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Economic Forces and Stock Markets under Arbitrage Price Theory: Empirical Evidence from Turkey

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Abstract

Our aim is to identify common risk factors among some pre-determined macroeconomic variables in a way that whether they are presented significant risk premiums in pricing equation that was given above. First we identified number of potential factors explaining returns in Turkish markets as suggested by Ross (1980) when presented APT. We found two factors were significantly explaining returns and then to find out which factor they are. we have used methodology of Chen, Roll, Ross (1986) where we have ranked portfolios according to size (market capitalization) and portfolio returns are calculated as log-returns. Our main results have showed that stock returns are exposed to systematic economic news that they are priced in accordance with their exposures. Those variables in our study are MP, DEI, BIST 100, BIST 30 and CG that must be given importance for considering their impact on stock returns.

Keywords: Arbitrage Pricing Theory, Factors Analysis, Economic Forces, Macroeconomic Factors

I. Introduction.

The Arbitrage Pricing Theory (APT) and Capital Asset Pricing Model (CAPM) have been created as two models that have measured the potential for assets to generate a return or a loss. The Capital Asset Pricing Model assumes that stock returns are generated by a one-factor model. The factor corresponds to the market portfolio of all risky assets. Measuring the true market portfolio has emerged as main difficulty in the estimation of the CAPM.

Arbitrage Pricing Theory (APT) have been proposed by Ross (1976) as an alternative to the CAPM due to the severe problems in the testing the CAPM. The APT proposes that there are many sources of risk in the real economy and they cannot be eliminated by diversification. The common economic factors such as inflation constitute sources of risk. In the APT, an asset's return has sensitivity called as beta to changes in each factor, however in the CAPM there is only one beta.

In Arbitrage Pricing Theory, a security return is a linear function of several factors. Therefore the risk premium of an asset is related to the risk premium for each factor with the rate of sensitivity coefficients.

According to Chen (1986), changes in fundamental economic variables such as interest rate, inflation, market index are the main reasons for risk factors.

There are two main methods for testing the APT empirically. The first one is exploratory factor analysis. In this method, the asset sensitivities and unknown factors can be estimated simultaneously. However, the exact content and even the number of relevant factors aren't predicted. The other method is using pre-specifying general factors. Identifying common risk factors affecting stock prices and consequently returns has been the topic addressed by many researchers in earlier periods of academic finance fields. These common risk factors can be perceived as sources of systematic risks that are not diversified away by portfolio formation. Hence, general argument led by researchers is that an additional component of return is needed whenever an asset is influenced by systematic risk factors. In asset pricing theories developed by Sharpe-Lintner (1964,1965) and Ross (1976) have made no reference to macro-economic environment as potential source of common risk factors. Fama-French (1993) work identified some micro-factors such as firm size, BE/ME ratio, term structure etc. The study of Chen, Roll, Ross (1986) on the other hand, aimed to test whether innovations in macroeconomic variables are rewarded in the stock market. In that study, they were looking to some macroeconomic variables and trying to find a link between returns and state variables (as they name).

In this study, we aim to replicate Roll(1980) and Chen, Roll, Ross (1986) paper by taking methodology without any change and plugging Turkey's data into the model. Structure of this research is as follows: After Introduction and Literature Review, In Third Part we have replicated Roll (1980) and In Fourth Part we have replicated Chen, Roll, Ross (1986) where, first we will provide a summary of replicating paper, data and derived series that we have used, methodology, Analysis (which are correlations, autocorrelations and risk premium estimates) and results will be contrasted with original study.

II. Literature Review

Yusuf Demur(2009) analyzed macroeconomic factors which affects stock return of banks traded in Istanbul Stock Exchange(İMKB) using the Arbitrage Pricing Theory. In that study monthly returns and sensitivity of stocks to the macroeconomic variables of 13 continuously traded banks in IMKB were investigated. Foreign exchange rate, capacity utilization ratio, Treasury bill rate, IMKB-100 index, money supply, industrial production rate, gross domestic product, gold prices and current accounts balance are considered as main factors in this study.

Javed Iqbal and Aziz Haider (2005) investigate the validity of the Arbitrage Pricing Theory (APT) model on returns from 24 stocks in Karachi Stock Exchange with monthly data from January 1997 to December 2003. Explanatory factor analysis shows that there are two factors. According to pre-specified macroeconomic approach, these two factors are the anticipated and unanticipated inflation and market index and dividend yield.

Sulaiman D. Mohammad, Syed Iqbal Hussain Naqvi and Irfan Lal (2012) examined the variability of Arbitrage price theory (APT) in in Karachi Stock Exchange with the monthly data from Jan 1985 to Dec 2008. Johnson co integration and Error correction model are used to check out the validity of APT in this study. According to conclusion of this study there is an inverse relationship between quasi money with KSE 100 index return. On the Contrary bullion price and inflation rate are insignificant regarding to KSE 100 index returns

