“The dynamic relationship of interest rate, price level, money supply and real gross domestic product: case study of Iran”

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The dynamic relationship of interest rate, price level, money supply and real gross domestic product: case study of Iran

Abstract

The main purpose of the present study is to investigate the relationship between macroeconomic variables such as interest rate, price level, money supply and real gross domestic product for Iran by considering the effect of economic sanctions during a time period 1980-2014. To analyze the collected data, the VARX method was used and the data were analyzed by Eviews 9 software. Also, for data analysis, the variable of economic sanction was considered as exogenous variable and other variables were considered as endogenous variables. The empirical findings of the study show that there is a significant and bilateral relationship between most endogenous variables of the model. Also, it was observed that the variable of economic sanction has a significant effect on the intended macro variables.

Keywords: interest rate, price level, money supply, real gross domestic product, economic sanction.
JEL Classification: E40, E51, F51.

Introduction

The relationship between macroeconomic variables has been always considered by researchers, because most theoretical questions raised in macroeconomic framework can be discovered. But there are also different approaches to study these relationships. Some researchers only evaluate the macroeconomic attitudes, for example, how the economic attitudes of Keynesian are supported in society. While some other researchers study the nature and concepts of these variables. For example how can inflation be a monetary phenomenon or how it can be related to economic development or the total economy? (Herwartz and Reimers, 2006) this regard, there are other questions that need to study the relationship between macroeconomic variables related to them in order to find the answers.

Although the relationship between the variables like interest rate, price level, money supply and real gross domestic product has been studied for developed countries (Urbanovsky, 2016), the results of previous works cannot be referred to, since in developing countries like Iran, interest rate was stabilized by the banking system. Most theoretical foundations discussed on the relationships between these variables are true for developed countries and the hypotheses of these theories are in accordance with the economic structure of these countries. Thus, the study results and testing the relationship between the discussed variables by using the data related to developing countries like Iran have more validity and the results and findings related to developed countries cannot be generalized to the country.

However, the issue that has been highly considered in the economy of the country after the victory of the Islamic revolution of Iran is the economic sanctions raised against Iran that can affect the macroeconomic variables. The macro effects of sanction on the economy of a country can be studied from two aspects: first, an economy needs to obtain production factors from different sources for growth and development and these production factors in an economic process can have an appropriate estimate for the economic development. In other words, economy needs capital resources, modern technology, initial or primary materials, appropriate management and organization and skilled human resource in order to be mixed and create an economic activity in different parts like industry, agriculture and services in form of production factors. However, the important point is that today not only country relies on its internal resources as production factors, but also relies on international resources in order to increase its productivity and attempts to use the external or foreign resources more than its internal or domestic resources. In other words, the production factors out of borders do not enter the internal economy of a country. Thus, the economy cannot be increasingly developed with a pure reliance on internal or domestic resources.

On the other hand, it should be said that healthy and productive economy does not mean without the presence of international markets and increase of competitiveness. If the economy of a country does not have a share and contribution in global markets, it will gradually face recession and lose its efficiency by moving away from the competitive atmosphere. Also taking a share from international markets needs the presence of normal conditions in the political atmosphere of a country. Thus, if the country is under sanction conditions, it cannot have an appropriate share of international markets and will lose its competitiveness. Thus, it should be generally said that, on the one hand, sanction will decrease the

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supply resources of production factors in the country of Iran and, on the other hand, it will increase our distance from other neighboring countries by reducing the economic share of Iran from international markets. The manifestation and expression of these two effects in the reduction of Iran's economic development is certainly revealed. In other words, the reduction of economic development is the main effect of macro sanction.

In this regard, the variable of economic sanction must be considered to answer this question: how is the potential relationship between interest rate, price level, money supply and real gross domestic product in Iran? Then, the theoretical foundations between macroeconomic variables in the study are presented. The next sections study the empirical background of the study and after that the research method and the estimation of the relationship between variables will be presented. Finally, data analysis and the obtained results will be presented.

