

**THE CROSS-SECTION OF EXPECTED STOCK RETURNS  
AN EMPIRICAL STUDY IN THE ATHENS STOCK EXCHANGE**

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**ABSTRACT**

This paper explores the ability of the capital asset pricing model, as well as the firm specific factors, to explain the cross-sectional relationship between average stock returns and risk in Athens Stock Exchange (ASE). The objective of this study is to investigate the cross-section of stock returns in the Greek stock market for the period from July 1993 to June 2001. A methodology similar to that of Fama and French (1992) is employed, by taking into account the constraints imposed by a smaller sample both in time and in terms of number of stocks.

Our findings indicate that in the Greek stock market there is not a positive relation between risk, measured by  $\beta$ , and average returns. On the other hand, there is a “size effect” on the cross-sectional variation in average stock returns. Regarding, the “book-to-market effect” we found that when this variable is the only variable in explaining average returns there is a strong positive relation between average returns and book-to-market ratio. But when other explanatory variables were added in the cross-sectional regressions the “book-to-market effect” diminishes a lot.

Key words: CAPM, APT, beta, size, book-to-market ratio.

## 1. INTRODUCTION

The Capital Asset Pricing Model (CAPM) developed by Sharpe (1964), Lintner (1965), and Black (1972) specify that the expected return on a stock is affected by a function of the stock's sensitivity to the overall movements in the market, i.e. its beta coefficient. Empirical tests of the model, generally, supported its main prediction as beta being the only explanatory variable in explaining the cross-sectional variation across portfolios [e.g. Black, Jensen, and Scholes (1972), and Fama and MacBeth (1973)].

The validity of this model has been the subject of remarkable arguments since more recent empirical tests on asset pricing have identified a number of factors that help explain the cross-section of average returns in addition to the market risk factor and typically called anomalies of CAPM. Particularly, firm capitalization [Banz (1981), Keim (1983)], ratio of a firm's book value of common equity [Rosenberg, Reid, and Lanstein (1985)], leverage [Bhandari (1988)], earnings-price ratio [Basu (1983), Ball (1978)], and ratio of book-to-market equity [Fama and French (1992)], are among those variables that are found to have a significant explanatory power in asset pricing tests. In a previous research Chan, Hamao, and Lakonishok (1991) reach the same conclusion on book-to-market equity and Kubota and Takehara (1996) on size and book-to-market equity, in the Japanese market.

Fama and French (1993) suggest, as an alternative to the capital asset pricing model, a three-factor empirical model that can explain most of the empirical anomalies cited in the literature. Daniel and Titman (1997) argue that the three factors in Fama and French (1993) are not priced, hence they cannot be considered as risk factors.

The present research paper is inspired by the empirical test of Fama and French (1992). The area we are going to study is the Athens Stock Exchange during the period of 1993 to 2001. We use a rather similar methodology as Fama and French (1992) and our data collection includes all non-financial firms listed in ASE during the above mentioned time period.

In order to compare their findings with the current study, we summarize the results that Fama and French (1992) found. They practically reject the implications of the traditional capital asset pricing theory because of two reasons. First, they found that betas are not associated with cross-sectional variations of expected stock returns. Second, the ratio of book-to-market equity and size are found to be the most significant variables that can account for the cross-section of expected stock returns.

Thus, they conclude that beta is neither a single relevant risk measure nor a subset of variables in a multivariate specification to explain cross-sectional stock returns' variations of

U.S. firms. Consequently, the empirical evidence supporting the capital asset pricing theory is no longer valid.

The purpose of the present research is to find out whether the empirical tests of Fama and French (1992) have implementation in the Athens Stock Exchange (ASE).

The objective of this study is to investigate the cross-section of stock returns in the ASE. We are primarily interested in finding whether  $\beta$  is significantly related to the average stock returns and whether average returns are related with size and book-to-market equity ratio. These observations and our main interest into the workings of the traditional CAPM per se are the major motivations why we have chosen a research design similar to Fama and French (1992) and rank stocks based on size first and then on  $\beta$  and also construct portfolios based on size and BE/ME for comparison purposes.

The findings of this study are consistent with the results of Fama and French (1992) that there is a “size effect” in the cross-section of average stock returns. Our findings conflict with the predictions of the CAPM that beta is positively related to expected return and that it is the only explanatory variable. We find that  $\beta$  cannot explain the cross-sectional variations of average returns in the ASE. In contrast with the study of Fama and French (1992) we find that there is a “book-to-market effect” only in the case where it is the only explanatory variable in the cross-section of average stock returns. The significance of book-to-market ratio reduces when the influence of the other explanatory variables are added to the model.

The remainder of this paper is organized as follows: section 2 provides a brief theoretical review of the CAPM, section 3 describes the data and the methodology used in this research, section 4 presents the empirical results of our findings, and finally section 5 concludes the paper.

## **2. THEORETICAL LITERATURE REVIEW**

The capital asset pricing model has an extensive history of theoretical and empirical study. Many writers have contributed to development and to improvement of a form explaining the pricing of capital assets under condition of market equilibrium.

The Sharpe (1964)-Lintner (1965) model is the extension of one period mean-variance portfolio models of Markowitz (1959) and Tobin (1958), which sequentially are constructed on the expected utility model of von Nuemann and Morgenstern (1953).

Early work on the Sharpe-Lintner Capital Asset Pricing Model (CAPM) tended to be broadly supportive. The classic studies of Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973), for example, found that high-beta stocks tended to have higher average

returns than low-beta stocks and that the relation was roughly linear. Although the slope of the relation was too flat to be consistent with the Sharpe-Lintner version of the CAPM, this could be explained by borrowing constraints of the sort modeled by Black (1972).

