BETA, BOOK-TO-MARKET RATIO, FIRM SIZE AND THE CROSS-SECTION OF THE ATHENS STOCK EXCHANGE RETURNS

CHRISTOS SIMITSIS

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An efficient performance of pricing mechanism of stock market is a driving force for channeling into profitable investment and hence, facilitate in an optimal allocation of capital. This means that pricing mechanism by ensuring a suitable return on investment will expose viable investment opportunities to the potential investors. Thus in stock market, the pricing function has been considered important and a subject of extensive research.

The cross-sectional relationship between firm-specific characteristics and average stock returns has attracted a significant amount of attention in the financial literature. Because these patterns are not explained by the CAPM, they are called CAPM regularities or anomalies. This paper examines the influence of beta and the size and book-to-market ratio on average stock returns in the Athens Stock Exchange (ASE) for the period from January 1993 to June 2001. Throughout the examining period very important different facts occurred; a) During 1998-1999 period there was a sharp increase in the share’s value of all the companies whose shares were trading in ASE (with parallel multiple increase in the market values of the companies), b) during 2000-2001 occurred exactly the opposite (a fall in the values of the shares – at the same time a large number of those shares appeared at values much lower than those at the beginning of the rise).

Following Fama and MacBeth’s cross-sectional regression methodology (by taking into account the constraints imposed by a smaller sample both in time and in terms of number of stocks) enhanced with Shanken’s adjustments for the Errors In Variables problem, a statistically significant positive relationship between the book-to-market ratio and average stock returns is reported, specially when this variable (BMR) was the only variable in explaining average returns. On the other hand, there is a “size effect” on the cross-sectional variation in average stock returns. Furthermore, these two variables (BMR and MV) together have the more explanatory power in explaining average returns, while risk-measured by $\beta$, has not (there isn’t positive relation). It is also remarkable, the fact that when other explanatory variables-over the MV- were added in the cross-sectional regressions the “book to market effect” diminishes a lot.

We use a firm’s market equity at the end of December of year $t-1$ as well as it’s book equity to compute its book-to-market. We estimate $\beta$ as the sum of the slopes in the regression of the return on a stock on the current and prior month’s market returns. The time-series means of the monthly regression slopes then in regression with size and book-to-market equity examine the cross-sectional variation in average returns in ASE for the examining period 93-01.
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INTRODUCTION

The proposition that a well-regulated stock market renders a crucial package of economic services is widely accepted in financial economics. The various important functions of stock exchange include provisions for liquidity of capital and continuous market for securities from the point of view of investors. From the point of view of economy, in general, a healthy stock market has been considered indispensable for economic growth and is expected to contribute to improvement in productivity. More specifically, the indices of stock market operations such as capitalization, liquidity, asset pricing and turnover help to access whether the national economy is proceeding on sound lines or not. In addition to free and fair-trading the stock market can assure and retain a healthy market participation of investors besides improving national economy. Moreover, there are well-documented potential benefits associated with foreign investment in emerging markets.

A major factor hindering the foreign investment in these markets is lack of information about characteristics of these markets especially about the price behavior of equity markets of these countries.

The Capital Asset Pricing model (CAPM) developed by Sharpe (1964), Lintner (1965), and Black (1972), provides an approach to the equilibrium pricing of capital assets under conditions of uncertainty. The model implies that expected returns are a linear function of their market beta, and that market betas suffice to describe the cross-section of expected returns. The CAPM has undergone many tests since its development, with recent empirical work finding a number of anomalous factors (anomalies-regularities) that appear to be priced in the cross-section of expected returns. Two of the most notable of these anomalous factors are market value of equity and the ratio of book value of equity to market value of equity.

From the above these two CAPM regularities the most prominent is the size effect of Banz (1981), who found that average returns on small market capitalization stocks were too high given their $\beta$ estimates,
while the opposite occurred for large stocks (Reinganum, 1981). Rosenberg (1985) reported that average returns on U.S. stocks were positively related to the ratio of a firm’s book value of common equity to its market value. The cross-sectional relationship between stock returns and variables like size, book-to-market ratio, price-earnings ratio and dividend yield has been extensively studied for most of the world’s developed stock markets.

The selection of such firm characteristics does not have its route from an explicit theoretical model, but it has guided more by intuition and by their popularity among practitioners. Despite a number of different studies reaffirming the explanatory power of these variables, the interpretation of the findings remain debatable. Some argue that they are proxies for non-diversifiable factor risk (Fama and French, 1992), while others argue that it is the characteristics rather than the covariance structure of returns that appear to explain cross-sectional variation to stock returns (Daniel and Titman, 1997).

The fact remains that tests of the model do not allow the distinction to be made between market inefficiency and misspecification of the asset pricing model, but the study of these anomalous pricing factors does contribute to our understanding of the behaviour of security returns. The purpose is not to shed light on the economic interpretation of these pricing effects, but rather to help establish their existence and examine their attributes.

Even more the empirical evidence seems to confirm that there is not a clear cut economic interpretation for these firm-specific characteristics. Many researchers have sought a rational asset-pricing framework incorporating these types of variables (Fama and French, 1996). An opposite view states that it is irrational pricing which causes the high premium for relative distress (the book-to-market effect). Proponents of this view include Lakonishok, Shleifer and Vishny (1994), Haugen (1995), and MacKinlay (1995), who argue that the premium is due to investors’ over-reaction. In particular, they conclude that investors do not like distressed stocks and so cause them to be underpriced. Finally, a last view supports that the CAPM holds and the
premia associated with the various CAPM regularities are spurious results of survivor bias, data snooping or bad proxies for the market portfolio in tests of the CAPM (Kothari, Shanken and Sloan, 1995) and MacKinlay (1995).

The main objective of this paper is to examine whether the following firm characteristics, namely the size and the book-to-market ratio can capture the cross-section variation in average ASE stock returns. We intend to fill this gap in the literature and shed some light on the significance of the main firm characteristics that have been extensively studied, especially for the U.S. market.

The rest of this dissertation is organized as follows: chapter 1 gives a brief theoretical review of the two models (CAPM and APT), chapter 2 presents the empirical tests of these models, chapter 3 describes the research methodology used, the data and shows the correlation between the various explanatory variables. The statistical analysis and results, together with their implications and applications are displayed in chapter 4. Finally, chapter 5 concludes the paper and sets the limitations of this research as well as some proposals for further research direction.
CHAPTER 1

THEORETICAL LITERATURE REVIEW

1.1 Introduction

The Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), and Black (1972) in its various formulations provides predictions for equilibrium expected returns on risky assets. More specifically, one of its formulations states that an individual asset’s (or a group of assets) expected excess return over the risk-free interest rate equals a coefficient, denoted by $\beta$, times the (mean-variance efficient) market portfolio’s expected excess return over the risk-free interest rate. This relatively straightforward relationship between various rates of return is difficult to implement empirically because expected returns and the efficient market portfolio are unobservable. Despite this formidable difficulty, a substantial number of tests have nonetheless been performed, using a variety of ex-post values and proxies for the unobservable ex-ante variables. Recognizing the seriousness of this situation quite early, Roll (1977) emphasized correctly that tests following such an approach provide no evidence about the validity of the CAPM. The obvious reason is that ex-post values and proxies are only approximations and therefore not the variables one should actually be using to test the CAPM.

Fama and French (1992, 1993) conducted extensive tests of the CAPM and found that the relation between average stock return and $\beta$ is flat, and that average firm size and the ratio of book-to-market equity do a good job capturing the cross-sectional variation in average stock returns.
Another principal theory is APT (Ross, 1976), which is built on similar intuition as CAPM but is more general. The following parts display the theoretical review of these two models.

1.2 Capital Asset Pricing Model: The Sharpe-Lintner Version

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 Mongenstern (1953). The Markowitz mean-variance analysis has to do with how the investor should allocate his wealth among the numerous assets existing in the market, given that he is one-period utility maximizer. The Sharpe-Lintner asset-pricing model then uses the characteristics of the investor’s wealth allocation decision to obtain the equilibrium relationship between risk and expected return for assets and portfolios.

In order to define the relationship between risk and return that affects security prices, CAPM rests upon a set of assumptions about the real world. These assumptions are (Sharp, 1964):

(a) investors are risk-averse and assess securities on the basis of expected return and standard deviation or variance of return. Higher return for a given standard deviation is preferred, (b) all investors have a single-period horizon and this is the same for all investors, (c) everyone in the market has the same forecast, i.e. everyone agrees on the probability distributions of the rates of return (i.e. homogenous expectations), (d) investment opportunities in the market are the same for all the participants although the amounts invested differ between participants, (e) a perfect market is assumed in the sense that there are no taxes and transaction costs; also, securities are completely divisible and the market is perfectly competitive, (f) investors can borrow and lend freely at the riskless rate of interest, (g) the stock of risky securities in the market is given; all securities that were to be issued for the
coming period have been issued and all firm financial decisions have been made.

The development of the asset-pricing model begins with the description of the market where equilibrium must be established. The point is to examine the nature of equilibrium in the capital market, and particularly on the measurement of the risks of assets and portfolios and the relationship between risk and equilibrium expected returns. The optimal investment decisions determine the risk structure of equilibrium expected returns. This assessment continues from partial equilibrium (consumption-investment) to capital market equilibrium, taking optimal production-investment decisions by firms and equilibrium in the markets.

Hypothesis that all distributions of portfolio returns are normal and the consumers are risk averse denote that any expected utility maximizing portfolio must be a member of \( E(R_p), \sigma(R_p) \), efficient frontier, where \( E(R_p) \) is the expected return of the portfolio and \( \sigma(R_p) \) is its standard deviation (Markowitz, 1952). An efficient portfolio is one that has the most expected return for a given risk, or the least risk for a given amount of expected return. This assumption means that all investors agree about the expected returns, variances and covariances of the security at the end of some period of time, which is the same for all investors.

