

# An Analysis About The Impact of Monetary Policy Shocks On The Flow of Funds Account: The Case of Iran

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## Research

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# An Analysis About The Impact Of Monetary Policy Shocks On The Flow Of Funds Account: The Case Of Iran

Mohammad Vaez Barzani<sup>1</sup> . Meymanat ebrahimi<sup>2</sup>. Leila Torki<sup>3</sup>. Hassan Heydari<sup>4</sup>

## Abstract

The flow of funds account provides information on various economic sectors' financial transactions. The present study has investigated the impact of monetary shocks on the dynamics of lending and borrowing of various economic sectors such as households, non-financial enterprises, the banks, the Central Bank of Iran (CBI), the government, and the foreign sector as well as the changes in financial assets and liabilities of mentioned sectors. An accurate analyzing in this regard could provide helpful guidance in making the appropriate policies for influencing macroeconomic variables. For this purpose, a FAVAR model was employed using data from 1973-2017. It was concluded that monetary shocks increased both the acquisition of new financial assets and the issuance of new liabilities of various national economic sectors and the banks were net borrowers from other economic sectors while other sectors – except the non-financial enterprises and the government that response with a delay– were net lenders in the first year. However, all national economic sectors turned into lenders and the foreign sector had become the borrower after the first year is passed. The reason for this appears to be the difference between domestic and foreign interest rate. Net capital outflow occurs for two years significantly.

**Keywords** Flow of funds. Financial account. Monetary policy impact. Factor Augmented Vector Auto Regression model.

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## 1 Introduction

The flow of funds account is one of the components of the System of National Accounts (SNA), which indicates financial transactions and flow of funds among various economic sectors of the economy.

Economic operations in the flow of funds account are divided into five main economic categories including households, nonfinancial firms, financial institutions, the government and its affiliated enterprises, and the foreign world. Information obtained from the flow of funds account could be used to determine from which sector and with the help of which instruments have each economic sector financed its required funds over a given period or to which sector and through which instruments has it granted its surplus fund (Cristiano et al., 1996).

Thus, the flow of funds accounts specify each economic sector's financial deficit or surplus (net lending / net borrowing) and provide an accurate reflection of how deficits have been covered or surpluses have been used (Shrestha et al., 2012). Besides, these accounts could be used to analyze the impact of various fiscal and monetary shocks on the dynamics of lending and borrowing of various economic sectors and changes in financial assets and liabilities of these sectors (Central Bank of Iran, 2018).

Monetary policy-makers must perform an accurate evaluation of their policies' impacts on the economy and the duration of such impacts to succeed in steering their policies. Monetary policies can impact real economic variables through a variety of channels. Among the channels of monetary policy transmission, the credit channel is of great importance, especially in developing countries (see Janssen et al., 2019; Tunc and Kilinc, 2019; Raei et al., 2018; Heidari and Mollabahrani 2016).

The importance of the credit channel –specifically in developing countries- is because, despite the financial innovations and development of financial markets in these countries, banks still play an extremely prominent role in their credit market as financial intermediaries. Besides, any friction or shortcoming (e.g. the lack of equal access to financial resources for small and large firms) in the credit market would result in changes in various economic sectors' net lending or borrowing which can result in reinforced impacts for monetary shocks on real economic variables through the financial decisions of various sectors.

Given the differences in various economic sectors, the amount and speed of net financial investment response (net lending / borrowing) and the composition of these sectors' assets and liabilities are expected to have different responses to monetary policy shocks.

Net lending/ borrowing responses of the various economic sectors vary across different countries.

Christiano et al. (1996) were the first, to our knowledge, to employ the information content of the US flow of funds to assess the impact of monetary policy by means of an estimated VAR model. One of their main findings is that firms borrow more funds (in net terms) after the policy tightening; firms' net borrowing declines only one year later, when the slowdown in output induced by the policy shock gains momentum.

Christiano et al. (1996) argued that this model was not captured by existing monetary business cycle models and suggested, as a possible explanation, firms' difficulty to adjust nominal expenditures once the fall in cash-flow materializes. They also found that net funds raised (financial liabilities – financial assets) by households remain unchanged for several quarters after the shock, consistent with limited participation models of the type discussed in Christiano et al. (1997). Finally, they observed a (puzzling) lower public deficit in the short run, which they explained with a temporary increase of personal tax receipts.

