INTERTEMPORAL ASSET PRICING:

EVIDENCE FROM GREECE

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ABSTRACT

This paper applies an Intertemporal Capital Asset Pricing Model (ICAPM) to describe the cross-section of stock returns in the Greek Stock Market.

The critical importance of firm characteristics like size, book-to-market equity and momentum in explaining average returns on common stocks, as it has been demonstrated in many previous works was the motive for using them in the model and explain the cross-sectional relationship between average stock returns and risk in the Athens Stock Exchange (ASE). This research proposes to examine the joint roles of market beta, size, book-to-market ratio and momentum in the cross-section of average returns on ASE stocks for the period from January 1997 to December 2005. The tests are applied on portfolios formed from ASE stocks during this period based on a methodology similar to that of Fama and French (1996) and of Carhart (1997).

The results give evidence that in the Greek Stock Market there is a strong-sectional relation between average returns and beta. It is also proved a reliable momentum effect but a weak relation between B/M ratio and average returns.

The findings of this dissertation are consistent with the results of Carhart and do support the most basic prediction of the CAPM that average stock returns are positively related to market β’s. However, for the period examined it was not discovered a size effect similar to that found in tests of Fama and French (1993).

Key words: beta, CAPM, ICAPM, size, book-to-market ratio, momentum
CHAPTER I

1. INTRODUCTION

Regardless of whether or not one believes that markets are efficient, or even if they were efficient, the efficient market hypothesis is almost certainly the right place to start when thinking about asset price formation. “Evolving from an initially puzzling set of observations about the random character of security prices, the efficient market hypothesis became the dominant paradigm in finance during the 1970s” (Dimson, E. and Mussavian, M., 1998) and has improved our understanding of the time-series and cross-section behavior of security returns.

The term efficiency is used to describe a market in which information is rapidly disseminated and reflected in prices. In practice, security markets are expected to be efficient because all the participants (analysts and theorists) focus primarily on gathering all publicly available information and trading on that information in order to become competitive among the others. Ideally this process quickly moves the prices of securities to their “fundamental” values. However, in a relatively efficient market, those who eventually succeed in getting rewards to technical analysis and fundamental analysis are only the traders with some sort of comparative advantage.

“A prerequisite for the market efficiency is that information and trading costs, the costs of getting prices to reflect information are always zero” [(Grossman and Stiglitz 1980) Fama 1991].

The use of electronic computers became a useful tool in the hands of researchers in the early 1950s and helped them to study more conveniently the behavior of lengthy price series. The assumption of economists was that one could “analyze an economic time series by extracting from it a long-term movement, or trend, for separate study and then scrutinize the residual portion for short-term oscillatory movements and random fluctuations” (Kendall, 1953). When Maurice Kendall examined this proposition, however, the results surprised him. He concluded that “in series of prices which are observed at fairly close intervals the random changes from one term to the next are so large as to swamp any systematic effect which may be present. The data behave almost like wandering series”. It was observed that the near-zero serial correlation of price changes appeared inconsistent with the views of economists. In
spite of this, these empirical observations were to be labeled the “random walk model” or even the “random walk theory”. Intelligent investors competing to discover relevant information on which to buy or sell stocks before the rest of the market becomes aware of that information, was the cause of randomly evolving stock prices and not a proof of market irrationality.

Fama (1969, 1970) was the first to introduce the term ‘efficient market’ into the economics literature by assembling a comprehensive review of the theory and evidence of market efficiency. The theory necessitates defining an efficient market as one in which trading on available information does not provide an abnormal profit. Another hindrance to deductions about market efficiency, put forth by Fama (1991) is the joint-hypothesis problem. He argues that a market can be considered to be efficient only if we pose a model for returns. Thus, it must be tested jointly with some model of equilibrium. With this as a starting point, economists have embarked on weak form, semi-strong and strong-form efficiency tests which have become joint tests of market behavior and models of asset pricing and which have uncovered a wide variety of apparent anomalies. These phenomena (anomalies) are cross-sectional and time-series patterns in security returns, not anticipated by a central model or theory. Some of these are: a) the day-of-the-week effect b) the January effect c) the size effect d) the holiday effect e) the Friday the 13th effect (examined only for the U.S. market) f) the E/P phenomenon and the most frequent appearing of them are analyzed afterwards. These anomalies are often interpreted as evidence of market inefficiency but the fact that many of these patterns have persisted for the last 50 years discredits this belief.

“As a result, when we find anomalous evidence on the behavior of returns, the way it should be split between market inefficiency or a bad model of market equilibrium is ambiguous”. (Fama, F. Eugene, 1991)

**Weak form tests.** In the pre-1970 literature, tests of market efficiency, using a common equilibrium model, gave evidence that it would be a better forecast for a return if we would use its historical mean rather than past returns or other past variables. Early tests, however, for return predictability, reveal that daily, weekly and monthly returns are predictable from past returns. The way weak-form tests discerned trends in stock prices was by measuring the serial correlation of stock market returns
i.e., the tendency for stock returns to be related to past returns. For example, Fama (1965) finds a positive first-order autocorrelation examining daily returns for 23 of the 30 Dow Jones Industrials. A year later Fisher also finds that the autocorrelations of monthly returns on diversified portfolios are positive and larger than those for individuals stocks. Likewise, both Conrand and Kaul (1988), and Lo and MacKinlay (1988) examine weekly returns of NYSE stocks and find positive serial correlation over short horizons.

The prime proponents of short-horizon returns story are French and Roll (1986), who established an irregularity about market efficiency. They examined stock prices on an hourly basis and found that during a trading week, stock prices are more variable when the market is open (trading hours). In short, all the results tend to confirm the point of view that variation in daily and weekly-expected returns is a small part of the variance of returns. However, the early research papers show that the autocorrelation in daily and weekly returns is not construed as important evidence against the joint-hypothesis of market efficiency and expected returns. “The argument is that even when the autocorrelations deviate reliably from 0, they are close to 0 and thus economically insignificant”. (Fama, F. Eugene, 1991)

On the contrary, the more impressive recent evidence on the predictability of returns observing past returns comes from long-horizon returns. The Shiller-Summers’ (1986) model generated a series of papers on the predictability of long-horizon returns and implied a strong negative serial correlation in the performance of the aggregate market.

In 1988 Fama and French’s tests confirmed the Shiller-Summers’ model. The autocorrelations of returns on diversified portfolios of NYSE stocks (1926-1985) were close to zero at short-horizons but they became strongly negative for 3 to 5 year returns. Similarly, Poterba and Summers (1988) discover that for a time span of 2 to 8 years, a negative autocorrelation in returns, which is caused by transitory price swings, is detected. “Even with 115 years (1871-1985) of data, however, the variance tests for long-horizon returns provide weak statistical evidence against the hypothesis that returns have no autocorrelation and prices are random walks” (Fama, F. Eugene, 1991).

Additionally to these studies, there are many others suggesting that over long-horizons, extreme performance in particular securities tends to reverse itself. DeBondt

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and Thaler (1985, 1987) and Chopra, Lakonishok and Ritter (1992) launch an offensive empirical attack on market efficiency finding that stocks identified as losers in the recent past tend to offer above-average future performance. Conversely, the best past performers tend to have weak returns relative to the market in following periods. This reversal effect, in which losers bounce back and winners decline, suggests that the stock market overreacts to relevant news. This point of view, however, has been challenged by many critics (Chan (1988), Ball and Kothari (1989), Zarowin (1989), Chan and Chen (1991)), who argue that the winner-loser effect is related to other explanations than market overreaction.

Finally, several studies for return predictability were enriched with forecasting variables without, however, being themselves evidence for or against market efficiency. For example, Fama and French (1988) use dividend yields (D/P) to predict short-horizon stock returns whereas Campbell and Shiller (1988b) find that E/P ratios have dependable forecast power on market returns, increased with the return horizon.

**Semi-strong form tests.** Literature had begun with studies of weak form market efficiency but early enough it was already overwhelmed with results from studies of the semi-strong form of the efficient market hypothesis, using the *event study* as the principal research tool in this area. An event-study is the technical way for assessing the impact of a particular event on a firm’s stock price after an empirical financial research has taken place. The general strategy is to observe the market’s performance. Around the date that new information about a stock becomes public, observers must be able to estimate the abnormal return about the stock and attribute the abnormal stock performance to the new information.

“Event studies are the cleanest evidence there is on efficiency (the least encumbered by the joint-hypothesis problem)”. (Fama, F. Eugene, 1991)

A disadvantage is that all models for expected returns are deficient in describing the systematic patterns in average returns during any sample period. This problem is less serious in event studies that concentrate on short-return windows (a few days) due to the fact that daily-expected returns are close to zero and so have little effect on estimates of abnormal returns. Using daily data, a more precise measurement of the stock-price reaction is allowed, which is after all the main issue for market efficiency.
In addition, daily data helps eliminating the joint-hypothesis problem. However, the return horizon may cause a bigger problem.

Researchers document noticeable regularities in the response of stock prices to investment decisions, financing decisions and changes in corporate control. The so-called size or small-firm effect was originally documented by Banz (1981) and gave rise to a plethora of papers examining this phenomenon. Banz analyzed the historical performance of portfolios formed by NYSE stocks according to firm size and found that average annual returns were consistently higher on the small-firm portfolios.

The original event-study was introduced by Fama, Fisher, Jensen and Roll (1969) and produces useful evidence of the speed of adjustment of prices to new information, even though the first published one was by Ball and Brown (1968). An unexplainable anomaly is the evidently indolent response of share prices to stock splits and firm’s earnings announcements and event-studies can provide evidence on the above. Dimson and Mussavian (1998) mention that the first published paper to draw together literature on earnings-related anomalies was the survey by Ball (1978).

In addition to these regularities Reinganum (1988) as well as Fama and French (1992) draw further attention to a value effect that ratios of market value such as the book-to-market ratio (the ratio of the book value of the firm’s equity to the market value of equity) can be a strong predictor of returns across securities. The main finding of Fama and French is that betas are not associated with cross-sectional variations of expected stock returns in contrast to the book-to-market equity, suggesting either that high book-to-market ratio firms are relatively underpriced or that the book-to-market ratio is serving as a proxy for a risk factor that affects equilibrium expected returns. In fact, Fama and French found that after controlling for both the size and book-to-market effects, beta seemed to have no power to explain average security returns, generating an important challenge to the concept of rational markets and enfeebling the ability of beta in affecting systematic risk.

The recent research findings also include papers, which documented the existence of anomalies that substantiate "seasonals" in stock returns. Monday returns are on average lower than returns on other days ((Cross (1973), French (1980), Gibbons and Hess (1981)). Returns are on average higher the day before a holiday (Ariel 1990), and the last day of the month (Ariel (1987)) (Fama, F. Eugene, 1991). Furthermore, there seems to be a seasonal in intraday returns, with most of the average daily returns
coming at the beginning and end of the day (Harris (1986)). The most mystifying and most often reported in literature size-related effect is the ‘January effect’, documented in empirical research by Keim (1983, 1986), Roll (1982, 1983) and Reinganum (1983). Stock returns, especially those on small stocks, are on average higher in January than in other months. Moreover, much of the higher January returns on small stocks appear on the last trading day in December when the tax-loss incentives induce selling pressure (Keim (1983), Roll (1983)). Keim (1988) reviews this literature arguing that seasonals in returns are anomalies in the sense that asset-pricing models do not predict them but they are not necessarily embarrassments for market efficiency (Fama, F. Eugene, 1991).

