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RESEARCH ARTICLE

Empirical Testing of the APT Model with Pre-Specifying the Factors in the Case of Romanian Stock Market

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Abstract

Since the discovery and the development of the financial equilibrium asset pricing models, they were constantly and repeatedly tested mainly for the big markets and scarcely for the smaller or the emerging ones. Romania belongs to the last category, hence empirical testing of these models for its case was almost inexistent. So, this paper examines the validity and the applicability of the Arbitrage Pricing Theory model for the Romanian stock exchange, conditioned of course by the available data. The data used is represented by monthly returns of 60 companies, listed on the Bucharest Stock Exchange, using a 6-year period, from 01.01.2005 to 31.12.2010. The pre-specifying of possible economic factors method was implied, using a total of 16 economical variables, among which some were used also in the more famous studies, and the rest were added. The obtained results show as significant for influencing assets' return a number of 4-6 variables with respect to the testing approach, but of course the conclusions can be subdued to potential errors, they are not exhaustive and can surely be improved.

Keywords: *APT, Bucharest stock exchange, Factor loadings, Multiple regressions, Pre-specifying factors.*

Introduction

JEL Classification: C31, G12

The present paper is organized as follows: sections 1 and 2 introduce the APT model and resume its development; section 3 summarizes the concerns in the field and some of the empirical studies conducted through time; section 4 contains the actual testing of the model on the Romanian market, including the descriptions of used database, methodology and obtained results, along with their interpretations; section 5 resumes the conclusions and outlines some obvious limitations; section 6 presents the references used during the analysis; section 7 presents the annexes.

Arbitrage Pricing Theory

Formulated by S. Ross [1] in 1976, offers a testable alternative to CAPM, trying to improve some of the latter's disadvantages. Whereas CAPM states that the security rates of return will be linearly related to a single common factor, which is the rate of return of the market portfolio, APT is more general, predicting that the rate of return on a stock is a linear function of different multiple factors. Hence:

$$R_i = E(R_i) + b_{i1}\times F_1 + b_{i2}\times F_2 + \ldots\ldots\ldots + b_{ik}\times F_k + \varepsilon_I \quad (1)$$

where: R_i = the random rate of return on the "i"th asset; $E(R_i)$ = the expected rate of return on the "i"th asset; b_{ik} = the sensitivity of the "i"th asset's return to the F_k factor; F_k = the "k"th factor common to the returns of all considered assets, having mean zero, representing the systematic risk of the "i"th asset; ε_i = a random zero mean noise term for the "i"th asset. In matrix form: $R_i = E(R_i) + B\times F + \varepsilon_i$, Where: B = the matrix of sensitivities b_{i1}, b_{i2},…., b_{ik}; F = the matrix of all factors considered, presumable to influence assets' returns. As it can be seen, CAPM can be regarded as a special case of the APT, with the market rate of return being the single relevant factor. APT is developed with classical hypothesis: a frictionless and perfect competitive market, where the agents have homogeneous expectations that the random returns of more assets will follow the multi-factorial model given by equation (1). Additionally, the number *n* of considered assets must be greater than the factor number, *k*.

Theoretical and Mathematical Development

In this section, aspects from Copeland and Weston [2] or Mishkin [3] will be used. The development of APT begins with equation (1) and has its base on the following idea: in equilibrium, all portfolios than can be selected from the set of assets under consideration and that satisfy the conditions.

- without additional wealth invested
- without any risk involved

must not earn a return on average. These portfolios are called *arbitrage* portfolios, and they will be made so: let w_i be the change of sum invested in the "i"th asset, as a percentage of an individual's total invested wealth, aiming to modify the proportions of the stocks in his/her portfolio. In order to obtain an arbitrage portfolio that requires no change in wealth (deposit or withdrawal), the logical action will be selling some assets and then buying others using the gained sum. Mathematically, the zero change in wealth is written as:

$$\sum_{i=1}^{n} wi = 0 \qquad (2)$$

If there are n assets in the arbitrage portfolio, then the additional return gained by modifying the proportions of the included assets is:

$$R_p = \sum_{i=1}^{n} wi \times Ri = \sum_{i=1}^{n} wi[E(Ri) + bi1 \times F1 + bi2 \times F2 + \cdots\cdots + bik \times Fk + \varepsilon i]$$

so:

$$R_p = \sum_{i=1}^{n} wi \times E(Ri) + \sum_{i=1}^{n} wi \times F1 \times bi1 + \ldots + \sum_{i=1}^{n} wi \times Fk \times bik + \sum_{i=1}^{n} wi \times \varepsilon i \quad (3)$$

For obtaining a riskless arbitrage portfolio, it is necessary to eliminate both types of risk, systematic (non-diversifiable) and unsystematic (diversifiable, idiosyncratic). This can be done by meeting the following conditions: (4)

- The arbitrage portfolio being well-diversified; in other words "n" must be a large number
- The percentage changes in each asset' s investment must be small and approximating 1/n:$w_i \approx 1/n$
- Choosing changes w_i in such a manner that for each factor "k" no systematic risk exists; in other words the weighted sum of the systematic risk components b_k to be zero:

$$\sum_{i=1}^{n} wi \times bik = 0$$

Because the error terms ε_i are independent and "n" is a big numbers, the law of large numbers ensures that $\sum_{i=1}^{n} wi \times \varepsilon i$ approaches zero, hence the last term of equation (3) will disappear, which is equivalent to the disappearance of the idiosyncratic risk. Now the equation takes this form:

$$R_p = \sum_{i=1}^{n} wi \times E(Ri) + \sum_{i=1}^{n} wi \times F1 \times bi1 + \ldots + \sum_{i=1}^{n} wi \times Fk \times bik \qquad (4)$$

Since the systematic risk doesn't exist as well (by 4.iii), all the terms besides the first one disappear from equation (4), and such a arbitrage portfolio without both types of risks becomes possible, having a return equal to:

$$R_p = \sum_{i=1}^{n} wi \times E(Ri) \qquad (5)$$

But no portfolio is an equilibrium portfolio if its return can be improved without taking an additional risk and without an additional sum invested; and since the analyzed portfolio didn't imply any of them, it is necessary that:

$$R_p = \sum_{i=1}^{n} wi \times E(Ri) = 0 \qquad (6)$$

Equations (2), (4.iii) and (6) are confirmed also by linear algebra elements: any vector w_i (i=1….n) that is orthogonal to the constant vector "e", that is:

$(\sum_{i=1}^{n} wi) \times e = 0$,and also orthogonal to each of the coefficient b_k (k=1….n), that is:$\sum_{i=1}^{n} wi \times b_{ik} = 0$, (for each k)must be orthogonal to the vector of expected returns, so:$\sum_{i=1}^{n} wi \times E(R_i) = 0$

The algebraic consequence of this is that the expected return vector must be a linear combination of the constant vector and the coefficient vectors. Mathematically, it is necessary that a set of coefficients λ_0, λ_1….λ_k (in a number of "k+1") exists, such that:

$$E(R_i) = \lambda_0 + \lambda_1 \times b_{i1} + \lambda_2 \times b_{i2} + \ldots\ldots + \lambda_k \times b_{ik} \qquad (7)$$

,where b_{ik} is the sensitivity of the "i"th asset's return to the F_k factor.If a riskless asset is available on the market, it will offer a riskless return R_f and so:$b_{0k} = 0$ and $R_f = \lambda_0$,So equation (7) can be rewritten in "excess returns form" as:

$$E(R_i) - R_f = \lambda_1 \times b_{i1} + \lambda_2 \times b_{i2} + \ldots\ldots + \lambda_k \times b_{ik} \qquad (8)$$

In equilibrium, all assets must fall on the *arbitrage pricing line*. $\lambda_1 \ldots \lambda_k$ represent "risk premiums"(prices of the risk) in equilibrium, being defined as the difference between the expected returns of a portfolio with maximum sensitivity to factor 1,2…k and zero sensitivity to the other factors, and the riskless rate of interest:

$$\lambda_1 = E(F_1) - R_f$$

$\lambda_2 = E(F_2) - R_f$

……

$\lambda_k = E(F_k) - R_f$

Hence, the APT form can also have the following expression:

$E(R_i) - Rf = [E(F_1)-R_f] \times b_{i1} + [E(F_2)-R_f] \times b_{i2} + \ldots\ldots + [E(F_k)-R_f] \times b_{ik}$ (9)

or:

$E(R_i) = Rf + [E(F_1)-R_f] \times b_{i1} + [E(F_2)-R_f] \times b_{i2} + \ldots\ldots + [E(F_k)-R_f] \times b_{ik}$, and b_{ik} are defined in a similar way as ß from CAPM, like: $b_{ik} = cov(R_i,F_k)/var(F_k)$, where:

$cov(R_i,F_k)$ = the covariance between the "i"th asset's returns and the linear transformation of the "k"th factor; $var(F_k)$ = the variance of the linear transformation of the "k"th factor.

