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The Impact of Daily Macroeconomic Variables on Tehran Stock Price Index

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ABSTRACT

Background: Financial market uncertainty, especially in stock market, has been the focus of many studies generally conducted with the aim of reducing investment risk for investors. **Objective:** The present study examined the short-term impact of exchange rate (dollar) as an endogenous variable and that of oil shocks as an exogenous variable on Tehran Exchange Price Index (TEPIX) using Vector Autoregressive (VAR) and daily data. In the first step, we estimated the risk of Tehran Stock Market and added it to the model as a GARCH model. In the second, we estimated the model as VAR equation system. **Results:** Our results indicated that the impact of exchange rate (dollar) on the Stock Index is positive and the impact of exogenous oil shocks is positive and significant in the 4th period (day). Also the impact of risk on Stock Index is positive such that with an increase in variance, we expected to observe an increase also in Stock Index. **Conclusion**: According above-mentioned information, we could conclude that given the negligible effects of these variables, in short-term, exchange rate would not provide a proper tool for stock market development. Oil prices, on the other hand, as an exogenous variable, could provide the investor with a good indication. If a rise in oil prices is expected, investors would gain profits by investing in stock market, either in industry section in general and in oil companies in particular. In summary, it is concluded that: With rise in exchange rate (US $), it is effective on the stock price index in 5 per cent significance level, in that the possibility increases for exporting companies to positively adjust their income. Oil price is effective on stock price index in 5 per cent significance level. In other words, investors has used their knowledge about news related to rising oil prices in their decisions to invest in stock market. With increases in oil price, the expectations of rising exchange rates dwindles and thus attracting the capital to sock markets.

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INTRODUCTION

Financial market development attracts investments and channels them into the productive sector of the economy in the one hand, and on the other hand, given the investors with different appetite for risk-and-return, it leads investments to sector with more return and less risk, thus bringing about optimum allocation of resources.

With drastic changes in today's world, especially in developing countries usually facing prominent threats, it is imperative that these countries find optimum solutions to use their natural wealth in an attempt to tackle economic problems. One such important approach is to develop and boost investment (Manavi, 2008).

Providing grounds for approaches mentioned above requires a capital market with relative efficiency; a market which attracts the investors and where stock prices are reflection of all real information of the market (Mohammadi, *et al*, 1999).

Due to high place of the financial markets in the world and the links between these markets and real economics, this paper is a modest attempt to explore the association of international oil markets and Iranian domestic currency exchange market and possible effects on Tehran Exchange Price Index. For more precise prediction of the trends in capital market, here in the present study, we examine the effect of short-term fluctuations of exchange rate and oil prices on stock price index. This would provide investors and financial analysts information which help them decide effectively (Karimzadeh, 2006).

Fluctuations of this variables, that is, exchange rate and oil prices, wield great influence on the whole economy in general and profitability of companies in the stock exchange in particular; any fluctuation in these

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Journal of Applied Science and Agriculture, 9(3) March 2014, Pages: 1042-1052

two variables could change the earnings per share (EPS), which leads to changes in intrinsic value, and consequently changes in market price of stocks and also in index in general (Amirrahimi, 2006).

Review of Literature:

Foreign empirical studies:

Yang and Doong (2004) explores the nature of the mean and volatility transmission mechanism between stock and foreign exchange markets for the G-7 countries. Empirical evidence supports the asymmetric volatility spillover effect and shows that movements of stock prices will affect future exchange rate movements, but changes in exchange rates have less direct impact on future changes of stock prices (Eslamlouian and Zare, 2006). The implication is particularly important to international portfolio managers when devising hedging and diversification strategies for their portfolios (Yang and Doong, 2004).

The paper examines the relationship between stock prices and exchange rate drawing upon generalized Multivariate EGARCH models which is a powerful model in detecting any possible asymmetries in the volatility transmission mechanism. In fact, the paper not only tests the simple causal relationship between stock price and exchange rate, but it also systematically addresses the information transmission through exploring the nature of the mean and volatility transmission mechanism between stock and foreign exchange markets; in fact, it tests the fact that whether mean and volatility spillover from a market to another market is symmetrical. In doing so, it explores the question whether negatives shocks in domestic stock market (exchange market) could have more or less effect compared to the same amount of positive shocks on stock market (exchange market).

Empirical evidence shows that positive changes in domestic stock is effective on future changes in exchange rates; however, changes in exchange rates had little direct effect on future stock prices. Findings also indicate that there was a significant volatility or mutual asymmetrical impact from stock market to exchange market for France, Italy, Japan, and the US (Yang and Doong, 2004).

The empirical results indicate an information inflow between these two markets, integrating them in one or other way, where domestic stock market plays more important role than the exchange market in transmissions and interactions in first moments.