1. Theoretical foundations of the study

To study the relationship between macroeconomic variables and theoretical foundations related to these relationships, the theories in macro economy can be used. According to the highlighted role of the state in Iran's economy, the Keynesian economic models were selected as the theoretical framework of the study, because the Keynesian-oriented economists consider the presence of states and their active role in economy in their theories and argue that the decisions of the private sector may sometimes lead to inefficient results in macro economy and, thus, support the active policy making of the state in public sector.

In the framework of Neo-Keynesian monetary model, the monetary authorities of the country stabilize interest rate in a specific level and, then, supply the money according to the market demand. Thus, in this case, no change in demand for money in the society was completely answered and it will have no effect on the variables like gross domestic product and inflation. Theoretical foundations related to a standard monetary model were studied through optimizing the factors by Woodford (2003). The studies conducted by Woodford show that money plays an insignificant role in these models and the balance path related to production and inflation can be determined by considering interest rate at the desired level regardless of money supply or the factors related to demand for money.

This conclusion is in conflict with the current empirical evidences. Friedman and Kuttner (1996) and Sterlla and Mishkin (1997) presented some evidence that money can have a determining role in determination of production and general level of prices. Its reason is the irregular behavior of velocity of money. In this regard, Nelson (2000) used the data related to the USA and England and concluded that money is an important and determining factor in production and general level of prices even if interest rate is controlled.

Leeper and Zha (2000) used the VAR structure model and concluded that removing money from empirical models is not harmless.

Thus, it can be said that money has an important and determining role in determination of the relationship between gross domestic product and general price level and it cannot be easily eliminated from empirical models. Now, the relationship between the above mentioned variables is studied by considering a Keynesian framework.

In this framework, it is assumed that the general price level increases in the society. According to this approach, the first variable that can be affected by the increase of the general price level is the real money balance. In other words, the increase of the general price level reduces the real money supply. In the framework of Keynesian analyses, the excess demand for money causes some disturbances in the economy. According to the Walrasian balance, a balance is created in the economy when the creation of the excess demand for money in the money market leads to the creation of oversupply in the bond market. It will also lead to the decrease of the bond price and increase of interest rate in the market. Thus, it is theoretically expected that the increase of the general price level increases interest rate and, thus, there will be a positive causal relationship from inflation rate toward interest rate. On the other hand, the increase of interest rate increases the cost of using capital that leads to the increase of production costs.

The above mentioned issues showed that in Keynesian framework, there is a relationship between macroeconomic variables of interest rate, general price level, gross domestic product and money and the relationship between each of these variables cannot be studied without considering other variables. Now, after the stabilization of the relationship between the mentioned variables, before testing this variable empirically in Iran, a brief study is carried out on the literature and background of the subject inside and outside of the county.

2. Empirical background of the study

Some studies were performed on the relationship between macroeconomic variables including interest rate, money supply, price level and real gross domestic product out of the country. However, in some cases like research methodology, the economic conditions of the studied countries and even the obtained results are different and here are some of these studies.