Fama (1998) argues that studies on long-term returns suggesting market inefficiency, specifically over and underreaction to information don’t prove that efficiency should be discarded. Literature identified that long-term return anomalies split randomly between underreaction and overreaction as predicted by market efficiency. Studies on long-term return anomalies include DeBondt and Thaler (1985), Mitchell and Stafford (1997), Dharand and Ikenberry (1995). DeBondt and Thaler (1985) relate and present the behavioral decision theory of Kahneman and Tversky (1982) as an interpretation of the overreaction to past information. Thus one could consider overreaction to be the prediction of a behavioral finance alternative to market efficiency. In the main, however, Fama (1998) reports that the anomalies literature has not accepted the discipline of an alternative hypothesis.

There would be no market efficiency if apparent overreaction was the general result in studies of long-term returns, and market efficiency would have been replaced by the behavioral alternative of DeBondt and Thaler (1985). In fact, the frequency of apparent underreaction is about as equally as that of overreaction. The predecessor of underreaction events is the evidence that stock prices seem to respond to earnings for about a year after they are announced (post-announcement drift in abnormal returns) (Ball and Brown, 1968; Bernard and Thomas, 1990). More recent is the momentum effect identified by Jegadeesh and Titman (1993) in which the most recent performance of individual stocks continues over time. Specifically, tests conducted by Jegadeesh and Titman (1993) showed that stocks with high returns over the past year tend to have high returns over the following 3 to 6 months.
Other recent event-studies that have produced long-term post-event abnormal returns that suggest underreaction are those of Cusatis et al. (1993), Desai and Jain (1997), Ikenberry et al. (1995, 1996), Lakonishok and Vermaelen (1990) and Michaely et al. (1995). There still are, however, some long-term return anomalies that are difficult to classify as to whether they are due to underreaction or overreaction to the information or another reason (Asquith (1983), Agrawal et al. (1992), Roll (1986), Mitchell and Stafford (1997), and Ikenberry and Lakonishok (1993)).

The remaining question is after all if these anomalies are due in fact to market inefficiency or if they are generated by an inappropriate equilibrium model. “Do the models produce rejectable predictions that capture the menu of anomalies better than market efficiency?” (Fama, F. Eugene, 1998)

**Strong form tests.** The strong-form version of the efficient market hypothesis is quite extreme and in general it is not expected markets to be strong form efficient. The proposition that corporate insiders have access to pertinent information about their firm’s stock long enough before it would become publicly available that would help them make superior profits is extreme. The Securities and Exchange Commission requires all insiders to register their trading activities and then it publishes these trades in an *Official Summary of Insider Trading*.

Jaffe (1974), Seyhun (1986), Givoly and Palmon (1985) are some of those who studied the ability of corporate officers to trade profitably on their own stock. Jaffe’s studies showed that corporate insiders have private information that leads to abnormal returns but Seyhun’s (1986) studies, which carefully traced the public release dates of the *Official Summary*, found that following inside transactions would be of no use. Although there is a trend for stock prices to increase even after the *Official Summary* reports insider buying, the abnormal returns are not of sufficient extent to overcome transaction costs. Outsiders could never profit from public information about insider trading.

“Unlike event studies, evaluating the access of investment managers to private information involves measuring abnormal returns over long periods. The tests thus run head-on into the joint-hypothesis problem: measured abnormal returns can result from market inefficiency, a bad model of market equilibrium, or problems in the way the model is implemented” (Fama, F. Eugene, 1991).
CHAPTER II

2. REVIEW OF THEORETICAL LITERATURE

Because market efficiency and equilibrium pricing issues are inseparable, the discussion of predictability takes into consideration the cross-sectional predictability of returns as well, that is, tests of asset-pricing models which are always joint evidence on efficiency and an asset-pricing model. Besides, many of the anomalies in finance that are encountered on the front-line empirically arise from tests directed at asset pricing models.

Having in mind the joint hypothesis problem, we cannot suggest whether such anomalies arise from not adequately prescribed asset-pricing models or market inefficiency.

The unofficial constant expected returns model and the market model (event studies, like Fama, Fisher, Jensen and Roll (1969)) constitute the only type of models that one can find in the pre-1970 efficient market literature.

The 1970 literature review, presents the one factor asset-pricing model of Sharpe (1964), Lintner (1965), and Black (1972) and market efficiency as an adequate description of the behavior of security returns. The most general consequence of the model is that equilibrium pricing implies that the market portfolio of invested wealth is mean-variance efficient as Markowitz (1959) first pointed out.


The Capital Asset Pricing Model, almost always referred to as the CAPM has originated the modern asset pricing literature and has a long history of theoretical and empirical investigation.

The originators of the CAPM are William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) who managed to create a model that is considered for many years now the centerpiece of modern financial economics and has resulted even in a Nobel Prize for Sharpe in 1990.

The introduction of three important modern finance paradigms by the CAPM has radically changed the landscape of finance. These are the Efficient Market Hypothesis.
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(EMH), beta risk premium and specific risk diversification. The CAPM theory is built in the sense of Markowitz’s portfolio ideas and it simplifies an investor’s optimal portfolio decision even further. The meaning of the CAPM for Fama and French (2003) is that the risk of a stock should be measured relative to a comprehensive “market portfolio” that in principle can include not just traded financial assets but also consumer durables, real estate and human capital. The attraction of the CAPM is that it offers a powerful and precise prediction of the relationship between the beta (sensitivity to overall market movements) of an asset and its corresponding expected return.

In order to define this relationship CAPM like any other mathematical model rests upon a set of assumptions about the real world. These simplifying assumptions and limitations make the model more realistic and comprehensible:

1. Investors pose homogeneous expectations. They all perceive identical opportunity sets and share the same beliefs about the distribution of returns and risks when investing in the available securities.

2. All investors are characterized by a myopic behavior and have the same one period time horizon, which does not allow them to examine events that might take place after their planned holding period.

3. There is borrowing and lending at a risk free rate, which is the same for all investors although the amounts invested differ between the participants.

4. There are no market imperfections such as taxes, commissions or service charges on trades in securities and so the investors’ transactions are free.

5. There is a large number of small investors who act as though they cannot impact security prices by their own trades.

6. All investors are rational, risk averse and when choosing among portfolios they care only about the mean and variance of their one-period investment return. Thus, they all use the Markowitz portfolio selection model.

These assumptions ignore many real-world complexities but in no case do they invalidate the CAPM’s primary conclusions. On the contrary, all these simplifying assumptions are required to provide the degree of abstraction necessary to understand the nature of equilibrium in security markets.
“When the CAPM assumptions are satisfied, everyone in the economy will hold all risky assets in the same proportion. Hence, the betas computed with reference to every individuals portfolio will be the same, and we might as well compute betas using the market portfolio of all assets in the economy” (Jagannathan, R. and McGrattan, E.R., 1995).

**Deriving the Model**

The CAPM generates a mathematically elegant relationship between the expected rate of return on a security and its risk measured relative to the market portfolio. The model succeeds in collapsing all macroeconomic risks into a well-defined single factor, the return on the market portfolio. Specifically, the theory indicates that expected return is an increasing linear function of its covariance risk or beta. Formally, beta is defined as:

\[
\beta_i = \frac{Cov(r_i, r_M)}{\sigma^2_M}
\] (1)

Where:
- \( r_i \) is the return of the asset
- \( r_M \) is the return of the market
- \( \sigma^2_M \) is the variance of the return of the market, and
- \( Cov(r_i, r_M) \) is the covariance between the return of the market & the return of the asset

More simply, beta is a measure of relative risk and is defined as the ratio of the expected excess return of an asset relative to the overall market’s excess return. Furthermore, excess return is defined as the return on any given asset less the return on a risk-free asset.

Based on this intuition the CAPM is built. If we consider an asset (or investment) with no risk such as Treasury bills, we will realize that its returns do not vary with the market and as a result it has a beta of zero (0) and an expected return equal to the risk-free rate. A much riskier investment can move in lock step with the market and have average market risk with a beta of one (1.0).
The Capital Asset Pricing Model comes to give an answer about the expected risk premium when an asset experiences different regressions in periodic returns than the market, or in other words has a beta other than 0 or 1. If the relationship between expected returns on assets and their exposure to market risk is generalized, the CAPM equation is formed:

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

In words, the expected return on any asset \( i \) is the risk-free interest rate, \( R_f \), plus a risk premium, which is the asset’s market beta, \( \beta_i \), multiplied with the per unit beta risk premium \( E(R_M) - R_f \). Thus, the model’s message is that all investments must plot along the sloping line, known as the security’s market line.

Figure 1

2.2 Capital Asset Pricing Model: Black Version

After publication of the Sharpe, Lintner and Mossin articles, there was a wave of papers trying to extend the model to move to more realistic scenarios. The first attempt to relax the assumptions that underpin the original CAPM was made by...
Fischer Black (1972) who shows how the model needs to be adapted when riskless borrowing is not available. Black shows that without a risk-free asset, expected returns on the risky assets satisfy this relationship:

\[ ER_i = ER_z + (ER_m - ER_z) \beta_i \]  

where \( R_z \) is the return on a zero-beta portfolio [that is \( \text{cov} (R_z, R_m) = 0 \)], \( R_m \) is the return on the market portfolio, and \( \beta_i = \text{cov} (R_i, R_m)/\text{var} (R_m) \) (Jagannathan, R. and McGrattan, E.R., 1995, p.3)

His version is known as the zero-beta CAPM and rests on three properties of mean-variance efficient portfolios:

- Any portfolio constructed by combining portfolios on the efficient frontier is itself efficient.
- All portfolios on the efficient frontier have “companion” portfolios that are uncorrelated, and for this reason the companion portfolio is referred to as the zero-beta portfolio of the efficient portfolio.
- The expected return of any individual asset can be expressed as an exact, linear function of the expected return on any two-frontier portfolios.

With these three properties, the Black model can be applied to any of several variations: absence of riskless asset, risk-free lending but no risk-free borrowing, and borrowing at a rate higher than \( r_f \).

### 2.3. Validity of the Capital Asset Pricing Model

Usually, empirical tests of the CAPM use either cross-section or time-series regressions (early tests of the model). One of the earliest empirical studies that have supported the model is that of Black, Jensen and Scholes (1972), who had worked with portfolios rather than with individual securities. Using portfolios in cross-section regressions of average returns on betas, they find that the data are consistent with the predictions of the CAPM and that the model is close to reality.

Fama and Macbeth in 1973 examine whether there is a positive relation between average return and beta and find that high beta stocks tended to have higher average returns than low beta stocks, and this relation was roughly linear. Using estimations of month-by-month cross section regressions of monthly returns on betas for the period 1926 to 1968, for stocks traded on the NYSE, it was also discovered that the residuary...
valuation in average returns on assets, that beta alone wasn’t able to explain, could be interpreted by the squared value of beta instead.

Beside that classic support, however, the glamour of the model starts to weaken in the late 1970s when other various studies reveal several unsatisfactory features of the model and cast doubt on the ability of the market beta to describe the cross-section of expected returns.