Concerns and Empirical Tests along Time

One of the most used methods to test APT and mentioned pretty much in literature is pre-specifying some economical variables as possible factors, followed by the actual testing of those in order to see if they really influence assets' returns. This method was introduced and firstly used by Chen, Roll, Ross [4]. They used 7 macro-economic and financial variables and found as being relevant the following: unanticipated inflation, term structure of interest rates, an index of industrial productions and default premium. Some of the later studies used those variables as well, adding more that were believed to have influence, with respect to the market on which the analysis was made. Among other tests known by the author and realized along time are: Virtanen and Yli-Olli [5] found as relevant actual and unanticipated inflation, long term interest rates and economical real activity; Wahlroos and Berglund [6] or Asprem [7] concluded that expected inflation is an influencing variable; Viskari [8] found that the change in money supply, Loflund [9] doing the same with the exchange rates. Clare and Thomas [10], Beenstock and Chan[11], Groenewold and Fraser[12] found that inflation is relevant for stock markets in Great Britain, Australia and USA. Cagnetti[13] concluded that the national stock market index and import level are relevant for the Italian market. Iqbal and Haider [14] found as having influence the following: unanticipated inflation, dividend yield and the index of the national stock market. The only study conducted so far on the Romanian market (as far as the author knows) about testing APT was realized by F.Bîlbîie, A.Gherman and M.Tureatcă[15]. The used data included 2 different groups of assets: for the first one 9 stocks with 343 observations from the 16 June 1997-20 November 1998 interval were used, the observations being daily prices of the stocks with the highest capitalization on BVB; for the second one, 11 stocks listed on RASDAQ market were used, with 394 daily observations from the 27 March 1997-20 November 1998 interval, with highest liquidity being the chosen criteria. The missing observations were completed by an interpolation process. The results of this research indicated the existence of minimum 2 relevant factors for BVB stocks and minimum 3 factors relevant for RASDAQ stocks. But in the same time they left room for future studies.

Empirical Testing on the Romanian Market

The Database Used for Testing

The current study is based on monthly returns for stocks listed on the Bucharest Stock Exchange during the 01.01.2005 – 31.12.2010 interval, with respect to the available information. Logarithmical values are used to ensure the series' stationarity. The data was obtained from the web pages of BVB[1] and of "Kmarket"[2] investment firm. The missing observations were completed with interpolation. All the stock market's categories are taken into account (I,II şi III), and they include 76 assets having available data, and from those, some are eliminated. The time period. Hence the final sample consists of 60 assets, each of them with 72 observations of monthly return (12 months for 6 years). The table 1 shows the name, the listing category and the code of the stocks included in the sample: For a proxy of the riskless interest rate, the government bonds were used, with respect to the available data. This rate had an annual value of 8.8404% in the 01.01.2005 – 31.12.2010 period, equaling an average monthly value of 0,7367%. The data was obtained from the monthly reports of BNR, on its web site[3].In this study, 16 economic variables were chosen; among them 7 are the ones used in Chen, Roll and Ross' research: industrial production index, unanticipated inflation, a relevant index for the national stock market, oil price on the international market, growth of real consumption, default risk premium and the term structure of interest rates; the other added ones are: the exchange rates between national currency and 2 important foreign currencies, M1 money

[1] http://www.bvb.ro
[2] http://www.kmarket.ro
[3] www.bnr.ro

supply, GDP(gross domestic product) index, average interest on deposits in national currency, real rate of interest, consumer price index and the evolution of 2 relevant indexes of foreign stock markets. The summary of the variables is shown in the table 2.The internal data were obtained from monthly and annually reports of BNR and from the web site of National Institute of Statistics. The external ones were obtained from Datastream and Yahoo Finance. For series' stationary and for obtaining the unanticipated component of the variables; the first difference of the logarithmical value of them was used. Chen, Roll, Ross and many other later studies used also the unanticipated component of the analyzed variables. For variables calculated like a difference between otherseries (DP, TSIR, RIR), the transformation is not necessary since the difference itself ensures directly the unanticipated component. Below is the way how variables were calculated for testing.It can be observed that the variables can be considered uncorrelated, with a few normal exceptions, like the correlations between the stock market indexes (BET-C with FTSE and with S&P500) and marginally the consumption growth with inflation rate and with consumption price index.

Methodology, testing results and their interpretations

Microsoft Excel and SPSS software will be used. For a determination of the number of factors with influence and for getting their "factor loadings" in SPSS, "principal component analysis" method was implied, followed by a "orthogonal varimax" rotation.

Testing will be made through 2 different approaches:

(A) The first one is the one used by Fama and Mac Beth, taken later by Chen, Roll and Ross for their study. This approach implies the following sequence of steps:

Collecting data for each of the chosen variables related to the chosen interval of time;

- Calculation of the unanticipated component for the variable time series;
- Estimating sensitivity coefficients (b_{i1}….b_{ik}) of the stocks, with respect to the unanticipated components obtained in the previous step;
- Using the estimated sensitivity coefficients in order to explain the stocks' returns by implying a "cross-section" regression:

$$R_i = \lambda_0 + \lambda_1 \times b_{i1} + \lambda_2 \times b_{i2} + \ldots\ldots + \lambda_k \times b_{ik} + e_i$$

,where:R_i = average return of the "i"th asset on the studied interval b_{i1}….b_{ik} = sensitivity coefficients, previously estimatedλ_{1}….λ_k= risk premiums associated with the 16 macroeconomic variables The regression has the sensitivity coefficients as independent variables and the average return of the stocks as the dependent variable; the non-zero risk premiums will correspond to macroeconomic variables that indeed have influence on the assets' return. Since steps 1 and 2 are already resolved, step 3 offers the values for the sensitivity coefficients presented in annex 2. These coefficients will become independent variables in step 3, in the regression who establishes which risk premiums will be non-zero. After resuming it, the regression gives statistical relevant risk premiums for 3 economic variables clearly and one extra marginally: BET-C, RON/USD, MIR şi IPI.
Summarizing, we obtain:

Macroeconomic variables with influence
BET-C, RON/USD, MIR, IPI

(B) The second possible approach has the following sequence of steps:

- Collecting data for each of the chosen variables related to the chosen interval of time.
- Identifying the number of factors with influence for the variables, using "principal component analysis" in SPSS; "scree plot" and "total variance explained" table are giving the proper number of factors to be used.
- Calculating "factor loadings" using a "varimax" rotation, because the variables are not correlated; otherwise an "oblimin" rotation is recommended; immediately follows a distribution of variables on each factor: a factor is sensible to a certain variable if its "factor loading" has a high absolute value.
- The determination of "factor scores" requires a combination of the time series for each variable with the relevant "factor loading" for each factor.
  $Fs_i = \sum_{i=1}^{n} Vit \times Fl_i$
- Previously-calculated "factor scores" will represent independent variables in a linear regression having as the dependent variable the returns of the stocks; the results of the regression estimate the sensitivity coefficients related to the influence factors:

Table 1: Name, the listing category and the code of the stocks included in the sample

Name	Categ.	Code	Name	Categ.	Code
Alro S.A.	I	1	Compa S. A.	II	31
Antibiotice S.A.	I	2	Compania energopetrol S.A.	II	32
Azomureş S.A.	I	3	Electroargeş curtea DE Argeş	II	33
Banca comercială carpatica S.A.	I	4	FARMACEUTICA REMEDIA DEVA	II	34
Banca transilvania S.A.	I	5	Mechel targovişte S.A.	II	35
Biofarm S.A.	I	6	Mefin S.A.	II	36
Brd - groupe societe generale S.A.	I	7	Petrolexportimport S.A.	II	37
concefa sibiu	I	8	Prodplast S.A.	II	38
Impact developer & contractor S.A.	I	9	Retrasib Sibiu	II	39
Oil terminal S.A.	I	10	Şantierul naval orşova S.A.	II	40
oltchim s.a. rm. vâlcea	I	11	SC Transilvania construcții SA	II	41
OMV Petrom S.A.	I	12	Sinteza S.A.	II	42
Prefab Bucureşti	I	13	Siretul paşcani S.A.	II	43
Ropharma Braşov	I	14	T.M.K. - artrom S.A.	II	44
S.S.I.F. Broker S.A.	I	15	Uamt S.A.	II	45
SIF Banat Crişana S.A.	I	16	Uztel S.A.	II	46
SIF Moldova S.A.	I	17	Ves Sa	II	47
SIF Muntenia S.A.	I	18	Vrancart Sa	II	48
SIF OLTENIA S.A.	I	19	Zentiva S.A.	II	49
SIF Transilvania S.A.	I	20	Zimtub S.A.	II	50
Socep S.A.	I	21	Ucm reşița S.A.	III	51
Turbomecanica S.A.	I	22	Armătura S.A.	II	52
Aerostar S.A.	II	23	comcm constanța	II	53
Altur S.A.	II	24	dafora sa	II	54
Amonil S.A.	II	25	Electroputere S.A.	II	55
Bermas S.A.	II	26	romcarbon buzău	II	56
Boromir Prod Buzău (Spicul)	II	27	Rompetrol rafinare S.A.	II	57
Carbochim S.A.	II	28	Rompetrol well services S.A.	II	58
Cemacon Zalău	II	29	Titan S.A.	II	59
Comelf S.A.	II	30	Turism marea neagră S.A.	II	60

$R_i = \alpha_i + Fs_1 \times b_{i1} + Fs_2 \times b_{i2} + \ldots\ldots + Fs_k \times b_{ik} + e_i$

Where R_i = average return of the "i"th asset on the studied interval, $Fs_{1....}$ Fs_k = previously-calculated "factor scores" $b_{i1....}b_{ik}$= sensitivity coefficients

- Using these sensitivities as independent variables and the average return as dependent variable, we will see which factors are meaningful, and by doing so, which variables have truly an influence on assets' returns. As step 1 was already made by presenting the transformed values of the 16 variables in the above table, we can move to the next stages. "Scree plot" offers the following representation:

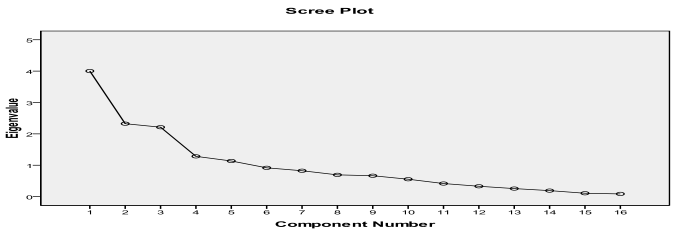

Fig. 1: Scree plot

Since the graph trend tends to change its trajectory from vertically to horizontally somewhere between 5 and 6 factors, it is normal to choose one of the two cases. In the present situation 5 factors are chosen, explaining together more than 68% from the total variance, fact shown in annex 3. The relevance of the choice is confirmed by KMO&Bartlett test as well, offering a 0,673 level (the value can be only between 0 and 1 and it has as more meaning as the value is bigger; values over 0,5 can be considered relevant).Using the 5 factors in a "varimax" rotation, "factor loadings" values are obtained and presented in annex 4. A factor is influenced by a respective variable if the absolute value of the obtained "factor loading" is quite big. Although there is no strict rule of what a big value is, it can be considered that absolute values over 0,4-0,5 are qualifying for that. Results' interpretations are below:

Table 2: The summary of the variables

Variable number	Variable name
1	Relevant index for the national stock market: **BET-C** (points)
2	Exchange rate national currency/important foreign currency: **RON/USD** (units)
3	Exchange rate national currency/important foreign currency: **RON/EUR** (units)
4	Change in the money supply: **M1G** (millions RON)
5	**GDP** indicator (millions RON)
6	Industrial production index: **IPI** (units)
7	Average interest on deposits in national currency: **MIR (**% annually)
8	Relevant index of foreign stock market: **FTSE** (points)
9	Relevant index of foreign stock market: **SP 500** (points)
10	Consumer price index: **IPC** (units)
11	Change in oil price on the international market: **OPG** (units)
12	Real consumption growth: **RCG** (units)
13	Unanticipated inflation: **AIR (**% annually)
14	Default risk premium: **DP (**% annualy)
15	Term structure of interest rates: **TSIR (**% annually)
16	Real interest rate: **RIR (**% annually)

Table 3: Calculation method for different variables

Variable name	Calculation method
BET-C	First difference of the logarithmical value*
IPC	First difference of the logarithmical value
RON/USD	First difference of the logarithmical value
RON/EUR	First difference of the logarithmical value
M1G	First difference of the logarithmical value
GDP	First difference of the logarithmical value
IPI	First difference of the logarithmical value*
MIR	First difference of the logarithmical value
FTSE	First difference of the logarithmical value
SP 500	First difference of the logarithmical value
OP	First difference of the logarithmical value*
RCG	Percentage change related to previous interval*
AIR	First difference of the logarithmical value*
DP	DP = interest for corporative bonds - interest for long term government bonds*
TSIR	TSIR = interest for long term government bonds - interest for short term treasury bills*
RIR	RIR = interest for short term treasury bills - consumer price index

*= variables are calculated in a similar or close way as in the Chen, Roll, Ross studyThe transformed values of the 16 chosen variables on the studied interval (2005-2010) are presented in annex 1.

Factor 1: includes the national stock market index (positive correlation); 2 relevant ones on external stock markets (positive correlations); exchange rates between national currency and 2 important international currencies (negative correlations); and oil price on the international market (positive correlation);

Factor 2: is influenced by real consumption growth (positive correlation); by the consumer price index (positive correlation); and by unanticipated inflation (positive correlation);

Factor 3: includes real interest rate (negative correlation), default risk premium (positive correlation), average interest rate for deposits in national currency (negative correlation) and M1 money supply (positive correlation)

Factor 4: is composed by the gross domestic product (positive correlation) and by term structure of interest rates (positive correlation);

Factor 5: is composed by the industrial production index (positive correlation)

Stages 4 and 5 offer the "factor scores" values, presented in annexure 5, and for the sensitivity coefficients, presented in annexure 6.Last step of the methodology determines which of the 5 factors are significant and, implicitly, which of the macroeconomic variables truly influence the returns of the analyzed stocks. The result of the regression offers the below conclusions:

Table 4:The following table shows the correlation between the transformed values of the variables