During the 1980s and 1990s, researchers began to look at other characteristics of stocks besides their betas. Several deviations from the CAPM, or "anomalies," were discovered.

First, Banz (1981) reported the *size effect* that small (low-market-value) stocks have higher average excess returns than can be explained by the CAPM. Small stocks do have higher betas and higher average returns than large stocks, but the relation between average return and beta for size-sorted portfolios is steeper than the CAPM security market line. Fama and French (1992) drew further attention to the size effect by sorting stocks by both size and beta and showing that high-beta stocks have no higher returns than low-beta stocks of the same size. There is also a size-related "January effect" documented in empirical research by Keim (1983, 1986), Reinganum (1983), and Roll (1982-1983).

Second, several authors found a *value effect* that returns are predicted by ratios of market value to accounting measures such as earnings, the book value of equity (Basu (1983), Rosenberg, Reid, and Lanstein (1985), Fama and French (1992)), the book-to-market ratio (Lewellen (1999)), the dividend yield or payout ratio (Lamont (1998)), the share of equity in new finance (Nelson (1999), Baker and Wurgler (2000)), yield spreads between long-term and short-term interest rates and between low-and-high-quality bond yields (Campbell (1987), Fama and French (1989), Keim and Stambaugh (1986)), and the level of consumption relative to income and wealth (Lettau and Ludvigson (1999a)).

Third, Jegadeesh and Titman (1993) documented a *momentum effect* that stocks with high returns over the past three to 12 months tend to outperform in the future. This is related to the finding of DeBondt and Thaler (1985) that stocks with low returns over the past three to five years outperform in the future.

Empirically, these anomalies can be described, usually, using multi-factor models in which the factors are chosen either statistically or based on economic theory, or even atheoretically to fit the empirical evidence.

Fama and French (1993) introduced a three-factor model in which the factors include the return on a broad stock index, the excess return on a portfolio of small stocks over a portfolio of large stocks, and the excess return on a portfolio of high book-to-market stocks over a portfolio of low book-to-market stocks. Carhart (1997) augmented the model to include a portfolio of stocks with high returns over the past few months. These models

broadly capture the performance of stock portfolios grouped on these characteristics, with the partial exception of the smallest value stocks.

There is considerable debate about the interpretation of these results. The first and most conservative interpretation is that they are entirely spurious, the result of "data snooping" that has found accidental patterns in historical data (Lo and MacKinlay (1990), White (2000)).

A second view is that the anomalies result from the inability of a broad stock index to proxy for the market portfolio return. Roll (1977) takes the extreme position that the CAPM is actually untestable, because any negative results might be due to errors in the proxy used for the market. In response to this, Stambaugh (1982) has shown that tests of the CAPM are insensitive to the addition of other traded assets to the market proxy, and Shanken (1987) has shown that empirical results can only be reconciled with the CAPM if the correlation of the proxy with the true market is quite low.

Recent research in this area has concentrated on human capital, the present value of claims to future labor income. Because labor income is about two-thirds of U.S. GDP and capital income is only one-third of GDP, it is clearly important to model human capital as a component of wealth. Jagannathan and Wang (1996) argue that labor income growth is a good proxy for the return to human capital and find that the inclusion of this variable as a factor reduces evidence against the CAPM. In a similar thinking, Liew and Vassalou (2000) show that excess returns to value stocks help to forecast GDP growth, and Vassalou (1999) introduces GDP forecast revisions as an additional risk factor in a cross-sectional model.

A third view is that the anomalies provide genuine evidence against the CAPM but not against a broader rational model in which there are multiple risk factors. Fama and French (1993, 1996) have interpreted their three-factor model as evidence for a "distress premium"; small stocks with high book-to-market ratios are firms that have performed poorly and are vulnerable to financial distress (Chan and Chen (1991)), and they command a risk premium for this reason.

Fama and French do not explain why distress risk is priced. Given the high price of distress risk relative to market risk, this question cannot be ignored. In fact MacKinlay (1995) expresses skepticism that any rational model with omitted risk factors can generate sufficiently high prices for those factors to explain the cross-sectional pattern of stock returns.

One possibility is that the distress factor reflects the distinction between a conditional and unconditional asset pricing model. The CAPM may hold conditionally but fail unconditionally. If the risk premium on the market portfolio moves over time, and if the market betas of distressed stocks are particularly high when the market risk premium is high, then distressed stocks will have anomalously high average returns relative to an unconditional CAPM even if they obey a conditional CAPM exactly. Jagannathan and Wang (1996) try to capture this by using a yield spread between low-and high-quality bonds as an additional risk factor proxying for the market risk premium. Cochrane (1996) and Lettau and Ludvigson (1999b) introduce additional risk factors by interacting the market return with the dividend-to-price ratio and long-short yield spread, and a consumption-wealth-income ratio. These approaches reduce deviations from the model, and Lettau and Ludvigson are particularly successful in capturing the value effect. Campbell and Cochrane (2000) take a more theoretical approach, showing that a model with habit formation in utility implies deviations from an unconditional CAPM of the magnitude found in the data even though the CAPM holds conditionally.

Alternatively, the CAPM may fail even as a conditional model, but the data may be described by an intertemporal CAPM of the sort proposed by Merton (1973). In this case additional risk factors may be needed to capture time variation in investment opportunities that are of concern to long-term investors.

A fourth view is that the anomalies do not reflect any type of risk but are "mistakes" that disappear once market participants become aware of them. Keim (1983) pointed out that the small-firm effect was entirely attributable to excess returns on small firms in the month of January. A seasonal excess return of this sort is very hard to relate to risk, and if it is not purely the result of data snooping it should be expected to disappear once it becomes well-known to investors.

