference between the yields on a portfolio of Baa-rated bonds and a portfolio of Aaa-rated bonds
4) the dividend yield on the S&P500
5) the one-month Treasury Bill rate.

Thus, the moment conditions of the multivariate system[22] are $G(\beta) = \sum_t u_t \otimes Z_t$ and the GMM estimated coefficients are derived from

$$\min_\beta G(\beta)'[SW]G(\beta) \quad \text{where} \quad SW = \Sigma^{-1} \otimes Z' Z^{-1}. \tag{69}$$

The application the GMM procedure determines a new SW matrix after each iteration by taking the inverse of $\frac{1}{T}\sum_t (u_t \otimes Z_t)(u_t \otimes Z_t)'$. Customarily, the GMM estimation computes the most efficient minimum variance estimator by incorporating information about possibly present heteroskedasticity and correlation in the weighting matrix. However, there is another possibility of initially estimating the weighting matrix unconditionally and subsequently correct it with robust estimation. With the first option, the estimated covariance matrix of coefficients is

$$A^{-1} \text{ where } A = \left[\frac{\vartheta G'}{\vartheta \beta}[SW]\frac{\vartheta G}{\vartheta \beta}\right] \tag{70}$$

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[20] He, Kan, Ng, Zhang (1996): *Tests of the relations among marketwide factors, firm-specific variables and stock returns using a conditional asset pricing model, p. 1899*
[21] We would like to thank Prof. Kan for providing us the data for the instrumental variables up to the year 1991. The completion of the dataset for the rest of the years was with Datastream data.
[22] RATS manual.

With the second option, the covariance matrix becomes $A^{-1}BA^{-1}$ where

$$B = \left(\frac{\vartheta G}{\vartheta \beta}\right)' [SW](\Sigma \otimes Z'Z)[SW]\left(\frac{\vartheta G}{\vartheta \beta}\right) \tag{71}$$

In the empirical tests of the subsequent section we consider both options as we have already presented evidence in previous chapters about the serious effects that normality and heteroskedasticity problems have on final inferences. Thus, we want to double check whether slight differences in the methodology result in substantial changes.

The limitation with the application of either the SUR or the non-linear systems is the requirement of portfolio returns and not individual stock returns. Even though an important feature of these methodologies is the simultaneous estimation of betas ad their coefficients and thus the evasion of portfolio employment, the invertibility of residual covariance matrix requires that the number of time-series is larger that the number of assets. However, it seems more advantageous to construct portfolios with a great number of stocks instead of limiting the examination to a possibly biased small sample of stock returns. Furthermore, as we have already showed, the employment of stock portfolios is more beneficial than stock returns as it is less susceptible to econometrical problems. The construction of the portfolios that will be employed in the current chapter's empirical research has been described in previous methodological sections. More specifically, the set of portfolios consist of the 10 univariate factor portfolios, the 100 size-beta portfolios, the 25 multivariate portfolios and the additional portfolios that were constructed with the randomised procedure in order to remove correlation.

6.3 Empirical Results

6.3.1 Seemingly Unrelated Regressions

The first set of portfolios where the SUR model is applied is the FF 100 size-beta portfolios. The purpose is to compare the results conducted in the previous chapter within the traditional OLS framework with the more general and less restrictive GLS estimation with panel data. *Kothari and Shanken (1998)* stated but not reported that inferences about the MV and BEMV significance are not altered with the panel data approach. In Table 6.1 we report the coefficients and the t-statistics of the MV and BEMV factors when we apply the SUR model with portfolio returns. We confirm the results by *Kothari and Shanken* and the previous chapter's results for both factors' power. We also confirm that the BEMV significance is lowered with the inclusion of the market value variable. Furthermore, we clearly observe a highly significant constant, rejecting thus strongly the null hypothesis of zero excess returns even in the inclusion of the more significant market value and book-to-market equity factors.

The pooled model with GLS estimation in the FF 100 size-beta portfolios was also employed by *Amihud and Mendelson (1992)* with devastating results for the MV significance and highly powerful results for the positive beta-return relation. Although the contradictory to the FF results were attributed to the employment of the more advanced GLS estimation, the current replication does not confirm these results. Thus, we are able to infer that the *Amihud and Mendelson' s* conclusions are not the results of the GLS estimation but merely the employment of annual buy-and-hold returns. As we have already discussed, it was argued that this method of return calculation results in a significant positive beta-return relation. However, it is not a robust approach as the significance might be the outcome of low degrees of freedom and, in addition, it is not representative of the investment horizon.

In the previous chapter we employed the cross-sectional methodology to infer on the significance of the factors with portfolio returns. The basic approach was to calculate the average values of every factor for each of the 100 size-beta portfolios whose construction changes every year and run cross-sectional regressions with portfolio returns as the dependent variables and the mean factors as the independent regressors. In the current empirical chapter we employ the SUR model which combines cross-sectional and time-series properties in order to infer on factors' significance when we adjust for the market risk simultaneously and not in a second-pass regression.

In panel A of Table 6.2 we report the coefficients and t-statistics of the SUR estimation with the 100 size-beta portfolios and all the factors. In this case, we impose the restriction of availability of all the factors to address the survivor bias problem. The results strongly confirm the previous chapter's inferences about the employment of equally- and value-weighted portfolio returns. Prior cross-sectional tests were performed with the traditional OLS estimation and with combinations of the market value with individual factors to infer whether the MV absorbs the power of other variables. With the SUR model we apply the GLS estimation and we are able to simultaneously include all the factors as regressors instead of examining various combinations. With equally-weighted returns we find significant all the common in empirical literature factors apart from the GR, CAR12, DIV and SALE factors. However, the employment of value-weighted returns confirms the striking evidence that only the PRICE variable remains significant in the presence of all the factors.

To check the robustness of our results we estimate the SUR model with the approach adopted by *Brennan, Chordia and Subrahmanyam (1997)*. The inferences were based on a SUR methodology with portfolio returns where the first portfolio criterion was the market value and the subdivision was based on a second factor. Similarly with this approach, we employ the returns of the 25 portfolios where the first criterion is the MV and the second criterion the BEMV, GR, PR or TR. The restriction of availability for all the factors was imposed in their paper as well as in the present tests. The main conclusion drawn from the pooled cross-section time-series regressions of the portfolio returns on the portfolio characteristics was the strong divergences in the results across different portfolio groups. It was evident from the empirical results in that paper that the inferences on the significance of individual factors were greatly influenced by the selection of particular portfolio groups. Additionally, the conclusions were not unanimous among all the factors and the portfolios.

