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Testing the Capital Asset Pricing Model (CAPM): The Case of the Emerging Greek Securities Market

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Abstract

The article examines the Capital Asset Pricing Model (CAPM) for the Greek stock market using weekly stock returns from 100 companies listed on the Athens stock exchange for the period of January 1998 to December 2002. In order to diversify away the firm-specific part of returns thereby enhancing the precision of the beta estimates, the securities where grouped into portfolios. The findings of this article are not supportive of the theory's basic statement that higher risk (beta) is associated with higher levels of return. The model does explain, however, excess returns and thus lends support to the linear structure of the CAPM equation.

The CAPM's prediction for the intercept is that it should equal zero and the slope should equal the excess returns on the market portfolio. The results of the study refute the above hypothesis and offer evidence against the CAPM. The tests conducted to examine the nonlinearity of the relationship between return and betas support the hypothesis that the expected return-beta relationship is linear. Additionally, this paper investigates whether the CAPM adequately captures all-important determinants of returns including the residual variance of stocks. The results demonstrate that residual risk has no effect on the expected returns of portfolios. Tests may provide evidence against the CAPM but they do not necessarily constitute evidence in support of any alternative model (JEL G11, G12, and G15).

Key words: CAPM, Athens Stock Exchange, portfolio returns, beta, risk free rate, stocks
JEL Classification: F23, G15

I. Introduction

Investors and financial researchers have paid considerable attention during the last few years to the new equity markets that have emerged around the world. This new interest has undoubtedly been spurred by the large, and in some cases extraordinary, returns offered by these markets. Practitioners all over the world use a plethora of models in their portfolio selection process and in their attempt to assess the risk exposure to different assets.

One of the most important developments in modern capital theory is the capital asset pricing model (CAPM) as developed by Sharpe [1964], Lintner [1965] and Mossin [1966]. CAPM suggests that high expected returns are associated with high levels of risk. Simply stated, CAPM postulates that the expected return on an asset above the risk-free rate is linearly related to the non-diversifiable risk as measured by the asset's beta. Although the CAPM has been predominant in empirical work over the past 30 years and is the basis of modern portfolio theory, accumulating research has increasingly cast doubt on its ability to explain the actual movements of asset returns.

The purpose of this article is to examine thoroughly if the CAPM holds true in the capital market of Greece. Tests are conducted for a period of five years (1998-2002), which is characterized by intense return volatility (covering historically high returns for the Greek Stock market as well as significant decrease in asset returns over the examined period). These market return characteristics make it possible to have an empirical investigation of the pricing model on differing financial conditions thus obtaining conclusions under varying stock return volatility.

Existing financial literature on the Athens stock exchange is rather scanty and it is the goal of this study to widen the theoretical analysis of this market by using modern finance theory and to provide useful insights for future analyses of this market.

II. Empirical appraisal of the model and competing studies of the model's validity

2.1. Empirical appraisal of CAPM

Since its introduction in early 1960s, CAPM has been one of the most challenging topics in financial economics. Almost any manager who wants to undertake a project must justify his decision partly based on CAPM. The reason is that the model provides the means for a firm to calculate the return that its investors demand. This model was the first successful attempt to show how to assess the risk of the cash flows of a potential investment project, to estimate the project's cost of capital and the expected rate of return that investors will demand if they are to invest in the project.

The model was developed to explain the differences in the risk premium across assets. According to the theory these differences are due to differences in the riskiness of the returns on the assets. The model states that the correct measure of the riskiness of an asset is its beta and that the risk premium per unit of riskiness is the same across all assets. Given the risk free rate and the beta of an asset, the CAPM predicts the expected risk premium for an asset.