Fama (1970) points out that the single-period CAPM does not apply in a multiperiod setting if investor preferences change across time or if the available investment opportunity setting changes across time. The empirical failure of the CAPM could be the result of the stylized and simplified assumptions on which it is built. In fact, Cochrane (2001) argues: *In retrospect, it is surprising that the CAPM worked so well for so long.*

A main attack in empirical tests of the CAPM is the impressive Roll’s (1977) methodological criticism. Previous tests of the CAPM use an equity market index such as the S&P500 in order to examine the relationship between equity returns and beta. However, Roll demonstrates that the market, as defined in the theoretical CAPM, is theoretically and empirically elusive. It is not a single equity market, but an index of all the risky assets, including human capital. Roll points out that the portfolio used by Black, Jensen and Scholes does not come close to the portfolio of invested wealth called for by the model and thus the theory cannot be testable. Finally, Roll argues that empirical investigations of the CAPM, which uses proxies for the true market portfolio, are at best tests of the mean-variance efficiency of those proxies, not tests of the CAPM and tells us nothing about whether or not the CAPM is correct.

At the same year research begins to uncover variables with no special standing in asset-pricing theory, which show reliable power in explaining the cross-section of average returns. This fact makes it difficult to characterize markets as informationally efficient. Specifically, Basu (1977) introduce the notion that E/P may explain violations of the CAPM by showing that when common stocks are classified on earnings-price ratios, future returns on high E/P stocks are higher than predicted by the CAPM.

Few years later Banz (1981) adds to the tests of CAPM a size effect, trying to prove that size of the firms does explain the cross-sectional variation in average returns on
assets (stocks) better than beta. In addition, Bhandari (1988) explores the fact that high debt-equity ratios (a measure of leverage) are positively related with returns that are too high relative to their market betas. Additional tests are those of Statman (1980) and Rosenberg, Reid and Lanstein (1985) who document that stock with high book-to-market equity ratios have high average returns that are not captured by their betas. Kothari, Shanken and Sloan (1995) try to resurrect the CAPM by arguing that the weak relation between average return and beta is just a chance result. However, this argument seems to be irrelevant and to be overshadowed by the strong evidence that other variables seize variation in expected return missed by beta. If betas are not sufficient to explain expected returns, the market portfolio is not effective, and the CAPM cannot produce any results. Furthermore, substantial proof on the size of the market premium can neither save the model nor further condemn it.

The relations between expected returns and book-to-market equity, size, E/P, and leverage are usually interpreted as embarrassments for the CAPM, or the way it is tested (faulty estimates of market β’s), rather than as evidence of market inefficiency. In truth, though, the existing tests can’t tell whether the anomalies result from a deficient (CAPM) asset-pricing model or persistent mispricing of securities as Fama (1991) has argued several times in his article. One can surmise evidence relying on the continuation of a past anomaly in future data. If a past anomaly does not appear in future data then it might be market inefficiency. On the other hand, the explanation of an anomaly by other asset-pricing models can be attributed to a rational asset-pricing phenomenon.

Fama (1991) presents a second argument (after Roll’s view), in connection with the creation of anomalies, which is due to the fact that market β’s are noisy, and the anomalies variables are associated with true β’s. For example, Chan and Chen (1988) find that when portfolios are formed on size, the assessed β’s of the portfolios and the average size of stocks of which the portfolios are formed, present an almost perfect correlation.

The multifactor asset-pricing models of Merton (1973) and Ross (1976) are researchers’ another approach in trying to explain these characteristic empirical regularities. For example, Ball (1978) pinpoints that E/P is a catch-all proxy for omitted factors in asset-pricing tests. Fama’s (1991) tests also corroborate Ball’s finding. Specifically, Fama (1991) finds that if two stocks have the same current

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earnings but different risks, the riskier stock has a higher expected return, and it is likely to have a lower price and higher E/P. This confirms the marginal explanatory power of the E/P ratio, which acts as a general proxy for risk and expected returns, when asset pricing follows a multifactor model and all relevant factors are not included in asset-pricing tests. In conclusion, Chan and Chen (1991) argue that the size effect results from a priced distressed-firm factor, not captured by market $\beta$, in returns and expected returns.

The return-generating process can involve in these models multiple factors and thus the cross-section of expected returns on securities and portfolios are not only described by their market $\beta$’s but by the cross-section of factor loadings or sensitivities.

It is worth noting that the price-earnings, small-firm, book-to-market, momentum and long-term reversal effects may be, to some extent, related. Reinganum (1981) and Basu (1983) argue that size and E/P are related, after finding that small stocks tended to have high E/P. Chan, Hamao and Lakonishok (1991) and Fama and French (1991) found that size is also related with book-to-market equity. Many stocks become small in terms of market equity because of slow economic times and lower stock prices and thus have high book-to-market ratios. Moreover, Fama and French (1991) found that there is a correlation between leverage and book-to-market equity and Bhandari (1988) relates size with leverage arguing that small stocks include many firms that are highly levered, probably as a result of financial distress.

### 2.4. Multifactor Asset Pricing Models

The CAPM became widely popular mainly for its simplicity but this fact has also caused a lot of criticism which is focused on the point that relying on a single factor, namely the market index, might leave too much of an asset’s risk unexplained. Multifactor models on the other hand, such as the Intertemporal Capital Asset Pricing Model (ICAPM) by Merton (1973) and the Arbitrage Pricing Theory (APT) by Ross (1976), maintain that asset prices are mainly driven by several factors that, ideally, have some basic and plausible relationship to the underlying company.
2.4.1. Intertemporal Capital Asset Pricing Model

Merton’s (1973) intertemporal capital asset pricing model is a natural extension of the CAPM and invalidates its assumption that investors care only about the mean and variance of distributions of one-period portfolio returns. On the contrary, in the ICAPM investors are also concerned about the way their portfolio payoff covaries with state variables such as labor income, prices of consumption goods and future investment opportunities and, they can and do rebalance their portfolios on a regular basis. In general, investors trade in the market portfolio and a hedging portfolio that is used to hedge the risk of changing market conditions.

As a result Fama and French (1996) argue that optimal portfolios are “multifactor efficient”, which means they have the largest possible expected returns, given their return variances and the covariances of their returns with the relevant state variables. Moreover, a relation between expected return and beta risks is implied by multifactor efficiency but it is also required additional betas, along with a market beta, to explain expected returns.

Merton’s (1973) ICAPM is a model in which the number of sources of uncertainty would be priced not just over a fixed time period but intertemporally. It relies on a more realistic framework and it is more tractable than a discrete time model by assuming that time flows continuously. Because of its intertemporal nature it can capture effects, which would go unnoticed in a static model such as the CAPM. And the significant differences in the specification of the equilibrium relationship among asset yields obtained in the new model and the classical one are precisely caused by these effects.

The focal point of Merton’s model is that in an intertemporal setting, the fundamental risk is consumption risk. A specific state variable is able to earn a risk premium by transferring news regarding changes in the forecasts of future market returns or instabilities. The upshot of the model is that an asset, which performs poorly, may earn a risk premium when future investment prospects turn sour. In order to overcome the difficulty of measuring consumption, Campbell (1993, 1996) makes use of the total budget constraint to replace the consumption growth rate with current and future market returns. The instinct for this substitution is that an increased level of consumption today must be financed by a high current market return, an augmented
Intertemporal Asset Pricing: Evidence from Greece

forecast of future market returns which also represents a higher expected future income, or a lower expectation of future market volatilities which means that investors would save less.

Ross (1989) states that Merton (1973) produced “the first such model that went beyond simple analogies with the static models to introduce and approach a new phenomenon that is intrinsically intertemporal in nature” (Dimson, E. and Mussavian, M., 2000) For a specific trading interval that is selected the portfolio demands and the equilibrium relationships that will follow up, will be a function of this trading interval. It is clear that the choice of an investor about a portfolio decision, which is irreversible for years, will be different than the one made by an investor who has the choice to revise his portfolio daily. Merton (1973) points out that the primary issue is the market setting and not the tastes of the investors and the time interval between successive market openings is not enough for the continuous-time assumption to be considered a good approximation for any well-developed capital market.

If we assume that asset prices are governed by the Merton’s (1973) ICAPM then there are total of S state variables that hedge special concern to investors, capturing future investment-consumption opportunities. Merton shows that under such circumstances, the expected return on any asset i is driven primarily by the hedge component:

$$E (r_i) - r_f = \varphi_m \text{cov}(r_i, r_m) + \sum_{s=1}^{S} \varphi_s \text{cov}(r_i, r_s)$$  (4)

where $r_i$ is the risk free rate, $r_m$ is the return on the market portfolio, $r_s$ is the return on the s-th hedge portfolio, $\varphi_m = -W J_{ww} / J_{W}, \varphi_s = -W J_{wks} / J_{W}, J(W, k_1, k_2, \ldots, k_S)$ is the indirect utility function of investors who make sequence of decisions to maximize their expected utility of lifetime consumption, and $k_s$ represents the s-th state variable. (Avramov, D. et al., 2002, p.5).

Merton (1973) points out that knowing two things is sufficient for an intertemporal investor: (i) the transition probabilities for returns on each asset over a future trading opportunity set and (ii) the transition probabilities for returns on assets in future periods (i.e. knowledge of the stochastic processes of the changes in the investment opportunity set). In other words, it must be taken into account the relationship
between current period returns and returns that will be available in the future. For instance assume that the correlation of the current return on a specific asset with changes in yields is negative. Then the investor expects a higher return by holding this asset, if, ex post, yield opportunities for the next period are lower than were expected.

2.4.2. Asset Pricing Theory

Around the time that Roll’s critique was starting to lose its strength, Stephen Ross in 1976 developed the Arbitrage Pricing Theory (APT) as an alternative model that could potentially overcome the CAPM’s problems while still retaining the underlying message of the latter. The simple version of Ross’s model assumes that only one systematic factor affects security returns. However, after Ross’s original proposition, the APT was extended by Huberman (1982), Chamberlain and Rothschild (1983), Chen and Ingersoll (1983), Connor (1984), Chen (1983), Chen and Korajczky (1988) and Lehmann and Modest (1988), as well as numerous other researchers and since then the usual discussion of the theory is concerned with the multifactor case.

It is worth noting that like the CAPM, the APT predicts a Security Market Line linking expected returns to risk, but the path it takes to its SML is quite different. In contrast to the CAPM, the APT does not require that the benchmark portfolio in the SML relationship be the true market portfolio. Any well-diversified portfolio lying on the SML may serve as the benchmark portfolio.

The formulation of the APT is based more on an arbitrage relation than on an equilibrium condition. The primary idea behind APT is that in equilibrium all portfolios that can be chosen from among the set of assets that we consider and which satisfy the conditions of (a) using no wealth and (b) when there is no risk they must earn no return on average.

