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Πανεπιστήμιο Πειραιώς

"The Usefulness of Size and Book-to-Market Equity Factors in Explaining Security Mean Returns: The Case of The Athens Stock Exchange"

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1. INTRODUCTION

In the last two decades there has been a plethora of papers documenting size and earnings/price ratio "effects" on stock returns, representing an unusual coincidence of interest among a broad group of financial economists. These papers relate in different ways to the size effect and provide substantial new information about this "phenomenon": that is, that average returns to small firms' stocks are significantly higher than any known capital asset pricing model predicts. In particular, a large part of the high return occurs in the first few days of January and this exists in Australia as well as in United States.

The magnitude of the size effect varies over time and it is related to other evidence concerning high average returns to stocks with low earnings/price ratios and high book-to-market-equity.

Most papers upon this issue are concerned with systematic cross-sectional differences among stock returns. This simple observation does not seem to be forecasted by any of the various models. Standard capital asset pricing models are based on the proposition that individuals are risk averse and predict a positive relation between a stock's risk and its expected return. Moreover, they have such an important place in contemporary finance that they are used as a pedagogic device to measure the opportunity cost of capital.

The statistical evidence supporting the positive relation between risk and expected return is surprisingly weak. In tests of Sharpe, Lintner and Black capital asset pricing models, the statistical association between these two variables is often only marginally significant. While there are many possible explanations about these empirical results, the weak statistical relation between average return and risk provides an interesting benchmark for measuring the strength of other types of discrepancies in average returns among securities. For example, the association between firm size and average stock returns is about as strong as the association between risk and average returns. For this perspective, it is not surprising that there has been a growth in papers on the size effect or the book-to-market equity effect and other empirical regularities in average cross returns.

In fact, both of these characteristics, along with other firm attributes, have been subject to considerable analysis in the finance literature. It has been shown through empirical studies that these variables have a significant power in explaining and predicting the cross-section of expected stock returns.

Although researchers generally accept the success of this finding, there is a disagreement concerning the reasons for this success. Leaving aside the arguments about investors' irrationality and data related biases, for these attributes to have such explanatory power, they should represent sensitivities to some risk factors in an asset-pricing-test like model. That is, we can view stock returns as a form of compensation for different kinds of risks a firm is exposed to. For instance, high debt is likely to be associated with bankruptcy risk, a growth firm is likely to be more vulnerable to technological risk, etc. The main idea is to consider that an attribute is uniquely related to a risk factor and to construct a mimicking portfolio for this factor by sorting stocks with respect to the given attribute.

Fama and French (1992) construct mimicking portfolios in this way, by sorting stocks on their book-to-market and size. They argue that their mimicking portfolios are priced along with market factors. That is, investors require excess returns of these portfolios, because holding them generates risk. The return premium of high book-to-market firms may represent a compensation for increased financial distress. Their argument is based on the empirical fact that such firms are, in general, bad recent performers in terms of earnings growth and profitability.

The purpose of this paper is to examine whether firm size and book-to-market equity ratio have an explanatory power of the average returns of stocks listed on the Athens Stock Exchange (ASE) for the 1997-2000 period. The motivation for this research has been the previous empirical evidence about the non-existence of the CAPM's validity in the ASE[1], as well as the influence of many articles about the association of stocks' expected returns with other factors, like firm capitalization, dividend yield, leverage, earnings-per-price and book-to-market equity.

In spite of the fact that the Greek Stock Market is inefficient relative to other stock markets in various parts of the world, the results of the present paper were nearly similar to those found by other researchers using data drawn from other countries. We employed the simple ordinary least squares and showed that size and book-to-market equity along with the market factor do a good job explaining the average returns on ASE stocks for the period under investigation. Especially the size factor seems to exert a more significant influence on share returns compared to the book-to-market equity factor.

We also applied stability tests, using the recursive coefficients estimation model, in order to trace the evolution of estimates for the regression coefficients and found evidence that the coefficients display an insignificant variance during the 1997-2000 period, which is an indication of stability.

This paper contributes to the literature in the sense that it extends the international empirical evidence on the aforementioned size and book-to-market effects on the average stock returns and also provides additional insight into the relative explanatory power of the existing theories.

The outline of the thesis is as follows: in section 2 a general literature review is presented. Section 3 describes the data, the methodology for the construction of the factor mimicking portfolios, and the time-series regression model used for our analysis, introducing as well the explanatory variables and the returns to be explained by the model.

[1] Diakogiannis G. & Segredakis C.: "The effect of systematic risk and firm size on the returns of stocks listed on the Athens Stock Exchange" (1996).

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Section 4 refers to the estimation method of the model and the specification tests applied. Section 5 discusses the empirical results; in section 6 conclusions are summarized and finally suggestions for further research are illustrated in section 7.

In the appendix, all tables including the statistical and econometric results from the time-series regressions, as well as the specification tests' plots are exhibited.

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2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

The asset-pricing model of Sharpe (1964), Lintner (1965) and Mossin (1966), usually referred to as CAPM, has long shaped the way academics and practitioners think about average returns and risk. The central prediction of the model is that the market portfolio of invested wealth is mean-variance efficient in the sense of Markowitz (1959). The efficiency of the market portfolio implies that (a) expected returns on securities are a positive linear function of their market betas (i.e. the slope in the regression of a security's return on the market return) and (b) market betas suffice to describe the cross-section of expected returns.

However, CAPM is based upon several simplifying assumptions, which do not hold in the real world. Several papers have developed new methodologies for testing whether the simple CAPM adequately describes returns, as well for examining whether there exist other factors which best explain expected returns. In particular, it has been found that a number of firm characteristics are related to the excess returns of stocks. The relationship between firm attributes and excess returns is a difficult set of empirical findings to reconcile with the concept of efficient markets. Indeed, these are often referred to as market anomalies, since in an efficient market it should not be possible to earn an excess return on the basis of observable firm characteristics.

One of the most important anomalies with respect to the efficient market hypothesis is the so-called size, or small-firm effect, originally documented by Banz (1981). He found that both total and risk-adjusted rates of return tend to fall with increases in the relative size of the firm, as measured by the market value of the firm's outstanding equity. Later studies showed that the small-firm effects occurs virtually entirely in January, in fact, in the first two weeks of January, thus concluding that the size effect is a "small-firm-in-January" effect.

Another significant irregularity observed when examining the cross-average returns of stocks is the book-to-market equity effect. Fama and French (1991) and Reinganum (1988) show that a very powerful predictor of returns across securities is the ratio of the book value of the firm's equity to the market value of its equity. The reliance of returns on this ratio is independent of beta, suggesting either that low-ratio firms are relatively underpriced or that the book-to-market equity is serving as a proxy for a risk factor that affects equilibrium expected returns.

A large number of papers have attempted to explain the existence of the aforesaid "phenomena". Some of these papers are presented in the following paragraphs of this section. Table 1, at the end of the section, depicts the most noteworthy empirical studies in the aforementioned area.

Basu (1983) analyzed the empirical tests of Banz (1981) and Reinganum (1981a) about the size effect on average returns using a different sample period and a different procedure for creating portfolios of stocks ranked on both size and earnings/price ratio. Basu utilized a variety of procedures to control for risk and found that returns to stocks of firms with low market value are riskier than stocks of large capitalization firms. In one of his tests, Basu sorted stocks into portfolios with different E/P ratios but similar market value and concluded that high E/P stocks earn statistically significant positive risk-adjusted returns.

On the other hand, when stocks were sorted into portfolios with different market value but similar E/P ratios, Basu found that no significant risk-adjusted returns related to market value for the 1963-1980 period. Thus, it seems that his results contradicted Reinganum's (1981a) conclusion that the size effect subsumes the E/P effect.

Finally, Basu noted that there existed some interaction between size and earnings-per-price ratios in the sense that the magnitude of risk-adjusted returns was largest for small firms with high P/E ratios. Basu postulated that both the E/P effect and size effect probably are an indication of deficiencies in the capital asset pricing model, not a sign of market inefficiency.

Chan and Chen (1991) examined differences in structural characteristics that lead firms of different sizes to react differently to the same economic news. Their view, regarding the issue why small capitalization stocks earn higher mean returns than large capitalization stocks, is that size by itself does not explain the difference in return behavior of large and small firms; neither smallness necessarily implies higher risk. Instead, it is the marginal firm characteristics that elucidate average returns of size-ranked portfolios.

The researchers suggest that small firms are marginal firms in the sense that they are less efficiently run, have higher financial leverage and cash flow problems, and are less likely to survive adverse economic conditions. As a result of these attributes, small firms tend to be riskier than large ones and this risk is not likely to be captured by a market index heavily weighted by large firms.

Chan and Chen, in their approach to explain the return characteristics of small firms, construct two size-matched return indices of marginal firms. The first index is intended to mimic the return behavior of firms that have recently cut their dividends substantially (i.e. firms in distress), and is built by taking the average returns of dividend-decrease firms and subtracting from them the average returns of firms that have not cut dividend payouts, but are strictly smaller in size and have been newly listed on the NYSE during the past 5 years (this is the DIV series). The second index is intended to capture the behavior of firms with high financial leverage and is constructed by taking the return difference between a portfolio of high-leverage firms and a portfolio of low-leverage firms that are strictly smaller in size (this is the LEV series).

Data used is for 1956-1985. The dividend change classification in year t is based on the percentage dividend change of each stock from year t-2 to year t-1. The size classification in year t is based on the market value of equity at the end of year t-1. Each process is updated once every year from 1956 to 1985. The researchers form 20 size portfolios, then classify firms into one of these portfolios arranged in order of increasing size, each containing the same number of securities, and generate 360 non-overlapping monthly rebalanced, equally-weighted rates of return for each portfolio.

In constructing the indices DIV and LEV, Chan and Chen note that the marginal firms are always *bigger* than the control group (i.e. matching portfolio) and also that the concept of marginal firm is capturing the important return fluctuations of small firms relative to large firms over time. Additionally, when subtracting the value-weighted market (i.e. NYSE) index rather than the matching portfolios of smaller firms from the portfolios of dividend-decrease firms and size-leverage firms, in creating DIV and LEV series, the average returns of these series are substantially higher than those of the initial two difference series (i.e. when subtracting the matching portfolios); in any case, these size-matched series exhibit a strong January seasonal (i.e. the return differences are much stronger in January).

Moreover, Chan and Chen measured the risk of each stock (or portfolio) by its sensitivities to the fluctuations of the (a) value-weighted market index, (b) LEV and (c) DIV. For their purpose, they grouped firms that have been on the NYSE for the previous 5 years into five size quintiles, based on their market capitalization as of December of previous year. Within each quintile they estimated the multiple betas for all stocks and then classified the stocks according to their estimated LEV-β and DIV-β, thus forming three equally-weighted portfolios: the first one consisting of stocks with high LEV-β and high DIV-β, the second one consisting of stocks with low LEV-β and low DIV-β and the third one containing all the remaining stocks. What they found is that within each size quintile they were able to create portfolios that mimic the difference between relatively risky and relatively safe firms.

Finally, by regressing the 20 size portfolios' returns on the value-weighted NYSE index, the size-matched index mimicking the leverage effect (LEV) and the size-matched index mimicking the marginal firms with dividend decrease (DIV), they postulated that the aggregate market affects firms of every size, but the differential responses of small and large firms can be captured much well by their size-matched portfolios DIV and LEV. Since both DIV and LEV are positively correlated with the value-weighted market, the aforementioned observation is also suggestive of why smaller firms have higher market betas in univariate regressions.