Bonci and Columba (2008) applied a similar methodology to Italy. Differently from Christiano et al. (1996) they find that following a restrictive monetary policy shock nonfinancial corporations decrease both the acquisition of new financial assets and the issuance of new debt; in other words, they find no evidence of financial frictions which would prevent firms from adjusting the level of their nominal expenditures, as seemed to be the case for the US economy.

Also in contrast with the limited participation hypothesis, households are found to adjust their portfolios relatively quickly in Italy, switching from deposits and shares to securities. Finally, consistent with the slowdown in economic activity induced by the interest rate hike, with automatic stabilizers at work on one hand and lower tax receipts on the other, the public sectors deficit increases after the shock.

Gameiro and Sousa (2010) used the Portugal funds flow account in a VAR model and concluded that following a contractionary monetary impulse, nonfinancial corporations and households initially increase their net funds raised. In the case of nonfinancial corporations, this indicates that both financial assets and liabilities increase, but the debt side increases more. This result is also found for the United States.

Net funds raised is increased by households, reflecting a decline in acquisition financial assets that exceeds the reduction in the issue of financial liabilities. This Behavior could be related to consumption smoothing given that, typically, disposable income is negatively affected by the shock. The behavior of households in Portugal is qualitatively similar to that found for the euro area, while for the United States evidence points to a small effect or no significant impact of a monetary policy shock in the financial transactions of households.

Bonci (2012) applied a similar methodology to Euro Area and find that the policy tightening is followed by a worsening of the budget deficit; firms cut on their demand for bank loans, partially replacing them with inter-company loans, and draw on their liquidity to try to offset the fall of revenues associated with the slowdown of economic activity; households reduce net borrowing and increase precautionary saving in the short run. Consistent with the bank lending channel of monetary policy at work, the interest rate hike is followed by a short-run deceleration of credit growth, mainly driven by the response of banks.

Reserve Bank of India (2017), Narayan et al. (2017) and Singh (2019) used the flow of funds account of the Indian Economy in their studies.

Narayan et al. (2017) observed in their finding that throughout the period (1955-2015), the consolidated government sector is the largest net deficit sector and households are the largest net

surplus sector. However, the private corporate sector is now running larger deficits as a fraction of GDP than at any time in the past, implying a greater reliance on external credit from other sectors than in the past. Despite the development of capital markets, private corporate businesses rely on loans and advances more extensively than on debt instruments, and the reverse is true for the government sector. Households have maintained roughly the same portfolio composition throughout the period. The liberalization and globalization of finance in India that began in the 1990s has led to a substantively different picture than in the past. The Rest of the World sector, for example, is now the second largest net surplus sector in the economy.

In general, the results of previous research indicate that the impact of monetary shocks on various economic sectors varies across different countries.

The present study seeks to analyze the impacts of monetary policy shocks on the flow of funds accounts as well as the changes in various economic sectors' financial assets and liabilities after the occurrence of a monetary shock in Iran.

For this purpose, annual financial data from various economic sectors and macroeconomics of the country over 1973-2017 and the Factor Augmented Vector Auto- Regressive Model (FAVAR) were used.

Oil shocks could result in monetary shocks through changing oil revenues in Iran as an oil-exporting country since changing the oil revenue into domestic currency will increase the Central Bank's net foreign assets which will increase the monetary base and money supply and eventually result in increased liquidity. Therefore we chose the oil revenues as indicator of monetary policy.

Results of the experimental model indicate that following an expansionary monetary impulse, various national economic sectors such as households, nonfinancial enterprises, financial-institutions (the Central Bank and the banks) and the government initially increased both the acquisition of new financial assets and the issuance of new debt and the banks sector were net borrowers from other economic sectors while other sectors –except the nonfinancial enterprises and the government that react with a delay- are net lenders in the first years. However, all national economic sectors turn into lenders and the foreign sector becomes the borrower after the first year is passed. The reason for this appears to be the difference between nominal domestic interest rate and real foreign interest rate. Net capital outflow occurs for four years, a response that is only significant for the first two years.

The present article has the following sections after the introduction: the second section discusses Theoretical foundations. Data and research method will be introduced in the third section, and the fourth and fifth sections will discuss the analysis of results and conclusions, respectively.

## **2 Theoretical foundations**

Having been initially developed in the United States, the flow of funds account has been published by the Federal Reserve and is used for evaluating financial development and its impacts on economic activities as well as evaluation of the price perspective (see Copeland, 1952). The data provided by this account did not use to receive much attention before the 2007 financial crisis;

however, this financial crisis resulted in the need for increased supervision over financial flows in various economies and at the global level with a focus on monetary and financial imbalances and financial intermediation (Shrestha, 2012). The flow of funds accounts proved to be quite useful in this regard since it gave access to the most consistent and comprehensive set of macroeconomic data.