The APT model states that the long-term average returns of securities can be affected only by a small number of systematic pulls. It is a single-period model showing that the stochastic properties of returns of capital assets are consistent with a factor structure, derived under the usual assumptions of perfectly competitive and frictionless capital markets. More specifically Ross’s APT relies on three key propositions:

- security returns can be described by a factor model,
- there are sufficient securities to diversify away idiosyncratic risk and...
Well-functioning security markets do not allow for the persistence of arbitrage opportunities. Ross postulated that the expected return of each stock is connected to some macroeconomic factors, which are the basic sources of risk and are unique for each company. Hence to the fact that there might be an innumerable number of factors that control the price of every individual stock, Ross developed a model that enables the estimation of the return of each asset by taking under consideration all possible factors expressed by the following equation:

$$ \textit{Expected risk premium} = r - r_f = b_1(r_{\text{factor}1} - r_f) + b_2(r_{\text{factor}2} - r_f) + \ldots $$

“Ross’ approach suggest using factor analysis to extract the common factors in returns and then tests whether expected returns are explained by the cross-sections of the loadings of security returns on the factors (Roll and Ross (1980), Chen (1983))”. (Fama, F. Eugene, 1991)

Thus, applying the APT someone is confronted with the task of finding an acceptable trade-off between model size and model reliability by hunting for unknown and preferably small set of factors that captures as much of the asset’s price changes as possible. The problem of factor selection is therefore crucial for the successful application of the APT but the multifactor APT gives no guidance concerning the determination of the relevant risk factors or their risk premiums. Fama (1991) adds to the Ross’ approach the fact that APT leaves no perceptions about how the factors relate to uncertainties about consumption and portfolio opportunities that are of concern to investors, namely, the hedging arguments for multifactor model of Merton (1973).

The many unidentified risk factors and the unlimited explanatory variables do not enable us to simplify the description of security returns and constitute the basic deficiencies of APT. APT would provide a good handle on expected returns only if it could be possible to identify a reasonably short number of macroeconomic factors, measure the expected risk premium on each of these factors and measure the sensitivity of each stock to these factors.
CHAPTER III

3. INTERPRETATION OF THE VALUE AND SIZE EFFECTS

3.1. Portfolio Formation

“Determining which factors explain the return of individual securities is one of the key issues in investment research. Which of these factors are priced is the fundamental issue of asset pricing theory”. (Elton J. Edwin, Gruber J. Martin and Busse A. Jaffrey, 1998).

Uncertainty in asset returns arises from common or macroeconomic factors and firm-specific returns. The single-factor model’s decomposition of returns into systematic and firm-specific components is compelling, but confining systematic risk to a single factor is not. It stands to reason that a more explicit representation of systematic risk allowing for the possibility that different stocks exhibit different sensitivities to its various components would constitute a useful refinement of the single-factor model.

It is easy to see that multifactor models can provide better descriptions of security returns. Roll and Ross (1994) have pointed out that it is the number of priced factor, which is important, not the total number of factors. Fama and French (1997) also argue that ignoring estimation problems, it is possible to find the set of priced state variables when the state variables are identified (named). Nevertheless, because the APT is silent about the choice of factors, many attributes with multiple priced risk factors have been suggested in the literature, and the additional factors are often motivated as proxies for borderline utility growth.

In order that researchers may be accommodated when they search to specify a reasonable list of factors, they must keep in mind and be guided by two basic principles. At first it’s important to confine themselves to systematic factors, which have the significant ability to explain security returns. If the model requires hundreds of explanatory variables, it does not contribute much towards simplifying the description of security returns. Furthermore, researchers should try and choose factors that are likely to be important risk factors i.e., factors that relate to investors sufficiently so that they will demand meaningful risk premiums to expose themselves to those sources of risk.
“Unfortunately, tracing a common factor in returns to a economic state variable does not in itself imply that the state variable is of special hedging concern to investors and so carries a special risk premium. Merton clearly recognizes this problem. It lurks on the horizon in all tests of multifactor ICAPM’s or APT’s”. (Fama, E., French, K., 1996)

Chen, Roll and Ross (1986) constructed a model with 5 factors rested on their ability to present a broad picture of the macro economy and this can serve as an example of a multifactor approach. Using a multiple regression of the returns of the stock in each period on the 5 macroeconomic factors, they were able to estimate the firm-specific risk.

As it has already been mentioned in the previous section, tests of the cross-section of average returns on U.S. common stocks using the CAPM of Sharpe (1964) and Lintner (1965) showed little relation to the market beta and revealed that other variables with no special standing in asset-pricing theory could have more explanatory power. The use of firm characteristics as candidates for relevant sources of systematic risk constitutes alternative approach to specifying macroeconomic factors. Most notable amongst the multi-factor models is the one of Fama and French (1992, 1993, and 1996).

The results of FF can have practical implications for portfolio formation and performance evaluation by investors. The SMB (Small minus Big) and the HML (High minus Low) factors have been constructed in order to address size risk and value risk respectively. The SMB is also referred to as the “size premium” and represents the additional return received by an investor after investing in stocks of companies with small market capitalization. HML on the other hand measures the “value premium” received by investors after investing in companies with high book-to-market values.

3.2. The Fama-French results

Fama and French (FF in short) update and synthesize the evidence on the most prominent contradictions of the CAPM. Inspired by the theoretical work of Merton (1973) and Ross (1976) they estimate cross-sectional regressions with multiple value and size factors included as explanatory variables.
Fama and French (1992) document that the motive to use size and book-to-market equity variables for explaining average stock returns, is their relation to economic fundamentals. Size, BE/ME, E/P and C/P are scaled versions of price and proxy for expected returns doing an excellent job in identifying the real failures of the CAPM. Characteristically, firms that have high BE/ME tend to have low earnings on assets, which they persist long before and after the measurement of book-to-market-equity. Conversely, low BE/ME is associated with persistently high earnings. As far as size is concerned, it is also related to profitability. “Controlling for book-to-market equity small firms tend to have lower earnings on assets than big firms”. (Fama, E., French, K., 1993) This view is justified more precisely on empirical grounds in Fama and French (1995). Using HML and SMB to explain returns is also in line with the evidence of Chan and Chen (1991) (covariation in returns due to relative distress) and Huberman and Kandel (1987) (covariation in returns on small stocks not captured by market return).

The size effect, however, is found only until the 1980-1982 recession when small firms present earnings depression but they do not participate at all in the economic boom of the middle and late 1980s. Fama and French’s (1992) finding was that there is a stronger relation between book-to-market equity and average stock returns than size and relying on this they formed their portfolios.

Fama and French first in 1992 try to evaluate the joint roles of those variables with market $\beta$ in the cross section of average returns on NYSE, AMEX and NASDAQ stocks for the period 1963-1990, carrying out asset-pricing tests using the cross-section regressions of Fama and MacBeth (1973).

They form size portfolios following the evidence of Chan and Chen (1988) that size produces a wide spread of average returns and $\beta$s, but they also subdivided each size decile into 10 portfolios on the basis of pre-ranking $\beta$s for individual stocks in order to allow in variation in $\beta$. Their results give evidence that there is a reliable size effect but a weak relation between $\beta$ and average return. It is also proved a strong-sectional relation between average returns and book-to-market equity. Finally, the combination of size and book-to-market equity seems to replace the apparent roles of leverage and E/P in average stock returns.

The average monthly returns on the NYSE Equal-weighted and Value-weighted portfolios revealed a negative premium on size in the cross-section of stock returns.
and a positive one for book-to-market equity. The average premium for market $\beta$ is essentially zero. Like the overall period, the sub periods show in general terms the same results proving that the book-to-market equity is consistently the most powerful for explaining the cross-section of average stock returns.

Fama and French (1992) explain their results arguing in two contrasting rationales, one based on a market rationality story and the other on a market irrationality story.

The evidence that size and book-to-market equity proxy for sensitivity to risk factors in returns is consistent with a rational-pricing story for the role of size and BE/ME in average returns. Specifically, book-to-market equity proxies for the relative prospects of firms: high BE/ME suggests poor prospects requiring higher expected returns. However, tests cannot explain returns’ results from an economic perspective. The relation of size and BE/ME with risk factors in returns remains economically unexplainable. The return results are consistent with a multifactor version of Merton’s (1973) intertemporal asset-pricing model in which size and BE/ME proxy for sensitivity to risk factors in returns” (Fama, E., French, K., 1995)

On the other hand, investor overreacting to relative prospects is the case, which shows how the market irrationality story goes. When overreactions are corrected, low BE/ME indicates lower prices in the future and predicts lower returns. Likewise, high BE/ME indicates higher prices in the future and predicts higher returns. Additionally, Fama and French in 1992 also examine and prove that the January seasonal in the relation between book-to-market equity and average return as it had for the first time been put forward by Roll (1983) and Keim (1983) still is in effect but the positive relation between BE/ME and average return is strong throughout the year.

In short, the results for the 1963-1990 period do not support the central prediction of the CAPM, that average stock returns are positively related to market $\beta$ but prove that size and book-to-market equity succeed in capturing the cross-sectional variation in average stock returns associated with size, E/P, book-to-market equity, and leverage. These results also hold over the fifty years 1941-1990 for a larger sample.

Fama-French themselves have investigated their 1992 results further. The strength of the BE/ME variable for predicting stock returns, allowed it to act again as the central factor in the their asset-pricing model one year after they conducted the cross-section regressions’ tests.
In an ideal implementation of the ICAPM one would specify the state variables that affect expected returns. Fama and French (1993) approach it in a more indirect manner, which is perhaps more in the spirit of Ross’s (1976) arbitrage pricing theory (APT). Their argument is that the higher average returns on small stocks and high book-to-market stocks reflect unspecified state variables that produce covariances in returns that cannot be differentiated and are not captured by the market return but are priced separately from market betas. This stands even though size and book-to-market equity are not themselves state variables. To support their assertion, they show that the returns on the stocks of small firms fluctuate more in relation to one another than with returns on the stocks of large firms, and returns on high book-to-market (value) stocks fluctuate more in relation to one another than with returns on low book to market (growth) stocks.

Based on this interpretation, Fama and French (1993) propose a three-factor model to describe the cross-sectional variation in expected returns connected with most non-risk characteristics which contains, together with the market portfolio, size (SMB) and value (HML) mimicking portfolios:

\[
E(R_{it}) - R_f = \beta_i M [E(R_{Mt}) - R_f] + s_i E(SMB_t) + h_i E(HML_t) \tag{6}
\]

In this equation, SMB\(_t\) (small minus big) is the difference between the returns on diversified portfolios of small and big stocks, HML\(_t\) (high minus low) is the difference between the returns on diversified portfolios of high and low B/M stocks, and the \(\beta\), \(s\) and \(h\) measure the level of exposure to risk on \(R_{it} - R_f\), on \(R_{Mt} - R_f\), SMB\(_t\), and HML\(_t\) i.e. they constitute the factor sensitivities or loadings.

Assuming rational expectations, equation (6) can also be written as:

\[
R_{it} - R_f = \alpha_i + b_i (R_M - R_f) + s_i SMB + h_i HML \tag{7}
\]

Fama and French (1993) carry out tests using the time-series regressions of the Black, Jensen and Scholes’s approach using their three-factor model and confirm that the size and book-to-market factors have significant incremental explanatory power over the differences in average returns across stocks.

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Namely, portfolios of U.S. common stocks were constructed to imitate risk factors related to size and BE/ME caught strong common variation in returns, explained by a market portfolio no matter what else was in the time-series regressions. Indeed, this is evidence that these variables proxy for sensitivity to common risk factors in returns. The model has been widely and empirically confirmed and seems to explain numerous previously reported incidences of anomalous cross-sectional return patterns. The main weakness of the three-factor model considered from a theoretical perspective is its empirical motivation. The SMB and HML explanatory returns are not prompted by predictions about state variables that are of interest to investors. On the contrary they are brute force fabrications meant to capture the patterns that were uncovered by previous work on how average stock returns vary with size and book-to-market equity ratio.

