Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

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Abstract

This study aimed to analyze the sensitivity of the oil market and its effects on financial markets in Iran, using dynamic systems and MV-GARCH models from 2008 to 2025. Accordingly, first the data related to the oil, gold, stock and currency sectors were extracted from the data collected from the World Bank, the Central Bank and the Statistics Center of Iran. In order to evaluate the flow of data into statistical analysis and simulation software, these data were extracted. In this study, some scenarios were designed for further analyses and sensitivity analysis. Based on the results, the existence of turbulence in the oil markets causes fluctuations in the parallel financial markets in Iran. Due to the stability of these fluctuations, prices have not returned to the previous state and maintain their increased trend. The presence of fluctuations in the exchange, oil and gold markets is more effective, and the exchange market is affected by these markets due to the lack of development in Iran, and it cannot serve as a protective agent against other sectors of the economy.
Keyword: Sensitivity Analysis; Oil Market; Financial Market; Dynamic Systems; MV-GARCH Model.

1. Introduction

The present study, by modeling all types of scenarios in the current oil market of Iran economy under the conditions of sanctions and various economic problems; the oil sector is modeled and analyses its impact on the financial markets of Iran. Then, different scenarios of oil market are investigated and the necessary solutions are presented to compensate oil revenues.

Financial markets and oil sector

Uncertain price movements and risk contagions have been observed in the financial and energy markets due to unpredictability in economic development, discontinuity of economic policy and international geopolitical conflicts (e.g., see Li & Wei, 2018; Wei et al., 2017; Zhang & Wang, 2019; Mei et al., 2017; Fratzscher, 2012; and Wei et al., 2018). Investors typically select several hedging assets to offset their risk in the financial and energy markets. Crude oil and gold have long served as risk management tools to hedge against economic risks (Cunado et al., 2019; Lin et al., 2016; Ruan et al., 2016; Tang & Xiong, 2010; and Lei et al., 2019).

The relationship between the oil, stock, currency and gold markets and the ability to transfer risks between them is strongly affected by news and sustainability, and their prices are intrinsically related to the economy. The stability of the trend of increasing oil prices and fluctuations in the

trend of increasing gold prices has led to an important relationship between efficiency and improvement of turbulence transfer between the four mentioned markets. It is natural to expect that prices or conflicts between the price of oil and the stock market are linked in the asset pricing models. Also, the unreliable news in the markets indicates that asymmetric acceptance of bad news and good news in an oil market, for example, in the oil market, can contribute to strengthening and strengthening the small danger between the markets. Dynamics may change over time because of structural changes in the economy and the foundations that are pushing these markets forward. Therefore, considering the possibility of random changes or differences in the time set of these prices or their corresponding conflicts is important. (Ewing and Malikb, 2015)

Structural failure in turbulence can be justified by different reasons such as natural, economic, social or political events. Detailed understanding of the time-sequence relationship between markets will be useful for participants in the financial market and policy-makers. Oil prices affect consumer behavior that directly affects overall economic performance.

Fluctuations in Financial Markets and Their Transfer to Other Markets

Fluctuations in Oil Markets

One of the important issues in the oil sector is the issue of oil prices and fluctuations in oil prices, so that any unexpected increase or decrease in oil prices may result in oil revenues, which in turn affects the economy directly and leads to crisis and economic imbalance if the correct economic policies are not implemented. Over the past three decades, oil prices have seen major changes. For example, oil prices increased by about 76% between March 2007 and June 2008, then by 48% between June and October 2008. In 2011, crude oil prices recorded lower than $100 per barrel, and recently dropped to $55 per barrel. Therefore, these sharp changes in oil prices could have impact on the market, including the stock market in a country like Iran, which one of the major oil-exporting countries.

Since the first and most important factor affecting the decision of investors on the stock exchange, the stock price index is important, therefore it is important to know the factors affecting the price of shares. Naturally, many factors are effective in the formation of information and view of market parties and finally the price of shares of the companies. Some of these factors are local and sector, due to the situation of variables outside the local economy. Generally, it that the present situation in the stock market depends on the current conditions of the economy and information on the future prospects facing the companies, and this is if the predicament of is improved by using other data, it is possible to use that information (Gerland, 2008).

Oil prices and oil fluctuations are one of the factors affecting the stock price index. Oil and its used as the most important source of energy in manufacturing processes in the world. Therefore, fluctuations in oil prices can affect the cost of production and profitability of production companies. Oil is considered the most important source of income for some of its exporting countries, and oil prices and its fluctuations in the channel may affect the real sector as well as the capital market, such that in many countries where oil revenue management is not suitable for oil

prices. The increase in oil prices has accompanied the government's rise in revenues and the rise in the currency base, which has inflationary effects. The rise in inflation also positive effects on stock prices. Therefore, the main aim of this paper is to investigate the effects of oil price fluctuations on the fluctuations in the efficiency of the Tehran Stock Exchange Index (KSE). Considering the importance of the oil market and the stock market in economic growth, it is important to consider the impact of these two markets each other.

2. Literature of Subject:

Korbinian Lang, Benjamin R.Auer (2019), in a research titled Economic and Financial Properties of Crude Oil, presented a structured review of the dynamic model of crude oil prices. In this research, evidence of the important factors that determine oil prices and the impact of oil market shocks on macroeconomics and stock market is discussed and then there are ways to predict the price of crude oil and fluctuations. By comparing the results with the most important fluctuations in recent decades and studies done, the major developments and research gaps in each field are identified. The most important variable among the many variables mentioned in this study is the changes and political conflicts in the Middle East and the incidence of unpredictable political incidents.

Abura and Chivalir (2015) studied the relationship between efficiency and fluctuations among goods markets, stocks, securities and currency in 2013-1983 using the DCC-GARCH model. The evidence of their research shows that there is a significant overflow between efficiency and fluctuations in the commodity and financial markets.

Mensi et al. (2015) used to model symmetrical fluctuations, asset allocation and price adjustment between US dollar/euro dollars at energy prices in six oil cash markets in different regions of the world, using the DCC-GARCH model since 1998-2012. Their results indicate that asymmetric fluctuations have significant dollar exchange rate to oil markets.

In a study titled "2018" (2018), Dehghan Jabarabadi et al. (2018), a study published by the Iranian financial market has found that the starting point of the sprouting in Iran's financial markets is oil market and the rate of synchronization of the stock market with oil is higher than the other markets, respectively. In the next step, it was found that there is a significant correlation in the short term between the oil market and other financial markets, but in the long run this alliance only exists between the oil market and the two stock and foreign exchange markets. After oil sanctions against Iran in 2012, the correlation between the oil market and foreign exchange markets and stock markets was growing in the mid-term.

In a study titled "Overflow of Oil Price Fluctuations on the Return of the Stock Exchange (BCE), IPOs found that the presence of conditional correlations in short-term fluctuations and the effects of oil prices on the stock exchange index is clear.

These problems are not limited to developing countries but are also faced by many developed countries, but developing countries such as Iran have a high degree of instability among macroeconomic variables. A review of the developments in the stock, gold and foreign exchange

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)
markets in Iran shows that the prices of these assets and the turbulence associated with it have been significantly altered in recent years. Husseinion et al. (2016).

Qasemi and Nazari (2016) examined the relationship between economic growth and market turbulence. It concluded that higher economic growth will not create economic turbulence, and the result of economic growth will reduce economic growth by affecting productivity and reducing investment because of long-term uncertainty.

Farzin Arbabi (2018) in a study that predicted the turbulence of the return of gold coins, using the data from the day 2009 to 2016 shows that the turbulence of other financial markets such as exchange rate fluctuations, oil price change and stock price index in the stock exchange can improve the ability to predict the gold coin recovery model. Using the information of parallel markets and increasing the prediction period can better be found in explaining the problem.