The most radical view is that the anomalies reflect enduring psychological biases that lead investors to make irrational forecasts. Lakonishok, Shleifer, and Vishny (1994) argue that investors irrationally extrapolate past earnings growth and thus overvalue companies that have performed well in the past. These companies have low book-to-market ratios and subsequently underperform once their earnings growth disappoints investors. Supporting evidence is provided by La Porta (1996), who shows that earnings forecasts of stock market analysts fit this pattern, and by La Porta *et al.* (1997), who show that the underperformance of stocks with low book-to-market ratios is concentrated on earnings announcement dates. This view has much in common with the previous one and differs only

in predicting that anomalies will remain stable even when they have been widely publicized.

All these views have difficulties explaining the momentum effect. Almost any model in which discount rates vary can generate a value effect: stocks whose discount rates are high, whether for rational or irrational reasons, have low prices, high book-to-market ratios, and high subsequent returns. It is much harder to generate a momentum effect in this way, and Fama and French (1996) do not attempt to give a rational risk-based explanation for the momentum effect. Instead they argue that it may be the result of data snooping or survivorship bias (Kothari, Shanken, and Sloan (1995)). Psychological models also have difficulties in that momentum arises if investors underreact to news. Such underreaction is consistent with evidence for continued high returns after positive earnings announcements (Bernard (1992)), but it is hard to reconcile with the overreaction implied by the value effect.

### **3. RESEARCH METHODOLOGY**

In the previous section an attempt was made to fully cover the theoretical and the empirical literature review concerning the capital asset pricing models. In this chapter we will describe the research methodology used and state the restrictions related to the collection and the analysis of our data. We will, then, proceed to the statistical analysis of the data collected and present the results from our research. This study concerns stocks traded in the Athens Stock Exchange during the time period of 1993-2001.

In the present study we will examine monthly return series for 327 listed Greek non-financial firms. All data used in this study is obtained from the Athens Stock Exchange Data Bank. The sample selection includes all common stocks, which have been listed on the Athens Stock Exchange (ASE) for the period of July 1993 to June 2001 (96 months). These data do not include dividends but is adjusted to stock splits. The accounting variables, market equity and book-to-market ratio, were taken from the PROFILE company, an IT Greek company, which keeps a detailed data bank concerning the ASE and all listed companies.

Initially, we had daily closing prices from ASE return files. The daily returns for each stock were calculated using logarithmic approximation. Then the daily returns were converted into monthly returns.

Although, some researchers like Chan, Hamao, and Lakonishok (1991) used all firms in their sample, including financial and non-financial Japanese firms, in the current study we follow the methodology of Fama and French (1992) faithfully. Thus, financial firms-banks

and insurance companies-are excluded from our sample because the expected high leverage in these firms, does not have the same value as for non-financial firms, where it is a likely indicator of financial distress. We include firms with common equity, but we exclude firms with preferred equity because for these firms we do not have market value.

PROFILE'S files of balance sheet data, use a firm's market equity and book value of equity at the end of December of year  $t-1$  to compute its book-to-market ratio, and use, also, its market equity for June of year  $t$  to measure its size. Thus, to be included in the return tests for July of year  $t$ , a firm must have a stock price for December of year  $t-1$  and June of year  $t$ . It must also have monthly returns for at least 36 months preceding July of year  $t$  (for pre-ranking  $\beta$  estimates, discussed below). In the study of Fama and French (1992), firms with a negative book value of equity are excluded. No firm included in our sample did have negative book value of equity, and therefore it was not necessary to exclude any of these firms.

The variables used in this study are: a)Market value of equity, b)Book-to-market ratio, and c)Book value of equity. The market return used to calculate beta is the monthly continuous return on ASE General Index, while the risk free rate is the monthly rate based on the 90-day Government Treasury Bill rate.

Black, Jensen and Scholes (1972) state that the accuracy of portfolio betas is higher than that of individual securities. They argue that skewness in the underlying return distribution, sampling errors and misspecification will provide a biased estimation. Assigning stocks to portfolios, based on the previous period's estimated beta, can reduce this bias. After regressing the portfolio excess returns on the market portfolio excess returns, the bias left will be insignificantly small.

In the present study, the pre-ranking betas of individual stocks' estimations are based on the 36 previous monthly excess returns on stocks. All the calculations of excess returns, the sorting of portfolios, the time-series and the cross-sectional regressions are made in the Excel. We regress the 36 continuously compounded monthly excess returns of each stock on the 36 monthly excess returns of the ASE General Index. The monthly excess return of the stocks is defined as the difference between the return of the stock and the risk free rate, and the monthly excess return of the ASE General Index is defined as the difference between the return of the market and the risk free rate.

From these regressions we take the 36-month post-ranking  $\beta$ s. We reject the stocks with F-significance higher than 0,05, because these values are not valid and these data might create wrong statistical results. After that we have the stocks of the sampling of each period.

The sorting procedure takes place as follows: In June of each year these stocks of ASE that have also the required data from PROFILE, are allocated into 3 size portfolios. The



portfolio formation according to size is done because of the evidence of Chan and Chen (1988) that size produces a wide spread of average returns and betas. However, using only size portfolios we will have a high correlation between size and  $\beta$ s of the size portfolios (Fama and French, 1992).