In Panel B of Table 6.2 we report similar to *Brennan, e.t.a.* results for the magnitude of the coefficients and the t-statistics of the factors. We are able to confirm the argument that across different portfolio grouping procedures there is no unification in individual factors' significance. For example, the cumulative returns over the past 12 months are reported with an insignificant coefficient in the MVBEMV portfolios whereas the power increases in the MVGR portfolios. However, this is evident with the application of equally-weighted returns precisely as in Brennan, etc. 's paper. A look at the rows where the results from the value-weighted procedure are reported shows that the so widely pursued and desired unanimous conclusion over the significance of a specific factor is reached with the simple consideration of the more representative value-weighted returns for investment portfolio decisions where only the price variable is found significant.

In sum, the tests in this section that applied the less restrictive in terms of model econometrical assumptions methodology of the SUR model strongly confirmed that the sole significant factor is the price variable. Among all the factors considered in the empirical literature and re-examined in the current research, only the price factor seems to absorb the power of all the other effects and constitutes the strongest evidence against the CAPM.

6.3.2 Non-linear Systems and GMM

The application of time-series models in the corresponding empirical chapter was based merely on the traditional CAPM with the major assumptions of an available risk-free rate and the power of the market return to absorb risk-adjusted excess returns. Instead of unquestionably rejecting the CAPM in the case of the null hypothesis' rejection for zero constants, an alternative solution as suggested by

Black (1972) was to relax the assumption of unrestricted borrowing and lending at given risk-free rate and introduce a new portfolio whose return is ex-ante unknown and has to be estimated. Thus, the first estimated model is the market model with real instead of excess stock and market portfolio returns which is considered the unconstrained model. The constrained model contains the restriction $a_i = \gamma(1 - \beta_i)$ where γ is the return on the zero-beta portfolio uncorrelated with the market portfolio return. As the parameters β and γ are both unknown and have to be estimated, they enter the second model in a nonlinear fashion. The Black's version of the CAPM is then rejected in the case where the LRT test does reject the null hypothesis of valid restrictions.

The Black version of the CAPM was introduced to allow for the possibility to accept the CAPM within a less restrictive framework. However, we have shown that the traditional CAPM can be relatively easily saved by the simple employment of value-weighted returns for most of the factor portfolios. Thus, it is rational to implement the non-linear systems application of the Black's version to the factor portfolios where the traditional CAPM was unanimously rejected. Thus, the LTR test was performed in the MV, PRICE and SALE value-weighted portfolios to infer whether the Black version is valid. The p-value of the chi-squared test for the log-likelihood ratio was found very low, rejecting thus the validation of the constraints. Therefore, neither the Black version of the CAPM is adequate to explain the persistence of excess returns in the presence of value-weighted returns and the market portfolio. Furthermore, the non-linear constraints of the zero-beta portfolio returns on the market model constant were also tested with the 25 portfolio and the 100 portfolio returns. The LRT rejected as well the constraints and the validity of the Black CAPM to these groups of portfolios.

After the preliminary analysis concerning the attempt to save the traditional CAPM in the cases of the portfolios where we had found weak evidence, we move on to the more robust examination of the non-linear CAPM constraints. Specifically, we apply the test of non-linear systems suggested by *McElroy, Burmeister and Wall's (1985)* in the area of CAPM to infer whether the risk premium is the same across all the subsets of assets. In Table 6.3 we report the p-values of the LRT for the validity of the non-linear constraints for the univariate factor portfolios and we can infer that the results are quite similar to the corresponding table of chapter 4 where we tested the traditional CAPM. Thus, once more the portfolios where the null hypothesis is rejected are the MV, PRICE and SALE value-weighted portfolios and the multivariate portfolios where all the p-values were found nearly zero whereas in the randomised portfolios only the MV-PRICE portfolios reject the null.

However, even though the constraint of equal risk premium across all the portfolios is not rejected, the non-linear estimation results reveal a puzzle for the validity of the CAPM that could not straightforward be tested with the multivariate GRS F-test. The theoretical background of the CAPM asserts that the risk premium should be unanimous across subsets of assets but it should also be positive as the market return is expected, on average, to yield higher return than the risk-free rate. The second part of this set of theoretical implications is not confirmed with our tests. In all the cases we find a negative risk premium which contradicts one of the basic CAPM presuppositions.

The combination of the empirical evidence present in the time-series models, the cross-sectional tests and the panel data application in relation with the latest results in non-linear systems about the power of the CAPM provide a justification for the change in the direction of the research into a more restrictive area. More specifically, up to this point of empirical research in this thesis we have showed that evidence for the presence of excess risk-adjusted factor portfolio returns is not sufficient to reject the CAPM as a valid model in financial practice. With time-series tests we proved that the only cases where the CAPM is not valid among a broad class of factors are the MV, PRICE and SALE value-weighted portfolios, evidence confirmed with non-linear systems as well. Subsequently, the cross-sectional regressions and the SUR estimation showed that the combination of all the factors with and without the presence of the market portfolio and the employment of value-weighted returns resulted in the isolation of the factor among the three candidates that constitutes the strongest evidence against the CAPM with no possibility of correlation sources, the price variable. Thus, we will attempt to examine more thoroughly this specific case of evidence with the well-developed approach of GMM.

The contradictory results with the estimation of the non-linear systems for the two major CAPM hypotheses directs the investigation towards the more robust GMM estimation in order to infer on possible deviations. Thus, we test the market model with the price factor portfolios as the unrestricted model and subsequently we re-estimate the model with the restriction that the risk premium is equal across the portfolios. We find that the introduction of instrumental variables linked with the GMM methodology does not improve the situation and the negative risk premium remains present with a statistically significant t-statistic. Thus, the CAPM presumption about the positive beta-return relation could not be confirmed in the presence of the price effect either with the prevailing methodology for asset pricing models or with the introduction of the more advanced time-varying parameter model.

The focus should now be re-directed to the explanation for the presence of negative risk premium which implies that the investment on the market portfolio does not yield an average higher return than the risk-free rate. This evidence about the negative risk premium is not unique in the current study. *Zhou (1997)* employed the NLSUR method for estimating the three-factor model with the 25 MV-BEMV portfolios and the maximum likelihood procedure resulted in a significant negative risk premium on the market factor. In addition, *He, et. al. (1996)* applied the GMM estimation in the one-factor model and the 25 size-book portfolios and confirmed the presence of negative risk premium.