Since the model incorporates only risky assets, Sharpe (1964) has demonstrated that the set of mean-deviation efficient portfolios create a concave curve in mean-standard deviation space. Further assumption that there are risk-free borrowing and lending opportunities available in the market and that all consumers can borrow or lend as much as they like at the risk-free rate \( R_f \) make the efficient set to become a straight line. Since the expectations and portfolio opportunities are identical throughout the market for all investors, when equilibrium is achieved all investors face the efficient set and efficient portfolio is now represented by portfolio \( m \). The \( m \) is market portfolio, which consists of all assets in the market each entering the portfolio with weight equal to the ratio of its total market value to the total market value of all assets. In addition
$R_t$ must be such that net borrowing are zero, that is, at the rate of $R_t$ the total quantity of funds that people want to borrow is equal to the quantity that others want to lend.

Thus, Sharpe (1964) and Lintner (1965) making a number of assumptions extended Markowitz' s mean-variance framework to build a relation for expected return, which can be written as:

$$E(R_i) = R_f + \beta_i [E(R_m) - R_f]$$

Where $E(R_i)$ is the expected return on asset $i$, $R_f$ is the risk free rate, $E(R_m)$ is the expected return on market portfolio and $\beta_i$ is the risk of the market measured by beta or the definition of market sensitivity parameter defined as $\text{cov}(R_i, R_m) / \text{var}(R_m)$.

Thus given that investors are risk averse, it seems naturally sensible that high beta stocks should have higher expected return and low beta stocks should have lower expected return.

In fact this is what the asset pricing model, given by the equation below, implies. It says that in equilibrium an asset with zero systematic risk ($\beta=0$) will have expected return equal to that on the riskless asset $R_f$, and expected return on all risky assets ($\beta>0$) will be higher by a risk premium, which is directly proportional to their risk as measured by $\beta$.

In a rational and competitive market investors diversify all unsystematic risk away and thus assess assets according to their systematic or non-diversifiable risk. Thus the model invalidates the traditional role of standard deviation as a measure of risk. This is a natural result of the rational expectations hypothesis (applied to asset markets) because if, on the contrary, investors also take into account diversifiable risks, then over time competition will force them out of the market. If, on the contrary, the CAPM does not hold, then the rationality of the asset’ s markets will have to be reconsidered. In risk premium form CAPM equation can be written as:
\[ E(R_i) - R_f = \beta_i [ E(R_m) - R_f ] \]

Where \([E(R_i)-R_f]\) is the excess return on asset \(i\) and \([E(R_m)-R_f]\) is the excess return on the market portfolio over the risk free rate. This equation says that expected asset risk premium is equal to its \(\beta\) factor multiplied by the expected market risk premium.

Testing the CAPM theory depends on the assumption that the ex-post distribution from which returns are drawn is ex-ante perceived by the investor. When CAPM is empirically tested in the literature it is usually written in the following form:

\[ r_i = \gamma_0 + \gamma_1 \beta_i + \epsilon_i \]

In the last equation an intercept term \(\gamma_0\) is added, the term \(\gamma_1\) is excess return of market over risk free rate and \(r_i\) is excess return on asset \(i\). If \(\gamma_0=0\) and \(\gamma_1>0\) then CAPM holds.

The CAPM is a relationship between the ex-ante expected returns on the individual assets and the market portfolio. Such expected returns of course are not exactly measurable. The usual process in such cases is to assume that the probability distribution generating the ex-post outcomes is stationary over time and then to replace the sample average return with ex-ante expectations.

Most tests of the asset pricing models have been performed by estimating the cross-sectional relation between average return on assets, and their betas over some time interval and comparing the estimated relationship implied by CAPM. The time series estimation approach is also used in the literature. With the assumption that returns are normally distributed the maximum likehood estimation technique can be used to estimate the parameters \(\gamma_0\) and \(\gamma_1\).
1.3 Capital Asset Pricing Model: The Black Version

Black (1972) proposed that the relationship between risk and return is linear considering the assumption where the investors neither borrow nor lend at the riskless rate of interest, and developed the model of zero beta portfolio, $R_z$, as a proxy for riskless asset, that is the $\text{cov}(R_z,R_m) = 0$. In this case CAPM depends upon two factors: the non-zero beta portfolio, which is the market portfolio, and the zero beta portfolio whose rate of return has no correlation with the rate of return with the market portfolio. Black’s model is referred as the two factor CAPM or the $R_z$–version, which may be represented as:

$$E(R_i) = E(R_z) + \beta_i [ E(R_m) - E(R_z) ]$$

Where $E(R_i)$ is the expected return on security $i$, $E(R_z)$ is the expected return on the minimum standard-deviation zero-beta portfolio, and $\beta_i$ is the beta coefficient of security $i$. In excess return form the above equation can be written as:

$$E(R_i) - E(R_z) = \beta_i [ E(R_m) - E(R_z) ]$$

The zero-beta model specifies the equilibrium expected return on asset to be a function of market factor defined by the return on market portfolio $R_m$ and a beta factor defined by the return on zero-beta portfolio—that is the minimum variance portfolio which is uncorrelated with market portfolio. The zero-beta portfolio plays a role equivalent to risk free rate of return in Sharpe-Lintner model. If the intercept term is zero implies that CAPM holds. Gibbons (1982), Stambaugh (1982), and Shanken (1985) have tested CAPM by first assuming that market model is true, that is the return on the $i_{th}$ asset is a linear function of a market portfolio proxy.
Black (1972) two-factor model requires the intercept term $E(R_z)$ to be the same for all assets. Gibbons (1982) points out that the Black's two factor CAPM requires the constraint on the intercept of the market model:

$$a_i = E(R_z) (1-\beta_i)$$

for the assets during the same time interval. When the above restriction is violated the CAPM must be rejected.

Stambaugh (1982) has estimated the market model. Using the Lagrange multiplier test has found evidence in support of Black's version of CAPM. Gibbons (1982) has used a similar method to that of Stambaugh but employed the likelihood ratio test (LRT) indeed. Finally MacBeth (1975) has used Hotelling $T^2$ statistics to test the validity of Black's version of CAPM.

1.4 Capital Asset Pricing Model: The Conditional Version

The traditional CAPM, which explains stock return solely on $\beta$ measure, is based on the assumption that all market investors have identical subjective expectations of mean and variance of return distribution, and portfolio decision is exclusively based on these moments. But empirical evidence from literature proposes a deviation of the model from its official theory. Engle (1982) and Bollerslev (1986) stated that return distribution varies over time. In other words, the stock return distribution is time variant in nature and, hence, the subjective expectation of moment differ from one period to another. This means that the investor expectations of moments behave like random variables rather than constant as assumed in the traditional CAPM for stock returns.
The major proposition while taking care of time varying moments in CAPM is that, the investors still share homogenous subjective expectations of moments but these moments are conditional on the information at the time $t$. This is the conditional version CAPM (CCAPM).

In earlier research works the presence of time varying moments in return distribution has been in the form of gathering large shocks of the dependent variable and thereby exhibiting a large positive/negative value of the error term according to Mandelbrot (1963) and Fama (1965). A formal specification was at last proposed by Engle (1982) in the form of Autoregressive Conditional Heteroscedastic (ARCH) process. Engle and Bollerslev (1986) have attempted with their studies to improve Engle’s ARCH specification. The approaches that are useful in specifying functional form of error term in the test of Conditional Capital Asset Pricing Model involve the approaches given by Engle and Bollerslev (1986) and Bollerslev, Chou and Kroner (1992) in case of ARCH model.

In terms of error distribution Engle’s (1982) ARCH process may be represented as:

$$r_{it} = \alpha + \beta r_{mt} + \varepsilon_t$$

where $r_{it}$ is excess return on asset $i$, $r_{mt}$ is excess return on market, and $\varepsilon_t$ is the error term. The ARCH model characterizes the random error term $\varepsilon_t$ to be conditional on realized value of the given information set. More specifically, the error term $\varepsilon_t$ is expected to keep the following assumptions: (a) the distribution of the current error term is normal with mean zero and variance, which is not a constant, (b) the variance of the current error, conditional on the past error is monotonically increasing function of its past error and hence heteroscedastic.
Mandelbrot (1963) has observed that large/small changes are tending to be followed by large/small changes. As ARCH model characterizes the error term conditional on information set, it can mimic the clustering of large shocks by exhibiting large/small errors of either sign to be followed by large/small error according to Bera and Higgen (1995). Hence the application of ARCH appears to be a natural choice to express conditional variance.

Bollestev (1986) has specified a generalization of ARCH model referred as GARCH (Generalized Autoregressive Conditional Heteroscedastic), where the conditional variance is function of past errors and past variances.

The implicit assumption of Engle’s ARCH and Bollestev’s GARCH is that the return distribution characterized with time variation is due only to variance. But Domowitz and Hakkins (1985) have shown time variation in both mean and variance of return distribution. Incorporating this idea Engle, Lilien, and Robins (1987) has proposed the ARCH-M (Autoregressive Conditional Heteroscedastic Mean) to account for time variation in both mean and variance. If an asset is related with higher risk, it is expected to yield a higher return. Hence the volatility of risk represented by variance, is attempted to account for increase in the expected return due to increase in variance of the asset.

The test of ARCH, or any other alternative like GARCH or ARCH-M, is accomplished by a simultaneous estimation of parameters in mean and variance. As the error variance is expressed in non-linear form, a non-linear optimization procedure is required for estimation. Bollestev, Engle and Woldridge (1988) used ARCH-M model and maximum likelihood as estimation procedure, while Harvey (1989), and Bodurtha and Mark (1991) used the generalizated method of moments (GMM).
1.5 Multiperiod Models of Asset Pricing

There are two basic cases of a multiperiod general equilibrium model that deserve some interest: the consumption CAPM, and the multi-risk CAPM.

In Merton’s (1973) multiperiod model, trading takes place continuously, and all returns and betas are computed directly rather than over finite horizons. Also the means and covariances of the returns of assets are determined by the evolution of a random variable over time that determines the feasible set in the future. Here the sensitivity of an asset return to the return of the market portfolio, or β, is not the only factor determining the expected return of an asset at a point in time. Additionally, the sensitivity of the return to a portfolio that has the maximum correlation with the random variable over time also determines the expected returns of assets.

Breeden (1979) has built up a model in which a security’s risk is assessed by its sensitivity to changes in investors’ consumption. If the model holds, a stock’s expected return should move in line with its consumption beta rather than its market beta.

In the standard model of CAPM, investors are concerned exclusively with the amount and risk of their future wealth. Each investor’s wealth ends up perfectly correlated with the return on the market portfolio.

