Analysis of Arbitrage Pricing Theory to Predict Stock Returns during and after the Stock Market Bubble in Tehran

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Abstract Understanding the mechanism and efficiency of a risk and return in capital markets, is one of the important issues that have attracted the view of financial user for long time. Pattern introduce the process of return, risk and return relationship of various factors as independent. Among these models there are capital asset pricing model (CAPM) and arbitrage pricing. This study uses two basic hypotheses to test the arbitrage pricing theory of capital market in the period of 1999 to 2008 in Tehran. First the number of factors that influence the efficiency is estimated that involved 13 in the pre-bubble, 12 in the bubble period and 14 after bubble period. The main purpose is the test arbitrage pricing theory (APT) technique using factor analysis and the efficiency of the odd week, and finally with an average balance equation obtained by even weeks were analyzed to estimate the model predictive power The results should that there is no significant difference between the mean squared errors of odd and even days with the 95 confidence Research findings suggest that the arbitrage pricing. Theory is true only in the bubble period, and Iran's stock market returns is affected of two-factor model, these two factors supply 48.6 percent of total output fluctuations.

Introduction

Until now different patterns of risk and return relationship of the various factors are introduced as independent variable. Capital asset pricing model (CAPM) is a single-factor model. This model corresponds the expected rate of return of per share to the risk of its share that measured by the Beta (β), bat the experimental tests have been met with skepticism to this pattern. Arbitrary pricing theory, expressed as stock returns as a linear function of unknown and indefinite reason, which is not linearly related to beta .factor analysis approach used to achieve this goal that can estimate factors affecting the stock return. There is an implicit assumption in the factor models that says yields of two different securities have correlation to one or more than one common factor.

The theory of arbitrage indicates this fact too. When the stock price has fluctuated around its intrinsic value, there by causing an increase in price volatility (price deviations from intrinsic value) may cause bubbles in the market. 50 they reach risk-free way to earn profits in their business. In this study, arbitrage pricing theory before, during and after the stock market bubble in Tehran will be reviewed to determine which of these theories is established.

Problem:

Arbitrage pricing theory was proposed by Ross in 1977 and later continued by conner, chen, Routchlid and chamberlin, Daybvyg , Grnlat and Tatman ,Haberman , Ingrsoul , chental, Mac Alry…This theory states that stock yields is a linear function of unknow factors and indefinite that is not linearly related to the Beta(systematic risk). Experimental evidence from tests of arbitrage pricing showed that there are more than one factor in determining stock market returns in the market sets. Another test option is introduced under the arbitrage pricing theory that.

Claims efficiency of securities and capital market at the macro-economic impact of various factors. It is worth noting that the theoretical basis of the unit price is the arbitrage pricing model, is a equal price to the product. Arbitrage pricing model, , unlike the capital asset pricing model, does not depend on the market portfolio and it is the advantage of this model. Arbitrage pricing model is a model that describes the cross-sectional variations in assets return. Return of property is concerned linely to the common factors and individual responses or non-systematic risk.

The important point in this study is that, expected returns is depended on estimated amount obtained directly via factor analysis covariance matrix of historical stock returns, This means that only the risk –in the portfolio is analysised an this is the only risk that investors may realized. Determinates factors study the expected return an assets in the three periods of before, during and after the bubble.

Bubbles are destructive phenomena that fracture the functioning of capital markets in stagnant investment and allocation of resources to productive sectors of the economy. Examine the past behavior of stock prices and investors expectations of future increases in price cause the formation and growth the bubbles in the market. Sometimes phenomenon occurs that proposed models for the evaluations and market pricing of securities is not able to explain, that it can be pointed to a bubble in the market. Techniques used in this study is factor analysis and there are the two ways to find the effective factors , although there are equivalent :

1.first, one can assume and present a theory to determine which variables should be put into the priced equation and then test it.

2. asset return can be analysed and tested to determine the major related variables.