The evidence for negative risk premium on the market portfolio is not entirely against the implications of the CAPM. *Pettengill, et. al. (1995)* argued that the employment of ex-post stock returns in the tests of the CAPM should be modified to accommodate the requirement that a portion of the market return distribution lies below the risk-free rate. This can be easily verified after a look at figure 6.1 where we plot the actual market excess returns over the period 1964-1995. It is evident that the number of occurrences of down markets where $R_{mt} < R_{ft}$ is not negligible over the whole period. In these states of the world, the portfolios with high betas are expected to earn lower returns than the low beta portfolios. Thus, the introduction of instrumental variables allows the model estimation to take into account the magnitude of this phenomenon and the effects on final inferences. This is why with the traditional approach we find a statistically insignificant beta effect as we consider the average value of market return whereas in the latest methodology we find a significant negative premium as we value separately the states of the market across time.

A rationale behind the pattern of frequent occurrence of down markets is provided by *Boudoukh, et. al. (1993)* who showed that the assumption of a positive *ex ante* risk premium could be violated. In that case, it would still be advantageous for agents to hold the less than the risk free rate profitable market portfolio only if the conditional covariance between the marginal rate of substitution and the return on the market is positive in some states of the world[23]. The sources of present negative *ex ante* risk premium are possible states of world where the term structure is downward sloping and the economy faces high expected inflation. The introduction of instrumental variables allows the consideration of these phases of the business cycle and this is the reason behind the evidence for negative risk premium with the GMM model estimation. In order to observe the effect of instrumental variables that transmit information for these economic conditions, we plot in Figure 6.2 the average recursive estimates of the market risk premium with the univariate price portfolios. We can see clearly that the model estimation results in a considerably large number of negative signs for the risk premium which constitutes the source of evidence for the final conclusion.

To further examine the issue of negative risk premium, we extend the research by *Pettengill, et. al. (1995)* who tested the conditional relation between beta and returns in a traditional dummy regression framework. The basic implication of the CAPM for a positive risk-return relation should be present in good states of the world whereas a negative risk premium is also consistent with the CAPM in cases where the excess market return is negative. Thus, the empirical approach was to estimate the CAPM model with dummies for good and bad states of the market and with the application of the traditional OLS. We also divide the estimation procedure into positive and negative market excess returns but we apply the advantageous estimation of GMM in the price factor portfolios. With the equally-weighted price portfolios, we found a positive risk premium with a t-statistic of 1.98 in good states of the world and a negative risk premium's t-statistic of –2.13 during the bad states of the world. The evidence is stronger with the value-weighted portfolios where the corresponding values of t-statistics are 2.64 and –3.13 respectively. Thus, we verify within the GMM framework that the risk-return relation is statistically significant with a sign according to the cycle in the market. According to *Pettengill, e.t*, the verification for the presence of an overall positive risk-return relation should be the result of the previous evidence in combination with two additional points. The market portfolio return should be on average and there should be a symmetrical occurrence of good and bad states of the world. In the procedure of testing the two elements, we found a 0.95 mean market return and the risk premium values in the presence of the negative and positive market excess returns were very close in magnitude i.e. –0.31 and 0.39 respectively. Therefore, it is feasible to prove with a more robust methodology the argument that the negative risk premium cannot constitute strong evidence against the validity of the CAPM.

Although there is evidence even on a theoretical basis that the presence of the negative risk premium is not contradictory to the CAPM implications, we further examine some issues that could alter the inferences. Firstly, we test the possibility that the price effect could be a phenomenon mainly present in the NASDAQ market comprised primarily of low priced firms. Thus, we re-estimated the SUR model with 100 portfolios and the GMM model with the price factor portfolios in the restricted sample of NYSE and AMEX stocks. The negative risk premium was slightly mitigated but still significant. Furthermore, an argument put forward but not tested in the papers that the negative risk premium was also found present was

[23] Boudoukh, J., Richardson, M., Smith, . (1993), *"Is the ex ante risk premium always positive?" p.389*

that this could be a result of the employment of an inefficient market portfolio. Thus, we extended the market portfolio of all common stocks to include the long-term government and corporate yields for the years 1973-1995. The yield values were extracted from Datastream and the weights in the final portfolio of the three components were calculated according to the their market values. The basic conclusion is that the magnitude of the risk premium's significance is mitigated but it remains negative. Thus, the change in the composition of the market portfolio is not adequate to reverse the negative effect.

To sum up, the application of non-linear systems in the context of the attempt to save the CAPM in the framework of the less restrictive Black's CAPM did not result in favourable evidence. The extension of non-linear systems and the GMM estimation to test the general implication of the CAPM of equal risk premium across all the assets was successful for the most important price factor portfolios whereas at the same time we found a negatively significant price of beta risk. Although this seems quite controversial, we presented some justification based on previous empirical evidence.

6.4 Concluding Remarks

The framework of the empirical research conducted in the current chapter has been established on the basis of the more robust application of panel data. The motivation for this introduction was the divergences in the results obtained from independent employment of either the cross-sectional or time-series tests. Thus, the next rational stage would be to efficiently combine the properties of both approaches with the construction of panel data for portfolio returns and factors.

This panel data introduction made feasible the division of the research into two distinctive areas of empirical methodological study. The first approach is formulated with the uncomplicated and rather indisputable format of linear factor models. The groundwork is rather simple and assumes linearity in the relation between portfolio returns and various factors and, thus, the estimation procedure is quite straightforward. In the area of panel data, the more representative methodology is the Seemingly Unrelated Regression model where we simultaneously estimate the factors' coefficients with the inclusion of the market portfolio, avoiding thus the two-stage estimation. The SUR model was first applied in the 100 size-beta portfolio returns as the dependent variable and the important variables of market value and book-to-market equity as the regressors. The purpose was to compare the results in the previous chapter derived with the OLS estimation with the less restrictive SUR methodology that applies the GLS procedure and allows for contemporaneous residual correlation. We were not able to locate any divergences and we confirmed the specific factors' significance but with a lower BEMV effect than the small size phenomenon.

