MULTIVARIATE METHODS IN EXAMINING MACROECONOMIC VARIABLES EFFECT ON GREEK STOCK MARKET RETURNS, 1997-2004

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Abstract

The ability to identify which factors best capture systematic return co-variation is central to applications of multifactor pricing models. In the framework of the Arbitrage Pricing Theory (APT), this paper estimates the set of factors that influence Greek stock market returns. The estimation procedure follows both the classic APT and the identification of the factors outliers through factor analysis. Using eight years of data from 1997 to 2004, the examined period is split in two sub-periods, prior and after the entrance of Greece to the European Monetary Union.

Keywords CAPM, APT, macroeconomics, returns, beta, factor loadings

JEL classification E44, G11, G12, G14

1. Introduction.

Equity returns change over time. These changes might be due to economy wide factors or to firm-specific factors, such as changes in accounting variables like an increase in leverage, earnings/price and book-to-market equity.

Asset prices are commonly believed to react sensitively to economic news. Daily experience seems to support the view that individual asset prices are influenced by a wide variety of economic events and that some events have more pervasive effect on asset prices than do others.

Consistent with the ability of investors to diversify, modern financial theory has focused on pervasive or systematic influences as the likely source of investment risk. The relation between the stock market and macroeconomic forces has been widely analyzed in the finance and macroeconomic literature. The linkages between equity prices and variables such as money supply, inflation and industrial production are of crucial importance not only in analyzing equity returns, but also in understanding the connections between expected returns and the real economy.

Ross (1976) with the arbitrage pricing theory (APT) introduced the idea that few factors govern the asset prices while the work of Chen, Roll and Ross (1986b) has given new impetus to research on the macroeconomic determinants of equity returns. Research has concentrated mainly on the significance of the risk premia attached to each macroeconomic factor, providing considerable evidence that state variables such as industrial production growth, default risk premia and yield spreads between long and short-term government bonds are important in explaining equilibrium asset prices. Since the theory does not indicate which macroeconomic factors to include on the model, statistical methods are applied to infer the presence of factors from patterns in the time series data on assets' rates of return. The specialised tools of factor analysis and principal components analysis are employed in these investigations.

This paper identifies the macroeconomic state variables that influence Greek equity returns for the period from 1997 to 2004. Since different economies are likely to be

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idiosyncratic to some degree in selecting the relevant macroeconomic factors the attention is not confined to variables used in previous research on other countries, but rather to variables which might have a specific relevance for the Greek stock market. The study examines the ability of the macroeconomic series to explain their relationship with the Greek stock market once based on their ability to predict the factor scores estimated using Factor Analysis and once by regressing directly the macroeconomic variables in examining their significance in explaining expected stock returns.

Assuming that asset prices depend on their exposure to state variables in the economy, how well does factor analysis illustrate this exposure? How well do parameter estimates for innovations in pre-specified macroeconomic variables describe security returns? What are the implications of the answers to these questions for tests of the Arbitrage Pricing Theory (APT)? These three questions are addressed in the following pages.

Despite the extensive literature on testing the relation between macroeconomic variables and stock market returns very few studies has been conducted in regard to the Greek stock market. This paper has been focused on the examined period from 1997 to 2004, a period which incorporates significant changes in the Greek economic and financial environment. The study examined the linkages between the macroeconomic state variables and equity returns under an APT framework. Since the theory does not specify which factors should include in the model, the factor analysis technique has been used as a data reduction method.

The results of the analysis suggest that the variance of returns can be explained prior to the year of 2000 from the selected macro-variables for the Athens stock exchange. However, the sensitivities to the macroeconomic variables are highly unstable after the year of 2001 and other exogenous variables that are not captured by the model affect stock market returns.

The paper is organized as follows. Section 2 refers to the APT theory, Section 3 comments the examination period while Section 4 describes the macroeconomic variables. The statistical characteristics of the macro-variables are described in Section 5 while Section 6 presents the selection of the systematic factors. The macro-economic modeling and the conclusions are presented in Section 7 and 8.

2. Background of the apt.

The arbitrage pricing theory introduced the idea that few factors govern the prices of assets: if no arbitrage opportunities exist, then the risk premium on any asset is determined by the factor loadings of the asset; the remaining loadings of the idiosyncratic residuals bear (almost) no risk premium, since idiosyncratic risk can be diversified in a large portfolio.

The theory begins with the traditional assumptions of perfectly competitive and frictionless markets, with homogeneous beliefs among investors that expected returns are governed by a K-factor linear return generating model of the form:

$$r_i = E_i + b_{i1} \bullet d_1 + ... + b_{ik} \bullet d_k + e_i ,\ i = 1,...,n \qquad (1)$$

where the return on asset i is a function of asset i expected return and the sensitivity (beta) of the asset to each common factor (d). Roll and Ross (1980) propose that estimated expected returns depend on estimated factor loadings; and variables such as e_i (the random disturbances or noise) do not add any explanatory value to the model. If they did, there would be a need for more than the k hypothesized factors. However, in practice it is difficult to distinguish between an exact model for which same factors have been left out and an appropriate model for which all the factors are present.

In addition the APT does not provide any indications about which variables should appear on the right hand side of equation (1), since the systematic factors are not identified and the existence of the linear relation between the factors and securities returns is merely an assumption of the model. The factors are chosen among financial indicators and macroeconomic variables.

The APT is a substitute for the Capital Asset Pricing Model (CAPM) in that both assert a linear relation between assets' expected returns and their covariance with other random variables. (In the CAPM, the covariance is with the market portfolio's return.) The covariance is interpreted as a measure of risk that investors cannot avoid by diversification. The slope coefficient in the linear relation between the expected returns and the covariance is interpreted as a risk premium. The APT differs in two distinct ways from the CAPM in that no particular market portfolio plays a role in the APT and that the model allows for more than one generating factor.

Empirical work on multiple factor models and the APT bears a close resemblance to that of the CAPM, though from a different theoretical perspective. The main difference is that other explanatory variables are introduced in addition to, or instead of, the market rate of return. The interpretation is based on the arbitrage principle where the explanatory variables are the parameter estimates from the time series regressions (instead of estimated beta-coefficients together, possibly, with other variables).

Despite the sophisticated tools for studying multifactor models and the APT, a fundamental problem remains: how to select the factors. In an age of powerful computers and plentiful data, the temptation is to keep trying different sets of factors until one is found that fits the data well. This process of data mining or data snooping often results in empirical estimations that appear highly satisfactory. But they should be regarded with the greatest suspicion. For conventional statistical criteria are not valid in such circumstances. There are at least two possible ways to circumvent the problem of factor selection. One is to use the estimated parameters to make forecasts out of sample that is, to forecast observations that were not included in estimating the parameters in the first place. This can be a handy method of eliminating bad models but it provides little guidance about how to find good ones. The second method is to build multifactor models that correspond more closely to the predictions of economic theory. Statistical methods are applied to infer the presence of factors from patterns in the time series data on assets' rates of return. The specialised tools of factor analysis and principal component analysis are employed in these investigations in order to reduce the number of variables and to detect the structure in the relationship between the variables. In Annex 1 we include a section on APT tests.

3. The period of examination.

The investigation covers an eight year period from January 1997 to December 2004. This choice is motivated by the fact that the examined period incorporates the characteristics of a changing economic environment. First, the period from 1997 to 2000 is characterised by a relatively homogenous economic environment in terms of monetary and fiscal policy and exchange rate regime. By contrast, after 2000, the Greek economy and financial markets were increasingly influenced by Greece's participation in EMU.

Looking at the economic and stock market development the examined period, 1997 to 2004, was a very significant period for the Greek economy and the history of the Athens stock exchange. At the end of 1996 and the beginning of 1997 the downward phase of a major cycle in the Greek economy was completed. This downward phase began in 1974 when the first effects of oil prices surfaced and were almost all of the world's major economies were quickly sliding into recession. The Greek economy remained in a state of stagflationary recession for over 20 years. The phase was last brought to a close at the end of 1996 with the achievement of a high rate of growth in GNP and a low rate of inflation. At the same time, showed signs that it had once again the characteristics of an economy that could progress and evolve with high rates of growth. Finally at the end of 1996, a stock market cycle came to its close. It was a cycle that had to do not so much with the level of prices and valuations but rather one with a qualitative nature where the political leadership supported by the whole of the stock exchange community declared and implemented a series of interventions of both institutional and functional nature.

With the drawing of 1997 a new cycle began, both for the Greek economy and the Athens stock exchange. During the period 1997 to 2000, the Greek economy was characterized by its attempt to readjusting its macroeconomic indicators and achieving the criteria to become the 12th member of the Euro-zone, that is achieving Economic and Monetary Union, a feat which was realized on January 1, 2001. The main goals of this attempt were the reduction in the inflation rate under 3%, the reduction to the fiscal deficit and the reversal in the upward trend of public debt. From 1997 to 2000, GNP rose by an average rate of 3.50% and the inflation rate was at 3.20%. By the end of 2000, the Greek economy had transformed into a modern economy with an updated structure and strong dynamism.

