

The Relationship between Macroeconomic Variables and Stock Returns in the Tehran Stock Exchange

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Abstract

Relationship between stock returns and macroeconomic variables of interest to many researchers have been, But so far not reached a definitive conclusion about this relationship. This relationship varies from country to country due to the economic structure provides different results. In this study the impact of macroeconomic variables including exchange rates, world gold prices, inflation, liquidity and oil price on the stock returns index in Tehran Stock Exchange data is evaluated monthly over the period 1379 to 1389 by " GACH " economic model. Results showed that the gold price , inflation and exchange rate variables influencing on the stock return and oil price and liquidity had no impact on the stock returns. The results indicate that there is a lever on Tehran stock market.

Keywords: Index of stock returns, Arbitrage pricing theory, Generalized Autoregressive Conditional Heteroskedasticity, Leverage effect, Stock Exchange

1. Introduction

Nowadays recognition of investors' behavior and effective variables on stock return in capital markets is very important due to the increasing importance and development of these markets in mobilization and collection of individual small capitals towards manufacturing activities. Undoubtedly, investment in the stock exchange constitutes an important part of the whole country's economy and the highest amount of capital is exchanged through stock markets across the world. Moreover, national economy is intensely affected by performance of the stock market. Also this market is available as an investment tool both for professional investors and the public. Since potential investors of the stock exchange are composed of an extensive group in the society providing a suitable context for extensive presence of this group and

attracting their confidence, reinforcement and deepening of capital market would be led to one of the most basic tools of economic development. Conducting various studies in this regard could play a significant role in attracting investors' confidence. Objective of investment in the stock is to obtain suitable return. Investors consider a set of variables and financial and non-financial factors simultaneously while they make decision to invest in the stock. Decision-makers could determine behavior of stock prices more precisely by knowing effective factors on stock return and as a result they would make more proper decisions. Stock return is affected by all kinds of properties, changes of political and economical conditions, behavioral reaction of a large group of decision-makers, risk and many known and unknown factors (Jafari, 2011; 190).

Knowing whether macroeconomic variables are effective on stock return or not makes users and more importantly investors and financial analysts hopeful to compile an algorithm and obtain a fair price and a reasonable return from investment. Therefore, methods must be proposed to evaluate macroeconomic variables and recognize their role. It is tried in the present survey to evaluate the impact degree of macroeconomic variables on stock return using various methods and models. Results are summarized in research findings and conclusion section. The survey is organized in six sections. Previous studies are illustrated in the second section after studying the most important factors on stock return. The third section includes explanation of the applied model. Studying the impact of macroeconomic variables is conducted in section four. Evaluation of the estimated model is performed in section five and the last section contains conclusion and recommendations.

2. Theoretical Principals

It is believed that stock return is determined by some macroeconomic variables such as interest rates, foreign exchange rate and inflation. Several studies have been conducted to show the impact of economic forces on stock returns in various countries. For instance arbitrage pricing theory by Ross (1976) and Chen et al. (1986) was applied to explain the impact of some macroeconomic variables on stock return in capital markets of America. Their findings reveal that industrial productions, changes in risk premium and changes in the term structure have a positive relationship with the expected stock returns. This is while the relationship among predicted and unpredicted inflation rate with expected stock returns is negative significantly (Raee and Puyanfar, 2011; 367). Stephan Ross (1976) proposed arbitrage pricing theory as a replacement for capital assets pricing model which starts processing from the point that how investors could create an "efficient investment basket". But arbitrage pricing theory views risk and its measurement from a totally different perspective and doesn't look for efficient investment baskets, rather it is based on the basis that stock prices are modified while shareholders look for arbitrage profits. When arbitrage profits are lost it is said that stock prices are in equilibrium state. Defining efficiency in this theory means nonexistence of arbitrage situation.