Hussain, A. et al (2009) finds the long run relationship between macroeconomic variables and prices of shares in Karachi stock exchange in Pakistan context. their study considers the monthly data of several macroeconomic variables such as real foreign exchange rate, foreign exchange reserve, industrial production index, whole sale price index, gross fixed capital formation, and broad money M2 , these variables are obtain from 1987 to 2008 period. For the purpose of finding long run relationship among the variables Johansen co-integration test is applied. The results show that after the reforms in 1991 the influence of foreign exchanges rate and foreign exchange reserve effects significantly to stock market. The result also shows that there was positive relationship between GFCF and M2 while WPI is negative relationship with stock price. The result also highlighted that interest rate is insignificant with stock prices in the long run. The VECM analysis illustrated that the coefficients of ecm1 (–1), and ecm2 (–1) were significant with negative signs. The coefficients of both error correction terms showed high speed of adjustment. The results of variance decompositions revealed that out of seven macroeconomic variables inflation showed greater forecast error for KSE 100 Index

Abdullah and Hayworth (1993) investigate macroeconomic variables which are Granger causal to the monthly stock returns. This paper utilizes Granger causality tests and Sims' innovation accounting to focus on fluctuations in stock returns within a vector autoregressive (VAR) model. The variables used in the model are planned to be derived from 4 important economic markets: money, goods, securities and labor. Hence, because of the trend in stock market, labor market is dropped from study. Because of several reasons like its impact on discounting cash flows, its impact on business cycle movement or its impact on asset allocation; interest rates are included in the study as Moody's AAA corporate bond yield. It's expected in economic theory that fluctuations in money supply (narrowly defined M1 money supply) may affect stock prices through revisions in inflationary expectations and through portfolio substitution. As a result, M1 money supply is another variable. Furthermore, index of industrial production is used as a variable proxy for aggregate economic activity. CPI (used for inflation), budget deficit, trade deficit are other variables in the model of this paper. S&P 500 stock price index is used to represent stock prices. On the other hand, in the model (in the Choleski decomposition), two theoretically motivated orderings of variables based on their exogeneity level are given.

There are some important points to be considered in model selection of this paper. The order of autoregression is determined by likelihood ratio test based on chi-square statistic. Here, lower order VAR is restricted model and tested against higher order model. At 10% significance level, optimal lag length is 4. As a result of empirical study conducted in this paper; budget deficit, interest rate and money growth are found to be Granger causal prior to stock prices. These variables together with output growth and inflation account for important proportion of variance of forecast error of stock prices. Specifically, choice of interest rates variable is not an issue affecting results.

Gibbons (1981) aims to empirically validate the implication that a variety of financial models can be regarded as nonlinear parameter restrictions on multivariate regression models. In this paper, a development for conceptual framework is observed, on contrary to previous cross section framework which may lead to measurement errors. Return on market portfolio is chosen as the return on CRSP equal-weighted index. Time period for the study covers the interval between 1926 and 1975 which is divided into ten equal five-year subperiods. As equation 5 shows, one implication in the paper putting restriction on intercept term of market model and it's used as a test of CAPM's validity. As a result of empirical analysis, plots for 1926-30 and 1971-75 periods specify that CAPM tended to misprice securities. In table 1, one important finding is that reduction achieved in standard errors by using MVRM ranges from 50 to 76 percent.

Flannery and Protopapadakis (2002) is a study starting from the idea that the impact of macroeconomic factors on aggregate equity returns are not linear and not time invariant. Hence, a GARCH model is used to describe daily equity returns. In this GARCH model, both returns and their conditional variance are varying with 17 macroeconomic series' announcements. One important distinction of this paper is that previous papers in asset pricing literature were looking to time-invariant effects of macro innovations on equity returns. This paper also considers the possibility that the impact of a macro development can also change with the economy's condition. 17 macro announcement series are constructed over the period 1980-1996. According to results of this paper, two popular measures of economic activity which are real GNP and industrial production are not among risk factors to be priced. Furthermore, real GNP announcements are related to lower instead of higher returns and industrial production exhibits similar pattern. Two inflation measures in the study are found to be effective on only market portfolio's return. Three real factors which are balance of trade, employment and housing stats are affecting only returns' only conditional volatility. Monetary aggregate that is M1 monetary base is found to be effective on both returns and conditional volatility.

Part III: Roll (1980)

A. Data

Table 1 describes data used in this research. To test Arbitrage Price Theory we have used Bloomberg portal provided by Department of Management, Faculty of Business Administration, Bilkent University, Ankara, Turkey. Sample of 348 listed companies of Istanbul All Index were used for this purpose. Daily Shares Prices were obtained from there for the period of January 1, 2003 to December 31, 2013 giving Maximum Daily Observation of 4016 However, Data of Some companies was not available due to Suspension of trading, temporary delisting or simply to missing data for some of individual securities. Then from the Shares prices Daily Log Returns were calculated for all 348 companies. To make portfolios, 20 securities per group were decided and portfolios were form alphabetically. However, 9 of the securities were not having enough observation to be part of groups so those securities were discarded leaving 18 or 19 securities in some of Group. So Total 17 portfolios were formed out of which 9 portfolios were having 20 securities, 7 portfolios were having 19 securities and only 1 portfolio with 18 securities and 8 Securities with Last Alphabet were left as Group of 8 was insufficient to observe as portfolio.