Subsequently, we extended the factors considered in the SUR model with the 100 size-beta portfolios to accommodate all the factors that have not exhibited strong inter-correlation patterns in order to infer on isolated effects. In addition, we also applied the tests to the 25 double-sorted portfolios constructed on the constant basis of market value and a second floating criterion of the PR, TR, BEMV or GR factors. Previous research in the empirical literature conducted with the SUR estimation and applied with multivariate portfolio returns and average factor values has resulted in mixed results as different factors were found significant under different sorting procedures. This result was also confirmed by our tests and the inferences were quite contradictory and confusing. However, we were able to isolate the source of these divergences, the employment of equally-weighted returns. This was evident as the application of the value-weighted procedure resulted in unanimous conclusion about the significance of a sole factor across all the portfolios, the price variable.

The main subject at the second part of the methodological issues in the field of panel data was the examination of non-linear models. The application of non-linear systems in the area of asset pricing models introduces complexity in the estimation methodology through iterations in the function maximisation procedure. The first case considered was the examination of the non-linear constraints the Black's version of the CAPM imposes on the market model. The purpose was to examine whether the PR, SALE and MV portfolio cases where the traditional CAPM was rejected with all the tests could provide evidence for the acceptance of the less restrictive two-factor CAPM. The LRT rejected the null hypothesis of valid constraints and, thus, the CAPM.

The structure of the non-linear systems was then extended in order to test the more general presupposition of the CAPM that the risk premium should be unanimous across all the subsets of assets. The NLSUR estimation in relation with the LRT resulted in similar to the time-series tests chapter where again only in the cases of the PR, MV and SALE portfolio returns we rejected the null hypothesis. These results in combination with the SURM inferences confined the research in the special case of price portfolios.

The striking evidence about the NLSUR results was the presence of negative risk premium which is contrary to the traditional CAPM positive risk-return relation. Subsequently, we applied the more robust approach of GMM that allows for the introduction of instrumental variables obtained from real market conditions in order to make inferences about the previous controversial evidence. However, even the instrumental, time-varying, non-parametric GMM methodology did not result in a positive risk premium but simply confirmed the significance of negative price for beta risk. The next stage would be to examine the sources of this result and we support the not widely accepted conception in the empirical literature that the presence of negative risk premium is not entirely conflicting to the CAPM. When there is an increased number of down markets where the market portfolio is lower than the risk-free rate because of high expected inflation and downward sloping term structure, it is normal to expect a negative relation between returns and risk. Furthermore, we applied the GMM model separately in the cases of positive and negative excess market portfolio return and we showed that the beta-risk relation is significant in both states but as the occurrence of bad states of the market is more frequent the negatively significant risk premium dominates the positive. The different composition of the market portfolio did not alter the inferences.

At the end of this empirical chapter which marks the end of the empirical research in the current thesis we could briefly make a statement about the asset pricing models application in financial practice before we extend the discussion in the conclusions chapter. The re-consideration of all the strategies formulated on the basis of firms' attributes in order to exploit the information to achieve higher returns shows that the results are not so reliable. The CAPM can be revived on a rather uncomplicated basis to proclaim that the high returns do not necessarily beat the market. Evidence for the time-series properties of the risk-adjusted excess returns, the examination of the factors as cross-sectional stock return determinants and the application of non-linear systems shows that the CAPM cannot be easily disregarded as a valid model even in the case with negative risk premium because of the flexibility in its theoretical background.

TABLE 6.1

SURM ESTIMATION OF THE 100 SIZE-BETA PORTFOLIOS

All common stocks of NYSE, AMEX and NASDAQ are allocated each year first to 10 market value (MV) portfolios according to NYSE breakpoints and then each portfolio is subdivided into 10 pre-ranking NYSE beta portfolios where beta is estimated with a Dimson market model for individual firms. Then, we calculate the 100 portfolio returns for the following twelve months and we update the portfolios annually. At the end, we have 372 post-ranking portfolio returns for each of the 100 portfolios. Each month, the portfolio returns are regressed on MV and BEMV variables calculated for the previous month as the average of the stocks that comprise the portfolios corresponding variables. The methodology is the SURM with simultaneous estimation of the factor coefficients adjusted for the market risk.

Panel A: Equally-weighted return

CONSTANT	MV	BEMV
0.567	-0.154	
(3.095)	(-6.303)	
0.187		0.504
(3.985)		(5.651)
0.455	-0.102	0.425
(2.484)	-4.056	(3.728)

Panel B: Value-weighted returns

CONSTANT	MV	BEMV
1.021	-0.231	
(5.156)	(-6.974)	
0.331		0.467
(7.184)		(5.086)
1.783	-0.245	0.247
(9.753)	(-5.111)	(3.221)

TABLE 6.2

SURM ESTIMATION WITH ALL THE FACTORS

All common NYSE, AMEX and NASDAQ firms are allocated each year in five MV portfolios according to NYSE breakpoints. Then, each MV portfolio is further subdivided in five portfolios according to GR, TR, BEMV and PRICE. The stock returns in each of the 25 portfolios are averaged with equally- or value-weighted rebalancing to calculate the portfolio monthly returns. The time-series of the portfolio monthly returns are then regressed with the SUR methodology on portfolio characteristics. The characteristics are calculated as the average of the previous month stock factors.

	CONSTANT	MV	BEMV	TR	PR	GR	CAR60	CAR12	DIV	DEBT	EP	SALE
Panel A:												
MVBETA												
EQ												
	1.5945	-0.1551	0.3221	-0.1163	-0.7554	-0.0286	-0.0023	0.0018	-0.4511	0.2476	2.0026	0.0394
	(5.9223)	(-4.6251)	(2.7821)	(-2.6419)	(-8.1744)	(-0.9794)	(-3.6495)	(1.4606)	(-0.9403)	(3.7811)	(3.2407)	(0.5710)
VW												
	0.8528	-0.0258	0.0343	0.0052	-0.4701	-0.0083	-0.0016	0.0011	-0.3123	0.0080	1.9815	0.0947
	(3.0787)	(-0.7891)	(0.3183)	(1.3904)	(-6.6685)	(-0.3012)	(-1.8419)	(0.9792)	(-0.7177)	(0.1298)	(1.8562)	(1.4671)