The theory itself has been criticized for more than 30 years and has created a great academic debate about its usefulness and validity. In general, the empirical testing of CAPM has two broad purposes (Baily et al, [1998]): (i) to test whether or not the theories should be rejected (ii) to provide information that can aid financial decisions. To accomplish (i) tests are conducted which could potentially at least reject the model. The model passes the test if it is not possible to reject the hypothesis that it is true. Methods of statistical analysis need to be applied in order to draw reliable conclusions on whether the model is supported by the data. To accomplish (ii) the empirical work uses the theory as a vehicle for organizing and interpreting the data without seeking ways of rejecting the theory. This kind of approach is found in the area of portfolio decision-making, in particular with regards to the selection of assets to the bought or sold. For example, investors are advised to buy or sell assets that according to CAPM are underpriced or overpriced. In this case empirical analysis is needed to evaluate the assets, assess their riskiness, analyze them, and place them into their respective categories. A second illustration of the latter methodology appears in corporate finance where the estimated beta coefficients are used in assessing the riskiness of different investment projects. It is then possible to calculate "hurdle rates" that projects must satisfy if they are to be undertaken.

This part of the paper focuses on tests of the CAPM since its introduction in the mid 1960's, and describes the results of competing studies that attempt to evaluate the usefulness of the capital asset pricing model (Jagannathan and McGrattan [1995]).

2.2. The classic support of the theory

The model was developed in the early 1960's by Sharpe [1964], Lintner [1965] and Mossin [1966]. In its simple form, the CAPM predicts that the expected return on an asset above the risk-free rate is linearly related to the non-diversifiable risk, which is measured by the asset's beta.

One of the earliest empirical studies that found supportive evidence for CAPM is that of Black, Jensen and Scholes [1972]. Using monthly return data and portfolios rather than individual stocks, Black et al tested whether the cross-section of expected returns is linear in beta. By combining securities into portfolios one can diversify away most of the firm-specific component of the returns, thereby enhancing the precision of the beta estimates and the expected rate of return of the portfolio securities. This approach mitigates the statistical problems that arise from measurement errors in beta estimates. The authors found that the data are consistent with the predictions of the CAPM i.e. the relation between the average return and beta is very close to linear and that portfolios with high (low) betas have high (low) average returns.

Another classic empirical study that supports the theory is that of Fama and McBeth [1973]; they examined whether there is a positive linear relation between average returns and beta. Moreover, the authors investigated whether the squared value of beta and the volatility of asset returns can explain the residual variation in average returns across assets that are not explained by beta alone.

2.3. Challenges to the validity of the theory

In the early 1980s several studies suggested that there were deviations from the linear CAPM risk-return trade-off due to other variables that affect this tradeoff. The purpose of the above studies was to find the components that CAPM was missing in explaining the risk-return trade-off and to identify the variables that created those deviations.

Banz [1981] tested the CAPM by checking whether the size of firms can explain the residual variation in average returns across assets that remain unexplained by the CAPM's beta. He challenged the CAPM by demonstrating that firm size does explain the cross sectional-variation in average returns on a particular collection of assets better than beta. The author concluded that the average returns on stocks of small firms (those with low market values of equity) were higher than the average returns on stocks of large firms (those with high market values of equity). This finding has become known as the size effect.

The research has been expanded by examining different sets of variables that might affect the risk-return tradeoff. In particular, the earnings yield (Basu [1977]), leverage, and the ratio of a firm's book value of equity to its market value (e.g. Stattman [1980], Rosenberg, Reid and Lanstein [1983] and Chan, Hamao, Lakonishok [1991]) have all been utilized in testing the validity of CAPM.

The general reaction to Banz's [1981] findings, that CAPM may be missing some aspects of reality, was to support the view that although the data may suggest deviations from CAPM, these deviations are not so important as to reject the theory.

However, this idea has been challenged by Fama and French [1992]. They showed that Banz's findings might be economically so important that it raises serious questions about the validity of the CAPM. Fama and French [1992] used the same procedure as Fama and McBeth [1973] but arrived at very different conclusions. Fama and McBeth find a positive relation between return and risk while Fama and French find no relation at all.

2.4. The academic debate continues

The Fama and French [1992] study has itself been criticized. In general the studies responding to the Fama and French challenge by and large take a closer look at the data used in the study. Kothari, Shaken and Sloan [1995] argue that Fama and French's [1992] findings depend essentially on how the statistical findings are interpreted.