3. Methodology:

Many applied in developed markets show that stock prices fluctuate by changing the macroeconomic variables, so it is expected that stock price index is strongly related to macroeconomic variables. The reason for the theoretical investigation of such a relationship is that the price of stocks can be considered as a future cash flow. This relationship can be stated as follows:

$$P0 = \sum_{n=1}^{0} [E(Dn)/(1+i)n]$$

In the above-mentioned case, P represents the value expected, i.e. the appropriate rate of the lazdown and D of cash payments at the end of t-period. It is clear that any economic variable that affects the expected cash flow or the discount rate will also affect the stock price (Kang et al., 2008). The first and most important factor affecting the decision of investors on the stock exchange is the stock price index. Therefore, knowledge of factors affecting stock prices is important. Naturally, many factors are effective in the formation of the information and view of market parties, and finally the price of shares of the companies. Some of these internal factors, in part, are due to the situation of variables outside the scope of the internal economy. Therefore, factors affecting the stock price can be classified to internal factors and external factors (Samadi et al., 2007).

1) Internal factors include the factors affecting the stock price in relation to the company's operations and decisions. These factors include revenue of each share (EPS), dividends profit per share (DPS) and price ratio on income (P/E), increase in stock capital and other incorporate factors.

2) External factors include the factors outside the company's management powers, which to influence the company's activity. These factors are those of events, events and decisions outside the company and affect stock prices. In general, these factors can be divided into the following two parts (Pevari and Shahsavar, 2008).

(a) Political factors such as war, peace, cut off political and economic ties with other countries, change the political organs, and adopt the competing political parties (Pakdin Amiri et al., 2008).

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

(b) The economic factors that are severely affected by the economic recession, so that during the period of economic, by increasing investment in growth companies' stock companies, the price of shares will increase and in the recession will lead to a decline in stock prices for companies; Because under these conditions, investment in financial assets with fixed income leads to investment in ordinary stocks (Samadi et al., 2007).

Many methods have been used to estimate the dependence structure between two variables, such as correlation coefficients, cointegration tests, Granger causality, dynamic conditional correlation, and generalised autoregressive conditional heteroscedasticity (GARCH) modelling and its variants (GARCH-MIDAS, FIGARCH, TGARCH, etc.). Some non-parametric quantitative techniques, such as Kendall (K)-plots, can be used to detect the existence of a dependence structure, and some parametric techniques, such as copulas, can capture how much one variable contributes to joint distribution on the tail (along with other variables). The main reason to use a non-parametric approach is to ensure the robustness of the results of a parametric technique (here, copulas). Nguyen and Bhatti (2012) and Huynh et al. (2018) examine parametric and non-parametric approaches.

A copula function generates the links from the nth-dimension of univariate marginal distributions to full multivariate distributions, which results in a joint distribution function of these random variables. Correlation is a scalar measure of dependence, and so cannot present the dependence structure of risks. On the other hand, copulas determine the dependence relationship and can indicate the position of tail dependence (left, right or normal).

The global oil price index is one of the most important affecting the economic factors and political factors in the country Global oil price as a powerful exogenous variable is affected by many macroeconomic variables, such as the stock price index, many macroeconomic variables. Explaining such relationship is a guide for policy in the monetary and foreign policy (Samadi et al., 2007).

Oil Price Fluctuations Overflow

With 11.31 percent of the world's oil reserves, Iran is one of the world's most oil-rich countries (Central Bank economic symbols 2012).

In fact, oil and its production and sales revenues have greatly affected the performance and efficiency of the entire economy. Therefore, oil revenues play a strategic role in the structure of Iran's economy. On the one hand, Iran, the second biggest producer among oil exporting countries of OPEC, is a major oil supplier in the global energy market that can both affect and impact the global oil market (economic symbols of the Central Bank, the fourth quarter, 2012).

In this situation, any momentum oil markets can affect the economic structure from various sectors of the country. Since the value of the stock is equal to the total of the future cash currents, and these cash currents are affected by the events and events of the big economy, they may also be affected by oil shocks, it seems quite logical to say that the stock market absorbs oil impairment of oil impairment and repercussions at stock prices (Gerland, 2008).

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

The stock market (Securities Exchange) is one of the components of the capital market and a function of it as part of the economic complex. If the market does not have a logical with other sectors, then problems and deficiencies in its performance will occur. In developing countries, the impact the economy due to the impact of the stock market is more deep compared to the developed countries, because there is concern about the decrease in capital value with concerns of perceived instability in the economy (Pyroi et al., 2008).

Oscillating Currency Market

With regard to the impact of exchange rate fluctuations on the stock exchange Adler and Dommas (1984), companies whose priced or priced prices are affected by the exchange rate movement are affected by the exchange rate changes, even if their entire operations are carried out inside the country. In economic literature, there is a profound view that exchange rate changes affect the competitiveness of companies operating in the international arena. Increasing exchange rates and reducing the value of local currency have led to an increase in the competitiveness of local companies, which can reduce the price of their goods abroad (Loirman, 1961)

According to economic theories, there is a bilateral relationship between stock prices and exchange rates. The effect of exchange rate change on stock prices can be examined from two aspects of traditional and paramount approach. In addition, stock prices also affect the exchange rate (influence of the exchange market from the stock market). Change in the exchange rate could have two different effects on stock prices. On the one hand, an increase in the exchange rate (after demand) leads to an increase in the income of COMMODITY exporting companies, as well as a result of their stock prices, and on the other hand, it leads to a decrease in the interest of the import companies of brokerage firms and a decrease in their stock prices. In addition to dividing the stock market, stock buyers are also paying attention to the company's intrinsic changes.

Oscillating Gold Market

Gold has always been a precious metal in the focus of human attention. Given the fact that gold and stock have a large share in the people's portfolio, the selection of the portfolio of optimal assets is subject to a proper understanding of the behavior of fluctuations. It is also important to distinguish the behavior of price fluctuations in these markets in order to make suitable control policies, since fluctuations lead to uncertainty, public trust, and the decrease of investment. The misunderstandings between the markets can lead to the adoption of improper and anti-production economic policies.

Structural Failure Due to Financial Market Overflows

In analyzing time series in macroeconomics, one of the important issues is structural failure. In many time series structural changes can be for several reasons, such as political changes, financial and economic crises, regime change, and even changes in institutional arrangements and frameworks. The important point is that if the structural changes are observed in the time series

data and are not used in economic and financial estimates, the results are intact towards the misconception of the data being misinterpreted. (Perron, 1997) (Perron, 1989). Therefore, it is wrong to conclude that the time series under review has a random process. The results show that any shock or momentum by supply and demand or due to political changes in the long term will affect variables. Therefore, the important point is considering potential structural failures in data and doing more reliable test (Samadi and Pahlavani, 2009).

Structural failure is not only about social variables and management. Rather, fluctuations will occur in financial markets if there is an overflow. In order to prove the existence of fluctuations in financial markets, first, the causality relationship will be investigated and then structural failure tests will be conducted to explain the effects of various markets.

Model Assessment:

Sensitivity analysis is called "The Effect of Output Variables" through the input variables of a model. In other words, a method for changing the inputs of a model is systematically (systematic), which can predict the effects of these changes in the model output.

Sensitivity analysis determines how sensitive the obtained solution (solve the logical solution in dynamic system and optimal solution in linear programming) against certain changes in the main model is. As we know, every parameter used in the model is estimated based only on assumptions and predictions. Usually, these estimates are based on information which is usually incomplete and sometimes do not exist in the universe. Therefore, parameters which are first entered in the formula are only as an experimental and even contagious estimate. Therefore, a specialist in this field always deals with scientific doubt and preliminary results. Sensitivity analysis is of the probable variations of parameters on the logical response of the model. In this perspective, the parameters are divided into two categories:

1. Some parameters can choose different logical values and, at the same time, have no effect on the solution.

2 Some parameters that may create a new logical response with a little change. The importance of this issue is increased when new logical solutions cannot be counted according to the reader's own connotation and perspective, and a wise decision can be made in this regard.

