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TESTING THE RELATION BETWEEN RISK AND RETURNS USING CAPM AND APT: THE CASE OF ATHENS STOCK EXCHANGE (ASE)

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Abstract

This article investigates the determinants of stock returns in Athens Stock Exchange (ASE) using both frameworks the classical CAPM and the statistical APT model. The analysis is conducted with monthly data from the Greek stock market. Empirical tests in this study suggest that the relationship between β and return in the ASE, over the period January 1987 - December 2001, is weak. More analytically, the Capital Asset Pricing Model (CAPM) has poor overall explanatory power, whereas the Arbitrage Pricing Theory (APT) model, which allows multiple sources of systematic risks to be taken into account, performs better than the CAPM, in all the tests considered. Shares and portfolios in the ASE seem to be significantly influenced by a number of systematic forces and their behaviour can be explained only through the combined explanatory power of several factors. Factor analysis replaces the arbitrary and controversial search for factors of the APT model by "trial and error" with a real systematic and scientific approach.

Key words: CAPM, APT, risk-return trade-off.

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1. Introduction

Finance has evolved into a highly technical subject since the 1950s. Prior to that time it was largely institutionally oriented and a descriptive subject (Ryan, Scapens and Theobald, 2002). The two main precursors of the change in the scope of finance were the treatment of risk in the portfolio context by Markowitz (1952) and the mathematical economic analysis by Modigliani and Miller (1958) of capital structure.

While portfolio theory dealt with the individual investor's portfolio decision it provided the basis for an equilibrium asset pricing model-the capital asset pricing model (CAPM)-developed by Sharpe (1964), Lintner (1965) and Mossin (1966).

The CAPM assumes that all investors maximise the utility of terminal wealth defined over the mean and variance of portfolio returns, and that all investors have unconditional homogeneous expectations of means, variances, and covariance's. The capital market is assumed to be perfect. In the single period analysis, a '*separation theorem*' at the aggregate level will arise (manifested by the capital market line) in the presence of a risk-free asset and the capital asset pricing model can be derived by the Lagrangean multipliers technique. The linear risk return trade off, with risk measured by the beta coefficient (which reflects covariance or non-diversifiable risk) is perhaps one of the best known models in the finance field. Its message is simple; the only risk that is '*priced*' at equilibrium in the market is that risk which cannot be diversified away. The CAPM was developed in a relatively restricted theoretical environment. However, it did provide strong empirical implications, that is, that systematic risk and return are linearly related in the capital market. In the last twenty years the field of asset pricing, in both the theoretical and empirical domains, has advanced considerably, although with a remarkable amount of controversy on the way.

This was the main reason that induced us to the decision of devoting this paper on the empirical testing of both CAPM and APT on ASE. To our knowledge, there is no such research undertaken for the ASE, up to now, probably because many authors consider it as an emergent market. So, the main argument of this article is to discover which of the two models (CAPM or APT) fits better, i.e., has more explanatory power to explain the relationship between stock returns and risk, in the Greek capital market (ASE).

The rest of the paper consists of five sections. Section two includes a summary of the literature review on CAPM and APT. Section three describes the research methodology used. Section four proceeds to the statistical analysis and gives the outcoming results. Finally, section five ends the paper with all important conclusions deriving from the preceding statistical analysis and the comparison of the two models, CAPM and APT.

2. Literature review

After the publication of Markowitz's (1959) Portfolio Selection book, Treynor (1961) started intensive work on the theory of asset pricing. The intention of Treynor's paper is "*to lay the groundwork for a theory of market value which incorporates risk* ". Shortly after Treynor began his work on asset pricing, Sharpe also set out to determine the relationship between the prices of assets and their risk attributes. The paper published by Sharpe (1964) notes that through diversification, some of the risk inherent in an asset can be avoided so that its total risk is obviously not the relevant influence on its price; unfortunately little has been said concerning the particular risk component which is relevant. Sharpe aims to use the theory of portfolio selection to construct a market equilibrium theory of asset prices under conditions of risk and notes that his model sheds considerable light on the relationship between the price of an asset and the various components of its overall risk.

After the publication of the Sharpe (1964), Lintner (1965) and Mossin (1966) articles, there was a wave of papers seeking to relax the strong assumptions that underpin the original CAPM. The most frequently cited modification is the one made by Black (1972), who shows how the model changes when riskless borrowing is not available; his version is known as the zero-beta CAPM. Another important variant is that of Brennan (1970), who proves that the structure of the original CAPM is retained when taxes are introduced into the equilibrium. Also, Mayers (1972) shows that when the market portfolio includes non-traded assets, the model also remains identical in structure to the original CAPM. Solnik (1974) and Black (1974) extended the model to encompass international investing.

The capital asset pricing models of Sharpe-Lintner-Black (SLB) have been subjected to extensive empirical testing in the past 30 years (Black, Jensen and Scholes, 1972; Blume and Friend, 1973; Fama and MacBeth, 1973; Basu, 1977; Reiganum, 1981; Banz, 1981; Gibbons, 1982; Stambaugh, 1982 and Shanken, 1985). In general, the empirical results have offered very little support of the CAPM, although most of them suggested the existence of a significant linear positive relation between realised return and systematic risk as measured by β.

APT, founded upon the work of Ross (1976), aims to analyse the equilibrium relationship between assets' risk and expected return just as the CAPM does. The two key CAPM assumptions of perfectly competitive and efficient markets and homogeneous expectations are maintained. Moreover, in line with the CAPM, the APT assumes that portfolios are sufficiently diversified, so that the contribution to the total portfolio risk of assets' unique (unsystematic) risk is approximately zero.

Testing the APT is tricky. Arbitrage arguments can only be used to provide an approximate factor pricing equation for some unknown number of unidentified factors. Shanken (1982), however, argues that testing requires an exact pricing equation, which in turn requires additional assumptions.

Like many issues in empirical finance, the contention that testing the APT requires an exact pricing equation is open to debate. First, Dybvig (1983) and Grinblatt and Titman (1985) argue that, given a reasonable specification of the parameters of the economy, theoretical deviations from exact factor pricing are likely to be negligible. Hence, they conclude that we may not need to rely on equilibrium-based derivations of the APT. Dybvig and Ross (1985) and Shanken (1985) debate the issue. Second, Roll and Ross (1980) put forth a series of arguments to support the contention that the APT could be rejected without having to rely on exact factor pricing.

The Arbitrage Pricing Theory of Ross (1976) provides a theoretical framework to determine the expected returns on stocks, but it does not specify the number of factors nor their identity. Hence, the implementation of this model follows two avenues: factors can be extracted by means of statistical procedures, such as factor analysis or be pre-specified using mainly macro-economic variables.