This apprehension, however, is not fateful. It is not required according to the ICAPM that the extra portfolios used along with the market portfolio “mimic” the relevant state variables in order to explain expected returns. It is sufficient in both the ICAPM and the APT that the additional portfolios are well differentiated and that they are sufficiently different from the market portfolio in order to be in a position to capture covariation in returns and variation in average returns missed by the market portfolio. In this way, it is in the spirit of both the ICAPM and the APT to add diversified portfolios that capture covariation in returns and variation in average returns left unexplained by the market.

Fama and French (1994) use the three-factor model to explain industry returns and they point out the importance of variation through time in the slopes. They show that it is crucial to make provision for the variation in SMB and HML slopes when applying the three-factor model to industries because industries wander between growth and distress. They also find that the three-factor model shows higher costs of equity for distressed industries than for strong industries, mainly because of their higher loadings on HML.

In their attempt to explain economically their previous results by examining whether the behavior of returns in relation to size and book-to-market is consistent with the behavior of earnings, Fama and French (1995) try to establish an economic reasoning. Size and book-to-market factors are documented like those in returns, and tests show

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that both factors are related to profitability, with the market size and book-to-market factor to present a major explanatory power in earnings as well as in returns. In other words, someone can tell that the common factors in returns mirror common factors in earnings. This fact leans us toward the conclusion that the market factor combined with size and book-to-market factors in earnings are the source of the corresponding factors in returns. However, even though the market and size factors in earnings succeed in explaining the market and size factors in returns, there is no link found between the book-to-market factor in earnings and the book-to-market factor in returns.

After the 1992 study in which CAPM was rejected, Fama and French make an effort to infer whether a multifactor ICAPM or APT can generate size and book-to-market effects. Until their 1996 article Fama and French (1993, 1994, 1995) have shown that their three-factor model is an equilibrium pricing model, a three-factor version of Merton’s (1973) intertemporal CAPM (ICAPM) or Ross’s (1976) arbitrage pricing theory (APT) as it is suggested by its empirical successes. According to this view, SMB and HML imitate combinations of two deeper risk factors or state variables of special hedging concern to investors. “Tests of a three-factor ICAPM or APT ask whether loadings on three portfolios can describe the average returns on other portfolios” (Fama, E., French, K., 1996, p.75) the same way tests of the CAPM do.

Fama and French (1996) describe a powerful intuition of ICAPM, building on concepts underlying the CAPM and try to prove through tests that the three-factor model is capable to absorb many of the patterns that appear in average stock returns or as they are otherwise named anomalies of the CAPM. Specifically, they apply and show the efficiency of the model to capture the returns to portfolios formed on E/P, C/P and sales growth.

They first test on the 25 Fama-French (FF 1993) Size-BE/ME portfolios and the 0.093 percent average intercept proves that the model in fact captures most of the variation in the average returns on the portfolios and is doing an even better job when other sets of portfolios are used.

Fama and French (1996) in order to create their portfolios each year, use NYSE, AMEX and Nasdaq stocks for the period 1963-1993 with the same methodology that Lakonishok, Shleifer and Vishny (LSV 1994) used. Specifically, FF (1996) examine the returns on sets of deciles breakpoints for BE/ME, E/P, C/P and five-year sales...
rank, which is the weighted average of the annual sales growth ranks for the prior five years. Thus, FF (1996) follow LSV double-sort portfolios’ procedure, in order to produce larger spreads in average returns, aiming to examine LSV finding that past sales growth is negatively related to future return. The methodology is to sort firms each year into three groups on BE/ME, E/P and C/P and then to form sets of nine portfolios as the intersections of the sales-rank sort and the sorts on BE/ME, E/P or C/P.

The GRS test shows that the three-factor model describes the spreads in average returns on the LSV double-sort portfolios sparingly and does not attribute them to risk or overreaction as LSV does.

In a follow-up study FF (1996) prove that the model can explain the patterns in the future returns for the 1963-1993 period on portfolios formed on E/P, C/P, sales growth and long-term past returns, mainly because they fall into line with the loadings of the portfolios on HML. Thus, the model agrees with the reversal effect of long-term returns documented by DeBondt and Thaler (1985). In portfolios formed on long-term past returns, losers present high future returns and winners present low future returns.

FF (1996) argue that their model works because long-term past losers load more on SMB and HML and thus the model predicts that they will have higher average returns. However, the model misses the continuation of short-term returns.

It is worth mentioning that FF (1996) point out that except of the $R_M-R_F$, SMB and HML, other combinations of three portfolios explain returns as well.

The tests that followed aimed at proving the explanatory power of a three-factor ICAPM.

Fama (1994) shows that Merton’s ICAPM is driven by a generalized portfolio-efficiency concept. As it has already been mentioned in Chapter 2, ICAPM investors are risk-averse and care not only about the mean and variance of their portfolio return but also about the way of hedging more specific state variables such as consumption risks. As a result, optimal portfolios are multifactor-minimum-variance (MMV).

Fama and French (1996) pinpoint that portfolios with two state variables and a finite number of risky securities need a third MMV portfolio that mimics the two state variables of special hedging concern to investors. Consequently, any three MMV portfolios can be used to generate MMV portfolios and describe returns.
The Fama-French portfolios include the market (M), the small stock portfolio (S), the low book-to-market portfolio (H), the difference between H and L (HML) and the difference between S and the return on the big-stock portfolio B (SMB).

Fama and French start off with the assumption that the components of SMB and HML as well as M are not perfectly but close to MMV, since $R_M - R_F$, SMB and HML are satisfactorily describing average returns. The results of the regressions show that every different triple-combination of M, S, L, H, SMB and HML provides equivalent descriptions of returns for portfolios formed on long-term past returns. Moreover, taking a step further, Fama and French (1996) show that additional MMV proxies combined with the market portfolio produce three-factor description of returns.

Finally, Fama and French (1996) examine whether the expected excess returns on MMV portfolios are explained by their market $\beta$s in order to prove that a multifactor return process results in CAPM rather than multifactor ICAPM or APT pricing. The results of the test reveal large average pricing errors for the CAPM specifically 25 to 30 basis points per month and only 5 to 10 basis points per month for the three-factor model proving that the latter prevails over CAPM.

In the same sense that they have interpreted their results in 1993, 1994, 1995, Fama and French (1996) argue that asset pricing is rational and complies with a three-factor ICAPM or APT that is not converted to the CAPM. Moreover, they argue that what prevents the three-factor model from being reduced to the CAPM in describing returns is investors’ irrationality thus causing a high premium for relative distress.

A final proposed possible limitation is that the CAPM holds but is spuriously rejected.

All of the above examples of application of the three-factor model give a minimal interpretation of the model. In summary, Fama and French relying on their results end up with the conclusion that regardless of the economic explanation that can be given, a three-factor model captures the CAPM anomalies formed from sorts on size, BE/ME, E/P, C/P, sales rank and long-term past return, excluding of course the short-term momentum in stock prices. However, Fama and French (1996) admit that there remains a hole in their whole work because of not-clearly identifying the two consumption-investment state variables of special hedging concern to investors.
3.3. Other studies

Although size and value effects have initially been observed in the beginning of the '80s in the USA capital markets, one can find a lot of researches on these phenomena in the literature for other European countries as well as for Greece. Similar to Banz’s (1981) findings are those of Levis (1985) in the UK market and Ho et al. (2000) in the Hong Kong market.

Wong and Lye (1990) studied the phenomena of the size and the E/P ratio for Singapore’s Stock Exchange companies for the period 1975-1985. Their results showed that the stocks of the SES are related significantly to the size and the E/P ratio. More specifically, the E/P phenomenon is stronger than the size effect but in no case independent of it.


Fong (1992) studied the size effect in the London Stock Exchange for the period 1979-1988 in relation to the influence of the various strategies in the management of the portfolios using the methodology of Roll (1983) and Blume and Stambaugh (1983). His results showed that his calculation of the average yield of the portfolios of small companies is sensitive to the investment strategy followed each time, that is to say to the continuous rebalancing or buy and hold, with the yields of the first strategy being superior.


Cheung, Leung and Wong (1994) examined the phenomena of small firm and the ratio E/P in the Korean Stock Exchange for the period 1982-1988. Their results showed that yields of stocks of small firms (or with a high E/P ratio) are higher than those of large firms (or with a small E/P ratio).

Evidence of the book-to-market effect comes also from Fama and French (1998). They also underline that the contradictions of the CAPM associated with price ratios are not sample specific since they found that the price ratios that produce problems for the CAPM in U.S. data show up in the same way in the stock returns.
Liew and Vassalou (LV) (2000) and Lettau and Ludvigson (LL) (2001) show that SMB and HML could be a proxy for a distress factor. Specifically, they document that SMB and HML help forecast GDP growth in international markets. LL explain specifically, the sensitivity of HML to bad news at hard times of economic distress.

Other recent studies about stock price behavior are those of Perez-Quiros and Timmermann (2000) who present a connection between size and credit market conditions and those of Elton, Gruber, Agrawal and Mann (2001) who provide evidence on a potentially important link between the equity and fixed income markets. Finally, Pastor and Stambaugh (2001) argue that sensitivity to market wide shifts in liquidity might be priced risk factor.

Research relevant to the existence of the size effect of firms listed in the Athens Stock Exchange (ASE) is limited.

Diakogiannis and Segredakis (1996) first researched the hypothesis that systematic risk and the size of firms affect the weekly-expected yield of stocks placed in the ASE for the period 1989-1994. Regarding the influence of the size of the firms to the weekly yields of stocks, the empirical results showed that there is no such influence. This means that the investment strategy of buying stocks with the lowest Stock Exchange value in the hope of collecting higher yields for the investors, does not apply in Greece for the period under examination.

Spyrou (1999) investigated empirically the phenomenon of stocks of small capitalization in the ASE. He used monthly prices for all the stocks that were continuously traded for the period between December 1988 and January 1997. The empirical results showed that stocks of small capitalization have higher yields than the stocks of larger capitalization, at least for the period 1992-1997. On the contrary, for the full period of 1988-1997 stocks of larger capitalization prevail.

Finally, Malliaropoulos and Chardouvelis (1999) attempted to make a valuation of stock prices in the ASE in relation to the expected level of their future gains. Their results showed that firms of small capitalization presented exorbitant optimistic valuation in relation to the expected future gains of the year 1999, considerably different from their valuation for the year 1998.
CHAPTER IV

4. THE PRIOR RETURN OR MOMENTUM EFFECT

It has been shown that prior stock returns can explain things in the cross-section of common stock returns. Stocks with prices on an upward (downward) trajectory over a prior period of 3 to 12 months are more likely to continue on that upward (downward) trajectory over the subsequent 3 to 12 months. We refer to this temporal pattern in prices as momentum.

It was Jegadeesh (1990) who first found that stock returns tend to exhibit short-term momentum. His results provide evidence that “stocks that have done well over the previous few months continue to have high returns over the next month. In contrast, stocks that have had low returns in recent months tend to continue the poor performance for another month”. (Davis, L. J., 2001)

An investigation of intermediate-horizon stock price behavior in 1993 in collaboration with Titman generally confirms the 1990 results showing that the momentum lasts for more than just one month. Moreover, as it was indicated by the results, momentum appears to be stronger for firms that have had poor recent performance and weaker for firms with recent good performance. It is worth mentioning that this tendency contradicts everything that has been found in the long-term overreaction papers, where long-term losers seem to outperform long-term winners.