Table 1: Data Description

Source	Bloomberg Portal, Department of Management, Bilkent University, Ankara, Turkey
Sample	348 Listed Companies of Istanbul All Index
Selection Criterion	17 Portfolios were created on the basis of alphabetical sequence listed on Istanbul All index on October 15, 2014. Daily Share Prices of All listed companies were taken from January 1, 2003 to December 31, 2013
Basic Data Unit	Daily Log Returns were calculated for All available Listed Companies
Maximum Sample Size per Security	4016 Daily returns
Number of Selected Securities	339 (Total 17 Portfolios, 9 Portfolio with 20 Securities, and 7 with 19 Securities and 1 with 18 Securities; 8 Securities with Last Alphabets were Left)

B. Estimating the Factor Model

Our research analysis includes following stages:

- For every portfolio, a sample product moment co-variance matrix is computed from their time series returns of Istanbul Stock Exchange from January 1, 2003 through December 31, 2013
- Initially maximum likelihood factor analysis was performed on the co-variance matrix of every portfolio but it was result in Heywood case which results in boundary solution so second best alternative method of principle component analysis was adapted to estimates the number of factors presented in series of returns from each portfolio.
- The individual assets factors loading estimates from previous steps were used to explain cross sectional variation of individual estimated expected returns. For this purpose ordinary least square cross sectional regression was used.
- Estimates from the cross sectional model were used to measure the size and statistical significance of risk premia associated with the estimated factors

Table 2 is showing the Factor Analysis with Principle Component Method on all 17 portfolios. Factor analysis shows the orthogonal factors presented in returns of all portfolio. We can see that in portfolio 1 there were three orthogonal factors with Eigen Value greater than or equal to 1. These three factors in portfolio 1 are capturing 55% of variation in returns. Similarly, in portfolio 2, again three factors were identified capturing two-third of variation of returns. We can see that orthogonal factors are capturing almost more than 50% of variation of returns from different portfolios. Even In portfolio 17, captured variation is around four-fifth almost 80% which were captured on average by three orthogonal factors.

Table 2.1 summarize how many orthogonal factors were identified in available portfolios we can see that 11 out of 17 portfolios have three orthogonal factors around 65% whereas 4 portfolios out of 17 (24%) are having even more than three orthogonal factors. Only two portfolios out of 17 around 11% are having only two factors.

Table 2.1: Possible Factors present in Portfolios

Number of Factors	Portfolios
Five Factors	1
Four Factors	3
Three Factors	11
Two Factors	2
One Factor	0
Total Portfolios	17

Table 3.1: Cross-sectional least squares regressions of Mean Sample Returns on factor loadings Estimates (17 groups of 20 individual securities per group, 2003-2013 daily returns)

Percentage of groups with at least this many factor risk premia significant at the 95% level				
Factors	**1**	**2**	**3**	**4**
% of Groups	41.18%	17.65%	5.88%	0.00%
Note: 10 out of 17 (58% portfolio does not have any significant Factor)				
Percentage of groups with at least this many factor risk premia significant at the 90% level				
Factors	**1**	**2**	**3**	**4**
% of Groups	64.71%	23.53%	11.76%	0.00%
Note: 6 out of 17 (35.3% portfolio does not have any significant Factor)				

Table 3 shows results of all the portfolio showing number of factors significant with regression including intercept as risk free returns. We can see out of 17 portfolios only 6 portfolios having significant F statistics showing although number of hidden factors are presented in returns but they are not significant on regular basis (6 out of 17). We can see that In portfolio P1, P11 and P13, out of 3 factors identified in factors analysis only 1 is significant, in portfolio P4, out of 4 factors identified in factors analysis two factors are significant, where as in P17, factors analysis was showing 3 potential factors explaining returns out of which 2 are significant. Only in one portfolio P6 which identified 4 factors from factors analysis, three were significant. Risk Free rate is not significant in 13 out of 17 portfolios showing weakness of efficient market hypothesis in turkey.

Table 3.1 summarizes table 3 in more concise way showing number of factors which are significant at 95% in first panel and factors which are significant at 90% in second panel of table. First Panel of 3.1 is showing 7 out of 17 (41.18%) portfolios were having at least 1 factor significant in explaining returns and 3 portfolios having 2 significant factors and only 1 portfolio having 3 significant factors. However, if we sacrifice margin of errors by 5% and checks the results again we can claim that 11 out of 17 approx. two-third of the portfolios having at least one factors significant in explaining returns and 4 portfolios around one fourth portfolios having two significant factor and 2 having 3 significant factors.

Table 4.1: Cross-sectional least squares regressions of Mean Sample Returns on factor loadings Estimates (17 groups of 20 individual securities per group, 2003-2013 daily returns)

Percentage of groups with at least this many factor risk premia significant at the 95% level				
Factors	**1**	**2**	**3**	**4**
% of Groups	58.82%	23.53%	0.00%	0.00%
Note: 7 out of 17 (41.1% portfolio does not have any significant Factor)				
Percentage of groups with at least this many factor risk premia significant at the 90% level				
Factors	**1**	**2**	**3**	**4**
% of Groups	76.47%	29.41%	0.00%	0.00%
Note: 4 out of 17 (23.5% portfolio does not have any significant Factor)				

Table 4 shows results of all the portfolio showing number of factors significant with regression excluding intercept assuming zero risk free rates. We can see out of 17 portfolios most of portfolios are having at least 1 significant Factor presented in returns but overall significance of regression is presented in only 7 portfolios out of 17. We can see that In portfolio P8, P9, P11 and P14 does not have any significant factors at all and portfolio P1, P4, P13 and P16 are having 2 factors significant., whereas all other factors having only 1 factor significant.