The same conditions prevailed in Greece after 2001, with economic growth, monetary stability, investment in infrastructure, growth in industry, growth in exports, and redirection of phase of growth. Finally the Greek stock market continued its course and having achieved all the necessary changes in its institutional and regulative framework and in its technological systems it entered in a new era, with its promotion in May 2001 to the category of developed and mature markets.

4. The macroeconomic factors.

This section describes the state variables that are used in the empirical analysis. No claim is made that all the macroeconomic variables which influence stock returns are included; however, the variables that are analyzed are of some economic interest and many of them have been widely used in the financial literature (see table 1 for a summary of variables).

The rational expectations and market efficiency assumptions require the identification of changes in the series. Particular attention is paid to the timing of the arrival of information: financial variables are generally measured precisely and can be observed in real time, while information on non-financial variables is often released with substantial delay. This paper assumes that stock prices are influenced by the announcements about the macroeconomic factors, although the information embedded in the announcement might refer to previous periods.

4.1. Industrial production

As previously mentioned the selection of the macroeconomic factors depends on the idiosyncrasy of the Greek economy and not on relevant factors used in previous studies on other countries. The basic series of growth rate for every country is industrial production. However, Greece cannot be characterised as a country with heavy reliance on industry. The most important factor that affects Greek economy is manufacturing. Thus, for the purpose of the study the index of total manufacturing is used as a proxy for industrial production. This index includes the production on crucial branches of Greek economy like food, tobacco, textile, clothing, leather, wood, paper, chemicals, paper products, non-metallic minerals and basic metals. Monthly data has been used for a period of eight years between January 1997 and December 2004 as announced by the National Statistic Service of Greece.

These figures are released with approximately 45 days of delay: for example, the data on the level of industrial production in January is released around mid-March. Given such delays, one has to consider how to model the relation between news on industrial production and equity returns. In this paper the hypothesis is made that stock market returns are influenced by the announcement of the most recent figures on industrial production, although they refer to month t-2. This implies, for example, that in March investors formulate their investment decisions on the basis of the news on the January figures for industrial production.

If IP denotes the rate of industrial production in month then the monthly growth of industrial production is given by:

$$\Delta IP = \ln IP_t - \ln IP_{t-1} \qquad (2)$$

Because IP actually is the flow of industrial production, ΔIP measures the change in industrial production lagged by at least a partial month. The monthly growth series were examined because the equity market is related to changes in industrial activity in the long run. Since stock market prices involve the valuation of cash flows over long periods in the future, monthly stock returns may not be highly related to monthly changes in rates of industrial production, although such changes might capture the information pertinent for pricing. This month's change in stock prices probably reflects changes in industrial production anticipated many months into the future.

4.2.Inflation

The expected value of firms’ future cash flows might be influenced by revisions in expected inflation, if inflation has real effects - for example, redistributing resources among different sectors of the economy - which are larger when average inflation, is higher. In this case a change in inflation will have a systematic effect on share prices.

The inflation rate is calculated as the monthly logarithmic change in the consumer price index whose value for each calendar month is released by the National Statistic Service of Greece.

$$\Delta INF = \Delta \ln(CPI_t) = \ln(CPI_t) - \ln(CPI_{t-1}) \qquad (3)$$

4.3.Interest rates

To capture the risk reflected in unexpected changes in equation (2), interest-rate-related variables are also examined. Since stock prices reflect the value of all future cash flows, the discount operator in equation (2) is influenced by modifications in the term premium and in the risk premium. Therefore, proxies are examined for shifts in the slope of the term structure and for innovations in the spread between the bank lending rate paid by high and low-quality borrowers, a proxy for the default risk premium.

4.3.1. Term structure. The change in the slope of the term structure has been proxied with the monthly logarithmic rate of return on long bonds, measured by the difference between the holding period return on a portfolio of long-term government bonds in month t (LGBt) and the yield on short-term Treasury bills at the end of the month (SRBt). For the purpose of the study as a proxy for the LGBt has been used the 10 year government bond while 3 month Treasury bill has been used as a proxy for the SRBt. The following equation has been used:

$$\Delta TERSTR = \ln(LGB_t - SRB_t) - \ln(LGB_{t-1} - SRB_{t-1}) \qquad (4)$$

4.3.2. Risk premia. In Chen, Roll and Ross (1986) the impact of changes in risk premia on equity returns has been captured using the difference between the return on government bonds and that of low grade bond portfolios. Unfortunately, in Greece there are no data on corporate bonds or on company grading. Data on bank lending rates were therefore employed: the first indicator which has been calculated is the difference in the spread between the minimum bank lending rate in month t (MINBRt) and the average bank lending rate of the same month (AVEBRt). The second indicator is the difference in the spread between the minimum bank lending rate in month t-1 (MINBRt-1) and the average bank lending rate of the same month (AVEBRt-1). Finally the monthly logarithmic rate between the current and past month has been calculated using the following equation:

$$\Delta RISKPR = \ln(AVERLR_t - MINLR_t) - \ln(AVERLR_{t-1} - MINLR_{t-1}) \qquad (5)$$

A change in RISKPR can be interpreted as a shift in the degree of risk aversion which is implicit in the discount applied to future cash flows.

4.4.International factors

International factors have a strong impact on the competitiveness of Greek economy and their inclusion proxies for future economic growth opportunities. The effects of the fluctuation of the exchange rate drachma/US dollar or Euro/US dollar and the oil price changes as incorporated from the changes in the price of UK Brent are important indicators of the economy of every country.

4.5.Exchange rates

The proxy which has been used to capture the effect of changes in exchange rates on stock returns is the rate of change in drachma/US dollar and after the year of 2000 the exchange rate of Euro/US dollar.

$$\Delta EXRUSD = \ln(SX_t) - \ln(SX_{t-1}) \qquad (6)$$

The decision to use the US dollar exchange rate is motivated mainly by the fact that the US dollar was the most important currency (in terms of its relevance for Greek international trade) that was not part of the EMS, so that its fluctuations should reflect market forces more accurately than other exchange rates included in the EMS.

4.6.Oil Prices

It is often argued that oil prices must be included in any list of the systematic factors that influence stock market returns and pricing. For the purpose of the study using as a proxy for oil prices the price of UK Brent oil, each month the logarithmic change was estimated using the following equation:

$$\Delta OILPR = \ln(OILG_t) - \ln(OILG_{t-1}) \qquad (7)$$

4.7.Consumption

The inclusion of the percentage change of consumption among the state variables is motivated by the consumption-based asset pricing theories (Lucas, 1978 and Breeden, 1979). Since monthly data on consumption in Greece are announced with delay the index of retail sales volume has been used as a proxy for the purpose of the study. The data were gathered from the bulletin of conjectural indicators as announced from the economic research department of the Bank of Greece.

The monthly logarithmic change in the series was taken to obtain the growth rate using the following equation:

$$\Delta CONS = \ln(RSV_t) - \ln(RSV_{t-1}) \qquad (8)$$

4.8.Money growth

The impact of the weekly money stock announcements on securities returns has been analyzed by Cornell (1983), Pearce and Roley (1983) and Ulrich and Watchel (1981). The consensus finding is that money growth in monetary aggregates is associated with lower stock prices. The decline in stock prices could be due to the fact that in response to an increase in money supply agents anticipate tighter monetary policy and higher interest rates. The second interpretation is based on the possibility that an increase in the money supply causes weaker inflation expectations, and thus a fall in stock prices. Monthly data has been used from the bulletin of conjectural indicators as announced from the economic research department of the Bank of Greece. In order to estimate the growth rate of this indicator the following equation has been used:

$$\Delta MG = \ln(MG_t) - \ln(MG_{t-1}) \qquad (9)$$

4.9.Imports and Exports

It is generally expected that foreign trade plays a large role in a small open economy such as exists in Greece. A measure of the relative weight of trade is the ratio of the sum of exports and imports to the country's GDP. In Greece this ratio grew until 1985, when it reached almost 50 percent, but it declined from that point to about 40 percent in 1998. The decline has been evenly divided between exports and imports. The export decline verifies the weakening competitive position of Greek products in the world market, and especially in the market of the EC/EU. The import decline is simply the outcome of domestic demand being weakened by the austerity policies of the early 1990s. Because it imports more than twice the value of its exports, Greece has registered chronic annual deficits in its balance of payments. Greece's productive base expanded in 1999 and 2001, however, in part due to a thriving stock exchange, and low interest rates.

The US Central Intelligence Agency (CIA) reports that in 2002 the purchasing power parity of Greece's exports was $12.6 billion while imports totalled $31.4 billion resulting in a trade deficit of $18.8 billion. The International Monetary Fund (IMF) reports that in 2001 Greece had exports of goods totalling $10.6 billion and imports totalling $29.7 billion. Nevertheless, the Greek economy remains highly internationalized and quite sensitive to developments in foreign trade, as compared with larger economies such as that of the United States, in which the sum of exports and imports is less than 20 percent of GDP.