Other than Jegadeesh and Titman’s (1990, 1993) studies are those of Grinblatt and Keloharju’s (1998) who provide evidence of momentum in Finland and Rouwenhorst’s (1998) in 12 other European countries.

The three-factor model couldn’t, as it has been finally shown by the tests of Fama and French, to explain the continuation of short-term returns. Stocks that have low short-term past returns tend to load positively on HML, in the same way that long-term losers do. On the other hand, short-term past winners load negatively on HML like long-term winners. This pattern in the HML slopes gives us a prediction of reversal rather than continuation for future returns the same way it does for long-term returns. The model, thus, cannot explain the continuation of short-term returns.

That the three-factor model is accepted is indicated by the frequency with which it is now used as a benchmark for performance measurement. Quigley and Sinquefield
(2000) use for example a three-factor benchmark to analyze the performance of UK unit trusts, and Carhart (1997) and Davis (2001) use the Fama-French model in studies of US mutual fund performance. However, the use of a single-factor model in the sense of the CAPM is quite usual in most mutual fund studies prior to the 90’s. The intercept ($a_i$) of such a model gives the Jensen alpha, which is usually interpreted as a performance measure relative to the used market proxy:

$$R_{it} - R_{ft} = a_i + \beta_i (R_{mt} - R_{ft}) + \epsilon_{it} \quad (8)$$

where $R_{it}$ is the return on fund $i$ in month $t$, $R_{ft}$ the return on a one month T-bill in month $t$, $R_{mt}$ the return on the local equity benchmark in month $t$ and $\epsilon_{it}$ an error term.

Mutual fund performance is well documented by several other authors as well, who use a more suitable multi-factor model accounting for all possible investment strategies. In particular, Hendricks, Patel and Zeckhauser (1993), Goetzmann and Ibbotson (1994), Brown and Goetzmann (1995) and Wermers (1996) all maintain that mutual fund performance over short-term horizons exists. Evidence of mutual fund return predictability over longer horizons comes from Grinblatt and Titman (1992), Elton, Gruber, Das and Hlavka (1993), and Elton, Gruber, Das and Blake (1996) who ascribe this pattern to manager differential information or stock-picking talent.

Chan, Jegadeesh and Lakonishok (1996) maintain the momentum anomaly is market inefficiency, which is due to slow reaction to information. However, this effect is durable to time periods (Jegadeesh and Titman (1993)) and countries (Asness, Liew and Stevens (1996)).

Jensen (1969) presents contrasting evidence and does not find that good subsequent performance follows good past performance. Carhart (1992) shows that much of the long-term persistence in mutual fund performance is driven by persistence in expense ratios. Carhart’s (1997) study also confirms that the gains from following a momentum strategy in stocks are consumed by transaction costs. Specifically, results indicate that performance can significantly be reduced from trading expenses, by approximately 0.95 percent of the trade’s market value.

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It is worth discussing Carhart’s (1997) study in a little more detail because a significant part of my applied research in the Athens Stock Exchange will be based on his model. Carhart (1997) employs a four-factor model of performance measurement demonstrating that most of performance persistence found in the previous studies can be attributed to the one-year momentum effect. Thus, in order to reflect Jegadeesh and Titman’s (1993) one-year momentum anomaly Carhart (1997) enriches Fama-French three-factor model with one additional factor. In the resulting model the coefficients and premia on the factor-mimicking portfolios indicate the proportion of mean return that can be attributed to four basic strategies:

Formally:

\[ R_{i,t} - R_{f,t} = a + \beta (R_{M,t} - R_{f,t}) + s SMB_t + h HML_t + m MOM_t + \varepsilon_{i,t} \]  

(9)

Where \( R_{i,t} - R_{f,t} \) is the excess fund return, \( R_{M,t} - R_{f,t} \) is the value weighted excess return on the market portfolio and SMBt, HMLt, MOMt represent the systematic factors of size, book-to-market and one-year momentum in period t, respectively. By using such a model it is easy to estimate the risk-adjusted return of a given fund as well as its factor betas, thus defining the fund’s investment strategy or style.

What Carhart (1997) first examines is the persistence in one-year return-sorted mutual fund portfolios. The methodology used includes the formation of ten equal-weighted portfolios of mutual funds for the period 1963-1993 using returns net of operating expenses and transaction costs. The portfolios are equally weighted monthly so that portfolio weights can be readjusted appropriately whenever a fund disappears.

The CAPM and the four-factor model are tested simultaneously and Carhart (1997) compares their results. The four-factor model as well as the three-factor model prevail over the CAPM in explaining the relative returns on these portfolios. Carhart (1997) thinks that it is very significant and he emphasizes the pronounced pattern in the funds’ MOMt coefficients. The funds’ highest past one-year returns are positively correlated with the one-year momentum factor, while the funds’ lowest returns are strongly negatively correlated with the factor. The four-factor model accounts for almost all of the cross-sectional variation in expected return on portfolios of mutual funds sorted on lagged one-year return other than the relative underperformance by ©Karaoglanidou Olga
last year’s worst performing funds. The strong pattern in MOMt loadings on portfolios sorted on lagged one-year returns can be simply explained by the fact that these mutual funds do not follow the momentum strategy, but are funds that accidently end up holding last year’s winners. On the contrary, the four-factor model explains a smaller fraction of return spread in the long-term sorted portfolios because there is a less intense pattern in HML loadings. Past-winner mutual funds load negatively on HML and positively on MOMt, whereas past-loser mutual funds do not load significantly on either factor.

Thus far Carhart (1997) argues that persistence in mutual fund performance (“hot hands effect”) is mostly explained by sensitivity to common factors in stock returns and persistence in expense ratios. Additionally, the cross-section tests indicate that performance for the average fund is reduced by turnover. Any remaining abnormal performance not fully accounted for by the four-factor model is described by transaction costs. Moreover, after examination of the characteristics (total net assets (TNA), expense ratio, turnover (Mturn) and maximum load fees) of the mutual fund portfolios, he finds that they are significantly and negatively related to performance.

In order to interpret the performance on past-winner mutual funds, Carhart (1997) examines the consistency in fund ranking and returns on the portfolios after ranking and find that most top-ranked mutual funds do not maintain their high relative returns. Nevertheless, funds that follow a momentum strategy in stocks could possibly earn above-average returns, even if their four-factor model performance is not abnormal.

In general, tests of Carhart are consistent with market efficiency, despite interpretations of the size, book-to-market and momentum factors. It must be noted, however, that most funds underperform by about the magnitude of their investment costs even though the top-decile mutual funds earn back their investment costs. Carhart (1997) points out that these results are not apparently restricted to mutual funds. Christopherson, Ferson and Glassman (1995) arrive qualitatively at similar conclusions about pension fund performance.

As far as skilled or informed mutual fund managers are concerned, Carhart (1997) gives us only very scant evidence. He measures stock-picking talent more accurately picking mutual funds on alphas from the four-factor model. Carhart (1997) concludes that the strategy that could be implemented for capturing Jagadeesh and Titman’s (1993) one-year momentum effect in stock returns essentially
without transaction costs would be to buy last year’s winners. The actual trading costs are shifted in this case to the long-term holders of mutual funds. Nevertheless, this current mutual fund practice cannot be a long-run equilibrium after this strategy is widely followed.

Concluding Carhart (1997) emphasizes the three important empirical rules emanated from his article for wealth-maximizing mutual fund investors: 

1. Avoid funds with persistently poor performance
2. Funds with high returns last year have higher-than-average expected returns next year, but not in the coming years and
3. The investment costs of expense ratios, transaction costs and load fees have a direct, negative impact on performance.

This line of evidence, however, does not claim to have discovered the best asset-pricing model. The range of researchers’ different beliefs and thoughts would always provide literature with further research for alternative asset pricing models.
CHAPTER V

5. DATA AND METHODOLOGY

Within the framework of this present study, the data set consists of monthly stock and index returns for a period of nine years from January 1997 to December 2005 for a sample of Greek nonfinancial firms listed in the Athens Stock Exchange (ASE). Financial firms are not included in the data set (following the methodology of Fama and French (1992)) because the expected high leverage, which for these firms is normal, does not have the same meaning as for nonfinancial firms where high leverage more likely indicates distress.

The purpose of the present research is to investigate whether Intertemporal Asset Pricing is applied in the ASE.

The objective of this study is to examine the cross-section of stock returns in the ASE. Tests are primarily focused in finding whether the beta is a good risk factor for the Greek Stock Market and if it is adequate to explain the different expected portfolio returns. I am going therefore, to arrive at some conclusions as regards the degree that expected returns of each portfolio are affected by systematic risk (beta), i.e., from the various economy wide perils that threaten the business and the market uncertainties in which investors are exposed. Furthermore, it is going to be identified whether returns are related with size, BVE/MVE and momentum (i.e., if these factors need to be priced in the ASE). These observations are the major motivation for choosing a research design similar to Fama and French (1996) and to Carhart (1997).

The findings indicate that there is a strong-sectional relation between average returns and beta. The tests’ results of this study also provide evidence that there is a reliable momentum effect but a weak relation between B/M ratio and average returns.

The findings of this dissertation are consistent with the results of Carhart and do support the assumptions of the CAPM that beta is positively related to expected returns as well as that it is the only explanatory variable.

However, for the period examined it was not discovered a size effect similar to that found in tests of Fama and French (1993).

The remainder of this paper is organized as follows: sections 5.1 and 5.2 describe the data and the methodology used in this research, in section 5.3 I interpret and discuss...
applications of the empirical results of my findings and finally section 6 summarizes and concludes the paper.

5.1. The Data Set
Within the scope of this study the data set includes a total number of stocks that varies from month to month. The sample contains all sample firms listed in the ASE from the period January 1997 to December 2005 (108 months). The number of companies in the sample ranges from 109 in April 1997 to 248 in August 2005. Stock prices were obtained electronically from the ASE’s databank and they were adjusted monthly for stock splits and new share issues. Data for book value of equity (BVE) and market value of equity (MVE) for all sample firms were taken from the yearly editions and statistical bulletin of the ASE.

The main criterion for selecting the data set was the existence of a full series of monthly closing prices for the period under examination. In this way firms that had no available stock-price information were initially excluded from the sample. Moreover, following the methodology of Fama and French (1992), financial sector firms (financial firms, banks and insurance companies) were also excluded because the book value of equity is small and the value of book-to-market ratio is extremely large. Thus, the sample contains firms that fell only into the manufacturing and the service sectors.

In addition, for new listed firms, data for the first month were excluded in order to avoid IPO underpricing effects. Thus, the sample contains monthly data for a number of stocks, which varies from month to month and includes newly listed firms, firms that have long presence in the ASE and firms that have gone bankrupt in subsequent months. Therefore, the sample is representative for the period examined and it is free from any survivorship bias. Thus no case arises where our measurement of persistence in stock market returns could be affected.