Fama and French (1992) attempted to evaluate the joint roles of market β, size, E/P ratio, leverage and book-to-market equity in the cross section of average returns on NYSE, AMEX and NASDAQ stocks for the 1963-1990 period. Their motive was the fact that the central prediction of the asset-pricing model of Sharpe, Lintner and Black (SLB), that average stock returns are positively related to market β, had exhibited several empirical contradictions: Banz (1981) documented a strong negative relation between average return and firm size. Bhandari (1988) found that average return is positively associated to leverage, and Basu (1983) showed that earnings-per-share ratio (E/P) helps explain the cross-section of stock returns; E/P is higher for stocks with higher risks and expected returns. Finally, Stattman (1980) and Rosenberg, Reid and Lanstein (1985) provided evidence that the relation between average returns and book-to-market equity for US stocks is positive.

Fama and French first examine the relations between average return and β and between average return and firm size; furthermore, they evaluate the roles of E/P, leverage and book-to-market equity (BE/ME) in average returns. For their purpose, they form a sample of non-financial listed firms and use income-statement and balance-sheet data maintained by CRSP, and monthly returns for all NYSE, AMEX and NASDAQ stocks from July 1963 to December 1990. To ensure that the accounting variables are known before the returns they are used to explain, Fama and French match these accounting data for all fiscal yearends in calendar year t-1 (1962-1989) with the returns for July of year t to June of t+1. They utilize a firm's market equity at the end of December of year t-1 to compute its book-to-market, leverage and earnings-price ratios for t-1, and its market equity for June of year t to measure its size.

In June of each year, all NYSE stocks are sorted by size (ME) to determine the NYSE decile breakpoints for size and then, NYSE, AMEX and NASDAQ stocks are allocated to 10 size portfolios based on the NYSE breakpoints. Fama and French form portfolios on size because of the evidence of Chan and Chen (1988) and others that size produces a wide range of average returns and βs. However, the βs of size portfolios are almost perfectly correlated with size (-0.988 in their data), so tests on size portfolios are unable to disentangle β and size effects in average returns. In order to surpass this obvious problem, Fama and French subdivide each size decile into 10 portfolios on the basis of pre-ranking βs for individual stocks, thus allowing for variation in β that is unrelated to size. After assigning firms to the size-β portfolios in June, they calculate the equal-weighted monthly returns on the portfolios for the next twelve months, from July of year t to June of year t+1. Portfolios are formed yearly. In the end, they have post-ranking monthly returns for July 1963 to December 1990 on 100 portfolios formed on size and pre-ranking βs. Betas (βs) are estimated as the sum of the slopes in the regression of monthly returns on the current and prior month's returns on the value-weighted portfolio of NYSE, AMEX and NASDAQ stocks.

For their asset-pricing tests, the researchers utilized the cross-sectional regression approach of Fama and MacBeth (1973), that is, the cross-section of stock returns is regressed on variables hypothesized to explain average returns, and found a strong relation between average returns and size, but no relation between average returns and β. More specifically, when portfolios are constructed on size alone, they observe the familiar strong negative relation between size and average returns (Banz (1981)) and a strong positive relation between average returns and β, as predicted by the Sharpe, Lintner and Black (SLB) model. However, portfolios formed on the basis of the ranked market βs of stocks do not support the SLB model. There is little spread in average returns across the β portfolios and thus, no reliable relation between β and average returns seems to exist. Concisely, the proper inference -confirmed by Fama-MacBeth regressions- is that size and average return are strongly associated, but controlling for size, there is no relation between β and average return-even when beta is the only explanatory variable.

Moreover, Fama and French followed the same methodology for constructing portfolios on the basis of ranked values of book-to-market equity (BE/ME) or earnings-price (E/P) ratio for all stocks, as for the size and β portfolios. After allocating firms to each portfolio according to the aforementioned breakpoints, they calculated each portfolio's monthly equal-weighted return for July of year t to June of year t+1, and then reform the portfolios at the end of year t. They, also, include leverage variables, apart from BE/ME or E/P, the ratio of book assets to market equity (A/ME) and the ratio of book assets to book equity (A/BE), and utilize them in combination with size, BE/ME and E/P in the Fama-MacBeth regressions in order to evaluate their roles in explaining average returns of stocks during the 1963-1990 period.

The more striking evidence stemming from Fama and French tests is the strong positive relation between average return and book-to-market equity; this strong relation is unlikely to be a β effect in disguise, since post-ranking market βs vary little across portfolios formed on ranked values of BE/ME. When both size and book-to-market equity are included in the FM regressions, they explain impressively the cross-section of average returns. As to the E/P ratio, it demonstrates a U-shape relation with average return: average returns decline for the negative E/P portfolio and for portfolios that have very low but positive E/P, and then increase monotonically for the highest E/P portfolios. The results suggest that most of the relation between positive E/P and average return is due to the positive correlation between E/P and BE/ME. Regarding the FM regressions of returns on the natural logarithms of the leverage variables, ln(A/BE) and ln(A/ME), they resulted in that these two variables are related to average returns, but with opposite signs: as in Bhandari (1988) higher market leverage is associated with higher average returns,

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though higher book leverage is associated with lower average returns. Therefore, it is the difference between market and book leverage that plays a significant role in explaining average returns; but this difference is book-to-market equity. Fama and French suggested that BE/ME may capture the relative-distress effect postulated by Chan and Chen (1991), and this effect can be interpreted as a leverage effect, which is encapsulated by the difference between A/ME and A/BE.

Furthermore, the researchers split the overall period into two equal subperiods (July 1963-December 1976 and January 1977-December 1990) and ran monthly FM cross-sectional regressions of returns on (a) size and BE/ME and (b) β, size and BE/ME. The subperiod results support the conclusion that, among the variables considered, book-to-market equity is consistently the most powerful for explicating the average stock returns, since the positive relation between BE/ME and average returns is strong throughout the year. On the other hand, there is a hint that the size effect is weaker in the 1977-1990 period, though it remains a strong explanatory variable of average stock returns.

Moreover, the researchers found that there exists a January seasonal in the book-to-market equity effect, but the positive relation between BE/ME and average return is strong throughout the year.

The final message from the average FM regressions for the 1963-1990 period is that β seem to lack power in explaining the cross-section of average stock returns, and that the combination of size and BE/ME seems to absorb the roles of leverage and E/P in average stock returns, at least during 1963-1990 sample period.

In another paper **Fama and French (1993)**, extending the asset-pricing tests in their previous work, studied the common risk factors in stock and bond returns and tested whether these shared risks capture the cross-section of average returns. They identified that there are at least five common factors in returns: three stock-market factors, that is an overall market factor and factors related to firm size and book-to-market equity, and two bond-market factors, related to maturity and default risks. Further, they attempted to examine whether variables that are important in bond returns help to explain stock returns, and vice versa.

In order to test their assumptions, Fama and French did not follow the cross-section regressions of Fama and MacBeth (1973); instead they utilized the time-series regression approach of Black, Jensen and Scholes (1972). Monthly returns on stocks and bonds are regressed on the returns to a market portfolio of stocks and mimicking portfolios for size, book-to-market equity and term-structure risk factors in returns. The time-series regressions use excess returns (monthly stock or bond returns minus the one-month Treasury bill rate) as dependent variables and either excess returns on zero-investment portfolios as explanatory variables. The regression slopes constitute factor loadings that, unlike size or book-to-market equity, have a clear interpretation as risk-factor sensitivities for bonds, as well as for stocks.

For stocks, the explanatory variables of the regression model are two portfolios meant to mimic the risk factors in returns related to size and to book-to-market equity respectively, as well as the market portfolio. The first portfolio, SMB, is the difference, each month, between the simple average of returns on small-and-big-stock portfolios with about the same weighted-average BE/ME, and the second portfolio, HML, constitutes the difference, each month, between the returns on high-and-low book-to-market equity portfolios with about the same weighted-average size. As to the proxy for the market factor in stock returns, is the excess return of the market portfolio over the one-month Treasury bill rate.

As for bonds, the explanatory variables of the regression model are two portfolios: the first one, TERM, proxies for the variation of long-term bond returns due to unexpected shifts in interest rates, and is the difference between the monthly long-term government bond return and the one-month Treasury bill rate. The second one, DEF, reflects the likelihood of default due to shifts in economic conditions, and is the difference between the return on a market portfolio of long-term corporate bonds and the long-term government bond return.

The two factor-mimicking portfolios for stocks described above, are constructed as follows: in June of each year t from 1963 to 1991, all NYSE stocks are ranked on size (stock price times shares outstanding), and then the median NYSE size is used to segment NYSE, AMEX and NASDAQ stocks into two groups, small and big. The sample stocks are also split into three book-to-market equity groups -low, medium and high- based on the breakpoints for the bottom, middle and top ranked values of BE/ME for NYSE stocks. In this way, Fama and French construct six portfolios from the intersection of the two ME and the three BE/ME groups, and calculate monthly value- weighted returns from July of year t to June of year t+1. Then, they take the differences, each month, between the simple average returns on size portfolios having about the same book-to-market equity, and between the simple average returns on BE/ME portfolios with about the same size, and thus form the two mimicking portfolios, SMB and HML, used as explanatory variables.

Moreover, the researchers use 25 stock portfolios formed on the basis of size (ME) and book-to-market equity (BE/ME) and seven bond portfolios, two for government bonds and five for corporate bonds, as dependent variables in the time-series regressions. The 25 stock portfolios are constructed much like the six size-BE/ME portfolios: in June of each year t from 1963 to 1991, all NYSE stocks are ranked on size and book-to-market equity independently, and then NYSE breakpoints are used to allocate NYSE, AMEX and NASDAQ stocks to five size quintiles and five BE/ME quintiles respectively. In BE/ME, book common equity is for the fiscal year ending in calendar year t-1, and market equity is for the end of December of t-1. Consequently, the 25 portfolios are formed at the intersections of the five size and the five BE/ME groups. Value-weighted monthly percent returns are calculated from July of year t to June of t+1 and the excess returns on these portfolios for July 1963 to December 1991 are used as the dependent variables.

Fama and French in their approach associate size and book-to-market equity with economic fundamentals; they conjecture that small firms and firms that have high book-to market equity (i.e. low stock price relative to book value) tend to have low earnings on assets, and conversely, big firms and firms with low BE/ME (high stock price relative to book value) are likely to exhibit persistently high earnings. Hence, the relative profitability and earnings depression constitute the source of a common risk factor in returns that might explain the positive relation between BE/ME and average returns and the negative relation between size and average returns respectively.

The 25 stock portfolios formed on size and BE/ME equity confirm the Fama and French (1992a) evidence about the relation of these two attributes independently with the average stock returns: in all but the lowest-BE/ME quintile, average returns tend to decrease from the small- to the big-size portfolios. Additionally, in every size quintile, average returns tend to increase with book-to-market equity ratio. As to the bond portfolios, the cross-section of average returns are puny; there is little evidence that (a) average returns in government bonds increase with maturity, (b) long-term corporate bonds have higher average returns that government bonds and (c) average returns on corporate bonds are higher for low-rating groups.

Examining separately the explanatory power of bond-market and stock-market factors, Fama and French first find that TERM and DEF variables capture common variation in stock and bond returns, but for stocks and low-grade bonds a great part of shared variation is left to be explained by stock-market factors. In fact, the excess return on the market portfolio of stocks encapsulates more common variation in stock returns than the term-structure factors, and also captures shared variation in bond returns. On the other hand, in the absence of competition from the market portfolio, SMB and HML typically incorporate substantial time-series variation in stock returns, but have little power to predict bond returns. When the three stock-market factors are included in the regressions, they capture strong common variation in stock returns; besides, these factors play an important role in explaining variation in bond returns.

and this apparent role stems from the covariation between term-structure and stock-market factors.