	CONSTANT	MV	BEMV	TR	PR	GR	CAR60	CAR12	DIV	DEBT	EP	SALE
MVBEMV												
EQ												
	1.2445	-0.1947	0.1957	-0.0024	-0.2755	-0.0020	-0.0011	0.0018	-1.1245	0.4211	1.0672	0.0274
	(3.2430)	(-4.1407)	(3.1305)	(-2.4631)	(-4.7198)	(-0.0356)	(-0.4681)	(1.4594)	(-0.5564)	(3.4949)	(0.9437)	(0.2224)
VW												
	0.6566	-0.0139	0.2114	0.0014	-0.2624	-0.0955	-0.0015	0.0013	-1.6910	0.0327	1.1018	0.1335
	(1.7743)	(-0.3188)	(1.2814)	(0.8886)	(-4.8094)	(-1.7310)	(-0.6812)	(1.1420)	(-0.8816)	(0.2797)	(1.0023)	(1.1908)
MVGR												
EQ												
	2.3615	-0.2760	0.6982	-0.0028	-0.1365	-0.0141	-0.0019	0.0032	-3.8481	0.1848	0.0123	0.1228
	(5.9231)	(-5.1201)	(2.4189)	(-1.6751)	(-2.0758)	(-0.3919)	(-0.7239)	(2.3808)	(-1.4210)	(1.3345)	(0.0095)	(0.8359)
VW												
	1.3020	-0.0305	0.1663	0.0110	-0.1978	-0.0481	-0.0043	0.0032	-0.3224	0.1452	0.0446	0.1720
	(3.7946)	(-0.6459)	(0.8503)	(0.3255)	(-3.7381)	(-1.3762)	(-1.9061)	(1.8069)	(-0.1457)	(1.1794)	(0.0390)	(1.4000)

MVPR												
EQ												
	2.2186	-0.2598	1.1373	-0.0002	-0.2660	-0.0425	-0.0029	0.0048	-3.8948	0.7494	1.2996	0.0124
	(5.8660)	(-5.3605)	(4.5433)	(-0.1011)	(-6.5652)	(-0.7485)	(-1.1719)	(3.6341)	(-1.5476)	(3.3060)	(1.0120)	(0.0765)
VW												
	0.1054	-0.0009	0.8210	0.0015	-0.3393	-0.0185	-0.0017	0.0032	-0.9636	0.5017	2.1690	0.0557
	(2.2916)	(-0.0198)	(1.7071)	(0.9955)	(-8.2336)	(-0.3467)	(-0.7825)	(1.7130)	(-0.4555)	(1.6149)	(1.8276)	(0.3965)
MVTR												
EQ												
	2.0378	-0.2944	0.8920	-0.0021	-0.2618	-0.0310	-0.0042	0.0061	-3.1800	0.3556	3.4856	0.1651
	(5.4860)	(-5.8712)	(3.6598)	(-1.5986)	(-4.5697)	(-0.5168)	(-1.7334)	(4.0044)	(-1.3431)	(2.5810)	(2.4738)	(1.1798)
VW												
	0.4823	-0.0996	0.3806	0.0029	-0.1978	-0.0846	-0.0058	0.0046	-3.7053	0.1304	2.4837	0.1160
	(3.2806)	(-2.1788)	(1.6913)	(1.3863)	(-3.8221)	(-1.4748)	(-2.5662)	(1.8783)	(-2.1374)	(1.0035)	(1.8340)	(0.9148)

TABLE 6.3

NON-LINEAR SYSTEM ESTIMATION FOR THE CAPM CONSTRAINTS

We report the p-values from the LRT that the non-linear constraints implied by the CAPM are valid across the 10 decile equally- and value-weighted factor portfolios.

	BEMV	BETA	CFL	CSHO	DEBT	DIVC	DIVS	EP	MV	PRICE	SALE
EQ	0.0000	0.0663	0.0000	0.1558	0.0000	0.6320	0.0493	0.0000	0.0000	0.0000	0.0000
VW	0.0210	0.0753	0.2021	0.3063	0.0586	0.1535	0.0913	0.0623	0.0000	0.0000	0.0000