In the consumption CAPM, risk about stock returns is connected directly to risk about consumption. Of course, consumption depends on wealth (portfolio value), but wealth does not appear explicitly in the model.

Compared to stock prices, estimated aggregate consumption changes steadily over time. Changes in consumption often seem to be out of phase with the stock market. Individual stocks seem to have low or unpredictable consumption betas.
Moreover, the volatility of consumption seems too low to explain the past average rates of return on common stocks unless one assumes measures of consumption or perhaps poor models of how individuals distribute consumption over time.

*It seems too early for the consumption CAPM to see practical use.*

### 1.6 Arbitrage Pricing Theory

In the early 1970s Stephen Ross (1976) offered a model of security pricing known as *arbitrage pricing theory (APT)*. With his work Ross proposed a new and different approach to explaining the pricing of assets. Ross has developed a mechanism that, given the process that generates security returns, derives asset prices from arbitrage arguments analogous to those used to derive the CAPM. After Ross, APT extended by Huuberman(1982), Chamberlain and Rothschild (1983), Chen and Ingersoll(1983), Connor(1982), Chen(1983), Connor and Korajczky(1988), Lehmann and Modest(1988), and numerous other researchers.

The final APT model can look deceptively similar to the CAPM. In fact, the two theories can lead to the same investment implications. But the theories are based on completely different logical developments and *do not necessarily* result in the same investment implications. Comparing the two models APT is a theory that competes with CAPM- it is not an extension. It is another way to view the world. True arbitrage involves no risk. In short, an arbitrage transaction results in a risk-free profit with no capital commitment. It is the potential for such arbitrage profits between securities which drives the Arbitrage Pricing Theory.

The formal Arbitrage Pricing Theory is a development of the 1970’s, but arbitrage transactions have existed since humans developed the most primitive economies. Today arbitrage in the security markets is extensive. A large number earn a lot by selling gold in one country and simultaneously buying it in
another, by purchasing T-bills from one bank and simultaneously selling them to another, by purchasing shares of SHELL on one stock exchange and simultaneously selling them on another etc. Arbitrage operations are possible as long as prices of perfect substitutes are different.

The APT is derived under the usual assumptions of perfectly competitive and frictionless capital markets. Furthermore, individuals are assumed to have homogeneous beliefs that the returns are generated by a k-factor process. The theory requires that the number of assets must be larger than the number of factors.

The basic assumption of APT is that in equilibrium all portfolios satisfy the conditions of (a) using no wealth and (b) having no risk must earn no return on average.

These portfolios are called arbitrage portfolios. The APT relies on the absence of arbitrage opportunities. In particular, two portfolios with the same risk cannot offer different expected returns because that would offer an arbitrage opportunity with a net investment of zero. An investor could then guarantee a riskless positive expected return by short selling one portfolio and holding an equal and opposite long position in the other. The equilibrium in the APT specifies that the single period expected return on any risky asset is approximately linearly related to its associated factor loadings (in the context of arbitrage pricing models the betas are often referred to as the factor loadings i.e., systematic risks) as shown below:

\[
R_i = E(R_i) + b_{i1}F_1 + \ldots + b_{ik}F_k + \epsilon_k
\]

where \( R_i \) is the random rate of return on asset \( i \), \( E(R_i) \) is the expected rate of return on asset \( i \), \( b_{ik} \) is the sensitivity of asset \( i \) to factor \( k \), \( F_k \) is the systematic risk factor \( k \), and \( \epsilon_k \) is the random error term for asset \( i \) (unsystematic risk).
Whereas in the CAPM systematic risk was equivalent to market risk, under the APT it is the joint influence of all risk factors identified to be common to the assets in the portfolio. To acquire a riskless arbitrage portfolio it is needed to eliminate both diversifiable (i.e. unsystematic or idiosyncratic) and undiversifiable (i.e. systematic) risks.

In order to specify the factors there are two main directions. First, factors can be extracted by means of statistical procedures, such as factor analysis or principal component analysis (asymptotic principal component and standard principal component). Second, factors can be pre-specified using mainly macroeconomic variables.

Using factor analysis the hypothesis is that there are \( k \)-common hidden factors (not directly observable) that affect the stock prices. Particularly it is assumed that the common factors capture the cross-sectional covariances between the asset returns. Principal component analysis is a more technical approach. Nevertheless, there are no clear-cut research results which one should be better choice in APT analysis.

Chen (1983) is the first author who suggests an economic interpretation to statistical factors. The idea is that firm’s expected cash flows and discount rates, and hence expected returns, are sensitive to various macro-economic influences. In a widely quoted paper, Chen, Roll, and Ross (1986) use a six-factor model consisting of market index returns, changes in expected inflation, unexpected inflation, industrial production, the risk premium and the term structure premium. They find that the last three variables are significant determinants of U.S. stock returns. Chan, Chen, and Hsiech (1985) show that the size effect no longer exists in that model because it is captured by the risk premium.

Using an alternative technique based on the generalized method of moments (GMM), Zhou (1999) confirms that four out of the six macro-economic variables used by Chen, Roll, and Ross (1986) are relevant to explain U.S. stock returns. Other authors estimate the APT equilibrium relationship using non-linear seemingly unrelated regressions. They found that other variables, such as real final sales,
the budget deficit and nonfarm employment, are also important in explaining stock returns. As is the case for the statistical implementations, the macroeconomic models also have some important drawbacks:

(1) the factor structure is not robust to the portfolio formation criteria (Clare and Thomas, 1994),
(2) it changes over time (Chen, Roll, and Ross, 1986) and
(3) it suffers from the error-in-variables (EIV) problem (MacKinlay, 1995).

Papers that have implemented macroeconomic APT for other countries found that the same types of variables as those used by Chen, Roll, and Ross (1986) are priced as well as other more country-specific variables (e.g. the growth rate of money supply, gold prices and exchange rates of various countries).

Connor (1982) used a competitive equilibrium assumption to show that the elimination of infinite security assumption does not change the pricing relation if the market portfolio is well diversified in a given factor structure. A competitive equilibrium consist of set of portfolios such as that all portfolios are budget constraint optimal for every investor and security supply equal to security demand. In a competitive equilibrium, there exists an exactly linear pricing relation in such asset factors betas or sensitivities that APT model holds exactly.

Chen and Ingersoll (1983) have reached the same conclusion provided that a well-diversified portfolio exists in a given factor structure and this portfolio is the optimal portfolio for at least one utility maximizing investor. More specifically the pricing relation of the APT, given either of these diversified portfolio assumptions, is exact in the finite economy.

A major problem in testing Arbitrage Pricing Theory is that the pervasive factors affecting asset returns are unobservable. Most of the researchers like, for example, Chen (1983), Roll and Ross (1980), Reingaum (1981) and Lehmann and Modest (1988) have used the factor analysis to measure these economic common factors.
On the other hand, statistical APT has been criticized for many reasons: (a) the factors are not selected in the same order between two different samples, their sign is not reliable and they have scaling problems (Elton and Gruber, 1995), (b) the number of factors extracted and priced increases with the number of stocks in the sample (Dhrymes, Friend and Gultekin, 1984) and the length of the time series (Dhrymes, Friend, Gultekin, and Gultekin, 1985), (c) the estimates of the risk premium are sensitive to seasonality (Cho and Taylor-1987; Gutelkin and Gutelkin,1987) and to the choice of the criteria used to create portfolios (Lehman and Modest, 1988), and (c) they suffer from the standard error in variables (EIV) problem (Kothari, Shanken and Sloan, 1995, and MacKinlay, 1995).

Chamberlain and Rothschild (1983) and Ingersoll (1984) have extended Ross (1976) result by showing that APT model holds even for an approximate factor structure. In an approximate factor structure, it is assumed that the $\varepsilon_k$ in the last equation is correlated with each other. The notion of an approximate factor seems to be a significantly weaker restriction on the return generating process than the Ross strict structure. However, Griblatt and Titman (1983) demonstrate that any finite economy satisfying the approximate factor structure may be transformed into another finite economy satisfying in Ross strict factor structure in a manner that does not alter the characteristics of investors’ portfolios. In other words, a strict factor structure is equivalent to an approximate factor structure in an infinite economy.

Most of the empirical studies performed on the U.S. market conclude that a five-factor structure is appropriate to explain stock returns (e.g. Roll and Ross-1980; Connor and Korajczyk, 1988). The number of relevant factors differs in studies that have implemented statistical models for other countries. For the French market, Dumontier (1986) uses factor analysis and finds seven factors, but only three have significant risk premium. For Finland, Yli-Olli and Virtanen (1992) report four factors. For the U.K., Morelli (1999) finds six to nine variables.
according to a factor analysis, but only two to four with a principal component analysis.

In using maximum likelihood procedure, if one knows the factor loadings for say \( k \) portfolio, then one can compute the \( k \) factor loadings for all securities (Chen, 1983). We can employ factor analysis only on one group of securities or portfolios and the factor loadings of all securities will correspond to the same common factor. Since \( b_{ik} \) are not observable, we have to construct a proxy for the factor loadings. In factor analysis we can use estimated \( b \) as proxy, then run a cross-sectional regression of \( R_i \) on \( b_{ik} \). We can use autoregressive approach as well and derive proxy from the return generating process. The intuition behind this is that historical excess returns are useful in explaining current cross-sectional returns because they extend over the same return interval as \( b_{ik} \), and thus can be used as proxies for systematic risks. The substitution of access return for unobservable \( b_{ik} \) is similar in spirit to the technique of substituting mimicking factor portfolio return for unobservable factors used by Jobson (1982). After identifying the factor, we use the estimated factor loadings to explain the cross-sectional variation of individual estimated expected returns and to measure the size and the statistical significance of the estimated risk premium associated with each factor.
CHAPTER 2

EMPIRICAL LITERATURE REVIEW

2.1. Tests of Capital Asset Pricing Model

The capital asset pricing models have been subjected to extensive empirical testing in the past 50 years. These studies have suggested that a significant positive relation existed between realized return and systematic risk as measured by $\beta$, and relation between risk and return appeared to be linear. Most of early tests of CAPM have employed the methodology of first estimating betas by using time series regression and then running a cross section regression using the estimated betas as explanatory variables to test hypothesis implied by the CAPM. To the next paragraphs the empirical tests of CAPM and APT will be presented.