The basic principle in the flow of funds account is that total financial assets and liabilities must be equal in each economic period. Despite the requirement of savings and investments being equal across the whole economy, this equality is not mandatory for each economic sector.

Table 1 demonstrates a simple image of the general structure of an economic sector's flow of funds account.

Uses	Resources
Capital expenditures	Gross savings Net capital transfers
paid loans	received Loans

**Table 1** the structure of a sector's flow of funds accounts table. Source: the central bank of Iran

The following is obtained based on the equality of funds resources and uses:

$$\text{Paid loans} + \text{capital expenditures} = \text{received loans} + (\text{net capital transfers} + \text{gross savings})$$

$$\text{Paid loans} - \text{Received loans} = (\text{net capital transfers} + \text{gross savings}) - \text{capital expenditures}$$

The right side of the equation indicates the equality of savings investments while the left side represents the equality of net lending/ borrowing (net financial investment). If gross savings and net capital transfers of an economic sector exceed the funds spent on its capital expenditures, the economic sector's net financial investment will be positive which means this sector supplies funds for other economic sectors of the economy. On the contrary, if the capital expenditures of an economic sector exceed its savings, this economic sector's net savings will be negative which means it uses the surplus funds of other economic sectors in the economy.

The economy has been divided into four main economic sectors in the Iranian flow of funds account. Tables 2 and 3 indicate these sectors and their sub-sectors as well as financial trading instruments.

Also these tables indicate the average composition of the uses (assets) and resources (liabilities) of the Iranian flow of funds account's sectors and sub-sectors over 1973-2017.

	gold	exchange and exchange currency deposits	Other exchange deposits	SDR	IMF	Other international institutions	Cash and demand deposits	Other deposits	Bonds	Capital and contribution in companies(equities)	short run loans	long run loans	Household' share in insurance and pension	Trade documents (bills) and prepayments	Other receivables
<b>Economic sectors and sub-sectors</b>															
<b>Households and enterprises sector</b>	0.00	0.44	4.26	0.00	0.00	0.00	6.38	<b>49.37</b>	2.51	<b>29.75</b>	0.00	0.33	0.59	0.34	6.01
(Private sector)															
Households	0.00	0.60	1.97	0.00	0.00	0.00	6.58	<b>62.02</b>	1.04	<b>21.54</b>	0.00	0.00	1.00	-0.13	5.38
Non-financial enterprises	0.00	0.23	7.57	0.00	0.00	0.00	6.10	<b>31.03</b>	4.63	<b>41.65</b>	0.01	0.82	0.00	1.03	6.93
<b>Financial institutions sector</b>	0.79	5.13	6.58	0.21	0.01	0.30	1.55	<b>11.29</b>	1.74	4.71	<b>6.43</b>	<b>50.18</b>	0.00	0.52	10.56
Central bank	4.40	14.83	<b>34.81</b>	1.18	0.03	1.60	0.54	0.05	0.30	0.00	<b>16.09</b>	<b>37.23</b>	0.00	0.00	-11.07
Private and public banks	0.00	3.08	0.37	0.00	0.00	0.02	1.79	<b>13.51</b>	2.06	5.65	<b>4.45</b>	<b>54.60</b>	0.00	0.63	13.84
insurances	0.00	0.74	1.71	0.00	0.00	0.00	1.23	<b>21.05</b>	1.88	<b>8.45</b>	0.01	3.07	0.00	0.70	<b>61.13</b>
<b>Public government sector</b>	0.00	6.21	0.30	0.00	0.00	0.00	2.64	0.09	0.01	<b>15.53</b>	0.18	8.69	0.00	1.39	<b>64.74</b>
Government	0.00	15.36	0.00	0.00	0.00	0.00	6.46	0.41	0.00	<b>34.79</b>	0.30	<b>20.16</b>	0.00	0.28	<b>22.05</b>
Government enterprises	0.00	0.49	1.34	0.00	0.00	0.00	1.03	-0.28	0.04	5.17	0.31	5.23	0.00	5.13	<b>81.06</b>
Oil and Gaz	0.00	0.87	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.41	0.00	0.00	0.00	0.38	<b>95.22</b>
<b>Foreign sector</b>	-25.03	5.03	8.99	-6.70	0.04	0.00	0.09	0.00	1.86	0.19	-12.75	<b>68.03</b>	0.00	0.57	<b>59.69</b>