For this reason, we follow the methodology proposed by Fama and French (1992) and we further divide the 3 size portfolios into 3 sub-portfolios on the basis of estimated individual  $\beta$ s computed from pre-testing period to allow for variation in beta that is not related to size. Thus, we finally have the creation of 9 portfolios over the 8 years sample period. This grouping processing would give portfolios with reduced estimated errors in  $\beta$  than originally estimated at the individual firm level. Based on these sample portfolios we examine the explanatory power of  $\beta$ , as well as each one of the other financial variables (size, BE/ME ratio), selected in the following way:

Each portfolio is formed every June and is equal-weighted. The equal-weighted monthly returns are estimated for each portfolio for the following year, from July of year  $t$  to June of year  $t+1$ , and the process is repeated for each of the 8 sample periods. More analytically, these 8 sample periods, which are called investigation periods. For these periods we have to estimate the equal-weighted monthly returns. Because we use monthly returns for 36 months preceding the July of year  $t$ , the estimation periods are shaped as follows:

The equal-weighted monthly return is defined as the average of all stocks in each portfolio. Finally, we have post-ranking monthly returns from July 1993 to June 2001 on the 9 portfolios formed according to size and pre-ranking beta.

Thus, constructed portfolios will be regrouped on June of every year, and in this way the continuous monthly observations of ranked portfolios are constructed with a different composition every year.

With the purpose of comparing the results we also construct portfolios according to size alone and to pre-ranking  $\beta$ s alone. When we form portfolios according to one variable only (pre-ranking  $\beta$ s, size, or BE/ME), we create 3 portfolios and the equal-weighted monthly returns are estimated for these portfolios. Further, we divide each of the initial 3 size portfolios into 3 sub-portfolios based on BE/ME ratio to be used as an alternative sample set for comparison purposes. Thus, we create 9 size-BE/ME portfolios. At the end we will compare the results between size-pre-ranking  $\beta$ s portfolios and size-BE/ME portfolios.

## 4. DATA RESULTS

### 4.1. Time-Series Regressions

In the time-series regressions the estimated equal-weighted monthly excess returns for each portfolio are regressed on the market premium (the excess return on the market), which was calculated for the full sample period. From these regressions we take the full-period post-ranking  $\beta$ s of each portfolio. These are the  $\beta$ s that we use in the Fama and MacBeth (1973) cross-sectional regressions later on.

Table II shows post-ranking average returns from July 1993 to June 2001 for portfolios formed according to size alone. Arranging portfolios on size alone (Table II), the post-ranking  $\beta$ s range from 0,88 for the smallest ME portfolio to 0,92 for the largest ME portfolio. This spread of post-ranking  $\beta$ s across the 3 portfolios is smaller than the spread of  $\beta$ s produced by the 9 size and pre-ranking  $\beta$ s portfolios (Table I, Panel B). For example, the post-ranking  $\beta$ s for the 3 portfolios in the smallest size sorting range from 0,82 to 0,94 ( $0,94 - 0,82 = 0,12$ ). Through out all 9 size- $\beta$  portfolios, the post-ranking  $\beta$ s range from 0,82 to 1,08 ( $1,08 - 0,82 = 0,26$ ), a spread larger than the spread obtained from size portfolios alone ( $0,88 - 0,92 = 0,04$ ) in Table II.

When we construct portfolios on size alone (Table II) we cannot say that our tests meet the predictions of Sharpe, Lintner, and Black (1972) —SLB— according to which average returns are positively related to  $\beta$ . In fact, the average returns of the common stocks in ASE are negatively correlated with  $\beta$  and the average values of  $\ln(ME)$  are also negatively correlated with average returns. Only the average values of  $\ln(BE/ME)$  are positively correlated with average returns. Regarding the relation of  $\beta$  and  $\ln(ME)$  we can say that there is a positive correlation between them.

The findings of Banz (1981) that there is size effect on average returns are confirmed by this research. He found that size adds to the explanation of the cross section of average returns provided by  $\beta$ s and that small size firms have high average returns while large size firms have low average returns. Tables II, III, and IV show the time-series averages of the 96 monthly observations for portfolios formed on size alone (ME), pre-ranking  $\beta$ s alone, and BE/ME ratio alone, respectively. The average returns fall from  $-0,43$  for the smallest ME portfolio to  $-2,04$  for the largest one (a spread of 1,61). The return differences in the case of estimated  $\beta$ s between the smallest ( $-0,50$ ) and the largest ( $-2,04$ ) pre- $\beta$ s portfolios are 1,54, while in the case of BE/ME classification the return spread is 0,65 ( $= 1,55 - 0,90$ ). In fact, the two variables, size and estimated  $\beta$ s, are the only ones that generate return differences of more than one percent, while the BE/ME generates only 0,65 percent in return difference.

Another remarkable observation can be found in the relationship between size and estimated  $\beta$ s on portfolios formed on size alone. As we can see from Table II we find that the smaller firms have smaller estimated  $\beta$  values, which is completely opposite to previous findings of Fama and French (1992) on U.S. firms, while there is a rise that is higher when someone looks at the middle portfolio. So, as we have already said, in our investigation the negative relation between  $\beta$  and average return is established.

The portfolios formed on the basis of pre- $\beta$ s (Table III) produce a wider range of  $\beta$ s (from 0,88 for portfolio  $\beta_1$  to 1,02 for portfolio  $\beta_3$ ) than the portfolios formed on size. In the pre-ranking  $\beta$ s portfolios there is a strong negative correlation between  $\beta$  and average returns. Again, a similar tendency can be found by reading through each column from top to bottom: the smaller firms (with smaller  $\ln(\text{ME})$ ) have smaller estimated  $\beta$  values than larger firms.

The only case that we have a strong positive relation between average return and a specific variable is the case of portfolio formation according to BE/ME alone (Table IV). Average return rise from  $-1,55$  for the lowest BE/ME portfolio to  $-0,90$  for the highest, a difference of  $-0,65$  percent per month.

In sum, by this one-way classification scheme, we find that BE/ME do not produce strong and systematic variations in average returns, while size and pre- $\beta$  rankings explain wide variations in cross-sectional returns. However, as size and  $\beta$  are highly associated with, we further rank portfolios by a two-way classification scheme and continue our analysis.