	GR	TR	TABE	TAMV	CAR12	CAR60
EQ	0.0000	0.0000	0.6215	0.0000	0.2642	0.0000
VW	0.1045	0.2262	0.5231	0.0645	0.2022	0.0563

FIGURE 6.1

GRATH OF THE MARKET PORTFOLIO EXCESS RETURN
OVER THE TIME PERIOD 1964-95

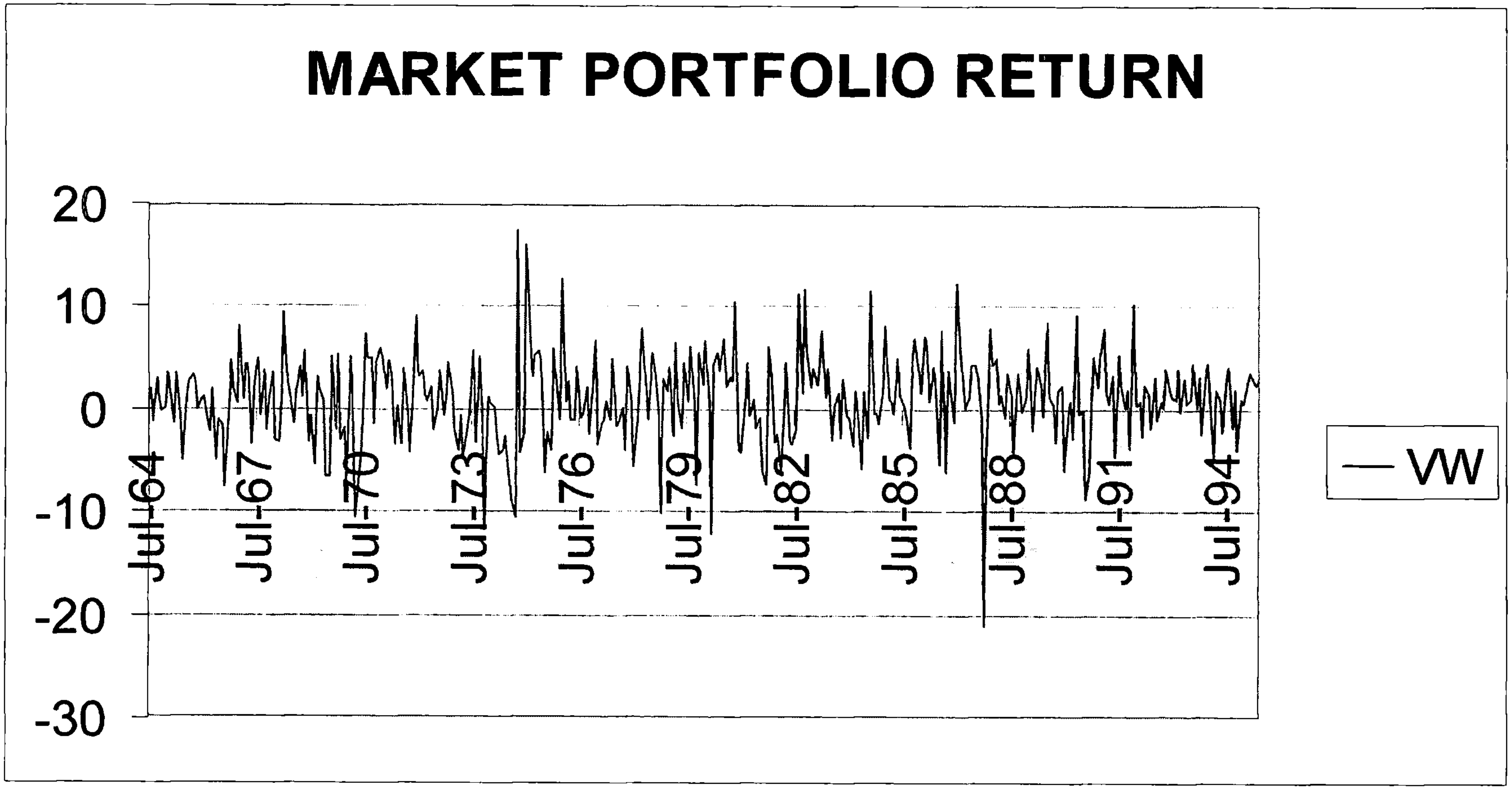
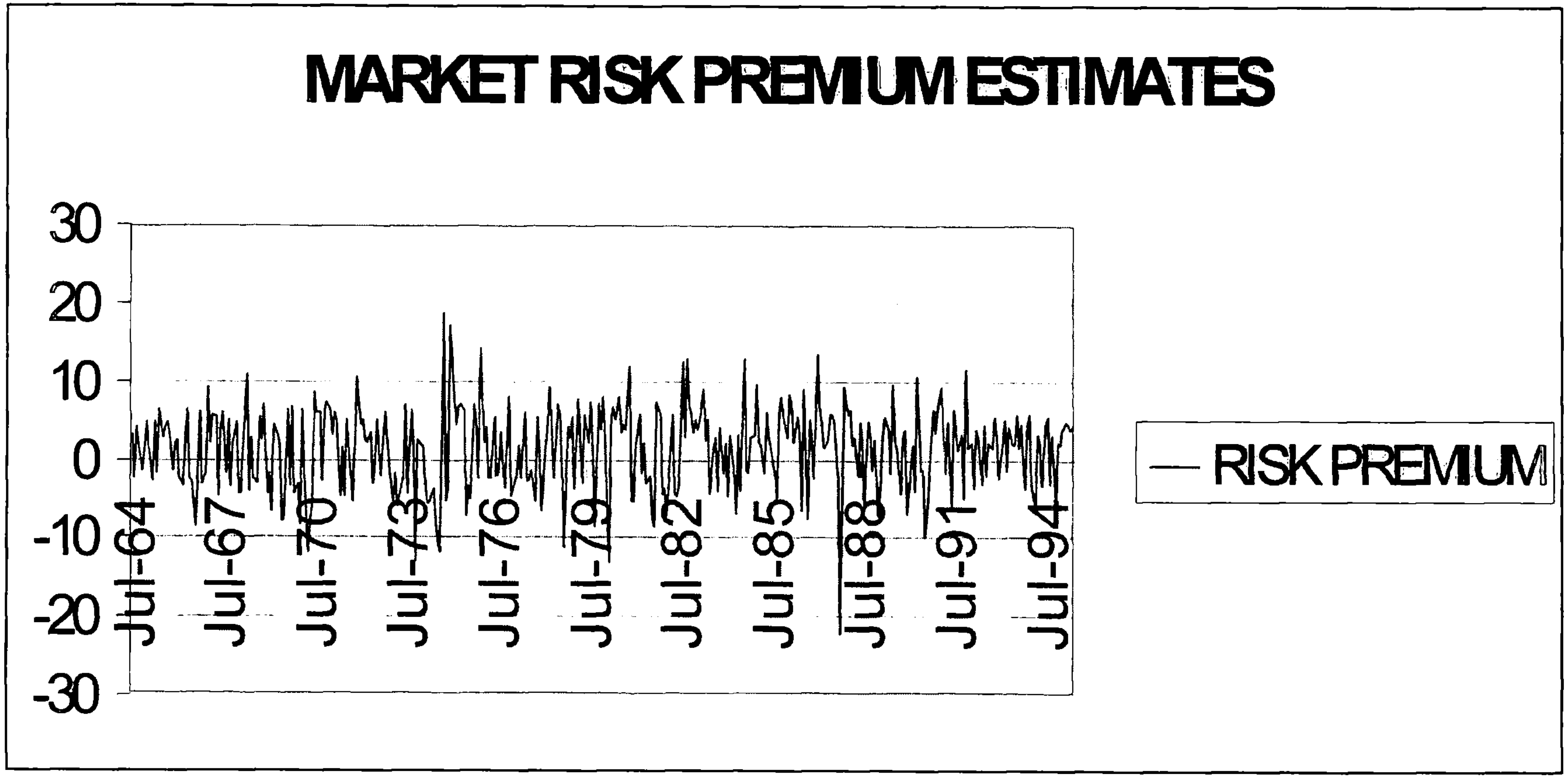


FIGURE 6.2

GRATH OF THE RECURISVE ESTIMATES OF THE MARKET RISK PREMIUM OVER THE TIME PERIOD 1964-95



Chapter 7

Conclusions and Further Research

The primary area of research in the current thesis was the examination of single and multifactor asset pricing models. The representative case of the single factor model is the familiar Capital Asset Pricing Model whereas within the multifactor framework we consider the firm attribute-based models. Another widely empirically examined area of multifactor models is the Arbitrage Pricing Model where the focus is centred on either unidentified factors extracted with factor analysis or macroeconomic variables. However, in this project we examined the broader class of multifactor models where the exploration of risk sources is restricted in the set of information obtained from firm's historical figures and the profitable investment opportunities that could thus be exploited.

The main argument drawn from the empirical literature around the factor models is that specific firm attributes can be employed to extract information for the future performance of stock returns. More specifically, certain patterns in the direction of firm attributes transmit information for the presence and persistence of excess returns. The failure of the traditional CAPM to explain and absorb these excess returns has introduced the label 'anomaly' as a reference to this class of models. However, in order to address previous empirical evidence with this term it is necessary to draw definite conclusions that these factor models indeed deviate from the current financial paradigm of the CAPM. The re-consideration of the empirical research with its derived results that led to this devastating conclusion is the framework of this thesis.