Amihudm, Christensen and Mendelson [1992] and Black [1993] support the view that the data are too noisy to invalidate the CAPM. In fact, they show that when a more efficient statistical method is used, the estimated relation between average return and beta is positive and significant. Black [1993] suggests that the size effect noted by Banz [1981] could simply be a sample period effect i.e. the size effect is observed in some periods and not in others.

Despite the above criticisms, the general reaction to the Fama and French [1992] findings has been to focus on alternative asset pricing models. Jagannathan and Wang [1993] argue that this may not be necessary. Instead they show that the lack of empirical support for the CAPM may be due to the inappropriateness of basic assumptions made to facilitate the empirical analysis. For example, most empirical tests of the CAPM assume that the return on broad stock market indices is a good proxy for the return on the market portfolio of all assets in the economy. However, these types of market indexes do not capture all assets in the economy such as human capital.

Other empirical evidence on stock returns is based on the argument that the volatility of stock returns is constantly changing. When one considers a time-varying return distribution, one must refer to the conditional mean, variance, and covariance that change depending on currently available information. In contrast, the usual estimates of return, variance, and average squared deviations over a sample period, provide an unconditional estimate because they treat variance as constant over time. The most widely used model to estimate the conditional (hence time- varying) variance of stocks and stock index returns is the generalized autoregressive conditional heteroscedacity (GARCH) model pioneered by Robert.F.Engle.

To summarize, all the models above aim to improve the empirical testing of CAPM. There have also been numerous modifications to the models and whether the earliest or the subsequent alternative models validate or not the CAPM is yet to be determined.

III. Sample selection and Data

3.1. Sample Selection

The study covers the period from January 1998 to December 2002. This time period was chosen because it is characterized by intense return volatility with historically high and low returns for the Greek stock market.

The selected sample consists of 100 stocks that are included in the formation of the FTSE/ASE 20, FTSE/ASE Mid 40 and FTSE/ASE Small Cap. These indices are designed to provide real-time measures of the Athens Stock Exchange (ASE).

The above indices are formed subject to the following criteria:

(i) The FTSE/ASE 20 index is the large cap index, containing the 20 largest blue chip companies listed in the ASE.

(ii) The FTSE/ASE Mid 40 index is the mid cap index and captures the performance of the next 40 companies in size.

(iii) The FTSE/ASE Small Cap index is the small cap index and captures the performance of the next 80 companies.

All securities included in the indices are traded on the ASE on a continuous basis throughout the full Athens stock exchange trading day, and are chosen according to prespecified liquidity criteria set by the ASE Advisory Committee[1].

For the purpose of the study, 100 stocks were selected from the pool of securities included in the above-mentioned indices. Each series consists of 260 observations of the weekly closing prices. The selection was made on the basis of the trading volume and excludes stocks that were traded irregularly or had small trading volumes.

3.2. Data Selection

The study uses weekly stock returns from 100 companies listed on the Athens stock exchange for the period of January 1998 to December 2002. The data are obtained from MetaStock (Greek) Data Base.

In order to obtain better estimates of the value of the beta coefficient, the study utilizes weekly stock returns. Returns calculated using a longer time period (e.g. monthly) might result in changes of beta over the examined period introducing biases in beta estimates. On the other hand, high frequency data such as daily observations covering a relatively short and stable time span can result in the use of very noisy data and thus yield inefficient estimates.

All stock returns used in the study are adjusted for dividends as required by the CAPM.

The ASE Composite Share index is used as a proxy for the market portfolio. This index is a market value weighted index, is comprised of the 60 most highly capitalized shares of the main market, and reflects general trends of the Greek stock market.

Furthermore, the 3-month Greek Treasury Bill is used as the proxy for the risk-free asset. The yields were obtained from the Treasury Bonds and Bill Department of the National Bank of Greece. The yield on the 3-month Treasury bill is specifically chosen as the benchmark that better reflects the short-term changes in the Greek financial markets.