The data of the volume of imports and exports that has been used in the study has been derived from the bulletin of conjectural indicators as announced from the economic research department of the Bank of Greece. The following equations have been used to calculate the monthly logarithmic change of the above two variables:

$$\Delta IMP = \ln(IMP_t) - \ln(IMP_{t-1}) \tag{10}$$

$$\Delta EXP = \ln(EXP_t) - \ln(EXP_{t-1}) \tag{11}$$

4.10. Market Index

The main purpose of the article is to examine the relation between various economic variables and stock returns. However, because of the smoothing and averaging characteristics of most macroeconomic time series, in short holding periods, such as a single month, these series cannot be expected to capture all the information available to the market in the same period. Stock prices, on the other hand, respond very quickly to public information. The effect of this is to guarantee that market returns will be, at best, weakly related and very noisy relative to innovations in macroeconomic factors.

This should bias our results in favour of finding a stronger linkage between the time-series returns on market indices and other portfolios of stock returns than between these portfolio returns and innovations in the macro variables. To examine the relative pricing influence the basic Athens stock exchange market index was used. The composition, the scheduled or unscheduled review of the general index, is regulated by an appropriate set of ground rules of which the following may be the main points:

- Capitalisation and trading value of shares (except of the blocks of shares trading value) consist of the basic criteria used to determine which shares will participate in an index, with equal weight attributed to both criteria. Each company is represented in a price index by the value of a common share with voting right.
- Shares traded with the call auction method are not eligible for inclusion in the indices.
- A share will not be introduced into an index unless it has an active presence in the stock market for at least six months, unless the share of the company represent an average market capitalisation ≥2% total average market capitalisation of the total number of the markets of shares of ATHEX during the period considered.
- For the main market no sector may be represented by more than five companies.

- All kind of securities (regular, preferred etc, regardless of the trading method are eligible for inclusion in All shares Index.
- Finally sector indices include at least five listed companies, unless the total average market capitalization of the sector is ≥3% of the total average market capitalisation of the market of shares of the ATHEX market and the sector may contain only three listed companies.
- The composition of the indices is reviewed every six months.

In order to examine the exposure of equity returns to state variables as a proxy for the market it has been used the ATHEX Composite Share Price Index which is a market value weighted index comprised of the 60 most highly capitalised shares of the main market and reflects general trends of the stock market.

5. Statistical characteristics of the macroeconomic variables

Table 2 in the Annex shows the descriptive statistics of the macro series used in the study. Point of discussion of the table is the high values of standard deviation observed in the money growth, the level of imports and exports. The main characteristic of the examined period, is the attempt of Greek authorities to readjust the macroeconomic indicators so as to become a member of the Euro-zone. In order to control for inflation the quantity of money in the financial system plays a crucial role while the entrance of Greece in the year of 2001 at the Economic and Monetary Union changed the level of international trade by increasing exports at a higher rate than imports, allowing for more efficient economic policy by reducing the chronic annual deficit in the balance of payments. In addition the kurtosis value in the industrial production variable is not expected to affect.

Table 3 in the Annex shows the correlation coefficients among the macroeconomic factors. The correlations among the macroeconomic variables are generally small. As in previous studies for the US by Chen, Roll and Ross (1986) and for Japan by Hamao (1988), the correlation between the term structure factor and the risk premium factor is also low. The same results are obtained with that of Chen, Roll and Ross and Hamao who employed the return on the long-term bond series to construct both variables.

Stationarity is a critical assumption of time series analysis. A time series is stationary when its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. In the time series literature such a stochastic process is known as weak stationarity. A stricter definition of stationarity also requires that the variance remain homogenous for the series. Sometimes this can be achieved by taking the logarithm of the data. Because many time series (most economic indicators, for instance) tend to rise, simple application of regression methods to time series encounters spurious correlations and even multicollinearity. A first step in time series analysis is to achieve stationarity in the data to avoid these problems. A way of testing stationarity in time series is the so-called autocorrelation function (ACF).

The results (table 4) indicate that since the AC's are not significantly positive, in fact they are negative, and the AC(k) do dies off geometrically with increasing lag k, it is a sign that the series do not obey a low-order autoregressive (AR) process. In addition, since the partial autocorrelation (PAC) is not significantly positive at lag 1 and not close to zero thereafter, the pattern of autocorrelation cannot be captured by an autoregression of order one (i.e., AR(1)). The findings do not indicate that the derived series violate the criterion for stationarity and provides strong evidence that the examined series are stationary. The same results, for the non-stationarity of the derived series, are obtained when tests are conducted with the augmented Dickey-Fuller test (table 5). The computed absolute values of the t statistics of the ADF test exceed the McKinnon critical values, so the hypothesis that the series are stationary cannot be rejected. Additionally all Durbin Watson values are greater than 2 indicating no evidence for autocorrelation.

6. The selection of the variables

Statistical methods do not provide an unequivocal criterion to select the systematic factors which influence stock returns from among the potential candidates. In the previous literature the pervasive factors have therefore been selected either on the basis of empirical considerations, such as their explanatory power in predicting equity returns (see Chen, Roll and Ross, 1986a and Chen and Jordan, 1993) or on the basis of a priori beliefs (see McElroy and Burmeister, 1988, Shanken and Weinstein, 1987, He and Ng, 1994).

The selection of the macro-variables that are more closely related to the factors influencing securities returns is based on their ability to explain the factor scores using Factor Analysis. The main applications of factor analytic techniques are: (1) to reduce the number of variables and (2) to detect structure in the relationships between variables, that is to classify variables. Therefore, factor analysis is applied as a data reduction or structure detection method and for the purpose of this study the tests were conducted using the SPSS data analysis programme:

6.1. Principle component analysis

Before conducting a component analysis the correlation matrix between the variables has to be examined. If any of the correlations are too high (above .9), these variables must be removed from the analysis, as these variables seem to be measuring the same thing and the purpose of the method is to reduce the number of items (variables). From table 3 all the examined variables have acceptable correlation values so the analysis can continue.

Additional criteria for the appropriateness of factor analysis and the sampling adequacy of the set of variables is the Kaiser-Meyer-Olkin (MSA) value which must exceeds the minimum requirement of 0.50. As it can be seen from table 6 the overall MSA for the examined series has acceptable value at 0.541.

Also PCA requires that the probability associated with Bartlett's test of sphericity be less than the level of significance. The probability associated with the Bartlett test is <0.001, which satisfies this requirement. Finally the ratio of cases to variables should be at least 5 to 1. With 96 observations and 10 variables, the ratio of cases to variables is 9.6 to 1, which exceeds the requirement for the ratio of cases to variables. Taken together, these tests provide a minimum standard which should be passed before a principal component analysis should be conducted (table 6).

In the principle component analysis we look the directions (principle components) that collect the variation of the variables. The each principle component has its own eigenvalue that tells the variation that principle component has collected. Eigenvalue 1 tells that the principle component has collected the variation that is as much as the variation of a one variable. Because the main idea of the analysis is to collect the information of the data, the principle components witch eigenvalues less than 1 are not good. The most used method to select the number of the factors is to select the principle components that have the eigenvalues more than 1. The values in the column initial eigenvalues-total indicate the proportion of each variable's variance that can be explained by the principal components. Variables values greater than 1 are well represented in the common factor space, while variables with values lower than 1 are not well represented (table 7 in the Annex).

In the second column (eigenvalue) we find the variance on the new factors that were successively extracted. In the third column, these values are expressed as a percent of the total variance. As we can see, factor 1 accounts for 19 percent of the variance, factor 2 for 17 percent, and so on. The third column contains the cumulative variance extracted. For example, the third row shows a value of 48.392. This means that the first three components together account for 48.39% of the total variance. The fifth row has a value of 70.120 meaning that the first five components together account for 70.12% of the total variance. It should be mentioned here that in principal components analysis, all variance is considered to be true and common variance. In other words, the variables are assumed to be measured without error, so there is no error variance. The variances extracted by the factors are called the eigenvalues.

6.2. Choice of the number of factors

Now that we have a measure of how much variance each successive factor extracts, we can return to the question of how many factors to retain. First, we can retain only factors with eigenvalues greater than 1. In essence this is like saying that, unless a factor extracts at least as much as the equivalent of one original variable, we drop it. This criterion was proposed by Kaiser (1960), and is probably the one most widely used. Using this criterion, we would retain 5 factors (principal components).

6.3. Choice of the rotation method and doing the rotation

In the rotation we round the selected principle components into the directions, that we could easily interpret the result. The main idea is to divide the variables to the factors. Very high and very low factor loading are easy to interpret, and that is why the varimax rotation method is the most used. That method maximises the variation of the loadings. Still the factors are independent (table 8).

6.4. Naming the factors and calculation of the combined variables

As the result of the factor analysis we get the factor loading matrix that shows witch variables belong to witch factors. Before continuing the factor analysis we must think which variables should belong together.