Stock market and macroeconomic variables:

The paper explores the causality between Jakarta stock market and macroeconomic variables using VECM (Vector Error Correction Model) in a period from January 1990 to December 2001. Jakarta Stock Exchange Index (JSE) has been taken as a dummy variable of stock returns. The variables are as follow:

CPI: consumer price index for inflation

M_1: money volume

OIL: oil price

LOP: interest rate

ER: exchange rate

EP_t: exports

Believing seemingly a positive linkage between stock price and exchange rate, the paper indicate that this phenomenon is totally acceptable, since growth of economic activities would also influence the stock prices through cash flow. The paper shows that JSE is cointegrated with other economic variables, and that Indonesian stock market behaviour is mainly under the impact of monetary factors and, is under the impact of major macroeconomic variables in the second place. Thus, the paper gives a negative relationship for stock price and exchange rate; a negative relationship for short- and long-term interest rate and oil international price; and a positive relationship for exchange rate and economic activities (export and GDP). (Raii, and Talangi, 2009)

Domestic empirical studies:

The effects of macroeconomic variables and alternative assets on Iranian stock price: an autoregressive distributed lag (ARDL) model.

this paper is an attempt to capture the effective variables on Tehran stock price index in the period extending from fourth quarter of 1993 to second quarter of 2003 drawing upon method used in Pesaran et al to analyze cointegration by autoregressive distributed lag (ARDL) and Lucas Asset Pricing Model. The paper uses descriptive variables including Index of Industrial Production (IIP), export/domestic price ratio, money volume, and oil price as important macroeconomic variables, and foreign currency, coin price, gold price, and housing price as major alternative assets (Abrishami and Mehrara, 2002).

The fundamental relation of Lucas model shows that stock price equals current discounted value of expected profits; thus, any changes in expected profits could change stock price. Since future profits is not evident as discount rate, we can attribute changes in the discounted value of expected profits to macroeconomic factors and other effective market factors. Lucas theory deals with an asset pricing, and it would not directly address other types of assets; however, Markowitz's theory emphasized upon the diversity of assets, maintaining that investors look for an optimal basket which is a collection of diverse assets (Jafari Tirabadi, 2004).

According to this theory, it is not necessarily required that all assets show only negative or positive correlations; but what matters in this theory, is the sheer diversity of assets in asset basket and differences among these assets (Derakhshan, 2004).

Put differently, this theory assumes that, since different assets are not affected equally by economic mechanisms, they do not always move in the same direction and by diversifying the assets in a given basket, the risk could be reduced in a manner so as to keep the turnover unaffected as well. As such, changes in the prices of a competing asset could influence the relative quota of the given asset in the basket, thus introducing change in the composition of assets held (Derakhshan, 2004)

For this reason, looking for prices of other effective and alternative assets is important in the explanation of stock price index behavior. To estimate the equation of stock price index, here, we use method suggested in Pesaran and Shin to analyze cointegration using autoregressive distributed lag (ARDL). The method has some advantages in estimation of the model. It can be shown that estimations through this method are less biased and more efficient for small sample size (when lags are well-specified). Furthermore, the approach makes possible the examination of cointegration problem when time-series data is not stationary (Pesaran, & Shin, 1996).

Another important issue is that method suggested in Pesaran and Shin makes possible simultaneous examination of short- and long-term relationships as well. Their findings indicate a balanced long-term relationship between stock price index and the examined variables. The results of short- and long-term models estimation show that export/domestic price ratio, oil price, housing price index, and coin prices have positive effect on stock price index, and two variables, that is, exchange rate and money volume have negative effect on stock price index. Also, their findings indicated no effect of Index of Industrial Production (IIP) on stock price behavior in Iranian context. Furthermore, estimation of error correction model indicated that about half of imbalance is adjusted in each period (Pesaran, & Shin, 1996).

The paper essentially was an attempt to provide an explanation of the relationship between Iran's stock price index and key monetary variables including liquidity, real exchange rate, and real interest rate, which were taken as monthly data in a period of 1990-2002, using portfolio approach and Dornbush-Fisher fundamental theorem. Alternative portfolio theory explains the substitution of shares and other asset types such as foreign currency, bank savings, gold, and housing. Fisher's fundamental theorem addresses the relationship between stock price and monetary variables such as liquidity, interest rate, and inflation rate. To determine substitution between shares and bank savings and foreign currency, and to analyze the degree and mechanism of impact of liquidity on stock price, the paper opts for monetary variables for model estimation; for an econometric estimation of specified model, it draws upon autoregressive distributed lag (ARDL). (Enders, 2009)

The results of estimation indicated a vector of cointegration between Tehran stock price index and key monetary variables. The estimated long-term relationship reveals a positive relationship between stock price index and liquidity, and a negative relationship between stock price index and real interest rate. So, economic policy-makers should bear in mind that expansionary monetary policy, reduction of exchange rate, and reduction of interest rate could work to raise stock prices.