**Table 2** the composition of uses (assets) of the economic sectors of the economy (%). Source: authors' calculations

	Financial Instruments	gold	exchange and exchange currency deposits	Other exchange deposits	SDR	IMF	Other international institutions	Cash and demand deposits	Other deposits	Bonds	Capital and contribution in companies(equities)	short run loans	long run loans	Houshold' share in insurance and pension	Trade documents (bills) and prepayments	Other receivables
<b>Economic sectors and sub-sectors</b>																
<b>Households and enterprises sector</b>		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.43	<b>26.22</b>	4.07	<b>42.89</b>	0.00	0.92	25.96
(Private sector)																
Households		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.11	2.83	<b>38.26</b>	0.00	0.80	57.82
Non-financial enterprises		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	<b>51.31</b>	5.26	<b>47.35</b>	0.00	1.02	-5.77
<b>Financial institutions sector</b>		0.00	4.66	5.84	0.00	0.00	0.00	<b>8.26</b>	<b>50.72</b>	0.29	11.04	3.01	6.57	0.48	-0.02	9.13
Central bank		0.00	<b>21.34</b>	8.53	0.00	0.01	0.00	<b>20.59</b>	<b>31.38</b>	1.04	1.03	0.00	1.07	0.00	0.18	14.76
Private and public banks		0.00	1.21	5.44	0.00	0.00	0.00	<b>5.85</b>	<b>56.45</b>	0.14	13.19	3.75	7.95	0.00	-0.07	6.09
insurances		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	<b>11.29</b>	0.03	0.03	<b>19.43</b>	0.23	<b>68.90</b>
<b>Public government sector</b>		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	6.25	11.48	-0.58	<b>30.42</b>	0.00	1.50	<b>50.58</b>
Government		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	10.74	0.00	0.84	<b>11.46</b>	0.00	0.38	<b>76.28</b>
Government enterprises		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	2.57	19.46	-4.91	<b>45.36</b>	0.00	6.29	<b>30.36</b>
Oil and Gaz		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	25.73	0.07	<b>52.69</b>	0.00	0.02	<b>20.37</b>
<b>Foreign sector</b>		0.00	<b>39.93</b>	<b>38.69</b>	0.00	0.04	2.56	0.00	-0.01	-0.03	2.83	0.08	2.94	0.00	1.52	11.45

**Table 3** the composition of resources (liabilities) of the economic sectors of the economy (%). Source: authors' calculations

Resource and uses data illustrated in the above tables demonstrate the bank-orientation of economic sectors' financing operations and the insignificant role of the capital market in these sectors' financing.

In addition to the composition of each sector's resources and uses, the percentage of this composition could be obtained in the national economy, which has been demonstrated in Table 4. The index of each variable's ratio to the GDP has been used to compare the annual numbers given that flow of funds accounts data are presented in current prices.

	Average ratio of financial assets to GDP	Average ratio of financial liabilities to GDP	Average ratio of net financial investment to GDP
<b>The whole economy</b>	563.72	326.67	15.06
<b>Households and enterprises sector(Private sector)</b>	164.69	171.39	-6.70
Households	32.28	26.37	5.91
Non-financial enterprises	32.28	26.37	5.91
<b>Financial institutions sector</b>	53.06	57.48	-4.42
Central bank	230.33	229.22	1.11
Private and public banks	96.92	94.58	2.34
Insurances	130.25	131.79	-1.54
<b>Public government sector</b>	3.16	2.85	0.31
Government	168.70	148.04	20.66
Government enterprises	139.44	99.21	40.24
Oil and Gaz	29.26	48.83	-19.57

**Table 4** percentage of financial assets, financial liabilities and net financial investment of economic sectors in the national economy. Source: authors' calculations

As demonstrated in table 4, the average ratio of net financial investment of the national economy to GDP is positive throughout 1973-2017. This means that the foreign sector's net investment is negative since the sum of all sectors' investments in the flow of funds accounts equals zero. The foreign sector's net financial investment being negative means that the national economy has been lending to the foreign sector over the studied period, and in other words, we have witnessed the net outflow of financial capital from the country.

Among the three public government sub-sectors except the oil sector with a mean surplus of 5.9%, the two sectors of government and government enterprises have negative net lending over the studied period and have been borrowers throughout this period.