IV. Methodology

The first step was to estimate a beta coefficient for each stock using weekly returns during the period of January 1998 to December 2002. The beta was estimated by regressing each stock's weekly return against the market index according to the following equation:

$$R_{it} - \mathrm{R}_{ft} = \mathrm{a}_i + \beta_i \cdot (R_{mt} - \mathrm{R}_{\mathrm{ft}}) + \mathrm{e}_{it} \tag{1}$$

where,

R_{it} is the return on stock i (i=1…100),

R_{ft} is the rate of return on a risk-free asset,

R_{mt} is the rate of return on the market index,

β_i is the estimate of beta for the stock i , and

e_{it} is the corresponding random disturbance term in the regression equation.

[Equation 1 could also be expressed using excess return notation, where $(R_{it} - R_{ft}) = r_{it}$ and $(R_{mt} - R_{\mathrm{ft}}) = \mathrm{r}_{\mathrm{mt}}$]

In spite of the fact that weekly returns were used to avoid short-term noise effects the estimation diagnostic tests for equation (1) indicated, in several occasions, departures from the linear assumption.

[1] www.ase.gr

In such cases, equation (1) was re-estimated providing for EGARCH (1,1) form to comfort with misspecification.

The next step was to compute average portfolio excess returns of stocks (r_{pt}) ordered according to their beta coefficient computed by Equation 1. Let,

$$r_{pt} = \frac{\sum_{i=1}^{k} r_{it}}{k} \tag{2}$$

where,

k is the number of stocks included in each portfolio (k=1…10),

p is the number of portfolios (p=1…10),

r_{it} is the excess return on stocks that form each portfolio comprised of k stocks each.

This procedure generated 10 equally-weighted portfolios comprised of 10 stocks each.

By forming portfolios the spread in betas across portfolios is maximized so that the effect of beta on return can be clearly examined. The most obvious way to form portfolios is to rank stocks into portfolios by the true beta. But, all that is available is observed beta. Ranking into portfolios by observed beta would introduce selection bias. Stocks with high-observed beta (in the highest group) would be more likely to have a positive measurement error in estimating beta. This would introduce a positive bias into beta for high-beta portfolios and would introduce a negative bias into an estimate of the intercept. (Elton and Gruber [1995], p. 333).

Combining securities into portfolios diversifies away most of the firm-specific part of returns thereby enhancing the precision of the estimates of beta and the expected rate of return on the portfolios on securities. This mitigates statistical problems that arise from measurement error in the beta estimates.

The following equation was used to estimate portfolio betas:

$$r_{pt} = a_p + \beta_p \cdot \mathrm{r_{mt}} + \mathrm{e}_{pt} \tag{3}$$

where,

r_{pt} is the average excess portfolio return,

β_p is the calculated portfolio beta.

The study continues by estimating the ex-post Security Market Line (SML) by regressing the portfolio returns against the portfolio betas obtained by Equation 3. The relation examined is the following:

$$r_P = \gamma_0 + \gamma_1 \cdot \beta_P + \mathrm{e}_P \tag{4}$$

where,

r_p is the average excess return on a portfolio p (the difference between the return on the portfolio and the return on a risk-free asset),

β_p is an estimate of beta of the portfolio p,

γ_1 is the market price of risk, the risk premium for bearing one unit of beta risk,

γ_0 is the zero-beta rate, the expected return on an asset which has a beta of zero, and

e_p is random disturbance term in the regression equation.

In order to test for nonlinearity between total portfolio returns and betas, a regression was run on average portfolio returns, calculated portfolio beta, and beta-square from equation 3:

$$r_p = \gamma_0 + \gamma_1 \cdot \beta_p + \gamma_2 \cdot \beta_p^2 + \mathrm{e}_p \tag{5}$$

Finally in order to examine whether the residual variance of stocks affects portfolio returns, an additional term was included in equation 5, to test for the explanatory power of nonsystematic risk:

$$r_p = \gamma_0 + \gamma_1 \cdot \beta_p + \gamma_2 \cdot \beta_p^2 + \gamma_3 \cdot \mathrm{RV_p} + \mathrm{e}_p \tag{6}$$

where

RV_p is the residual variance of portfolio returns (Equation 3), $RV_p = \sigma^2(e_{pt})$.