2.1 The empirical testing of CAPM and APT in the ASE

There has been limited research on the behaviour of stocks traded on the ASE. Papaioannou (1982; 1984) reports price dependencies on stock returns for a period of at least six days. Panas (1990) provides evidence of weak-form efficiency for ten large Greek firms. Koutmos, Negakis, and Theodossiou (1993) find that an exponential generalised ARCH model is an adequate representation of volatility in weekly Greek stock returns. Barkoulas and Travlos (1996) test whether Greek stock returns are characterised by deterministic non-linear structure (chaos).

More recently, Diacogiannis, Glezakos and Segredakis (1998) examined the effect of the Price / Earnings (P/E) ratio and the Dividend Yield (DY) on expected returns of ASE common stocks for the period 1990 – 1995. He found that P/E is statistically significant variable explaining the cross section variation of expected returns, while the explanatory power of DY was documented rather weak.

Karanikas (2000) examined the role of size, book to market ratio and dividend yields on average stock returns in the ASE for the period from January 1991 to March 1997. Following Fama and MacBeth's (1973) cross sectional regression methodology, enhanced with Shanken's adjustments for the Error in Variables (EIV) problem, he found that a statistically significant positive relationship exists between book to market ratio, dividend yields and average stock returns. He also found that the market capitalisation variable ("*size effect* ") does not seem to explain a significant part of the variation in average returns.

Theriou *et al.* (2005) explore the ability of CAPM, as well as the firm specific factors, to explain the cross-sectional relationship between stock returns and risk by adopting a methodology similar to Fama and French (1992). The findings indicate that in the Greek stock market there is not a positive relation between risk, measured by β, and average stock returns. On the other hand, there is a 'size effect' on the cross-sectional variation in the average stock returns.

Niarchos and Alexakis (2000) examined whether it is possible to predict stock market returns with the use of macroeconomic variables in the ASE, for the period from January 1984 to December 1995, on a monthly base using cointegration analysis and as explanatory variables some macroeconomics factors. The macroeconomic factors used are, the inflation rate measured by the Consumer Price Index (CPI), the M3 measure of money supply, and the exchange rate of US Dollar/ Drachmae (Drachmae is the Greek currency prior to Euro). With the results of their investigations, they reject statistically the Efficient Market Hypothesis for the case of the Athens Stock Exchange; they noted the statistical significance of the lagged returns which suggest that the monthly returns in the ASE are positively correlated. The above findings can not be explained as a thin trading effect or as non synchronous trading effect because of the monthly time interval used in the investigation. On the contrary, someone can reasonably assume that either news is reflected with some delay on stock market prices or that the Greek stock market is influenced by psychological factors i.e. a period of price increase lead to optimism and further price increase, and a period of price decrease leads to pessimism and further price decrease. In addition they found that there is statistical evidence that the lagged values of inflation rate have explanatory power in a model were the stock return is the depended variable.

3. Research Methodology

3.1 Data Collection

Our data is daily closing prices of the common stocks traded in the Athens Stock Exchange. They are row prices in the sense that they do not include dividends but are adjusted for capital splits and stock dividends. The data was taken from Athens Stock Exchange data bank. The data set covers the 180 month period from January 1987 to December 2001 and is divided into three non overlapping 60 month sub-periods for analysis (see table 1). Securities are included in a sub-period sample if they have a complete price relative history (no missing values) in that period. The market return is obtained from the ASE Composite (General) Share Price Index. Time series of excess returns on the market and individual securities are taken over the three month *Government Treasury Bill* rate, which is considered to be the short term risk-free interest rate. Daily returns are calculated using the logarithmic approximation.

Source :	Athens Stock Exchange
Sample Period :	January 1987 – December 2001 inclusive. The entire period is divided into three sub periods • January 1987 – December 1991 • January 1992 – December 1996 • January 1997 – December 2001 • January 1987 – December 2001
Selection Criteria :	The selection criteria for the shares in the sub periods are : • Shares with no missing values in all the sub period • Shares with adjusted R^2 <=0 or F significant >0.05 of the first pass regression of the excess returns on the market risk premium are excluded. • Shares are grouped by alphabetic order into groups of 30 individual securities. The alphabetically last shares were not used since complete groups of 30 were required.

Table 1: Sample periods and selection criteria.

Then daily returns are aggregated to compose the monthly returns, which are the input of our investigation. To reduce the dimension of the equation system to feasible proportions, securities in each sub-period are allocated by alphabetic order into groups of 30 individual securities (see Roll and Ross, 1980). It is important to note that portfolios (rather than individual assets) are used for the reason of making the analysis statistically feasible. This is in contrast with the reasoning of using portfolios in traditional (univariate) CAPM tests. In these tests, portfolios were formed to attenuate the problem of errors-in-variables (EIV), introduced by the well known two-stage testing approach (Campbell, Lo and MacKinlay, 1997).

3.2 Sample summary statistics

The data is filtered by keeping only the shares that have no missing values in the sub periods. This procedure produces sample sizes of 71, 145 and 217 for the three sub-periods, respectively. Firstly, summary statistics are produced to check out the null hypothesis of the normal distribution[2] of our data. Analytically, we estimate the mean, standard deviation, skewness[3] and kurtosis[4], and

[2] *The Normal Distribution* has skewness and kurtosis values equal to zero. It is fully described by the first two central moments, the mean and standard deviation.
[3] *Skewness* measures the direction and degree of asymmetry of a distribution. A value of zero indicates a symmetrical distribution.
4 *Kurtosis* measures the degree of peakedness and heaviness of the tails of a distribution. A normal distribution has a kurtosis value equal to 0.

then, based on those statistics, we proceed to the normality test of Kolmogorov & Smirnov[5] (per cent of Gausian distribution), of all the shares included in the sub periods under examination, using SPSS.

As *table 2* (final column) shows the null hypothesis of normality cannot be rejected at the 5 per cent level of confidence in 21 per cent of the shares in the period 1987 – 1991, 28 per cent in the period 1992 – 1996, 22 per cent in the period 1997 – 2001 and 0 per cent in the period 1987 -2001. The above results are in accord with the findings of Mandelbrot (1963) and Fama (1970) for the US market.

After the test of normality, excess returns (for each individual security) and market premiums are computed in each of the sub periods and we regress the excess returns on the market premium.

Table 2 (column three) shows that 7 per cent of the shares of our sample in the period 1987 – 1991 and 13 per cent in the period 1992-1996 have negative adjusted R squared[6], which probably means that these specific equations could be non linear. In order to make our model more suitable we eliminate all the shares that they produce negative adjusted R squared.

Table 2 (column four) shows that 8 per cent of the shares of our sample in the period 1987 – 1991 and 23 per cent in the period 1992-1996 have significance value of the F statistic[7] higher than 0.05. In order to make our model more efficient we also eliminate all the shares that they produce significance value of the F statistic higher than 0.05.