Test arbitrage pricing (APT) is a second way. In the first method we can not reach the goal, because it requires extensive data mining. Collaborative effort , cost and time of data mining, moreover there is probability of large error in data mining, instead , with the second solution and calculate the load factor by factor analysis we can construct portfolio that is compatable with any shared factor. It is worth nothing that we use the factor analysis used as a statistical tool to reveal the pervasive forces (factors) in our economy and for this goal we test the synchronization of the return an assets and its varing. Arbitrage model is designed for relationships between events and issues of return and the value of the securities that investors can assess based on it.

In research on arbitrage pricing theory, the results suggest that there is a two-agent model in explaining stock returns. the study is completed in 3 periods including the before and during and after bubble period. Bubble period that is important economically is put beside the arbitrage pricing theory.

Background Research:

The first test conducted on the arbitrage pricing model by Roll and Ross in 1980. The technique that these two persons used to estimate was the technique of factor analysis. Due to the complexity factor analysis is used on the relatively large number of stocks at a time. Roll and Ross used the securities analysis for 42 of the 30 shares in the period of June 1962 to December 1972. They found that four factors have an important role.

Roll and Ross planned a two-step process to plan included of:

1- Use a separate time series of asset return to estimate expected returns and the factor coefficients.

2- Use of estimates for the initial evaluation test of arbitrage pricing theory, particularly to estimate the public factor.

With a portfolio of any given set of assets. Shanken shows that different structures of factor analysis can be manipulated to determine the portfolio. He makes clear that in the best conditions, if results of portfolio were not related 2 by 2 factor analysis does not provide any common factor.

Gyanis in a research in 1986 studied about the stock returns of different groups and different time scales, with the use of monthly data for 200 shares of stock in London and the period between 1956 and 1981, he concluded that increasing portfolio size increases the number of agents needed to explain the efficiency. The number of different time scales for the portfolio in the same size is not fixed. Therefore it is likely to impact the industry type on the factor in the APT.

Bumeister and wall in 1986 identified four macroeconomic variables affecting an asset returns in the arbitrage pricing theory, that included of unexpected changes in risk or the non-payment, unexpected changes in the structured of interest rates, unpredictable inflation, non – expected and unpredictable changes in growth rate of final sales. APT model was used to test the japans macro-economic factors in the capital market in Japan in 1988. The test consists of operating in industrial production, inflation, investor confidence, interest rates, foreign exchange and oil price. He found that changes in expected inflation and unforeseen changes in the term structure of interest rates have a significant import on the securities market in Japan.

McGowan and Dobson in 1993 used a combination of factor analysis and correlation kano Nical to determine factors in arbitrage pricing theory, Results of studies showed that the fist factor strongly associated with the industrial output index 5(s & P) 500, whilefoure others are highly correlated with the structure of interest rates, inflation rates, regardless of risk, and the industrial production. Macro economic factors in pricing efficiency of stock market have been effective in England during 1983 and 1990. There for, the monthly data from 840 companies was used to access the beta and the market value of portfolio securities by rating . They found that several economic variables were efficient over the course of using the beta of a portfolio of securities on the market was used only measure of inflation and risk are priced. Moreover the value of ranked market has no role in efficiency of Bazaar.

Yasuiro Yonezawa in 2004 examined the theory, during, before and after the bubble period in capital market in a study entitled "Evaluation of the arbitrage

pricing theory using Japanese macroeconomic variables".

The study introduces four factors consisted of money supply, inflation, exchange rates in the stock market and macro-economic as factors affecting the efficiency of industrial production. These factors were fixed in 3 mentioned periods Research suggest that the risk in the bubble period was more than other periods (before and after the bubble) and that was due to fear of recession.

Jalal Naeini and Babak Teymourian in 1998 perform a study titled "Evaluation of the relationship between risk and return in the Tehran stock Exchange based on the theoretical foundations of the capital asset pricing model (CAPM) and arbitrage pricing model (APT) using a market experimental model perform. The results showed that the Tehran stock Exchange is Knock out and the true measure of risk for Iranian investors and capital markets is fluctuations of its stock price not beta.

According to their findings, test the arbitrage pricing model (APT) was rejected, meaning that other factors are effective such as pricing policies on the market deficiency, lack of transparency and market information or incomplete information to investors on stock returns and it is necessary to find them.