	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16
v1	1,00															
v2	-0,54	1,00														
v3	-0,53	0,61	1,00													
v4	0,77	-0,39	-0,55	1,00												
v5	0,71	-0,43	-0,47	0,87	1,00											
v6	0,03	-0,18	-0,07	-0,03	0,05	1,00										
v7	-0,02	-0,08	-0,06	-0,05	-0,13	0,16	1,00									
v8	-0,17	0,13	0,03	-0,16	-0,15	0,00	0,10	1,00								
v9	0,00	0,07	-0,04	0,09	0,01	0,09	-0,09	0,04	1,00							
v10	0,38	-0,21	-0,37	0,40	0,37	-0,09	-0,08	-0,03	-0,10	1,00						
v11	0,20	-0,30	-0,21	0,18	0,15	0,37	0,13	-0,25	0,06	0,08	1,00					
v12	0,06	-0,17	-0,27	-0,01	-0,03	0,21	0,13	-0,01	0,01	0,01	0,27	1,00				
v13	-0,11	0,21	0,18	-0,10	-0,09	-0,36	-0,10	0,27	0,04	-0,08	-0,87	-0,29	1,00			
v14	-0,13	0,18	-0,05	-0,02	-0,06	-0,07	0,21	-0,09	-0,04	0,10	-0,12	-0,10	0,09	1,00		
v15	-0,19	0,27	0,08	-0,17	-0,21	-0,21	0,01	-0,11	0,21	0,05	-0,07	-0,17	0,07	0,45	1,00	
v16	-0,13	0,25	0,07	-0,09	-0,14	-0,17	0,13	-0,13	0,07	0,07	0,07	-0,17	-0,11	0,68	0,64	1,00

F1	F2	F3	F4	F5
significant	non-significant	non-significant	non-significant	significant

As we know from a previous stage the compound of factors, the conclusion is that only variables forming factors 1 and 5 have influence on assets' return, being: industrial production index, national stock market index, relevant ones on external stock markets, exchange rates between national currency and the 2 important international currencies, and oil price on the international market. Summarizing, we obtain:

Macroeconomic variables with influence
IPI, BET-C, FTSE, S&P500, RON/EUR, RON/USD, OP

Conclusions and Limitations

Without the request that the current article describes totally and absolutely correct the set of macroeconomic variables which might influence stock market stocks' returns, there were some obtained results, resumed here. Comparing the conclusions of both used approaches, following variables were found as significant:

	Method A	Method B
2005-2010 interval	BET-C, RON/USD, MIR, IPI	IPI, BET-C, FTSE, S&P500, RON/EUR, RON/USD, OP

It can be observed that the first approach offered 4 economical variables having influence, whereas the second one offered more, as much as 7. Only 2 variables are common to both approaches, and those are the national stock market index and the exchange rate between the national currency and the American dollar. Among the variables found as significant by the famous studies, only the industrial production index is relevant for the Romanian market. The unanticipated inflation, the term structure of interest rates and the default premium risk changes, found as significant by Chen, Roll, Ross and other analyzes, seem to have little to no effect on the stocks listed on Bucharest Stock Exchange. But variables like stock market indexes (national and foreign), the exchange rate between the national and international currencies, oil price on the international market or the interest rates for deposits in national currency seem to be significant in this context, even if their relevance is obtained only through 1 of the 2 used approaches. The results of this testing and their interpretations can not be necessarily considered as references. The following aspects used in this empirical process could possibly provoke some errors and, through this, some deviations from a set of accurate conclusions.

- The availability and the accuracy of the data is not fully guaranteed, and the missing observations were completed by interpolation, which is not similar with being totally exact.
- Using a "proxy" for the riskless interest rate.
- The existence of some possible miscalculating, including some caused by the author.

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Annexure1: The time series of the unanticipated components of the 16 economic variables tested

	BET-C	RON/EUR	RON/USD	S&P500	FTSE	M1	PIB	GDP	IPI	OP	DP	TSIR	RIR	IPC	AIR	RPG
jan. 05	0,0675	-0,0073	-0,025	0,0121	0,0226	0,0168	0	-0,1032	-0,1371	0,0917	7,25	0	-8,9	-0,0134	-0,1891	0,8
feb. 05	0,0792	-0,0377	-0,029	0,0188	0,0237	0,0297	0	-0,1385	-0,0863	0,1507	7,25	1,8	-3,7	0	-0,139	0,6
mar. 05	-0,185	-0,0117	-0,0242	-0,0193	-0,0151	0,0329	0	0,0812	-0,0246	-0,0301	0,45	0	-10	-0,0018	-0,1598	0,3
apr. 05	-0,0673	-0,0013	0,017	-0,0203	-0,0191	0,0479	-0,0141	-0,2165	0,0041	-0,0752	7,25	-5	-5	0,0119	0,4221	1,8
may. 05	-0,0125	-0,003	0,0165	0,0295	0,0333	0,0735	0	-0,095	0,126	0,1463	7,25	2,1	-4,7	0	-0,1233	0,3
jun. 05	0,0307	-0,0012	0,0408	-0,0002	0,0296	0,0851	0	-0,0687	-0,0743	0,0457	0,15	0	-9,3	-0,0028	-0,139	0,3
jul. 05	0,0909	-0,0135	-0,0029	0,0354	0,0325	0,0274	-0,0009	-0,0086	0,1009	0,1079	7,25	0	-8,9	-0,0036	0	1
aug. 05	0,0113	-0,0169	-0,0378	-0,0113	0,0028	-0,0118	0	-0,0294	-0,0194	0,0085	7,25	5,4	-8,5	-0,0037	-0,1598	0,1
sep. 05	0,0953	0,0013	0,0048	0,0069	0,0335	0,0603	0	-0,0922	-0,0346	-0,0606	1,85	0	-8,1	-0,0036	0	0,6
oct. 05	-0,0163	0,0248	0,0437	-0,0179	-0,0297	0,0006	-0,0153	-0,1746	-0,0061	-0,0742	7,25	0	-8,7	-0,0037	0,1598	0,9
nov. 05	0,0814	0,015	0,0344	0,0346	0,0197	-0,0174	0	-0,0839	0,058	0,0219	7,25	0	-8,6	0,0055	0	1,2
dec. 05	-0,0294	0,0017	-0,0045	-0,001	0,0355	0,1053	0	0,0559	0,0364	0,1084	7,25	0	-8,89	-0,0009	0	0,5
jan. 06	0,1912	-0,004	-0,0254	0,0252	0,0248	-0,0035	-0,0018	-0,0024	-0,009	-0,0647	7,25	0	-8,49	0,0026	0,3733	1,03
feb. 06	0,0149	-0,029	-0,0144	0,0004	0,0054	-0,0001	0	-0,0264	-0,1184	0,014	7,25	0	-8,41	-0,0036	-0,5331	0,24
mar. 06	-0,0754	-0,0093	-0,0155	0,0111	0,0295	-0,0044	0	0,1235	-0,0181	0,1203	7,25	0	-6,92	-0,0008	-0,1879	0,21
apr. 06	0,0256	-0,0047	-0,024	0,012	0,0098	0,0434	-0,0063	-0,0022	0,0534	0,007	7,25	0	-7,26	-0,0138	0	0,42
may. 06	-0,0618	0,0046	-0,0371	-0,0314	-0,051	0,0553	0	0,0463	0,1098	-0,0014	7,25	0	-7,11	0,0032	0	0,6
jun. 06	-0,0209	0,0117	0,0204	0,0001	0,019	0,0553	0	-0,0208	-0,1296	0,0531	7,25	0	-6,21	-0,0014	-0,2285	0,15
jul. 06	0,0741	0,0067	0,0055	0,0051	0,0161	0,0309	-0,0092	-0,0063	0,1437	-0,0206	7,25	0	-6,02	-0,0085	0	0,11
aug. 06	0,0034	-0,0126	-0,0228	0,0211	-0,0038	0,0359	0	0,0435	-0,027	-0,1528	7,25	0	-5,48	-0,0018	-0,2935	-0,07
sep. 06	0,0461	-0,0002	0,0058	0,0242	0,0093	0,0092	0	-0,0082	-0,0243	-0,0891	7,25	0	-4,8	-0,0051	0	0,05
oct. 06	0,0818	-0,0022	0,0073	0,031	0,0278	0,0366	0,0326	0,0479	-0,0262	0	7,25	0	-4,67	-0,0064	0	0,21
nov. 06	-0,0347	-0,0068	-0,0276	0,0164	-0,0132	-0,0197	0	0,0096	0,0415	0,0587	7,25	0	-4,87	-0,0013	0,2935	1,09
dec. 06	0,0064	-0,0235	-0,0492	0,0125	0,0281	0,1281	0	-0,0214	0,061	-0,15	7,25	6,61	-4,01	0,0019	0	0,74
jan. 07	0,0825	-0,006	0,0115	0,014	-0,0029	0,058	0,0053	0,3192	-0,0217	0,0988	0,64	0,6	2,2	-0,0082	-0,7045	0,2
feb. 07	0,0291	-0,0033	-0,0097	-0,0221	-0,0051	0,0124	0	-0,0072	-0,1371	0,0246	0,64	0,98	2,39	-0,0019	-0,6981	0,04
mar. 07	-0,0104	-0,0039	-0,0169	0,0099	0,0219	0,0462	0	0	0,0152	0,0633	0,22	0,18	3,26	-0,0015	0	0,07
apr. 07	0,0666	-0,0103	-0,0303	0,0424	0,0221	0,0087	0,0018	-0,0204	0,068	-0,0117	0,04	-0,04	3,42	0,0011	0,6981	0,52
may. 07	-0,0061	-0,015	-0,0152	0,032	0,0264	0,0265	0	-0,0074	0,0664	0,0667	-0,19	-0,16	3,38	0,0004	0,411	0,64
jun. 07	0,1048	-0,018	-0,0109	-0,0179	-0,0021	0,0518	0	-0,0119	-0,0347	0,1072	-0,02	-0,13	3,15	-0,0001	0	0,14
jul. 07	0,0675	-0,0292	-0,0514	-0,0326	-0,0382	0,0592	0,0079	-0,006	0,0464	-0,0265	-0,01	-0,02	1,92	0,0018	0	0,29
aug. 07	0	0,0283	0,0355	0,0128	-0,009	0,0273	0	-0,0045	-0,015	0,0993	0,14	-0,01	0,68	0,0093	0	0,86
sep. 07	-0,0605	0,0374	0,0176	0,0352	0,0256	0,0234	0	0	-0,0139	0,0893	0,3	0,27	0,16	0,0101	0,2935	1,08
oct. 07	0,0457	0,0018	-0,022	0,0147	0,0387	0,022	-0,0035	0,003	-0,0928	0,1139	-0,27	-0,58	1,18	0,0076	0,2285	0,97
nov. 07	-0,0965	0,0347	0,0036	-0,045	-0,044	0,0663	0	0,018	0,0955	-0,0406	-0,27	-0,38	1,28	-0,0016	0	0,93
dec. 07	0,0598	0,0166	0,0248	-0,0087	0,0038	0,0791	0	0,0074	-0,0047	0,0147	-0,47	0,35	1,68	-0,0009	0	0,64
jan. 08	-0,2546	0,0454	0,0352	-0,0631	-0,0936	0,0043	0,0234	0,0058	-0,116	0,0227	-2,29	0,35	0,97	0,0065	0,61	0,86
feb. 08	0,0068	-0,0109	-0,014	-0,0354	0,0007	0,031	0	0,0317	-0,2133	0,1116	-2,29	0,04	0,8	0,0066	-0,1233	0,7
mar. 08	-0,0467	0,0187	-0,0327	-0,006	-0,0314	0,0119	0	0,0403	0,0516	0,074	-2,47	0,2	0,81	0,006	-0,139	0,67
apr. 08	0,0126	-0,0215	-0,0369	0,0465	0,0654	0,0138	-0,0129	0,0608	-0,0062	0,1182	-2,63	-0,61	1,76	0	0	0,52