The estimated parameters allow us to test a series of hypotheses regarding the CAPM. The tests are:

i) $\gamma_3 = 0$ or residual risk does not affect return,

ii) $\gamma_2 = 0$ or there are no nonlinearities in the security market line,

iii) $\gamma_1 > 0$ that is, there is a positive price of risk in the capital markets (Elton and Gruber [1995], p. 336).

Finally, the above analysis was also conducted for each year separately (1998-2002), by changing the portfolio compositions according to yearly estimated betas.

V. Empirical results and Interpretation of the findings

The first part of the methodology required the estimation of betas for individual stocks by using observations on rates of return for a sequence of dates. Useful remarks can be derived from the results of this procedure, for the assets used in this study.

The range of the estimated stock betas is between 0.0984 the minimum and 1.4369 the maximum with a standard deviation of 0.2240 (Table 1). Most of the beta coefficients for individual stocks are statistically significant at a 95% level and all estimated beta coefficients are statistical significant at a 90% level. For a more accurate estimation of betas an EGARCH (1,1) model was used wherever it was necessary, in order to correct for nonlinearities.

Table 1: Stock beta coefficient estimates (Equation 1)

Stock name	beta	Stock name	beta	Stock name	beta	Stock name	beta
OLYMP	.0984	THEMEL	.8302	PROOD	.9594	EMP	1.1201
EYKL	.4192	AIOLK	.8303	ALEK	.9606	NAOYK	1.1216
MPELA	.4238	AEGEK	.8305	EPATT	.9698	ELBE	1.1256
MPTSK	.5526	AEEXA	.8339	SIDEN	.9806	ROKKA	1.1310
FOIN	.5643	SPYR	.8344	GEK	.9845	SELMK	1.1312
GKOYT	.5862	SARANT	.8400	ELYF	.9890	DESIN	1.1318
PAPAK	.6318	ELTEX	.8422	MOYZK	.9895	ELBAL	1.1348
ABK	.6323	ELEXA	.8427	TITK	.9917	ESK	1.1359
MYTIL	.6526	MPENK	.8610	NIKAS	.9920	TERNA	1.1392
FELXO	.6578	HRAKL	.8668	ETHENEX	1.0059	KERK	1.1396
ABAX	.6874	PEIR	.8698	IATR	1.0086	POYL	1.1432
TSIP	.6950	BIOXK	.8747	METK	1.0149	EEGA	1.1628
AAAK	.7047	ELMEK	.8830	ALPHA	1.0317	KALSK	1.1925
EEEK	.7097	LAMPSA	.8848	AKTOR	1.0467	GENAK	1.1996
ERMHS	.7291	MHXK	.8856	INTKA	1.0532	FANKO	1.2322
LAMDA	.7297	DK	.8904	MAIK	1.0542	PLATH	1.2331
OTE	.7309	FOLI	.9005	PETZ	1.0593	STRIK	1.2500
MARF	.7423	THELET	.9088	ETEM	1.0616	EBZ	1.2520
MRFKO	.7423	ATT	.9278	FINTO	1.0625	ALLK	1.2617
KORA	.7520	ARBA	.9302	ESXA	1.0654	GEBKA	1.2830
RILK	.7682	KATS	.9333	BIOSK	1.0690	AXON	1.3030
LYK	.7684	ALBIO	.9387	XATZK	1.0790	RINTE	1.3036
ELASK	.7808	XAKOR	.9502	KREKA	1.0911	KLONK	1.3263
NOTOS	.8126	SAR	.9533	ETE	1.1127	ETMAK	1.3274
KARD	.8290	NAYP	.9577	SANYO	1.1185	ALTEK	1.4369