Morteza Qarebaqi and Zahra Nasrollahi tested arbitrage pricing theory in Tehran stock Exchange and shares of 57 companies listed in Tehran stock Exchange in period of 1992 to 1997 this study was performed based on factor analysis and only two factors were priced by the market, or in other words these factors had a significant risk statistically and it described 26 percent of changes in the rate of return.

Jalali Naini and Ali Reza sadeqi in 1993 examined the arbitrage pricing model based on time – series approach in a period of factory periods in the set of 150 firms. They studies eight factors included of the rate change of government oil revenues, construction costs and the current exchange rate (free market), stock index , GDP, money stock and index returns of seven active housing industries in the Tehran stock Exchange. The formed basket of securities of every industry and axamined the relationship between the baskets of securities and economic risk factors.

The research findings showed that:

1.There is a negative relationship between changes in housing price index and output of active industries in stock .

2.change in the inflation rate for the industry under study was a meaningless factor.

3.The ratio of government oil revenues for the chemical industry and paper products was positive .

4.The relationship between risk factors of the exchange rate in the chemical industry and paper products was positive.

5.The relationship between risk factors of the current costs government and basic metals industries group and transportation was positive.

6.Risk factors associated with the construction cost of government in cement and chemical industries were positive .

Hosseini Nasab and Godary in 2006 have done the study in a title of "Analysising of bubbles in the Tehran Stock Exchange during the last years (2000-1999). This study examines nature bubble from the prespective of psychology, general systems theory in the economy and Pay tares sections, in one hand, and review the econometric tests to detect bubbles, in other hand. They performed the test of reliability and cost benefits using bubble originated in 1999 in Tehran Stock Exchange index, they used the root of the stock market bubble over 23 companies in 1999 in Tehran.

This test is based on the logarithm of the price earning ratio and the unit root test on this variable. If the existence of unit root in logarithm of price rejects hypothesis of existence of bubble would be Rejected too and vice verse the test results are as follows:

Stock price has been bubble in 83 year but it hasn't in 84 year because of falling prices and there for bursting bubble in the viewpoint of many expects.

Rahnema Roudposhtiand Mohammad Reza moradi guided the research in 2006 entitled "study of the mechanism arbitrage pricing (APT) using factor analysis in the Tehran Stock Exchange". This study uses the technique of factor analysis over seven –year period(1998 to 2004).

The results of this study showed that stock returns in the market, at least under the influence of Iran, is a two-agent model. These two factors can explain 40 percent of the total variation in portfolio returns. The research findings show that arbitrage opportunities don't exist in the Iranian capital market.

The Research objectives:

The main purpose of testing the arbitrage pricing theory (APT) is the predicting stock returns before, during and after the market bubble in the Tehran Capital Market. The research will show that whether the number is different or not.

The research Hypotheses:

First hypothesis: The number of risk factor before, during and after the bubble period is different.

Second hypothesis: In order to predict stock returns, the theory of arbitrage –based assessment is established before, during and after the bubble period.

Analytical model to study:

The assumption is that asset markets fully open and competitive, or in other words, markets are

efficient, and on this basis, suppose investor believe that the return on assets of the factor was created, so that the out put of the assets is :

$$r_i = E_i + b_{i1}F_1 + ... + b_{ij}F_j + \varepsilon_i$$

E_{i} = expect return

F_j = share of assets with a zero mean that $j = 1، 2، 3.....،j$

ε_i = ith remainder assets risk

b_{ij} = sensitivity to fluctuation in operating return on assets of i | j

When the market is efficient and competition is perfect, There are no arbitrage opportunities, the caution of expected return for ith asset is a follows:

$$E_i = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} + ... + \lambda_k bij$$

λ_k , is zero – risk, if we have risk-free assed as $\mathbf{b_{ij} = O}$ its excepted return and will be λ_O .

Research method :

The natuer of this research is descriptive and correlational .

Detection of bubbles: Trend analysis of P/E ratio (price to earning) is used in order to detect the bubble period and time.

This study has been made in four years from 2009 to 2012. According to the table average of P/E ratio has increased in 2010 and 2011 increasingly and this upward trend is indicator of the price bubble in the stock market, but this ratio has suddenly dropped in 2005 so many experts believe the bubble has recently burst by the price drop.