Period	Number of Shares	Negative Adjusted R^2	F significant > 0.05	Durbin Watson 1.8<= .p. <= 2.2	Durbin Watson < 1.5	% Gausian distribution
1987 - 1991	71	7%	8%	46.5%	0.0%	21%
1992 - 1996	145	13%	23%	45.8%	3.5%	28%
1997 - 2001	217	0%	0%	58.3%	1.3%	22%
1987 - 2001	60	0%	0%	80%	0.0%	0%

Table 2: Regression results of the sample in the sub periods

The analysis of the residuals includes also the Durbin Watson (DW) statistic test[8]. *Table 2*

[5] *Kolmogorov-Smirnov (Lilliefors):* is a modification of the Kolmogorov-Smirnov test that tests for normality when means and variances are not known, but must be estimated from the data. The Kolmogorov-Smirnov test is based on the largest absolute difference between the observed and the expected cumulative distributions.

[6] The R-squared statistic, or the coefficient of determination, is the percentage of total response variation explained by the independent variables. Adjusted R-squared is preferable to use if you have a lot of independent variables since R-squared can always be made larger by adding more variables Adjusted R squared is the relative predictive power of a model and is a descriptive measure between 0 and 1. The closer it is to one, the better your model is. By "*better*" we mean a greater ability to predict.

[7] The F statistic is the regression mean square (MSR) divided by the residual mean square (MSE). If the significance value of the F statistic is small (smaller than say 0.05) then the independent variables do a good job explaining the variation in the dependent variable. If the significance value of F is larger than say 0.05 then the independent variables do not explain the variation in the dependent variable.

[8] The Durbin Watson is a test for first order serial correlation and measures the linear association between adjacent residuals from a regression model. If there is no serial correlation, the DW statistic will be around 2. The DW statistic will fall if there is positive serial correlation (in worst case, it will be near zero). If there is a negative correlation, the

(column five) shows that 46.5, 45.8, 58.3, and 80 per cent of shares in the three sub periods and all the period respectively, have a Durbin Watson test between 1.8 and 2.2, and only 3.5 and 1.3 per cent of the shares, in the second and third sub period respectively (column six) show a very strong serial correlation (p<1.5). The above procedure of filtering produces sample sizes of 65, 110 and 217 for the three sub-periods, respectively. At this point shares are grouped by alphabetic order into groups (portfolios) of 30 individual securities; the alphabetically last shares were not used since complete groups of 30 were required. This procedure produce sample size of 2, 3 and 7 groups of 30 shares in each sub period respectively.

3.3 Data analysis methodology

After the data filtering process and the formation of the groups (portfolios) the main part of our investigation begins. It is focused on the testing and comparison of CAPM and APT. The test used for the CAPM and APT is a two-step test, which is extensively used in the literature (see Roll and Ross, 1980; Chen, 1983; Lehmann and Modest, 1988; Cheng, 1995; Groenewold and Fraser, 1997). The first step involves the use of time series to estimate the betas of the shares for the CAPM and a set of factor scores, through factor analysis, for the APT; the second step, then, regresses the sample mean excess returns on the beta (for the CAPM) and on the factor scores (for the APT).

Test of CAPM

The analysis proceeds in the following stages:

1. For a group (or portfolio) of individual securities, (in our case a portfolio of 30 selected alphabetically), we estimate the excess returns ($R_{i,t} - R_{f,t}$) of each security from a time series of returns of ASE listed stocks for each sub period under examination. We, also estimate the market Premium ($R_{m,t} - R_{f,t}$) for the same period. We then regress the excess returns (dependent variable) on the market premium (independent variable). Such regression is called first – pass regression. The outputs of the regressions are the beta coefficients of the individual shares in the sub period under examination. The formula used for the above estimation is the following: $R_{i,t} - R_{f,t} = (R_{m,t} - R_{f,t})\beta_i$ where $R_{i,t}$ is the average monthly returns of the security i (dependent variable), $R_{f,t}$ is the risk free interest rate and $R_{m,t}$ is the average monthly return of the market (independent variable).
2. Then a regression of the average holding period excess returns of the securities on the estimated betas are computed, this cross sectional regression is called second pass regression.

statistic will lie somewhere between 2 and 4. Usually the limit for non serial correlation is considered to be DW= (1.8; 2.2). A very strong positive serial correlation is considered at DW lower than 1.5.

The second pass regression has the following form: $\hat{R}_{i,t} = \lambda_o + \lambda_1 \beta_i + \varepsilon_{i,t}$ where $\hat{R}_{i,t}$ is the average monthly excess returns of the security i (dependent variable) and β_i the estimated beta coefficient of security i (independent variable).

3. Steps 1 through 2 are repeated for all groups in all the sub periods and the results are tabulated. (see *table 5*)

Tests of APT

The analysis proceeds in the following stages:

1. For a group of individual assets, (in our case a group of 30, selected alphabetically), a sample product – moment covariance matrix is computed from a time series of excess returns (of all Athens Stock Exchange listed stocks for the sub period under examination).
2. A principal component analysis is performed on the covariance matrix. This estimates the number of factors and the factors scores. The results of KMO and Bartlett tests are tabulated. To decide the number of factors to be retained, both the scree test and the Kaiser criterion were used.
3. Then a regression of the average holding period excess returns of the securities on the factor scores is computed, this cross sectional regression is called second pass regression. The second pass regression has the following form: $\overline{R}_i = \lambda_0 + \lambda_1 \tilde{b}_{i1} + \lambda_2 \tilde{b}_{i2} + ... + \lambda_n \tilde{b}_{in}$, where $\overline{R}_{i,t}$ is the average monthly excess returns of the security i (dependent variable) and β_{ij} the factor scores (independent variable).
4. Steps 1 through 3 are repeated for all groups (portfolios) in all the sub periods and the results are tabulated (see *table 6*).

Comparison of the models

The comparison of the two models proceeds in the following stages:

1. For each group (portfolio) of individual shares a first comparison is done using as measures the adjusted R squared and the F statistics of the cross sectional regressions of the two models under examination.
2. A second comparison of the two models is done using the Davidson and MacKinnon equation. This equation has the following form $R_i = \alpha R_{APT} + (1-\alpha) R_{CAPM} + e_i$, where R_{APT} and R_{CAPM} are the expected excess returns generated by the APT and the CAPM respectively, as independent variables and $R_{i,t}$ the average monthly excess returns of the security i as dependent variable; α is a measure of the effectiveness of the two models.