Table 4.1 summarizes table 4 in more concise way showing number of factors which are significant at 95% in first panel and factors which are significant at 90% in second panel of table. First Panel of 4.1 is showing 10 out of 17 (approx. two-third) portfolios were having at least 1 factor significant in explaining returns and 4 portfolios having 2 significant factors but no portfolio having 3 significant factors. However, if we sacrifice margin of errors by 5% and checks the results again we can claim that 13 out of 17 more than three-fourth of the portfolios having at least one factors significant in explaining returns and 5 portfolios around 30% of portfolios having two significant factor again no portfolio has three of more significant factors.

Part IV: Chen, Roll, Ross (1986)

Here the research is in nature an exploration study. It is different from other papers that we have seen the nature of not formally testing pricing theories. This part's aim is to test the relation between macroeconomic variables (innovation in them) and return by checking appropriate risk premium for each factor. Those macro variables can be regarded as common factors in pricing equation of APT. Main results can be seen in Table 5. Part A of Table 5 shows that over entire sample period MP, UI and UPR are significant while UTS is marginally so. EWNY and VWNY are not found to be significant in any subperiod. YP is not significant in any subperiod and as it can be seen on part B, deleting it has no effect on the remaining state variables. Table 6 can be regarded as a test of CAPM, or more simply the efficiency of the index. That is if the index is efficient the factors should not improve its pricing ability. In part A, it can be seen that t-stat for VWNY is significant, hence CAPM is supported. In part B of this table, other variables put into the system in addition to VWNY. These results however differ from Table 5 as here cross-sectional regressions are run with simple betas of VWNY index instead of time-series betas. One of the most important conclusions of this paper is that even though a stock market index explains a significant portion of the time-series variability of stock returns, it has an insignificant influence on pricing when compared against economic state variables.

Data and Derived Series

In finance theory, one basic method to price a stock (hence also a way to make reference to return) is discounted cash flow method, where possible cash flow stream is dividend received. Hence, the systematic forces that might influence the returns should be those that affect "discount rate" and "expected cash flows". In original paper, by following this logic, some economic factors are identified affecting "discount rate" and "expected cash flows" and from those factors some series derived to be used in return generating process. Because of infeasibility two of those variables are not used in our study which are long-term government bonds (LGB) and low-grade bonds (Baa). Hence, two of the derived series are also not created which are risk premium (UPR) and term structure (UTS). Remaining variables, their descriptions, and derived series can be found in following table. Besides, our sample period is between January 2004 and December 2013 (10 years). As used in the original study, we have used monthly values for data.

Basic Series		
Symbol	**Variable**	**Defn or Source**
Exp Inflation	Expected Inflation	TUES01EU Index obtained from Bloomberg
XU100	BIST-100 Index	Used for equally-weighted equities in original study, obtained from BIST
XU30	BIST-30 Index	Used for value-weighted equities in original study, obtained from BIST
I	Inflation	12 months lagged log-relative of CPI of Turkey, from TUIK
IP	Industrial Production	Industry Production Index, from TUIK
RF	Risk-Free Rate	1 month deposit rate, obtained from Bloomberg
CG	Consumption	Quarterly household consumption data taken from GDP related publications of TUIK, then quarter values divided by 3 and uniform distribution assumed for months. Annual population data taken from Bloomberg and divided by 12. Then simple growth in monthly consumption per capita is found.
OG	Oil Prices	Brent oil prices found in Bloomberg, divided by monthly PPI of Turkey, log-relative is taken.
Derived Series		
MP	Monthly Production Growth	1 month log-relative of IP
YP	Annual Production Growth	12 month log-relative of IP
Exp Inflation	Expected Inflation	TUES01EU Index obtained from Bloomberg
UI	Unexpected Inflation	I(t)-Exp Inflation(tIt-1)
RHO	Ex-Post Real Interest	TB(t-1)-I(t)
DEI	Change in Exp Inflation	Exp Inflation(t+1It)-Exp Inflation(tIt-1)

Correlations & Autocorrelations

In original study, after identifying macrovariables and forming derived series, authors checks correlations and autocorrelations in order to see possible level of multicollinearity (the co-movement between independent variables) and heteroscedasticity (the time-wise dependence of independent variables with their previous values).

In original study, variables UPR and UTS are found to be highly correlated but since we don't have data for 2 variables in Turkish market (as stated before), we are not able to comment on them. In original study, 0.916 (very high) correlation is observed among equity indices and in our results same high correlation is found between BIST 100 and BIST 30 (0.99 correlation). DEI and UI are found to be strongly correlated in original study and we confirm them, our correlation between these variables is -0.47 (but our finding yields negative sign compared to 1986 paper). Original paper shows a somewhat strong correlation between production variables (MP,YP) and other ones except for inflation variables DEI,UI; but our results show that MP and YP mostly correlated with themselves and CG, not with other variables. Most of the variables are far from perfect correlation which is a good indicator of strength of study. However, one should note that resulting collinearity tends to weaken the individual impact of these variables that will be used in pricing. There is also a very high correlation between expected inflation and 2 inflation variables UI and DEI which is acceptable as both of these series use inflation as input. In original study, YP has high autocorrelation and MP has seasonal at 12 month lag, our results prove this (lag-12 autocorrelation for MP is 0.69). In original paper, low autocorrelations are observed for inflation-related variables. However, our results differ from the paper in this point as we observe very high values (like around 90%, 60%) for inflation-related macrovariables. One should also note that high autocorrelations indicate errors-in-variables problem.