Thus, the sensitivity analysis of these parameters (type 2) is quite sensitive to more accurate estimation of them. In this study, the following policies (parameters) are considered which are Analyzed Sensitivity.

Table 1 shows the main characteristics of the model scenarios to simulate the price level in the oil market and parallel markets.

1- Basic scenario (continuation of the current situation)

2- Increasing the amount of sanctions and political disputes in Iran

3- Increasing support for the stock market in Iran

4- Creating technology and alternative fuels for oil

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

Table 1. Main Characteristics of Model Scenarios for Model Simulation

Scenarios	Basic scenario	Scenario 1	Scenario 2	Scenario 3
Basic scenario	Continue the current trend			
Increasing sanctions and political disputes in Iran		Increase by 0.5% each year		
Increasing support for the stock market in Iran			Increase by 2% each year	
Creating technology and alternative fuels for oil				Increase by 10% each year

Sensitivity Analysis of Increasing Sanctions and Political Disputes in Iran

With the increase in Iran's political conflict and sanctions in previous years, a scenario on the rise in conflict has been developed. According to figures from the World Bank, Iran's political risk is 68%, and a half percent increase in each year will have a significant impact on other financial markets. In this section of the study, we will examine the impact of the increasing sensitivity of sanctions on the political disputes in Iran on the financial markets inside Iran.

Increasing Iran's political problems will reduce Iran's share of OPEC in oil exports. Within Iran, this effect leads the stock market to a shortage of financial resources, and the stock exchange index to decline relative to the base situation. Political problems lead to widespread fluctuations in the exchange and gold sectors in the Iranian economy. Therefore, the stock exchange sector is affected by political differences in Iran's economy.
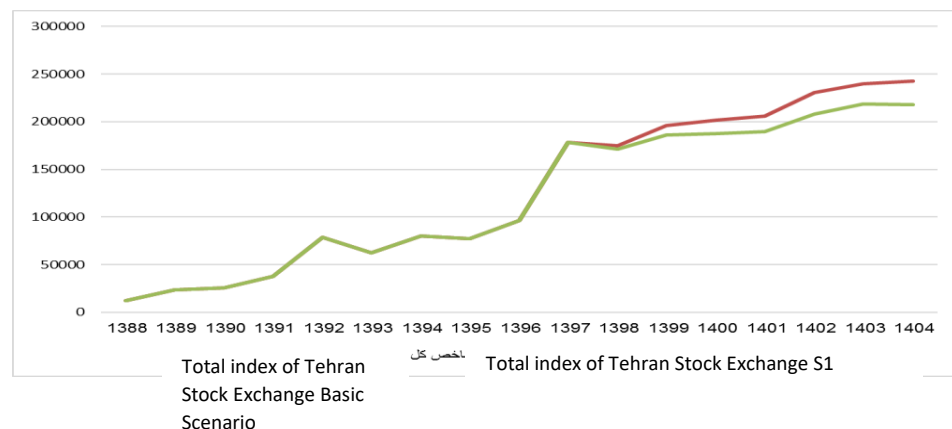

Figure 1. Stock Index in The First Scenario

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

With the creation of political disputes, the price of gold in the Iranian economy is on the rise and will increase to 6%. This increase will cause the prices of other commodities to increase and also the Iranian stock market sector will suffer more. Because in this market, short-term profits are created and everyone enters the gold market.
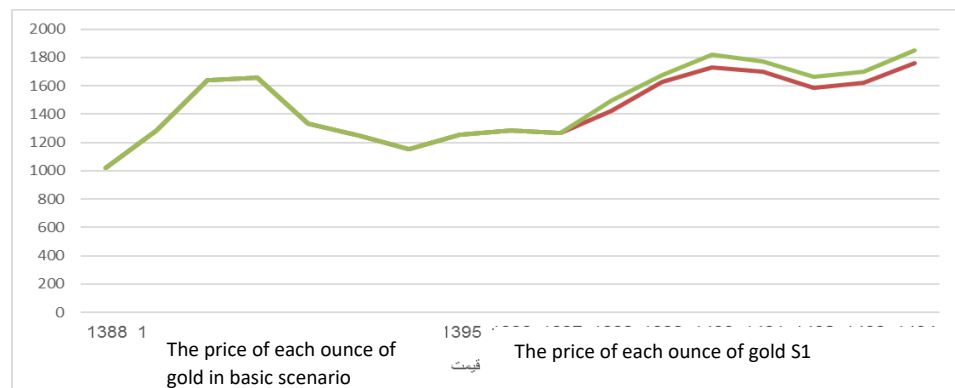

Figure 2. Gold Price in The First Scenario

The exchange rate in Iran is also rising due to political disputes. Considering that the dollar rate in Iran is stabilized under the currency system and is under the control of the Central Bank, but the rate considered in this study is the dollar rate in the free market, under the influence of which the prices of goods increase.
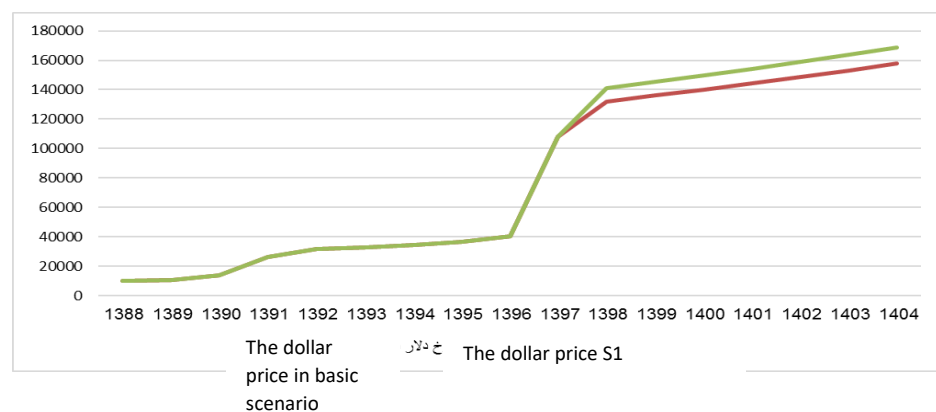

Figure 3. Dollar Exchange Rate in The First Scenario

Sensitivity analysis of stock market support increase in Iran

The increase in support of the stock sector in Iran, if carried out by the public sector, would cause negative tires in the long run. However, this effect is influenced by the increased public's encouragement of savings and their use in investment in the real and productive sectors of the economy. In the long run, the Iranian stock market will be subdued. Given that the stock market does not have a major impact on the exchange and gold rates in Iran's economy. No other related items.
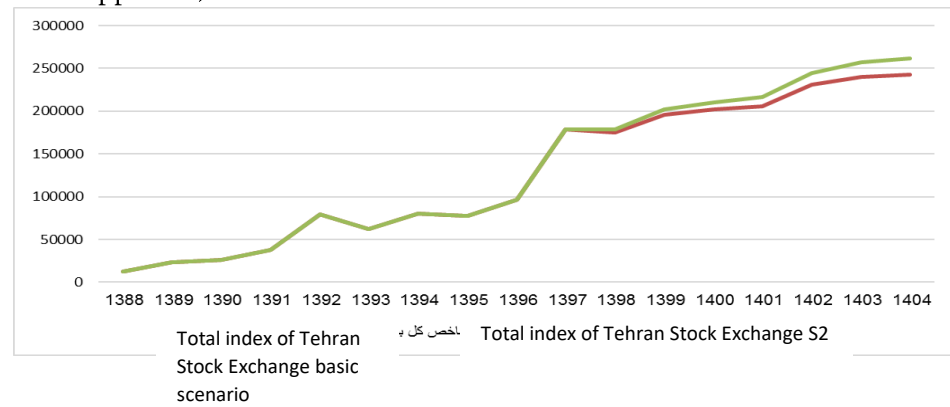
Figure 4. Stock Index in The Second Scenario