The principal concept in arbitrage pricing theory is "law of one price", that is two properties which are similar in risk and return could not be sold by various prices. When capital assets pricing model was analyzed it was in fact a simplified copy of arbitrage pricing theory which

assumes only one systematic factor affects bonds return (Bodie, Kane & Marcus, 1966; 289-292). Advocates of arbitrage pricing theory state this model has two major advantages with regard to capital assets pricing model. First is that arbitrage pricing theory proposes assumptions about preferences of the investor with regard to risk and return that some claim it has less limitation. Second, it is believed that this model could be reliable experimentally. The major problem in arbitrage pricing theory is to identify effective factors and distinguish predicted changes from unpredicted ones in measuring sensitivities. In other words, only the three following cases are essential for arbitrage pricing theory among assumptions of capital assets pricing model:

- 1- Investors look for return with balanced risk and are risk-averse. They want to maximize their final wealth.
- 2- Investors could receive and make a loan by risk free rate.
- 3- There is no market limitation like transaction costs, tax or sales limitation and borrowing.

Three above assumptions illustrate behavior of investors totally but are failed to describe factors based on which decisions are made and this is the important difference between these two models (Harrington, 17; 26-95). Roll and Ross (1980-1984) and Chen et al. (1986) believe reality lies in five economic factors and different stock have different sensitivities towards these five systematic factors. The above factors constitute a major portion of the origin of risk regarding stock basket. According to them these five factors are as below:

- 1- changes in the predicted inflation rate
- 2- unexpected changes in inflation
- 3- unexpected changes in industrial productions
- 4- unexpected changes in return to differential maturity between junk bonds and preference bonds (risk premium of securities)
- 5- unexpected changes in return to differential maturity between long-term and short-term securities

The first three factors affect cash flows of the firm and finally stock return and its growth and the two other factors affect rate of discount and stocks assessment. According to the above model, investors regulate stock basket given to their motivation and intention in facing with the risk of each of the five factors, because different investors have different tastes with regard to risk.

Accomplished experiments about arbitrage pricing theory show this theory excels capital assets pricing model (Chen, 1983). Now it is possible to estimate the relationship among stock return and factors of such model which has the capability to predict future as well by perceiving arbitrage pricing theory in this way and modeling based on economic factors and assuming that the stock market acts reasonably. Poon and Taylor (1986) conducted a study similar to that of Chen et al. (1991) in England Stock Market. Results of their study indicated macroeconomic variables had no impact on stock returns in England. This conclusion was inconsistent with Chen's findings in the stock market in America. Poon and Taylor believed the reason for their different conclusion was that either other macroeconomic variables were effective on England Stock Returns or the applied methodology of Chen et al had been ineffective.

In the past decade attempts were made to study the impact of economic forces in theoretical form and measure such impacts experimentally. The dynamic relationship among macroeconomic variables and stock return has been studied extensively. Basis of these studies is the theory that stock prices reflect current value of future cash flows of that stock (the current value model). For this reason, future cash flows and expected stock return (rate of discount) are needed. Thus, economic variables are effective both on future cash flows and expected return rates (Elton & Gruber, 1991; 100-120).

The following variables are applied in the framework of objective of the present survey and given to the applied model to conduct the experimental test:

Total return index: stock return in this survey would be representative of the capital market that is calculated through the below formula:

$$R_t = \frac{D_t + P_t - P_{t-1}}{P_{t-1}} \quad (1)$$

R_t : stock return in period t,

P_t : stock price at the end of period t,

D_t : cash dividend allocated to each share in period t.

Inflation rate: nominal profit of companies is increased averagely after a period of time due to decreasing of value for money.

Foreign exchange rate: debt increase is followed by liquidity shortage which has a negative impact on profit distribution and cash return on equity.

Growth rate of liquidity volume: according to monetary theory of inflation, continuous increasing of liquidity volume with a rate more than the product of real income growth rate and income elasticity of demand for money is the necessary and sufficient condition for continuous inflation.

Oil price: although oil price increase is led to increase gross national product for oil exporting countries but it must be considered that developing countries are final consumers of oil products totally. Given that Iran is one of such countries existence of a reverse relationship between oil price increase and stock return increase is expected.

Gold price: gold is a substitute investment tool for investors. When gold price is increased intention of investors to invest in the stock market is decreased and as a result stock return is dropped. Therefore, it is expected that there is a negative relationship between gold price and stock return.

3. Research Background

Buyuksalvarci (2010) studied the impact of macroeconomic variables on stock return in Turkey in his article. He applied multi-variable regression model and monthly data of variables such as consumer price index, interest rate, gold price, industrial productions index, oil price, and foreign exchange rate and money stock in the period 2003-2010. Results indicate interest rate, industrial productions index, oil price and foreign exchange rate have a positive impact on stock returns in Turkey. And inflation and gold price don't have a significant impact on stock return of this country.