MATERIAL AND METHODS

Factors effective on investment in stock exchange markets:

When stock price is set according to arrangements governing demand and supply such that the current prices reflect the intrinsic value of stocks, investors direct their capital to the stock exchange with more certainty; however, since a host of economic, political, social, and other factors influence the stock prices, there is a sort of uncertainty of special nature in stock market due to the lack of information about mechanisms of influence by these factors on stock prices. It seems likely that through examination of factors effective on stock price index and comparison of the level of effectiveness, this lack of information in part of the investors could be alleviated, and improve the grounds for investors to enter the stock exchange markets. Generally, two categories of factors are effective on stock market index.

Internal factors:

External factors:

Individuals often care for external factors when they decide to sell or buy stocks (mainly political and economic factors). Research show that exchange rage and oil prices could possibly have impacts on stock price index. Thus, examination of such factors is important in offering valuable information to investors about the optimal time of trading shares in an attempt to improve quality and quantity of investing in the stock markets and resource allocation.

Stock markets is more or less a self-contained competitive market per se. A perfectly competitive market in the stock market competitively sets prices and allocates resources. So, it will be safe enough to say that stock market provides a mechanism to bring about economic order, in that it punishes incompetent managers and rewards competent leaders.

Currently stock exchange market is the core of capital market in most of the countries and it directs huge amounts of wandering capital into productive sectors of economy. In certain framework, stock exchange market could distributes share to the public, thus improving their power of purchase and reducing the liquidity and inflation in the one hand, and boosting production through allocation of resources to productive sectors, which in turn improves the managers' performance. Stock market attract different investors with different motivations and degrees of risk acceptance. If this market gives return for investors proportionate to their risk acceptance, it will be competent in terms of resource allocation through optimum allocation. Again, if the stock market succeeds in channelling resources to lenders to borrowers with the least transfer expenses, they will contribute to performance of operation. In the same vein, if stock market performs well in its function which is moving dormant capital and optimal allocation, it will contribute to economic growth through attraction of foreign capital.

Total stock market index:

Before addressing total stock market index, it imperative to know that expectations are a strong factor effective on supply and demand in stock market such that expectations on rising stock prices or positive trend in market increase the demand for the shares; on the opposite side, expectations on falling prices or a negative trend in market boosts supply versus demand for that share. The question is, how these expectations take shape? And whether these expectations are the same? In response to these questions, we could say that expectations are born out of data and data analysis, and it would not be far from exaggeration to say that to the number of brokers in the stock market, there are different expectations. The Tehran Stock Price Index is calculated based on shares' current prices and with greater emphasis on current prices, the price index is calculated through Laspeyres' formula. According to this formula, the current value of all variables which are constituents of an index is divided into the value of these variables in the base period prices.

$$\mathrm{TEPIX}_t = \frac{\lambda \sum_{i=1}^{n} c_{it} P_{it}}{\sum_{i=1}^{n} C_{it} P_{it}} \qquad (1\text{-}2)$$

C_{it}: the number of shares the firm has on issue at time t

P_{it}: the price of share i at time t

P_{ib}: base period price

←λ: adjustment factor to set the base period price (March 21 1990= 100), and used to adjust the index according to further change of dimensions in the number and nature of firms' share.

As indicated by TEPIX formula, this Tehran stock price index is more often than not used to measure returns from changes in stock price.

Stock price index and cash return

Fluctuations in stock price index

The Companies' Annual General Meeting divides stock price index fluctuations to two distinct categories: first, the discounted prices derived from cash returns given as following:

As unit:

$$= \frac{\lambda \sum_{i=1}^{n} C_{it} P_{i(t-1)} - D_{it}}{\sum_{i=1}^{n} C_{it} P_{ib}} \qquad (2.2)$$

As percent:

$$= \frac{\sum_{i=1}^{n} C_i \left(P_{i(t-1)} - D_{it}\right) + \sum_{i=1}^{n} C_i P_{i(t-1)}}{\sum_{i=1}^{n} C_i P_{i(t-1)}} \qquad (2.3)$$

P_{t-1}: Price before Annual General Meeting

D_t: Cash dividend of each share

And the second is price fluctuations derived from supply and demand mechanisms, given as the following:

$$= \frac{\lambda \sum_{i=1}^{n} C_{it} P_{it} - P_{it}^{e}}{\sum_{i=1}^{n} C_{it} P_{ib}} \qquad (2.4)$$

P_{it}^{e}: The adjusted price after the Annual General Meeting

The ultimate effect of change in price following the Annual General Meeting of companies could be positive, negative, or even zero depending on the magnitude and direction of the cash turnover vectors of the shares.