Sensitivity analysis of oil technology and alternative fuels

Iran's oil revenues will be affected by the development of alternative energy or alternative technologies. Because these factors have led to a drop in oil demand in the world and focus on the environmental effects that have increased significantly in the present era. Increasing the knowledge of alternative oil sector along with Iran's political problems such as sanctions will reduce Iran's oil demand and thus reduce oil revenues. The reduction in oil revenues in Iran, if along with the improvement of economic structure in the various production sectors, will lead to economic growth and development.
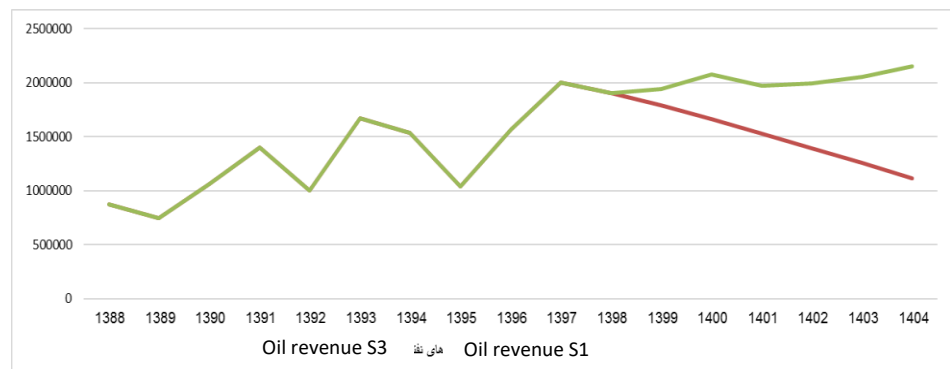

Figure 5. Oil Revenues in The Third Scenario

The decline in oil revenues, with the increase of capital in the economy, will improve the stock exchange index in the Iranian economy. This change will help to keep the stock exchange from fluctuations in the exchange and gold sectors, as the investment process increases. Development of the stock sector in Iran has a significant impact on Iran's output in agriculture, industry and services sectors. Also, given that the country's development is dependent on financial development, It is possible to reduce the amount of liquidity of banks created by the lending process by developing their financial sectors. This will also reduce inflation in the economy.
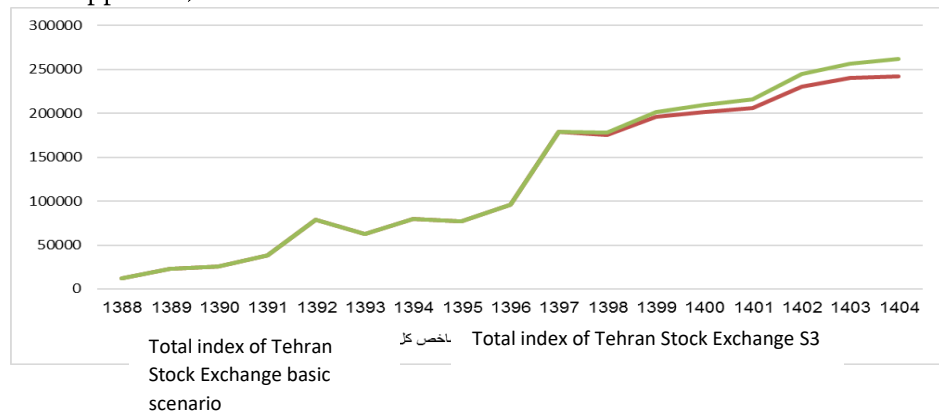
Figure 6. Stock Index in The Third Scenario

The price per ounce of gold in the domestic markets of Iran in dollars increases due to the decrease in oil revenues. This increase in the price of gold is due to the trend of gold in different periods, which, despite many fluctuations, has had an upward trend.
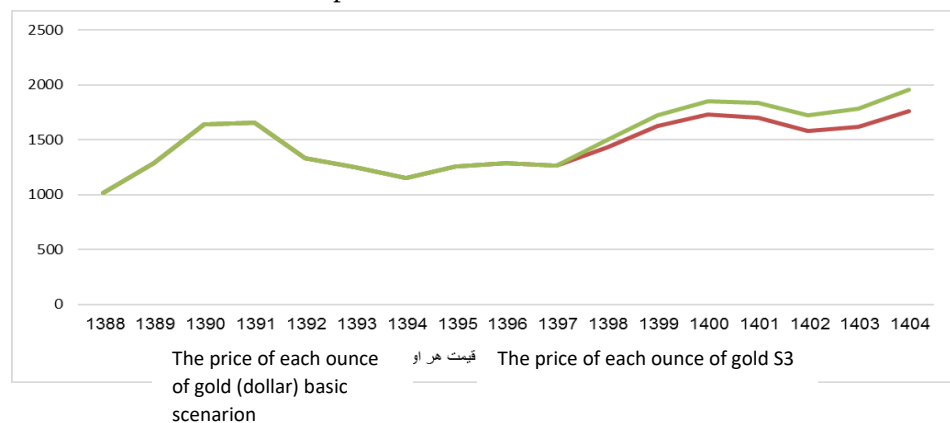

Figure 7. Gold Price in The Third Scenario

Following changes in oil revenues, the exchange rate in Iran, which is affected by gold markets and political risk, has changed and the dollar exchange rate is rising. But in the case of financial and structural reforms in the Iranian economy, this rate can take a downward trend.
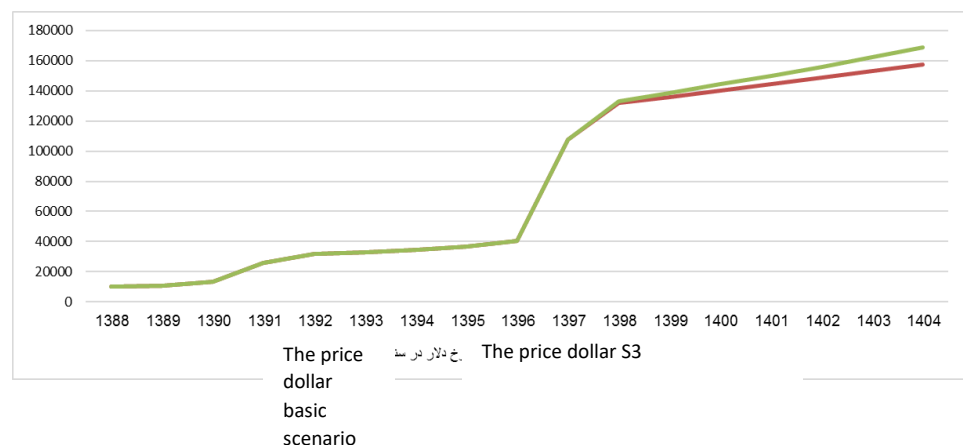

Figure 8. Dollar Exchange Rate in The Third Scenario

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic
and MV-GARCH Model Approach)

Overflows From Financial Markets:

The relationship between the oil, stock, currency and gold markets and the ability to transfer risks between them is strongly affected by news and sustainability, and their prices are intrinsically related to the economy. The stability of the trend of increasing oil prices in the last decade has caused important relationship between efficiency and boosting turbulence transfer between the four mentioned markets. It is natural to expect that prices or conflicts between the price of oil and the stock market are linked in the asset pricing models. Also, the unreliable news in the markets indicates that asymmetric acceptance of bad news and good news in an oil market, for example, in the oil market, can contribute to strengthening and strengthening the small danger between the markets. Dynamics may change over time because of structural changes in the economy and the foundations that are pushing these markets forward. Therefore, considering the possibility of random changes or differences in the time set of these prices or their corresponding conflicts is important.