Leon (2008) studied fluctuation impacts of interest rate on stock return fluctuation in Korea. He used GARCH (1, 1) model in his study and research data was in weekly form in the period 1992-1998. Results illustrate there is a negative significant relationship between interest rate and stock return.

Robert Gay (2008) studied the impact of macroeconomic variables on the stock market return for four emerging economies including Brazil, Russia, India and China and concluded that there is no considerable relationship among relative foreign exchange rate, oil price and prices of the stock market index. He stated this issue may be due to the influence of other internal and external macroeconomic factors (like production, inflation, interest rates, balance of trade) on the stock market return which needs more investigation. Also his research results reveal that there is no considerable relationship among current and previous returns of stock market and this shows markets of these countries are at weak efficiency level.

Brahmasrene et al. (2007) examined the relationship among stock market return and macroeconomic variables (industrial productions, money stock, consumer price index, interest rate, exchange rate and oil price) in Thailand's Stock Exchange. The period under study was from 1992 to 2003. They used co-integration and Granger causality tests in their study. Results indicate existence of a significant relationship among macroeconomic variables and stock market return. On the other hand, results of Granger causality test indicate money stock is the only positive effective variable on stock return.

Saeedi and Kuhsarian (2010) studied the relationship among inflation indexes (CPI, PPI) and stock return in the stock exchange from July 1993 until June 2009. Thus they used Exponential

Generalized Autoregressive Conditional Heteroskedasticity model (EGARCH). Results show these two macro economy variables as two determinant variables of inflation don't have the power to explain stock return and are not appropriate in this regard. To put it differently, none of these two variables explain stock return changes.

4. Representing the Model

Extent and effectiveness degree of total stock return of Tehran Stock Exchange from changes of macroeconomic variables have been measured in the present survey using GARCH econometrics model.

4.1 Methodology of GARCH model

Most time-series econometrics tools are used to model conditional average of economic variables while most economic theories have been designed for working with conditional variance or fluctuations of a process. Researchers tend to measure and predict stock return fluctuations and price index of the stock market due to fluctuations of financial markets. Several models have already been proposed about analyzing stock return fluctuations and stock price index. Engle (1982) represented Autoregressive Conditional Heteroskedasticity (ARCH) model for the first time to model and predict fluctuations and conditional variance description as a self-explanatory process. Most analytical time-series using ARCH model need long intervals and a high number of estimated parameters. The solution to this problem is to use generalized ARCH or GARCH (p, q) model in the form of the below relations. This model was proposed by Bollerslev in 1986.

$$y_t = x_{kt} \alpha_k + \varepsilon_t \tag{2}$$

$$\varepsilon_t = v_t \sqrt{h_t} \tag{3}$$

In the above relation h_t shows function of conditional variances and is as below.

$$h_t = \gamma_0 + \sum_{i=1}^p \gamma_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \phi_j h_{t-j} \tag{4}$$

$$= \gamma_0 + \gamma(l) \varepsilon_t^2 + \phi(l) h_t^2$$

In the above relation $\gamma(l) \varepsilon_t^2$ is the term GARCH with rank p and $\phi(l) h_t^2$ is the term ARCH with rank q.

The following conditions are necessary for reliability of variance and covariance.

$$\gamma > 0, \quad \gamma_i \geq 0 \quad i=0, \dots, p \tag{5}$$

$$\phi_j \geq 0 \quad j=0, \dots, q$$

Simple model of GARCH (1,1) in most cases explains all kinds of fluctuations well (Caiado, 2004; 30-45). GARCH (1,1) modeling has been used in this survey which is the commonest model in modeling of financial time-series with high alternation. Predicting time varying variance in GARCH (1,1) model depends on logged variable of property. Any unexpected increase or

decrease of return in time t increases the expected variability in the future period. According to relation (3) in GARCH (1,1) model amount of h_t is shown as the below relation.

$$h_t = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \phi_1 h_{t-1} \quad (6)$$

$$\gamma_0 > 0, \gamma_1 > 0 \quad (7)$$

Where ε_{t-1}^2 shows ARCH term and h_{t-1} shows GARCH term.