Table 1. Empirical background of the study

Researcher	The studied variables	Research method	Conclusion
Urbanovský (2016)	Interest rates, price levels, money and GDP	VAR method	There is a causal relationship of price level to interest rates, GDP to interest rate and GDP to price level.
Nguyen (2015)	Money supply and inflation	Panel method	money supply affects the inflation in Selected Asian Countries
Thornton (2014)	Money supply and inflation	ARDL method	money supply affects the inflation in the United States of America
Cendejas et al. (2014)	Interest rates and money supply	Panel method	There is a close relationship between interest rates and money supply for eurozone countries
R Jha and TN Dang (2012)	Inflation and economic growth	Time series data and panel data	If the inflation rate is more than 10%, there will be a significant negative relationship between inflation and .economic growth
Canova and Menz (2011)	Money and production	VAR method	There is a causal relationship between money and production
Omay and Kan (2010)	Inflation and economic growth	Non-linear panel regression model	There is A significant negative correlation between inflation and production
Bittencourt (2010)	Inflation and economic growth	Panel observation model	high inflation costs a lot on economic activities particularly in developing economies.
Wanna and Chiava (2007)	Inflation, population growth, education, government cost share of production and growth	Method of instrumental variables	The level of threshold inflation is equal to 12 percent and above that inflation is harmful to economic growth.
Lenza (2006)	Money growth and inflation	VAR method	There is a relationship between money supply growth and inflation in the long term
Gul and Ekinic (2006)	Interest rate and inflation	Johansen co-integration and Granger causality methods	There is a Causal relationship between nominal interest rate and inflation in Turkey.
Favara and Giordani (2006)	Money, production and general price level	VAR method	The incidence of shock to Broad money demand affects production and general price level
Benati (2005)	Money growth and inflation	ARDL method	There is a long term relationship between money growth and inflation.
Drukker et al. (2005)	Inflation and economic growth	Non-balanced panel method	There is a nonlinear negative relationship between inflation and growth
Ravn and Psaradakis and Sola (2005)	Money and production	VAR method	There is a causal relationship between money and production over time.
Garsia and Rigbon (2004)	Interest rate and macroeconomic variables	VAR method and Monte Carlo simulation	There is a correlation between macroeconomic variables and interest rates in Brazil.
Booth and Ciner (2001)	Interest rate and inflation	Johansen co-integration method	There is A close relationship between interest rate and inflation for the countries of Europe and America.
Gilman et al. (2001)	Inflation and economic growth	Endogenous growth model	There is a Non-linear negative relationship between inflation and growth.

Source: research findings.

As Tables 1-1 and 1-2 show, many studies have been carried out inside and outside the country on the relationship between macroeconomic variables and their effectiveness on economic development. But it is observed that no study inside the country has investigated the relationship between these variables. Abroad, only one study was performed by Urbanovsky (2016) in Czech Republic and due to the different economic nature of this country from Iran, the obtained results cannot be simply generalized to Iran and it needs an empirical test on these variables.

After the review of literature and theoretical - empirical foundations related to the research subject, then, the research method and data analysis related to the desired variables will be discussed.

1. Research method

The main purpose of this study is to evaluate the dynamisms of the relationship between four macroeconomic variables of interest rate, money supply, price level and real gross domestic product in Iran. But one of the subjects that have been raised in Iran since the early years of the Islamic revolution is the issue of economic sanctions that have affected the macroeconomic status of Iran. In this regard, the virtual variable of economic sanction was also considered to measure the relationship between the intended macroeconomic variables.

In this regard, the structural autoregressive model with weak endogenous variables (VARX) is used to study the relationship between the above mentioned variables. VAR models used Cholesky decomposition to obtain the impulse response functions. Cholesky decomposition implies a causal order and may be acceptable when the researcher wants to study the effects of more than one shock (Elbourne, 2008).

Bernanke (1989) developed the SVAR mode by considering the theoretical limitations of simultane-

ous effects of shocks. Then, he identified the impulse response functions by theoretical limitations on the long-term effects of shocks. The main advantage of SVAR models than primary VAR models is that unlike non-binding VAR models in which the identification of structural shocks is done implicitly, the structural autoregressive models have explicitly an economic logic based on economic theories to apply limitations; these limitations can be short term or long term. After applying the limitations, the structural shocks are identified. These shocks can be used for creating impulse response functions, analysis and variance in order to evaluate dynamic effects on different variables. VAR models that used the Cholesky decomposition usually focused on partial identification and the focus on partial identification means that only one shock can be studied in each model.

Since the internal conditions of developing countries do not have much effect on economic variables at the international level, thus in VAR models, there are a series of endogenous variables for these countries. In fact, these variables cannot have a bilateral relationship in the system of equations. Thus, co-integration autoregressive models are used with exogenous variables (VARX).