1-1-1 Shock Impact On The Exchange Market in Parallel Markets:

1-1 Garch-Mv Model Estimation

In this part, data related to the price index of securities exchange, gold market, oil and currency prices are considered monthly from April 2011 to March 2019. In first step, the IU root test was performed to identify the time series of the price index. In this study, the KPSS test was used and the results were indicated that the time series was at the level of 1 and 5%.

In the next step, for modeling the turbulence of price index in markets, its optimal conditional mean equation must be estimated at first. The ARMA model was determined by using the Box-Jenkins method to estimate the model. This model consists of three stages: diagnosis, estimation and review. The most important tool for determining the order, using self-correlation function and partial autocorrelation, as well as the least criteria of actiic information (AIC) and Schwarzenesian (SBC). As observed in the table below, the optimal model is ARMA(1,2) which is a combination of AR(1) and MA(2). All of the model coefficients at level 1% were significant except MA(2), which is not meaningful, but since its t-test is larger than one, therefore it is considered as the model and it cannot be removed.

The results of the model indicate that there are some notions between financial markets. These variables are confirmed by the statistics of Prob of zero and also by the high impact of z.

Table 2. Model Estimation Using MV-Garch

$$GARCH = C(10) + C(11)*RESID(-1)^2 + C(12)*GARCH(-1)$$

Variable Coefficient	Std. Error	z-Statistic	Prob.
N -2.006220	0.000292	-21.27082	0.0000
S-12.002230	5.70E-05	-39.09658	0.0000

A	8.917562	0.081946	35.60348	0.0000
AR(1)	0.627709	0.205915	3.048383	0.0023
AR(2)	0.376654	0.206380	1.825051	0.0680
MA(1)	0.390853	0.209732	1.863580	0.0624
MA(2)	0.099445	0.023976	4.147653	0.0000
MA(3)	0.252137	0.032329	7.799058	0.0000
MA(4)	0.132328	0.046226	2.862657	0.0042

Variance Equation

C	68443692	3145887.	21.75656	0.0000
RESID(-1)^2	0.040087	0.001232	32.54562	0.0000
GARCH(-1)	-0.999875	9.03E-06	-110690.5	0.0000

R-squared	0.998649	Mean dependent var	50063.17
Adjusted R-squared	0.998646	S.D. dependent var	28057.78
S.E. of regression	1032.396	Akaike info criterion	18.19404
Sum squared resid	3.49E+09	Schwarz criterion	18.21630
Log likelihood	-29880.80	Hannan-Quinn criter.	18.20201
Durbin-Watson stat	2.489212		

Inverted AR Roots	1.00		-.38	
	Estimated AR process is nonstationary			
Inverted MA Roots	.31+.58i	.31-.58i	-.51-.21i	-.51+.21i

1-1 Model Garch Effect

In model economics, a model is called the autoregressive conditional heteroscedasticity feature, which is assumed to be the variance of error terms or innovations is a function of the size of the error terms of the previous time periods: Usually variance is associated with the square of previous innovations. Such a model is usually called ARCH (Engle, 1982) of course there are other abbreviations for the same-based models. ARCH models are usually used for financial time series, which show time-based oscillating classifications that are accompanied by fluctuations with non-fluctuation periods.

In this method, the random term has an average of zero and a series of non-correlated cases. However, the variance with its past data is assumed to have been variable (Parasite, 1982). In this case, it is expected that variance during the random processes of the series is not constant and is a function of the behavior of the wrong sentences. In fact, the ARCH model can explain the process of conditional variance according to its past data. In summary, the structure of the ARCH model can be written as follows:

$$Pt = \beta 0 + \sum_{1=l}^{s} \beta iPt - i + \gamma Xt + \varepsilon t$$

$$e_t^2 = \alpha 0 + \sum_{j=1}^{q} \alpha j \varepsilon_{t-j}^2 + \lambda zt + vt$$

There are two relationships in the system of equations. The first relationship of dependent variable variables during the external variables, Zt and Xt. Provides time. while the second relation relates to conditional variance, respectively (Parasite, 1982).

ARIMA, AC and PAC models for the remainder were evaluated to test the frequency and their significance was evaluated. Based on this test, there are approximately the coefficients within the boundary (dotted), so all the AUV factors have no significant difference from zero. Also, Q-statistics is also much smaller than the Chi-Do table values, so the Self-correlation coefficients have no significant difference from zero. The most probabilities in the last column are larger than 5 percent which indicates that the Autocorrelation coefficients are zero.

The GARCH model can be extended to include any number of lags on the squared error term and conditional variance term. The GARCH (p,q) model has p lags on the conditional variance term and q on the squared error term. However in general a GARCH(1,1) model is sufficient.

Asymmetric GARCH models due to the leverage effect with asset prices, where a positive shock has less effect on the conditional variance compared to a negative shock. This can be incorporated into the GARCH model using a dummy variable. This was introduced by Glosten, Jangathann and Runkle (GJR), and showed that asymmetric adjustment was an important consideration with asset prices. The model is of the form:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 + \lambda u_{t-1}^2 I_{t-1}$$

Where I is a dummy variable that takes the value of 1 when the shock is less than 0 (negative) and 0 otherwise. To determine if there is asymmetric adjustment, depends on the significance of the last term, which can be determined using the t-statistic. Given the following set of results:

$$\sigma_t^2 = 0.5 + 0.7u_{t-1}^2 + 0.2\sigma_{t-1}^2 + 0.17u_{t-1}^2 I_{t-1}$$

If we assume that $\sigma_{t-1}^2 = 0.7$ and $\hat{u}_{t-1} = \pm 0.5$, when the shock is positive, $\sigma_t^2 = (0.5 + 0.175 + 0.14) = 0.815$, if the shock is negative $\sigma_t^2 = (0.5 + 0.175 + 0.14 + 0.0425) = 0.8575$.

The alternative to the above model is to use EGARCH, which has a number of advantages over the basic GARCH model, as the non-negativity constraint does not need to be imposed and the asymmetries are also allowed for using this model:

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

$$ln(\sigma_t^2) = \chi + \beta\, ln(\sigma_{t-1}^2) + \gamma\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha\left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right]$$

In this class of models, the conditional variance enters into the conditional mean equation as well as the usual error variance part.

$$y_t = \mu + \delta\sigma_{t-1} + u_t$$
$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2$$

If y_t is assumed to be an asset return, then in effect the first equation suggests that the mean return is dependent on the risk, if the parameter δ is positive and significant, then it means that the mean return increases when there is greater risk, in effect δ can be interpreted as a risk premium.

In the next step, after the ANOVA model, the conditional variance is applied for modeling and extraction of fluctuations (turbulence). Because time series oscillation may not respond to positive and negative shocks and it is necessary to use an asymmetrical model to analyze the behavior of fluctuations. The ARCH method has superiority over other conditional heterogeneity models. Based on the result, the estimated model is confirmed.