The researchers also perform joint tests on the stock- and bond-market factors, showing that, used together to explain returns, these factors continue to have a prominent role in stock returns and bond returns respectively. They observe that in the five-factor regressions for stocks, only the low-grade bond portfolio produce nontrivial slopes on the stock-market factors. In short, they argue that stock returns share three stock market factors and the links between stock and bond returns come largely from two shared term-structure factors.

Furthermore, Fama and French tested for January seasonals in the residuals from the five-factor regressions and discovered that they indeed exist in excess returns of both stocks and bonds.

Finally, the researchers aiming to check their inferences about the role of size and book-to-market risk factors in returns examined whether these variables explicate the returns on portfolios formed on other variables known to be informative about average returns, that is earnings-per-price (E/P) and dividend-per-price (D/P) ratios. They concluded that both E/P and D/P portfolios consist an interesting corroboration of their conjectures that there are common risk factors in stock returns related to size and BE/ME and that the mimicking returns for market, size and book-to-market equity capture the cross-section of average stock returns.

In a recent article **Fama and French (1995)**, recognising the lack of an economic justification of their earlier factor models, first investigated the relationship of earnings with the return of a market factor and the returns on two portfolios constructed to represent the size factor in earnings and the book equity to market equity factor in earnings, respectively. Second, they examined whether these three factors influence stock returns.

Their work was guided by two hypotheses: if the average return relations are due to rational pricing then (a) there must be common risk factors in returns associated with size and book-to-market equity (BE/ME), and (b) the size and BE/ME patterns in returns must be explained by the behavior of earnings. The authors used the time-series regression approach, as they did in their previous research in 1993, where they showed that size and BE/ME proxy for sensitivity to risk factors that capture strong common variation in stock returns and help explain the cross-section of average returns.

That is, they focused on six portfolios, formed yearly from a simple sort of firms into two groups on size and another simple sort into three groups on book-to-market equity. The dependent variables in the regressions were the value-weighted excess returns on the six size-BE/ME portfolios, calculated from July of year t to June of year t+1 for the 1963-1992 period. The explanatory variables were the excess return on the value-weighted market portfolio and the returns SMB and HML on the portfolios Fama and French (1993) utilized to mimic the risk factors in returns related to the aforementioned firm attributes.

In view of their first task, they found that size and book-to-market equity are related to profitability. More specifically, firms with high book-to-market equity (a low stock price relative to book value) tend to be persistently distressed and are associated with sustained low earnings on book equity. On the other hand, low book-to-market equity (a high stock price relative to book value) is related with sustained high earnings. In fact, firms having this characteristic are on average more profitable than high-BE/ME firms for four years before and at least five years after portfolio formation. Nevertheless, their profitability improves prior to portfolio sorting and deteriorates a bit thereafter. The reverse pattern of decline and then improvement in earnings is observed for high-BE/ME stocks.

Additionally, controlling for BE/ME, small stocks tend to have lower ratios of earnings to book equity than do big stocks. Fama and French argued that the size effect in earnings is, however, largely due to the low profits of small stocks after 1980; prior to this year, they inferred no significant relation between size and profitability.

In relation to their second objective, i.e. their goal to document that the common variation in returns is driven by the common factors in earnings, the evidence they provided is partially successful. Indeed, they found that the market and size factor in earnings determines the market and size factors in returns. Unfortunately, their results show that the book-to-market equity factor in earnings does not influence stock returns. Fama and French offered a possible explanation for this conclusion; they stated that their final result might be due to measurement errors in variables.

Daniel and Titman (1997) attempted to analyze whether the return patterns of characteristic-sorted stock portfolios (i.e. size and book-to-market equity) are really consistent with a factor model. More specifically, they studied the existence of: (a) pervasive factors that are directly associated with the aforementioned firm attributes, and (b) risk premia related to these factors, practically testing whether the high returns of high book-to-market and small size stocks can be attributed to their factor loadings.

Following the methodology that Fama and French (1993) used for the portfolio sorting according to size and (independently) to book-to-market equity, as well as for factor portfolios' formation, the researchers found that there is no evidence of a separate factor associated with high or low book-to-market (characteristic) firms, i.e. distress factor. This means that most of the co-movement of high BE/ME stocks is not due to distressed stocks being exposed to this specific risk, but rather, because stocks with similar factor sensitivities tend to have similar properties.

Second, they showed that it is the firm characteristics rather than factor loadings in the regression model that determine expected stock returns. Their analysis to this direction indicated that factor loadings do not explain the high returns related to small and high book-to-market stocks beyond the extent to which they act as proxies for these attributes. Further, their tests showed that, with equities, the market beta has no explanatory power for returns even after controlling for size and book-to-market ratios.

In general, the results of Daniel and Titman are disturbing in that, like Fama and French (1993), they suggested that traditional measures of risk (like the market beta mentioned above) do not explain the cross-sectional variation in expected returns. Yet, the researchers conjectured that variables, which reliably predict the future covariance structure do not predict future returns. In fact, high book-to-market stocks and stocks with low capitalization have high average returns whether or not they have the returns patterns (i.e. covariances) of other small and high BE/ME stocks. Similarly, after controlling for the two attributes in question, a common share that "acts like" a bond (i.e. has a low market beta) has the same expected return as other common shares with high market betas.

Asgharian and Hansson (2000) investigated the ability of factor mimicking portfolios both as determinants of common variation in returns and as portfolios explaining expected returns in a multifactor equilibrium model. Their analysis of the factor mimicking portfolios' role is applied on Swedish stock market for the period 1980 to 1997, and is first performed for individual assets, and then for industrial portfolios as well as for portfolios sorted according to a number of different attributes.

The researchers chose variables that are important for an open economy, like the Swedish one, and divided them in four categories: *market factors* that include both the world market and the Swedish home market, *fundamental factors* that comprise firm characteristics like size, book-to-market equity, leverage and earnings-per-price ratio, *technical factors* that refer to past returns with different lags and *macroeconomic factors* like the exchange rate, the maturity premium, the slope of the yield curve and so on.

They sorted stocks on the basis of their value for the fundamental and technical factors, and for the remaining ones they estimated the loading for each firm on each of the factors and then ranked stocks by their factor loadings. The loading is estimated by regressing the excess return of the stock on the value of the factor, using the most recent 36 months historical observations before the portfolio formation month; excess returns on the world market as well as on the Swedish market portfolio are included in the regression.

For each factor, the researchers utilized stocks in the first/last quartile to form portfolio with low/high loading on that factor. Factor mimicking portfolio is constructed by taking a long position in the portfolio with high loading and a short position in the portfolio with low loading on that factor (HML). To compute the monthly returns of the high-loading and low-loading portfolios, they weighted all stocks equally in each portfolio. As to the fundamentals they used the value from the end of December of year t-1 to form mimicking portfolios for July of year t to June of year t+1. For other factors they updated the portfolio each month.

Asgharian and Hansson begun with an analysis of the sensitivities of the individual assets towards the imitating portfolios. For this purpose, they run a regression for each asset on the market indices[2] and one portfolio at a time. The result showed that for individual assets the market portfolio betas are positive for almost all assets. However, for the other factors the betas are both positive and negative. When they substituted portfolios imitating the market for the market indices some assets had negative betas and the average betas were reduced substantially.

[2] The market indices are represented by the world market index and the part of the Swedish value-weighted index that is orthogonal to the former index.

On a portfolio level they started by estimating ten industrial portfolios, and later on portfolios sorted in accordance with the loadings of the firms on different background variables. They first tested the market model, and also analyzed the covariance matrix of the residuals from the multifactor model. The results indicated that the aforementioned model including all factors was not sufficient for explaining covariation in returns. To ascertain that the rejection of the model for industrial portfolios is not the effect of an "unfortunate" sorting, they examined the market model for portfolios sorted on the basis of several different attributes. The most striking finding was that this simple specification was only rejected for one single sorting out of sixteen -the sorting according to the lagged return of the previous month was not explained by the market model. This may therefore extract some common traits in the residuals.

After performing their analysis, the authors concluded that there were some missing factors besides the market indices that are important for explaining covariation among stock returns. Mimicking portfolios constructed as zero-investment strategy have a limited ability to mirror expected returns of an arbitrary chosen portfolio. An essential result is that the market portfolio as measured by two market indices, the internal and the external one, is essential for equilibrium pricing.

The table below presents a summary of a literature review, containing the author(s), the year of the research and the variables utilized to explain the cross-section of expected stock returns.

Table

Author (s)/Year	Factor Used
Basu/1977	-Earnings/Price
Ball/1978	-Earnings/Price
Blume/1980	-Dividends/Price
Stattman/1980	-Book Equity/Market Equity
Banz/1981	-Market Equity
Reinganum/1981	-Beta -Earnings/Price -Market Value
Basu/1983	-Earning/Price -Market Value
Cook & Rozeff/1984	-Market Value -Earnings/Price
Rosenberg, Reid & Lanstein/1985	-Book Equity/Market Equity
Banz & Breen 1986	-Market Value, Earnings/Price
Lakonishok & Shapiro/1986	-Beta -Earnings/Price -Market Value
Wilson/1986	-Cash Flow/Price
Bhandari/1988	-Total Assets/Market Equity -Total Assets/Book Equity
Chan & Chen/1988	-Market Equity
Keim/1988	-Earnings/Price
Jaffe, Keim & Westerfield/1989	-Earnings/Price -Market Equity
Ritter & Chopra/1989	-Market Value -Earnings/Price

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Chan & Chen/1991	**-Size** **-Leverage** **-Dividend changes**
Chan, Hamao & Lakonishok/1991	**-Book Equity/Market Equity** **-Earnings/Price** **-Market Equity**
Fama & French/1992	**-Size** **-Book Equity/Market Equity**
Fama & French/1993	**-A Value-Weighted Market Index** **-Size** **-Book Equity/Market Equity**
Fama & French/1995	**-Size** **-Book Equity/Market Equity**
Daniel & Titman/1997	**-Size** **-Book Equity/Market Equity**
Asgharian & Hansson/2000	**- A Value-Weighted Market Index** **- Book Equity/Market Equity** **- Leverage** **- Earnings\price** **- Size** **- Past stock returns** **- Macroeconomic factors**

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3. DATA AND RESEARCH METHODOLOGY

a. Data

The data cover the period from January 1997 to December 2000 and consist of Greek stock returns, which are corrected for dividends, and capital changes like splits etc. The data are collected from the database "Finance". The sample includes 205 firms, whose shares are listed on the Athens Stock Exchange (ASE) for the period under examination. The sample represents a high percentage of the total market value of all shares. All information on accounting data, that is, book common equity, as well as on market capitalization, is also gathered from "Finance". Data concerning the three-month rate of Treasury bills and the general index of ASE, which is used as proxy for the market portfolio, are collected from "Bloomberg" and "Finance" databases, respectively.

A firm to qualify for inclusion in the sample had to satisfy the following criterion: to be traded continuously on the Athens Stock Exchange during the four-year period. This criterion probably introduces a survival bias in the sense that it has only accepted firms in existence for the specific period. However, this is a natural consequence of all studies of this type, working with a time-series data, which has a fixed length.

Moreover, only firms with ordinary common equity were used in the tests; this means that preferred stocks, listed on ASE, were excluded from the sample. In addition, firms that have been acquired by or merged with others were rejected from the sample, for the simple reason that after such transformations the shares of these firms become delisted.

b. Methodology

This paper uses the time-series regression approach of Black, Jensen and Scholes (1972); weekly returns on stock portfolios are regressed on the returns to the market portfolio of stocks, which is proxied by the ASE General Index, and mimicking

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portfolios for size (i.e. market capitalization) and book-to-market equity (BE/ME). Since the sample is quite small -the stocks included are 205 in number- weekly returns are utilized here instead of monthly ones. The time-series regression slopes are factor loadings that, unlike size or BE/ME, have a clear interpretation as risk-factor sensitivities for stocks.