Source: Metastock (Greek) Data Base and calculations (S-PLUS)

The article argues that certain hypotheses can be tested irregardless of whether one believes in the validity of the simple CAPM or in any other version of the theory. Firstly, the theory indicates that higher risk (beta) is associated with a higher level of return. However, the results of the study do not support this hypothesis. The beta coefficients of the 10 portfolios do not indicate that higher beta portfolios are related with higher returns. Portfolio 10 for example, the highest beta portfolio ($\beta = 1.2024$), yields negative portfolio returns. In contrast, portfolio 1, the lowest beta portfolio ($\beta = 0.5474$) produces positive returns. These contradicting results can be partially explained by the significant fluctuations of stock returns over the period examined (Table 2).

Table 2: Average excess portfolio returns and betas (Equation 3)

Portfolio	r_p	beta (p)	Var. Error	R^2
a10	.0001	.5474	.0012	.4774
b10	.0000	.7509	.0013	.5335
c10	-.0007	.9137	.0014	.5940
d10	-.0004	.9506	.0014	.6054
e10	-.0008	.9300	.0009	.7140
f10	-.0009	.9142	.0010	.6997
g10	-.0006	1.0602	.0012	.6970
h10	-.0013	1.1066	.0019	.6057
i10	-.0004	1.1293	.0020	.6034
j10	-.0004	1.2024	.0026	.5691
Average R_f	.0014			
Average $r_m=(R_m-R_f)$	.0001			

Source: Metastock (Greek) Data Base and calculations (S-PLUS)

In order to test the CAPM hypothesis, it is necessary to find the counterparts to the theoretical values that must be used in the CAPM equation. In this study the yield on the 3-month Greek Treasury Bill was used as an approximation of the risk-free rate. For the R_m, the ASE Composite Share index is taken as the best approximation for the market portfolio.

The basic equation used was $r_P = \gamma_0 + \gamma_1 \cdot \beta_P + e_P$ (Equation 4) where γ_0 is the expected excess return on a zero beta portfolio and γ_1 is the market price of risk, the difference between the expected rate of return on the market and a zero beta portfolio.

One way for allowing for the possibility that the CAPM does not hold true is to add an intercept in the estimation of the SML. The CAPM considers that the intercept is zero for every asset. Hence, a test can be constructed to examine this hypothesis.

In order to diversify away most of the firm-specific part of returns, thereby enhancing the precision of the beta estimates, the securities were previously combined into portfolios. This approach mitigates the statistical problems that arise from measurement errors in individual beta estimates. These portfolios were created for several reasons: (i) the random influences on individual stocks tend to be larger compared to those on suitably constructed portfolios (hence, the intercept and beta are easier to estimate for portfolios) and (ii) the tests for the intercept are easier to implement for portfolios because by construction their estimated coefficients are less likely to be correlated with one another than the shares of individual companies.

The high value of the estimated correlation coefficient between the intercept and the slope indicates that the model used explains excess returns (Table 3).

Table 3: Statistics of the estimation of the SML (Equation 4)

Coefficient	γ0	γ1
Value	.0005	-.0011
t-value	(.9011)	(-1.8375)
p-value	.3939	.1034
Residual standard error: .0004 on 8 degrees of freedom		
Multiple R-Squared: .2968		
F-statistic: 3.3760 on 1 and 8 degrees of freedom, the p-value is .1034		
Correlation of Coefficients $\rho_{\gamma_0,\gamma_1} = .9818$		

However, the fact that the intercept has a value around zero weakens the above explanation. The results of this paper appear to be inconsistent with the zero beta version of the CAPM because the intercept of the SML is not greater than the interest rate on risk free-bonds (Table 2 and 3).