Subsequent to the literature review section where we presented the description of the main methodological approaches and the primary results in previous empirical research, the initial subject addressed in the empirical part of the current research was the performance of the factor mimicking portfolios. The factor mimicking portfolios were constructed as the difference between the highest and the lowest portfolio returns from individual factors sorting procedure. The set of the factors considered included the book-to-market, market value, price, shares outstanding, dividends, earnings-price, cash flow-price, debt, sales, trading volume, sales growth variables and the cumulative past returns over twelve and sixty prior months. The question to answer in this part was to identify and isolate on a preliminary basis the factors that are the strongest candidates to refute the power of the CAPM. The set of the factors under consideration is derived from firm specific characteristics and covers the majority of the factors previously examined in the empirical literature for their 'anomaly' nature. The first issue was to detect the factor portfolios that exhibited the highest return performance as this is an indication of possible present excess returns. The analysis showed that, as confirmation to previous results, high return performance was evident in the market value, book-to-market and price portfolios. However, even though this is important evidence we should also focus the attention in the magnitude of return volatility. The purpose for this examination is that high volatility transmits more vital information about the factor's contribution to the portfolio return performance. Surprisingly enough, we found that the factor portfolio with the highest spread in volatility is the beta portfolio irrespective of its low mean return.

As the research around the seasonality patterns has covered a substantial part of the empirical literature, we also dedicated a section to examine this subject. Consistent with previous results, we confirmed the highest return and volatility in the month of January, a phenomenon known as the January effect. However, examining more thoroughly the seasonality pattern and re-directing the focus from the January effect we were able to identify a distinct volatility circle across the months. More specifically, the high January volatility is followed by a sharp drop in the subsequent months with few deviations until it reaches peak points in the October month and is follows a descending trend until December. The puzzle behind the October pattern is twofold. Firstly, there is absence of rational explanation whereas many scenarios have been proposed for justifying the January effect such as the tax-loss selling hypothesis. Secondly, the high October volatility is accompanied by returns in the opposite direction of the high January returns and it is not substantially priced in terms of high mean returns.

An additionally noteworthy result derived from the first empirical chapter was the first indication of divergences derived from different rebalancing procedures. In order to infer on the statistical significance of the high risk premia, a regression of the factor mimicking portfolio returns on a constant was performed and implications were derived from the constant's t-statistic. The first important point drawn from these simple regressions was the confirmation of the return direction for each factor. Insignificance of return premia was found present in the dividend, CAR12 and TABE factors. For the rest of the cases, the notable divergences are the reversion of the results with value-weighted returns where the beta becomes a significant factor and the trading volume factor inverts to a positive inefficient effect. Although these are issues that have not been adequately examined in the empirical literature and transmit evidence important for the performance of the factor mimicking portfolios, they have to be more thoroughly examined in the context of the CAPM implications.

The verification of the evidence of high factor return premia in the first empirical chapter does not constitute proof against the CAPM validity. To infer on the latter we are examining the time-series properties of the factor portfolios as the CAPM implies zero excess returns i.e. zero constant in the market model. The traditional tests in this area consider not the factor mimicking portfolio returns but the performance of all the decile factor portfolios. Thus, the initial stage in the second empirical chapter was to examine the patterns across the ten decile portfolios for each factor. Within the CAPM framework the magnitude of the return spread should be corresponding to the beta spread, a presupposition that was not confirmed for the majority of the portfolios. The exceptions were the DIVCOM, DIVSUM, TABE and value-weighted GR portfolios. A more general conclusion is that the beta spread substantially increases with the employment of the Dimson corrected for non-synchronous bias beta and with the value-weighted beta portfolios. At this point, we also presented evidence of high return spread within multivariate portfolios constructed first on the basis of market value and then on the second factor-criterion of price, trading volume, book-to- market equity or sales growth.

With the examination of the return performance across the ten decile factor portfolios we were able to thoroughly explore the seasonality patterns. The results from the test of return equality across the months revealed that the exclusion of January led to the acceptance of the null hypothesis. On the other hand, the consideration of all the months rejected the null hypothesis only for particular subsets of the factor portfolios where the high performance was present e.g. the small market value portfolios. The portfolios that did not exhibit this pattern were the BETA and TR portfolios. However, the striking evidence in the seasonality patterns is present in the value-weighted portfolios where we accept the null hypothesis of equal returns across months including January far more often. Thus, only a limited number of factors still exhibit the January effect in the latter case of value-weighted procedure. It is noteworthy that the sole case where the January phenomenon was not an issue was the value-weighted price portfolios.

The presence of the January high risk premia could not necessarily be an anomaly phenomenon if it is accompanied by higher risk. The analysis performed to test the equality of beta and volatility across months resulted in unanimous rejection for all the cases. Thus, there is a possibility that higher return acts as compensation for higher risk but no definite conclusion can be drawn on the magnitude equality. Although there could be a rational or risk mismeasurement story behind the January effect, the examination of the significance of volatility across months resulted in high variance also in the month of October, confirming thus and adding in the seasonality area the October effect for which we could not provide a rational explanation.

Following the vague evidence about CAPM misspecification from the beta-return relation along the ten decile factor portfolios, we step to the more robust multivariate analysis of the constant significance in the market model. This way we test the important time-series implication of the CAPM. The powerful GRS F-test was performed in all the portfolios and although with the equally-weighted procedure most of the portfolios were found to achieve high risk-adjusted returns, the value-weighted procedure accepted the constant insignificance for all the cases apart from MV, PRICE and SALE portfolios. These results were double checked and confirmed with the application of the LRT.

The multivariate approach for the constants' joint significance of the factor portfolios was also employed with the FF 1993 three factor model which supplements the market portfolio with the additional risk portfolios constructed on the basis of market value and book-to-market factors. The three-factor model was employed first in the previously mentioned univariate portfolios where the CAPM was rejected but we could not either support the significance of the three-factor model. Additionally, the one- and the three-factor model was also applied to test the significance of any present excess returns in multivariate double-sorted portfolios. We again failed to replicate the FF results for zero constants whereas the CAPM failed as well to absorb the excess returns from multivariate portfolios. However, the alternative randomising procedure for constructing value-weighted multivariate portfolios to remove the factors' correlation sources worked in favour of the CAPM as the only case where we rejected the null hypothesis of excess returns was the MV-PRICE portfolios. Thus, we could argue that the introduction of the three-factor model is reluctant as the employment of value-weighted returns accounts for the size and financial distress factors in the one-factor model.