The dependent variables in the time-series regressions are excess returns, that is, weekly stock portfolios returns minus the three-month Treasury bill rate, and the explanatory variables consist of either excess returns on the market portfolio and returns on mimicking portfolios of the aforementioned firm attributes. Although size and BE/ME seem like ad hoc variables for explaining average stock returns, there is reason to expect that they proxy for common risk factors in returns.

c. Explanatory variables

For the construction of the explanatory variables in the time-series regressions, four portfolios are used formed from sorts of stocks on size and book-to-market equity in order to compose portfolios meant to mimic the underlying factors related to these two variables. The construction of factor mimicking portfolios has the advantage, compared to directly using the variables, that these portfolios allow for time series tests where both the independent and the dependent variables are portfolio returns.

In December preceding each year t from 1997 to 2000 -period for which portfolios returns are calculated- that is, in December 1996, 1997, 1998 and 1999, all stocks are ranked on size. The middle 30% of the classified values (about 61 stocks) are then excluded and only two groups are left, small and big (S and B) each containing 72 stocks. We also break stocks into two book-to-market equity groups based on the breakpoints for the bottom 35% (low) and top 35% (high) of the ranked values of this variable (again, the middle 30% is excluded). Book-to-market equity is defined as book common equity for the fiscal year ending in calendar year t-1, divided by market equity at the end of December of t-1. Fiscal year is in December for almost the entire sample of firms. The market equity of a firm for a given year is calculated as the product between the firm's stock price at the end of the fiscal year and the number of its outstanding shares.

Next we construct four portfolios (S/L, S/H, B/L, B/H) from the intersections of the two ME and two BE/ME portfolios (i.e. the S/L portfolio contains the stocks in the small-ME group that have low book-to-market equity ratio). Weekly equally-weighted returns on the four portfolios are calculated from January of year t to December of the same year. We calculate returns beginning in January of year t to be sure that book equity for the previous year is known to investors. The process of return calculation, as described above, is repeated each year for the 1997-2000 period.

Then factor mimicking portfolios are built as follows: the portfolio SMB (small minus big), meant to mimic the risk factor in returns related to size, is the difference each week, between the simple average of the returns on the two small-stock portfolios (S/L, S/H) and the simple average of the returns on the two big-stock portfolios (B/L, B/H). Thus, SMB is the difference between the returns on small- and big-stock portfolios with about the same weighted-average book-to-market equity ratio. This difference should be largely free of the influence of BE/ME, focusing instead on the different return behaviors of small and big stocks.

Accordingly, the portfolio HML (high minus low), meant to mimic the risk factor in returns related to book-to-market equity, constitutes the difference between the simple average of the returns on the two high-BE/ME portfolios (S/H, B/H) and the average of the returns on the two low-BE/ME portfolios (S/L, B/L). The two components of HML are returns on high- and low-BE/ME portfolios having about the same weighted-average size. Then, the difference between the two returns should be largely free of the size factor returns, focusing instead on the dissimilar behaviors of high- and low-BE/ME firms.

Apart from the weekly returns on the SMB and HML portfolios, the third explanatory variable in the times-series regression is the weekly rate of the market portfolio return in excess of the three-month Treasury rate, as aforementioned.

d. Dependent Variables

We use excess returns on four portfolios formed on size and book-to-market equity, as dependent variables in the times-series regressions. The reason for utilizing portfolios constructed this way is because we seek to examine whether mimicking portfolios SMB and LMH capture common factors in stock returns related to size and book-to-market equity. The four size-BE/ME portfolios are built much like the four portfolios discussed earlier. In December of each year t, beginning from December 1996, ASE stocks are sorted by size and independently by book-to-market. For the sorting process, market value of equity ME is measured at the end of December of year t-1, and BE is book equity for the fiscal year ending in calendar year t-1.

We construct the four portfolios from the intersection of the size and BE/ME groups and calculate equally-weighted weekly returns on these portfolios from January of year t to December of the same year. The excess returns on these four portfolios for January 1997 to December 2000 are the dependent variables for stocks in the time-series regressions.

e. Regression Model

The purpose of the thesis is to test whether the factor mimicking portfolios can explain expected stock returns, which are assumed to represent risk premium in an equilibrium model. The model to estimate is:

$$(R_P - R_f)_t = \alpha + b^*(R_m - R_f)_t + c^*(R_{SMB})_t + d^*(R_{HML})_t + e_t$$

where:

$\mathbf{(R_p - R_f)_t}$ represents each time the returns $R_{S/L}$, $R_{B/L}$, $R_{S/H}$ and $R_{B/H}$ in excess of the three-month Treasury bill rate for week t. This means that we have to run four regression equations, using the four variables independently.

$\mathbf{R_{SMB}}$ and $\mathbf{R_{HML}}$ are the returns on factor portfolios SMB and HML respectively for week t.

$\mathbf{a_i}$ is the unexplained expected return of stock portfolios, i.e. the excess return which is not captured by the included factor portfolios. Our null hypothesis is that $a_i = 0$. Rejection of this hypothesis means that at least for one stock portfolio our factor model does not explicate the expected return.

$\mathbf{R_m}$ is the return on the ASE General Index, which proxies for the market portfolio.

$\mathbf{R_f}$ is the three-month Treasury bill rate, representing the risk-free rate of return.
b, c and **d** are the regression coefficients that constitute factor loadings for the time-series regressions.

Finally, $\mathbf{e_t}$ is the stochastic term that reflects all other variables mirroring risk factors in average stock-returns, but which are not included in the regression equation.

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4. METHOD OF ESTIMATION AND SPECIFICATION TESTS

a. Estimation method

The method applied to evaluate the regression equation presented above, and thus to obtain estimates for the specific coefficients, is the *ordinary least squares*. For this purpose we used the Econometric Views (Eviews) program, Version 3.

The regression coefficients measure the marginal contribution of the independent variables to the dependent variable, holding all other variables fixed. If present, the coefficient of the C is the constant or intercept in the regression - it is the base level of the prediction when all of the other independent variables are zero. The other coefficients are interpreted as the slope of the relation between the corresponding independent variable and the dependent variable, assuming all other variables do not change.

Other coefficient results provided by the ordinary least squares (OLS) estimation method, are the estimated standard errors. The standard errors measure the statistical reliability of the coefficient estimates - the larger the standard errors, the more statistical noise in the estimates. If the errors are normally distributed, there are about 2 chances in 3 that the true regression coefficient lies within one standard error of the reported coefficient, and 95 chances out of 100 that it lies within two standard errors.

The t-statistic, which is computed as the ratio of an estimated coefficient to its standard error, is used to test the hypothesis that a coefficient is equal to zero. To interpret the t-statistic, you should examine the probability of observing the t-statistic given that the coefficient is equal to zero.

Another element of the equation output is the probability of drawing a t-statistic as extreme as the one actually observed, under the assumption that the errors are normally distributed, or that the estimated coefficients are asymptotically normally distributed.

This probability is also known as the p-value or the marginal significance level. Given a p-value, you can tell at a glance if you reject or accept the hypothesis that the true coefficient is zero against a two-sided alternative that it differs from zero. For example, if you are performing the test at the 5% significance level, a p-value lower than 0,05 is taken as evidence to reject the null hypothesis of a zero coefficient.

The p-values are computed from a t-distribution with T-k degrees of freedom.

Additionally, the OLS method provides some interesting statistics, which are summarized below:

The *R-squared* (R^2) statistic measures the success of the regression in predicting the values of the dependent variable within the sample. R^2 is the fraction of the variance of the dependent variable explained by the independent variables. The statistic will equal one if the regression fits perfectly, and zero if it fits no better than the simple mean of the dependent variable. It can be negative if the regression does not have an intercept or constant, or if the estimation method is two-stage least squares.

One problem with using R^2 as a measure of goodness of fit is that the R^2 will never decrease as you add more regressors. In the extreme case, you can always obtain an R^2 of one if you include as many independent regressors as there are sample observations.

The *adjusted* R^2, commonly denoted as $\overline{R}^2$, penalizes the R^2 for the addition of regressors, which do not contribute to the explanatory power of the model. The $\overline{R}^2$ is never larger than the R^2, can decrease as you add regressors, and for poorly fitting models, may be negative.

The *standard error of the regression* is a summary measure based on the estimated variance of the residuals. The sum of squared residuals can be used in a variety of statistical calculations.

EViews reports the value of the *log likelihood* function (assuming normally distributed errors) evaluated at the estimated values of the coefficients. Likelihood ratio tests may be conducted by looking at the difference between the log likelihood values of the restricted and unrestricted versions of an equation.

The *Durbin-Watson statistic* measures the serial correlation in the residuals. As a rule of thumb, if the DW is less than 2, there is evidence of positive serial correlation in the residuals. In general, there are better tests for serial correlation, such as the Q-statistic, and the Breusch-Godfrey LM test, both of which are more general tests of serial correlation than the Durbin-Watson test.

The *Akaike Information Criterion (AIC)* is often used in model selection for non-nested alternatives - smaller values of the AIC are preferred. For example, we can choose the length of a lag distribution by choosing the specification with the lowest value of the AIC. The *Schwarz Criterion (SC)* is an alternative to the AIC that imposes a larger penalty for additional coefficients.

The *F-statistic* tests the hypothesis that all of the slope coefficients (excluding the constant, or intercept) in a regression are zero. Under the null hypothesis with normally distributed errors, this statistic has an F-distribution with k-1 numerator degrees of freedom and T-k denominator degrees of freedom. The p-value given just below the F-statistic, denoted Prob(F-statistic), is the marginal significance level of the F-test. If the p-value is less than the significance level we are testing, say 0,05, we reject the null hypothesis that all slope coefficients are equal to zero. For the example above, the p-value is essentially zero, so we reject the null hypothesis that all of the regression coefficients are zero. Note that the F-test is a joint test so that even if all the t-statistics are insignificant, the F-statistic can be highly significant.

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b. Specification tests

Empirical research is usually an interactive process. The process begins with a specification of the relationship to be estimated. Selecting a specification usually involves several choices: the variables to be included, the functional form connecting these variables, and if the data are time series, the dynamic structure of the relationship between the variables. This latter means that, a priori, it is not obvious whether the regression coefficients are fixed or random. Knowledge of this characteristic is important, for it will allow researchers to use the correct specification.

Inevitably, there is uncertainty regarding the appropriateness of this initial specification. Once we estimate our regression equation, EViews provides tools for evaluating the quality of our specification along a number of dimensions. In turn, the results of these tests influence the chosen specification, and the process is repeated.

In this paper, we performed stability tests for the coefficients of the OLS-estimated regression equations by applying the *recursive coefficient estimates* method. This test enables us to track the evolution of estimates for any coefficient as more and more of the sample data are used in the estimation. The view provides a plot of selected coefficients in the equation for all feasible recursive estimations. Also shown are the two standard error bands around the estimated coefficients.

If the coefficient displays significant variation as more data is added to the estimating equation, it is a strong indication of instability. Coefficient plots will sometimes show dramatic jumps as the postulated equation tries to digest a structural break.