may. 08	0,0876	0,0046	0,0178	0,0106	-0,0056	0,0245	0	0,05	0,0071	0,0733	-2,61	-0,89	2,02	-0,0015	-0,1598	0,49
jun. 08	-0,1685	-0,001	-0,0004	-0,0899	-0,0733	0,0575	0	0,0672	0,0088	-0,0013	-2,74	-0,72	1,7	0,0014	0	0,28
jul. 08	-0,0559	-0,0212	-0,0355	-0,0099	-0,0387	-0,0085	0,0095	0,037	0,0008	-0,1512	-3,02	-0,46	2,92	0,0039	0	0,69
aug. 08	-0,0782	-0,0147	0,0382	0,0121	0,0406	0,009	0	0,0482	0,0113	-0,1207	-3,48	-1,23	3,86	-0,0094	-0,1879	-0,09
sep. 08	-0,2258	0,0276	0,0683	-0,0952	-0,1395	0,0173	0	0,0249	0,0018	-0,3389	-2,93	-0,1	3,91	-0,0067	0	0,4
oct. 08	-0,3997	0,0325	0,1086	-0,1856	-0,1133	-0,0093	-0,0122	0,0478	0,006	-0,3291	-4,2	-0,35	6,26	0,0009	0,1879	1,06
nov. 08	0,0036	0,008	0,052	-0,0778	-0,0206	0,0075	0	0,0786	0,0136	-0,403	-5,65	-0,98	7,68	-0,0061	-0,1879	0,32
dec. 08	-0,0965	0,0364	-0,0207	0,0078	0,0335	0,0022	0	0,0871	0,0092	0,0039	-6	-1,24	7,52	-0,0041	0	0,23
jan. 09	-0,2691	0,0779	0,0975	-0,0896	-0,0663	-0,0519	-0,0355	0,0906	0,0158	-0,0633	-5,99	-1,37	5,96	0,0038	0,9145	1,24
feb. 09	-0,1937	0,0121	0,0453	-0,1164	-0,0802	-0,0357	0	0,0355	-0,005	0,2506	-4,48	-0,02	4,76	0,0017	-0,0926	0,88
mar. 09	0,2199	-0,0005	-0,019	0,0819	0,0248	-0,0407	0	0,0238	-0,0268	0,0565	-4,45	0,02	5,03	-0,0017	-0,2119	0,5
apr. 09	0,2287	-0,0204	-0,0332	0,0898	0,0778	-0,0121	-0,0378	-0,005	-0,0172	0,1898	-4,5	-0,34	5,54	-0,0024	-0,2623	0,27
may. 09	0,0554	-0,0063	-0,0393	0,0517	0,0402	-0,0077	0	-0,0253	0,0432	0,1862	-4,15	-0,1	5,39	-0,0047	-0,1598	0,01
jun. 09	0,0213	0,0104	-0,0171	0,0002	-0,0389	0,0229	0	-0,058	0,005	-0,0902	-4,15	0,04	5,86	-0,0009	-0,1879	0,2
jul. 09	0,0967	0,001	-0,0032	0,0716	0,0811	-0,003	-0,0649	-0,0825	0,0041	0,1118	-3,96	-0,51	5,8	-0,0076	-0,2285	-0,07
aug. 09	0,083	0,0004	-0,0122	0,033	0,0632	0,0163	0	-0,0908	0,0179	-0,0295	-3,25	-0,47	5,51	-0,0009	0	-0,19
sep. 09	0,0536	0,0048	-0,0159	0,0351	0,0448	-0,0272	0	-0,0598	-0,0097	0,1006	-2,98	0,04	5,65	-0,0002	0	0,39
oct. 09	-0,0017	0,0108	-0,0071	-0,02	-0,0175	-0,0299	0,0267	-0,0349	0	0,0292	-2,99	0,02	5,33	-0,0061	0	0,44
nov. 09	0,0472	0,0007	-0,0057	0,0558	0,0285	0,0055	0	-0,0164	0,0113	-0,0457	-3	0	5,26	0,0033	0	0,67
dec. 09	-0,0242	-0,0148	0,0074	0,0176	0,0419	0,0093	0	-0,0135	0,0064	-0,2153	-3	-1,2	4,8	0,0009	0	0,32
jan. 10	0,0887	-0,0201	0,0015	-0,0377	-0,0423	-0,0353	-0,002	-0,019	0,0167	0,2671	-1,8	-1,35	4,27	0,0044	1,5192	1,68
feb. 10	0,0322	-0,0056	0,0364	0,0281	0,0315	0,0026	0	-0,0468	-0,0024	-0,0263	-0,41	-0,59	3,21	-0,0068	-0,6807	0,2
mar. 10	0,1388	-0,0073	0,0014	0,0572	0,0589	-0,0047	0	-0,0539	0,0326	0,069	0,18	0,34	2,29	-0,0028	-0,2623	0,22
apr. 10	-0,0245	0,0099	0,0212	0,0146	-0,0225	-0,0012	0,0146	-0,0746	-0,0015	0,0457	0,09	0,98	1,6	0,0008	-0,1598	0,35
may. 10	-0,1514	0,011	0,0766	-0,0855	-0,0679	0,0297	0	-0,0521	-0,0123	-0,1414	0	0,66	1,93	0,0013	-0,1879	0,15
jun. 10	-0,0513	0,0156	0,044	-0,0554	-0,0538	0,0229	0	-0,0312	0,0046	0,0131	0,03	0,31	-0,35	-0,0004	0	0,16
jul. 10	0,0556	0,005	-0,0386	0,0665	0,0671	-0,0081	0,0387	-0,0139	0,0054	0,0117	-0,1	0,11	-0,59	0,0261	0,4867	2,58
aug. 10	0,0036	-0,0052	-0,0163	-0,0486	-0,0063	0,0079	0	-0,0014	-0,017	0,0063	-0,1	0,1	-0,77	0,0041	-0,139	0,23
sep. 10	0,0419	0,006	-0,0065	0,0839	0,0601	0,0127	0	0	0,017	-0,0171	-0,1	0	-0,88	0,0018	0	0,56
oct. 10	-0,0014	0,0036	-0,0583	0,0362	0,0226	-0,0361	-0,0416	0,0014	0,0152	0,0917	0	0,1	-0,73	0,001	0	0,55
nov. 10	-0,0342	0,0031	0,0198	-0,0023	-0,0263	0,0164	0	0,0014	-0,0068	0,0316	-0,1	0,16	-0,9	-0,0014	0	0,52
dec. 10	0,0383	-0,0001	0,0325	0,0633	0,0651	0,0209	0	0,0028	-0,0008	0,0639	-0,22	-6,87	6,87	0,0022	-0,1598	0,53