2.1.1 Statistical Weaknesses in empirical tests of CAPM

The initial tests of CAPM on individual stock in the excess return form have been conducted by Lintner (1965) and Douglas (1968). They have found that the intercept had a value larger than $R_f$, the coefficient of beta is statistically significant but has a lower value and residual risk has also an effect on security returns. Their results seem to be a contradiction to the CAPM model. But both the Douglas and Lintner studies appear to suffer from various statistical weaknesses that might explain their anomalies’ results: the measurement error that incurred in estimating individual stock betas is due to the fact that estimated betas and unsystematic risk are highly correlated and also to the skewness present in the distribution of observed stock returns. Thus Lintner's results have appeared to be in inconsistency with the CAPM.
Miller and Scholes (1972) in a classic article introduced an analysis of the statistical problems inherent in all empirical tests of the CAPM. They begin with a discussion of possible biases due to misspecification of the major estimation equations.

A possible source of equation misspecification, which could give an explanation for finding an intercept too high and a slope too low, may be the fact that the relationship between expected return and beta is, in fact, nonlinear. Miller and Scholes (1972) tested the nonlinearity and concluded that any nonlinearity that was present did not cause the increased intercept and the decreased slope.

Another possible source of misrepresentation could be the presence of heteroscedasticity. Heteroscedasticity is an often encountered problem in econometric tests. It occurs when the variance of the error is larger for higher values of the independent variable than it is for smaller values. In this case, it would mean that higher beta stocks have higher variance return, unexplained by the market, than lower beta stocks. Although Miller and Scholes obtained proof of heteroscedasticity they did not find that heteroscedasticity justified the high intercept and low slope. In fact, it biased the results in the other direction. Heteroscedasticity does reduce the estimate of the errors in the regression coefficients and so may lead to conclude that a relationship is statistically significant when, in fact, it is not.

Miller and Scholes (1972) next, considered the effect of possible errors in the definition of variables. One form of the bias was due to the error in measuring beta for the second pass regression (i.e. the cross-section regression). Any error in the estimate of beta will cause the coefficient of beta in the second pass regression to be downward biased and the intercept to be upward biased. Miller and Scholes showed that this had a significant consequence on the results they estimated, in the second-pass regression where beta coefficient was
only 64% of its true value, and this caused a proportionate increase in the intercept.

There is a second effect of the betas being measured with error that is also very important. To the extent that the true value of beta is positively correlated with a company’s residual variance will lead the residual variance to serve as a proxy for the true beta and the return will be positively correlated with residual risk. Thus, although return is not dependent on residual variance, residual variance may show up as being statistically related to return in cross-sectional regression analysis because residual risk acts as a proxy variable for the true, but unobserved, beta.

Miller and Scholes (1972), finally, showed that return distributions appeared to be positively skewed and, that the cross-sectional regression showed a relation between residual risk and return, even though there was no such relation.

2.1.2 Tests of Black, Jensen and Scholes

Black, Jensen and Scholes (1972) introduced the time series methodology of the CAPM, examining the restrictions on the intercepts of time-series market model regressions. They took as their basic time series model:

\[
R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it} \tag{2.1}
\]

This model is substantially identical to the equation regression of cross-sectional methodology except that excess returns are used in lieu of returns. The CAPM implies that the intercept \( \alpha_i \) is zero for every stock of portfolio.
Black, Jensen and Scholes (1972) formed portfolios in order to maximize the spread in betas across portfolios so they can test the effect of beta on return. The most obvious method to do this is to classify stocks into portfolios by true beta. They used five years of monthly betas to estimate the average betas of each stock and then classified individual stocks into deciles (from highest to lowest). Each decile was then considered one portfolio in the next (e.g., sixth) year. Then data for the second through sixth year was used to classify stocks and form deciles (portfolios) for the seventh year. This was done until deciles and the return for each decile was computed for 35 years. Thus, the return for decile one in each year was considered a series of returns from a portfolio, the return for decile two in each year considered a series of returns on a portfolio, and so on. Each of the 10 portfolios could then be regressed against the market and an intercept, a beta and a correlation coefficient for the equation was computed.

Black, Jensen and Scholes (1972) found how well the model explains excess return (the high value of correlations coefficients). This would tend to support the structure of the linear equation as a good explanation of security returns. However, the intercepts varied quite a bit from zero. In fact, when $\beta > 1$ the intercepts tend to be negative and when $\beta < 1$ the intercepts tend to be positive. This is exactly what most of the empirical results showed.

They repeated these tests for four subperiods and found the same type of behavior as for the overall period.

Concerning the cross-sectional tests (second pass regression) the major problem was the inability to recognize the true beta. This biased the intercept of the second-pass regression upward and its slope downward, and caused residual risk to serve as a proxy variable for beta risk. One way to reduce significantly the error in estimating beta is to measure betas for portfolios rather than for individual. As far as the errors in measuring each stock’s beta are random, they will cancel out and the aggregate error will be very small when betas are estimated for
portfolios. Black, Jensen and Scholes (1972) analyze the intercept of the second-pass regression over several subperiods. This analysis granted further evidence that the two-factor model is a better description of security returns than the one-factor model.

Stambaugh (1982) has employed slightly different methodology. He has estimated the market model and using Lagrange multiplier (LM) test has found evidence in support of Black’s version of CAPM, but has not agreed with the validity of Sharpe-Lintner CAPM. Gibbons (1982) has used a similar method as the one used by Stambaugh but instead of LM test he has used maximum likelihood ratio test and rejected the both standard and zero beta CAPM.

2.1.3 Tests of Fama and MacBeth

Fama and MacBeth (1973) used the two-stage cross-sectional methodology to test the CAPM. They formed 20 portfolios of securities to estimate betas from a first-pass regression, using the same procedure as Black, Jensen and Scholes (1972). Each of these regressions, one for each security, can be represented by the equation:

\[ r_i = \alpha + \beta ( R_m ) \]  \hspace{1cm} (2.2)

Where \(\alpha\) = the regression’s intercept
\(\beta\) = the regression’s slope coefficient
\(r_i\) = the monthly return on security \(i\)
\(R_m\) = the monthly return on market index

The second stage obtains estimates on the intercepts and slope coefficient of a single cross-sectional regression, in which each data observation corresponds to a stock. Equation (2.2) can be represented algebraically as:
\[ \bar{r}_i = \alpha + \beta (R_m) + \gamma \]  

(2.3)

Where

\[ \bar{r} = \text{the average monthly return of security } i \]
\[ \beta = \text{the estimated slope coefficient from the time series regression} \]
\[ R_m = \text{the monthly return on market index} \]
\[ \gamma = \text{the regression residual of security } i \]

If the CAPM is true, the second stage regression should have the following features:

- the intercept, \( \alpha \), should be the risk-free rate of return
- the slope, \( \beta \), should be the market portfolio’s risk premium
- \( \gamma \) should be zero since variables other than beta should not explain the mean returns once beta is accounted for.

### 2.1.4 Roll’s Critique

In a well-known paper, Roll (1977) has made a crucial methodological criticism of the empirical tests of Sharpe-Lintner-Black (SLB) model. He claimed that general equilibrium models of CAPM are not open to testing and the tests performed until now grant little support on CAPM. Roll (1077) raised some reasonable questions, and his arguments are well worth reviewing.

He argues that tests completed with any portfolio other than the true market portfolio are not tests of the CAPM. They are only tests of whether the portfolio selected as a proxy for the market is efficient or not. Since over an period of time efficient portfolios exist, a market proxy may be selected that satisfies all the implications of the CAPM model, even when the market portfolio is inefficient. On the other hand,
an inefficient portfolio may be selected as a proxy for the market so that the CAPM will be rejected when the market itself is efficient. Roll (1977) demonstrates that the high correlation that exists among most reasonable proxies for the market does not denote that the choice of a proxy is unimportant. Though they are highly correlated, some may be efficient while others are not.

On the other hand, Stambaugh (1982) has shown that tests of the SLB model are not sensitive to the proxy used for the market and have suggested that Roll’s criticism is too strong. He has expanded the type of investments included in his proxy from stocks listed on New York Stock Exchange to corporate and government bonds to real estate and to durable goods such as house furnishing and automobiles. His results have indicated that the nature of conclusion is not materially affected as one expands the composition of the proxy for the market portfolio.

The conclusion of Roll’s work is that equilibrium theory is not testable if not the precise structure of the true market portfolio is not known and used in the tests. The logic behind Roll’s report is that we don’t know the structure, much less the return, on the true market portfolio. Most tests of CAPM use some portfolio of common stocks as the market, but the true market contains all risky assets. These include not only traded assets like stocks, bonds, and preferred stocks, but assets on which data are not as readily available, such as diamonds, gold, old coins and items such as human capital.

Several efforts have been made to deal with Roll’s criticism of tests of the CAPM. Many tried alternative definitions of the market portfolio to test for linearity or the reasonableness of the intercept. The most imaginative effort to deal with this problem is an approach advocated by Shanken (1987). He recognized that the acceptance or rejection of the CAPM depends on how well the proxy for the market replicates the true but unobserved market portfolio. Shanken (1987) forms a joint test that permits acceptance or rejection of the joint
hypothesis that the correlation of the proxy with the market portfolio exceeds some limit and the CAPM is valid.

Shanken’s rationale is adequately flexible that it allows sets of variables (or portfolios) to be tested as proxies for the market portfolio. For example, Shanken repeats his tests using a mixture of the CRSP (Center for Research in Security Prices) equally weighted stock portfolio and the return on long-term government bonds as a proxy for the market portfolio. He concludes that the results are substantially similar (rejection of CAPM) with the more complex proxy rather than just the stock portfolio.

### 2.1.5 Anomalies of CAPM

The empirical attack on the SLB model has started with the studies that have identified variables other than market $\beta$ to explain the cross-sectional expected returns. These variables are called *anomalies* of the traditional CAPM.

Banz (1981) has found that firm’s size (ME), which is its stock’s price multiplied by the number of shares outstanding, could help explaining expected returns provided by market $\beta$s.