Methodology

We assume that using the state variables defined above, individual stock returns follow a factor model of the form:

$$R = a + b_{MP}MP + b_{YP}YP + b_{EXP\ INF}EXP\ INF + b_{UI}UI + b_{RHO}RHO + b_{DEI}DEI + b_{BIST\ 100}BIST100 + b_{BIST\ 30}BIST\ 30 + b_{CG}CG + b_{OG}OG + \epsilon$$

Where betas are the loadings on the state variables, a is the constant and ε is the idiosyncratic error term. In original paper and in our study, a version of Fama-Macbeth (1973) regressions is used. Only asset group whose returns are investigated to find a reference to macrovariables is common stocks. Steps in forming model can be summarized as follows:

1) A sample of assets is chosen. First, we find tickers of all assets traded in BIST through XUTUM function in Bloomberg. Stocks market capitalizations are also obtained from Bloomberg. Then at the January of each month, stocks are ranked according to their respective sizes (market capitalization). Then 20 portfolios are formed for each year (of course by looking at the size ranking at the January of each year). Sample size for each ranking has been found as number of stocks whose size values are available for that January month. In each year, 19 portfolio have "sample size divided by 20) stocks and remaining stock are assigned to 20th portfolio. This procedure did not cause too much disturbance to number of stocks assigned to last portfolio (except for year 2006 where 20 assigned to last portfolio and for year 2013 where 24 stocks assigned to last portfolio). Then log-returns of portfolios have been calculated started from 2002, assuming equal investment to each stock.
2) Each of these 20 portfolios for each year have been taken and treated as dependent variables in time-series regressions where independent variables are values for state variables. In other words, the portfolios' exposure to the macro variables is estimated by regressing their returns on the unanticipated changes in economic variables over 2 years estimation period. To clarify, for instance, we take portfolios formed according to size rankings data from Jan 2004. We take portfolio 1 in that year group then regressed its 24 months return series on 24 months series of macro variables between January 2002 and December 2003. We apply the same procedure to all portfolios in January 2004 groups. Then same procedure applied to 10 years in sample period. (20*10=200 regressions run in this stage). We ended up having 20 beta estimates for each macro variable in each year of sample period.
3) In next step, we take resulting betas from time series regressions and used them as independent variables in 12 cross-sectional regressions, one regression for each of the next month (120 regressions were run in this stage). To clarify, for instance for Jan 2004, we take calculated 20 beta estimates (estimated in time series regression using 2002-2004 estimation period) for each of 10 macrovariables

and used them as independent variables while dependent variable is the returns of 20 portfolios for Jan 2004 (however composition of these 20 portfolios changes as 20 portfolios formed on the basis of size ranking values coming from January 2005 is used here). Resulting coefficients from this regression provide us risk premium estimates for each macrovariable. Rolling over the same process we obtained 120 risk premium estimates. We calculate estimated value of risk premium for each state variable by taking simple average. T-stats are calculated by:

$$\frac{Estimate}{\left(\frac{\sigma}{\sqrt{n}}\right)}$$

Results (Table 4 in Paper Chen, Roll & Ross(1986))

Risk premium estimates and related t-statistics (with respect to both all sample period and two sub-periods) are presented in table 6.

In original study, in Table 4, variables MP, UI, UPR, UTS are found to be significant for whole sample period. In our results, MP, DEI, BIST 100, BIST 30 and CG are significant as they have t-statistics more than 2 (it means that we can reject the null hypothesis that risk premium estimates for these variables are zero, so we can conclude that risk premium estimates are significantly different from zero). Surprisingly, for subperiod 2004-2008, no state variable has significant risk premium estimates. For subperiod 2008-2014, MP, Expected Inflation, DEI, BIST 100, BIST 30 and CG are significant.

In original paper, inflation related variables DEI and UI were significant in one subperiod and hold no significance in other periods. In our result, on the other hand, UI is not significant in any subperiods and DEI (although it's significant in whole period) loses significance in subperiod 2004-2008. In original paper, negative coefficients have been found for UI and DEI, our results confirm this. In original paper, state variable YP is not significant in whole sample period and in subperiods. Our results prove this as YP is not significant for whole period and subperiods 2004-2008 and 2008-2014. In 1986 paper, neither value-weighted nor equally-weighted equity series are found to be priced, but in our results, BIST 100 and BIST 30 variables that we have used to approximate them are very significant for whole period and 2008-2014 subperiod (although they lose explanatory power in 2004-2008 subperiod). Moreover, in our result, MP has display no significance for whole sample period.

In original study, oil series OG is not priced hence it was not a common risk factor. Our results confirm this logic since t-stats for OG are not higher than 2 for any period. In original study, consumption series CG is found to be ineffective as a common risk factor but CG is significant in whole period and second subperiod. This is also one of the points where our results deviate from original study.