Heteroskedasticity Test: ARCH

F-statistic	4.803690	Prob. F(1,3283)	0.0285
Obs*R-squared	4.799594	Prob. Chi-Square(1)	0.0285

Test Equation:
Dependent Variable: WGT_RESID^2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.176817	0.023895	7.399597	0.0000
WGT_RESID^2(-1)	0.038224	0.017440	2.191732	0.0285

R-squared	0.001461	Mean dependent var	0.183844
Adjusted R-squared	0.001157	S.D. dependent var	1.357966
S.E. of regression	1.357180	Akaike info criterion	3.449303
Sum squared resid	6047.079	Schwarz criterion	3.453016
Log likelihood	-5663.481	Hannan-Quinn criter.	3.450633
F-statistic	4.803690	Durbin-Watson stat	2.018421
Prob(F-statistic)	0.028469		

Shock Impact On The Exchange Market in Parallel Markets:

a) Stock

If a shock is created in the exchange market, the stock price in the first phase will be reduced because a portion of the capital is transferred to the exchange market by investors. The price drop

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

continues until two periods, and gradually, with the return of profits in the exchange market, the transfer of capital to the stock market begins, and the trend of stock prices increases gradually from the second to the fourth period. After the fourth period, the transfer of capital increases, and stock prices are growing from the fourth to the next period and stock prices rise.
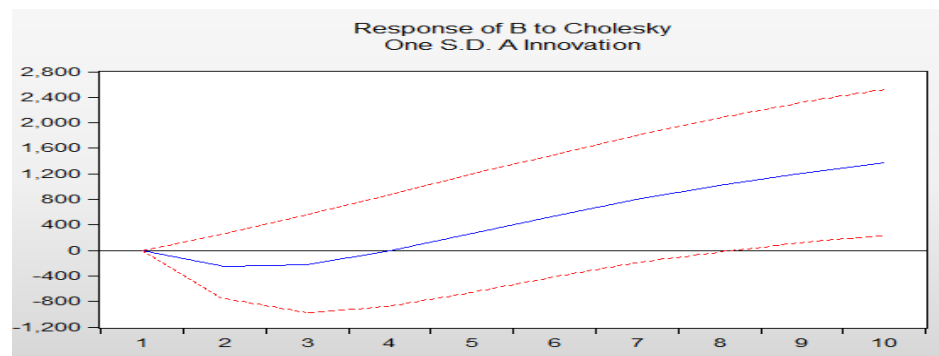
Figure 9. Shock Impact on Currency Market

b) Gold

The shock in the exchange market affects the gold and gold market from the start and very quickly. This price increase continues until two periods, followed by a very weak process. With the increase in the exchange rate, gold prices will never return to its original price even if the price of the increase is slow.
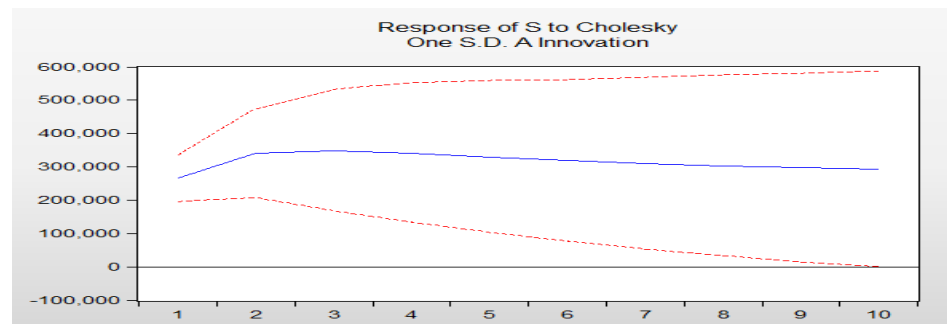
Figure 10. Shock Effect on The Exchange Market on The Gold Market

c) Oil

Shock in the exchange market does not usually affect the oil market much. The price of oil is set in OPEC and partially controlled. But in Iran, with the rise in foreign currency prices, the rate of oil revenues has decreased and then the rate of oil revenues is on the rise.
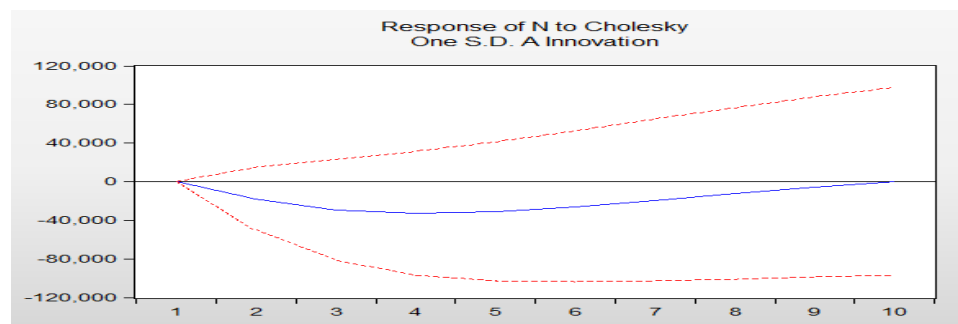
Figure 11-the Effect of Shock in The Exchange Market on Oil Prices

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

The impact of shock on the oil market in parallel markets:

a) The Currency Market

If the oil market creates a positive shock, the exchange rate will initially increase and then fall. Oil revenues usually lead the public to neglect tax revenues. These earnings are usually accompanied by high rent.
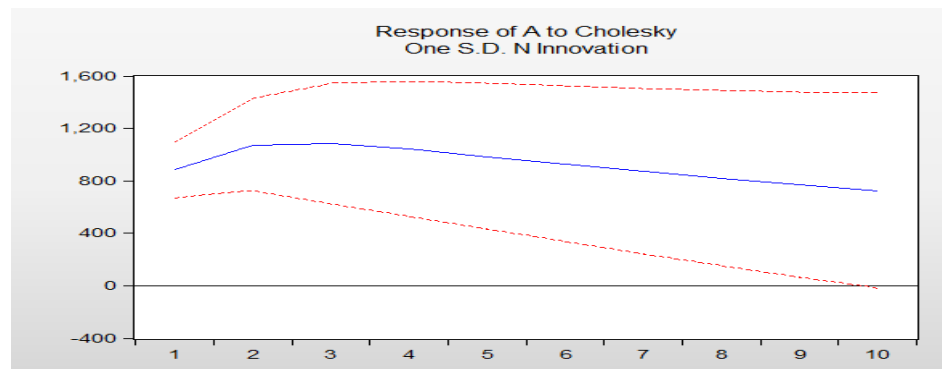

Figure 12. Shock Effect on The Oil Market

B. Stock Market

In the event of a shock in the oil market, financial resources from the stock sector will be transferred to other sectors of the economy with short-term profits and the stock sector will be severely damaged.
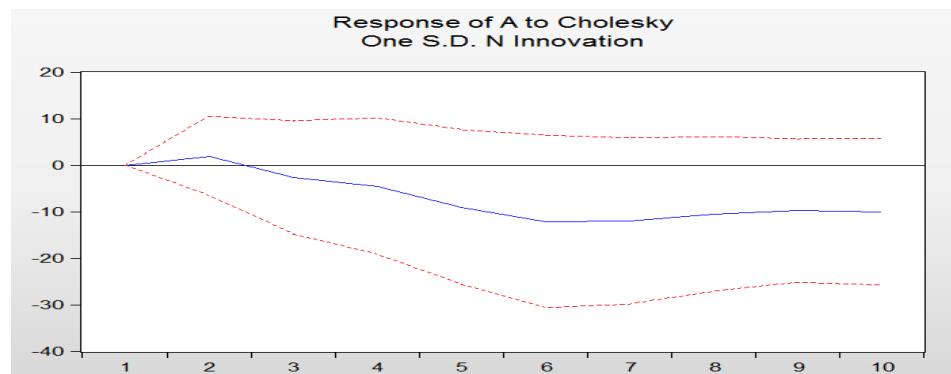
Figure 13-The Shock Effect on The Oil Market

(c) The Gold Market

The shock in the oil market leads all investors to the oil market, and the gold market suffers from liquidity and price cuts. In the first phase of the rise in oil prices, as the exchange rate increases, gold prices rise, but with the increase in stock and currency prices, the capital will be transferred and prices will drop.
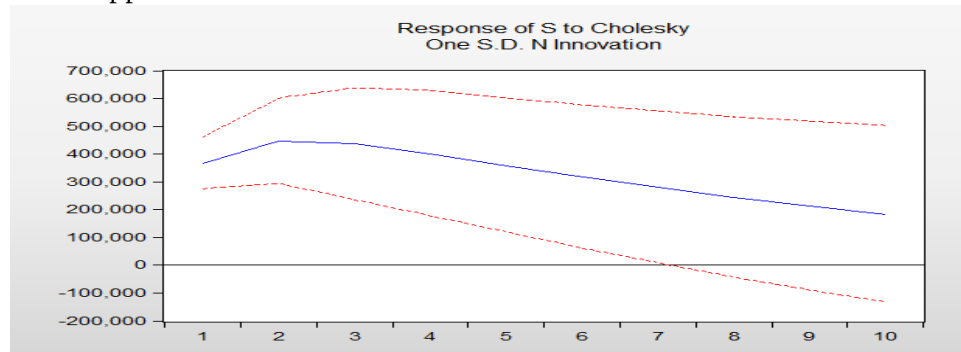
Figure 14. Shock Effect on The Oil Market on The Gold Market