3. A third comparison is done using the posterior odds ratio using the formula $R = \left[\frac{ESS_0}{ESS_1}\right]^{\frac{N}{2}} N^{\frac{(k_0-k_1)}{2}}$ where ESS is the error sum of squares, N is the number of observations, and k is the dimension (i.e., the number of independent variables) of the respective models (k_0=APT mode and k_1=CAPM model).
4. A forth comparison is done using the residual analysis. In order to test the efficiency of the CAPM a regression is computed with e_i (the residuals of the CAPM) as dependent variable and the factor scores of the APT as independent. Then an analogous regression is computed of the APT residuals on the CAPM β to find out whether CAPM captures information missed by the APT model.
5. Steps 1 through 4 are repeated for all groups in all the sub periods and the results are tabulated (see *tables 7, 8, 9, 10*).

4. Results

In order to test CAPM and APT as described above, the two-step methodology is adopted, which is extensively used in the literature. In the first step, a regression is computed of the excess returns on market premium in order to estimate the betas of the shares for the CAPM and a factor analysis in order to produce a set of factor scores for the APT. In the second step, a cross sectional regression is computed of the average monthly excess returns on the estimated betas (for the CAPM) and on the factors scores (for the APT).

4.1 Test for the CAPM and the APT

Tests for the CAPM

The results of the test for the CAPM are displayed in *Table 5* (Appendix I). The p-values for the t test of significance are displayed below the coefficients in italics. During the period 1987-91 β is not significant. However, the beta is priced[9] at the 95 per cent level of confidence, in the period 1992-1996, for portfolio 2 (p value 0.008), where the percentage of variance explained, represented by the adjusted R^2, is 19.6 per cent[10]. In the period 1997 – 2001 beta is priced in portfolio's 1,5,6,7, and in all shares (p value: 0.000, 0.040, 0.049 and 0.003 respectively), with adjusted R^2 35.7, 11.1, 10.1, 25.2 and 13 per cent respectively. Finally, in the period 1987 – 2001 beta is priced in portfolio 1 and in all shares (p value 0.015, and 0.004 respectively), with adjusted R^2 16.5 and 12.3 per cent

[9] By the term "priced" we mean that the specific value is statistically significant
[10] We use the Adjusted R^2 as a measure of the total variance explained by the models to adjust for the fact that a large number of exogenous variables can artificially produce a high R^2 causing in our case bias toward the APT.

respectively. As we notice in all cases where betas are priced they have a negative sign, something that does not support the theory and its assumptions (risk aversion).

In conclusion, the above results suggest that the relationship between β and return is weak in the Greek stock market and is consistent with the findings of Fama and French (1992), Chen (1983), Cheng (1995) and Groenewold and Fraser (1997) for the US, UK and Australian stock markets respectively. The weak explanatory power displayed by β suggests that additional variables may be needed to explain the behaviour of shares prices in the ASE.

Tests for the APT

The number of factors and factor scores in the APT model are determined through Principal Component Analysis (PCA), and Varimax rotation in order to minimise the number of variables that have high loadings on a factor. The matrix X in our tests is the (60, 30) matrix of excess returns formed by the 60 share vectors (each vector has 30 components (shares), corresponding to the 60 monthly observations of excess returns). The Kaiser-Meyer-Olkin (KMO) test values for all the tests are very high and Bartlett's test of sphericity is significant at 99 per cent level, indicating that the factor analysis is an appropriate technique for our data. *Table 3* reports the Kaiser-Meyer-Olkin test[11] and the Bartlett's test of sphericity in all the sub periods and in all the formed portfolios. Bartlett's test tests the hypothesis that the correlation matrix is an identity matrix (i.e., a matrix containing ones on the leading diagonal and zeros elsewhere). In other words, it is a test proving that there is no shared variance in the matrix. The test produces a chi-square statistic. A large and highly significant chi-square indicates that the data is suitable since the correlation matrix is not adequately described by an identity matrix; a non-significant chi-square suggests that factor analysis (FA) is not appropriate for the data set under examination. In our case both tests prove the appropriateness of the adopted FA.

Portfolios	Periods											
	1987 -1991			1992-1996			1997 – 2001			1987 - 2001		
	KMO	Bartlett		KMO	Bartlett		KMO	Bartlett		KMO	Bartlett	
		Chi sq.	Sig		Chi sq.	Sig		Chi sq.	Sig		chi sq.	Sig
Portfolio 1	.841	1376	0.000	.751	1065	0.000	.887	1806	0.000	.906	3686	0.000
Portfolio 2	.795	1505	0.000	.691	1127	0.000	.891	1857	0.000	.901	3967	0.000
Portfolio 3				.676	1267	0.000	.848	1586	0.000			
Portfolio 4							.858	1832	0.000			
Portfolio 5							.873	1927	0.000			
Portfolio 6							.835	1662	0.000			
Portfolio 7							.860	1744	0.000			

Table 3: KMO and Barlet tests for all the formed portfolios

[11] KMO test describes values between 1 and 0.9 as marvellous; values between 0.8 and 0.9 as excellent; values between 0.7 and 0.8 as good; values between 0.6 and 0.7 as mediocre, values between 0.5 and 0.6 as miserable and values below 0.5 as unacceptable;

To decide the number of factors to retain, both the scree test and the Kaiser criterion[12], were used. *Table 4* reports the number of the factors and the total variance explained on all the cases under examination. As we could observe from this table the number of factors changes from case to case but the total variance explained by these factors in all the cases is greater than 70 per cent.

Portfolios	Periods							
	1987 -1991		1992-1996		1997 – 2001		1987 - 2001	
	Factors	Total Variance	Factors	Total Variance	Factors	Total Variance	Factors	Total Variance
Portfolio 1	7	75.162	7	74.797	5	77.267	7	71.195
Portfolio 2	8	78.902	7	73.047	5	77.957	6	69.040
Portfolio 3			7	71.768	5	71.747		
Portfolio 4					5	76.866		
Portfolio 5					5	76.799		
Portfolio 6					5	73.141		
Portfolio 7					5	76.408		

Table 4: Results of factor analysis of all the formed portfolios

To test the model, we examine in the second step, according to Chen (1983), the results of the cross sectional regression of average excess returns of each security for each sub-period (dependent variable) on the estimated factor scores ($\widetilde{b}_i$) (independent variables). The results of the regression are shown in *Table 6* (Appendix I). Significance levels (*p-values*) are reported in italics.

The APT is overall significant (*F statistic*) and outperforms the CAPM in every period: curiously, its worst performance is during the period 1997 – 2001 where most of the betas of the CAPM are priced. In fact, in this period no one factor is priced for the second, third, forth and fifth portfolio. Another result that we could observe is that in the first portfolio, during the period 1987 – 2001, where the beta is priced in the CAPM, no one factor is priced.