Expected returns on small stocks are too high given their $\beta$ estimates, and expected returns on large stocks are too low. Basu (1983) found that apart from the size effect, shares with high earnings to price (E/P) ratios, on average, gave higher adjusted returns than those with low E/P ratios. Ball (1978) argues that E/P is a catch-all proxy for unnamed factors in expected returns; E/P is likely to be higher for the stocks with higher risks and expected returns, whatever the unnamed sources of risk. There is also a size-related “January effect” documented in empirical research by Keim (1983, 1986), Reinganum (1983), and Roll (1982-1983). They have shown that small capitalization
firms earn “exceptionally large returns” at the beginning of January each year. There is also evidence suggesting that short-term contrarian strategies realize positive abnormal returns. For the short-horizon returns, Jegadeesh (1990) and Lehmann (1990) found that strategies that choose stocks that did poorly over the past month or week, do well in the following month or week. Bhandari (1988) has explored that leverage is positively related to expected stock returns.

Fama and French (1992) claimed that after accounting for expected returns based on a firm’s capitalization and its book-to-market ratio, the stock’s betas, and the other characteristics (earnings-to-price ratio and leverage) have almost no ability to explain expected returns across stocks.

They have found that might be a negative relation between beta and stock returns after controlling for firm capitalization. In their study, large capitalization firms with high betas realized very poor returns over the time period from 1963 to 1990. They formed portfolios on the basis of size (ME) and book-to-market ratio (BE/ME) and they have found that the effect of book-to-market ratio on stock returns is substantially stronger for the small capitalization firms.

### 2.2 Tests of Arbitrage Pricing Theory

#### 2.2.1. APT Tests that use Factor Analysis

Roll and Ross (1980) issued one of the initial APT tests using factor analysis. Because of the computational restrictions of standard statistical factor analysis programs, they were compelled to estimate factors on small numbers of stocks. They applied factor analysis to 42 groups of 30 stocks each, using daily data for the time period from July 1962 to December 1972. The results of their first-pass test are rather
striking. These tests showed that, in over 38% of the groups, there was less than a 10% chance that a 6th factor had explanatory power and in over three-fourths of the groups there was a 50% chance that 5 factors were sufficient. While Roll and Ross (1980) test various different second-past tests, their major results are that, at least, three factors are important for the APT’s risk-expected return relation, but probably no more than four are important. Sententiously, it seems that they found more factors significant than someone would expect to find under the standard CAPM model or the zero-beta version of the CAPM.

Chen (1983) claimed that his factors explain the “size effect”: after controlling for differences in factor sensitivities between large and small firms, the return premium for size becomes negligible. However, Lehmann and Modest (1988) argued that there is still a “size effect”, even after controlling for these differences.

Lehmann and Modest (1988) applied the idea of forming portfolios of assets that mimic factor realizations (returns). By creating a portfolio that has minimum residual risk for each factor, they can then use this set of portfolios as independent variables to estimate the sensitivities of each of a large number of securities to each influence (factor). Each portfolio is identified by finding a set of weights aggregating to one across stocks, so that the portfolio has minimum residual risk and a sensitivity of zero to all factors except the one under study. Lehmann and Modest (1988) tried to explain certain phenomena not explained by the standard CAPM. They proved that a multi-index APT could explain away differences due to dividend yield and own variance, but the extra return on small firms and the “January effect” are only partially explained by the model. On efficient markets the standard CAPM does not adequately justify extra returns related with high dividends, the stock’s own variance, small size (low capitalization), and the “January effect”. The ability of the Lehmann and Modest’ s model to explain some factors not explained by the CAPM is in fact support to the model as an alternative to the simple CAPM.
Connor and Korajdzyk (1986) provided a test of APT using the asymmetric principle components technique proposed by Chamberlain and Rotschild (1981). They found that using five factors, they can explain the extra return on small firms and in January better than th CAPM based on a value-weighted index.

### 2.2.2 APT Tests with Macroeconomic Factors

Chen, Roll and Ross (1986), have assumed and analyzed a number of macroeconomic variables. They found that stock prices are significantly related to:

1. **Inflation.** Inflation impacts both the level of the discount rate and the size of the future cash flows.
2. **The term structure of interest rates.** Differences between the rate on bonds with a long maturity and a short maturity affect the value of payments far in the future relative to near-term payments.
3. **Risk premium.** Differences between the return on safe bonds (Aaa) and more risky bonds (Baa) are used to measure the market’ s reaction to risk.
4. **Industrial production.** Changes in industrial production affect the opportunities facing investors and the real value of cash flows.

They found a significant relationship between the hypothesized macroeconomic variables and the statistically identified systematic factors- extracted by the factor analysis used by Roll and Ross (1980) in stock market returns.

Following, they examined whether returns are related to the sensitivity of a stock to their macroeconomic variables. The process is similar to the two-stage process used by Fama and MacBeth (1973) to examine the CAPM. In the first stage, time-series regressions are run for each of a series of portfolios to estimate each portfolio’ s sensitivity to each macroeconomic variable. Then the market price of risk is estimated by running a cross-sectional regression each month and
looking at the average of the market price in each month. Chen, Roll, and Ross (1986) found that the macroeconomic variables have strong explanatory influences on pricing. In addition, when added to the regression, the return of the market index could not explain expected returns. They also performed tests using consumption and oil prices as factors and found that neither affected the expected returns of common stocks.

Merton (1973) has constructed a generalized intertemporal asset pricing model in which factors other than market uncertainty are priced. In his model individuals are solving their lifetime consumption decision in a multi-period setting. In this multiperiod setting uncertainty exists about not only the future value of securities, but also about such others influences as future labor income, future prices of consumption goods, future investment opportunities, and so on. He has shown that return on assets depend not only on the covariance of asset with the market but also with the covariance with changes in investment opportunity set and thus can be interpreted as another form of APT.

Chan, Chen, and Hsiech (1985) tested the “size effect” in the context of the Roll and Ross (1980) model. They created 20 size-sorted portfolios and estimated the factor sensitivities of each portfolio to the five factors, which were found by Roll and Ross (1980), as well as the equal-weighted NYSE portfolio. They found that the difference in residuals between the portfolio of smallest firms and that of the largest is positive, but not statistically significant, They also conducted a test using the logarithm of firm size as an independent variable and found its coefficient to be insignificantly different from zero in the multivariate model. The authors concluded that the multivariate model explains the size anomaly.

A more recent research of Jagannathan and Wang (1996) employs some of the Chen, Roll, and Ross (1986) macrovariables to forecast time series changes in the risk premius related to the variables and
inserts an additional macrovariable, the aggregate labor income, to explain the average stock returns. A number of interesting comments come from Chan, Chen, and Hsieh (1985) and Jagannathan and Wang (1996) papers, which provide some insights about the small firm effect:

- Small company stock returns seem to be highly correlated with changes in the spread between Baa and default-free bonds.
- The spread seems to be a fairly good predictor to future market returns.
- Small companies have higher market betas when the spread is higher.
- Small company stock returns seem to covary more with labor income than do the returns of large company stocks.

The first and last points denote that it is possible, at least in part, to explain the small firm effect using APT-type model that identifies the default spread and labor income as systematic factors associated with positive risk premiums. The middle two comments propose that small firms, in essence, successfully “time the market”. In other words, small firms have higher betas when the market risk premium is highest. The explanation of the small firm effect that comes from these studies is that small capitalized stocks have higher returns than large capitalized stocks because they are riskier in two aspects: (1) their returns are more sensitive to short-term business cycle and credit movements that seem to be captured by the spread between high and low-grade bonds and changes in aggregate income; (2) small capitalized stocks are especially sensitive to movements in the overall market when the market is the most risky. This means that the CAPM beta of the stock of a typical small company underestimates the stock’s true risk.
2.2.3 Other Tests of Arbitrage Pricing Theory

Huberman, Kandel, and Stambaugh (1987) created three factor portfolios based on market capitalization: small firms, medium-sized firms, and large firms. They used the returns of these portfolios as factors to explain the returns of other portfolios formed on the basis of firm size. They found that the size effect could not be captured fully by three size factors.

Some other tests of APT tried another alternatives in order to specify a set of portfolios that a priori are thought to affect the stock returns. These set of portfolios selected on the basis of a belief about the types of stocks and/or the economic influences that affect stock returns.

Fama and French (1993) used this approach to construct a model in order to explain returns on both common stocks and bonds. They identified five common risk factors in the returns on stocks and bonds. More specifically, they found 3 stock-market factors: 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. They construct 3 zero-cost (i.e., self-financing) portfolios, which are:

- the difference in return on a portfolio of small stocks and a portfolio of large stocks (small minus large)
- the difference in return between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks (high minus low)
- the difference between the monthly long-term government bond return and the one-month Treasury-bill return.

It is worth mentioned, that these tests are fundamentally different from the approach of factor portfolios, which have been stated above, of
Lehmann and Modest (1988) and Huberman, Kandel, and Stambaugh (1987). In these approaches either factor analysis is used to extract factors or macroeconomic variables are hypothesized as significant but mathematic programming problem is solved in order to find portfolios that mimic the underlying factors.

The unique aspect of this model is in the formulation of the variables representing size and book-to-market ratios, Fama and French (1993) covered the size component from a direct measure to a return concept by constructing a portfolio to capture this influence.

In this article Fama and French (1993) examined the model, which described above, in a number of time series tests. The cross-sectional implications are tested by examining whether the intercepts of the time-series of excess returns indeed equals zero as APT would suggest. They found that in fact the intercepts was zero and that this portfolio was successfully explained expected stock returns. More specifically, they conclude that “at a minimum, our results show that five factors do good job explaining: a) common variation in bond and stock returns and b) the cross-section of average returns”.

Daniel and Titman (1997) reconsidered the Fama and French (1993) characteristic-based factor portfolios and asked whether the betas related to the characteristics portfolios or the characteristics themselves determine expected stock returns. In other words, they asked whether high or low expected returns are related to small firms that have stock returns patterns that are similar to large firms and high book-to-market firms that have return patterns that look more like the return patterns of low book-to- market firms.