In state $\phi_1 > 1 + \gamma_1$ unconditional variance ε_t is calculated as below.

$$Var(\varepsilon_t) = \frac{\gamma_0}{1 - \gamma_1 - \phi_1} \quad (8)$$

Coefficients of the model are easily interpretable in this state. By estimating γ_1 impact of current events on conditional variance is considered and by estimating ϕ_1 permanence of fluctuations in shock or impact of previous events on fluctuations could be calculated. Sum of γ_1 and ϕ_1 is the response rate to fluctuations. Whatever this rate is closer to 1, impact of response to shocks and fluctuations is eliminated later. In other words, total return index is being influenced by the new shock in the market. Older information in such markets is more important than the recent information and impact of such information is eliminated later (Magnus and Fosu, 2006; 593-620). Hsing and Buyuksalvarci's study (2011) is used in the selected model of the present survey.

$$R = F(M2, \Pi, EX, OIL, GOLD)$$

R: total return index

M2: volume of liquidity

Π : inflation rate

OIL: Iran's heavy crude oil price

GOLD: global gold price

EX: foreign exchange rate

$$R_t = \beta_0 + \beta_1 M2_t + \beta_2 \Pi_t + \beta_3 OIL_t + \beta_4 GOLD_t + \beta_5 EX_t \quad (9)$$

Research Hypotheses

- 1- Macroeconomic variables are effective on stock return.
- 2- The impulse or shocks by defined variables on stock return are durable.
- 3- There is leverage impact in Tehran stock exchange.

Given that data related to total return index has been calculated and issued since April-March 1999 in Tehran Stock Exchange the time period related to studying the relationship among economic variables and stock return index contains the second quarter of 2011 until the end of 2011 (where information is considered monthly). Spatial domain of the survey includes all companies listed in Tehran Stock Exchange in the period under study. Companies listed in the

stock exchange are those that their price in the calculated cash return of stock index by the stock exchange has been effective. If companies haven't been listed in the board during the years under study, indexes calculated by the stock exchange are balanced in this regard.

8. Testing Hypotheses And Model Representation

Using traditional and common methods of econometrics to estimate model coefficients through time-series data is based on the assumption that model variables are stationary. Augmented Dicky-Fuller (ADF) test is used to study whether variables are stationary or not.

Results of Augmented Dicky-Fuller (ADF) test show stationary of all research variables that are represented below:

Variables	ADF	Critical Values		Prob
		%1	%5	
foreign exchange rate	-4/6242	-4/0313	-3/4453	0/0316
global gold price	-10/0608	-3/4828	-2/8844	0/0000
volume of liquidity	-13/5286	-3/4828	-2/8844	0/0000
oil price	-15/4606	-3/4824	-2/8842	0/0000
inflation rate	-12/8943	-3/4828	-2/8844	0/0000
total return index	-4/6796	-4/0313	-3/4453	0/0273

Source: research findings

8.1. The test to determine variance dissimilarity

Null hypothesis and alternative hypothesis are stated as below to determine variance dissimilarity:

H_0 : there is variance similarity among error terms.

H_1 : there is no variance similarity among error terms.

Existence of such problem (variance dissimilarity of error terms) brings about inefficiency of OLS results. Therefore, models of GARCH group are used.

Table 2- results of variance dissimilarity test

Source: research findings

F statistic	948/4406	احتمال	0/0000
Views $\times R^2$	112/2111	احتمال	0/0000

Results confirm existence of dissimilarity.

8.2. Results of GARCH model goodness

GARCH model is stated as below in studying stock return fluctuations:

$$R_t = c + \varepsilon_t \tag{10}$$

$$\sigma^2 = \omega + \gamma_1 \varepsilon_{t-1}^2 + \phi_1 \sigma_{t-1}^2 \tag{11}$$

The first and second equations show stock return and return fluctuations respectively. Estimation results of GARCH model are as the below table.