Thes claims can be proved. If you consider the graphs presented using a logarithmic graphs of P/E in the appendix, you would see profit drop in this index.

Logarithm of the price gains will help to provide normal indicator. So years of 2003 and 2004 are the bubble period, the years of 2002 to 1999 are before bubble period, years of 2005 to 2008 are after bubble period. In addition in 2002 and 2003, people was highly recommended to invest on the securities beside the real assets like land, gold, housing, real estate, cars, etc. therefore, in these years we see more people investing in the stock. But for various reasons, the stock indexes were down in large amount in 2004year. most stock market experts and officials introduced the inappropriate price increases in the years 2002and 2003as the fillip of a bubble that waiting to burst, and lowering the indices.

Other causes of severe decline in stock indices of 2004were the high demand and limited supply in stock. Due to geographical expansion and established scholarships for local and provincial markets and the influx of investments in 2002and 2003years caused to increase demand and the stock price index growth. This bubble burst in 2004 and showed its effects.

Community and sample: All the companies listed in Tehran Stock Exchange as a statistical population are taken into consideration study time period is from the beginning to the end of march 1998(the Persian date is farvardin 1998). Elimination method of sampling is selected. Thus, the companies under study should be listed in stock Exchange in the beginning of 1999 or before it and they shouldn't have any interruption in their transactions, moreover they should have necessary information for this study. The33 companies were selected by this method as example.

Statistical methods: Study uses the factor analysis method factor analysis is one of the methods and tools to determine the validity of the underlying measured data, it has two general forms:

1. Exploratory factor analysis 2. Confirmatory factor analysis we use this method to answer this question, whether a small number of common factors and explain the pattern of correlations among a large number of variables. Mining factor in the decision-making is necessary in two cases: first in the extraction factors method and other determine the number of host factors. 3. companies are selected to investigate the efficiency of the primary.

Variables. One of the main stage of factor Analysis identification of those that can explain observed correlations between variables, logically and satisfactority. The factor analysis of the following methods are used to extract a number of factors below.

Cumulative percentage of variance criterion:

With this method the total variance is calculated by the efficiency of selective companies, we continue operating until the number of extractive egent can explain at least 85 percent of the total variance or special value of the last factor be at least 5percent of total variable.

Cattell Pebbles Criteria:

Pebbles cattle test is the most appropriate method to select the correct number of factor. This diagram is plotted based on the number of factors and special amount and special amount are presents according to descending order in terms of their importance. In frist stage of factor analysis, factors are estimate via analysis table and kotal graph. Then, using the following equation:

$$E_i = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} + ... + \lambda_k bij$$

E_{i} : Expected return

λ_k : The only risk

b_{ij}: Sensitivity to fluctuations in operating return on assets of the i⏐j

Using the covariance matrix of odd weeks we have, these results it is worthful to mention that the analysis should be done in the three periods; before, during and after the bubble period. Estimation of load factors has been completed as independent variable, the next step is to estimate the alone risk(λ_k) and balance equation.

Balance equation is defined:

$$r_i = E_i + b_{i1}F_1 + ... + b_{ij}F_j + \varepsilon_i$$

r_i :Return on assets of the

F_j : Share of assets with a zero mean that

ε_i :the remainder asset risk

b_{ij}: Sensitivity to fluctuations in operating return on assets of the i⏐j

Thus the average total return for the odd weeks is estimated as the regression dependent multi variable, than we extract total balance equation. This reqression is done again in three periods, several variable should be realized to perform the multiple regression analysis, so we have multi- linear regression analysis to test the first hypothesis:

1.The average error is zero

2.The variance of errors equals one

3. There is no correlation between the error model

4. The dependent variable is normally distributed

In addition of their Durbin Watson test (DW) and the normal dependent Variable of the Kolmogorov-Smirnov test is used to examine correlation between the errors.

Hypothesis testing:

Test the first hypothesis:

"The number of risk factors before, during and after the bubble period is different".