The APT and the CAPM suggest that the return patterns, not the characteristics, determine expected returns. Therefore, stocks with return patterns that look like small firms should have expected returns similar to other small firms regardless of whether they are large or small. However, some of the stories suggest that small firms have high returns for reasons other than risk, so that a small firm that trades like a large firm should still have high expected returns.
The evidence provided by Daniel and Titman shows that it is the characteristics rather than the factor betas on the characteristic-based factor portfolios that determine expected returns. Specifically, they found that stocks with low book-to-market ratios, but high betas with respect to the book-to-market factor portfolio, tended to have returns similar to other low book-to-market stocks. Similarly, the returns on high book-to-market stocks also were insensitive to their betas with respect to the book-to-market factor portfolios while stocks ranked on the basis of size were found to be insensitive to their betas with respect to the size factor portfolio.

Using SLB model some studies have been done to evaluate investment performance of mutual fund, pension funds and endowment funds. Jensen (1968,1969), Chang and Lewellen (1984), Ippolito (1989) are important in this area of mutual fund industry. Investment performance of pension funds was examined by Beebower and Bergstrom (1977) and Ippolito and Turner (1987). The evidence suggests that the univariate Sharpe-Lintner model has many problems in explaining cross-section of expected stock return while the multivariate model appears to do a better job in evaluating investment performance. For example, the three-factor performance evaluation method of Elton, Gruber, Das and Hklarka (1991) has given more insight in this issue.

Regarding the empirical tests of selected stock exchanges, Green (1990) have tested CAPM on UK private sectors data and found that the the SLB model does not hold. Sauer and Murphy (1992) have investigated this model in German stock data and conformed CAPM as the best model describing stock returns. Another contradictory evidence has been found by Hawawini (1993) in equity markets in Belgium, Canada, France, Spain, UK and USA. Some other studies, which tested CAPM for emerging markets are Sareewiwathana and Malone (1985) for Thailand stock exchange, Bark (1991) for Korean Stock Exchange

2.3 Summary

Although tests of CAPM have some drawbacks because the market portfolio is not directly observable, they provide valuable insights about the appropriateness of the theory as implemented with the specific proxies used in the test. There are substantial differences between a multifactor APT and the standard CAPM that favor the use of the APT in lieu of the CAPM. However, it appears that firm characteristics such as size and book-to-market equity explain average returns more successfully. In the following section we discuss the research methodology adopted for the empirical testing of CAPM in the ASE. We describe the data and the data collection method used. Finally, we present and discuss critically the results of our data analysis and discuss critically the results of our data analysis.
CHAPTER 3

RESEARCH METHODOLOGY

Introduction

In the previous sections an attempt was made to fully cover the theoretical and the empirical literature review concerning the capital asset pricing models and arbitrage pricing models. In this section 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 of our research. This study concerns stocks traded in the ASE during the time period 1993-2001.

3.1 Data

Our data are monthly closing prices of all common stocks (financial stocks are excluded due to the leverage in these firms being a likely indicator of financial distress in non-financial firms) traded in the ASE. They are row prices in the sense that they do not include dividends but are adjusted for capital splits and stock dividends. The data was taken from Datastream data bank. The estimation covers the period from July 1993 to December 2001. For further observations and results the examining period is divided into three sub-periods: The first one (1993-1999) which includes all the bubble period (98-99) of the ASE. Bubble period (98-99) is the period at the history of ASE where many Greek companies (bubbles) entered ASE through the manipulation of their financial statements. The second period (94-00) includes the bubble period and the first phase of the decline, and the third one (95-01) includes the (2000-2001)
where a slam of the price of the shares has happened and this period also includes a short time stability phase and of course the bubble period that finally led to the total stock-market crash.

The sample consists of 88 stocks continuously listed in the ASE. For an asset to be included in the initial sample, it is required that there must be data from the first month of the examining period until the last (this is why many stocks that were listed on the ASE in Dec 1999 are not included in the initial sample). As is customary with studies in this area (Fama and French (1992)), firms with a negative book value of equity are also excluded. The market return is obtained from the ASE General Share Price Index. Returns are calculated using the logarithmic approximation

\[ R_{it} = \log \left( \frac{P_{i,t}}{P_{i,t-1}} \right) \]  

(3.1.1)

where \( P_{i,t} \) is the end-of-month \( t \) price for asset \( i \).

The time-series of the firm-size variable for each asset is obtained from Datastream (Market Value (MV) files). MV is the market price of a common stock times the number of shares outstanding. It is calculated in Euros. Book values of common stocks are obtained from the Monthly Statistical Bulletins of the ASE where Book value is given as net tangible assets = fixed assets – depreciation + longer-term investments + current assets – current and deferred liabilities and prior charge and minority interest. For companies with more than one class of equity capital, the market value is expressed according to the individual issue. The book-to-market ratio is calculated as the book value of a common stock in 31/12 of each year, divided by its market price for the corresponding date.

We use logarithms for the firm-size and book-to-market variables because it leads to a simpler interpretation of their impact on average returns and it is shown to be a a better functional form in most of the empirical studies.

Summing up, the explanatory variables used in the asset pricing tests are: \( \log(ME) \) and \( \log(BM) \), where ME stands for the total market
capitalization of common equity on 31/12 of each year and BM for the book-to-market ratio.

Although most previous studies have used returns on portfolios as regressors in the FM regressions, the current analysis has been conducted using data on individual stocks in the asset pricing tests. This has been commanded for two main reasons: (a) the small sample size (88) stocks is quite restrictive in forming portfolios, (b) there is no reason to smudge the information in variables like size and book-to-market ratio by using portfolios, since they are measured precisely for individual stocks (the use of Shanken's adjusted standard errors overcomes the problem associated with the loss of precision in the estimation of market betas in (a)).

Furthermore, as Lo and MacKinlay (1990) suggest, grouping securities based on some empirically motivated fundamental variables (such as size or book-to-market ratio) may cause biases in the test statistics since it spuriously exaggerates the relationship between portfolio returns and the firm-specific characteristics.

To detect any possible effects of interdependence between the explanatory variables that might spuriously affect the results of estimation and the significance of the estimated coefficients, we estimate the averages of the cross-sectional correlations between market betas, size and book-to-market. These correlations are reported in Table 1.

**TABLE 1**

Correlation Matrix for the Independent Variables

This table shows the arithmetic averages of the monthly cross-sectional correlations between the explanatory variables in the cross-section regression equation

\[ R_{it} = \gamma_0 + \gamma_m \beta_{im} + \gamma_{size} \log(ME_i) + \gamma_{BM} \log(BMR_i) + \eta_{it} \]
Where \( ME_i \) denotes the total market capitalization of common equity and \( BMR_i \) the book-to-market ratio for asset \( I \) in 31/12 of the year in which the \( t_1,\ldots,t_{12} \) months belong.

Table I: I-O correlation matrix of

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>β</th>
<th>Log(ME)</th>
<th>Log(BMR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>-0.027</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log(ME)</td>
<td>-0.015</td>
<td>-0.014</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Log(BMR)</td>
<td>0.174</td>
<td>0.019</td>
<td>-0.568</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1 shows that the average of the monthly cross-sectional correlations between \( \log(ME) \) and \( \log(BM) \) is \(-0.568\). This correlation implies that firms with small market capitalization are more likely to have poor prospects, resulting in low stock prices and high book-to-market ratios. Conversely, large stocks are more likely to have stronger prospects, signaled here by higher stock prices, lower book-to-market ratios and lower stock returns.

### 3.2 Econometric Methodology and Estimation Procedure

The asset-pricing tests performed in this paper use the cross-sectional regression methodology of Fama and MacBeth (1973). Its implementation involves two steps of estimation. In the first step, given \( T \) periods of observations, the least squares estimates of market betas, denoted by \( \beta_{im} \), are obtained by running the following regression equation for each \( i \) over the sample period \((t=1,2,\ldots,n)\)

\[
R_{it} = \alpha_{im} + \beta_{im}R_{mt} + \epsilon_{it}, \quad i=1,2,\ldots,n \quad (3.2.1)
\]
where $R_{it}$ and $R_{mt}$ are the return on asset $i$ and the market at the end of month $t$, respectively, $\alpha_{im}$ is a constant, and $\beta_{im}$ is the risk of asset $i$ relative to the total risk of the market portfolio and $\varepsilon_{it}$ is a random disturbance that has expected value equal to zero and is independent of $R_{mt}$.

In the second step, the above estimates together with the firm specific characteristics enter into the following cross-sectional regression equation as explanatory variables

$$R_{it} = \gamma_0 + \gamma_m \beta_{im} + \gamma_{size} \log(ME) + \gamma_{BM} \log(BM) + \eta_{it}$$

where $\gamma_i$ are the associated with each variable slope coefficients. For case of market betas $\gamma_m$ is the market price of risk.

Since returns are normally distributed and temporally independently and identically distributed across time (IID), the $\gamma_i$ coefficients will also be normally distributed and IID. Hence, the time-series means of the monthly regression slopes can be tested using the common t-test and inferences can be made in the usual fashion.

The t-statistic is given by

$$t(\bar{\gamma}_j) = \frac{\bar{\gamma}_j}{\sigma_{\bar{\gamma}_j} / \sqrt{T}}$$

(3.2.3)

where $\bar{\gamma}_j = \frac{\sum_{t=1}^{T} \hat{\gamma}_{jt}}{T}$ is the sample mean over time of the cross-section least squares estimates of the coefficients $\gamma_i$ of equation (3.2.2), denoted by $\hat{\gamma}_{jt}$, and $\sigma_{\bar{\gamma}_j}$ is the standard deviation of $\bar{\gamma}_j$. If successive values of $\gamma_i$ are independent and identically distributed normal random
variables then the t-statistic of (3.2.3) follows a student distribution with $n-1$ degrees of freedom. In addition, under the assumption that the disturbance term $\eta_{it}$ is IID across $t$, the distribution of $l(\hat{\gamma}_t)$ is asymptotically normally distributed.
CHAPTER 4

Statistical Analysis and Results

This section is divided into two parts. In the first one, the role of size and book-to-market equity is evaluated in two-variable regressions using market betas and each of the firm-specific characteristics separately. This analysis will reveal if the well-documented CAPM regularities exist in the ASE (Table 3). In the second part, we examine the joint role of the firm-specific characteristics on expected returns using multi-variable regressions (Table 4). This procedure enables us to disentangle the impact of these variables on stock returns.