Pesaran et al. (2000), Pesaran and Shin (2002) and Pesaran and Smith (2006) completed the studies of Johansson (1991-1995) and presented VARX method to solve the recognition problem and test the hypotheses in vector error correction models with weak endogenous variables that are used in the present study, unlike Johansson method in which co-integration analysis in VAR models is performed in VAR models by using statistical linear constraints (recognition problem is only solved by normalization and statistical techniques). In structural long term modeling method (VARX), the economic theory is used in order to solve the recognition problem. In other words, the long term limitations derived from DSGE model can be imposed on VARX model. Specifically, the techniques like Johansson method are unable in modeling the national economy in global atmosphere, because the endogenous variables of the first order cannot be considered in co-integration VAR model while in VARX method, there are two groups of endogenous variables of the first order and exogenous variables in the model.

According to the topics discussed in the theoretical part of the study, the present study evaluates the dynamism of the relationship between interest rate, price level, money supply and real gross domestic product from 1980 to 2014. Also, since economic sanctions can affect macroeconomic variables whether inside or outside of the country, this variable was used in the specification of the research model. However, because using a bilateral relationship between the variables of interest rate, price level, money supply and real gross domestic product and economic sanctions is not reasonable, this variable was used as endogenous in the model.

1.1. The research model. According to the study performed by Urbanovsky (2016), the variables used in this study are the logarithm of interest rate, price level, money supply and real gross domestic product and virtual variable of economic sanction, the variables of the logarithm of interest rate, price level, money supply and real gross domestic product were considered as endogenous variables and the virtual variable of economic sanction was considered as exogenous variable. According to previous contents, the selected model in this study is as follows:

$$X_t = C + \beta(L)X_t + \gamma(L)Z_t + U_t, \quad (1)$$

In this mode, $X_t$is the vector variable of endogenous variable and Z_t is the vector of exogenous variable. And U_t is the vector of disturbance terms in the model.

$$x_t' = |GDP_t Mo_t Pr_t In_t|, \quad (2)$$

in which:

GDP_t indicates the real gross domestic product index for Iran.

Mo_t indicates the money supply (M2) for Iran.

Pr_t indicates the annual interest rate on bank deposits for Iran.

In_t indicates the general price level that was calculated by GDP inflator index.

$$Z_t' = |SANC_t|, \quad (3)$$

$SANC_t$ indicates the virtual index for economic sanctions, so that a value equal to 1 will be considered for the years that there has been economic sanctions against Iran, otherwise, a value equal to zero will be considered. Also, β(L)and γ(L) are interruption operators from the first order. Also, C is the vector of independent terms.

Also, the databases of the central bank of the Islamic Republic of Iran, statistical center of Iran, World Bank website and WDI were used during the years 1980-2014 for data collection. Finally, the collected data were analyzed by using Eviews 9 software.

1.2. Descriptive statistics of the research variables. The results obtained from descriptive statistics of these variables were given in Table 2.

Table 2. Descriptive statistics related to the research variables

	PR	MO	IN	GDP
Mean	1.267141	5.006710	1.101654	6.067337
Median	1.274060	4.998155	1.113943	6.042424
Maximum	1.693727	6.663412	1.380211	6.334038
Minimum	0.838849	3.550228	0.903090	5.836895
Standard deviation	0.190489	0.971611	0.133626	0.150078
Skewness	-0.107219	0.159718	0.127971	0.331031
Kurtosis	2.622574	1.713983	2.130942	1.894110
Observations	34	34	34	34

Source: research findings

Then, the stationary test of the research variables was performed.

1.3. Stationary test. The common econometric methods in empirical studies are based on stationary hypotheses of the studied variables. For this reason, there is the possibility of false estimates with non-stationary variables and referring to the results of such estimates will lead to misleading results. (Baltaji 2005). Thus, before the estimate of the proposed model, it is necessary to evaluate the stationary of the used variables in the estimate of time series data. In this study, the augmented Dickey-Fuller test was used for the stationary test of time series data. The results of unit root test were reported in Table 3.