The evidence about the CAPM power in the second chapter of empirical evidence is not adequate to conclude on the definite revival of the CAPM as we should also look into its important implication that the beta is the sole determinant of the cross-sectional stock return variation. The examination of this hypothesis has been widely performed with the *Fama and MacBeth* cross-sectional tests and it is the main subject of the third empirical chapter. At the first stage, we performed a replication of the influential FF 1992 where the MV and the BEMV factors were found as the only significant cross-sectional determinants. The employment of a dataset and methodology very similar to FF confirmed the flat relation between beta and return and the power of the two factors. However, we moved beyond the simple confirmation of the results and we examined the model more carefully.

The replacement of the post-ranking betas resulted from the full-period equally-weighted 100 size-beta portfolios with value-weighted results overturned the flat relation into a positive significant one. However, the power was not adequate to absorb the inclusion of the market value factor. After this evidence, we turned the attention into the consideration of some additional factors examined in the empirical literature to infer on interrelation patterns. We first applied the tests with individual stock returns and their variables and we found a limited number of insignificant factors consisted of DIVS, CAR12 and CSHO variables. As the MV has attracted the bulk of attention, the next step was to test bivariate models with the market value as the constant regressor in combination with another factor to see whose factor's power is absorbed by the small firm effect. The only case was the trading volume variable, evidence that confirmed the previous chapter's inference that the trading volume effect is absorbed by the small size effect. When we imposed the restriction of data availability of all the factors for the inclusion of stocks in the tests, we add the earnings/price ratio to the factors eliminated with the presence of the market value.

The problem with the employment of the individual returns which was also present in the FF 1992 model was the skewness and kurtosis patterns i.e. a severe normality problem. The traditional OLS estimation is basically formulated on the assumption of normality and, thus, the presence of outliers could seriously distort the final inferences. The attempt to substitute the OLS method with the robust iterated least squares estimation that takes into account deviations from normality was not very successful, as the resulted estimates were quite controversial and suspicious. This is why we tested the bivariate models with the 100 size-beta portfolio returns where the non-normality is a less serious problem. Thus, the regression models were estimated with the equally- and value-weighted portfolio returns as independent variables and the portfolios' mean factor values as the regressors with the additional restriction of all data availability. After many iterations of the model estimation with all the factor's combinations and the employment of robust estimation, the remarkable result was present with the value-weighted returns and showed that the only significant variable which absorbs the power of all the rest factors is the price variable. The correction for non-normality problems with the robust estimation did not alter the results. However, the inclusion of the market beta with the price variable showed that the CAPM relation is still violated.

The information we obtain from the application of time-series models in combination with the results of the cross-sectional tests is still not sufficient to reach a final conclusion about the power of the CAPM. The reason is that both methodologies are susceptible to serious econometrical flaws and, thus, the refutation of the above results can be easily supported with a slight change in the set of assumptions. There is also the more general sentiment in the area of econometrical research that the two prevailing methodologies are often result in contradictory results which should not be the case as they just examine the same issue from a different angle. To overcome these problems and justify our results on a more robust basis, in the final empirical chapter we employ the panel data set which combines and examines simultaneously the cross-sectional and time-series properties of return and factor data.

The first case of the panel data application was the Seemingly Unrelated Regression model where the beta and the factors' coefficients are estimated simultaneously, avoiding thus the two-stage methodology which is more sensitive to measurement errors. Furthermore, the SUR approach estimates the model with the GLS procedure which is more robust than OLS as it takes into account heteroskedasticity problems and contemporaneous correlation in the residuals. The re-estimation of the 100 size-beta portfolios model did not substantially alter the inferences about the power of the market value and the book-to-market equity variables. However, the employment of value-weighted returns for both the cases of the 100 portfolios and the multivariate 25 portfolios strongly confirmed our previous results about the significance of the price variable as the sole cross-sectional determinant with power over the market beta.

The second class of panel data extends the models' format to include the presence of non-linearities in the regression coefficients. The preliminary non-linear estimation is the test of the hypothesis that the non-linear constraints the Black's version of the CAPM imposes on the market model are valid. The examination of the hypothesis in the PR, SALE and MV portfolios did not result in favourable results for the less restrictive CAPM and, thus, we were not able to save the model. Subsequently, we employed the NLSUR estimation to test the more general implication of the CAPM that the risk premium should be equal across all the assets. Although we confirmed the acceptance of the null hypothesis with all the cases apart from the above portfolios, we also found the contradictory evidence of negative sign for the price of beta. Restricting the attention to the case of price portfolios that constituted the only evidence against the CAPM, we proceeded to apply the more robust GMM estimation which allows for time-variation in the model's coefficients. The negative risk premium was still present, evidence that does not contradict previous empirical results in prior papers. Even the presence of negative risk premium cannot be considered as devastating evidence for the power of the CAPM as on an ex ante basis of the beta-risk relation we would expect a negative relation during down markets. When the number of occurrences and magnitude of bad states of world are not negligible, it is not contradictory to the CAPM to expect a negative risk premium. Furthermore, the strong evidence that only the price factor retains its power against the beta is an additional argument for the CAPM acceptance according to *Black (1996)* who showed that there will be always an inverse relation between price and returns attributed to the internal connection through the calculation of returns and the discount rate.

Thus, the final inference can be summed up on the simple proposition that there is still evidence in favour of the CAPM as a valid model for financial practice to justify the excess factor portfolio returns. The introduction of multifactor models to account for more dimensions in the risk inherent in the marketable stocks is not desirable as they lack of theoretical background and their impact is eliminated with simple portfolio rebalancing procedures. The evidence against the CAPM based on the price variable can be refuted in the framework of the discount rate calculation whereas the presence of the negative risk premium can be justified on an empirical and theoretical basis.

However, even though there is rationale behind the presence of these issues it would be very interesting for future directions in the area of asset pricing models examination to consider the impact of the market portfolio composition. The main implication of the CAPM remains the *ex ante* efficiency of the market portfolio. Thus, all the previous findings in the empirical tests could be the result of employment of inefficient market portfolios. We attempted to address the issue but slightly extending the composition of the market portfolio consisted of all common stocks to accommodate government and corporate bonds but a more thorough and robust approach towards this direction seems very appealing for the future of the capital asset pricing model.

Chapter 8

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