Shock effects on the gold market in parallel markets:

(a) StockMarket

The presence of positive shocks in the gold market makes these markets profitable markets with high profits and a return to fast capital. Therefore, investors with high-risk motivations and stagnant capital are drawn to these markets. This will reduce the stock market price.
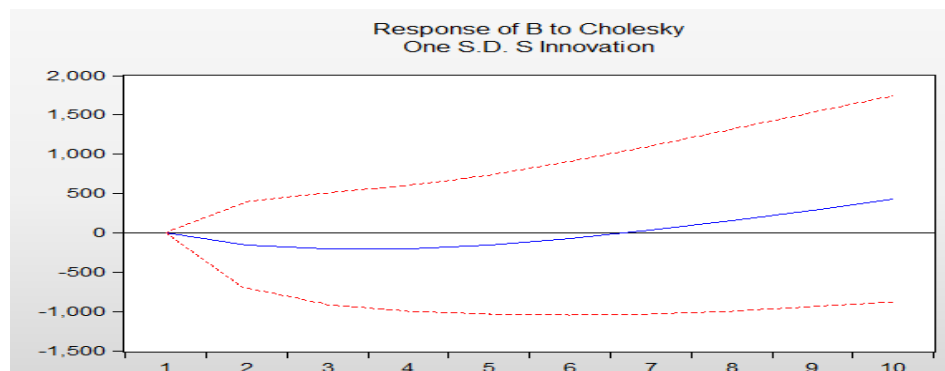

Figure 15. Shock Effect on The Gold Market

b) Foreign

A positive shock in the gold market increases the exchange price. There is a lot of fluctuations between the exchange and gold market, so that the smallest shock in any market affects the other market quickly and with a high impact.
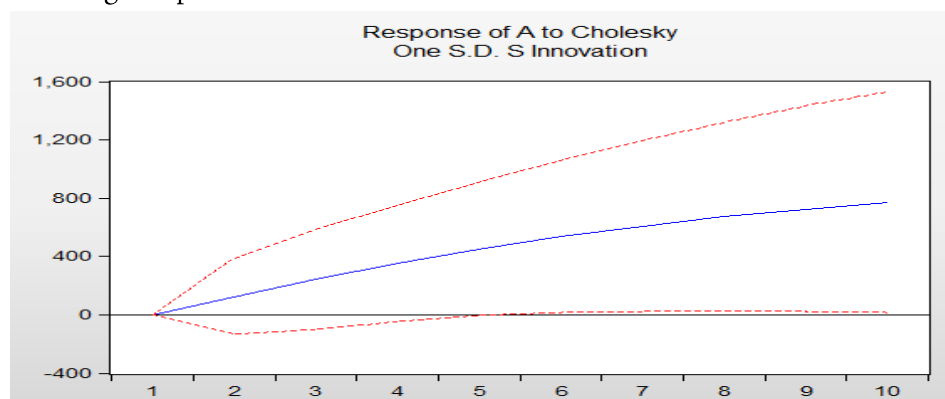

Figure 16. Shock Effect on The Gold Market

Ahmad Farhadi et al.
Sensitivity Analysis of Oil Market and Parallel Financial Markets in Iran's Economy (Dynamic and MV-GARCH Model Approach)

c) Oil

Shock in the gold market increases oil prices. The shocks that occur in the gold market are caused by the rise in currency prices, as well as the rise in stock prices and the rise in oil prices in world markets.
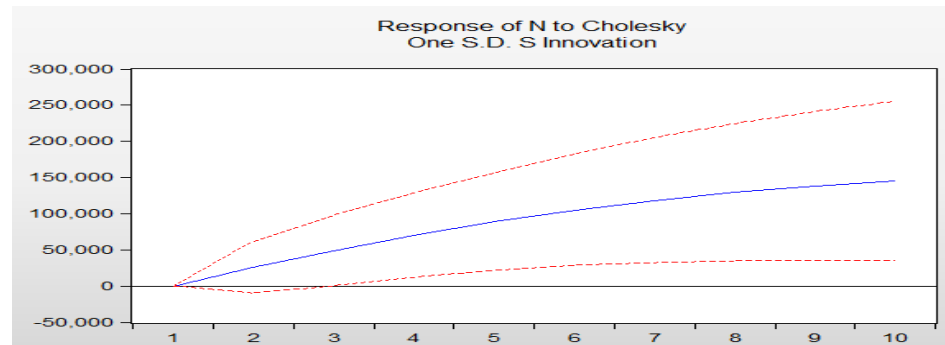

Figure 17. Shock Effect on The Gold Market

Shock affects stock market future prices

The shocks that were created on the stock market initially raised stock prices in a bubble form. After a while, the bubble exploded and the prices started to drop.
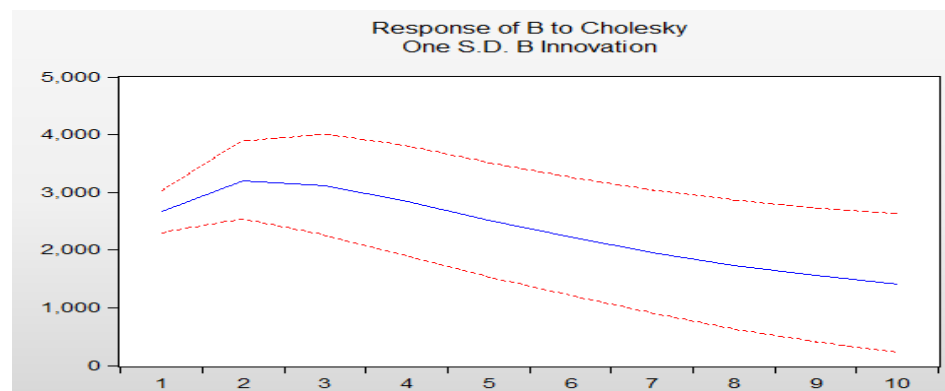

Figure 18-the Effect of Shock on The Stock Market's Future Price

Shock effects on currency market at upcoming prices

A shock in the exchange market, like the stock market, initially increases the exchange rate in a bubble form. In the next period, the psychological effects in the market are destroyed and the price of currency is decreased. But despite the drop in prices, it never returns to the original rate.
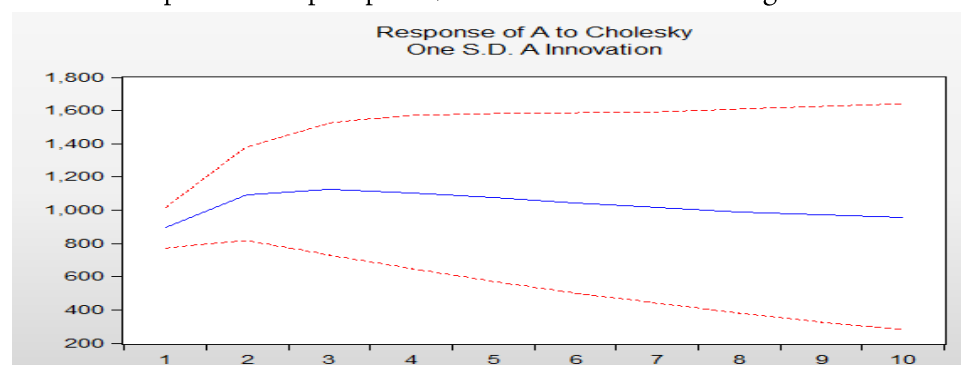