The sectors of households and nonfinancial enterprises had a positive net lending of 20.66% and favorable participation in the ratio of net financial investment of the national economy to GDP. In this sector, households have a mean positive net lending rate while other nonfinancial enterprises have a negative mean net lending rate.

In terms of the financial institutions, it can also be observed that this sector's participation in net lending has been positive overall, although quite insignificant.

All in all, it could be concluded that the highest borrowing over the studied period has occurred by nonfinancial enterprises and the government, to the extent that a considerable part of the generated surplus has been supplied by the households.

To be more accurate, the government has contributed a mean deficit (negative net lending) of -6.07% to the total positive mean 15.06% net lending of the economy over the studied period while households and nonfinancial enterprises (the private sectors) have contributed a mean surplus (positive net lending) of 20.66% to it.

Some of the changes in resources' structure and composition, uses, and net lending and borrowing of the economic sectors are influenced by the performance and decisions of their management and some are influenced exogenously by the changes in economic conditions and general state of

macroeconomic variables as well as fiscal and monetary policies. The present study concentrates on monetary shocks.

Monetary shocks can influence macroeconomic variables such as general prices and GDP through a variety of channels that be elaborated on in the following.

### ***2.1 Monetary transmission neoclassic channels (the monetary view)***

According to this viewpoint, financial market deficiencies play no part in the mechanism of money transfer which is the most important difference between this viewpoint and the credit channel view. The channels of the asset price, exchange rate, and interest rate are among the most important transmission channels of this viewpoint (Mishkin, 1995).

### ***2.2 Non-neoclassic monetary transmission channels (the credit view)***

Some scholars such as Bernanke and Blinder (1992); Gertler and Gilchrist (1993) and Bernanke and Gertler (1995) use the incomplete data assumption and other credit market frictions to explain the impact of monetary policy on the economy.

According to Mishkin (1995), the credit view includes two channels of bank lending and balance sheets.

The bank lending channel is based on the idea that banks play a significant part in supplying the financial needs of economic firms and shocks play a significant role in the transmission and generation of relations between the real sector of the economy and financial and monetary sectors. The process of monetary policy's influence through the mechanism of the bank lending channel is that implementing contractionary monetary policies reduces bank deposits which result in reduced bank credits. Reduced bank credits, in turn, result in a drop in investment and thus the decline of real production. The contrary occurs when expansionary monetary policies are implemented (Krylova, 2002).

Regarding the balance sheet channel, this channel acts through the net worth of financial firms.

Although most of the available literature on the credit channel is focused on the behavior of firms' investments expenditures as a result of monetary policy implementation, some scholars such as Stein (1995) indicate that shrinking bank lending as a result of contractionary monetary policy result in households' reduced demand for housing and durable consumption goods. The main idea behind this process is that households have no access or extremely limited access to credit resources other than banks. Similarly, increasing interest rates will result in an increased flow of funds for the household which will harm the households' balance sheets and will ultimately reduce consumption expenditures and total demand (Bernanke et al. (1995); Kiyotaki and Moore (1995) and Iakoylu and Neri (2010).

A variety of studies have been conducted in the field of credit channels. Peersman (2011); Dalhaus (2014); Johnson et al. (2019) and Tunc and Kilinc (2019) confirmed the transmission of monetary policy shocks through the credit channel in their studies. In Iran, Taghavi and Lotfi (2006)

considered the legal deposit rate as the indicator of monetary policy and confirmed the credit channel of the monetary policy in Iran, but reported it to be practically insignificant while Nadri and Haghghi (2006) consider the deviation of money supply growth as an indicator of monetary policy and confirmed the presence of a strong monetary policy transmission channel through the supply of banking facilities in Iran.

Having considered the monetary base as an indicator of monetary policy, Moshiri and Vashghani (2011) believe that transmission channels play no part in the transmission of monetary shocks to production but influence the transmission of monetary shocks' inflationary effects. Komijani and Alinejad (2012) also considered the monetary base as an indicator of monetary policy but reached a conclusion contradicting Moshiri and Vashghani (2011), and observed that monetary policies leave the greatest impact on real production through the channel of bank lending and the greatest impact on inflation rate through the exchange channel. Nazarian and Farhadipour (2013), Shah Hosseini and Bahrami (2016), Raie et al. (2018) and Heidari and Mollabahrani (2016) also confirm the presence of a credit channel in monetary policy transmission in Iran through their studies.