In Table I the portfolios are formed yearly according to size and pre-ranking  $\beta$ s. Average returns are shown in Panel A of Table I, post-ranking  $\beta$ s in Panel B, and the average of size distributions  $-\ln(\text{ME})$ — in Panel C. In any size portfolio (Table I, Panel C), the average values of  $\ln(\text{ME})$ , which are the time-series average of monthly averages of  $\ln(\text{ME})$  for stocks in the portfolio at the end of June of each year, are similar across the  $\beta$ -sorted portfolios. On the other hand, the values of  $\ln(\text{ME})$  are quite different across the size sorting of portfolios.

When we subdivide size portfolios according to pre-ranking  $\beta$ s (Table I), we find a strong negative relation between size and average return in all size portfolios. By reading through the columns in each  $\beta$  classification (Panel A), we find that the size differences from ME1 through ME3 uniformly explain the differences in returns for every  $\beta$  classification from  $\beta_1$  through  $\beta_3$  portfolio. On the other hand, by reading through rows for each size classification horizontally we notice that the differences in pre- $\beta$ s do not necessarily produce uniform differences in average return on these portfolios. Thus, on the basis of these casual observations of the two-way classification portfolios, we could say that cross-sectional behavior of portfolio returns are related to size variables, but not so much so to  $\beta$ s.

Finally, we also constructed another set of 9 portfolios series, as cross-examination sample. Panel A of Table V shows average returns of the two-way classification. Stocks sorted first based on size on 3 portfolios and then each is subdivided into 3 portfolios based ranked values of BE/ME for individual stocks. We proceeded to this classification because this variable showed relative weakness in explaining Greek average returns, as pointed out above, contrary to many previous findings (for example, Fama and French, 1992, for the US stock market, and Kubota and Takehara, 1996, for the Japanese market). When top panels in Table I and V are compared pair wise, the difference is quite remarkable. By reading through every row, one finds that the differences in BE/ME (Table V) produce smaller differences in average returns than  $\beta$  (Table I). For example, for the smallest size portfolio grouping (ME1), between the lowest BE/ME 1 portfolio and the highest BE/ME 3 portfolio (TableV, panel A), the return difference of 0,68 (=0,17-(-0,51)) percent is generated and, similarly, for the largest size portfolio group (ME3), the difference is 1,04 (=1,42-2,46), while the corresponding numbers for size- $\beta$  classified portfolios (Table I, panel A) are 1,22 and 1,42 percent, respectively. Similarly, looking down the columns of the average returns matrix shows a negative relation between average return and size and also negative relation between average return and book-to-market equity.

#### 4.2. Cross-sectional Regressions

In order to estimate the relationship between size, beta, and book-to-market, the Fama-MacBeth (1973) procedure is employed. This involves estimating different specifications of the following full empirical model:

$$R_{it} - R_{ft} = \gamma_{0t} + \gamma_{1t} \beta_{it} + \gamma_{2t} \ln(ME) + \gamma_{3t} \ln(BE / ME) + e_{it}$$

The following six specifications of this model are estimated in order to assess the individual variables explanatory power, as well as its interrelationship with the other variables.

#### Model

1.  $R_i - R_f = \gamma_0 + \gamma_1 \beta_i + e_i$
2.  $R_i - R_f = \gamma_0 + \gamma_2 \ln(ME)_i + e_i$
3.  $R_i - R_f = \gamma_0 + \gamma_3 \ln(BE / ME)_i + e_i$
4.  $R_i - R_f = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \ln(ME)_i + e_i$
5.  $R_i - R_f = \gamma_0 + \gamma_2 \ln(ME)_i + \gamma_3 \ln(BE / ME)_i + e_i$

$$6. R_i - R_f = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \ln(ME)_i + \gamma_3 \ln(BE / ME)_i + e_i$$

where  $\beta_i$  and  $R_f$  are the monthly returns on asset  $i$ , and the risk free rate on month  $t$ , respectively,  $\beta_i$  is the yearly-allocated beta estimated (using monthly data) for stock  $i$ ,  $\ln(ME)$  is the log of the market capitalization.,  $\ln(BE/ME)$  is the log of the book-to-market equity ratio, as used by Fama and French (1992). To ensure that accounting data is known when returns are calculated, from July to June sample period each year, the BE/ME ratio used is that available at December of the previous year,  $e_{it}$  is the residual error term.

The time-series averages of the slopes of these 96 month-by-month cross-sectional regressions are the estimates of the risk premiums associated with these risk factors or firm characteristics. Regressions are not estimated for subperiods of the full eight-year sample period as in the study of Fama and French (1992), due to the small size of the sample period.

### 4.3. Hypotheses

It might be useful to explain the hypotheses that we are testing. Although most conclusions will be extracted from examining the behavior of the coefficients across the six specifications of the model, the general hypotheses, which can be tested from model 6, are listed below.

$$R_i - R_f = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \ln(ME)_i + \gamma_3 \ln(BE / ME)_i + e_i$$

Hypothesis 1  $H_0: \gamma_0 = 0$   $H_1: \gamma_0 \neq 0$

Hypothesis 2  $H_0: \gamma_1 = 0$   $H_1: \gamma_1 > 0$

Hypothesis 3  $H_0: \gamma_2 = 0$   $H_1: \gamma_2 < 0$

Hypothesis 4  $H_0: \gamma_3 = 0$   $H_1: \gamma_3 > 0$

Given that the model is estimated using excess returns, the CAPM would imply that the intercept term should be zero, while the coefficient on beta should be positive, thus hypotheses 1 and 2.  $\gamma_1$  should also be expected to equal the excess return on the market.

Hypotheses 3 and 4 refer to the empirical evidence on the *size* and *book-to-market* effects.