To compare the product of cash turnover and price change, price index and cash turnover as components, price index and shares' cash turnover is defined as:

$$\mathrm{TEPIX}_t = \frac{\lambda \sum_{i=1}^{n} C_{it} P_{it}}{\sum_{i=1}^{n} C_{it} P_{ib}} \tag{2.5}$$

$$\mathrm{TEDPIX}_t = \frac{\lambda \sum_{i=1}^{n} C_{it} (P_{it-1} - D_{it})}{\sum_{i=1}^{n} C_{it} P_{ib}} \tag{2.6}$$

Thus, Tehran stock price index (TEPIX) is designed to measure only the interests accrued upon changes in share prices and it is effectively unable to capture the underlying trends of real turnover of shares in index basket or to detect the dynamics of price fluctuations.

With this in mind, the analysis of price fluctuations hinges upon other criteria which would truly capture the impact of effective factors on the share prices in stock market. It is obvious that announcement of chase dividend accrued upon each share during Annual General Meeting of companies is a factor of significant effect on changes of stock price index. Thus, indices such as TEDPIX and other indices could contribute positively to market transparency and to adjusting the shareholders' attitudes about Tehran stock exchange as complementary indices of assessment of stock price fluctuations.

Relationship between stock and currency markets:

Commodity market approach:

The impact of exchange rate fluctuations is of a demand side nature. Reduction of exchange rate (increase in domestic currency value) raises the price of commodities produced by firms given in foreign currency, and as a consequence, demand for the commodity is reduced. This, in large scale, would be translated as reduction of exports due to reduced exchange rate. Here, we face two phenomena. On the one hand, the price of exported commodities has risen, and on the other hand, the amount of exported goods has decreased. Thus, changes in export revenue (in US $) very much depends on the commodity-level export demand elasticities. If demand for exported commodities is elastic, rise in prices would result in considerable reduction in sales of the exported commodities and hence, reduced export incomes. However, if the demand for exported commodities is inelastic, rise in prices will contribute little to the sales reduction and hence, increased export incomes.

What matters here is the very nature of this relationship, with the direction of the relationship being of second-degree importance. If the demand for exported commodities are more elastic, decrease in exchange rate will bring the firms with reduced incomes of exported commodities. So, it will reduced dividend per share, which is reflected in the reduced stock prices.

Now, we address the issue using formula used for setting stock prices. The formula for setting the intrinsic value of each share is:

Intrinsic value of each share = $\frac{\mathrm{EPS}}{\mathrm{K}}$

Where EPS denotes dividend per share and K is the turnover rate expected by shareholders. In fact, expected turnover rate expected is regarded as the opportunity cost. In general, in such firms, with a decrease in exchange rate, EPS (profitability) of the firms is reduced, and with it, the dividend per share paid to shareholders. Reduction of EPS reduces the numerator, which in turn, reduced the outcome of fraction, that is, the intrinsic value of each share. It is obvious that the reverse of the above statement holds also true; if exchange rate increases, such firms export larger amounts of commodities. Put differently, they will have higher motivations to export. Therefore, firms with higher ability to export commodities would be benefited more. If an increase in exchange rate is predicted, investing in such firms with higher abilities to export will be highly desired. If the exported commodity price is inelastic, the direction of the relationship is reversed and increase in domestic currency value or decrease in foreign currency value (exchange rate) will raise the stock prices.

Increase in exchange rate will add to the costs of operation in firm dependent upon the import of raw materials. Thus, with increased dependence of such firm upon outside world, their operational costs will be more and more influenced by fluctuations in exchange rate. Sudden changes in exchange rates will create shocks in such firms with negative impacts, as the following: with increase in exchange rate, the required working capital will rise; that is, firms with operational competence consistent with prior exchange rates will need more financial resources. This will bring about higher cost and hence, reduced earnings per share (EPS) and reduced intrinsic value of each share. Taking into account the effectiveness of shares on price index and or the number of firms importing raw materials, this would impact the market trend and stock price index. It should be noted that here again, the amount of elasticity should be taken into account and the direction of relationship will be determined accordingly.

As seen above, shareholder expectations are manifested in stock prices in the market. Every decision or event by firms inconsistent with their expectations will affect stock prices. Thus, theory of rational expectations (TRE) is based on the notion that people act rationally and would choose the best and most rational behavior. According to this theory, people's insights into the future takes shape according to their information and their understanding of the workings of the economy. In the other hand, rational expectations would not assume that individuals do not err; but it assumes that the information to correct the errors are accessible, people would avoid the same errors in the future. According to this assumption, new information and expectations about the future are important factors of changes in stock prices.

Among other factor worthy of attention is the firm’s current assets and liabilities. If exchange rate increases and the firm’s assets exceeds its liabilities in foreign currency, the interests accrued upon foreign currency translation will effectively increase dividend per share and hence, increase the price of firm’s shares. If the firm’s liability in foreign currency exceeds its assets, the losses accrued upon foreign currency translation will decrease effectively the price of firm’s shares, and hence, decreased intrinsic value of shares. If the exchange rate decreases, the reverse of the above will happen.