In addition, in order to examine whether results obtained by the application of the recursive coefficients estimates method are valid, we performed a *Chow forecast test*. This test estimates the model for a subsample comprised of the first T_1 observations. The estimated model is then used to predict the values of the dependent variable in

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the remaining T_2 data points. A large difference between the actual and predicted values casts doubt on the stability of the estimated relation over the two subsamples. EViews reports two test statistics for the Chow forecast test. The F-statistic s computed as:

$$F = \frac{(\bar{u}'\bar{u} - u'u)/T_2}{u'u/(T_1 - k)},$$

where $\bar{u}'\bar{u}$ is the residual sum of squares when the equation is fitted to all T sample observations, $u'u$ is the residual sum of squares when the equation is fitted to T_1 observations, and k is the number of estimated coefficients. This F-statistic has an exact finite sample F-distribution only if the errors are independent, and identically, normally distributed.

The log likelihood ratio statistic is based on the comparison of the restricted and unrestricted maximum of the (Gaussian) log likelihood function. Both the restricted and unrestricted log likelihood are obtained by estimating the regression using the whole sample. The restricted regression uses the original set of regressors, while the unrestricted regression adds a dummy variable for each forecast point. The LR test statistic has an asymptotic X^2 distribution with degrees of freedom equal to the number of forecast points T_2 under the null hypothesis of no structural change.

In general, such test procedure described above involves the specification of a null hypothesis, which is the hypothesis under test. Output from a test command consists of the sample values of one or more test statistics and their associated probability numbers (p-values). The latter indicate the probability of obtaining a test statistic whose absolute value is greater than or equal to that of the sample statistic if the null hypothesis is true. Thus, low p-values lead to the rejection of the null hypothesis. For example, if a p-value lies between 0.05 and 0.01, the null hypothesis is rejected at the 5 percent but not at the 1 percent level.

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In our case, in order to carry out the Chow test, we partitioned the data into two sub-samples, the one covering the period before the date of April 3rd 1998 and the other referring to the period after this specific date. The first sub-sample includes 65 observations and is used for estimation, while the second one contains the rest 144 observations and is utilized for testing and evaluation.

Using all available sample observations for estimation promotes a search for a specification that best fits that specific data set, but does not allow for testing predictions of the model against data that have not been used in estimating the model. Nor does it allow one to test for parameter constancy, stability and robustness of the estimated relationship. That explains the reason for which we decided to perform the aforementioned test.

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5. EMPIRICAL RESULTS

The objective of the present paper was empirically to determine whether the average returns of common stocks listed in the Athens Stock Exchange (ASE) during the 1997-2000 period are explained by two firm characteristics suggested by financial theory: size and book-to-market equity. In this section we exhibit and interpret the statistical findings derived from the empirical regression model developed in section three. The methodology followed is first introduced by Fama and French (1993) and involves constructing stock portfolios mimicking risk factors related to the two aforementioned variables. The results are obtained by the application of the ordinary least squares method and the recursive coefficients estimates method, and are presented in tables 1 to 9 in the appendix. Especially, tables 6 to 9 represent the graphs of the four regressions coefficients' movement across time.

a. Ordinary Least Squares estimation results

When forming portfolios by stock rankings according to size and independently to book-to-market equity ratio, we observed that these portfolios produce a wide range of average returns during the whole period under investigation. This is not surprising, since one characteristic of the ASE is the perceived fluctuations in stock prices, and thus in returns, sometimes even in intra-day transactions. For instance, the average daily return of the ASE General Index for the third quarter of 1999 was about 0,538 with a volatility of 0,053.

For the year 1999, and specifically from June to September of the same year, the aforementioned portfolios confirm the Fama and French (1992) evidence that there is a strong negative relation between size and average returns, and a positive relation between average return and book-to-market equity. This was due to the fact that during this year investors tilted towards low- and medium-capitalization stocks as well as underpriced stocks, requiring higher returns for the extra risk assumed by investing in firms with such characteristics.

In our time-series regression approach, the average risk premiums for the common factors in returns are just the average values of the explanatory variables. The average value of R_m-R_f (i.e. the average premium per unit of market beta) is 0,57% per week. The average SMB return (the average premium for the size-related factor in returns) is 1,16% per week, which is large from an investment perspective. The book-to-market equity factor HML produces an average premium of 0,96% per week that is also large in both practical and statistical terms. On the whole, high average premiums (i.e. high volatility) imply that the two factors can capture substantial common variation in returns. In fact low means and high standard deviations of the size and BE/ME terms seem to be advantageous for explaining stock returns.

Tables 1 to 5 present separately the estimations of the four regression equations where the dependent variable is the excess return on the portfolio formed by combinations of big- and small- size stocks with high- and low- book equity to market equity stocks. The slopes of the explanatory variables and the R^2 (or $\overline{R}^2$) values are direct evidence on whether different risk factors capture common variation in stock returns. In fact, R^2 values range between 0,849 and 0,928 meaning that the independent variables explain a very large portion of the variances of the dependent variable; the coefficient of determination is the highest (R^2=0,928) for the third equation (table 3) where the dependent variable is the excess return on portfolio formed by small-size and high-book-to-market equity stocks. The adjusted R^2 values are almost identical to the R^2 ones for every single regression equation.

The F-statistic values are quite high for the all estimated equations, a fact that adds to the significance of the performance of our regression model in terms of its explanatory power and in terms of its overall reliability. F's highest value is 877,15 and belongs again to the third equation. It is obvious that for small capitalization and high BE/ME stock portfolios, the size and book-to-market equity factors, SMB and HML, are deemed to play a crucial role in determining average returns.

At this point it must be stressed that the estimation results for the regression of the excess returns of portfolio formed by small-size and high-book-to-market equity stocks (i.e. the third dependent variable) on the three independent variables are consistent with the findings of Tsiritakis (1996): using monthly data about ASE stocks' returns for the 1988-1992 period, he discerned that the size and BE/ME effects are more prominent in the case of the S/H portfolio.

Regarding the regression equations output we observe that the four portfolios produce slopes on SMB that have t-statistic values more than seven, which denotes the statistical significance of our results concerning the size factor. The lowest t-value of the SMB coefficient 7,18, is for the portfolio of big-size and high BE/ME stocks (table 1). Yet, the regression coefficient of the independent variable HML, for the same stock portfolio, has a t-value of 13,30. These findings demonstrate that for stocks of high capitalization, which are underpriced in the market for some reason (i.e. their market price is lower relative to their book value), the book-to-market equity 'effect' plays a prominent part in the formation of returns. This means that investors demand an extra return for investing in underpriced stocks in order to be covered for this pricing risk.

The HML effect is also very important for the portfolio of small-size and high BE/ME stocks (table 3). The t-statistic value for HML slope is 18,26 -the highest of all other t-values for this factor. In addition, SMB produces the highest t-value, 36,34 standard errors from zero. In this case, both the mimicking returns for the size factor and for the book-to-market factor clearly capture strong common variation in stock returns that is missed by the market factor. Actually, the excess market return gives a slope with a t-value of 32,40, a bit lower than the one of the SMB factor. Not surprisingly, investors who buy stocks of low capitalization which are also at a discount, face a double risk: small firms are prone to suffer a long earnings depression that bypasses big firms or less likely to survive adverse economic conditions, and firms with lower stock price relative to book value tend to be poor performers in terms of profits. Consequently, the greater return required when investing in such firms reflects the aforementioned sources of risk.

The book-to-market equity 'effect' seems to play no important role for the portfolio of big-size and low-BE/ME stocks (table 2). In effect, the t-value of coefficient of the HML is only 0,67, implying the statistical insignificance of this variable in the present equation regression. However, the size factor exerts a significant influence on share returns; SMB gives a slope with a t-value of 7,78. Again the market factor has a great power to explain stock returns, since the t-statistic of the market beta is 32,41. These findings indicate that for high-capitalization stocks, which are also overpriced by the market, the size factor absorbs the influence of the book-to-market equity factor on returns. Investors recognize that big firms are good performers and liable to have high earnings. So, they do not have to worry about their investment, rather they expect returns analogous to firm characteristics.

As to the regression of the excess return of the small-size and low-BE/ME stocks' portfolio on Rm-Rf, SMB and HML (table 4), the results demonstrate that the size effect is prevailing on stock returns. Once more, the t-value 32,23 obtained for the SMB slope is statistically significant. However, the HML factor produces a slope that has a negative sign and that is not satisfactorily significant. According to the theoretical relationships predicted by financial theory, we expect that book equity to market equity to be positively associated with share returns. Yet, our findings for this specific regression equation are not in line with theory.

One possible explanation for this output is that investors inclined towards low-capitalization stocks necessitate an extra return on them as mentioned before, for these stocks incorporate a higher risk than the high-capitalization ones. Investors are aware of a possible poor performance of these firms in terms of efficiency and profitability, thus is logical for them to seek for some kind of compensation from the market for this risky investment. This argument justifies the significance of the SMB factor for the returns pattern. On the other hand, in the case that these small-size stocks are traded at a premium -meaning that they are overpriced (i.e. their market price is greater relative to their book value)- investors are benefited from this 'overpricing' in the sense that they will end up with higher profits buying these stocks. Consequently, they are not apt to require an extra return from the market, since they are compensated anyway. This rationale may explain the relation observed between the HML factor and the stock returns.

Another justification may be the fact that low-capitalization stocks that are overpriced by the market, sometimes reach a 'peak' and then revert to their previous return levels. Investors are rational and very much aware of the fact that these stocks cannot obtain high returns forever; hence, prolonged high returns are not justified on the basis of the characteristics of marginal firms.

Firms are marginal in the sense that their prices tend to be more sensitive to changes in the economy, and they are less likely to survive a competitive environment with continuing technological changes; moreover they are prone to become inefficient and to decrease in relative size more easily. As a result, not only do investors require extra return on these stocks, but also they intend to sell them before stock prices begin to follow a declining trend.

Another point that is worth mentioning in our analysis is that regression intercepts are all quite small; they exhibit negative values, and are statistically insignificant. Intercepts close to zero reveal that the four regressions, which use Rm-Rf, SMB and HML to absorb common time-series variation in returns, do a good job in explaining the average of stock returns.

There is an interesting story behind low intercepts obtained by the estimation of the four equations. In the three-factor regressions, the stock portfolios produce slopes on R_m-R_f close to 1 (from 0,946 to 0,963). The average market premium, 0,57% per week, then captures the positive intercepts observed in the regressions of portfolios returns on SMB and HML. In short, the size and book-to-market equity factors can explain the differences in average returns across stocks, but the market factor is needed for an additional reason: to explicate why stock returns are on average above the three-month T-bill rate.

b. Specification tests' results

The main advantage of using time-series analysis is that it enables one to discover dynamic forces affecting the dependent variable in question. The regression coefficients are very important indicators of the influence that explanatory variables exert on the dependent variables.

One assumption that is widely made in applied research about the regression coefficients is stability through time. Yet, it is not obvious from the beginning whether estimators are stable or variable. Knowledge of this is essential, for it will allow us to use the correct specification. In order to find out whether this assumption holds true for our regression model, we applied the recursive coefficient estimation method.

Tables 6 to 9 show the plot of the coefficients of the four regression equations about the zero line. Plus and minus two standard errors are also shown at each point. As it can be shown, the values of the selected coefficients are all inside the standard error bands; this suggests parameter constancy, stability and robustness of the estimated relationship. In particular, the market beta *b* as well as the coefficient *c* of the SMB factor display a switch in their trend on April 3rd 1998: prior to this date *b* and *c* values move downwards reaching their lowest point, while they seem to revert and follow an upward slopping pattern a bit later. This structural change is due to the drachma depreciation occurred at the end of March of 1998.