The size effect predicts that  $\gamma_2$  should be negative, while the book-to-market effect predicts that  $\gamma_3$  should be positive.

The hypotheses being tested for each variable in model 6, can be applied to any of the models which incorporate that variable. It should be noted that the other models need to be

incorporated to assess whether the size of the particular coefficient is due to a relationship with another variable.

Table VI shows the average slopes and their  $t$ -statistics from month-by-month regressions of stock returns on  $\beta$ , size, and book-to-market ratio for July 1993 till June 2001. The adjusted  $R^2$  is described in order to define the proportion of dependent variable, which is explained by the variations of the independent variable. In cross-sectional regressions the dependent variable is always the average returns on portfolios and the independent variable is  $\beta$ ,  $\ln(ME)$ ,  $\ln(BE/ME)$  separately, or a combination between these three. As already mentioned, when portfolios are formed on the basis of BE/ME ratio there is a strong positive relation between average returns and book-to-market equity. This is confirmed by the cross-section of average returns from Fama and MacBeth regressions.

As it can be seen, the intercept coefficient,  $\gamma_0$ , of all the six models is significantly different from zero. Therefore, null hypothesis 1 must be rejected, as well as null hypothesis 2 because the slope coefficient,  $\gamma_1$ , is negative. This is the most remarkable result in our study because we find a significantly negative risk premium on beta, in contrast with SLB model where there is a positive relation between risk, measured by  $\beta$ , and expected return.

On the other hand, the results appear to be consistent with the “size effect”. The return premium on firm size  $-\ln(ME)$ – for models that include the size coefficient,  $\gamma_2$ , is negative as predicted and significantly different from zero. Under all specifications of the model, the “size effect” is observed and therefore, hypothesis 3 is accepted.

Concerning the explanatory power of book-to-market ratio,  $\gamma_3$ , we find that the premium on firm book-to-market ratio  $-\ln(BE/ME)$ – is positive with an average slope of 0,22 and  $t$ -statistic of 11,23 only in the case that the  $\gamma_3$  coefficient is the only explanatory power, which is coincident with empirical evidence of Fama and French (1992). Due to positive return premium on  $\ln(BE/ME)$  in model 3, we would say that hypothesis 4 is accepted but when other explanatory variables are added in our model [model 5:  $\ln(ME)$  and  $\ln(BE/ME)$  or model 6:  $\beta$ ,  $\ln(ME)$ , and  $\ln(BE/ME)$ ], the premium on  $\ln(BE/ME)$  turns to be negative and significantly different from zero, which is inconsistent with the “book-to-market effect” and therefore hypothesis 4 is rejected.

As it is mentioned, the average slope from the monthly regressions of returns on  $\ln(BE/ME)$  alone is 0,22 with a  $t$ -statistic of 11,23. This book-to-market relation is much stronger than the size effect, which produces a  $t$ -statistic of  $-5,17$  in the regressions of returns on  $\ln(ME)$  alone. But book-to-market equity does not replace size in explaining average stock returns in the case of model 5. When both  $\ln(ME)$  and  $\ln(BE/ME)$  are included in the

regressions, the average size  $t$ -statistic remains almost the same ( $-5,28$  from  $-5,17$ ) whereas the book-to-market equity  $t$ -statistic drops dramatically from  $11,23$  to  $-3,13$ .

A comparison of the slope coefficient in model 1 with that of model 6 can show whether the premium of beta is associated with other variables. An examination shows that the average slope of  $\gamma_1$  coefficient increases but is still negative (from  $-7,15$  to  $-3,03$ ), the coefficient of  $\ln(ME)$ ,  $\gamma_2$ , decreases slightly (from  $-0,56$  to  $-0,88$ ), and the coefficient of  $\ln(BE/ME)$  decreases impressively and turns to be negative (from  $0,22$  to  $-0,49$ ).

When we look the adjusted  $R^2$  in the regressions that only one explanatory variable is assessed (model 1, 2, and 3), we find the following: the adjusted  $R^2$  explains satisfactorily the dependent variable in the case of model 2 and 3 by 93% and 98%, respectively, while the adjusted  $R^2$ , in model 1, where the independent variable is the beta coefficient, explains only by 23% the dependent variable. As more variables are added in the regressions (model 4, 5, and 6), adjusted  $R^2$  decreases. More specifically, we find that: the adjusted  $R^2$  explains better the dependent variables in the case of model 5 and 6 by 79% and 80%, respectively, than in the case of model 4 that only  $\beta$  and  $\ln(ME)$  are the two explanatory variables. In this case, adjusted  $R^2$  explains by 65% the dependent variables.

## 5. CONCLUSIONS

The main predictions of the Sharpe-Lintner-Black model that the expected stock returns are a positive linear function of their market  $\beta$ s and that market  $\beta$ s suffice to describe the cross-section of expected returns, have documented by empirical tests of Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973). They found that beta, being the only explanatory variable, is positively related to expected returns.

Variables like size and book-to-market equity are firm's characteristics and versions of firm's stock price. So, they can be considered as another way to extract information from stock prices about the cross-section of expected stock returns. Banz (1981) supports that there is a strong negative relation between average return and firm size while Rosenberg, Reid, and Lanstein (1985) support that there is a positive relation between average return and book-to-market equity.

The study of Fama and French (1992) showed that two firm specific variables, firm size and book-to-market equity, combine to capture the cross-sectional variations of average stock returns. Their findings conflict with the forecasts of the CAPM, primarily that beta successfully describes the cross-section of expected stock returns.

This study investigates the cross-section of average stock returns in the Greek stock market. The methodology adopted in the present study is similar to Fama and French (1992).

The aim here is to provide a further insight into the existence of the anomalies, mentioned above, in the Greek stock market.