Table 3. The results of stationary test of the variables

Variable	Probability	Stationary state
GDP	00000/	I(1)
Mo	0/0000	I(1)
Pr	0/0229	I(0)
In	0/0000	I(1)
SANC	0/0267	I(0)

Source: research findings

The results obtained from the augmented Dickey-Fuller test show that the logarithm of interest rate, volume of money, and real gross domestic product with one differencing order and the variables of economic sanction and general price level are at a stationary level.

3.4. The estimate of the research model. Here, the results obtained from the estimate of the research model are presented by VARX model.

Table 4. The estimated coefficients in VARX model

Variable	GDP	PR	IN	MO
MO(-1)	0.085699	-0.136555	0.029836	0.999569
	(0.02556)	(0.06403)	(0.03150)	(0.02333)
	[3.35226]	[-0.83251]	[0.94727]	[42.8403]
IN(-1)	0.079761	0.995708	0.758265	0.209387
	(0.03226)	(0.04861)	(0.16295)	(0.02071)
	[0.60306]	[1.17334]	[4.65325]	[1.73460]
PR(-1)	-0.051334	0.378143	0.022843	0.011002
	(0.03026)	(0.09418)	(0.03729)	(0.02762)
	[-1.69624]	[1.94741]	[0.61262]	[0.39833]
GDP(-1)	0.390804	-0.200337	0.057153	-0.075564
	(0.03183)	(0.04583)	(0.06242)	(0.02032)
	[2.96453]	[-0.23685]	[0.35189]	[-0.62805]
C	3.251906	1.533164	-0.243148	0.315685
	(0.71264)	(4.57243)	(0.87802)	(0.65041)
	[4.56320]	[0.33531]	[-0.27693]	[0.48536]
SANC	0.006541	0.145182	-0.004884	-0.010236
	(0.01436)	(0.09213)	(0.01769)	(0.01311)
	[0.45555]	[1.57581]	[-0.27608]	[-0.78102]
R^2	0.974670	0.354549	0.949462	0.999465
Adjusted R2	0.969979	0.235021	0.940103	0.999366
F statistics	207.7838	2.966246	101.4506	10090.72

Source: research findings

For each variable, the first row shows the coefficient, the second row shows probability and the third row shows t statistics.

The numbers in Table 4 show the estimated coefficients in VARX model. However, these numbers cannot be trusted and used for analysis because the estimated coefficients in the mode are summarized. In this model, most coefficients were significant and show a bilateral relationship between endogenous variables. Even if Granger causality test cannot confirm the bilateral relationship between endogenous variables, the results obtained from VARX model have more validity, because, contrary to Granger causality test, other criteria were also considered and the bilateral relationship was not only mentioned. In short, the results obtained from VARX model that were estimated in this model show that:

In the first model of the study that real gross domestic product was considered as a dependent variable, the variables of volume of money with one interruption, interest rate with one interruption, real gross domestic product with one interruption and economic sanction with one interruption had a positive effect on dependent variable. While the variable of general price level had a negative effect and it is also observed that the effectiveness of all variables is statistically significant.

In the second model of the study that general price level was considered as a dependent variable, the variables of volume of money with one interruption, and real gross domestic product with one interruption had a negative effect on dependent variable, while other research variables had negative effectiveness. It is also observed that the effectiveness of all variables is statistically significant.

In the third model of the study that interest rate was considered as a dependent variable, the variables of volume of money with one interruption, interest rate with one interruption, general price level with one interruption and real gross domestic product with

one interruption had a positive effect on dependent variable, while the variable of economic sanction had a negative effectiveness. It is also observed that the effectiveness of all variables except interest rate is statistically significant.