Sometimes some variables are not well succeeded to measure what they are meant to measure. Those "bad variables" do not correlate highly with the others and they get low loadings. If this model is correct, then we should not expect that the factors will extract all variance from our items; rather, only that proportion that is due to the common factors and shared by several items. In the language of factor analysis, the proportion of variance of a particular item that is due to common factors (shared with other items) is called communality. Therefore, an additional task facing us when applying this model is to estimate the communalities for each variable, that is, the proportion of variance that each item has in common with other items. The proportion of variance that is unique to each item is then the respective item's total variance minus the communality. A common starting point is to use the squared multiple correlation of an item with all other items as an estimate of the communality. The variables with the low communality coefficient can be dropped form the model. Since all extracted values are not less than 0.50 then no variable should be removed (table 9).

By looking at the initial, un-rotated, extraction and making an initial judgment regarding how many components to retain. The extraction of too many components (over-extraction) or too few components (under-extraction) have been studied in principal factor analysis with varimax rotation. Over-extraction generally leads to less error (differences between the structure of the obtained factors and that of the true factors) than did under-extraction. Of course, extracting the correct number of factors is the best solution, but it might be a good strategy to lean towards over-extraction to avoid the greater error found with under-extraction. By using a varimax rotation statisticians extract the number of factors. Generally speaking on the basis of large loadings the values of above 0.3 is often a criterion. A value of 0.1 or below may be substantive (statistically significant) but do not explain much variance. A well-defined factor should have at least three variables loadings highly on it. Existence of factors with only one loading indicates factor number is too high. As it can be seen in tables 8 and 10 five factors have been extracted.

Table 8: Rotated component matrix

	Component	Component	Component	Component	Component
	1	2	3	4	5
EXP	0.8580	0.0074	0.0185	-0.0455	-0.0917
IMP	0.8440	0.2070	-0.0544	0.0035	0.0700
MG	0.0225	0.8780	-0.0517	-0.0333	0.0688
CONS	0.1940	0.7780	0.2180	-0.0183	-0.2070
INF	-0.0229	0.0296	0.8390	-0.1440	-0.0597
RISKPR	-0.3760	0.2500	0.4790	0.4140	0.0528
OILG	-0.0900	0.0581	-0.2610	0.7340	0.1600
EXR	-0.0640	0.1710	-0.1830	-0.6840	0.2670
IP	0.0625	0.1230	0.0832	0.1070	-0.8080
TERSTR	0.1070	0.1010	0.5420	0.2020	0.5950

Table 10: The selection of the factors

Component 1		Component 2		Component 3		Component 4		Component 5	
<u>EXP</u>	<u>0.8580</u>	<u>MG</u>	<u>0.8780</u>	<u>INF</u>	<u>0.8390</u>	<u>OILG</u>	<u>0.7340</u>	<u>TERSTR</u>	<u>0.5950</u>
<u>IMP</u>	<u>0.8440</u>	<u>CONS</u>	<u>0.7780</u>	<u>TERSTR</u>	<u>0.5420</u>	<u>RISKPR</u>	<u>0.4140</u>	<u>EXR</u>	<u>0.2670</u>
CONS	0.1940	RISKPR	0.2500	<u>RISKPR</u>	<u>0.4790</u>	TERSTR	0.2020	OILG	0.1600
TERSTR	0.1070	IMP	0.2070	CONS	0.2180	IP	0.1070	IMP	0.0700
IP	0.0625	EXR	0.1710	IP	0.0832	IMP	0.0035	MG	0.0688
MG	0.0225	IP	0.1230	EXP	0.0185	CONS	-0.0183	RISKPR	0.0528
INF	-0.0229	TERSTR	0.1010	MG	-0.0517	MG	-0.0333	INF	-0.0597
EXR	-0.0640	OILG	0.0581	IMP	-0.0544	EXP	-0.0455	EXP	-0.0917
OILG	-0.0900	INF	0.0296	EXR	-0.1830	INF	-0.1440	CONS	-0.2070
RISKPR	-0.3760	EXP	0.0074	OILG	-0.2610	EXR	-0.6840	IP	-0.8080

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 12 iterations

The first factors can be named as the "trade factor" since the factors of exports and imports have the highest loadings. The second factor can be named as the "production factor" since money supply and consumption produce the highest values and are the variables that are strongly related to the production level of an economy. The third factor is named as the "the financial factor" since the factors of inflation, term structure and risk premia have the highest loadings. The fourth factor is the "international factor" with high values on oil prices and risk premia affecting the level of the competitiveness of each economy. Finally, the fifth factor is the "country factor" with highest values of factor loadings on term structure and exchange rates. These two factors are typical criteria of the stability level of each economy since long term interest rates and exchange rates reflect future expectations.

7. The macroeconomic modeling

After the extraction and the naming of the factors, the factor scores or the component scores are calculated. Factor scores are the scores of each case (row) on each factor (column). To compute the factor score for a given case for a given factor, one takes the case's standardized score on each variable, multiplies by the corresponding factor loading of the variable for the given factor, and sums these products. Computing factor scores allows one to look for factor outliers that can be used as variables in subsequent modeling. The SPSS factor procedure saves standardized factor scores as variables.

The study continues by examining the significance of the macroeconomic variables in two different ways. Tests are conducted on the relation of factor outliers with asset returns while the initial selected macroeconomic variables are regressed directly to the proxy of market in order to examine their significance in explaining expected stock returns. The examined period covers eight years from January 1997 to December 2004. This choice is motivated by the fact that the examined period incorporates the characteristics of a changing economic environment. Tests have been made firstly for the period between 1997 to 2000 that is characterised by a relatively homogenous economic environment in terms of monetary, fiscal policy and exchange rate regime. By contrast, the second examined period, after the year 2000, the Greek economy and financial markets were increasingly influenced by Greece's participation in EMU.

The ATHEX Composite Share Price Index was chosen as a proxy to reflect the general trends of the stock market. Using monthly data two regression equations have been examined. The first equation uses the produced factor outliers and is the following:

$$R_{gindex} = \alpha_{\iota} + \beta_{1\iota}TR + \beta_{2i}PR + \beta_{3\iota}FIN + \beta_{4i}INT + \beta_{5i}CTRY + e_i \tag{14}$$

where R_{gindex} is the ATHEX Composite Share Price Index. The TR is the first outlier called as the trade factor, the PR is the production factor, the FIN is the financial factor, the INT is the international factor and finally the $CTRY$ is the country factor.

The second equation uses the initial macroeconomic variables and is described as follows:

$$\begin{gathered} R_{gindex} = \alpha_{\iota} + \beta_{1\iota}CONS + \beta_{2i}EXP + \beta_{3\iota}EXRA + \beta_{4i}IMP + \beta_{5i}INDPR + \beta_{6\iota}INF + \beta_{7i}MG + \\ \beta_{8i}OILPR + \beta_{9\iota}RISKPR + \beta_{10i}TERSTR + e_i \end{gathered} \tag{15}$$

where R_{gindex} is the ATHEX Composite Share Price Index. $CONS$ is the change in consumption, EXP is the change in exports, $EXRA$ is the exchange rate change, IMP is the change in imports, $INDPR$ is the change in industrial production, INF is the change in inflation, MG is the change in money supply, $OILPR$ is the change in oil prices, $RISKPR$ is the risk premium change and finally $TERSTR$ is the change in the term structure.

The results of the regression analysis of the general index of the Athens stock exchange with the produced outliers (Table 11) indicate that the model (equation 14) does not explain adequately the variation of returns for the period from 1997 to 2004. The model provides poor R-square results (0.3475) with small standard error values. All the calculated variables, apart from the $CTRY$ country factor, are not statistically significant with t-values less than 2. In fact the country factors' characteristic is the importance of the term structure macroeconomic variable that indicates the difference between long term and short term bonds. The specific macroeconomic variable played a crucial role in the readjusting process of economic indicators for the entrance of Greece in EMU. The model provides better results when the examined period is split in two sub-periods, prior and after the entrance of Greece in EMU. From 1997 to 2000 (prior the entrance) the R-square estimates increases (0.5810) while the standard error values remain small. Characteristic issue of this sub-period is the statistical significance of the produced outliers of TR-the trade factor, of the INT-the international factor and of the $CTRY$-the country factor, with t-statistics values greater than 2. In addition the model provides with a high F-value for the goodness of fit stat. These three factors provide insights for the importance of trade and exchange rates for the competitiveness of a small and exogenously influenced economy such as Greece's. The predictive power of the model is not satisfactory for the examined period after the entrance of Greece in EMU (2001 to 2004) with low values of R-square (0.1028) and F-value estimates for the goodness of fit stat. The low R^2 value reflects the fact that additional explanatory variables share with the produced outliers the capability in explaining the Greek stock market return variation.