Annexure 2: The sensitivity coefficients resulted through method (A)

b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15	b16
106,632	-142,091	-28,550	82,046	-121,580	-10,308	-62,856	-11,739	-14,747	-12,409	-0,155	-0,693	0,026	-217,926	13,443	-0,544
90,149	180,587	-38,548	33,144	-35,233	48,998	46,618	-8,309	-33,620	7,520	0,094	-0,307	-0,206	-733,467	0,150	8,240
178,311	194,233	90,652	65,752	-180,404	69,427	-8,409	51,869	3,289	28,678	-3,312	-1,375	-1,912	-131,518	-1,177	3,391
63,717	-144,859	20,670	53,502	-78,634	65,026	103,632	5,223	-17,315	-8,789	0,660	0,507	0,668	-843,111	-4,189	13,588
78,243	38,962	-17,401	-35,912	50,845	5,375	-114,551	-23,318	-24,881	-7,479	-0,201	0,518	0,020	-547,051	-5,605	8,420
-42,199	-239,438	-53,609	38,019	36,140	-42,606	-73,267	1,453	57,875	-15,711	-1,005	-0,265	-0,877	-840,642	-3,661	10,981
120,261	67,497	-55,097	-0,026	8,264	-6,513	-57,461	3,485	-30,273	-13,769	-0,160	0,027	0,050	-319,164	-0,704	4,048
-74,288	-1.147,465	72,925	502,294	-123,143	151,815	-344,009	9,834	0,420	38,174	1,158	0,349	2,690	-997,890	43,700	-3,743
163,066	135,796	-50,131	-43,653	88,360	8,129	-121,628	48,422	-16,232	-17,981	0,508	-1,523	0,695	-632,915	4,575	4,455
97,420	39,585	-115,354	10,288	-69,372	53,721	168,174	-19,797	27,300	3,771	-0,116	0,068	0,262	-2,751	13,906	-6,112
115,669	28,592	-2,271	124,938	-122,165	106,445	-367,942	-26,599	-64,690	19,073	-0,203	0,540	0,209	-630,683	1,286	11,014
113,442	81,620	10,462	-24,388	31,931	-23,865	29,797	12,134	3,068	6,935	-0,396	-0,031	-0,438	-177,689	0,683	0,720
142,141	-107,427	138,208	-16,381	-58,937	-30,972	-43,261	-15,041	23,049	57,569	-0,071	2,759	0,300	-525,341	-15,023	10,623
84,580	88,834	-199,866	-125,065	-31,465	-70,936	51,554	-25,044	20,750	-4,972	1,812	-1,033	1,808	-268,266	-10,830	6,827
195,149	6,045	125,710	115,000	-180,265	-40,124	-75,672	23,044	-25,717	-0,367	0,114	2,185	0,357	569,856	2,759	-2,759
145,601	-86,333	82,392	2,581	28,863	24,647	-321,281	-7,762	-29,865	-3,868	0,478	0,668	0,626	-509,837	1,532	12,287
161,286	-20,001	52,268	49,416	-4,323	15,090	-234,534	-13,171	-39,610	-28,441	0,329	0,181	0,334	-315,108	5,597	5,821
118,867	-80,337	76,983	-67,073	83,032	28,718	-117,449	-14,590	-15,418	-7,718	0,856	0,075	0,750	-395,219	1,513	8,811
151,470	32,500	12,856	25,545	-15,439	24,100	-200,515	-20,700	-23,860	-6,605	0,022	0,485	0,099	-570,741	5,132	8,467
130,108	13,026	18,131	-10,673	46,879	20,357	-129,483	-13,092	-33,793	0,390	0,845	0,049	0,909	-541,789	5,387	8,749
24,543	-111,043	17,307	75,582	-27,404	-20,252	54,691	3,769	-4,916	-0,933	0,106	-1,297	-0,091	448,895	9,988	-4,721
107,765	97,810	34,294	27,076	-27,820	-11,560	-284,382	2,382	-20,632	14,146	0,447	0,668	-0,147	-33,421	9,229	-3,299
85,510	114,871	15,257	-121,614	169,008	-40,945	382,588	21,262	-32,969	-3,981	1,433	0,859	1,058	-213,931	-1,901	-3,834
110,962	-93,161	71,843	27,140	-54,646	-61,101	-123,093	26,837	-16,184	40,546	-0,246	-0,028	0,095	45,243	-2,784	-0,889
87,803	7,809	-34,804	127,522	-208,544	-88,298	-68,317	-0,114	29,152	32,645	-0,334	-0,410	-0,520	-376,271	-14,561	10,688
80,133	-18,959	13,242	43,276	-48,220	-46,849	212,619	-8,892	30,810	40,930	1,399	-0,066	1,522	-206,120	1,004	0,012
90,795	-110,047	152,996	219,041	-174,213	22,950	-180,713	57,064	36,114	-17,206	1,682	2,151	1,182	-877,093	14,048	6,400
107,685	87,130	-78,893	-89,953	60,675	58,677	207,888	5,530	-46,155	-15,587	-1,501	-0,010	-1,402	-1.074,047	28,941	1,193
-21,094	-193,362	-111,327	231,627	-199,393	189,367	212,266	-26,547	-43,099	40,431	0,187	0,466	1,115	-875,108	6,201	5,578
46,504	-100,328	13,772	-25,100	-41,946	64,745	-74,413	-3,865	-13,347	-0,952	1,345	0,229	0,951	417,757	11,127	-6,929
82,964	17,536	42,605	54,333	58,091	-29,499	-18,709	-24,959	21,440	56,688	-0,090	0,860	0,441	-209,160	2,662	-0,568
46,843	-175,666	10,377	18,386	-63,631	0,203	-120,869	-19,805	-13,846	27,228	-0,117	0,211	-0,144	425,122	-3,898	2,101
57,426	-128,875	-56,251	71,753	-80,622	-110,243	181,170	12,011	42,597	13,400	-0,144	0,462	0,137	139,055	0,470	-3,897
139,598	-243,554	-42,477	-87,127	-29,742	-27,374	4,104	-26,608	64,122	-13,587	1,997	-0,884	1,426	2.066,948	54,412	-44,563
-65,372	-401,876	37,487	380,290	-32,655	394,511	-278,591	0,189	-88,799	-38,911	3,009	12,678	4,041	-1.570,406	19,355	32,245
64,747	-86,384	-20,490	-101,258	63,775	22,347	275,232	-28,855	13,239	2,255	-0,078	0,500	0,704	-1.160,102	0,132	10,224
32,990	12,588	-67,528	-6,326	70,659	-63,061	115,844	-15,765	-43,852	3,191	-0,260	0,888	-0,468	-1.238,156	10,701	5,919
72,813	-56,108	-14,276	-24,761	-64,428	-61,522	206,439	41,576	21,579	-15,442	0,257	0,202	-0,064	-449,939	-10,267	6,160
62,037	-321,752	64,987	130,782	-137,449	50,180	-321,625	33,811	-88,828	-21,175	1,870	0,210	1,401	537,418	21,397	-11,007
83,578	52,217	20,355	-49,385	6,131	50,331	262,037	-7,700	-20,897	17,075	1,435	-1,764	1,074	-210,304	18,307	-10,628
39,938	-17,862	-212,509	6,226	-123,922	180,563	-69,328	-9,782	-2,464	47,893	2,902	-1,183	2,219	905,303	13,196	-10,495
79,230	33,342	13,639	47,255	-79,671	19,062	-	13,113	-71,228	15,137	0,710	1,824	0,398	-393,838	-3,179	6,525