In the fourth of the study that volume of money was considered as a dependent variable, the variables of volume of money with one interruption, interest rate with one interruption, and general price level with one interruption had a positive effect on dependent variable, while real gross domestic product and economic sanction had negative effectiveness. It is also observed that the effectiveness of all variables is statistically significant.

Then, the results of the analysis of variance for real gross domestic product will be presented.

Table 5. The results of the analysis of variance for real gross domestic product

Period	S.E	GDP	PR	IN	MO
1	0.026246	98.19851	0.899179	0.470861	0.431448
2	0.029585	89.08982	10.05087	0.415998	0.44313
3	0.030584	85.24421	13.47799	0.397919	0.879579
4	0.030947	83.54501	14.23907	0.432675	1.783243
5	0.031201	82.21519	14.17883	0.61056	2.995423
6	0.031495	80.68885	13.9185	1.049764	4.342884
7	0.031862	78.84574	13.62202	1.82381	5.708434
8	0.032305	76.70809	13.32084	2.943434	7.027641
9	0.032817	74.34091	13.01696	4.371887	8.270246
10	0.033391	71.81722	12.70958	6.047705	9.425492

Source: research findings

The obtained results in Table 5 show that the shocks entered to gross domestic product occurred in the first ten periods. The first column from left shows the shocks resulted from changes in volume of money on real gross domestic product. The coefficients estimated for this column were significant from the first period, but this effectiveness in the first 3 periods is a small value and gradually increases. It can be said that in the short term, the increase of volume of money leads to the increase of a less value in real gross domestic product index, but in the next periods due to the money multiplier index, this increase is intensified and in the next periods, the effect of increase in volume of money on real gross domestic product will increase.

The second column shows the shocks resulted from changes in interest rate. The coefficients obtained for this column were significant from the first period and it shows that the shocks resulted from interest rate from the first period affect the real gross domestic product. The results obtained from this column show that the shocks from changes in interest rate in the short term have a little effect on real gross domestic product. Its reason is the indirect effectiveness of interest rate on real gross domestic product, because the increase of interest rate must lead to the change of investment and, then, this increase in investment demand leads to the increase of real gross domestic product, but from the fifth period onward, the trend of effectiveness of this variable increases and continuous to the 10^{th} period.

The third column involves the effect of the shocks resulted from the changes of general price level on real gross domestic product. The expectation of people for the temporary increase of prices in the short term leads to the fact that the effect of changes in the general price level is less in the first period, but in the next periods and after the adjustment of expectations, the effect of this variable from the second period takes an increasing trend. But the increase of general price level until 5 periods increases real gross domestic product but this effectiveness decreases in the long term and leads to the decrease of real gross domestic product.

The 4^{th} column also shows the effect of shocks resulted from changes in real gross domestic product in a period on the amount of this variable in the next periods. The coefficients estimated for the shocks are significant from the first period and shows that real gross domestic product is highly affected by the previous changes of this variable and is gradually decreased in the long term, so that as more periods are passed, the coefficient of shocks becomes smaller.

Finally, the effect of each shock entered to a variable and its effectiveness on other variables can be shown as follows:

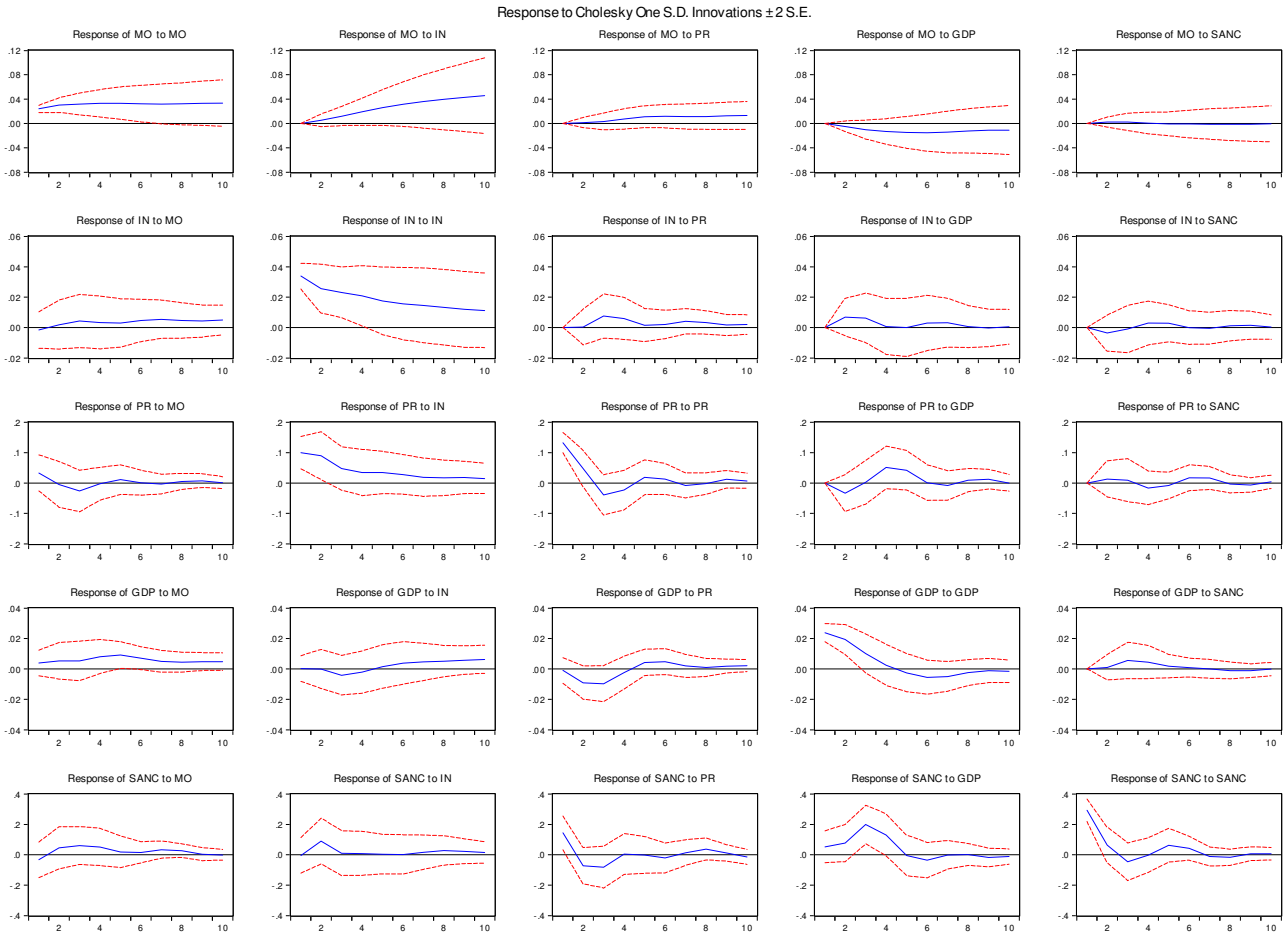


Fig. 1. The results of impulse response functions test

Source: research findings.

Discussion and conclusion

The main purpose of the present study is to investigate the potential relationship between macroeconomic variables such as interest rate, price level, money supply and real gross domestic product for Iran by considering the effect of economic sanctions on them. For this purpose, the data related to Iran in 1980-2014 and econometric method of VARX were used. In general, the research findings showed that the virtual variable of economic sanction had significant effects on all the intended macroeconomic variables.

The effectiveness of this variable on real gross domestic product and general price level was positive and on other variables was negative. In other words, the consecutive years of sanctions against Iran made the economy of Iran find an economic independency and use the sanctions as an opportunity to increase its development and production after about 35 years of sanction. Although this economic independency had some costs like the increase of volume of money and interest rate and (especially in recent years) in case of macroeconomic variables, it was observed that there is a significant and bilateral relationship between almost all variables.

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