Table 3- results of testing hypothesis one

Variables	Coefficient	S Error	z	Statistic	Prob
C	0/0112	0/0838		0/1338	0/7201
inflation rate	1/6642	0/5162		3/2240	0/0009
oil price	-0/0478	0/0239		-1/9976	0/0690
gold price	-0/2483	0/0966		-2/5708	0/0016
exchange rate	-0/1951	0/0226		-8/6286	0/0000
volume of liquidity	0/0027	0/0163		0/1684	0/8265

Source: research findings

The following equation is estimated as mean equation:

$$R_t = 0.011 + 1.664CPI_t - 0.050OIL_t - 0.248GOLD_t - 0.195EX_t + 0.002M2_t \tag{12}$$

Estimated coefficients show variables of inflation rate, gold price and foreign exchange are significant but liquidity and oil price coefficients are not significant explanatory variables for stock return although they are according to the theory.

Table 4- variance equation

Variables	Coefficient	S Error	z	Statistic	Prob
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C	0/0102	0/0076	1/3265	0/0139
ARCH	0/6169	1/4721	0/9082	0/0089
GARCH	-0/6162	3/6272	-0/6272	0/0003

Source: research findings

Thus the following equation is estimated to exploit ARCH and GARCH coefficients:

$$\text{GARCH} = 0.01021 + 0.61696\text{ARCH}(1) - 0.61268\text{GARCH}(1) \quad (13)$$

As results reveal, coefficients γ_1 and ϕ_1 are significant. The results confirm that GARCH model is suitable to explain fluctuations. Estimated coefficient ARCH shows impact of current events on conditional variance. This coefficient (0.617) shows that current time fluctuations have played much role in fluctuation and deviation of stock return index of Tehran Stock Exchange. Also estimated coefficient GARCH that is equal to -0.612 shows permanence of fluctuations in shock or influence of previous events on fluctuations of the dependent variable. Sum of ARCH and GARCH coefficients, i.e. 0.00427 reveals temporary response to probable shocks. Therefore, the second hypothesis is not confirmed.

Applying GARCH model under asymmetrical fluctuation conditions is not so suitable and thus exponential GARCH model is used. Results of leverage impact test for Tehran Stock Exchange will be represented in the next section that are stated using exponential GARCH model.

8.3. Results of leverage impact

Amount of fluctuations in leverage impact while return is decreased is relatively more than when return is increased. In other words, stock return fluctuations are not symmetrical in reaction towards good and bad news.

The below model has been estimated to test leverage impact:

$$R_t = c + \varepsilon_t \quad (14)$$

$$\log(\sigma_t^2) = \omega + \gamma_1 \log(\sigma_{t-1}^2) + \phi_1 \left(\left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| - \sqrt{\frac{2}{\pi}} \right) + \lambda \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad (15)$$

Coefficient λ shows that fluctuations and leverage impact are asymmetrical.

Hypotheses H_0 and H_1 in leverage impact test are defined as below:

H_0 : there is no leverage impact in Tehran Stock Exchange.

H_1 : there is leverage impact in Tehran Stock Exchange.

Coefficient λ must be positive in order to accept H_0 , otherwise H_1 is accepted:

$$H_0: \lambda \geq 0$$

$$H_1: \lambda < 0$$

Table 5- leverage impact test: results of model goodness

Variables	Coefficient	S Error	z Statistic	Prob
C	-0/0359	0/3726	-0/0965	0/9231
ARCH	0/7203	0/3195	2/2542	0/0000
Leverage effect	-0/0514	0/0204	-2/5217	0/0153
GARCH	0/7836	0/0864	9/0665	0/0000

Source: research findings

As it is observed in the above table, coefficient λ is negative and significant, so alternative hypothesis regarding existence of leverage impact is accepted.

9. Conclusion and Recommendations

Impact of variables such as inflation rate, liquidity, oil price, gold price and foreign exchange rate on stock return in Tehran Stock Exchange have been studied in the present survey. GARCH approach that is highly applied to explain financial phenomenon with high alternation has been used in this analysis. Results reveal foreign exchange rate, inflation rate and gold price are effective on stock return in the period under study (monthly data related to 2001-2011) and oil price and liquidity have no impact on stock return. In other words, stock return index in Tehran Stock Exchange has had a limited reaction towards oil price changes due to Iran's small capital market and delayed influence of oil price changes on profitability and stock price of companies despite undeniable impacts of global oil price changes on many macroeconomy variables.