We examine the impact of market risk measured by beta as well as the explanatory power of size and book-to-market equity ratio on monthly stock returns. Our findings strongly contrast with the predictions of the CAPM. We find that  $\beta$  cannot explain cross-section variations of average returns, of Athens Stock Exchange non-financial firms for July 1993 till June 2001, even though beta is the only explanatory variable. The cross-section of monthly returns indicates that average returns vary inversely with firm size and so the “size effect” is confirmed, as in the study of Fama and French (1992).

In contrast, evidence of “book-to-market effect” indicates that average returns vary directly with book-to-market ratio but it is found only in the model that this is the only explanatory variable. The significance of the coefficient on  $\ln(BE/ME)$  drops dramatically when the influence of other variables is taken in to account. These findings are confirmed with the Fama and MacBeth (1973) estimates that employ time-series and cross-sectional regressions.

The interrelationship of beta, size, and book-to-market equity satisfactorily explains the cross-section of average stock returns although the cross-section of average returns is explained better when size or book-to-market equity is used alone as explanatory variables.

The capital asset pricing model is still widely used by many practitioners. Although the theoretical problems with CAPM have been well documented, it is still one of the common approaches employed for valuation purposes. CAPM is widely taught in most undergraduate corporate finance classes. Even though its weaknesses have been documented, practitioners are typically left with no easy alternative to replace it with. Therefore, almost by default it is generally accepted.

### **Managerial Implications of the Test of CAPM**

The use of Fama and French model can be used in the management and the evaluation of portfolios. Many brokerage firms, financial institutions, and financial consulting firms can develop their own model to aid in the investment process. These models have become increasingly popular because they allow risk to be more tightly controlled and they allow the investor to protect against specific types of risk to which he or she is particular sensitive or to make specific bets on certain types of risk.

It is important to know that the major reason that we test the model of Fama and French (1992) is to analyze the relation between systematic risk and average returns of



portfolios as well as the relation between unsystematic risk, measured by the firm size and book-to-market equity ratio, and average returns.

Due to our findings, which indicate that there are variables -others than beta- that explain better the cross-section of average stock returns, we believe that the model of Fama and French can be used widely.

### **Research Limitations and Further Research Proposals**

In this survey, we attempted to be as precise as it was possible. However, during the data collection we faced some drawbacks. For an improved and more completed examination of the Greek stock market a larger sample period is needed. The lack of information from the Athens Stock Exchange databank is due to the fact that the most data are not computerized. This is the main reason for the restriction of our sample period to 8 years.

We also confront some problems in the collection of the other variables used in this study (size and book-to-market equity ratio) because a part of these data were elaborated by us.

Another drawback for our study was, probably, the war in Iraq in 1990, which caused a great impact in the oil prices, with result to affect the returns of the stocks on the Athens Stock Exchange, as well as the risk-free rate of return.

It is obvious that much has yet to be done to understand the nature of stock returns. As a first step, additional variables like earnings-price ratio, leverage, and cash flow-price ratio can be included in a similar analysis. Then proposed reasons for anomalous findings can be further elaborated. Depending on the availability of data, investigation of investor profile in different time periods and stocks may yield interesting clues.

Furthermore, the application of different data intervals to monthly data, and the different time periods between sampling the variables and using them to test returns could also be used. The possible influence of sampling bias cannot be ignored here, especially in light of the fact that the search criteria give a sample that may be too small to be truly reflective of the entire market. So, a further research could involve analyzing a longer sample period although that Chan, Hamao, and Lakonishok (1991) argue that a sample period of twenty to thirty years may not be long enough to justify the use of ex post data as proxies for market expectations.

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## APPENDIX

### TABLE I

**Portfolios formed according to ME (size) and then according to Pre-Ranking  $\beta$  from July 1993 to June 2001.**

In June of each year  $t$ , 9 portfolios are formed on the basis of ME and pre-ranking  $\beta$ s of individual stocks. ME1 is the smallest size portfolio and ME3 is the largest size portfolio, while  $\beta_1$  and  $\beta_3$  are the smallest and the largest pre-ranking  $\beta$  portfolios, respectively (here and in all other tables). Panel A presents the average monthly returns which are the time-series average of the monthly equal-weighted portfolio returns, in percent. Panel B shows the post-ranking  $\beta$ s estimated from time-series regressions of the full sample period from July 1993 to June 2001. Panel C presents the average size which is the time-series average of monthly averages of  $\ln(\text{ME})$  for stocks in the portfolio in June of each year. ME denominated in million of drachmas.

PANEL A: Average Monthly Returns			
	$\beta_1$	$\beta_2$	$\beta_3$
ME1	-0,14	0,21	-1,36
ME2	-1,06	-0,96	-2,52
ME3	-1,27	-2,16	-2,69

PANEL B: Post ranking $\beta$ s			
	$\beta_1$	$\beta_2$	$\beta_3$
ME1	0,82	0,88	0,94
ME2	0,92	0,95	1,07
ME3	0,88	0,82	1,8

PANEL C: Average Size $\ln(\text{ME})$			
	$\beta_1$	$\beta_2$	$\beta_3$
ME1	15,33	15,37	15,49
ME2	16,87	16,81	16,89
ME3	18,39	18,28	18,21

**TABLE II****Properties of Portfolios formed on Size**

In June of each year  $t$  we form 3 portfolios according to ME. The average return is the time-series average of the monthly equal-weighted portfolio returns, in percent.  $\ln(\text{ME})$  and  $\ln(\text{BE}/\text{ME})$  are the time-series averages of the monthly average values of these variables.  $\beta$  is the time-series  $\beta$ s of the monthly portfolios.