In the two weeks following drachma depreciation, the ASE General Index closing prices increased by 34,2% as a whole, outstripping the level of 2.000 points for the first time. This excellent performance was due to the capital inflows from foreign institutional investors, since prospective of Greek economy for convergence and accession in the eurozone was quite favourable. In specific, institutional investors

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tilted towards high-capitalization stocks and stocks composing the General Index, as such stocks tend to be a rather safe investment. This tendency justifies the reason for which, that period, the excess market return R_m-R_f in conjunction with the mimicking returns for size SMB exerted a significant impact on average stock returns. This is reflected in the coefficients' rebound in the first days of April, as shown by the graphs.

The recursive residual plots are exhibited in tables 10 to 13. The movement of the regressions' residuals is inside the critical lines, with the exception of only a few outliers observed.

Motivated by the shift observed in the trend of the coefficients *b* and *c*, we performed a Chow forecast test using the date of April 3rd 1998 as the date for the beginning of the forecasting sample. The sub-sample used to estimate the regression model includes the first 65 observations; the estimated model is then used to predict the values of the dependent variable in the remaining 144 data points. In other words, the test re-estimates the equation for the period January 3rd 1997 to April 3rd 1998, and uses the output to compute the prediction errors for the remaining weeks up to December 29th 2000. The results from the test applied for each of the four dependent variables of our regression model are reported at tables 14 to 17.

As it can be shown, the equations' estimates, under Chow forecast test, produce evidence that there has been a structural change in the relationship between the dependent and the explanatory variables, since the values of F-statistic reported by the test are greater than those exhibited in statistical tables. Out of the four regressions run under Chow test, one gives a value of R^2, adjusted for degrees of freedom, equal to 0,63 -i.e. the one using as dependent variable the excess return on portfolio formed by small-size and low book-to-market equity stocks. The rest of them generate higher values of R^2 ranging between 0,80 and 0,90.

In addition, the coefficient of the explanatory variable SMB is statistically significant for those regressions, which use as dependent variable: (a) the excess return on portfolio of small-size and high BE/ME stocks and (b) the excess return on portfolio of small-size and low BE/ME stocks (tables 16 and 17). Accordingly, the HML slope is significantly different from zero for the regressions where the dependent variable is: (a) the excess return on portfolio of big-size and high BE/ME stocks and (b) the excess return on portfolio of small-size and high BE/ME stocks (tables 14 and 16). As to the return on portfolio of big-size and low BE/ME stocks, the only variable that exerts important impact on it is the excess market return (table 15).

If anything, the split-sample regressions show less power to accept the hypothesis that R_m-R_f, SMB and HML capture the cross-section of average stock returns than the full-sample regressions. In other words, the estimated model used to forecast the values of the dependent variable in the remaining data for the period from April 3rd 1998 to December 29th 2000 lack in predictability, as the results here diverge from those obtained by the initial regressions.

6. CONCLUSIONS

In this paper we have been able to study common risk factors in stock returns and test whether these shared risks capture differences in returns among Greek firms quoted on the Athens Stock Exchange. We showed that the market factor itself does not explain in full changes in stock returns; with the addition of book-to-market equity and size mimicking portfolios, the performance of the regression model applied in our analysis has greatly increased in terms of explanatory power and overall reliability.

Table 5 summarizes the estimation results of the regressions equations. It is obvious that the systematic risk of stock portfolios (i.e. the market beta) is statistically significant, but it is not the only risk factor that explains variation in stock returns listed in ASE. The findings of our analysis indicate that firm size and book-to-market equity ratio are associated each one with a common risk factor that might explain the relation between size and book-to-market equity with average return. Specifically, the size and BE/ME effects are prevailing for the portfolio formed by big-size and high book-to-market equity stocks.

It is also shown that, for every BE/ME group the regression coefficients *c* decrease in relation to firm size (i.e. moving from low to high capitalization stocks). Accordingly, for each size group the regression coefficients *d* tend to increase corresponding to the book-to-market equity ratio (i.e. moving from low to high BE/ME stocks). In general, coefficients *c* and *d* are statistically significant, except for the portfolio of big-size and low-BE/ME stocks, where the t-value of the HML slope (*d*) is only 0,674. In addition, in the case of the portfolio of small-size and low-BE/ME stocks the coefficient *d* does not seem to be satisfactorily significant and also produces a negative sign, which is not validated by financial theory.

In a nutshell, the three-factor regressions that use R_m-R_f, SMB and HML as independent variables do surprisingly well in explaining average returns, given the simple way the returns of SMB and HML imitating size and book-to-market equity factors are constructed. The regressions produce intercepts for stocks that are close to zero, even though the two mimicking portfolios surely contain some firm-specific noise as proxies for the risk factors in returns related to size and book-to-market equity. As testimony to the success of the procedure for the formation of SMB and HML, the correlation between the 1997-2000 weekly mimicking returns for the size and book-to-market equity is only –0,152. This implicitly verifies the absence of multicollinearity from our regression model, a problem that times-series data usually pose.

Anyhow, the results found by this study were similar to those found by researchers from other countries. Thus, even though the Athens Stock Exchange is not as efficient as other Stock Exchanges the basic tenets of financial theory appear to be applicable to shares traded in various markets around the world.

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7. SUGGESTIONS FOR FURTHER RESEARCH & APPLICATIONS

a. Suggestions for further research

The results of our analyses suggest that there seem to exist a relation between size and book-to-market effects and average stock returns. This relation is quite strong and persistent, being in consistence with the findings of Fama and French tests (1993), which showed that there are common return factors related to the aforementioned variables that help capture the cross-section of average stock returns in a way consistent with multifactor asset-pricing model. However, there could be a further investigation about whether there is an economic justification behind these two firm attributes and the stock return patterns.

Specifically, it would be interesting to search for an association between the size and book-to-market equity factors in returns and the behavior of the earnings patterns of the firms included in the sample. How the profitability, or growth or other fundamental, could possibly produce common variation in returns associated with size and book-to-market equity that is not picked by the market return, is a noteworthy question for future research.

Yet, the issue of finding the underlying economic state variables that generate common variation in earnings and returns related to size and BE/ME is not free of difficulties. Most candidate state variables (gross national product, consumption, employment) have measurement problems as severe as earnings, so one must pay great attention when using these variables so as to avoid producing unconvincing results on them.

An elaboration of the approach used in the thesis for estimating the size and book equity-to-market equity effects in average stock returns is to use value-weighted returns in excess of the three-month Treasury rates instead of equally-weighted ones. Utilizing value-weighted components results in minimizing variance of firm-specific factors, since return variances are assumed to be negatively related to size. The reason for not calculating value-weighted returns in our analysis is the insufficiency of weekly data about size characteristics provided by "Finance" for the whole period under investigation.

Another issue that is very important to be evaluated is the role of firm betas, used as proxy for the systematic risk, in explaining the average stock returns. The idea is to first form portfolios on sorts of stock betas and then construct factor portfolios mimicking the market (systematic) risk, in a way similar to the one applied in our analysis in order to create portfolios imitating size and book-to-market equity. The purpose of this investigation would be to find whether returns of small-capitalization firms are justified by the higher betas of these firms, since financial theory suggests that small firms incorporate greater risk than big ones.

b. Applications

In principle, our findings can be used in any application that requires estimates of expected stock returns, such as selecting portfolios, evaluating portfolio performance and measuring abnormal returns in event studies. The applications depend on the evidence that the three factors (i.e. excess market return, SMB and HML) provide a good description of the cross-section of average stock returns for the period 1997 to 2000.

If this is the case, the aforementioned factors can be used to guide portfolio selection. The exposures of a candidate portfolio to the three factors can be estimated with a regression of a portfolio's past excess returns on the three explanatory returns. The regression slopes and the historical average premiums for the variables can then be utilized to evaluate the (unconditional) expected return on the portfolio. A similar procedure can be applied to estimate the expected return on a firm's securities, for the purpose of judging its cost of capital.

In addition, the estimation output can be used to assess the performance of a stock portfolio. Specifically, the intercept in the time-series regression of the managed portfolio's excess return on our three explanatory returns is the average abnormal return needed to judge whether a manager can be the market, that is, whether he can use special information to generate average returns greater than those on passive combinations of the mimicking returns for the three risk factors.

Finally, in event studies of the stock-price response to firm-specific information, the residuals from a one-factor regression of the stock's return on a market return are often used to abstract from common variation in returns. Our results suggest that the residuals from three-factor regressions that also use SMB and HML will do a better job isolating the firm-specific components of returns.

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APPENDIX

Πανεπιστήμιο Πειραιώς

Table 1

Regression of excess stock returns (in percent) on the excess market return (Rm-Rf) and the mimicking returns for the size (SMB) and book-to-market equity (HML) factors: January 1997 to December 2000, 209 weeks.

Dependent Variable: Excess return on portfolio formed by big-size and high-book-to-market-equity stocks.

$$R_{BH}(t) - Rf(t) = a + b[Rm(t) - Rf(t)] + cR_{SMB}(t) + dR_{HML}(t) + e(t)$$

Dependent Variable: RBHRF
Method: Least Squares
Date: 03/19/01 Time: 20:24
Sample: 1/03/1997 12/29/2000
Included observations: 209

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001658	0.001738	-0.953439	0.3415
RMRF	0.962508	0.033281	28.92106	0.0000
SMB	0.143313	0.019961	7.179699	0.0000
HML	0.431155	0.032407	13.30453	0.0000

R-squared	0.866979	Mean dependent var	0.009700
Adjusted R-squared	0.865032	S.D. dependent var	0.066310
S.E. of regression	0.024361	Akaike info criterion	-4.572711
Sum squared resid	0.121659	Schwarz criterion	-4.508743
Log likelihood	481.8483	F-statistic	445.3689
Durbin-Watson stat	1.793037	Prob(F-statistic)	0.000000

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Table 2

Regression of excess stock returns (in percent) on the excess market return (Rm-Rf) and the mimicking returns for the size (SMB) and book-to-market equity (HML) factors: January 1997 to December 2000, 209 weeks.

Dependent Variable: Excess returns on portfolio formed by big-size and low-book-to-market-equity stocks

$$R_{BL}(t) - Rf(t) = a + b[Rm(t) - Rf(t)] + cR_{SMB}(t) + dR_{HML}(t) + e(t)$$

Dependent Variable: RBLRF
Method: Least Squares
Date: 03/19/01 Time: 20:24
Sample: 1/03/1997 12/29/2000
Included observations: 209

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002144	0.001525	-1.405818	0.1613
RMRF	0.946078	0.029194	32.40644	0.0000
SMB	0.136307	0.017510	7.784556	0.0000
HML	0.019166	0.028428	0.674208	0.5009

R-squared	0.849366	Mean dependent var	0.005066
Adjusted R-squared	0.847161	S.D. dependent var	0.054662
S.E. of regression	0.021370	Akaike info criterion	-4.834719
Sum squared resid	0.093617	Schwarz criterion	-4.770751
Log likelihood	509.2281	F-statistic	385.3040
Durbin-Watson stat	1.814004	Prob(F-statistic)	0.000000

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Table 3

Regression of excess stock returns (in percent) on the excess market return (Rm-Rf) and the mimicking returns for the size (SMB) and book-to-market equity (HML) factors: January 1997 to December 2000, 209 weeks.