						207,097									
46,055	32,770	-39,676	112,786	-55,587	83,532	52,585	3,106	-19,953	-1,351	-0,935	0,642	-0,015	-1.317,785	4,079	13,390
84,862	16,066	-1,191	45,491	-9,020	7,370	96,473	-1,194	-47,394	10,423	2,798	0,127	1,368	-612,629	13,756	-5,891
86,558	46,620	-100,353	-93,083	25,130	43,495	88,882	-8,776	38,994	21,623	0,186	-1,213	0,526	-379,899	-0,218	1,533
144,684	150,804	335,449	190,195	-137,855	-32,632	-42,985	119,762	-15,473	29,515	0,198	3,664	-0,557	108,487	16,105	-12,223
95,291	231,133	-108,550	73,746	-196,304	21,218	-44,827	15,202	-42,130	-10,329	0,706	-2,209	0,333	-644,484	-1,291	6,878
-9,116	-260,485	-26,448	213,756	-154,179	129,419	45,934	-18,789	-21,591	15,756	-0,804	-1,392	0,658	-477,211	-0,056	2,460
59,120	54,540	99,562	134,780	-102,010	-30,929	-6,156	-12,181	7,254	15,398	-0,340	1,131	-0,407	-448,509	-3,359	3,367
82,208	130,346	-141,071	-42,378	-101,154	19,509	-42,485	-6,800	-83,702	-3,524	1,222	-1,421	0,702	-449,809	6,504	2,680
-75,464	-234,186	7,531	31,917	191,622	-73,979	289,523	5,909	-8,123	-3,593	-0,371	0,261	0,633	-598,678	3,470	9,054
77,315	-174,203	23,711	-0,947	-111,819	36,152	-150,081	-8,511	-21,274	23,694	0,664	0,086	0,627	-111,998	-1,118	0,326
198,773	-111,837	19,343	-147,517	30,051	313,431	-19,374	-4,246	-2,585	16,050	3,106	0,528	3,948	476,925	43,048	-14,610
152,351	229,098	-306,906	8,003	-88,278	-181,259	-10,372	28,571	-33,556	-31,366	2,067	-1,448	0,577	-589,429	-9,883	9,978
232,992	-19,735	37,692	-333,603	23,893	249,712	-64,304	-22,440	-130,742	80,502	2,471	-1,556	2,872	984,763	34,022	-30,026
-69,357	-195,493	57,265	240,451	62,856	-86,346	258,625	31,418	-22,038	7,003	2,143	4,143	1,254	-960,588	24,099	0,871
73,540	243,667	-16,266	8,013	-19,978	-15,891	-6,348	-7,833	10,663	28,493	-0,093	0,078	0,064	-781,167	-1,701	4,377
94,549	307,022	-139,431	-101,910	106,359	-15,718	437,848	20,640	-28,214	5,707	1,666	-0,908	1,061	-1.166,142	6,345	1,862
99,554	31,085	40,901	-150,770	109,641	33,400	-1,471	62,883	-15,546	-32,938	-2,273	-0,068	-1,754	-371,048	-1,851	9,321
56,042	-81,107	-36,939	-88,575	18,201	51,473	174,527	-2,090	7,330	20,793	1,018	-0,460	0,843	-114,554	4,438	-8,357

Annexure 3: Total variance explained in a cumulative way by the chosen number of factors

	Initial eigenvalues			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4,002	25,015	25,015	4,002	25,015	25,015
2	2,324	14,527	39,542	2,324	14,527	39,542
3	2,212	13,827	53,369	2,212	13,827	53,369
4	1,283	8,020	61,390	1,283	8,020	61,390
5	1,135	7,097	68,486	1,135	7,097	68,486
6	,918	5,736	74,222			
7	,825	5,154	79,377			
8	,693	4,333	83,710			
9	,666	4,160	87,870			
10	,554	3,464	91,334			
11	,417	2,605	93,939			
12	,330	2,062	96,001			
13	,256	1,599	97,600			
14	,191	1,194	98,794			
15	,107	,669	99,463			
16	,086	,537	100,000			

Annexure 4:Factor loadings values given by SPSS

	Component				
	1	2	3	4	5
SP500	0,896	-0,039	0,035	-0,134	0,105
FTSE	0,856	-0,120	0,046	-0,171	0,050
BETC	0,854	-0,123	0,086	-0,051	0,007
RONUSD	-0,748	-0,018	-0,095	-0,334	-0,066
RONEUR	-0,622	0,253	-0,222	-0,257	0,092
OP	0,578	0,185	-0,024	-0,059	-0,192
RCG	-0,076	0,904	0,100	-0,053	0,003

IPC	0,028	0,827	-0,103	0,155	-0,121
AIR	-0,140	0,783	-0,035	-0,148	0,234
RIR	-0,071	-0,015	-0,918	-0,095	0,051
DP	0,150	-0,009	0,903	0,112	0,053
MIR	-0,139	-0,171	-0,500	0,472	0,179
M1	-0,038	-0,222	0,464	0,398	0,206
PIB	-0,034	0,231	0,045	0,715	-0,190
TSIR	0,048	-0,189	0,318	0,505	0,066
IPI	0,013	0,089	0,012	-0,032	0,947