Although the relationship between inflation rate and stock return index is positive but because this increase is due to compensation of real profit decrease it is recommended to economic decision-makers and policy makers to consider impacts of these decisions on the stock market and other indexes of financial markets while compiling monetary and financial policies at macro levels. Also given to the existence of leverage impact in this market controlling effective endogenous factors on market return could be regarded as a strategic action to control risk in Tehran Stock Exchange.

The last point is that stock market as an important source of capital flow plays a considerable role in economy of each country, thus it is recommended to policy makers to pay special attention to this market while implementing macroeconomic planning to avoid occurrence of any crisis and finally capital flight.

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Appendix

Diagram 1- time trend of inflation rate during the period 2001-2011

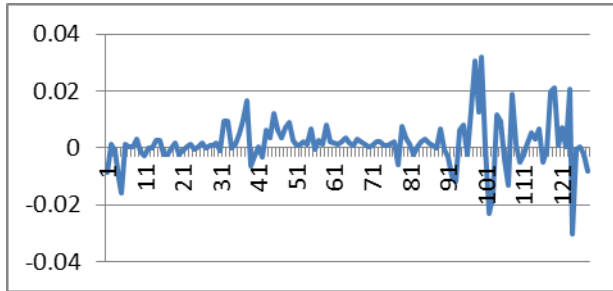


Diagram 2- time trend of Exchange rate during the period 2001-2011

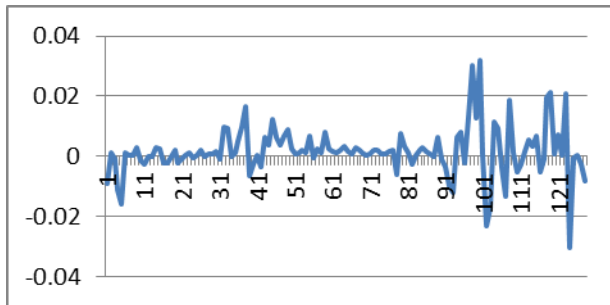


Diagram 3- time trend of Gold Price during the period 2001-2011

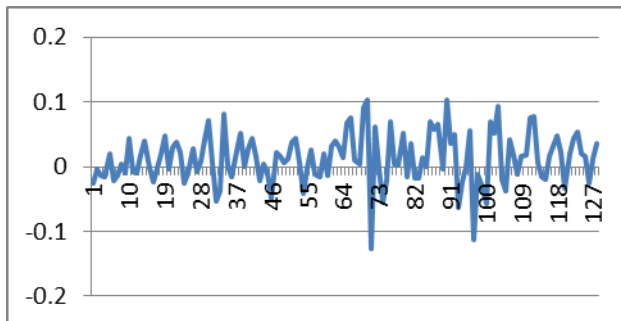


Diagram 4- time trend of Liquidity during the period 2001-2011

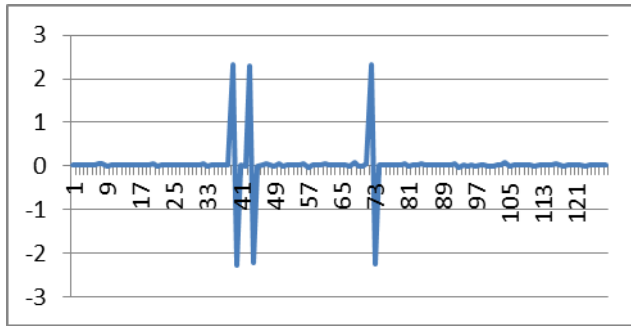


Diagram 5- time trend of Oil Price during the period 2001-2011

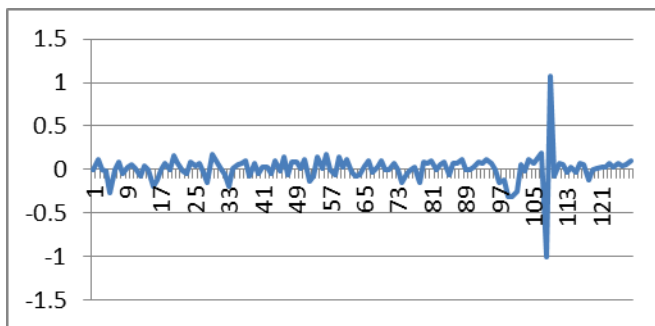


Diagram 6- time trend of Stock Index during the period 2001-2011