Dependent Variable: Excess returns on portfolio formed by small-size and high-book-to-market-equity stocks

$$R_{SH}(t) - Rf(t) = a + b[Rm(t) - Rf(t)] + cR_{SMB}(t) + dR_{HML}(t) + e(t)$$

Dependent Variable: RSHRF
Method: Least Squares
Date: 03/19/01 Time: 20:25
Sample: 1/03/1997 12/29/2000
Included observations: 209

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002144	0.001525	-1.405596	0.1614
RMRF	0.946038	0.029196	32.40344	0.0000
SMB	0.636338	0.017511	36.33962	0.0000
HML	0.519130	0.028429	18.26061	0.0000

R-squared	0.927727	Mean dependent var	0.015703
Adjusted R-squared	0.926669	S.D. dependent var	0.078919
S.E. of regression	0.021371	Akaike info criterion	-4.834619
Sum squared resid	0.093627	Schwarz criterion	-4.770651
Log likelihood	509.2177	F-statistic	877.1521
Durbin-Watson stat	1.814357	Prob(F-statistic)	0.000000

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Table 4

Regression of excess stock returns (in percent) on the excess market return (Rm-Rf) and the mimicking returns for the size (SMB) and book-to-market equity (HML) factors: January 1997 to December 2000, 209 weeks.

Dependent Variable: Excess returns on portfolio formed by small-size and low-book-to-market-equity stocks

$$R_{SL}(t) - Rf(t) = a + b[Rm(t) - Rf(t)] + cR_{SMB}(t) + dR_{HML}(t) + e(t)$$

Dependent Variable: RSLRF
Method: Least Squares
Date: 03/19/01 Time: 20:26
Sample: 1/03/1997 12/29/2000
Included observations: 209

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001659	0.001739	-0.954005	0.3412
RMRF	0.962570	0.033281	28.92248	0.0000
SMB	0.643320	0.019961	32.22853	0.0000
HML	-0.068786	0.032407	-2.122567	0.0350

R-squared	0.888268	Mean dependent var	0.010697
Adjusted R-squared	0.886633	S.D. dependent var	0.072353
S.E. of regression	0.024361	Akaike info criterion	-4.572680
Sum squared resid	0.121663	Schwarz criterion	-4.508711
Log likelihood	481.8450	F-statistic	543.2502
Durbin-Watson stat	1.792971	Prob(F-statistic)	0.000000

Πανεπιστήμιο Πειραιώς

Table 5

Summary of estimation results of the regression model

$$R_p(t) - Rf(t) = a + b[Rm(t) - Rf(t)] + cR_{SMB}(t) + dR_{HML}(t) + e(t)$$

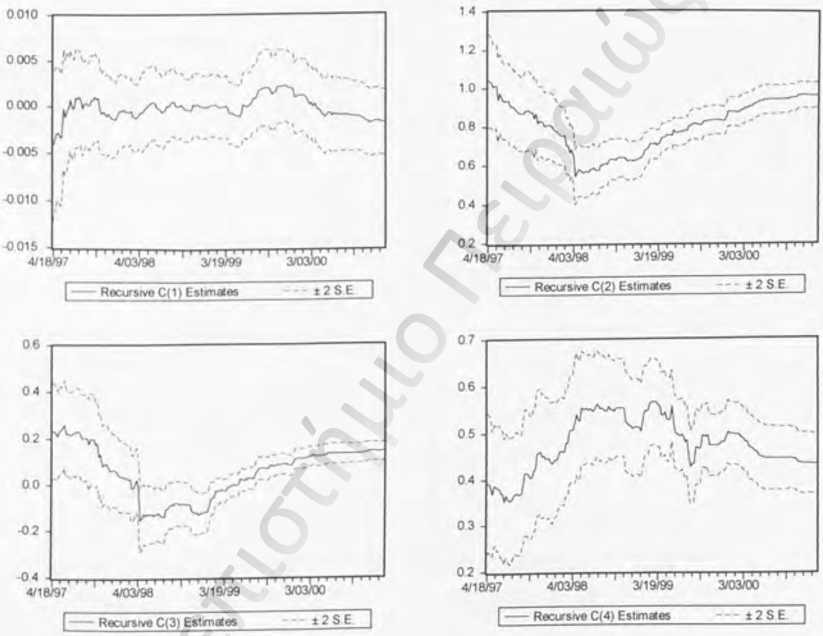
Sample: weekly returns on stocks for the 1997-2000 period

	Book-to-market equity			
Size	high	low	high	low
	a		t(a)	
Small	-0,002144	-0,001659	-1,405596	-0,954005
Big	-0,001658	-0,002144	-0,953439	-1,405818
	b		t(b)	
Small	0,946038	0,962570	32,40344	28,92248
Big	0,962508	0,946078	28,92106	32,40644
	c		t(c)	
Small	0,636338	0,643320	36,33962	32,22853
Big	0,143313	0,136307	7,179699	7,784556
	d		t(d)	
Small	0,519130	-0,068786	18,26061	-2,122567
Big	0,431155	0,019166	13,30453	0,674208
	R^2		R^2 adjusted	
Small	0,927727	0,888268	0,926669	0,886633
Big	0,866979	0,849366	0,865032	0,847161
	F-statistic		D.W.	
Small	877,1521	543,2502	1,814357	1,792971
Big	445,3689	385,3040	1,793037	1,814004

Table 6

Stability Test of Regression Coefficients

Dependent Variable: Excess return on portfolio of stocks with big size and high BE/ME

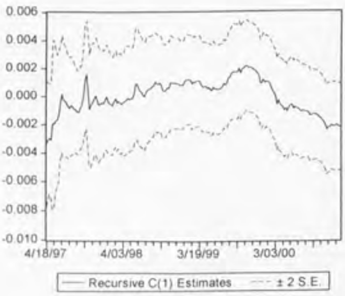


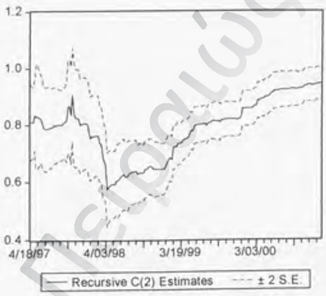
Πανεπιστήμιο Πειραιώς

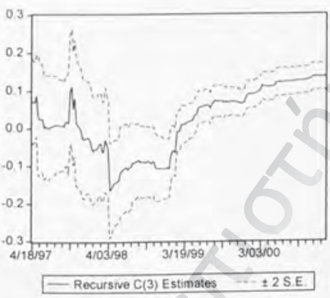
Table 7

Stability Test of Regression Coefficients

Dependent Variable: Excess return on portfolio of stocks with big size and low BE/ME







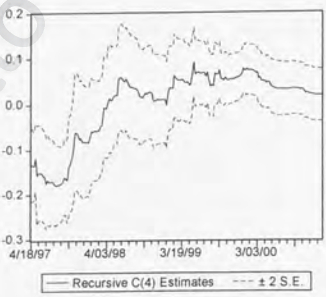


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Table 8

Stability test of Regression Coefficients

Dependent Variable: Excess return on portfolio of stocks with small size and high BE/ME

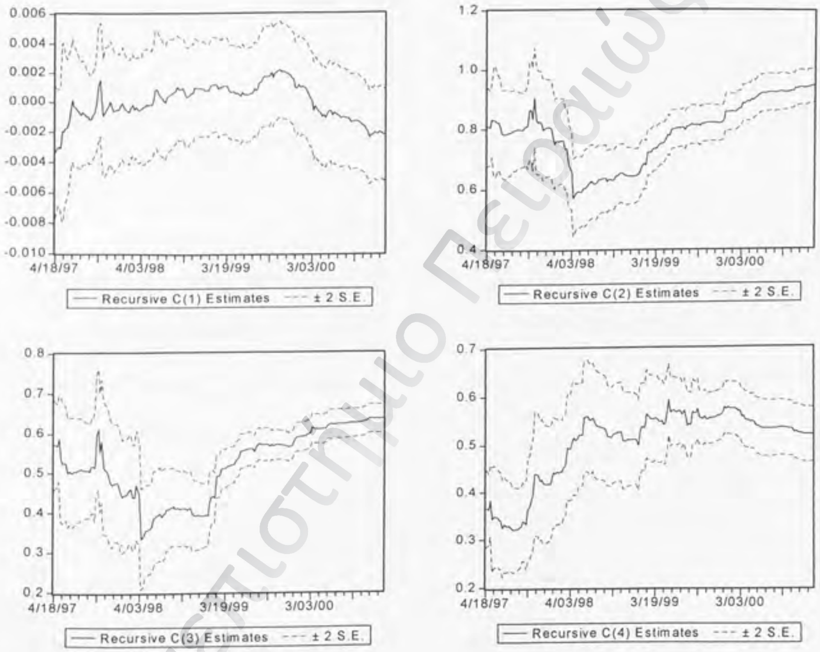

Table 9

Stability test of Regression Coefficients

Dependent Variable: Excess return on portfolio of stocks with small size and low BE/ME

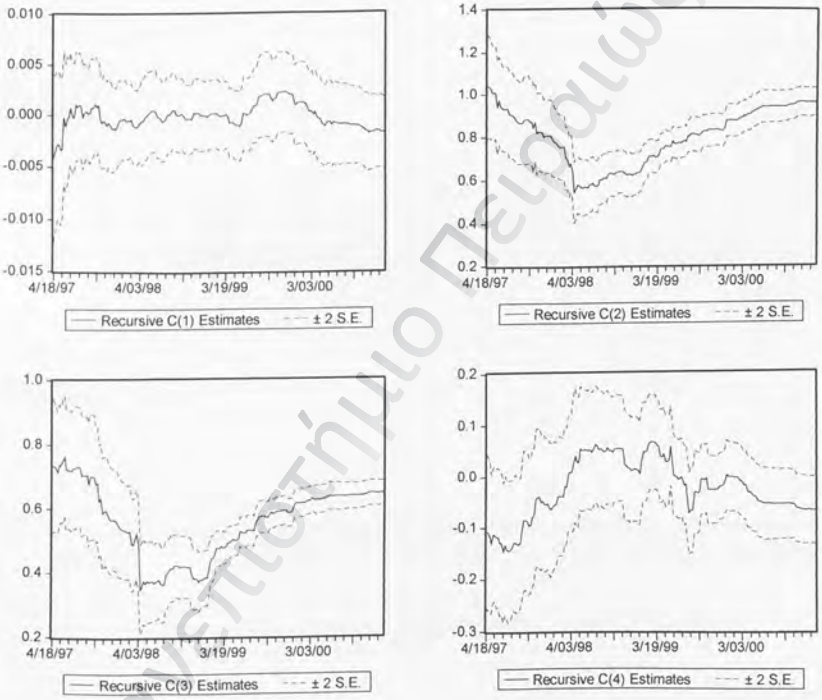

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Table 10

Recursive Residual Plot

Dependent Variable: Excess return on portfolio of stocks with big size and high BE/ME

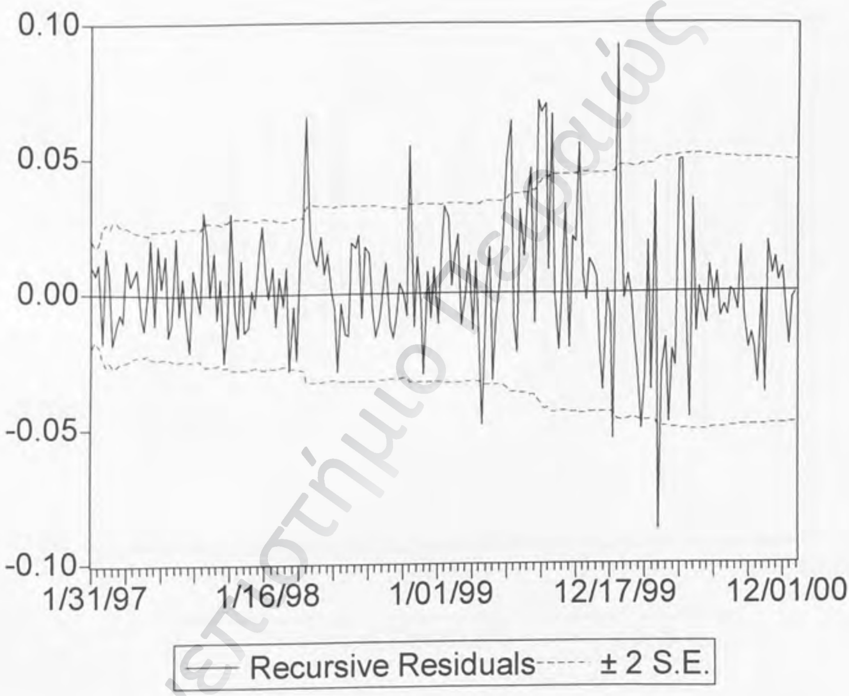

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Table 11

Recursive Residual Plot

Dependent Variable: Excess return on portfolio of stocks with big size and low BE/ME