When the pre-specified macro-economic variables are used in order to explain the exposure of equity returns the model (equation 15) produces a high R-square value of 0.630 with a significant F-value as a goodness of fit, for the whole sample period from 1997 to 2004. The variables of $INDPR$-industrial production, INF-inflation and $TERSTR$-term structure appear statistically significant with t-values greater than 2. The R-square estimate improves (0.7604) at the examined period prior to the entrance of Greece to the EMU. All the selected variables, apart from the industrial production, are not statistically significant with t-values less than 2 while the model produces a high F-value. The selected macro-economic variables do not capture all the necessary characteristics for examining the stock return variation for the Greek stock market from 2000 to 2004. The results are the same as in the prior entrance period with low R-square value (0.3259) and F-value estimates. Other variables apart from the selected ones that are not included in the model seem to provide more evidence about stock return variation.

Table 12: Regression output of ATHEX Composite Share Price Index against the initial macroeconomic variables

	1997-2004	1997-2000	2001-2004
C	0.0092	0.0167	-0.0028
Std. Error	0.0102	0.0176	0.0113
t-Statistic	0.8981	0.9464	-0.2522
CONS	0.0366	0.0264	0.0466
Std. Error	0.0881	0.1650	0.1244
t-Statistic	0.4159	0.1598	0.3748
EXP	-0.1114	-0.0943	0.1034
Std. Error	0.1390	0.3801	0.1440
t-Statistic	-0.8013	-0.2482	0.7177
EXRA	-0.2623	-0.8417	0.1940
Std. Error	0.3147	0.7161	0.3047
t-Statistic	-0.8338	-1.1753	0.6368
IMP	-0.1135	0.0514	-0.1297
Std. Error	0.1168	0.2089	0.1495
t-Statistic	-0.9712	0.2459	-0.8674
INDPR	0.2418	0.2479	-0.2449
Std. Error	0.0210	0.0250	0.1022
t-Statistic	11.5200	9.9217	-2.3953
INF	-0.8142	-0.6234	-1.0371
Std. Error	0.3355	0.4648	0.9905
t-Statistic	-2.4266	-1.3414	-1.0471
MG	0.3316	0.2489	0.1590
Std. Error	0.3116	0.3936	0.8925
t-Statistic	1.0643	0.6323	0.1781
OILPR	-0.0722	-0.0452	-0.1622
Std. Error	0.1201	0.1945	0.1209
t-Statistic	-0.6010	-0.2327	-1.3423

8. Conclusions

Despite the extensive literature on testing the relation between macroeconomic variables and stock market returns very few studies has been conducted in regard to the Greek stock market. This paper has been focused on the examined period from 1997 to 2004, a period which incorporates significant changes in the Greek economic and financial environment. The study examined the linkages between the macroeconomic state variables and equity returns under an APT framework. Since the theory does not specify which factors should include in the model, the factor analysis technique has been used as a data reduction method

Analyzing eight years of returns, the paper has shown that the variance of returns can be explained prior to the year of 2000 from the selected macro-variables in both ways of the analysis. However, the sensitivities of both the macroeconomic variables and the produced outliers of factor analysis are highly unstable after the year of 2001.

Changes in the sensitivity of the macroeconomic factors may be due to different responses of stock returns to the economic fundamentals in different phases of the economic cycle. It should be noted that the Greek stock market suffered from a sudden and sharp decrease in stock market prices from 2000 to 2001 making the financial environment rather unstable. Our results suggest that further research should be devoted to investigate the causes and the consequences of the instability of stock market returns from exogenous variables that are not captured by the model.

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Annex 1. APT

1.1 APT tests

There is a significant debate among academics about the link between macro-economic news and financial market volatility or more generally speaking, financial price dynamics. Numerous papers have empirically investigated the reaction of markets to prominent US macro-economic data (as instance French and Roll (1986), Hardouvelis (1988), Harvey and Huang (1991), Kim and Verrechia, (1991), Becker, Finnerty and Kopecky (1996), Ederington and Lee (1996), Mitchell and Mulherin (1994), Andersen and Bolersllev (1998), Jones, Lamont and Lumsdain (1998), Li and Engle (1998)).

APT supports that security prices respond to systematic factors. Under this premise, there exist industrial, utility and transportation indexes implying that investors think of the included stocks as responding to common factors. Examinations by King (1966) and by Elton and Gruber (1973) respond to this implication. King applies factor analysis to the covariance matrix of a serial stock price changes and discovers a set of pervasive market and industry factors. Elton and Gruber consider an alternative behavioural model that assumes stocks respond to common factors. Long (1974) describes expected returns with three factors: the term structure of interest rates, inflation expectations and the spread between riskless and risky security returns. Fama and MacBeth (1973) likewise affirm the appropriateness of a multi-factor model if the one-factor return generating process has correlated residuals. The macroeconomic factors modelled by Long and the multiple risk premiums selected by Fama and MacBeth share the intuition of the APT. In proposing the APT, Ross (1976) holds that systematic variability alone affects expected returns.

However, from the very start, many asset pricing researchers were deeply skeptical, and believed that APT offered too much for too little. The initial criticisms of APT were led by Shanken (1982) who pointed out the empirical arbitrariness of factor identification. Shanken’s critique led to the development of equilibrium versions of this theory, given as the equilibrium APT models of Dybvig (1983), Grinblatt and Titman (1983), and Connor (1984).

In the context of the APT, Reisman (1992) and Shanken (1992) demonstrate a striking result that the usual APT pricing approximation holds with respect to virtually any reference variables that are correlated with the true factors, reinforcing Shanken's (1982) earlier conclusion that the APT has no empirical content and raising serious concerns about its theoretical content. Reisman (1992) demonstrates that the upper bound on the sum of squared pricing deviations increases, causing a loss in pricing accuracy, as the correlation between the factors and the reference variables decreases. Shanken demonstrates a similar loss in pricing accuracy in the context of testing exact equilibrium pricing theories by using a multivariate proxy that is assumed to be correlated with a given equilibrium pricing benchmark. The approximate pricing result obtained by Reisman (1992) and Shanken (1992), also applies to the approximate factor structure based equilibrium APT models of Connor (1984) and Connor and Korajczyk (1989). An approximate factor structure assumes that the residual terms are weakly correlated such that the largest eigenvalue of the residual covariance matrix is bounded in an economy with a countable infinite number of assets.

The principal idea of the APT is that when markets are arbitrage free, the expected asset returns can be approximated by a linear combination of risk premia on systematic factors in the asset economy. However, most tests of APT ignore the pricing error between expected returns and risk premia. This pricing error, while small, is central to Ross APT and to the later extensions by Chamberlain and Rothschild (1983) and Khan and Sun (2001), (2003a), and (2003b). The pricing error represents diversifiable risk and, in the absence of arbitrage, the pricing error is strongly bounded as the number of assets increases.

Ross (1976) assumed that the returns are generated by a set of unknown and uncorrelated systematic factors, and that the cross-asset residuals are uncorrelated. Chamberlain and Rothschild (1983) relaxed the assumption of uncorrelated residuals so that the factor structure is approximate. In approximate factor structures, the covariance matrix of returns is assumed to have an infinite number of unbounded eigenvalues as the number of assets increases. Khan and Sun (2003a) and (2003b), assume that infinite, costless, riskless portfolios earn a zero rate of return. The absence of arbitrage assumption, whether asymptotic or infinite, is important because it is a weaker requirement than the market equilibrium imposed in mean-variance theory. Hence, as noted by Ross (1977), APT has greater generality than the capital asset pricing model.

Khan and Sun (2001) concluded that the pricing result holds under the general assumption that the eigenvalues of the covariance matrix of returns are bounded for infinite sets of assets and depends on the law of large numbers (LLN). The law of large numbers is important because it underwrites the generation of well-diversified portfolios. In a countable infinite setting, a well-diversified portfolio becomes the limit of the sequence of infinite portfolios (Khan and Sun (2003b) and, as recognized by Huberman and Wang (2005), it is the LLN that underscores this convergence. What is important is the limiting behaviour of the pricing errors as the number of assets increases. The principal result of APT, that the sum of squared pricing errors is infinite, is a strong condition.

A.1.2. Tests of the APT using Factor Analysis

Roll and Ross (RR) (1980) conduct a three-part examination of the ability of the APT to model expected returns through factor analysis. They first test the APT's ability to model returns. They then examine the correlations between residuals and, finally, they consider the difference between factor structures across groups of securities.

In testing the APT model, there has been more emphasis on testing the number of statistical factors in the returns equation rather than in testing the number of priced factors in the expected returns equation. Several tests have been proposed to determine the number of statistical factors.

The simplest are tests of the eigenvalue condition that an infinite number of eigenvalues are unbounded as the number of assets increases. Using eigenvalues calculated from the sample covariance matrix of returns, Trzcinka (1986) proposes three eigenvalue tests using a sample of 20 years of weekly returns of US equities. Direct tests of the factor structure have also been suggested; for example, Connor and Korajczyk (1993) propose a Wald-type test to test whether returns are generated by a K or (K + 1) factor model.

Tests of the statistical factors test only one of the sufficient conditions of arbitrage pricing, ignoring the pricing of the factors and the pricing errors. There are a number of tests to determine whether the factors are priced. One type of procedure assumes exact arbitrage pricing and tests the nonlinear restrictions implied by APT. A two step procedure is used, with factors extracted at the first step and restrictions tested at the second (Gibbons, Ross and Shanken (1989). An alternative, as proposed by Velu and Zhou (1999), is to embed the restrictions in a multi-beta framework.