In the period 1987-1991, only factor 7 of the first portfolio is statistically significant ($p=0.024<0.05$) and the adjusted R squared for this portfolio is 37.6 per cent; in the second portfolio no one factor is priced and the adjusted R squared is 29.9 per cent. In the period 1992 -1996 in the first portfolio no one factor is statistically significant and the adjusted R squared is 10.3 per cent; in the second portfolio all factors:1, 2, 3, 4 , 5 , 6 and 7, are priced with adjusted R squared 47.7 per cent, while in the third portfolio factors 1, 2, 4 and 5 are statistically significant with adjusted R squared 77.9 per cent, the best performance of the cases under examination.

In the period 1997-2001 none of the factors is statistically significant for the second, third, forth and fifth portfolio with adjusted R squared 11.2, 25.3, 52.8 and 19.6 per cent respectively; in the first and sixth portfolios all the factors are statistically significant with adjusted R squared 47.7

[12] The KMO criterion consists in dropping the eigenvalues less than one

and 32.8 per cent respectively; in the seventh portfolio factors 1 and 4 are priced with adjusted R squared 23.9 per cent.

Finally in the period 1987-2001 in the first portfolio no one factor is priced while in the second portfolio all the factors are statistically significant, the adjusted R squared is 27.3 and 67.2 per cent respectively. Observing the adjusted R squared of all the cases under examination it could be said that it shows a considerable improvement compared with the lack of explanatory power of the CAPM for the same cases.

4.2 Comparisons between CAPM and APT

The next step is to assess which one of the two competing models, CAPM or APT is supported by the data. Following the approach used by Chen (1983), three methods are used, the Davidson and McKinnon equation, the posterior odds ratio and the residual analysis.

Davidson and McKinnon Equation

The CAPM could be considered as a particular case of the theoretical APT with k=1 ($b_k=\beta$). However, when we consider the APT with artificial factors, this is true if and only if there exists a rotation of the factors such that one of the factors is the "*market*". The two models, CAPM and APT, are thus defined as "*non-nested*". One method to discriminate among non-nested models was suggested by Davidson and McKinnon (1981).

Let R_{APT} and R_{CAPM} be the expected excess returns generated by the APT and the CAPM, and consider the following equation $R_i = \alpha R_{APT} + (1-\alpha) R_{CAPM} + e_i$ where α is a measure of the effectiveness of the two methods. When is close to 1, the APT is the correct model relative to the CAPM.

The results of the regression, reported in *table 7* (Appendix I), are heavily in favour of the APT, with the possible exception of the period 1997-2001 (*portfolio 7 and all shares*), for which the results in favour of the APT are less substantial. The Davidson and McKinnon (DM) equation has been criticised because, even if the models are non-nested, there is still a risk of multicollinearity between the variables as the β of the CAPM could be strongly correlated with APT factors. However, the method has been extensively applied in the literature (Chen, 1983; Groenewold and Fraser, 1997).

Posterior Odds Ratio

Given the assumption that the residuals of the cross-sectional regression of the CAPM and the APT satisfy the IID (Independently and identically distribution) multivariate normal assumption (Campbell, Lo and MacKinlay, 1997), it is possible to calculate the posterior odds ratio between the two models. In general, the formula for posterior odds in favour of model A (in our case APT) over model B (in our case CAPM) is given by Zellner (1979): $R = \left[\frac{ESS_A}{ESS_B} \right]^{\frac{N}{2}} N^{\frac{(k_A - k_B)}{2}}$ where ESS is the error sum of squares, N is the number of observations, and k is the dimension (i.e., the number of independent variables) of respective models. If the value produced by the above equation is lower than 1 then model A has better performance than this produced by model B.

The posterior odds computed are overwhelmingly in favour of the APT. *Table 8* (Appendix I) shows that the posterior odds computed are all less than one, and thus in favour of the APT. The posterior odds ratio is in general a more formal method than the Davidson and MacKinnon equation and has sounder theoretical foundations.

Residual Analysis

The residuals from the CAPM are of interest as they are used for performance measurement. If the CAPM is not miss-specified, the expected return of an asset i would be captured by β_i and the residual e_i will behave like white noise with zero mean across time. Thus, if expectations in the market are rational, the realised excess return can be written as $R_i = E_i + v_i$ where E_i is the market rational expected excess return and v_i is the error term.

If the CAPM is not miss-specified, R_i can also be written as (Chen, 1983) $R_i = E_i(CAPM) + e_i$. Thus $e_i = \left[E_i - \widehat{E}_i(CAPM) \right] + v_i$, where $\widehat{E}_i(CAPM)$ is the expected excess return from the CAPM with the market proxies.

If the CAPM is correct then $E_i = \widehat{E}_i(CAPM)$ and $v_i = e_i$ should behave like white noise and should not be priced by any other models. If e_i is priced by any other model, e_i contains information that is not captured by $\widehat{E}_i(CAPM)$ and the CAPM is miss-specified. Therefore, a logical method to test the CAPM is to run a regression with e_i (the residuals of the CAPM) as dependent variable and the factor scores of the APT as independent. We then run an analogous regression of the APTs' residuals on the CAPM βs to check whether CAPM captures information missed by APT.

The results, reported in *Tables 9* and *10* (Appendix I) are clearly in favour of the APT. The CAPM fails to explain the variance of APT residuals in all the periods (*table 9*). On the other hand, the APT explains, in the period 1987-1991, 34.4, 23 and 12.8 per cent respectively of the variance unexplained by the CAPM. In the period 1992 -1996 the explanatory power of the APT has the best performance and explains 4.6, 32.7, 78.7 and 42 per cent of the variance unexplained by the CAPM. As expected, the worst performance of the APT is in the period 1997-2001, when the variance explained is only 9, 5.7, 26.5, 47.5, 11.2, 15.5, 0.8 and 9.9 per cent this is the period when β is priced and has some explanatory power. Finally, in the period 1987-2001 APT explains 7.9, 56.0

and 27.7 per cent of portfolios 1, 2, and all-shares respectively of the variance unexplained by the CAPM.

However, care is needed when looking at the results in *tables 5, 6, 9 and 10*. *Tables 6*, *10* and 5*, 9* are strictly connected. Any factor not priced in *Table 6* should also not be priced in *table 10* and any factor not priced in *table 5* should also not be priced in *table 9*. If a factor is not priced with the original data, but is priced in the regression of e_i on the $\tilde{\beta}_i$, the estimated λ may be spuriously induced by $\tilde{\beta}_i$.