Conclusion

In this replication study, our aim is to identify common risk factors among some pre-determined macroeconomic variables in a way that whether they are presented significant risk premiums in pricing equation that was given above. We have used methodology of Chen, Roll, Ross (1986) without any major alteration. Our time period for study is 10 years between 2004-2014 and we have used 2 years as estimation period in Fama-French regressions. Because of data limitation we are not able to generate and use UPR and UTS variables. We have ranked portfolios according to size (market capitalization) and portfolio returns are calculated as log-returns. Our main results have showed that stock returns are exposed to systematic economic news that they are priced in accordance with their exposures. Those variables in our study are MP, DEI, BIST 100, BIST 30 and CG that must be given importance.

Appendices

Table 2: Factor Analysis; Principle Component Method – Portfolio wise

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Cumulative Variation Captured	# of Securities
	Eigen Value	8.927	1.0938	1.0078				
P1	Proportion	0.4464	0.0547	0.0504			0.5515	20
	Eigen Value	9.042	1.199	1.124				
P2	Proportion	0.476	0.063	0.0592			0.5982	19
	Eigen Value	6.952	1.186	1.085				
P3	Proportion	0.365	0.062	0.057			0.484	19
	Eigen Value	5.892	1.119	1.067	1.0108			
P4	Proportion	0.294	0.056	0.053	0.05		0.453	20
	Eigen Value	6.95	1.2	1.07				
P5	Proportion	0.365	0.063	0.056			0.484	19
	Eigen Value	6.571	1.195	1.14	1.007			
P6	Proportion	0.328	0.0598	0.057	0.0504		0.4952	20
	Eigen Value	6.11	1.149	1.032				
P7	Proportion	0.306	0.0575	0.0516			0.4151	20
	Eigen Value	6.281	1.195	1.078	1.052			
P8	Proportion	0.3305	0.062	0.056	0.0554		0.5039	19
	Eigen Value	8.534	1.626	1.029				
P9	Proportion	0.426	0.081	0.051			0.558	20
	Eigen Value	7.748	1.1563	0.9852	0.9812			
P10	Proportion	0.387	0.058	0.049	0.049		0.543	20
	Eigen Value	7.212	1.06	1.003				
P11	Proportion	0.4007	0.0589	0.0556			0.5152	18
	Eigen Value	7.516	1.584	1.1667	1.085	1.068		
P12	Proportion	0.375	0.079	0.058	0.054	0.053	0.619	20
	Eigen Value	9.346	1.145	1.046				
P13	Proportion	0.491	0.0603	0.0551			0.6064	19
	Eigen Value	11.943	1.73	1.119				
P14	Proportion	0.628	0.0911	0.058			0.7771	19
	Eigen Value	9.213	1.278	1.023				
P15	Proportion	0.4607	0.0639	0.0512			0.5758	20
	Eigen Value	9.0568	1.213	0.978				
P16	Proportion	0.476	0.063	0.0515			0.5905	19
	Eigen Value	12.795	1.936	1.163				
P17	Proportion	0.6398	0.096	0.0582			0.794	20

Table 3: Regression of Factors Loading Estimates with Expected Returns of Securities

$$R_p = \gamma_0 + \gamma_1 b_{p1} + \cdots + \gamma_5 b_{p5}\ (\gamma_0\ estimated)$$

		Intercept	Factor1	Factor2	Factor3	Factor4	Factor5	Adjusted R Square	F Stats of Portfolio Regression	Significant Factors **(0.05)	Significant Factors * (0.1)
P1	Coefficient	0.000148	-7.00E-05	0.000609	-0.00023			0.290052	3.587506	1	1
	T Stats	0.594359	-0.214	2.328375	-1.0222						
P2	Coefficient	0.000178	-8.70E-06	-0.00019	-0.00017			-0.02118	0.875566	0	0
	T Stats	1.201862	-0.04553	-1.17216	-1.11507						
P3	Coefficient	-0.00021	4.85E-04	3.21E-05	4.83E-05			-0.02978	0.826471	0	0
	T Stats	-1.13604	1.574536	0.188149	0.268177						
P4	Coefficient	0.000477	-6.70E-04	-0.00041	-0.00028	-0.00053		0.293818	2.976313	2	2
	T Stats	1.539574	-1.194	-2.04727	-1.17529	-2.97977					
P5	Coefficient	8.86E-05	-7.60E-05	1.35E-06	-0.00036			-0.00234	0.986021	0	0
	T Stats	0.298022	-0.15372	0.006852	-1.70443						
P6	Coefficient	-0.00083	1.46E-03	-5.5E-05	-0.00111	0.000975		0.550831	6.825089	3	3
	T Stats	-2.77321	2.8331	-0.16359	-3.36415	2.728256					
P7	Coefficient	-5.8E-05	2.96E-04	-0.00015	-0.00011			0.023417	1.151865	0	0
	T Stats	-0.39817	1.132924	-1.00753	-0.71852						
P8	Coefficient	-0.00071	1.33E-03	0.00079	0.000185	0.00068		0.118704	1.606118	1	3
	T Stats	-1.98534	2.195633	1.877944	0.475979	1.722555					
P9	Coefficient	2.07E-05	-5.60E-05	0.000355	0.00037			0.048429	1.322329	0	0
	T Stats	0.05023	-0.08956	1.504094	1.169446						
P10	Coefficient	0.000218	-3.10E-04	-0.0007				0.071459	1.731109	0	1
	T Stats	0.45309	-0.40913	-1.83357							
P11	Coefficient	-0.00089	1.39E-03	6.79E-05	-7.4E-05			0.385362	4.552856	1	1
	T Stats	-3.58082	3.551722	0.272653	-0.28494						
P12	Coefficient	8.05E-05	-7.20E-05	-0.0002	0.00026	-0.00019	0.000645	0.030839	1.120915	0	1
	T Stats	0.190938	-0.10578	-0.68838	0.721617	-0.52801	1.831455				
P13	Coefficient	-0.00069	9.69E-04	-0.00038	0.00118			0.518244	7.45443	1	1
	T Stats	-1.49951	1.506821	-0.89165	3.740252						
P14	Coefficient	-0.0006	6.84E-04	0.000656	0.000664			0.07969	1.519544	0	1
	T Stats	-0.87552	0.795056	1.758739	1.437103						
P15	Coefficient	-0.00028	5.11E-04	-0.00014	0.000259			0.108348	1.769587	0	1
	T Stats	-1.33015	1.669272	-0.84304	1.378734						
P16	Coefficient	-7.8E-05	3.06E-04	-0.00015				0.310685	5.056442	0	0
	T Stats	-0.49962	1.356472	-1.33609							
P17	Coefficient	-0.00138	1.69E-03	4.24E-05	0.001081			0.411386	5.426413	2	2
	T Stats	-3.06859	3.020805	0.181946	3.510453						