The strict factor model is estimated using factor analysis. The extracted factors are unique only up to a rotation, that is, the factor loadings cannot be identified from the observed returns without further restrictions being imposed (Geweke and Zhou (1996). The model is estimated by principal components which generate unique estimates of the factor loadings (Brown 1989).

Two critical hypotheses are implied by the APT one that the intercept term equals the risk-free rate and a second that there is a linear relationship between the risk measures and expected returns. Gultekin (1987) posit that these two hypotheses are sensitive not only to the issues mentioned above, but also to such anomalies as the January effect and firm size. Rejection of the APT, based on its statistical sensitivity to such factors as firm size, is discussed also by Reinganum (1981) and Robin and Shukla (1991). The ability of a measure of unsystematic risk (such as firm size) to explain risk-adjusted returns violates the theory of the APT. Although Lehman and Modest (1988) suggest that the APT is pricing most listed securities with little error, they nonetheless acknowledge this deficiency. They likewise recognize the inherent problems encountered in measuring common factors implicitly through factor analysis. Brown (1989) concludes that a purely statistical technique may lead to false conclusions.

Chen (1983) notes that the development of the theory of arbitrage pricing is quite separate from the factor analysis. Factor analysis is used only as a tool to uncover the pervasive forces in the economy by examining how asset returns covary together. He admits that factor analysis can produce many different factor structures from the manipulated portfolios. Although he supports the APT in testing it against the explanatory power of firm size, he concludes that the APT is designed more in the spirit of macroeconomic variable modelling. Chen, Roll and Ross (1986a), limit the use of factor analysis by using prespecified macroeconomic variables to describe returns.

Brown & Weinstein (1983) by using factor analysis, confirm that the number of pervasive factors is probably no greater than five. Although the factor analytic technique, the use does not lend itself to economic interpretation, it still follows that a similar number of macroeconomic variables are at play; a similar number of economic factors explain the deviations of returns from expectations.

Berry, Burmeister and McElroy (1986), (BBM), show that an APT model that incorporates five selected macroeconomic variables is superior to CAPM. It does not depend on any particular market index. They estimate the sensitivities (factor loadings) of securities to known APT factors. BBM use an APT model that incorporates unanticipated changes in the five macroeconomic variables of Burmeister and Wall (1986) and Chen, Roll and Ross (1986) default risk, the term structure of interest rates, inflation or deflation, residual market risk and the long-run expected growth rate of profits for the economy. A consensus in the literature begins to develop with the publication of the work of BBM.

Jones (2001) modified the asymptotic principal components (APC) method of Connor and Korajczyk (1986, 1988) by extracting the principal components from all exchange stock returns. The modified APC method makes use of all stock return information and filters the common information from the noisy individual returns. Li and Chan (2001) developed the semi-parametric reduce-rank regression technique (SPARR model) that estimates the factors from the underlying forces driving the principal components extracted by the APC method. These PCs could be thought as "portfolios" that have got rid of the individual stock noise and capture common risk information.

Annex 2. Tables

Table 1: Glossary and Definitions of the article: Basic Series (monthly)

Symbol	Variable	Proxy or Source
IP	Industrial Production	Index of total manufacturing
INF	Inflation	Consumer price index
LGB	Long term government bond	10 year government bond
SRB	Short term Treasury bill	3 month Treasury bill
TERSTR	Term structure	The difference between LGB and SRB
MINBR	Minimum bank lending	National Statistic Service of Greece.
AVEBR	Average bank lending rate	National Statistic Service of Greece.
RISKPR	Risk premia	The difference between MINBR and AVEBR
SX	Exchange rate	The exchange rate of USD dollar versus Greek drachma and Euro
OILG	Oil price	UK Brent oil
RSV	Retail sales volume	Bulletin of conjectural indicators - Bank of Greece
MG	Money supply	Bulletin of conjectural indicators - Bank of Greece
IMP	Imports	Bulletin of conjectural indicators - Bank of Greece
EXP	Exports	Bulletin of conjectural indicators - Bank of Greece
Symbol	Derived Series	Equation used
ΔIP	Monthly growth of industrial production	$\Delta IP = \ln IP_t - \ln IP_{t-1}$
ΔINF	Monthly change in the consumer price index	$\Delta INF = \Delta \ln(CPI_t) = \ln(CPI_t) - \ln(CPI_{t-1})$
ΔTERSTR	Monthly change in the term structure	$\Delta TERSTR = \ln(LGB_t - SRB_t) - \ln(LGB_{t-1} - SRB_{t-1})$
ΔRISKPR	Monthly change in the risk premia	$\Delta RISKPR = \ln(AVERLR_t - MINLR_t) - \ln(AVERLR_{t-1} - MINLR_{t-1})$
ΔEXRUSD	Monthly change in the exchange rate	$\Delta EXRUSD = \ln(SX_t) - \ln(SX_{t-1})$

ΔOILPR	Monthly change in oil prices	$\Delta OILPR = \ln(OILG_t) - \ln(OILG_{t-1})$
ΔCONS	Monthly change in consumption	$\Delta CONS = \ln(RSV_t) - \ln(RSV_{t-1})$
ΔMG	Monthly change in money supply	$\Delta MG = \ln(MG_t) - \ln(MG_{t-1})$
ΔIMP	Monthly change in imports	$\Delta IMP = \ln(IMP_t) - \ln(IMP_{t-1})$
ΔEXP	Monthly change in exports	$\Delta EXP = \ln(EXP_t) - \ln(EXP_{t-1})$

Table 2: Summary statistics of the macroeconomic factors

Variable	**N**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
		Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
OILPR	96	41.3000	175.8000	88.0217	27.5149	0.4907	0.2462	0.2401	0.4877
INDPR	96	4.0000	130.6500	112.4078	15.7850	-3.4908	0.2462	22.3575	0.4877
INF	96	97.3800	132.5000	113.1718	10.0406	0.3553	0.2462	-0.9475	0.4877
EXRA	96	0.8500	1.3000	1.0583	0.1232	-0.0355	0.2462	-0.9852	0.4877
TERSTR	96	0.1500	3.9000	1.4985	0.7603	0.2428	0.2462	-0.1927	0.4877
RISKPR	96	0.0000	0.4000	0.1269	0.1155	1.0998	0.2462	0.2040	0.4877
MG	96	3,172.60	5,632.20	4,365.94	659.6590	0.1043	0.2462	-0.9825	0.4877
CONS	96	83.90	191.44	115.35	17.4789	1.2805	0.2462	3.1824	0.4877
EXP	96	767.70	1,658.48	1,223.17	300.3364	0.0870	0.2462	-1.7367	0.4877
IMP	96	1,322.68	3,626.00	2,548.91	504.8473	-0.5198	0.2462	-0.4948	0.4877

Table 3: Correlation matrix of the macroeconomic factors

		oilpr	indpr	inf	exra	terstr	riskpr	mg	cons	exp	imp
oilpr	Pearson	1.000	0.411	-0.304	0.107	0.162	-0.454	0.783	0.269	-0.525	0.771
	Sig. (2-tailed)	.	0.000	0.002	0.295	0.114	0.000	0.000	0.008	0.000	0.000
indpr	Pearson	0.411	1.000	-0.022	-0.016	0.143	-0.320	0.487	0.074	-0.413	0.456
	Sig. (2-tailed)	0.000	.	0.828	0.870	0.162	0.001	0.000	0.469	0.000	0.000
inf	Pearson	-0.304	-0.022	1.000	0.548	0.316	0.599	-0.200	-0.486	0.175	-0.538
	Sig. (2-tailed)	0.002	0.8282	.	0.000	0.001	0.000	0.050	0.000	0.087	0.000
exra	Pearson	0.107	-0.016	0.548	1.000	0.284	0.369	0.195	-0.140	0.241	-0.066
	Sig. (2-tailed)	0.295	0.870	0.000	.	0.004	0.000	0.056	0.173	0.018	0.519
terstr	Pearson	0.162	0.143	0.316	0.284	1.000	-0.002	0.323	-0.281	-0.327	0.092
	Sig. (2-	0.114	0.162	0.001	0.004	.	0.982	0.001	0.005	0.001	0.370

	tailed)										
riskpr	Pearson	-0.454	-0.320	0.599	0.369	-0.002	1.000	-0.566	-0.080	0.631	-0.653
	Sig. (2-tailed)	0.000	0.001	0.000	0.000	0.982	.	0.000	0.434	0.000	0.000
mg	Pearson	0.783	0.487	-0.200	0.195	0.323	-0.566	1.000	0.124	-0.772	0.840
	Sig. (2-tailed)	0.000	0.000	0.050	0.056	0.001	0.000	.	0.227	0.000	0.000
cons	Pearson	0.269	0.074	-0.486	-0.140	-0.281	-0.080	0.124	1.000	0.111	0.377
	Sig. (2-tailed)	0.008	0.469	0.000	0.173	0.005	0.434	0.227	.	0.278	0.000
exp	Pearson	-0.525	-0.413	0.175	0.241	-0.327	0.631	-0.772	0.111	1.000	-0.633
	Sig. (2-tailed)	0.000	0.000	0.087	0.018	0.001	0.000	0.000	0.278	.	0.000
imp	Pearson	0.771	0.456	-0.538	-0.066	0.092	-0.653	0.840	0.377	-0.633	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.519	0.370	0.000	0.000	0.000	0.000	.