To test this hypothesis the total variance table should be estimated using the cumulative percentage of variance for the three period, thus according to the result 13,12,14 factors were estimated. These factors explain 66/93, 67/56, 71/082 the total variance respectively. Thus based on factor analysis there are 13, 12, 14 factor operating in forming the efficiency of the Tehran Stock Exchange before, during and after the bubble respectively. In other word, there is a common featuer in the stock return of all stock companies before, during and after the bubble period/ As the following chart shows 13, 12 and 14 are operating with value more than 1.
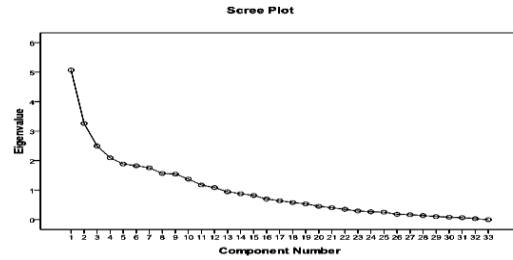
Before the bubble
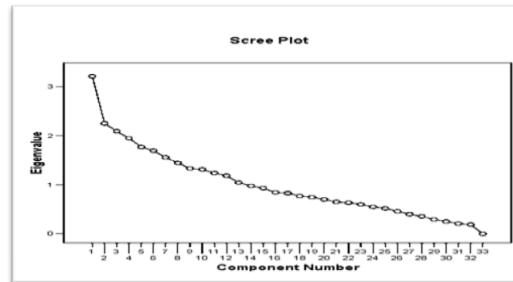
During the bubble
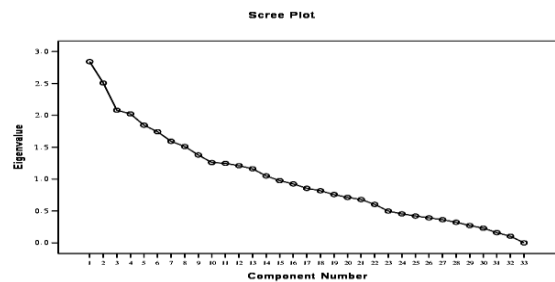
After the bubble

Figure 1. Before, during and after bubble

Test the second hypothesis:

Load factor expresses solidarity with the host variable .Load factor is placed in the rang of -1 to +1 and the closer this amount to 1, the higher correlation between factor and variable.

Factor matrix columns can be simple by varimax rotation. We are trying to decrease the number of variables that have a high load factor. In this method, The total change in load factor reach the possible maximum. It is expected to find a very high or very low load factor in the operating close many statisticians prefer this rotation method to other methods. This value can be very higher based on importance of research but typically value 1 is used for classified shipments. Load factor can be used to test the second hypothesis via regression for three periods. The necessary hypothesis for regression takes place in this way:

H0: Variable y has a normal distribution

H1: Variable y has no normal distribution

To prove the normality of the dependent variable we use Kolmogorov-Smirnov test that its result are presented in the following table:

According to the table output table we have p-value then >0.05 ,H0 was accepted for before and during the bubble and bubble period because $0.05 < $ P-value then H1 That suggested the unnormality of data, was accepted. After checking the normality of data We should continue to test weather there is a liner relationship between variables before and after the bubble or not thus

If Durbin Watson statistics is in the range of 1/5 to 2/5, there would be no correlation between errors. Durbin Watson statistic in this table shows that errors are independent. According to the coefficient obtained from the out put of the test change in the dependent variable is explained by the independent variables in the model, that were 19.9 percent 48.6 and 24.9 percent for before, during and after the bubble period.

The existence of linear relationship between variable:

To verify the linear relationship between 2 variables, statistical hypothesis test for significant overall regression model is as follows:

H0: There is no linear relationship between variables
H1: There is a linear relationship between variable

Sig in the table is 0.874, 0.006, 0.168, for before, during and after the bubble period respectively. Sig in the babble period is less than 5% (P- value <0.05) so zero can be rejected. Relationship between the independent variables and the dependent variable is confirmed. Before and after the bubble period, there is no relationship between the dependent variable. So, the regression test should only be used in the babble period, was student t statistic test with 95 percent reailbility. Thus the number of factors in the model is determined.