Portfolio approach:

According to portfolio approach, for an optimal composition of risk-and-return, investors diversify their portfolio on different foreign and domestic assets in such a way that ultimate return expected from each asset holds equal weight in their portfolio. As long as the risk and return remains constant for fixed assets, the initial balance will also be saved. The trade surplus brings an inflow of foreign investments to country and contributes to the foreign asset share in individuals’ portfolio basket. These changes, given that return rate of different assets remains constant, introduces imbalance in their asset basket. Restoring balance to portfolio replaces foreign assets with domestic assets. Increase in demand for domestic assets, including shares, directly raises their price. Put in better words, with emergence of a bullish stock market, foreign investors are attracted to such market, and hence, will raise the domestic money and will reduce foreign currency value. On the other hand, wealth coming from rises in domestic stock price increases the demand for money by domestic investors; furthermore, with introduction of foreign investments attracted by prospects for increased interest rates, exchange rate will decrease (Krueger, 1983; Branson, 1985; Gawain, 1989).

Factors affecting crude pricing system:

World’s total in-place crude oil reserves is estimated to be 1150 billion barrels, and assuming the current pace of extraction, these reserves would be depleted in 41 years. OPEC countries have 75 per cent of world’s oil reserves with 82 per cent of OPEC oil in Persian Gulf which amounts to 62 per cent of world’s total reserves. The Islamic Republic of Iran has 138 billion barrels of oil which is estimated to be depleted in 89 years assuming the current pace of extraction.

In general, long-term oil pricing systems should be analyzed according to economic theories of supply, demand, and other factors as scarcity, technology, and interest rate. In other words, the amount of extracted oil is influenced by oil price and interest rate; that is, when oil relative price rises, investors are provided with higher motivations to invest on extractions even in reserves where extraction is highly costly. On the other hand, access to technologies, conditions on reserves, and economic growth are effective in soaring oil prices in long run. In addition, technology and reservoir conditions could act as restricting factors of production and hence could impact the oil prices. However, it should be noted that in short-term, apart from economic theories, non-fundamental factors could revolutionize the pricing system to decrease or increase prices.

According to classical theories of economics, changes in commodity prices is influenced by supply balance or imbalance, and in general, oil markets could be analyzed according to these theories. However, in oil markets, policy decisions and the domination by special parties in oil market would impact the pricing system of oil in one or other ways, and since these players in the market could not easily be identified, and since they do not have enough authority to control markets, their impact could not easily be analysed; their impact, essentially, seen in short run. With this in mind, thus, any analysis of oil market far from the effect of these forces should be focused on analysis of supply and demand, and foundations of the market.

Studies in oil markets indicate that demand for oil is under the impact of different factors including oil price, economic growth, dramatic temperature changes, and strategic and commercial storage. It should be noted that supply of oil by non-OPEC producers— which supply oil in OPEC’s manner— have drastic effect on market. Here, the role of countries not committed to quota system and produce with maximum sustainable production capacity is pronounced (Neveu, Raymond P., 1985).

RESULTS AND DISCUSSION

To explore the relationship between Tehran stock price index and exchange rate (US dollar) and oil price, first we estimate the best-fitting mean equation for stock price index. Among the different estimated equations, we opt for a model with most fitting according to Schwarz information criterion, SIC.

Table 1 gives four best fitting estimated models for mean equation of stock price index. In all equations, we assume that $\varepsilon_t \sim N(0, \delta^2)$.

Journal of Applied Science and Agriculture, 9(3) March 2014, Pages: 1042-1052

Table 1: Mean equations

$SP = \alpha_0 + \alpha_1 SP_{t-1} + \alpha_2 SP_{t-2} + \alpha_3 DEX + \alpha_4 DOIL_{t-1} + \varepsilon_t$	(1)
$SP = \alpha_0 + \alpha_1 SP_{t-1} + \alpha_3 DEX + \alpha_4 DOIL_{t-1} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_1 \varepsilon_{t-2}$	(2)
$SP = \alpha_0 + \alpha_1 SP_{t-1} + \alpha_2 SP_{t-2} + \alpha_3 DEX + \alpha_4 DOIL_{t-1} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2}$	(3)
$SP = \alpha_0 + \alpha_1 SP_{t-1} + \alpha_2 SP_{t-2} + \alpha_3 DEX + \alpha_4 DOIL + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2}$	(4)

Model selection table:

The question rising naturally after estimation of any model is that to what extent the model is based on real data? In general, there are some criteria according to which to choose the best model (Abbasnejad, 2007).