<b>Portfolios Formed on Size</b>			
	<b>ME1</b>	<b>ME2</b>	<b>ME3</b>
<b>Return</b>	-0,43	-1,51	-2,04
<b>beta</b>	0,88	0,98	0,92
<b>ln(ME)</b>	15,40	16,86	18,29
<b>ln(BE/ME)</b>	-14,27	-15,35	-16,33

**TABLE III****Properties of Portfolios formed on Pre-Ranking  $\beta$ s**

Pre-ranking  $\beta$ s are estimated for each stock using monthly data for the previous 36 months and then stocks are ranked according to these estimated betas for each month. The ranked stock sample is divided into 3 portfolios in June of each year  $t$ . The average return,  $\beta$ ,  $\ln(\text{ME})$ , and  $\ln(\text{BE}/\text{ME})$  have the same meaning as in Table II.

<b>Portfolios Formed on Pre-Ranking <math>\beta</math>s</b>			
	<b><math>\beta</math>1</b>	<b><math>\beta</math>2</b>	<b><math>\beta</math>3</b>
<b>Return</b>	-0,50	-1,31	-2,04
<b>beta</b>	0,88	0,86	1,02
<b>ln(ME)</b>	16,68	16,76	16,94
<b>ln(BE/ME)</b>	-15,24	-15,27	-15,32

**TABLE IV****Properties of Portfolios formed on BE/ME ratio**

At the end of each year  $t-1$ , 3 portfolios are formed on the basis of ranked values of book-to-market equity ratio. The accounting ratio is measured using market equity (ME) in December of year  $t-1$ . Firm size  $\ln(\text{ME})$  is measured in June of year  $t$ , with ME denominated in million of draxmas. We calculate each portfolio's monthly equal-weighted return from July of year  $t$  to June of year  $t+1$ , and then reform the portfolios at the end of year  $t$ . The average return is the time-series average of the monthly equal-weighted portfolio returns, in percent.  $\ln(\text{ME})$  and  $\ln(\text{BE/ME})$  are the time-series averages of the monthly average values of these variables.  $\beta$  is the time-series  $\beta$ s of the monthly portfolios.

<b>Portfolios Formed on BE/ME</b>			
	<b>BE/ME1</b>	<b>BE/ME2</b>	<b>BE/ME3</b>
<b>Return</b>	-1,55	-1,31	-0,90
<b>beta</b>	0,89	0,94	0,92
<b><math>\ln(\text{ME})</math></b>	17,77	16,82	15,62
<b><math>\ln(\text{BE/ME})</math></b>	-16,64	-15,29	-13,69



**TABLE V**

**Portfolios formed according to ME (size) and then according to BE/ME ratio from July 1993 to June 2001.**

In June of each year  $t$ , 9 portfolios are formed on the basis of ME and BE/ME ratio. BE/ME1 and BE/ME3 are the smallest and the largest book-to-market equity portfolios, respectively. The average monthly return (Panel A) is the time-series average of the monthly equal-weighted portfolio returns, in percent. The post-ranking  $\beta$ s of the size-BE/ME portfolios (Panel B) are estimated from time-series regressions of the full sample period from July 1993 to June 2001. Panel C presents the average size which is the time-series average of monthly averages of  $\ln(\text{ME})$  for stocks in the portfolio in June of each year.

<b>Panel A: Average Monthly Returns</b>		
<b>BE/ME1</b>	<b>BE/ME2</b>	<b>BE/ME3</b>
0,17	-0,78	-0,51
-1,14	-1,77	-1,65
-1,42	-2,34	-2,46

**TABLE V (continued)**

<b>Panel B: Post-Ranking <math>\beta</math>s</b>			
	<b>BE/ME1</b>	<b>BE/ME2</b>	<b>BE/ME3</b>
<b>ME1</b>	0,81	0,95	0,90
<b>ME2</b>	0,98	0,92	1,03
<b>ME3</b>	0,91	0,96	0,92

<b>Panel C: Average Size <math>\ln(\text{ME})</math></b>			
	<b>BE/ME1</b>	<b>BE/ME2</b>	<b>BE/ME3</b>
<b>ME1</b>	15,73	15,43	14,96
<b>ME2</b>	16,97	16,84	16,75
<b>ME3</b>	18,66	18,10	17,97

**TABLE VI**

**Average Slopes (*t*-statistics) from Month-by-Month Regressions of Stock Returns on  $\beta$ , Size, and Book-to-Market Equity from July 1993 to June 2001.**

Cross-sectional regressions of stock returns on beta, size, and book-to-market equity are run for each month in the period of 1993-2001. The average slope is the time-series average of the monthly regression slopes and the *t*-statistic is the average slope divided by its time-series standard error (*t*-statistics are in parentheses). The adjusted  $R^2$  is the proportion of dependent variable, which is explained by the variations of the independent variable.

<b>Model</b>	<b>intercept</b>	<b><math>\beta</math></b>	<b>ln(ME)</b>	<b>ln(BE/ME)</b>	<b>R<sup>2</sup> adjusted</b>
<b>1</b>	5,31	-7,15			0,23
<i>t</i> -statistics	(1,02)	(-1,27)			
<b>2</b>	8,04		-0,56		0,93
<i>t</i> -statistics	(4,43)		(-5,17)		
<b>3</b>	2,13			0,22	0,98
<i>t</i> -statistics	(7,05)			(11,23)	
<b>4</b>	11,72	-5,35	-0,48		0,65
<i>t</i> -statistics	(3,68)	(-2,37)	(-2,85)		
<b>5</b>	6,51		-0,99	-0,58	0,79
<i>t</i> -statistics	(3,49)		(-5,28)	(-3,13)	
<b>6</b>	8,83	-3,03	-0,88	-0,49	0,80
<i>t</i> -statistics	(3,36)	(-1,21)	(-4,37)	(-2,56)	