Note: Only 23.5% (4 out of 17) Intercept are Significant at 95% and 90% Level

Table 4: Regression of Factors Loading Estimates with Expected Returns of Securities Without Intercept
$R_p = \gamma_1 b_{p1} + \cdots + \gamma_5 b_{p5}$ (assumed $\gamma_0 = 0$)

		Factor1	Factor2	Factor3	Factor4	Factor5	Adjusted R Square	F Stats of Portfolio Regression	Significant Factors (α = 0.05)	Significant Factors (α = 0.1)
P1	T Stats	3.5111219	3.5111219	-0.886488			0.3795918	5.6109446	2	2
P2	T Stats	2.6918665	-0.60361	-0.584737			0.2147067	2.9677948	1	1
P3	T Stats	2.0438847	0.0505595	0.0586139			0.0456811	1.3944898	1	1
P4	T Stats	2.8628687	-1.307125	0.0480155	-2.448656		0.3419582	3.9759303	2	2
P5	T Stats	0.8660437	0.007566	-1.730454			0.0258509	1.2481464	0	1
P6	T Stats	0.503205	-0.932975	-3.076786	1.8081523		0.3012061	3.4651039	1	2
P7	T Stats	3.2789488	-1.153471	-0.739132			0.2998933	4.2093656	1	1
P8	T Stats	1.0121827	0.7986473	-0.305617	0.9222588		-0.089025	0.6515863	0	0
P9	T Stats	-0.253014	1.5642165	1.3108362			0.0461775	1.4096914	0	0
P10	T Stats	0.2120419	-1.840032				0.0578657	1.7153488	0	1
P11	T Stats	0.2410698	-0.118476	-0.779052			-0.150914	0.2263566	0	0
P12	T Stats	0.4657478	-0.685723	0.9682612	-0.511916	2.1162198	0.044028	1.272998	1	1
P13	T Stats	0.1603594	-2.728992	3.3681611			0.4205187	6.2725014	2	2
P14	T Stats	-0.541092	1.5460631	1.1499796			0.0377428	1.3351326	0	0
P15	T Stats	1.8987254	-1.259249	0.8994455			0.1150888	1.9999932	0	1
P16	T Stats	6.2142479	-2.229390				0.6440773	21.792911	2	2
P17	T Stats	-0.068114	-0.810601	2.0135145			0.0662384	1.5719413	1	1

Table 5

	MP(t)	YP(t)	Exp Inflation	UI(t)	RHO(t)	DEI(t)	BIST100	BIST30	CG	OG
MP(t)	1.0000	0.2133	0.0400	0.0258	-0.0135	-0.0643	-0.0040	-0.0104	0.1508	0.0860
YP(t)	0.2133	1.0000	0.0968	0.1184	0.0791	-0.0390	0.0246	0.0231	0.0989	0.1017
Exp Inflation	0.0400	0.0968	1.0000	0.4952	0.5717	-0.7424	-0.0877	-0.0838	-0.0010	-0.0078
UI(t)	0.0258	0.1184	0.4952	1.0000	0.0855	-0.4754	-0.1346	-0.1259	-0.0630	0.0004
RHO(t)	-0.0135	0.0791	0.5717	0.0855	1.0000	-0.4120	0.0626	0.0652	0.0339	-0.0281
DEI(t)	-0.0643	-0.0390	-0.7424	-0.4754	-0.4120	1.0000	-0.1265	-0.1323	-0.0006	-0.0191
BIST100	-0.0040	0.0246	-0.0877	-0.1346	0.0626	-0.1265	1.0000	0.9961	0.1740	0.1190
BIST30	-0.0104	0.0231	-0.0838	-0.1259	0.0652	-0.1323	0.9961	1.0000	0.1782	0.1026
CG	0.1508	0.0989	-0.0010	-0.0630	0.0339	-0.0006	0.1740	0.1782	1.0000	0.1501
OG	0.0860	0.1017	-0.0078	0.0004	-0.0281	-0.0191	0.1190	0.1026	0.1501	1.0000