Figure 19 - Shock Effect in The Exchange Market on Future Currency Prices

Future price shocks on gold market

Price shocks on the gold market are swinging in gold prices. At first, the trend of price increases is harsher and gradually decreases. This leads to the return of gold prices in the first place. The existence of overflow effects from other markets increases this trend.
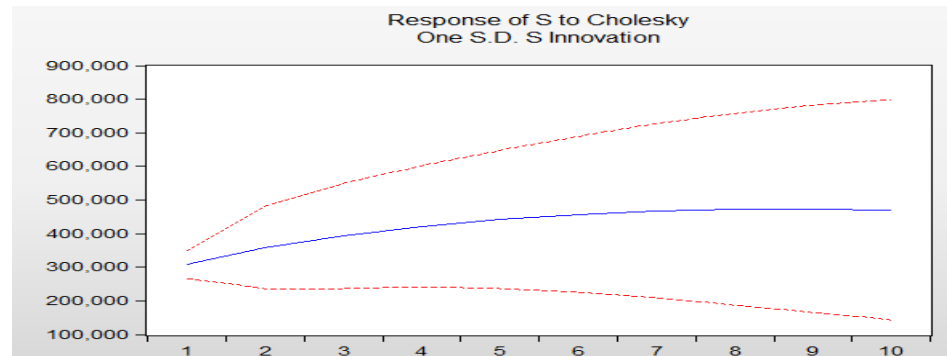

Figure 20-Effects of Price Shocks on Future Prices in The Gold Market

Price shocks on oil market affect future prices

The shock in the oil market initially leads to an increase in oil prices, but then it decreases by OPEC control. This may be the revenue of some countries in OPEC with high powers of decision-making and influence; Have an increasing trend. However, in Iran, due to international relations and overflow in other markets, oil prices and oil revenues are usually decreased. Given the amount of oil production in the OPEC group, Iran's output could be cut by the OPEC as oil prices increase, which reduces Iran's oil revenues and prevents the country from entering the country's economy.
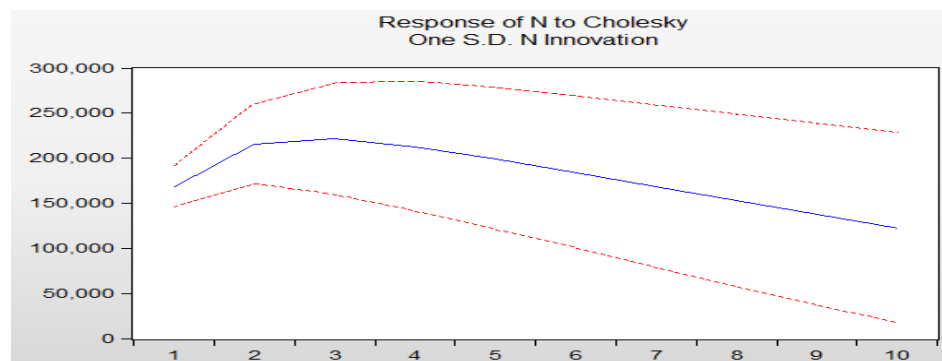

Figure 21. Effects of Price Shocks on Future Prices in The Oil Market

Conclusion

This study aimed to investigate the sensitivity of the oil market and its effects on financial markets in Iran, using dynamic systems and GARCH-models. Accordingly, first the data related to the oil, gold, stock and currency sectors were extracted from the data collected from the World Bank, the Central Bank and the Statistics Center of Iran. In order to evaluate the flow of data into statistical analysis and simulation software, these data were extracted. In this study, some scenarios were designed for further analyses and sensitivity analysis. Based on the results, the existence of turbulence in the oil markets causes fluctuations in the parallel financial markets in Iran. Due to

the stability of these fluctuations, prices have not returned to the previous state and maintain their increased trend. The presence of fluctuations in the exchange, oil and gold markets is more effective, and the exchange market is affected by these markets due to the lack of development in Iran, and it cannot serve as a protective agent against other sectors of the economy.

The findings of the present study are consistent with the findings of Jabarabadi et al. (2016). Findings show that the starting point of transmission in Iranian financial markets is the oil market and the rate of synchronization of the stock market with the oil market is higher than other markets and then the foreign exchange and gold markets are in other positions, respectively. In the next step, it was found that in the short run, there is a significant correlation between the oil market and other financial markets, but in the long run, this correlation exists only between the oil market and the two stock and currency markets, and after the oil sanctions against Iran in 2012, The oil market and the foreign exchange and stock markets have been growing in the medium term. Also, the findings of this study are in line with the findings of Botshekan (2016). The results of this study confirmed the existence of conditional correlations in short-term fluctuations and the existence of oil price overflow effects on the stock market index. In terms of the results obtained from the GARCH method, the research results are in line with the findings of Rostami et al. (2016). Preliminary studies show that the fluctuations are clustered, ie the characteristic of independent and uniform distribution and variance homogeneity is violated. Bruce Godfrey's test confirms the effects of Arch and Garch. The holistic test also indicates the presence of ARCH effects in the variable by estimating the kernel density according to the Monte Carlo rule by applying the Parsen weight.

The main financial markets in the Iranian Economy include the stock exchange, foreign exchange, oil, and gold markets. The sharp fluctuations in these markets, especially those caused by the severe sanctions imposed on Iran in May 2018, and the pandemic outbreak of Covid-19 have led to more confusion and uncertainty among investors. One of the effective approaches to examine such unstable conditions is to study the co-movement(s) between markets to identify the leading variable(s). The results showed that the oil price had a low co-movement with the other three markets, i.e. stock exchange, exchange rate, and gold markets. Thus, the oil market can be a suitable alternative for risk aversion investors. Meanwhile, the oil market could also act as a source of finance for the government during the sanctions period. That possibly explains the recent decision by the Iranian government to use the oil market to finance its budget deficit. Between the exchange rate and gold price, the gold price was identified as the leading variable. While the exchange rate and gold price did not show a significant co-movement in stable conditions, they did show a significant co-movement in unstable conditions, as in times of sanctions or during a global pandemic and thus influenced the investors' portfolio risk. This result is important from a policy-making perspective. Based on this result, the policymakers can, especially during crises and unstable conditions, control the gold market and make it more stable by managing the foreign exchange market.

In studies outside Iran, the research findings are consistent with the findings of Long and Ayre (2019). In a study entitled Economic and Financial Characteristics of Crude Oil, this researcher presented a structured review of the dynamic model of crude oil prices. In this study, the evidence related to the important factors determining oil prices and the impact of oil market shocks on the macroeconomy and the stock market are examined and how the crude oil markets affect the performance and productivity of the oil market and stock financial markets are discussed. Methods for predicting crude oil prices and fluctuations are presented. By comparing the results of the present study with the most important fluctuations of recent decades and the studies conducted, important developments and research gaps in each field are identified. The most important variable among the many variables mentioned in the present study is political changes and conflicts in the Middle East and the occurrence of unpredictable political events.

In studies outside Iran, the research findings are consistent with the findings of Lou et al. (2019). In a study called the instability of fluctuations between oil markets and agricultural products since the financial crisis, the researcher examined the dynamics of fluctuations between oil markets and agricultural products since the crisis of 2009-2009. In this research, a dynamic model has been used to investigate the fluctuations to identify the effects of short, medium and long term interference. During the financial crises of the crude oil market, the markets for agricultural goods witnessed bilateral developments in the short term compared to the long term. These findings show that after the crisis of 2008-2009, the markets for crude oil and agricultural goods have become integrated markets, and the market for agricultural products has attracted the attention of policymakers and investors.

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