Two criteria commonly used are Akaike information criterion (AIC) and Schwarz Bayesian criterion (SBC). To calculate these criteria, the following formula are used:

AIC=TLn (SSR) +2n

SBC=TLn (SSR) +nLn (T)

Where n denotes the number of estimated parameters (q + p + fixed terms), T denotes the number of observations in estimation, and SSR denoted the residual sum of squares. The smaller the values of AIC and SBC, the model will have the best fitting. Given the fact that these values could be negative, the more fitting a model is, the value of AIC and SBC tend to minus infinity (Abbasnejad, 2007).

More explanatory variables contributes to the fitting of the model when the residual sum of squares decreases. Thus, if the right-hand side variable does not have any explanatory power, adding it to the model raises the value of AIC and SBC. Since Ln (T) is usually greater than 2, SBC opts for smaller number of lags compared to AIC. SBC is more compatible with larger samples, but AIC produces better results in smaller samples. Since SBC opts for smaller number of lags, it is necessary to test for the white noise of residuals, and since AIC would opt for model with larger number of right-hand side variables, T-statistics for all coefficients in the model should have an acceptable level of confidence.

Table 2: AIC and SBC for Models

Criterion Model	AIC	SBC
Model (1)	11.316	11.333
Model (2)	11.365	11.382
Model (3)	11.307	11.328
Model (4)	11.310	11.330

According to Table 2 and criteria AIC and SBC, we see that Equation 3 is the best estimated model.

With choosing the best model, since to explore any effect of GARCH, model residues should not be autocorrelated, we used Q-statistic of Ljung-Box test to explore the autocorrelation with results ruling out the autocorrelation.

Table 3: Hypotheses of GARCH effects

The null hypothesis of GARCH effect (coefficients of squared lagged error terms= 0)	H_0
Hypothesis of GARCH effect	H_1

To test the GARCH effect, we used Lagrange multiplier test, which was reported for five lags in Table 4.5. As seen in the Table, the null hypothesis of the nonexistence of a GARCH effect was examined for all five lags, which indicated a GARCH effect on the residues of mean stock price index in the first lag.

Table 4: Statistics Lag length

Statistics Lag length	χ^2 (significance level)	F (significance level)
1	6.213 (0.012)	6.230 (0.012)
2	6.315 (0.042)	6.164 (0.042)
3	6.432 (0.092)	2.471 (0.092)
4	6.515 (0.163)	1.630 (0.163)

The stock price index chart indicated that fluctuations show autocorrelated conditional variance anisotropy or GARCH effect, which is evidenced by autocarrelogram of residual sum of squares.

Here, we estimated different variance models and opted for the best model using AIC and SBC criteria. The results of estimations are reported in Table 5.

Journal of Applied Science and Agriculture, 9(3) March 2014, Pages: 1042-1052

Table 5: AIC and SBC criteria for different GARCH Models

Model Criterion	GARCH(0,1)	GARCH(1,1)	GARCH(1,2)	GARCH(1,0)
AIC	11.311	11.113	11.110	11.164
SBC	11.341	11.147	11.147	11.194

We choose risk model using SBC criteria.

VAR model:

Vector autoregressive (VAR) is a special case of structural equation models (SEMs), also known as simultaneous equation models which explores the behavior of several variables of a time-series data, and is a more general case of vector autoregressive model for univariate time-series (Abrishami and Mehrara, 2002).

In simultaneous models, some variables are endogenous and some others are exogenous or predetermined (exogenous with lag). To estimate such models, it is necessary to ensure that system equations are well specified (or overspecified). The specification is often along with this assumption that some equations have only some of predetermined variables. This decision is often inferentially made. According to Sims, if there is true simultaneity among a set of variables there should not be any a priori distinction between endogenous and exogenous variables. The structural approach to time series modeling uses economic theory to model the relationship among the variables of interest. Unfortunately, economic theory is often not rich enough to provide a dynamic specification that identifies all of these relationships. Furthermore, estimation and inference are complicated by the fact that endogenous variables may appear on both the left and right sides of equations. It should be also noted that when a VAR model is estimated, it should not be expected that all estimated coefficients of variable lags are statistically significant, while it may be expected that all coefficients are significant according to F-statistics (Abrishami and Mehrara, 2002).

Table 6: HQ, SBC, AIC

Criterion Lag	HQ	SBC	AIC
0	53.636	53.644	53.631
1	33.063	33.105	33.037
2	28.980	29.057	28.934
3	28.205	28.316*	28.139
4	28.184*	28.329	28.097*

An issue to be addressed is that whether all variables included in VAR should be stationary. Sims (1980), Stock and Watson (1990) argue that even if the variables have a unit root, their differences should not be included in the system. They believe that the differencing leaves out the data indicative of cointegration of these variables, thus there is no need for detrending of variables in VAR model. In a VAR model, a unit root process with a fixed term is a good approximation of a model with trend. In the present study, despite the nonstationarity of the variables in 5 per cent level, we estimate the model without detrending (Abrishami and Mehrara, 2002).