Lags	1	2	3	4	5	6	7	8	9	10	11	12
MP(t)	-0.4647	0.0761	0.0422	-0.1651	-0.0706	0.2516	-0.0895	-0.1523	0.1756	-0.1915	-0.2125	0.6987
YP(t)	0.7248	0.7311	0.5950	0.5139	0.4435	0.3894	0.2919	0.2378	0.1606	0.0182	-0.0610	-0.0894
Exp Inflation	0.9979	0.9933	0.9880	0.9841	0.9813	0.9780	0.9730	0.9670	0.9595	0.9512	0.9440	0.9385
UI(t)	0.9102	0.7835	0.6240	0.4560	0.3373	0.2374	0.1359	0.0392	-0.0603	-0.1213	-0.1571	-0.1739
RHO(t)	0.9710	0.9452	0.9151	0.8758	0.8348	0.7932	0.7565	0.7269	0.6909	0.6643	0.6446	0.6151
DEI(t)	0.7382	0.5035	0.3089	0.2902	0.3908	0.4766	0.4850	0.5108	0.4210	0.2296	0.1530	0.2032
BIST100	-0.0870	0.0167	0.1029	0.0183	0.0124	-0.0333	-0.0079	-0.1127	0.0422	-0.0494	0.0862	-0.0540
BIST30	-0.1076	0.0157	0.0945	0.0152	0.0228	-0.0393	-0.0063	-0.1049	0.0511	-0.0564	0.0822	-0.0368
CG	-0.0137	-0.0138	-0.0361	-0.0137	-0.0138	-0.6741	-0.0097	-0.0098	-0.0112	-0.0102	-0.0103	0.7575
OG	0.2413	0.0754	-0.0387	-0.0623	0.0788	-0.2181	-0.1053	-0.1795	-0.1613	0.0681	0.0181	-0.0199

Table 6

		RISK PREMIUM ESTIMATES									
		MP(t)	YP(t)	Exp Inflation	UI(t)	RHO(t)	DEI(t)	BIST100	BIST30	CG	OG
2004-2014	Coefficients	0.1279	0.011299	0.003685552	-0.00245	-0.00063	-0.00434	-0.10036	-0.10843	0.093212	-0.00214
	T-stats	2.856791	0.845364	0.814473756	-0.64022	-0.1276	-3.49925	-2.7291	-2.79503	3.237139	-0.17433
2004-2008	Coefficients	-0.00539	0.022838	0.001087938	0.000216	-0.00344	-0.00136	0.022843	0.02217	-0.00485	0.013257
	T-stats	-0.22883	1.275217	0.122862185	0.059136	-0.50966	-1.14853	1.264332	1.228031	-0.93942	0.688936
2008-2014	Coefficients	0.261186	-0.00024	0.006283167	-0.00512	0.002191	-0.00733	-0.22355	-0.23903	0.191271	-0.01753
	T-stats	3.137686	-0.01208	3.157226239	-0.75828	0.30598	-3.44919	-3.2912	-3.32542	3.496777	-1.16351

References

Chen, N. F., Roll, R., & Ross, S. A. (1986). Economic forces and the stock market. *Journal of Business*, 383-403.

Demir, Y., Öztürk, E., & Albeni, M. (2007). Türkiye'de Finansal Piyasal ile Ekonomik Büyüme İlişkisi.

Flannery, M. J., & Protopapadakis, A. A. (2002). Macroeconomic factors do influence aggregate stock returns. Review of Financial Studies, 15(3), 751-782

Hussain, A., Lal, I., & Mubin, M. (2009). Short run and Long run Dynamics of Macroeconomics Variables and Stock prices: Case Study of KSE (Karachi Stock Exchange). *Kashmir Economic Review*, 18(1).

Iqbal, J., & Haider, A. (2005). Arbitrage Pricing Theory: Evidence From An Emerging Stock Market. *THE LAHORE JOURNAL*, 10(1), 123-139.

Mubin, M., Bhutto, S.A., Raza, H. (2015), Arbitrage Pricing Theory: Empirical Evidence from Turkish Stock Market, *Developing Countries Studies* , 5(11), 26-31

Muhammad, S. D., Lal, I., Naqvi, S. I. H., & Zehra, S. (2012). Arbitrage Price Theory (APT) and Karachi Stock Exchange (KSE). *Asian Social Science*, 8(2).

Roll, R. (1977). A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory. *Journal Of Financial Economics*, 4(2), 129-176.

Roll, R., & Ross, S. A. (1980). An empirical investigation of the arbitrage pricing theory. *The Journal of Finance*, 35(5), 1073-1103.

Zubair, M., Burney, A. I., Sarwat, S. S., & Mubin, M. (2014). Macroeconomics Relations between Exchange Rate Instability, Exchange Rate Volatility, Trade and Economic Growth Variables: The Case of Pakistan. *Journal of Economics and Sustainable Development*, 5(13), 44-53