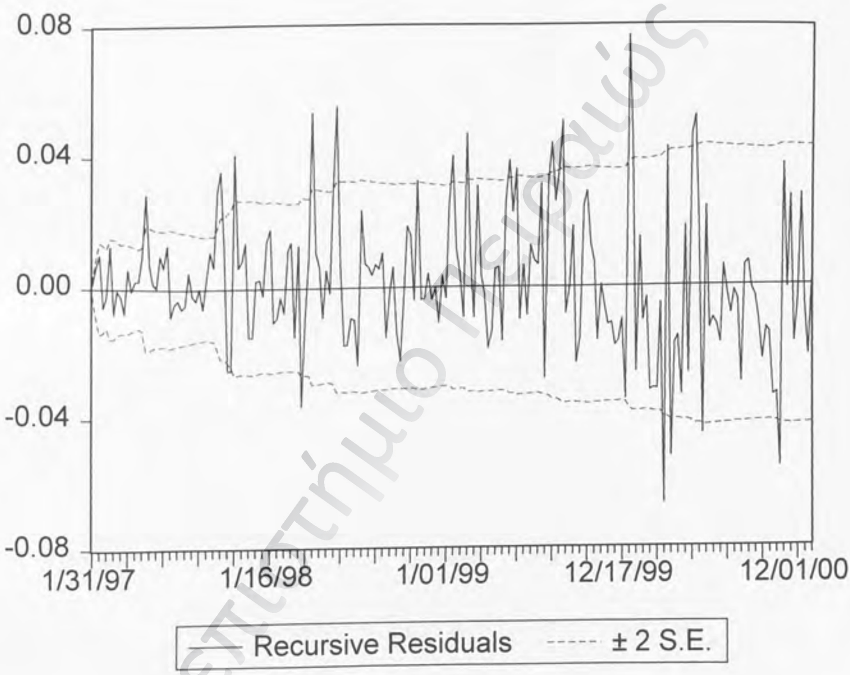

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Table 12

Recursive Residual Plot

Dependent Variable: Excess return on portfolio of stocks with small size and high BE/ME

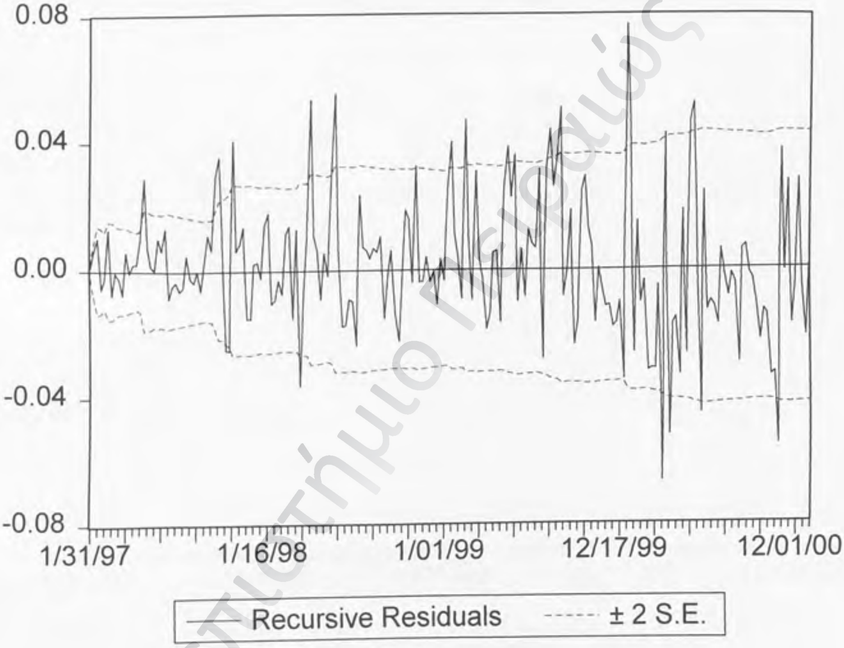

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Table 13

Recursive Residual Plot

Dependent Variable: Excess return on portfolio of stocks with small size and low BE/ME

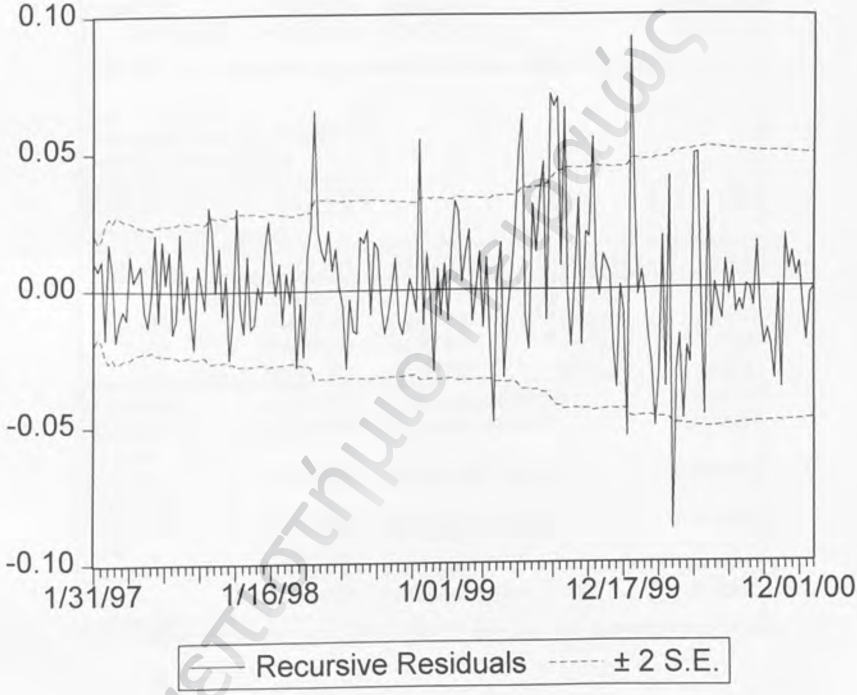

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Table 14

Dependent variable: Excess return on portfolio of stocks with big size and high BE/ME

Chow Forecast Test: Forecast from 4/03/1998 to 12/29/2000

F-statistic	3.851437	Probability	0.000000
Log likelihood ratio	483.1526	Probability	0.000000

Test Equation:
Dependent Variable: RBHRF
Method: Least Squares
Date: 03/26/01 Time: 21:25
Sample: 1/03/1997 3/27/1998
Included observations: 65

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000970	0.001827	-0.531165	0.5972
RMRF	0.681671	0.067741	10.06291	0.0000
SMB	0.020296	0.069925	0.290255	0.7726
HML	0.507445	0.057185	8.873778	0.0000

R-squared	0.902943	Mean dependent var	0.011014
Adjusted R-squared	0.898169	S.D. dependent var	0.044054
S.E. of regression	0.014058	Akaike info criterion	-5.631699
Sum squared resid	0.012055	Schwarz criterion	-5.497891
Log likelihood	187.0302	F-statistic	189.1650
Durbin-Watson stat	2.263083	Prob(F-statistic)	0.000000

Chow Breakpoint Test: 4/03/1998

F-statistic	3.270108	Probability	0.012646
Log likelihood ratio	13.17680	Probability	0.010443

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Table 15

Dependent variable: Excess return on portfolio of stocks with big size and low BE/ME

Chow Forecast Test: Forecast from 4/03/1998 to 12/29/2000				
F-statistic	3.095750	Probability		0.000001
Log likelihood ratio	442.4987	Probability		0.000000

Test Equation:
Dependent Variable: RBLRF
Method: Least Squares
Date: 03/26/01 Time: 21:29
Sample: 1/03/1997 3/27/1998
Included observations: 65

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000519	0.001766	-0.293627	0.7700
RMRF	0.672560	0.065493	10.26917	0.0000
SMB	-0.039533	0.067605	-0.584770	0.5609
HML	-0.007108	0.055287	-0.128562	0.8981
R-squared	0.877625	Mean dependent var		0.007655
Adjusted R-squared	0.871607	S.D. dependent var		0.037931
S.E. of regression	0.013591	Akaike info criterion		-5.699191
Sum squared resid	0.011268	Schwarz criterion		-5.565383
Log likelihood	189.2237	F-statistic		145.8226
Durbin-Watson stat	1.816719	Prob(F-statistic)		0.000000

Chow Breakpoint Test: 4/03/1998			
F-statistic	2.974302	Probability	0.020452
Log likelihood ratio	12.01845	Probability	0.017215

Table 16

Dependent variable: Excess return on portfolio of stocks with small size and high BE/ME

Chow Forecast Test: Forecast from 4/03/1998 to 12/29/2000			
F-statistic	3.097248	Probability	0.000001
Log likelihood ratio	442.5877	Probability	0.000000

Test Equation:
Dependent Variable: RSHRF
Method: Least Squares
Date: 03/26/01 Time: 21:30
Sample: 1/03/1997 3/27/1998
Included observations: 65

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000523	0.001766	-0.295854	0.7683
RMRF	0.672376	0.065482	10.26804	0.0000
SMB	0.460338	0.067594	6.810376	0.0000
HML	0.492514	0.055278	8.909734	0.0000

R-squared	0.802146	Mean dependent var	0.006023
Adjusted R-squared	0.792416	S.D. dependent var	0.029826
S.E. of regression	0.013589	Akaike info criterion	-5.699517
Sum squared resid	0.011265	Schwarz criterion	-5.565709
Log likelihood	189.2343	F-statistic	82.43608
Durbin-Watson stat	1.816261	Prob(F-statistic)	0.000000

Chow Breakpoint Test: 4/03/1998			
F-statistic	2.978495	Probability	0.020313
Log likelihood ratio	12.03491	Probability	0.017094

Table 17

Dependent variable: Excess return on portfolio of stocks with small size and low BE/ME

Chow Forecast Test: Forecast from 4/03/1998 to 12/29/2000				
F-statistic	3.851852	Probability		0.000000
Log likelihood ratio	483.1728	Probability		0.000000
Test Equation: Dependent Variable: RSLRF Method: Least Squares Date: 03/26/01 Time: 21:32 Sample: 1/03/1997 3/27/1998 Included observations: 65				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000970	0.001827	-0.531061	0.5973
RMRF	0.681633	0.067739	10.06268	0.0000
SMB	0.520011	0.069923	7.436933	0.0000
HML	0.007615	0.057183	0.133165	0.8945
R-squared	0.637413	Mean dependent var		0.000818
Adjusted R-squared	0.619581	S.D. dependent var		0.022792
S.E. of regression	0.014057	Akaike info criterion		-5.631765
Sum squared resid	0.012054	Schwarz criterion		-5.497957
Log likelihood	187.0324	F-statistic		35.74523
Durbin-Watson stat	2.260623	Prob(F-statistic)		0.000000

Chow Breakpoint Test: 4/03/1998			
F-statistic	3.265619	Probability	0.012739
Log likelihood ratio	13.15927	Probability	0.010523

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