Analysing *tables 6* and *10*, we see that in the period 1987-1991 factor 7 is priced in both regressions. This result strongly supports the ability of the APT to explain information not captured by the CAPM. In the period 1992 – 1996 we could observe that factors 1, 4 and 5 of third portfolio and factor 7 of the last portfolio are priced in both regressions but in the second portfolio factors 1, 2, 4, 5, 6, and 7are priced in the cross sectional regression but not in the residual regression. In the period 1997 – 2001 no one of the factors that is priced in the cross sectional regression is priced in the residual regression; this fact confirms that this period is the worst for the APT. Finally in the period 1987 – 2001 we could observe that in the second portfolio factors 1, 3, 5, and 6 are priced in both regression but factors 2, 4 are priced only in the cross sectional regression and in the last portfolio (all-shares) no one of the factors that are priced in the cross sectional regression are priced in the residual regression.

On the other hand, analysing tables 5 and 9 we notice that any of the factors priced on the original CAPM regressions, in *table 5* (Appendix I), are not priced by the regressions of the residuals in *table 9* (Appendix I). This means that CAPM is totally incapable of explaining the variance, which is not explained by the APT model.

5. Conclusions

Examining the history of the Greek Stock Exchange (ASE), it is observed that in the last 15 years a number of reforms have been introduced in order to increase the liquidity, efficiency, and transparency of stock trading. Liberation of the capital market should further improve the possibilities for the Greek stock market to respond more rapidly to new information. During the period of 1987 - 1997 market capitalisation of the Greek stock Exchange as a percentage of Gross Domestic Product is the lowest compared with all other European stock exchanges. However, it is also observed that during the years 1998 and 1999 the capitalisation rate increases tremendously, while in 2000 and 2001 it drops very much, in both cases without any specific reason. These findings confirm the findings of Niarchos and Alexakis (2000) that the Greek stock market is influenced by psychological factors. At the end of 2001 there were 345 listed companies, which represent the 74.5 per cent of the Greek GDP. This fact alone indicates that the ASE plays an important role in Greek economy the last few years.

The analysis of the chosen sample shows that 21, 28 and 22 per cent of the shares, in the three sub periods are normally distributed. This is an important finding, suggesting that, more or less, 25 per cent of the returns' distribution of the ASE may be normal in any sub period, in accord with the findings of Mandelbrot (1963) and Fama (1970) for the US stock exchange, which are widely accepted in the modern financial theory.

The relationships between β and return in the ASE in all the sub periods and all the formed portfolios is weak, and the Capital Asset Pricing Model displays poor explanatory power. However, it is difficult to assess the extent of this dependence that is due solely on the specification of the model itself. The apparent low informational efficiency of the ASE, the fact that there are few institutional investors, and that private investors in Greece often regard the stock market more as a place to gamble than to invest, could cause market "*irrationality*", undermining the assumptions upon which the CAPM is based. Similar results could be found in other developing/transitional countries with stock markets that could be characterised not-matured, having same characteristics as the ASE.

The Arbitrage Pricing Theory performs better, compared to the CAPM, in all the tests considered. From the evidence gathered in this study, the APT is a more powerful method that allows consideration of the risk borne on additional systematic "state variables", other than the market portfolio. The percentage of variance explained for the portfolios formed in the sub periods under examination is ranging from 10.3 to 77.9 per cent. This performance can be considered a good result compared with the results obtained by Chen (1985) in the US stock market (results ranging from 4 to 27.8 per cent in different sub-periods from 1963 to 1978) and Cheng (1995) in the UK (11 per cent during the period from January 1965 to December 1988).

The study was originally designed to compare CAPM and APT, but one of the main results obtained, is the appreciation of the wide range of potentialities offered by a relatively new tool used in testing the APT: factor analysis. If the identification of the number of factors and their identity is one of the most important directions for future research (Chen 1983), factor analysis technique, is a powerful instrument to replace the arbitrary and controversial search for factors by "*trial and error*" with a real systematic approach.

The overall conclusion of the study is that even if the market return is an important element, the behaviour of securities' returns in the ASE is complex and cannot be fully explained by a single factor. Shares and portfolios are significantly influenced by a number of systematic forces and their behaviour can be explained only through the combined explanatory power of several factors or macroeconomic variables. Considering that the APT does not explain the overall variance, we can ask ourselves where the missing information is, and why the APT fails to explain fully the returns' covariance's and means returns.

There can be several possible explanations (Cheng, 1995). First, risk and expected return may not be stationary during the period in consideration, while one of the assumptions in the study of the APT is that risk and expected returns are assumed not to change during the period. Second, the APT pricing relationship could hold only in some months of the year, and there is evidence of a "January effect" on the capability of the APT to explain the return-risk relationship (Gültekin and Gültekin, 1987). Third, and in our opinion more probable, there is the possibility of non-linear pricing relationships. The assumption of linear relationships between the APT and factors or macroeconomic variables is a strong assumption, which is often overlooked. The linear model is a simple model, ideal to explain observed correlations. If instead the objective is to predict mean returns, higher-order factor models would provide more accurate predictions, as minor factors are relatively unimportant in explaining covariances, and may be fundamental to explain mean returns. These, we think, may be important directions for future research.

6. References

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Appendix I (Tables 5-10)

Period	Portfolios	λ_0	λ_1	R^2 Adj.	F sig.
1987 - 1991	**Portfolio 1**	-0.699 *0.329*	0.900 *0.278*	0.008	0.278
	Port folio 2	-1.717 *0.108*	2.215 *0.097*	0.063	0.097
	All shares	-0.970 0.125	1.355 0.075	0.034	0.075
1992 - 1996	**Portfolio 1**	-1.464 *0.040*	-0.592 *0.378*	-0.007	0.378
	Port folio 2	-0.879 *0.061*	**-1.359** ***0.008***	0.196	0.008
	Port folio 3	-2.332 *0.037*	0.277 *0.811*	-0.034	0.811
	All shares	-1.335 *0.000*	-0.701 *0.061*	0.023	0.061
1997 - 2001	**Portfolio 1**	1.755 *0.080*	**-3.925** ***0.000***	0.357	0.000
	Port folio 2	-0.510 *0.674*	-1.591 *0.201*	0.024	0.201
	Port folio 3	-0.726 *0.684*	-1.772 *0.354*	-0.004	0.354
	Portfolio 4	0.390 *0.846*	-2.395 *0.272*	0.009	0.272
	Port folio 5	1.015 *0.503*	**-3.395** ***0.040***	0.111	0.040
	Port folio 6	-0.012 *0.990*	**-2.262** ***0.049***	0.101	0.049
	Port folio 7	0.186 *0.800*	**-2.546** ***0.003***	0.252	0.003
	All shares	0.338 *0.434*	**-2.594** ***0.000***	0.130	0.000
1987 -2001	**Portfolio 1**	-0.168 *0.686*	**-1.190** ***0.015***	0.165	0.015
	Port folio 2	0.393 *0.624*	-1.582 *0.108*	0.057	0.108
	All shares	0.120 *0.762*	**-1.390** ***0.004***	0.123	0.004