Pearson correlation**Correlation is significant at the 0.01 level (2-tailed)*Correlation is significant at the 0.05 level (2-tailed)

Table 4: Correlogram of the derived variables

Lag	CONS		EXP		EXR		IMP		IP		INF		MG	
	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	-0.3	-0.33	-0.3	-0.31	-0.1	-0.11	-0.5	-0.51	-0.5	-0.5	0.02	0.02	-0.47	-0.47
2	-0.1	-0.17	-0.2	-0.31	0.07	0.06	-0	-0.38	-0	-0.34	-0.1	-0.1	0.01	-0.28
3	0	-0.09	0.29	0.15	-0.1	-0.07	0.26	0.08	-0	-0.27	-0.05	-0.04	0.06	-0.1
4	-0.2	-0.22	-0.2	-0.09	-0	-0.03	-0.2	-0.04	0	-0.24	-0.09	-0.1	-0.1	-0.16
5	0.04	-0.13	-0	-0.01	-0	-0.03	0.04	-0.1	0.03	-0.17	0.02	0.01	-0.11	-0.34
6	0.12	0.05	0.19	0.11	0.1	0.1	0.23	0.19	-0	-0.15	0.2	0.18	0.28	0.02
7	0.06	0.13	-0.2	-0.02	0.1	0.12	-0.3	0.05	0	-0.13	0.01	0	-0.22	-0.14
8	-0.1	0.01	-0	-0.03	0.06	0.07	0.02	-0.12	0.02	-0.07	-0.1	-0.08	0.09	-0.08
9	-0	0	0.29	0.23	-0	-0.01	0.21	0.07	-0	-0.04	-0.07	-0.05	-0.06	-0.19
10	-0.1	-0.01	-0.3	-0.11	0.04	0.05	-0.2	0.07	-0	-0.05	-0.11	-0.1	-0.02	-0.19
11	-0.3	-0.41	-0.1	-0.24	0.18	0.22	-0.1	-0.18	-0.1	-0.18	0.01	-0.01	0	-0.2
12	0.68	0.53	0.39	0.16	-0.1	-0.1	0.23	0	0.12	-0.06	0.15	0.09	0.11	-0.14
13	-0.3	-0.02	-0.2	-0.02	0.17	0.12	-0.3	-0.07	-0	-0.04	0	-0.02	0.03	0.06
14	-0	-0.01	0.12	0.21	-0.1	-0.03	0.25	0.2	-0	-0.06	-0.11	-0.08	-0.06	-0.04
15	-0	-0.12	0.11	0.03	0.07	0.04	-0.1	-0.04	0	-0.08	-0.05	-0.02	-0.01	-0.04
16	-0.1	0.07	-0.2	-0.01	-0	0.02	-0.1	-0.04	0	-0.08	-0.09	-0.06	-0.04	-0.1
17	-0	-0.08	0.17	0.11	0.05	-0.01	0.1	-0.02	0.02	-0.06	0.03	0	0	-0.07
18	0.08	-0.06	0.11	0.09	0.09	0.09	0.01	0.02	-0	-0.08	0.18	0.11	0.01	-0.12
19	0.08	-0.01	-0.2	0.09	-0	-0.04	-0.1	-0.06	0.02	-0.05	-0.01	-0.02	0.05	-0.09
20	-0.1	-0.09	0.01	-0.08	-0.1	-0.09	0.09	-0.04	0.01	-0.01	-0.1	-0.06	-0.01	-0.01
21	0	-0.04	0.17	-0.03	-0	-0.07	-0	0	-0	0.01	-0.07	-0.05	0.01	0.02
22	-0	-0.04	-0.3	-0.16	-0	-0.06	-0	0.03	-0	0.02	-0.12	-0.1	-0.03	0.05
23	-0.3	-0.07	0.14	0.09	0.05	0.05	0.01	-0.12	-0.1	-0.11	0.04	0.01	-0.03	-0.03
24	0.58	0.16	0.07	-0.01	0	-0.1	0.01	-0.04	0.13	-0.01	0.14	0.03	0.03	0
25	-0.3	-0.06	-0.3	-0.06	-0	-0.04	-0.1	-0.08	-0.1	-0.03	0.01	0	0.02	-0.01
26	-0	-0.1	0.19	-0.1	0	-0.05	0.18	0.02	-0	-0.04	-0.09	-0.04	-0.03	-0.02
27	0.03	0.02	-0	-0.04	0.03	0.08	-0.1	-0.06	-0	-0.08	-0.04	-0.01	-0.01	-0.05

28	-0.1	-0.02	-0.1	0.14	0.12	0.14	0.06	0.03	0.01	-0.09	-0.04	0.01	0	-0.03
29	-0	-0.02	0.12	0.03	0.1	0.11	-0.1	-0.09	0.03	-0.05	0.02	-0.02	-0.02	-0.02
30	0.09	0.01	0	0	-0.2	-0.2	0.07	0.04	-0	-0.04	0.12	0.02	0.02	-0.03
31	0.03	-0.09	-0.1	-0.11	-0.1	-0.08	0.02	0.12	0.01	-0.02	0.01	-0.01	0.01	-0.03
32	-0.1	-0.1	0.08	-0.05	-0.1	0.01	-0.1	-0.08	-0	-0.04	-0.08	-0.04	0.01	-0.04
33	0.05	0.03	-0	-0.07	-0	-0.03	0.03	-0.11	0.01	-0.03	-0.02	0.01	0	-0.01
34	-0	-0.04	-0.1	0.02	0.12	0.07	0.03	-0.01	-0	-0.03	-0.03	0	0	0
35	-0.3	0.01	0.14	-0.11	0.05	0.03	-0.1	-0.13	-0	-0.09	-0.01	-0.05	-0.05	-0.05
36	0.46	-0.07	0.06	0.09	-0.1	-0.1	0.1	-0.14	0.08	-0.03	0.08	-0.02	-0.02	-0.13

Lag	**OILPR**		**RISKPR**		**TERSTR**	
	AC	**PAC**	**AC**	**PAC**	**AC**	**PAC**
1	0.04	0.04	-0.43	-0.43	-0.38	-0.38
2	-0.09	-0.09	0.03	-0.19	-0.08	-0.26
3	0	0	-0.1	-0.22	0.02	-0.15
4	0.06	0.05	0.13	-0.02	-0.15	-0.29
5	-0.02	-0.03	-0.05	-0.02	0.19	-0.03
6	0.03	0.04	-0.1	-0.15	-0.17	-0.21
7	-0.01	-0.02	0.15	0.06	0.13	-0.02
8	0.02	0.02	-0.14	-0.1	0.01	-0.02
9	-0.13	-0.14	0.07	-0.05	0	0.07
10	0.11	0.12	-0.07	-0.06	-0.1	-0.13
11	0.03	-0.01	-0.05	-0.2	0.09	0.09
12	-0.05	-0.03	0.17	0.09	-0.05	-0.06
13	-0.2	-0.19	-0.13	-0.03	-0.05	-0.06
14	0	-0.01	0.14	0.09	0.19	0.12
15	-0.17	-0.21	-0.24	-0.12	-0.15	0.03
16	-0.02	-0.01	0.27	0.08	0.02	-0.04
17	-0.1	-0.13	-0.2	-0.07	-0.03	-0.01
18	0	-0.01	0.13	0.05	-0.07	-0.12
19	0	0.03	-0.14	-0.12	0.29	0.23
20	0.01	-0.01	0.17	0.11	-0.19	0.06
21	-0.11	-0.1	-0.09	-0.04	0.02	0.09
22	0.11	0.09	-0.01	0.04	-0.05	-0.07
23	-0.15	-0.16	0.11	0.13	-0.01	0.05
24	0	0	-0.16	-0.1	-0.04	-0.19
25	0.07	0.06	0.01	-0.13	0.01	-0.04
26	-0.07	-0.17	0.08	0.05	0.14	0.02
27	-0.09	-0.05	0.09	0.17	-0.12	-0.05
28	0.09	0	-0.12	-0.01	0.11	0.02
29	0	-0.05	-0.21	-0.27	-0.17	-0.05
30	0.03	-0.08	0.3	0	0.14	0.03
31	-0.08	-0.04	-0.23	-0.09	-0.04	0.03
32	0	-0.13	0.1	-0.18	0	0.12
33	0.03	0.05	0.02	0.16	0.08	0
34	-0.01	-0.08	0.08	0	-0.11	0.03
35	0	-0.01	-0.07	0.06	0.01	-0.08
36	0.08	-0.03	-0.01	0.04	-0.06	-0.09