Therefore, 12 factors indentified in the bubble period as the coefficients of the regression equation and output show the number of elements remaining in the model.

A multivariate model is shown as follows:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots\ldots\ldots + \beta_{12} X_{12} + \varepsilon$$

Where:

Y: The dependent variable (return on assets during the bubble period

β_0 :Latitude of origin

β_1 ، β_2 ، β_3 ، β_4 ،........... ، β_{12} : The slope of the regression line and the amount spent on risk

$X_{12}, X_{11}, \ldots\ldots, X_1$: Load factors value for each company

Regression coefficient of all factors except F3 and F2 in the model is meaningless and should be removed from the model only the F3 and F2 with a significant level of Remain in the mode 1 the resulting regression equation was as follows:

$$Y = 0.880 - 0.584 X_2 + 0.468 X_3$$

With the above notation and the above equation can be noted that despite 12 factors into account. But the regression equation shows only two factors for explaining the yields in the bubble period. Due to the lack of significant of some of the regression coefficients we use the stepwise multiple regression analysis to obtain the best regression line equation.

In this way we inter identified 12 factors in the software and even by using the step by step approach can be seen that the two factors, F3 ،F2 remained in the model.

The coefficient of determination obtained from the test output shows that 51.6 percent of asset returns changes is explained by two factors f2 and f3 with significant levle of in the model. The regression equation method in according to the step by step regression method is as follows:

Y=0.695-0.487X2-0.503X3

This equation shows that a 2-factor model will explain the return on assets in this period. To achieve this, we used a model of efficiency of odd weeks. The question is this. If we use return results of even weeks, what will happen?

There for mean square errors odd and even weeks should be compared with the 95% reliability level to determine whether there is significant difference between their mean or not?

The hypothesis of this test is as fallows:

$$H_0 : MSE_{faed} = MSE_{zoj}$$

$$H_1 : MSE_{fard} \neq MSE_{zoj}$$

According the t statistic and p (p>0.05), it is proved that average size of data error for odd and even weeks is same.

It mean that estimated F2 and F3 have power to explain the data with 95 percent reliability.

Table 1: Mean P/E

Mean P/E	P/E	Year
6.42	1233	2002
9.23	2631.32	2003
8.90	2600	2004
6.76	2026.69	2005

Table 2: Kolmogorov-Smirnov test for 3 period

period	Asymp. Sig	Kolmogorov-Smirnov Z	Std.deviation	Mean	number
before	0.958	0.509	0.6778	0.9808	33
during	0.751	0.676	0.8456	0.5495	33
after	0.993	0.427	0.39516	0.2545	33

Table 3: Regression of asset return and factor in 3 period

Period	R	R Squar	Adjusted R Squar	Std. Error of the Estimate	Durbin-Watson
Before	0.742	0.594	0.199	0.6067	1.588
During	0.824	0.679	0.486	0.6062	2.438
After	0.545	0.279	-0.249	0.44166	2.408

Table 4: Analysis of variance and regression models terms of return on assets

Period	F	Sig
Before	1.611	0.168
During	3.521	0.006
After	0.544	0.874

Conclusion

The second hypothesis was accepted and the second one is rejected. Arbitrage opportunities can be achieved when an investor can from a portfolio with the zero-size investment, so that the safe (no risk) to be achieved. Investment portfolio with zero-size investment, means new investment does not need new capital [cash Surplus]. Arbitrage opportunity comes when there is no the law of single price. That is an exchange of assets with different price. APT model is based on the assumption that there is a reasonable balance in the capital markets, to prevent arbitrage opportunities.

Price bubble occurs when [a positive deviation from the intrinsic value of stock price], market equilibrium is established, in case the stock begins incorrect pricing and risk –free interest income is invested, when there is not the law of single rate on the market, arbitrage occurs.

The purpose of this paper is study the arbitrage pricing theory to predict stock returns during, before and after the bubble period.

This test was performed in a 10-year period that was divided into three distinct period. APT test was performed b separately in each period, and only in the bubble was established.

The results showed, that stock market return is effected by at least a two –agent model, these factors can account 48.6 percent of market fluctuations.

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1/3/2013