Table 5: Cross Sectional Regression of Returns (CAPM) $\overline{R}_i = \lambda_0 + \lambda_1 \widetilde{\beta}_i + \eta_i$

* The values in italic indicate the *p–value* of the statistics.
** The values in bold indicate the coefficients of priced factors scores

Period	Portfolios	λ_0	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6	λ_7	λ_8	R^2 Adj.	F sig.
1987 - 1991	P1	-0.50 *0.353*	8.50 *0.184*	6.07 *0.183*	4.69 *0.255*	0.42 *0.909*	1.74 *0.607*	2.89 *0.290*	**3.25** ***0.024***		0.376	*0.011*
	P 2	-1.32 *0.191*	12.0 *0.263*	12.61 *0.158*	14.16 *0.102*	3.12 *0.588*	9.31 *0.109*	6.58 *0.068*	3.35 *0.368*	1.49 *0.497*	0.299	*0.041*
	All shares	-0.53 *0.339*	16.20 *0.181*	13.19 *0.159*	13.88 *0.087*	4.47 *0.588*	7.52 *0.317*	2.38 *0.685*	8.28 *0.184*		0.170	*0.012*
1992 -1996	P1	-1.84 *0.001*	-2.53 *0.673*	-4.09 *0.195*	-0.62 *0.793*	0.06 *0.976*	-0.74 *0.750*	-0.91 *0.716*	-0.87 *0.576*		0.103	*0.228*
	P2	-1.17 *0.001*	**-7.96** ***0.010***	**-5.84** ***0.017***	**-9.01** ***0.000***	**-4.41** ***0.026***	**-4.10** ***0.023***	**-6.23** ***0.000***	**-3.10** ***0.007***		0.477	*0.002*
	P3	-2.75 *0.000*	**9.83** ***0.002***	**5.59** ***0.034***	-3.96 *0.079*	**6.68** ***0.011***	**7.04** ***0.003***	0.12 *0.951*	2.00 *0.168*		0.779	*0.000*
	All shares	-1.81 *0.000*	-5.63 *0.336*	-5.46 *0.246*	-4.88 *0.192*	-3.32 *0.390*	3.43 *0.262*	-0.99 *0.637*	**-14.33** ***0.000***		0.464	*0.000*
1997 - 2001	P1	0.18 *0.813*	**-35.03** ***0.002***	**-30.78** ***0.003***	**-19.23** ***0.017***	**-14.91** ***0.027***	**-8.13** ***0.008***				0.477	*0.001*
	P2	-1.82 *0.014*	-5.12 *0.592*	-0.97 *0.902*	-3.10 *0.664*	-0.54 *0.916*	-0.51 *0.834*				0.112	*0.165*
	P3	-2.37 *0.031*	5.53 *0.711*	-2.90 *0.831*	-1.07 *0.843*	-0.90 *0.838*	2.97 *0.113*				0.253	*0.032*
	P4	-1.26 *0.087*	-9.05 *0.278*	-5.28 *0.457*	-3.74 *0.599*	0.62 *0.92*	-8.63 *0.070*				0.528	*0.000*
	P5	-1.64 *0.022*	-6.07 *0.421*	-1.41 *0.830*	-7.51 *0.264*	-7.80 *0.251*	-2.74 *0.594*				0.196	*0.066*
	P6	-0.23 *0.710*	**-21.07** ***0.007***	**-23.53** ***0.003***	**-17.20** ***0.013***	**-12.28** ***0.014***	**-12.41** ***0.003***				0.328	*0.011*
	P7	-1.20 *0.031*	**-21.17** ***0.074***	-2.16 *0.132*	1.53 *0.161*	**-2.30** ***0.026***	-1.44 *0.128*				0.239	*0.038*
	All shares	-1.01 *0.000*	**-80.33** *0.000*	**-102.0** *0.000*	**-80.99** *0.000*	**-62.06** *0.000*	**-47.44** *0.000*				0.211	*0.000*
1987 - 2001	P1	-0.48 *0.310*	-10.78 *0.089*	-5.66 *0.123*	-3.94 *0.193*	-1.54 *0.535*	-4.71 *0.079*	-2.29 *0.26*	-1.82 *0.140*		0.273	*0.043*
	P2	0.98 *0.117*	**-25.71** ***0.004***	**-13.96** ***0.010***	**-13.65** ***0.001***	**-10.88** ***0.016***	**-11.59** ***0.002***	**-8.26** ***0.003***			0.672	*0.000*
	All shares	-0.28 *0.492*	**-17.83** ***0.050***	**-16.29** ***0.050***	-6.40 *0.261*	-9.51 *0.063*	**-10.59** ***0.008***	**-5.10** ***0.043***	-3.81 *0.173*		0.379	*0.000*

Table 6: Cross-Sectional Regression of Returns APT $\overline{R}_i = \lambda_0 + \lambda_1 \widetilde{b}_{i1} + \lambda_2 \widetilde{b}_{i2} + ... + \lambda_n \widetilde{b}_{in}$

* The values in italic indicate the *p–value* of the statistics
** The values in bold indicate the priced factors

Period	Portfolios	α	R^2 Adj.
1987 – 1991	Portfolio 1	0.999 *0.0000*	0.444
	Portfolio 2	1.013 *0.0000*	0.474
	All shares	0.980 *0.0000*	0.233
1992 -1996	Portfolio 1	1.031 *0.0017*	0.259
	Portfolio 2	0.956 *0.0000*	0.554
	Portfolio 3	1.019 *0.0000*	0.790
	All shares	1.016 *0.0000*	0.485
1997 -2001	Portfolio 1	0.977 *0.0016*	0.515
	Portfolio 2	0.968 *0.0079*	0.203
	Portfolio 3	0.948 *0.0004*	0.325
	Portfolio 4	1.003 *0.0000*	0.559
	Portfolio 5	0.824 *0.0064*	0.285
	Portfolio 6	1.057 *0.0004*	0.389
	Portfolio 7	0.754 *0.0385*	0.324
	All shares	0.866 *0.0000*	0.223
1987 - 2001	Portfolio 1	0.972 *0.0010*	0.393
	Portfolio 2	1.019 *0.0000*	0.695
	All shares	0.972 *0.0000*	0.426

Table 7: Davidson and McKinnon Equation results

* The values in italic indicates the *p–value* of the statistics

Portfolios	Periods			
	1987 -2001	1992-1996	1997 – 2001	1987 - 2001
Portfolio 1	1.07E+09	5.65E+06	1.99E+05	8.02E+06
Portfolio 2	8.54E+08	6.42E+08	3.77E+04	7.23E+11
Portfolio 3		1.11E+16	7.72E+05	
Portfolio 4			6.26E+08	
Portfolio 5			4.07E+04	
Portfolio 6			7.15E+05	
Portfolio 7			7.04E+03	
Portfolio all shares	4.01E+08	4.95E+21	1.53E+10	1.79E+11