Table 5: Testing the series for non-stationarity – Augmented Dickey-Fuller test (ADF)

	OILPR	**IP**	**INF**	**EXR**	**TERSTR**	**RISKPR**	**MG**	**CONS**	**EXP**	**IMP**
ADF test	-15.3914	-16.5533	-9.4609	-11.2968	-19.3698	-21.2339	-16.157	-13.8549	-13.4129	-17.0987
Test critical values										
1% level	-4.0586	-4.0575	-4.0575	-4.0575	-4.0586	-4.0586	-4.0575	-4.0575	-4.0575	-4.0575
5% level	-3.4583	-3.4578	-3.4578	-3.4578	-3.4583	-3.4583	-3.4578	-3.4578	-3.4578	-3.4578
10% level	-3.1552	-3.1549	-3.1549	-3.1549	-3.1552	-3.1552	-3.1549	-3.1549	-3.1549	-3.1549
*MacKinnon (1996) one-sided p-values.										
Augmented Dickey-Fuller Test Equation										
Coefficient	-1.4402	-1.4973	-0.9863	-1.1552	-1.6091	-1.6607	-1.4737	-1.336	-1.3243	-1.5146
Std. Error	0.0936	0.0905	0.1042	0.1023	0.0831	0.0782	0.0912	0.0964	0.0987	0.0886
R-squared	0.7225	0.7486	0.4931	0.5812	0.8048	0.8321	0.7394	0.676	0.6617	0.7607
Durbin-Watson stat	2.2622	2.3391	1.9971	2.0112	2.5764	2.5234	2.2841	2.155	2.2091	2.3997
Akaike info criterion	-1.5743	1.2258	-3.9208	-4.0141	2.4659	2.7533	-3.963	-1.2127	-2.1625	-2.2244
Schwarz criterion	-1.4932	1.3065	-3.8401	-3.9334	2.547	2.8345	-3.8824	-1.1321	-2.0818	-2.1437

Table 6: Standard requirements for Principal Component Analysis

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.541
Bartlett's Test of Sphericity	Approx. Chi-Square	111.804
df	45	
Sig.	0	

Table 7: The extracted components and their total variance explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.9180	19.1790	19.1790
2	1.7140	17.1390	36.3180
3	1.2070	12.0740	48.3920
4	1.1310	11.3070	59.6990
5	1.0420	10.4220	70.1200
6	0.8780	8.7780	78.8990
7	0.6440	6.4400	85.3390

8	0.6160	6.1560	91.4950
9	0.4630	4.6290	96.1240
10	0.3880	3.8760	100.0000

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.9180	19.1790	19.1790	1.6550	16.5540	16.5540
2	1.7140	17.1390	36.3180	1.5410	15.4060	31.9600
3	1.2070	12.0740	48.3920	1.3890	13.8890	45.8490
4	1.1310	11.3070	59.6990	1.2550	12.5530	58.4020
5	1.0420	10.4220	70.1200	1.1720	11.7190	70.1200

Table 9: Communalities

	Initial	**Extraction**
OILG	1.0000	0.6440
IP	1.0000	0.6910
INF	1.0000	0.7290
EXR	1.0000	0.6060
TERSTR	1.0000	0.7110
RISKPR	1.0000	0.6070
MG	1.0000	0.7800
CONS	1.0000	0.7350
EXP	1.0000	0.7460
IMP	1.0000	0.7630

Extraction Method: Principal component analysis

Table 11: Regression output of ATHEX Composite Share Price Index against the factors outliers

Factors Outliers	**1997-2004**	**1997-2000**	**2001-2004**
C	0.0113	0.0152	-0.0081
Std. Error	0.0129	0.0203	0.0107
t-Statistic	0.8769	0.7481	-0.7534
TR	-0.0053	0.0850	-0.0092
Std. Error	0.0130	0.0415	0.0086
t-Statistic	-0.4077	2.0470	-1.0647
PR	0.0258	0.0235	0.0091
Std. Error	0.0130	0.0153	0.0216
t-Statistic	1.9885	1.5340	0.4207
FIN	0.0073	0.0233	0.0170

Std. Error	0.0130	0.0157	0.0212
t-Statistic	0.5633	1.4859	0.8026
INT	0.0209	0.0640	-0.0111
Std. Error	0.0130	0.0222	0.0105
t-Statistic	1.6144	2.8782	-1.0565
CTRY	-0.0828	-0.1065	0.0294
Std. Error	0.0130	0.0155	0.0297
t-Statistic	-6.3944	-6.8574	0.9908
R-squared	0.3475	0.5810	0.1028
Durbin-Watson stat	2.2012	1.6475	1.8894
Mean dependent var	0.0113	0.0268	-0.0042
S.D. dependent var	0.1521	0.2027	0.0722
Akaike info criterion	-1.2406	-0.9954	-2.2985
Schwarz criterion	-1.0804	-0.7615	-2.0646
F-statistic	9.5864	11.6460	0.9628
Prob(F-statistic)	0.0000	0.0000	0.4515

Table 12: Regression output of ATHEX Composite Share Price Index against the initial macroeconomic variables

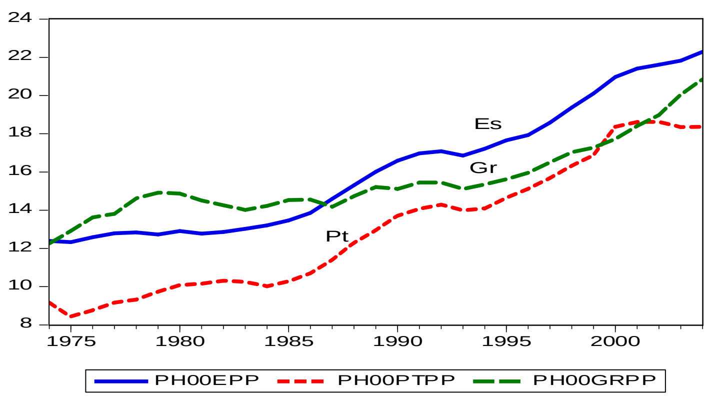
	1997-2004	**1997-2000**	**2001-2004**
C	0.0092	0.0167	-0.0028
Std. Error	0.0102	0.0176	0.0113
t-Statistic	0.8981	0.9464	-0.2522
CONS	0.0366	0.0264	0.0466
Std. Error	0.0881	0.1650	0.1244
t-Statistic	0.4159	0.1598	0.3748
EXP	-0.1114	-0.0943	0.1034
Std. Error	0.1390	0.3801	0.1440
t-Statistic	-0.8013	-0.2482	0.7177
EXRA	-0.2623	-0.8417	0.1940
Std. Error	0.3147	0.7161	0.3047
t-Statistic	-0.8338	-1.1753	0.6368
IMP	-0.1135	0.0514	-0.1297
Std. Error	0.1168	0.2089	0.1495
t-Statistic	-0.9712	0.2459	-0.8674
INDPR	0.2418	0.2479	-0.2449
Std. Error	0.0210	0.0250	0.1022
t-Statistic	11.5200	9.9217	-2.3953
INF	-0.8142	-0.6234	-1.0371
Std. Error	0.3355	0.4648	0.9905
t-Statistic	-2.4266	-1.3414	-1.0471
MG	0.3316	0.2489	0.1590
Std. Error	0.3116	0.3936	0.8925

t-Statistic	1.0643	0.6323	0.1781
OILPR	-0.0722	-0.0452	-0.1622
Std. Error	0.1201	0.1945	0.1209
t-Statistic	-0.6010	-0.2327	-1.3423
RISKPR	-0.0028	0.0063	0.0051
Std. Error	0.0155	0.0377	0.0145
t-Statistic	-0.1816	0.1660	0.3522
TERSTR	0.0474	0.0412	0.0634
Std. Error	0.0180	0.0233	0.0452
t-Statistic	2.6267	1.7647	1.4024
R-squared	0.6300	0.7604	0.3259
Durbin-Watson stat	1.9653	1.6334	1.6253
Mean dependent var	0.0115	0.0273	-0.0044
S.D. dependent var	0.1518	0.2020	0.0727
Akaike info criterion	-1.7078	-1.3528	-2.3621
Schwarz criterion	-1.4139	-0.9240	-1.9333
F-statistic	14.4731	11.7423	1.7887
Prob(F-statistic)	0.0000	0.0000	0.0974

Annex 3: A note on investment and development in Greece, 1997-2004.

Graph 1 shows the evolution of real GDP per inhabitant, in thousand dollars at 2000 prices and Purchasing Power Parities, of Greece in comparison with Spain and Portugal. We may notice that the period 1985-2005 has been positive for Greece, after slow evolution in the period 1974-1985.

Graph A1. Evolution of real Gross Domestic Product per capita
(thousand dollars at 2000 prices and Purchasing Power Parities)



Source: Elaborated from OECD National Account Statistics by Guisan (2008)