The necessary attributes, extracted from the sample firms, which are used in this study in order to later calculate the required variables of SMB and HML are the market value of equity (size) calculated by multiplying the firm’s number of shares outstanding by the end-of-month closing stock price, and the book-to-market (B/M) ratio calculated by dividing the firm’s book value of equity by the market value of
The book value of equity for each firm is calculated by dividing the stockholders’ equity (common stock plus retained earnings) by the number of shares outstanding and the B/M ratio is likewise calculated by dividing the book value of equity with the market value of equity. Moreover, momentum was calculated as in Carhart (1997) by taking the twelve-month performance prior to the month under consideration. Using past performance, firms are classified into five portfolios according to the prior-twelve-month average stock returns. The two extreme portfolios, the one with the highest performing firms (winners) and the one with the lowest performing firms (losers) are used to calculate the momentum risk factor (MOM). In particular for each month, MOM_t is calculated as the difference between the return on the winners portfolio and the return on the losers portfolio. The momentum portfolios are rebalanced each year according to the average prior performance of all firms on December of each year. Finally, the market return (R_m) used to calculate beta is taken from the monthly continuous returns of the ASE General Price Index while the risk free rate of return (R_f) is the three-months Greek Government Treasury Bill rate. These variables compose the three models for this research. After running the three regression models the explanatory power of beta for stock returns could be evaluated and we will see whether this explanatory power of beta is adequate to explain the expected portfolio returns or the mimicking risk factors of size, book-to-market ratio and momentum should be included.

5.2. The Methodology Approach

Three models of performance measurement are employed to test which one explains better stock returns in Greece. These models are described by the following equations:

1. \((R_{i,t} - R_{f,t}) = a + \beta (R_{M,t} - R_{f,t}) + u_{i,t}\)
2. \((R_{i,t} - R_{f,t}) = a + \beta (R_{M,t} - R_{f,t}) + s SMB_t + h HML_t + u_{i,t}\)
3. \((R_{i,t} - R_{f,t}) = a + \beta (R_{M,t} - R_{f,t}) + s SMB_t + h HML_t + m MOM_t + u_{i,t}\)

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where:
\( R_{i,t} - R_{f,t} \), is excess portfolio return for a period \( t \)
\( R_{M,t} - R_{f,t} \), is the value weighted excess return on a broad market portfolio for a period \( t \) with \( R_{f,t} \) to be the three-months Greek Government Treasury Bill rate and \( R_{M,t} \) to be the market return
\( SMB_t \) is the difference between the return of a small size portfolio and the return on a portfolio of large size stocks
\( HML_t \) is the difference between the return on a portfolio of high book-to-market equity stocks and the return on a portfolio of low book-to-market equity stocks
\( MOM_t \) is the difference between the return on a portfolio of the highest performing firms (winners) and the return on a portfolio of the lowest performing firms (losers)
The coefficients \( \beta, s, h \) and \( m \) are the factor loadings on the four relevant risk factors and
\( u_{i,t} \) is a normally distributed, zero mean error term

The intuition is that the models are nested i.e. Model 3 includes Model 2, which in turn includes Model 1. In essence Model 1 is the regression model of the single factor CAPM equation, Model 2 represents the regression model of the Fama’s-French’s (1993) three-factor model equation and Model 3 is extended by the additional momentum factor introduced by Carhart (1997). Thus, the goodness of fit of the models can be assigned by the value of the Adjusted R-square. However, other tests will also be used which include the Akaike and the Swartz-Bayesian information criteria, and the Ramsey RESET test for the informational and functional form of the models (Pesaran, M. H., Weeks, M., (2001), “Non-nested Hypothesis Testing: An Overview, in: Baltagi, B.H. (Ed.), A Companion to Theoretical Econometrics, Oxford, Blackwell, 279–309). Moreover, to avoid problems with heteroskedastic disturbance (error terms), regression test statistics will be estimated using White’s (1980) consistent covariance matrix. Finally, in order to avoid serial correlation it is very possible to use the Newey & West (1987, 1994) heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimators.
For the calculation of portfolio returns, which will consist our independent variables, the following procedure is followed: As a first step all stocks are sorted according to their size. Subsequently they are classified into 10 portfolios so that the first portfolio is made up from the stocks that show the higher market value of equity and portfolio 10 is made up from the stocks that show the lower market value of equity. The number of stocks varies for each portfolio and monthly weighted portfolio returns are calculated as the average return of all shares in the portfolio. The same procedure of forming portfolios is followed when stocks are classified according to book-to-market ratio. At this point we do not calculate momentum portfolios, because as Fama (1998) claims, the momentum effect is a short-lived effect and forming momentum portfolios is not appropriate for long-term studies.

For the calculation of the Fama-French mimicking risk factors, the intercept portfolios were formed following the procedure below: All sample firms for each year were classified into two portfolios according to their size so that for each year there was a Small size and a Large size portfolio. The Small size portfolio namely group S includes all firms with small capitalization and the Large size portfolio namely group B includes all big firms i.e., firms that have an above-median capitalization. Following this, each of these two portfolios was subdivided into three portfolios according to the B/M forming six more portfolios for each year. This procedure generated six time series of monthly returns for the period 1997 to 2005. The decision to sort sample firms into three portfolios on B/M and only two on size follows the evidence in Fama and French (1992a) that book-to-market effect is more profound in average stock returns than the size effect. Monthly returns, once again, are calculated for each portfolio as the average return of all shares in the portfolio. Sorting firms according to their B/M ratio led to the creation of group L (firms with low B/M ratio), group M (firms with medium B/M ratio) and group H (firms with high B/M ratio).
The calculation of the HML and SMB variables is based on the classification of the sample firms as was described above and is depicted in Figure 1. Specifically, the SMB (Small minus Big) variable is meant to mimic the risk factor in returns related to size in the three models examined and is calculated as:

$$SMB = \frac{P1 + P2 + P3 - (P4 + P5 + P6)}{3}$$

i.e. the difference between the average returns of the small size portfolio and the average returns of the large size portfolio.

Likewise, the HML variable (High minus Low) is meant to mimic the risk factor in returns related to the book-to-market ratio in the models and is calculated as:

$$HML = \frac{P3 + P6 - (P1 + P4)}{2}$$

i.e. the difference between the average returns of the high B/M portfolios and the average returns of the low B/M portfolios.

The portfolios formed on size and B/M will produce a wide range of average returns to be explained by the three models under examination.

The third variable of the models, Mom, stems from the anomaly observed by Jegadeesh and Titman (1993), which implies that there is persistence instead of reversal in medium term stock returns. In particular, for the calculation of the MOM, 

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risk factor, Carhart’s (1997) approach was followed, which has been described previously. Thus, the explanatory variables in the time-series regressions include the returns on the market portfolio of stocks and mimicking portfolios for the size, book-to-market and momentum. The results of running the three regression models would allow coming to a conclusion about the relationship between $\beta$ and returns in the Greek stock market, which would allow us to conclude if the additional variables (size, B/M ratio and momentum) in the models are necessary to explain the behavior of share prices in the ASE.

5.3. Interpretation of the empirical results

The empirical analysis of the models we have carried out in this paper proposed to answer the question of whether the beta coefficient as a measure of systematic risk is able to explain portfolio returns in the Greek Stock Market and further to analyze what happens when size, B/M ratio and momentum are added to the model for explaining portfolio returns. To get a sense of some empirical results we cite Table 1 and Table 2, which depict the descriptive statistics of our 10 portfolios sorted by size and by B/M respectively.

It appears that on the average small size portfolios deliver higher returns than large size portfolios. As we go from small to large portfolios the returns decrease. The values of the Mean and Median show that small size portfolios deliver higher returns than large size portfolios and thus we can argue that what Fama and French claim about the returns of portfolios on the basis of size, is valid for the Greek Capital Market. We see that the opposite holds true in Table 2. Specifically we observe that portfolios with small B/M deliver small returns and as B/M increases the returns are increasing too. Thus the data clearly indicate that portfolios of small firms and value firms earned significantly higher average returns. Moreover, by looking at the prices of Kurtosis and Skewness’ coefficients in both Tables we can clearly see that returns are not normally distributed. The prices of Skewness show a great asymmetry of the probability distribution of the returns. The high Kurtosis also means that more of the variance is due to infrequent extreme deviations. Finally, the prices of standard
deviation indicate a great volatility in returns, which implies considerable uncertainty about the true expected premiums.
Table 1: Descriptive statistics (Portfolios sorted by size)

<table>
<thead>
<tr>
<th>Portfolio 1 Small Size</th>
<th>Portfolio 2</th>
<th>Portfolio 3</th>
<th>Portfolio 4</th>
<th>Portfolio 5</th>
<th>Portfolio 6</th>
<th>Portfolio 7</th>
<th>Portfolio 8</th>
<th>Portfolio 9</th>
<th>Portfolio 10 Large Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.067</td>
<td>0.054</td>
<td>0.040</td>
<td>0.046</td>
<td>0.036</td>
<td>0.031</td>
<td>0.024</td>
<td>0.021</td>
<td>0.008</td>
</tr>
<tr>
<td>Median</td>
<td>0.032</td>
<td>0.036</td>
<td>0.016</td>
<td>0.003</td>
<td>-0.003</td>
<td>-0.005</td>
<td>-0.015</td>
<td>-0.013</td>
<td>-0.023</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.256</td>
<td>0.237</td>
<td>0.243</td>
<td>0.299</td>
<td>0.283</td>
<td>0.276</td>
<td>0.263</td>
<td>0.303</td>
<td>0.243</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>51.343</td>
<td>41.191</td>
<td>45.927</td>
<td>60.298</td>
<td>54.746</td>
<td>50.531</td>
<td>50.689</td>
<td>53.545</td>
<td>35.063</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.560</td>
<td>-0.564</td>
<td>-0.607</td>
<td>-0.594</td>
<td>-0.591</td>
<td>-0.580</td>
<td>-0.496</td>
<td>-0.561</td>
<td>-0.573</td>
</tr>
<tr>
<td>Maximum</td>
<td>2.269</td>
<td>1.979</td>
<td>2.070</td>
<td>2.715</td>
<td>2.509</td>
<td>2.392</td>
<td>2.276</td>
<td>2.653</td>
<td>1.904</td>
</tr>
</tbody>
</table>

Numbers are rounded to three decimal points

Table 2: Descriptive statistics (Portfolios sorted by B/M)

<table>
<thead>
<tr>
<th>Portfolio 1 Low B/M</th>
<th>Portfolio 2</th>
<th>Portfolio 3</th>
<th>Portfolio 4</th>
<th>Portfolio 5</th>
<th>Portfolio 6</th>
<th>Portfolio 7</th>
<th>Portfolio 8</th>
<th>Portfolio 9</th>
<th>Portfolio 10 High B/M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-0.021</td>
<td>0.013</td>
<td>0.025</td>
<td>0.034</td>
<td>0.041</td>
<td>0.030</td>
<td>0.043</td>
<td>0.044</td>
<td>0.051</td>
</tr>
<tr>
<td>Median</td>
<td>-0.029</td>
<td>-0.015</td>
<td>-0.018</td>
<td>0.001</td>
<td>0.009</td>
<td>-0.001</td>
<td>0.004</td>
<td>0.011</td>
<td>0.024</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.220</td>
<td>0.273</td>
<td>0.250</td>
<td>0.285</td>
<td>0.285</td>
<td>0.291</td>
<td>0.287</td>
<td>0.265</td>
<td>0.267</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>14.977</td>
<td>31.574</td>
<td>31.618</td>
<td>49.606</td>
<td>58.604</td>
<td>59.261</td>
<td>58.325</td>
<td>54.280</td>
<td>50.073</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.527</td>
<td>-0.565</td>
<td>-0.571</td>
<td>-0.558</td>
<td>-0.563</td>
<td>-0.558</td>
<td>-0.606</td>
<td>-0.481</td>
<td>-0.610</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.388</td>
<td>2.098</td>
<td>1.938</td>
<td>2.462</td>
<td>2.572</td>
<td>2.619</td>
<td>2.587</td>
<td>2.350</td>
<td>2.323</td>
</tr>
</tbody>
</table>

Numbers are rounded to three decimal points

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Additional evidence in our research is displayed in Tables 3, 4, 5, 6, 7 and 8, which show the results of the time-series regressions of the three nested Models.