In the estimation of SML, the CAPM's prediction for γ_0 is that it should be equal to zero. The calculated value of the intercept is small (0.0005) but it is not significantly different from zero (the t-value is not greater than 2) Hence, based on the intercept criterion alone the CAPM hypothesis cannot clearly be rejected. According to CAPM the SLM slope should equal the excess return on the market portfolio. The excess return on the market portfolio was 0.0001 while the estimated SLM slope was –0.0011. Hence, the latter result also indicates that there is evidence against the CAPM (Table 2 and 3).

In order to test for nonlinearity between total portfolio returns and betas, a regression was run between average portfolio returns, calculated portfolio betas, and the square of betas (Equation 5). Results show that the intercept (0.0036) of the equation was greater than the risk-free interest rate (0.0014), γ_1 was negative and different from zero while γ_2, the coefficient of the square beta was very small (0.0041 with a t-value not greater than 2) and thus consistent with the hypothesis that the expected return-beta relationship is linear (Table 4).

Table 4: Testing for Non-linearity (Equation 5)

Coefficient	γ0	γ1	γ2
Value	.0036	-.0084	.0041
t-value	(1.7771)	(-1.8013)	(1.5686)
p-value	0.1188	0.1147	0.1607
Residual standard error: .0003 on 7 degrees of freedom			
Multiple R-Squared: .4797			
F-statistic: 3.2270 on 2 and 7 degrees of freedom, the p-value is .1016			

According to the CAPM, expected returns vary across assets only because the assets' betas are different. Hence, one way to investigate whether CAPM adequately captures all-important aspects of the risk-return tradeoff is to test whether other asset-specific characteristics can explain the cross-sectional differences in average returns that cannot be attributed to cross-sectional differences in beta. To accomplish this task the residual variance of portfolio returns was added as an additional explanatory variable (Equation 6).

The coefficient of the residual variance of portfolio returns γ_3 is small and not statistically different from zero. It is therefore safe to conclude that residual risk has no affect on the expected return of a security. Thus, when portfolios are used instead of individual stocks, residual risk no longer appears to be important (Table 5).

Table 5: Testing for Non-Systematic risk (Equation 6)

Coefficient	γ0	γ1	γ2	γ3
Value	.0017	-.0043	.0015	.3503
t-value	(.5360)	(-.6182)	(.3381)	(.8035)
p-value	0.6113	0.5591	0.7468	0.4523
Residual standard error: .0003 on 6 degrees of freedom				
Multiple R-Squared: .5302				
F-statistic: 2.2570 on 3 and 6 degrees of freedom, the p-value is .1821				

Since the analysis on the entire five-year period did not yield strong evidence in favor of the CAPM we examined whether a similar approach on yearly data would provide more supportive evidence. All models were tested separately for each of the five-year period and the results were statistically better for some years but still did not support the CAPM hypothesis (Tables 6, 7 and 8).

Table 6: Statistics of the estimation SML (yearly series, Equation 4)

	Coefficient	Value	t-value	Std. Error	p-value
1998	γ0	.0053	(3.7665)	.0014	.0050
	γ1	.0050	(2.2231)	.0022	.0569
1999	γ0	.0115	(2.8145)	.0041	.2227
	γ1	.0134	(4.0237)	.0033	.0038
2000	γ0	-.0035	(-1.9045)	.0019	.0933
	γ1	-.0149	(-9.4186)	.0016	.0000
2001	γ0	.0000	(.0025)	.0024	.9981
	γ1	-.0057	(-2.4066)	.0028	.0427
2002	γ0	-.0017	(-.8452)	.0020	.4226
	γ1	-.0088	(-5.3642)	.0016	.0007

Table 7: Testing for Non-linearity (yearly series, Equation 5)