$$\begin{bmatrix} SP \\ EX \\ GARCH11 \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \\ C_3 \end{bmatrix} + \begin{bmatrix} B_{1,1} & \cdots & B_{1,12} \\ \vdots & \ddots & \vdots \\ B_{3,1} & \cdots & B_{3,12} \end{bmatrix} \times \begin{bmatrix} SP(-1) \\ SP(-2) \\ SP(-3) \\ OIL(-1) \\ OIL(-2) \\ OIL(-3) \\ EX(-1) \\ EX(-2) \\ EX(-3) \\ GARCH11(-1) \\ GARCH11(-2) \\ GARCH11(-3) \end{bmatrix} + [u_t]$$

$$\begin{bmatrix} SP \\ EX \\ GARCH11 \end{bmatrix} = \begin{bmatrix} 101.722 \\ 25.228 \\ 98.731 \end{bmatrix} + \begin{bmatrix} 1.286 & -0.008 & -0.279 & 1.983 & -0.042 & -1.793 & -0.175 & 0.057 & 0.107 & -0.057 & -0.216 & -0108 \\ 0.035 & -0.083 & 0.048 & 0.621 & 1.655 & -0.971 & 0.918 & 0.064 & 0.014 & -0.021 & 0.013 & 0.003 \\ -1.046 & 1.765 & -0.719 & 1.541 & 0.673 & -2.059 & -0.283 & 0.159 & 0.113 & 0.690 & -0.231 & -0.094 \end{bmatrix}$$

Journal of Applied Science and Agriculture, 9(3) March 2014, Pages: 1042-1052

$$\times \begin{bmatrix} SP(-1) \\ SP(-2) \\ SP(-3) \\ OIL(-1) \\ OIL(-2) \\ OIL(-3) \\ EX(-1) \\ EX(-2) \\ EX(-3) \\ GARCH11(-1) \\ GARCH11(-2) \\ GARCH11(-3) \end{bmatrix}$$

Impulse Reaction function (IRF)

The IRF gives the jth -period response of the system variables when the system is shocked by a one-standard-deviation shock. In this section, we give the dynamic response of the model variables when the system is shocked by a one standard deviation by oil prices, exchange rate, and TSE price index uncertainties, and give the related analysis. As observed in Table 4.8, the effect of exchange rate on TSE price index has been significant in the first period, with no significant effect in later periods. The effect of stock price uncertainties on the TSE price index was positive and significant in the first period, and oil price had a significant effect on TSE price index only in fourth period and later.

Table 7: Estimation Results

Variable Period	Stock price index	Exchange rate (US $)	Oil price	GARCH11
1	2.289 (0.041)	4.470 (1.723)	-0.751 (1.722)	68.320 (1.218)
2	2.946 (1.191)	0.887 (2.734)	1.266 (2.724)	83.994 (2.285)
3	3.875 (2.342)	-3.125 (3.619)	4.459 (3.569)	93.916 (3. 2)
4	4.841 (3.378)	-5.211 (3.988)	6.046 (1.514)	99.079 (4.011)

Analysis of variance:

Analysis of variance seeks to establish the cause and effect relationships between changes in a sequence and its error terms and other error terms of the system variables. Table below gives the results of analysis of variance in the estimated model. In the first period, 100 per cent of changes in TSE price index are effects of changes in the index itself; however, in later periods, the effect of other variables becomes evident in that in second period 99.77 per cent of changes in TSE price index is accounted for by stock index itself and only 0.179 per cent is accounted for by exchange rate (UD $). Oil price and stock index risks account for 0.040 and 0.001 per cent of changes, respectively.

Table 8: Analysis of variance

GARCH11	Oil price	exchange rate	Stock Index	Variable period
0.00	0.00	0.00	100	1
0.001	0.040	0.179	99.77	2
0.003	0.169	0.517	99.31	3
0.01	0.281	0.795	98.91	4

Equation system estimation:

Test of variable cointegration:

As we mentioned in the first section of the study, model variables are first-order cointegraed. Thus, to estimate variables as equation system, first it is necessary to examine that if these variables are interrelated in

Journal of Applied Science and Agriculture, 9(3) March 2014, Pages: 1042-1052

long-term. or, better to say, if there was a linear combination of these variables which are zero-order cointegrated. For doing so, we conduct a cointeration test and give the results in table below.

Table 9: Test of variable cointegration

P-value	λ trace	Specific Roots	Number of long-run relationship
0.001	35.011	48.045	*Zero
0.374	18.398	11.174	Max 1
0.028	3.841	4.821	Max 2*

As given in table, in 5 per cent level of significance, there is maximum a single long-term relationship. Thus, it would be possible to estimate variables as equation system.