4.1 CAPM Regularities in the ASE

In this section the cross-sectional regression models that are estimated are:

\[ R_{it} = \gamma_0 + \gamma_m \beta_{im} + \gamma_{size} \log(\text{ME}_i) \]  (4.1.1)

\[ R_{it} = \gamma_0 + \gamma_m \beta_{im} + \gamma_{BM} \log(\text{BM}_i) \]  (4.1.2)

If there is no relationship between \( \log(\text{ME}_i) \), \( \log(\text{BM}_i) \) and the expected returns the above equations collapse to the known two-parameter model. Thus these tests can be regarded as robustness tests of the two-parameter against the above variables. We assume a linear relationship between expected returns and \( \log(\text{ME}_i) \) and \( \log(\text{BM}_i) \). Linearity is assumed only for reasons of convenience, since there is no theoretical reason why the relationship should be linear.

Estimates of equations 4.1.1 and 4.1.2 are presented in table 2. The table shows the time-series averages of the coefficients \( \gamma_0, \gamma_m, \gamma_{size}, \)
and $\gamma_{BM}$, denoted $\overline{\gamma}_0$, $\overline{\gamma}_m$, $\overline{\gamma}_{size}$ and $\overline{\gamma}_{BM}$ respectively, and their associated adjusted t-values. All the $\overline{R}^2$ and the estimates of the average slopes are reported as percentages. From this table (2) with one regressor, becomes obvious the significance of BMR t-statistic=1.5757 and $R^2$=6.68% while the results for size are –0.0274 and 0.37% and for $\beta$ is 0.4139 and 1.53% respectively.

Table 2: RESULTS for N-2 regressors

*** RES: 1 regressor, 93-01

<table>
<thead>
<tr>
<th></th>
<th>$\gamma_0$</th>
<th>$\gamma_M$</th>
<th>$\gamma_{size}$</th>
<th>$\gamma_{BM}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate</td>
<td>0.0126</td>
<td>0.0341</td>
<td></td>
<td></td>
<td>0.0153</td>
</tr>
<tr>
<td>t-statistic</td>
<td>1.2409</td>
<td>0.4139</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>0.0165</td>
<td>-0.0006</td>
<td></td>
<td></td>
<td>0.0037</td>
</tr>
<tr>
<td>t-statistic</td>
<td>0.1069</td>
<td>-0.0274</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>-0.2408</td>
<td>0.0933</td>
<td></td>
<td></td>
<td>0.0668</td>
</tr>
<tr>
<td>t-statistic</td>
<td>-1.5156</td>
<td>1.5757</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1**
The trend of BMR, MV, beta BMR and beta MV during the sub-periods 93-99, 94-00 and 95-01.

<table>
<thead>
<tr>
<th></th>
<th>BMR</th>
<th>ME</th>
<th>betaBMR</th>
<th>betaME</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>0.0862</td>
<td>0.1152</td>
<td>0.0166</td>
<td>0.0129</td>
</tr>
<tr>
<td>97</td>
<td>0.0938</td>
<td>0.0167</td>
<td>0.0284</td>
<td>0.0403</td>
</tr>
<tr>
<td>98</td>
<td>0.1003</td>
<td>0.0059</td>
<td>0.0193</td>
<td>0.0377</td>
</tr>
</tbody>
</table>
NOTES

The chart shows, the value of the cross-sectional regression coefficient (one variable only, BMR or MV respectively), plotted for the years 96,97,98-middles of the periods 93-99,94-00 and 95-01. The BMR follows the "going up" tendency while MV does not. On the other hand the coefficients of these variables seem to be to some way correlated.

Table 3: RESULTS for N-1 regressors

*** RES: 2 regressors, 93-01

<table>
<thead>
<tr>
<th></th>
<th>$\gamma_0$</th>
<th>$\gamma_M$</th>
<th>$\gamma_{SIZE}$</th>
<th>$\gamma_{BMR}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate</td>
<td>0.0164</td>
<td>0.0366</td>
<td>-0.0005</td>
<td></td>
<td>0.0194</td>
</tr>
<tr>
<td>t-statistic</td>
<td>0.1000</td>
<td>0.4407</td>
<td>-0.0240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>-0.2418</td>
<td>0.0276</td>
<td></td>
<td>0.0946</td>
<td>0.0819</td>
</tr>
<tr>
<td>t-statistic</td>
<td>-1.5175</td>
<td>0.3521</td>
<td></td>
<td>1.5564</td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>-1.2321</td>
<td>0.1037</td>
<td>0.1863</td>
<td></td>
<td>0.1219</td>
</tr>
<tr>
<td>t-statistic</td>
<td>-1.4322</td>
<td>1.1765</td>
<td></td>
<td>1.7398</td>
<td></td>
</tr>
</tbody>
</table>
### *** RES: 2 regressors, 93-99

<table>
<thead>
<tr>
<th></th>
<th>$\gamma_0$</th>
<th>$\gamma_M$</th>
<th>$\gamma_{\text{SIZE}}$</th>
<th>$\gamma_{\text{BMR}}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimate</strong></td>
<td>-0.7559</td>
<td>0.0129</td>
<td>0.1152</td>
<td>0.1146</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-1.3808</td>
<td>0.1370</td>
<td>1.4346</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td>-0.2327</td>
<td>0.0166</td>
<td></td>
<td>0.0862</td>
<td>0.0697</td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-0.3544</td>
<td>0.1769</td>
<td></td>
<td>0.3813</td>
<td></td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td>-1.1750</td>
<td>0.1211</td>
<td>0.1263</td>
<td>0.1245</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-1.5439</td>
<td>1.3089</td>
<td>1.0106</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### *** RES: 2 regressors, 94-00

<table>
<thead>
<tr>
<th></th>
<th>$\gamma_0$</th>
<th>$\gamma_M$</th>
<th>$\gamma_{\text{SIZE}}$</th>
<th>$\gamma_{\text{BMR}}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimate</strong></td>
<td>-0.1091</td>
<td>0.0403</td>
<td>0.0167</td>
<td>0.0264</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-0.5185</td>
<td>0.4642</td>
<td>0.5932</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td>-0.2512</td>
<td>0.0284</td>
<td></td>
<td>0.0938</td>
<td>0.0945</td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-1.1948</td>
<td>0.3539</td>
<td></td>
<td>1.0174</td>
<td></td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td>-1.3293</td>
<td>0.1142</td>
<td>0.1875</td>
<td>0.1515</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-1.1489</td>
<td>0.9618</td>
<td>1.1406</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### *** RES: 2 regressors, 95-01

<table>
<thead>
<tr>
<th></th>
<th>$\gamma_0$</th>
<th>$\gamma_M$</th>
<th>$\gamma_{\text{SIZE}}$</th>
<th>$\gamma_{\text{BMR}}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimate</strong></td>
<td>-0.0314</td>
<td>0.0377</td>
<td>0.0059</td>
<td>0.0220</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-0.1317</td>
<td>0.3903</td>
<td>0.1809</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td>-0.2556</td>
<td>0.0193</td>
<td></td>
<td>0.0916</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-1.4648</td>
<td>0.2230</td>
<td></td>
<td>1.3718</td>
<td></td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td>-1.3848</td>
<td>0.1187</td>
<td>0.2022</td>
<td>0.1416</td>
<td></td>
</tr>
<tr>
<td><strong>t-statistic</strong></td>
<td>-1.2758</td>
<td>1.0459</td>
<td>1.6992</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
With respect to the size effect (Table 2), the results of the table show that there is no evidence of a size effect. For the full examining period (93-01) the t-statistic of $\gamma_{\text{size}}$ is $-0.024$, which provides weak evidence of an existence of a size effect in the Greek stock market, contrary to the evidence from more developed capital markets. The sign of $\gamma_{\text{size}}$ is negative which means that the shares of firms with large market values have the tendency to earn smaller risk adjusted returns, on average, than similar shares for smaller firms over the whole exam period. It may also be a relative-prospects effect, as the earnings prospects of distressed firms are more sensitive to economic conditions. In this sense, small firms tend to be riskier than large firms and the risk of smaller firms is not likely to be captured by a market index heavily weighted towards large firms (Chan and Chen (1991)). For the sub-periods examined separately this does not occur, the sign of $\gamma_{\text{size}}$ remains positive resulting to total different remarks than those that have been made above (it is remarkable here the t-statistic $-1.4346$ – for the second period which includes the whole bubble period 98-99). From the table 2 we also exact the insignificance of size in regression with beta for all the periods except the second one (where t-statistic is 1.4346) and its significance whenever it is regressed with BMR (this occurs because these two variables are high-correlated - Table 1)

With respect to the book-to-market effect (Table 3), the results clearly indicate that there is a strong cross-sectional relation between average returns and book-to-market ratio. This is clear for the whole sample period and the sub-periods too. The BMR effect seems to be thinner during the period 93-99 but its “come back” is obvious during the next two periods. The share’ s returns of companies with high BMR are higher following the general market tendency during the second phase of the “bubble period” and on the other hand during the “crash” period their prices’ downcomining was slower than the other ones that had low BMR.

The high t-statistics show that this effect is more powerful than the size effect. This fact becomes “stronger” remarking that the high t-
statistics of BMR occur independently whichever other variable comes in regression with BMR. The most prominent justification of the relation between stock returns and book-to-market ratio is that it captures the relative distress factor affecting stock returns. Chan and Chen (1991) provided evidence that there is covariation in returns related to relative distress which is not captured by the market return and is compensated in average returns. Furthermore, low book-to-market equity is typical of firms that have persistently strong earnings while a high BMR is associated with persistently lower earnings and higher expected stock returns, since these firms are penalized with a higher cost of capital (Fama and French (1995)).

The existence of BMR determines the $R^2$ for all the periods except the period 93-99 (see the column of $R^2$ – Table 2).