	Coefficient	Value	t-value	Std. Error	p-value
1998	γ0	.0035	(1.7052)	.0020	.1319
	γ1	.0139	(1.7905)	.0077	.1165
	γ2	-.0078	(-1.1965)	.0065	.2705
1999	γ0	.0030	(2.1093)	.0142	.0729
	γ1	-.0193	(-.7909)	.0243	.4549
	γ2	.0135	(1.3540)	.0026	.0100
2000	γ0	-.0129	(-3.5789)	.0036	.0090
	γ1	.0036	(.5435)	.0067	.6037
	γ2	-.0083	(-2.8038)	.0030	.0264
2001	γ0	.0092	(1.2724)	.0072	.2439
	γ1	-.0240	(-1.7688)	.0136	.1202
	γ2	.0083	(1.3695)	.0060	.2132
2002	γ0	-.0077	(-2.9168)	.0026	.0224
	γ1	.0046	(.9139)	.0050	.3911
	γ2	-.0059	(-2.7438)	.0022	.0288

Table 8: Testing for Non-Systematic risk (yearly series, Equation 6)

	Coefficient	Value	t-value	Std. Error	p-value
1998	γ0	.0016	(.7266)	.0022	.4948
	γ1	.0096	(1.2809)	.0075	.2475
	γ2	-.0037	(-.5703)	.0065	.5892
	γ3	3.0751	(.5862)	1.9615	.1680
1999	γ0	.0017	(1.4573)	.0125	.1953
	γ1	-.0043	(-.0168)	.0211	.9846
	γ2	.0015	(.0201)	.0099	.9846
	γ3	.3503	(2.2471)	1.4278	.0657
2000	γ0	-.0203	(-4.6757)	.0043	.0034
	γ1	.0199	(2.2305)	.0089	.0106
	γ2	-.0185	(-3.6545)	.0051	.0106
	γ3	2.2673	(2.2673)	.9026	.0639
2001	γ0	.0062	(.6019)	.0103	.5693
	γ1	-.0193	(-1.0682)	.0181	.3265
	γ2	.0053	(.5635)	.0094	.5935
	γ3	1.7024	(.4324)	3.9369	.6805
2002	γ0	-.0049	(-.9507)	.0052	.3785
	γ1	.0000	(.0054)	.0089	.9959
	γ2	-.0026	(-.4576)	.0058	.6633
	γ3	-5.1548	(-.6265)	8.2284	.5541

VI. Concluding Remarks

The article examined the validity of the CAPM for the Greek stock market. The study used weekly stock returns from 100 companies listed on the Athens stock exchange from January 1998 to December 2002.

The findings of the article are not supportive of the theory's basic hypothesis that higher risk (beta) is associated with a higher level of return.

In order to diversify away most of the firm-specific part of returns thereby enhancing the precision of the beta estimates, the securities where combined into portfolios to mitigate the statistical problems that arise from measurement errors in individual beta estimates.

The model does explain, however, excess returns. The results obtained lend support to the linear structure of the CAPM equation being a good explanation of security returns. The high value of the estimated correlation coefficient between the intercept and the slope indicates that the model used, explains excess returns. However, the fact that the intercept has a value around zero weakens the above explanation.

The CAPM's prediction for the intercept is that it should be equal to zero and the slope should equal the excess returns on the market portfolio. The findings of the study contradict the above hypothesis and indicate evidence against the CAPM.

The inclusion of the square of the beta coefficient to test for nonlinearity in the relationship between returns and betas indicates that the findings are according to the hypothesis and the expected return-beta relationship is linear. Additionally, the tests conducted to investigate whether the CAPM adequately captures all-important aspects of reality by including the residual variance of stocks indicates that the residual risk has no effect on the expected return on portfolios.

The lack of strong evidence in favor of CAPM necessitated the study of yearly data to test the validity of the model. The findings from this approach provided better statistical results for some years but still did not support the CAPM hypothesis.

The results of the tests conducted on data from the Athens stock exchange for the period of January 1998 to December 2002 do not appear to clearly reject the CAPM. This does not mean that the data do not support CAPM. As Black [1972] points out these results can be explained in two ways. First, measurement and model specification errors arise due to the use of a proxy instead of the actual market portfolio. This error biases the regression line estimated slope towards zero and its estimated intercept away from zero. Second, if no risk-free asset exists, the CAPM does not predict an intercept of zero.

The tests may provide evidence against the CAPM but that does not necessarily constitute evidence in support of any alternative model.

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