Annexure 5: Factor scores values obtained in working stage 4

Factor score total F1	Factor score total F2	Factor score total F3	Factor score total F4	Factor score total F5
0,1641	0,5641	14,7763	0,0000	-0,1298
0,2370	0,4336	10,0264	0,9090	-0,0817
-0,1802	0,1446	9,6422	0,0000	-0,0233
-0,1474	1,9675	11,2672	-2,5351	0,0039
0,1183	0,1747	10,9430	1,0605	0,1193
0,0480	0,1600	8,7467	0,0000	-0,0704
0,2101	0,9010	14,7340	-0,0006	0,0956
0,0456	-0,0378	14,3590	2,7270	-0,0184
0,0768	0,5394	9,1804	0,0000	-0,0328
-0,1464	0,9357	14,6209	-0,0109	-0,0058
0,0950	1,0893	14,4754	0,0000	0,0549
0,0693	0,4513	14,7287	0,0000	0,0345
0,1912	1,2256	14,3401	-0,0013	-0,0085
0,0546	-0,2034	14,2803	0,0000	-0,1121
0,0577	0,0421	12,8355	0,0000	-0,0171
0,0659	0,3683	13,2327	-0,0045	0,0506
-0,1005	0,5450	13,0762	0,0000	0,1040
0,0067	-0,0445	12,2836	0,0000	-0,1227
0,0614	0,0924	12,0906	-0,0066	0,1361
-0,0449	-0,2946	11,5723	0,0000	-0,0256
0,0133	0,0410	10,9615	0,0000	-0,0230
0,1173	0,1845	10,8268	0,0233	-0,0248
0,0326	1,2141	11,0035	0,0000	0,0393
0,0054	0,6705	10,2981	3,3381	0,0578
0,1328	-0,3776	-1,5744	0,3068	-0,0205
0,0242	-0,5120	-1,6067	0,4949	-0,1298
0,0704	0,0620	-2,7726	0,0909	0,0144
0,1361	1,0176	-3,0892	-0,0189	0,0644
0,1053	0,9007	-3,2584	-0,0808	0,0629
0,1530	0,1265	-2,8798	-0,0656	-0,0329
0,0370	0,2636	-1,7411	-0,0045	0,0439
0,0170	0,7851	-0,4829	-0,0050	-0,0142
0,0170	1,2145	0,1349	0,1364	-0,0132
0,1665	1,0621	-1,3183	-0,2954	-0,0879
-0,2081	0,8394	-1,3971	-0,1919	0,0904
0,0261	0,5778	-1,9336	0,1768	-0,0045
-0,3955	1,2604	-2,9592	0,1935	-0,1099
0,0564	0,5417	-2,8037	0,0202	-0,2020
-0,0165	0,5018	-2,9886	0,1010	0,0489
0,2177	0,4701	-4,0146	-0,3173	-0,0059
0,1057	0,3166	-4,2248	-0,4495	0,0067
-0,2870	0,2543	-4,0417	-0,3636	0,0083
-0,1374	0,6270	-5,4301	-0,2255	0,0008
-0,1104	-0,2363	-6,7058	-0,6212	0,0107
-0,6617	0,3561	-6,2396	-0,0505	0,0017
-0,8963	1,1061	-9,5675	-0,1855	0,0057
-0,3611	0,1371	-12,1880	-0,4949	0,0129
-0,0516	0,2045	-12,3639	-0,6262	0,0087
-0,5248	1,8402	-10,9496	-0,7172	0,0150
-0,2349	0,7244	-8,4494	-0,0101	-0,0047
0,3296	0,2847	-8,6667	0,0101	-0,0254
0,4896	0,0367	-9,1523	-0,1987	-0,0163
0,2690	-0,1200	-8,6864	-0,0505	0,0409
-0,0607	0,0329	-9,0873	0,0202	0,0047
0,2825	-0,2485	-8,8604	-0,3040	0,0039
0,1464	-0,1725	-7,9400	-0,2373	0,0170

0,1826	0,3524	-7,8604	0,0202	-0,0092
-0,0189	0,3927	-7,5893	0,0292	0,0000
0,0921	0,6084	-7,5269	0,0000	0,0107
-0,0898	0,2900	-7,1043	-0,6060	0,0061
0,1715	2,7119	-5,5521	-0,6832	0,0158
0,0407	-0,3578	-3,2924	-0,2980	-0,0023
0,2636	-0,0088	-1,9149	0,1717	0,0309
-0,0227	0,1919	-1,3508	0,5053	-0,0014
-0,4099	-0,0105	-1,7319	0,3333	-0,0116
-0,1745	0,1443	0,3746	0,1566	0,0044
0,1970	2,7350	0,4545	0,0832	0,0051
-0,0268	0,1025	0,6209	0,0505	-0,0161
0,1536	0,5077	0,7234	0,0000	0,0161
0,1450	0,4980	0,6527	0,0208	0,0144
-0,0523	0,4689	0,7428	0,0808	-0,0064
0,1578	0,3558	-6,4970	-3,4694	-0,0008

Annexure 6: Sensitivity coefficients obtained in working stage

b1	b2	b3	b4	b5
45,284	2,642	-0,057	-0,953	4,246
36,479	1,624	0,311	-0,703	-22,330
45,384	1,516	-0,574	-2,471	-12,568
24,803	-0,446	0,211	0,340	1,976
33,074	-0,948	0,039	0,154	-22,370
3,183	-0,598	0,194	-0,801	60,402
50,098	-0,740	-0,086	-0,029	-19,792
98,015	0,300	-0,561	-0,996	93,982
66,904	-1,979	-0,224	-3,690	15,463
42,176	2,041	-0,150	2,147	42,658
59,692	2,570	0,025	-0,117	-41,677
46,129	-0,491	-0,002	-0,356	1,359
62,017	-1,721	-0,099	3,978	-1,846
26,388	-0,001	-0,149	-0,215	21,303
64,068	1,652	-0,365	3,532	-19,755
63,264	2,496	0,002	-0,944	-11,882
63,976	0,981	0,051	-1,420	-12,905
46,141	1,357	0,138	-1,465	-4,619
62,545	2,619	0,078	-0,286	-4,406
60,546	3,017	-0,012	-1,219	-13,841
23,272	3,241	0,015	-2,349	-0,176
45,395	0,871	0,166	0,121	-3,763
33,257	-5,071	0,006	1,648	-33,326
56,191	-1,603	-0,340	-0,746	-27,264
44,217	1,294	0,112	-0,591	15,478
51,710	0,790	-0,244	-0,023	33,992
33,356	0,978	0,122	1,927	96,515
29,892	5,926	0,196	1,207	-29,312
33,804	0,727	-0,072	2,814	-16,031
12,099	0,678	0,117	0,914	3,394
73,273	0,675	-0,333	0,415	19,859
31,883	2,354	0,073	0,671	-31,121
41,707	-0,392	-0,310	2,120	36,137
51,696	3,263	-0,326	0,869	101,867
36,716	10,092	0,014	22,274	26,556
23,983	-0,344	-0,139	1,303	12,015
30,043	1,935	0,221	1,515	-35,110
12,238	-3,333	0,150	1,212	15,268
29,591	-0,420	0,001	-0,036	-43,609
28,532	-0,718	0,080	-2,849	-2,066
40,786	3,654	0,197	1,077	26,739
33,346	-0,130	0,142	2,830	-60,986
29,825	1,798	-0,162	1,022	4,658
47,941	-2,926	0,582	-0,193	-9,647
38,989	-1,097	-0,102	-1,127	40,627
41,463	-2,283	-0,090	4,268	9,205
18,804	0,949	0,174	-3,417	-18,782
28,997	-3,147	-0,410	-2,126	-3,470
27,594	-0,953	0,089	0,739	9,926
18,286	2,458	0,222	-1,333	-67,405
12,375	3,349	-0,474	-0,239	-10,823

29,737	-2,106	0,065	0,322	-19,763
70,693	5,100	-0,579	2,340	64,331
64,767	0,496	0,454	-0,939	-14,970
68,433	-2,195	-0,473	-0,880	-119,881
30,931	4,053	0,234	6,434	25,050
31,102	-0,414	-0,090	-0,460	15,960
39,198	-1,574	0,193	-0,590	-7,987
7,696	0,398	-0,071	-0,241	-29,361
24,515	-5,149	0,088	0,392	11,554