Finally, Table 3 shows that market betas have no estimating role in explaining average returns in the ASE. Fama and French (1992) argued that the non-explanatory power of beta may be due to the fact that the true betas are correlated with the firm-specific-characteristics. This obscures the relation between average returns and measured betas if market betas are estimated with big errors. $\gamma$ is positive and insignificant for all of the two-variable cross-sectional regressions (for all the examining periods). In short, our tests support the central prediction of the Sharpe-Lintner-Black model, that average stock returns are positively related to market $\beta$s. The insignificance of $\gamma_m$, has been the subject of many searchers. Reinganum, (1981), Chen (1986), and Lakonishok and Shapiro (1986), among others, provide evidence of market betas’ inefficiency to describe the cross-variation of average returns.
4.2 The Joint Role of Firm-Size and Book-to-Market Ratio on Expected ASE Returns

Suppose that the evidence in Table I showed that the explanatory variables in (3.2.2) are, to a degree, correlated. To control for any effects of multicollinearity on the estimates of (3.2.2), a stepwise estimation is followed where a sequential estimation of (3.2.2) is conducted. If there is interdependence across the explanatory variables, the stepwise estimation procedure is a convenient tool to assess the marginal explanatory power of each of the firm-specific characteristics as it can reveal which variables play the most important role in explaining the cross-section variation of expected returns.

The stepwise estimates of equation (3.2.2) are summarized in Tables 2 and 3. Table 2 examines each variable separately and alone against the stock’s average return. From the Table 2 the BMR (t-statistic=1.5757, \( R^2 = 6.68\% \)) seems to be the most powerful variable. Several interesting conclusions can be drawn from the table 3. First, the reliable positive relation between the book-to-market ratio and average stock returns persists no matter which other explanatory variables are used in the regressions. \( \bar{y}_{BM} \) is always more than one standard errors from 0 for all the cross-sectional regressions which are estimated (except the bubble period t-statistic=0.3813). The book-to-market ratio is thus the most powerful variable in explaining the cross-section variation of average returns in the ASE. Its influence is so strong, that when it is included with other variables in a regression, their average slopes become more significant (Table 4 all the periods for t-statistics) explaining bigger number of data (Table 4, \( R^2 \) from 13.68\% to 16.94\% for the period 94-00). Second the BMR and MV are the more powerful variables in the cross-section. The fact becomes obvious whenever these variables are coming both in regression. From Table 2 and the column of \( R^2 \) and for all the examining periods (full sample period and sub-periods) we can see easy the differences between the various \( R^2 \)
when BMR is in regression with MV or $\beta$. (For the whole period 93-01, when BMR is regressed with MV $R^2=0.1219$, when BMR is regressed with market beta $R^2=0.0819$ while $R^2=0.0194$ when MV is regressed with market $\beta$). For the sub-periods the results seem to be almost the same except the period 93-99. Even in this anomalous period the $R^2=0.1245$ explaining the existence of BMR and MV in the cross-section. Nearly to that $R^2$ is the $R^2$ (0.1146 extremely high) which is coming from the regression of MV to market $\beta$.

Table 4: RESULTS - all regressors

The Joint Role of $\beta$, Size and Book-to-Market on Average Stock Returns (Multi – Variable Regressions)

This table gives stepwise estimates of the cross–sectional regression model

$$R_{it} = \gamma_0 + \gamma_m \beta_{im} + \gamma_{SIZE} \log(ME_i) + \gamma_{BM} \log(BM_i) + \eta_{it}$$

The coefficient estimates and $R^2$ are reported as percentages.

*** RES: all regressors, 93-01

<table>
<thead>
<tr>
<th>Estimate</th>
<th>( \gamma_0 )</th>
<th>( \gamma_m )</th>
<th>( \gamma_{SIZE} )</th>
<th>( \gamma_{BM} )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-statistic</td>
<td>-1.3959</td>
<td>0.2870</td>
<td>1.1531</td>
<td>1.6983</td>
<td></td>
</tr>
</tbody>
</table>

*** RES: all regressors, 93-99

<table>
<thead>
<tr>
<th>Estimate</th>
<th>( \gamma_0 )</th>
<th>( \gamma_m )</th>
<th>( \gamma_{SIZE} )</th>
<th>( \gamma_{BM} )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-statistic</td>
<td>-1.4832</td>
<td>0.0570</td>
<td>1.2777</td>
<td>0.9816</td>
<td></td>
</tr>
</tbody>
</table>

*** RES: all regressors, 94-00

<table>
<thead>
<tr>
<th>Estimate</th>
<th>( \gamma_0 )</th>
<th>( \gamma_m )</th>
<th>( \gamma_{SIZE} )</th>
<th>( \gamma_{BM} )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-statistic</td>
<td>-1.1429</td>
<td>0.2836</td>
<td>0.9689</td>
<td>1.1028</td>
<td></td>
</tr>
</tbody>
</table>
*** RES: all regressors, 95-01

<table>
<thead>
<tr>
<th>Estimate</th>
<th>$\gamma_0$</th>
<th>$\gamma_M$</th>
<th>$\gamma_{SIZE}$</th>
<th>$\gamma_{BMR}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.4317</td>
<td>0.0109</td>
<td>0.1240</td>
<td>0.2067</td>
<td>0.1574</td>
<td></td>
</tr>
<tr>
<td>t-statistic</td>
<td>-1.2610</td>
<td>0.1242</td>
<td>1.0387</td>
<td>1.6844</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2

The trend of coefficients of BMR, MV and beta (their joint role in the regression equation)

<table>
<thead>
<tr>
<th>BMR</th>
<th>ME</th>
<th>beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>0.1304</td>
<td>0.1258</td>
</tr>
<tr>
<td>97</td>
<td>0.1887</td>
<td>0.1186</td>
</tr>
<tr>
<td>98</td>
<td>0.2067</td>
<td>0.124</td>
</tr>
</tbody>
</table>

NOTES

The chart shows the value of the cross-sectional regression coefficients on estimated beta, plotted for the years 96, 97, 98 (middles of the periods 93-99, 94-00, 95-01). Remarkable that from the two significant variables (BMR and MV) the BMR seems to be very sensitive to the stocks returns while the MV does not, being almost stable for all the sub-periods.
4.3. **Implications and Applications of the Results**

The tests that have been conducted in this paper based on two-variable and multi-variable regressions, presume a rational asset-pricing framework on the relation between size and book-to-market ratio. Our results show that there are firm-specific characteristics which can explain about 13.68% (93-01) of the cross-section variation in ASE returns {for the sub-periods this proportion becomes higher, till 16.94%(94-00)}. We do not claim that these characteristics are consistent with the multi-factor asset-pricing models of Merton (1973) and Ross (1976). A necessary condition for these models is multiple common sources of risks, but we have not identified the state variables of special hedging concern to investors that are necessary in a multi-factor ICAPM or APT, if they are not to collapse to the CAPM. Fama and French (1996) showed that their three-factor model could capture most of the CAPM anomalies. They argued that their factors like the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB, small minus big) and the difference between the return on a portfolio of high book-to-market stocks and the return on a portfolio of low BMR (HML, high minus low) mimic combinations of two underlying risk factors or state variables of special hedging to investors. 

Nevertheless, our findings have important applications for portfolio formation and performance evaluation, especially by investors who are primarily interested in long-term average returns. The size effect could contribute a great deal to the description of the returns on small-stock funds, while the book-to-market ratio could be crucial in describing the returns on growth-stock funds. Furthermore, the performance of pension or mutual funds could be evaluated by comparing their average return with the average return on benchmark portfolio with similar size and book-to-market ratio characteristics.
CHAPTER 5

5.1. Conclusions

This paper examines whether the well-documented CAPM regularities exist in the ASE. Several empirical studies have reported anomalies in average returns related to the firm-size and the book-to-market ratio (BMR). Our selection of firm characteristics is motivated mainly by their availability for the Greek firms and the existing empirical evidence. Since there is no theoretical foundation about the correct relationship between the above variables and stock returns, our results are based on a linear relationship. We do not, of course, claim that the list of explanatory variables employed in the tests is exhaustive, but the set of variables, which was chosen, performed well against some alternative candidates (e.g. the price-earning ratio). The Fama and MacBeth cross-sectional procedure is enhanced with Shanken’s corrections. Data on individual securities are used in order to keep our inferences safe from biased test statistics. This procedure prevents us from making arbitrary decisions on the order of grouping securities into portfolios, and so all the explanatory variables are assigned equal importance before each test.

Our findings reveal a significant positive cross-sectional relationship between the book-to-market ratio and average stock returns in two-variable regressions for the entire period and the sub-periods too (remarkable the results’ proximity comparing the periods 93-01, 95-01 and 93-99, 94-00). The stock’s return behavior according to the BMR seems to be similar during these periods. A separate “size effect”, although documented in most developed stock exchanges, is not detected in purely statistical terms for the Greek stock market. It is remarkable also the significance of the joint role of the “size effect” and BMR for all the periods.
In an attempt to unravel the separate influences of the firm-specific characteristics on returns, multi-variable regressions are also run. Perhaps the most impressive result from this procedure is that inferences are slightly sensitive to the regression specification. The performance of the book-to-market ratio is not altered in the inclusion of other variables; this variable has a consistently reliable performance and it proves to be the most important of the firm characteristics considered, either in statistical or economic terms.

Conversely, the market capitalization coefficients are more sensitive to the regression specification. Whatever the underlying economic causes for such interaction effects, our main result is still quite straightforward: two firm-specific characteristics, namely the book-to-market ratio and the firm-size, provide an ample characterization of the cross-section variation of average stock returns for the 1993-2001 period for the ASE.

In accordance with prior studies in this area, our results do not provide adequate justification whether the predictability in returns is a result of rational or irrational asset pricing, or a result of market inefficiency. However, if assets are priced rationally, our results suggest that stock risks are multidimensional; one dimension of risk is proxied by size and the other by the ratio of a stock’s book value to its market value. This could have practical implications on the formation and performance evaluation of managed portfolios (e.g. pension funds and mutual funds).

5.2. Limitations

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 ASE a larger sample period is needed. The lack of information from the ASE 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 eight years only.

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

Another drawback for our study was, probably, the “bubble period” 98-99, which caused a great impact in the share prices as well as the investors’ behaviour, with result to affect the returns of the stocks on the ASE.

5.3 Further Research

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 elaborated. Depending on the availability of data, investigation of investor profile in different time periods and stocks may yield interesting clues.

The findings here with respect to the size and book-to-market effect, indicate that more powerful tests might show the effects to be significant at conventional levels. Such further research could involve analyzing a longer sample period. The sample here extends to eight years and that of Anderson, Lynch and Mathiou (1990) to ten years. 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. Final 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.
REFERENCES