The first regression Model is the single factor CAPM. Table 3 shows the results of the regression of Model 1 when portfolios that were formed according to size are regressed. The estimated coefficients of market return \( R_m \) are statistically significant throughout all the portfolios indicating that beta \( \beta \) works really well and can explain the cross-section of average stock returns in the Athens Stock Exchange. Looking at the t-statistic and the p-value prices the explanatory power of beta in explaining the returns of stocks in the Greek Capital Market is again demonstrated. In addition, the values of Adjusted R-squared indicate that market returns explain significant percentages of the variation in portfolio returns starting from 12%, which is observed in 3 out of the 10 portfolios and reaching up to 20.6% in Portfolio 10 (Large Size Portfolio). Furthermore, the Akaike info Criterion (AIC) and Schwartz Criterion present sufficiently low values indicating that the goodness of fit of the estimated model is satisfactory.

Continuing with the regression of Model 2 that represents the Fama and French’s (1993) three-factor model equation and always with the 10 portfolios regressed on the size variable, the coefficient of \( R_m \) remains statistically significant and we observe that its values are in some portfolios greater than those observed in Model 1. Substituting the values of the Adjusted R-squared we observe that in 7 out of the 10 portfolios (P1, P2, P3, P4, P8, P9 and P10) the three-factor model can explain much more of the variation observed in realized returns than in regression Model 1, displaying Adjusted R-squared values of even 0.261 (in Portfolio 1) which is double the value of the Adjusted R-squared in Model 1 for portfolio 1. In essence, Model 2 can interpret by 26.1% every variation in the returns of Portfolio 1.

In Model 3 the momentum factor was added following the intuition of Carhart (1997) and the estimation results of the regression for the overall sample period are presented in Table 5. It once again appears that the beta coefficient is statistically significant for all size portfolios and predominates over all other variables. The values of the \( s \) coefficient are again found to be statistically insignificant something that allow us to contend that the size effect, first introduced by Banz (1981), is not confirmed for average returns of stocks in the Athens Stock Exchange. Moreover, the low prices of t-statistic for the \( s \) coefficient for the majority of the portfolios also provide weak
evidence of the existence of the size effect in the Greek Stock Market, something that is also valid for Model 2. With respect to the \( h \) coefficient the values show that it is a little more statistically significant than in Model 2 at the 10% level. Moving to the values of the additional \( m \) coefficient of the Model it appears that it is statistically significant at the 10% level in portfolios 4 and 7. Thus, we can say that there is a poor explanatory power of the momentum for the Greek Capital Market and it doesn’t go with its validity in other developed foreign markets. Finally, it is also observed that the values of Adjusted R-squared are not dramatically changed from those of Model 2 but they are even lower in certain portfolios as compared to those of Model 2 (Portfolios 1, 3, 8, 9 and 10). Finally, as far as the Durbin Watson statistic’s values in all three tables are concerned, we conclude that there is no autocorrelation of the time-series regressions. However, the Durbin Watson statistic results could be omitted since as we have already mentioned we have used for this problem the Newey & West (1987, 1994) heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimators so autocorrelation biases the results.

After the three regressions of excess portfolio returns on the size variable, it was carried out regressions of the three models but this time on portfolios that were formed according to the B/M ratio. As far as the beta coefficient is concerned, it is still presented statistically significant at the 1% level. Looking down the columns of the Adjusted R-squared in Table 7, prices are decreasing as we move to the high B/M portfolios. The highest Adjusted R-squared of 0.207 tells us that 20.7% of the variance of the returns experienced in Portfolio 1 was explained by the model. The following regression of Model 2 corroborates the up to now rule that beta is statistically significant in all of our portfolios in all regression tests. Similar to the values of the \( s \) coefficient of Table 4, the results in Table 7 are also presented, indicating that the size effect does not contribute a great deal to the description of stock returns in the Greek Stock Market. Contrary to this the \( h \) coefficient appears a little more significant than in Table 4, at the 5% level for Portfolio 1 and Portfolio 2 but still we cannot say that the B/M ratio is crucial in describing the Greek Stock Market returns. Moreover, the relatively low t-statistic prices of the loadings on the size and value factors show they are not contributing significantly to explanatory power. In addition, the explanatory power of the three-factor model shows no
significant improvement in relation to the CAPM as we observe steadily the Adjusted R-squared values.

The results of the last regression are presented in Table 8. A first remarkable observation is that the $m$ coefficient shows considerable improvement in relation to the results of Table 5. Specifically it appears significant at the 5% level for Portfolio 2 and at the 10% level for portfolios 1, 4, 5 and 6. Contrary to this we observe that with the addition of the momentum factor the HML factor is not present in any portfolio as a significant factor of the model. However, the Adjusted R-squared values range on the average in the same values as those of Table 6 and Table 7 but there is an increase among the higher values of the Adjusted R-squared of the three regressions: In Portfolio 1 (Table 8) the model explains the 27.1% of the variance of the returns while in the other two models the higher percentage of the explanatory power of the Model is 20.7% (Table 6). The explanatory power of momentum appears to be more significant. The $s$ coefficient remains statistically insignificant. Finally, in all the three tables the Akaike info Criterion (AIC) and Schwartz Criterion present sufficiently low values indicating that the goodness of fit of the estimated model is satisfactory.

5.4 Limitations & Further Research Proposals

Taking into account our results as well as the findings of other relevant researches for the Greek Stock Market we can propose some further research proposals. Empirical research of market efficiency and asset pricing models never stops in finance and the asset pricing models are continually enriched with additional factors in order to be improved and better explain anomalies that are discovered through the continual tests. Thus an attempt was made the anomalies of the CAPM, which is characterized as a misspecified model, to be explained with the addition of firm’s characteristics-variables that potentially proxy for omitted risk factors- like size and book-to-market ratio. A few years later the momentum was also included in the model and with the passing of time it is very likely that researchers will add variables in the models in order to improve them.

In this research portfolios are sorted according to size and B/M ratio but a good research field of an alternative approach could be composed of industry portfolios namely firms classified according the sector to which the firms belong. Another
limitation is that only the three variables of size, B/M and momentum were analyzed in the models. The results showed that beta works well but it appears that with only the beta the information content is small and when other explanatory variables are added into the models the information content improves. This means that market returns explain only part of the variability in portfolio returns. A parallel procedure could be to add additional variables in the models for explaining stock returns, like earnings-price ratio (E/P), cash-flow price ratio (C/F) or leverage. Thus further evidence is required to see what risk factors explain the cross-section of average stock returns in Greece. Furthermore, this research could also be repeated analyzing a longer sample period so that we can claim that the data sample is reflective of the entire Greek Market. This, however, is something that expands beyond the scope of this dissertation and needs further analysis.
CHAPTER VI

5. SUMMARY & CONCLUSIONS

This dissertation examined the cross-section of average stock returns in the Greek Stock Market and aimed at providing some evidence about the explanatory power of beta, size, book-to-market ratio and momentum on the ASE’s stock returns. For this purpose it was used a sample, which contained all firms listed in the ASE from the period January 1997 to December 2005.

From a theoretical perspective this paper first introduced the single factor CAPM based on a set of simple assumptions, offering a powerful and precise prediction of the relationship between the beta of an asset and its corresponding expected return. Following this the three-factor model of Fama and French (1993) was presented. In essence the three-factor model is an expansion of the CAPM describing the cross-sectional variation in expected returns connected with firm characteristics which contains, together with the market portfolio, size (SMB) and value (HML) mimicking portfolios. Thus, using this model it is easy to combine the examination of the relation between systematic risk and average stock returns as well as the relation of unsystematic risk and average returns. Finally, it was also analyzed the prior return or momentum effect introduced by Jegadeesh and Titman (1993), through Carhart’s (1997) studies.

Regarding the observations it appears that beta is a significant risk factor in explaining the cross-section of average stock returns in the Greek Market. A weaker explanatory power has the momentum, which appears to be more significant after the beta coefficient and last in significance appears to be the B/M ratio. The empirical results showed that for the period examined a strong size effect was not observed in the Athens Stock Exchange namely the firm size did not play an important role in the formation of the expected stock returns. This result conflicts with the empirical results from studies in other Stock Exchange Markets. Nevertheless we cannot document this in all portfolios. The result is transitory. Consequently we don’t refute that small size stocks deliver higher returns than large size stocks or that low B/M portfolios deliver smaller returns than high B/M portfolios, but for the particular sample and period, beta seems to be the “best” risk factor over the size, the B/M and the momentum.

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In general, results of our tests meet the predictions of Sharpe, Lintner and Black (1972) suggesting that there is a strong relationship between $\beta$ and return in the Greek Stock Market. In other words, results present the Greek Market able to explain the variation in the returns of our portfolios.
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APPENDIX
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Notes: 1) Numbers are rounded to three decimal points
2) Portfolios are formed according to size

Explanatory variables: the excess of the Market Portfolio

*indicates significance at the 1% level
**indicates significance at the 5% level
***indicates significance at the 10% level
### Table 4: Regression of excess portfolio returns on various explanatory variables

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**Notes:**
1) Numbers are rounded to three decimal points.
2) Portfolios are formed according to size.

**Explanatory variables:**
- the excess of the Market Portfolio
- the Fama and French's suggested risk factors of size & B/M ratio

*indicates significance at the 1% level
**indicates significance at the 5% level
***indicates significance at the 10% level
### Table 5: Regression of excess portfolio returns on various explanatory variables

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Notes: 1) Numbers are rounded to three decimal points  
2) Portfolios are formed according to size

Explanatory variables:  
- the excess of the Market Portfolio  
- the Fama and French’s suggested risk factors of size & B/M ratio  
- the Momentum factor

*indicates significance at the 1% level  
**indicates significance at the 5% level  
***indicates significance at the 10% level
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Notes: 1) Numbers are rounded to three decimal points
2) Portfolios are formed according to B/M ratio

Explanatory variables: the excess of the Market Portfolio

*indicates significance at the 1% level
**indicates significance at the 5% level
***indicates significance at the 10% level
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Notes: 1) Numbers are rounded to three decimal points
2) Portfolios are formed according to B/M ratio

Explanatory variables:
- the excess of the Market Portfolio
- the Fama and French's suggested risk factors of size & B/M ratio

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**indicates significance at the 5% level
***indicates significance at the 10% level
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Notes: 1) Numbers are rounded to three decimal points  
2) Portfolios are formed according to B/M ratio  
3) *indicates significance at the 1% level  
4) **indicates significance at the 5% level  
5) ***indicates significance at the 10% level  

**Explanatory variables:**  
- the excess of the Market Portfolio  
- the Fama and French's suggested risk factors of size & B/M ratio  
- the Momentum factor