Table 8: Posterior Odds Ratio results

Period	Portfolios	λ_0	λ_1	R^2 Adj.	F sig.
1987 - 1991	**Portfolio 1**	-0.006 *-0.011*	0.007 *0.112*	-0.036	0.991
	Port folio 2	-0.144 *0.854*	0.186 *0.849*	-0.034	0.849
	All shares	-0.103 *0.852*	0.129 *0.845*	-0.015	0.845
1992 - 1996	**Portfolio 1**	-0.182 *0.751*	0.182 *0.744*	-0.032	0.744
	Port folio 2	0.094 *0.772*	-0.110 *0.749*	-0.032	0.749
	Port folio 3	-0.423 *0.331*	0.474 *0.313*	0.002	0.313
	All shares	-0.143 *0.577*	0.157 *0.556*	-0.006	0.556
1997 - 2001	**Portfolio 1**	0.046 *0.955*	-0.046 *0.954*	-0.036	0.954
	Port folio 2	0.149 *0.889*	-0.152 *0.889*	-0.035	0.889
	Port folio 3	-0.233 *0.775*	0.251 *0.773*	-0.033	0.773
	Portfolio 4	-0.103 *0.936*	0.112 *0.935*	-0.035	0.935
	Port folio 5	1.191 *0.366*	-1.273 *0.360*	-0.004	0.360
	Port folio 6	-0.247 *0.763*	0.273 *0.758*	-0.032	0.757
	Port folio 7	0.380 *0.578*	-0.417 *0.567*	-0.023	0.567
	All shares	*0.322* *0.429*	*-0.342* *0.421*	-0.001	0.421
1987 -2001	**Portfolio 1**	*0.039* *0.909*	*-0.045* *0.906*	*-0.035*	*0.906*
	Port folio 2	*-0.177* *0.678*	*0.216* *0.673*	*-0.029*	*0.673*
	All shares	*0.080* *0.801*	*-0.094* *0.796*	*-0.016*	*0.796*

Table 9: Regression of residuals of the APT on beta $e_i = \lambda_0 + \lambda_1 + \eta_i$

* The values in italic indicates the *p–value* of the statistics
** The values in bold indicate the priced factors

Period	Portfolios	λ_0	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6	λ_7	λ_8	R^2 Adj.	F sig.
1987 - 1991	**P1**	-0.107 *0.844*	2.277 *0.718*	2.472 *0.583*	1.786 *0.662*	-2.914 *0.440*	-0.479 *0.888*	0.432 *0.874*	**2.496** ***0.047***		0.344	0.018
	P 2	-0.024 *0.981*	-2.594 *0.807*	2.232 *0.798*	2.210 *0.791*	-4.301 *0.455*	1.714 *0.760*	1.302 *0.706*	-0.887 *0.810*	0.050 *0.982*	0.230	0.085
	All shares	0.019 *0.973*	-0.965 *0.936*	1.580 *0.865*	3.945 *0.623*	-4.890 *0.554*	-0.206 *0.978*	-4.247 *0.472*	1.166 *0.850*		0.128	0.036
1992 -1996	**P1**	-0.115 *0.815*	1.616 *0.791*	-1.787 *0.571*	0.983 *0.686*	1.250 *0.568*	0.722 *0.761*	0.903 *0.725*	0.348 *0.826*		0.046	0.344
	P2	0.158 *0.601*	0.171 *0.952*	-0.121 *0.958*	**-5.032** ***0.017***	-0.723 *0.700*	0.168 *0.921*	-2.292 *0.112*	-1.503 *0.161*		0.327	0.022
	P3	-0.555 *0.129*	**8.909** ***0.004***	4.725 *0.064*	**-4.715** ***0.036***	**5.971** ***0.019***	**6.471** ***0.004***	-0.578 *0.770*	1.424 *0.314*		0.787	0.000
	All shares	-0.164 *0.377*	6.157 *0.304*	4.079 *0.396*	1.631 *0.670*	3.585 *0.364*	**8.699** ***0.006***	2.308 *0.287*	-11.27 ***0.000***		0.420	0.000
1997 - 2001	**P1**	0.119 *0.885*	-3.961 *0.712*	-1.818 *0.851*	-0.904 *0.909*	1.927 *0.771*	0.179 *0.952*				0.090	0.203
	P2	-0.521 *0.458*	5.837 *0.542*	7.537 *0.347*	4.776 *0.505*	5.006 *0.340*	2.085 *0.398*				0.057	0.277
	P3	-0.555 *0.589*	12.83 *0.383*	4.658 *0.725*	2.411 *0.650*	0.943 *0.828*	**4.079** ***0.030***				0.265	0.026
	P4	-0.121 *0.871*	-1.172 *0.890*	1.832 *0.802*	3.205 *0.663*	6.133 *0.369*	-4.529 *0.344*				0.475	0.000
	P5	-0.289 *0.664*	3.724 *0.611*	5.687 *0.380*	0.411 *0.949*	1.386 *0.832*	3.131 *0.532*				0.112	0.165
	P6	0.937 *0.165*	-11.20 *0.148*	-11.91 *0.120*	-7.119 *0.298*	-7.236 *0.146*	-7.400 *0.073*				0.155	0.104
	P7	-0.200 *0.701*	4.472 *0.690*	0.207 *0.880*	0.904 *0.393*	-1.864 *0.061*	-0.460 *0.613*				0.008	0.467
	All shares	-0.063 *0.808*	16.81 *0.455*	4.911 *0.821*	-1.711 *0.922*	-4.614 *0.720*	0.512 *0.960*				0.099	0.000
1987 - 2001	**P1**	0.274 *0.570*	-3.536 *0.570*	-2.349 *0.517*	-1.188 *0.693*	-0.401 *0.873*	-2.753 *0.298*	-0.714 *0.730*	-0.997 *0.418*		0.079	0.273
	P2	1.389 *0.049*	**-18.74** ***0.045***	-10.97 *0.057*	**-10.41** ***0.014***	-7.175 *0.134*	**-8.678** ***0.029***	**-6.112** ***0.040***			0.560	0.000
	All shares	0.143 0.728	-1.765 0.844	-3.659 0.655	0.074 0.990	-1.717 0.734	-4.797 0.220	-1.775 0.476	-0.242 0.931		0.277	0.001

Table 10: Regression of residuals of the CAPM on Factor scores $\eta_i = \lambda_0 + \lambda_1 \widetilde{b}_{i1} + \lambda_2 \widetilde{b}_{i2} + ... + \lambda_n \widetilde{b}_{in}$

* The values in italic indicate the *p–value* of the statistics
** The values in bold indicate the priced factors