Equation system estimation

In single-equation estimation, there is a probability that error terms of equation are correlated. To solve this problem and for a more efficient model estimation, we estimate endogenous equations as equation system below.

$$\begin{bmatrix} SP \\ EX \end{bmatrix} = \begin{bmatrix} 8370.21 \\ -70.15 \end{bmatrix} + \begin{bmatrix} 4.14 & 0.03 & 3.31 & 0.08 \\ -0.55 & 0.61 & 0.29 & 0.38 \end{bmatrix} \times \begin{bmatrix} OIL(-1) \\ EX(-1) \\ OIL(-2) \\ EX(-2) \end{bmatrix} + \begin{bmatrix} U_{sp} \\ U_{ex} \end{bmatrix}$$

In this model, oil price is taken as an exogenous variable, and given the significance of the variables, the above model is taken as final model. As seen, the effects of oil price and exchange rate on the TSE price index are positive in first periods. Variance-covariance matrix of equations is written as below.

$$\begin{bmatrix} 0.037 + 1.05\varepsilon_{1t-1}^2 + 0.018h_{11t-1} & 0.037 + 0.69\varepsilon_{1t-1}\varepsilon_{2t-1} + 038h_{12t-1} \\ 0.037 + 0.69\varepsilon_{1t-1}\varepsilon_{2t-1} + 038h_{12t-1} & 0.037 + 0.45\varepsilon_{2t-1}^2 + 0.76h_{22t-1} \end{bmatrix}$$

Conclusion:

For more precise prediction of the trends in capital market, here in the present study, we examine the effect of short-term fluctuations of exchange rate and oil prices on stock price index. This would provide investors and financial analysts information which help them decide effectively.

In general, studying stock and currency markets interactions is important in terms of theory, application, and policy analysis. Theoretically, discussions of the linkages between prices of assets, such as international models of asset diversification and risk coverage models is an important input in open macroeconomic models. In terms of application, the knowledge of links between asset prices provides investors with ample opportunities to diversify their capitals. Furthermore, policy-makers and financial and economic planners especially in oil exporting countries require to know about the short-term effects of oil shocks on domestic markets and mutual effects of prices of assets such as exchange rate and stock price in different policy analysis. As such, accurate understating of the relationship between asset markets in different times gains increasing importance, since this is a situation when economic planners should take immediate and critical decisions, which necessitates the understanding the mechanisms of causal relationship between exchange rate and other asset.

To estimate a fitting mean model, different ARIMA models are estimated, and best fitting model is determined with least values of AIC and SBC. Then, the mean effects of GARCH in error terms has been tested. Using the Q-statistic of Ljung-Box and ARCH-LM, we found GARCH effects in the first lag. To improve on the results, we continue tests up to 5 lags, and report the results. Having ensured the GARCH effects, best fitting model and variance are estimated, with GARCH (1,1) having the best fitted model and variance, which had the least AIC and SBC values. In the next step, we give GARCH (1, 1) as time-series, which indicates price uncertainties in stock price index. Finally, VAR model is estimated with four variables of TSE price index, exchange rate (US $), and oil price. For determining the optimal lags of the model, we used HQ, SBC, and AIC criteria, with first two criteria suggesting the second lag as optimal.

Having determined the favorable VAR model and having drawn the impulse impulse reaction function curves, we explore the mutual causal relationship between error terms of variables in subsequent periods and TSE price index.

Finally, we examine the long-term association between variables. For doing so, we draw upon cointegration test. The results of the test indicate that there is at least a single long-term relationship between variables.

According above-mentioned information, we could conclude that given the negligible effects of these variables, in short-term, exchange rate would not provide a proper tool for stock market development. Oil prices, on the other hand, as an exogenous variable, could provide the investor with a good indication. If a rise in oil prices is expected, investors would gain profits by investing in stock market, either in industry section in general and in oil companies in particular. In summary, it is concluded that:

With rise in exchange rate (US $), it is effective on the stock price index in 5 per cent significance level, in that the possibility increases for exporting companies to positively adjust their income. Oil price is effective on stock price index in 5 per cent significance level. In other words, investors has used their knowledge about news related to rising oil prices in their decisions to invest in stock market. With increases in oil price, the expectations of rising exchange rates dwindles and thus attracting the capital to sock markets.

Suggestions for further studies:

The present paper provides three suggestions in policy decisions, applications, and research. First, exchange rate as an effective monetary tool could be effective on stock price index in long term. With the Targeted Subsidies Plan implemented, and market-oriented prices, and consequent expenses of energy-intensive companies and manufacturers, if the exchange rate is set by the supply and demand mechanisms, it would contribute to exporter companies' incomes in domestic currency (Rial), which would increase the intrinsic value of shares, thus, restoring hopes on long-term growth in stock price index. Second, to work applied analyses, the researchers could investigate the effect of exchange rate and oil prices on other industries. Third, since in recent years, Iran's Central Bank has changed its portfolio from dollar to euro, the effect of exchange rate (euro) rather than US dollar, on stock price index could be the subject of an investigation.

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