The studies mentioned above indicate that the credit channel plays a significant role in monetary shock transmission to real variables of the economy, which highlights the importance of monetary shock analysis on the dynamics of borrowing and lending operation of various economic sectors and their interactions.

The overall impact of monetary shocks on the economic sector's assets and liabilities –and as a result, net lending / borrowing - in each sector is not specified and vary across countries and have been addressed in studies that summarized in the table 5.

	<b>US</b> Christiano and et al. (1996)  sample (1961-1992)  Response	<b>Italy</b> Bonci and Columba(2008)  sample (1980-2002)  Response	<b>Portugal</b> Gameiro and Sousa (2010)  Sample (1998-2009)  Response	<b>Euro area</b> Bonci (2012)  Sample (1991-2009)  Response
<b>Nonfinancial corporations</b>				
Net funds raised <sup>1</sup>	Increase	Small Increase	Increase	Increase
Financial liabilities	Increase	Decrease	Increase	Increase
Financial assets	Increase	Decrease	Increase	Increase
<b>Households</b>				
Net funds raised	Unchanged	Decrease	Increase	Increase
Financial liabilities	Small decrease	Decrease	Decrease	Decrease
Financial assets	Not significant	Increase	Decrease	Decrease
<b>Government</b>				
Net funds raised	Decrease	Increase	Not significant	Decrease
<b>financial corporations</b>				
Net funds raised	Not significant	Decrease	Increase	Not significant
<b>Foreign sector</b>				
Net funds raised	Increase	Increase	Not significant	Not significant

**Table 5** summary of the result of studies conducted on the impact of contractionary monetary shocks on the flow of funds account

These countries' differences in net lending/ borrowing and these countries' economic sectors' assets and liabilities could have different impacts on macroeconomic variables such as GDP, inflation, economic growth rate, etc.

Study and recognition of the financial interactions between various economic sectors could provide a suitable context for meeting the requirements of macroeconomic planning, prediction, and policy-making. Besides, investment-saving and asset-liability flows of each sector could be controlled and supervised according to its resources and uses which will result in optimal resource allocation in proportion to financial institutions' efficiency and volume of activity.

In this regard, the present study aims to investigate how monetary policy shocks will impact various economic sectors given the flow of funds account.

The distinction of the present study from other studies conducted on the flow of funds is that they have used Vector Auto-Regression to investigate the impact of monetary shocks on various sectors, a selection of macro variables have been picked out due to VAR models' limitations in the number of variables entering the model, they have introduced and run an individual VAR model for each sector due to the limited degree of freedom while the present study has considered

<sup>1</sup> Financial liabilities – financial assets

all the important macroeconomic variables and financial variables of various economic sectors such as net financial investment and their financial assets and liabilities together and in one model.

The other distinction between this study and other domestic studies mentioned earlier is that these studies have examined monetary shocks in two cases of financial corporations and the firm and household sector from the credit channel view. Meanwhile, no comprehensive study considering all the economic sectors has been conducted in Iran so far, but the present study discusses and addresses the impact of monetary policy shocks on the borrowing and lending dynamics of various economic sectors and their interactions with one another.

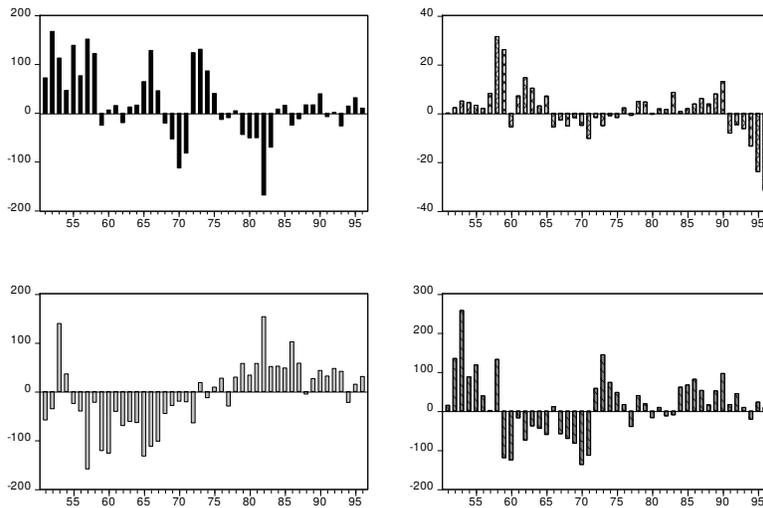
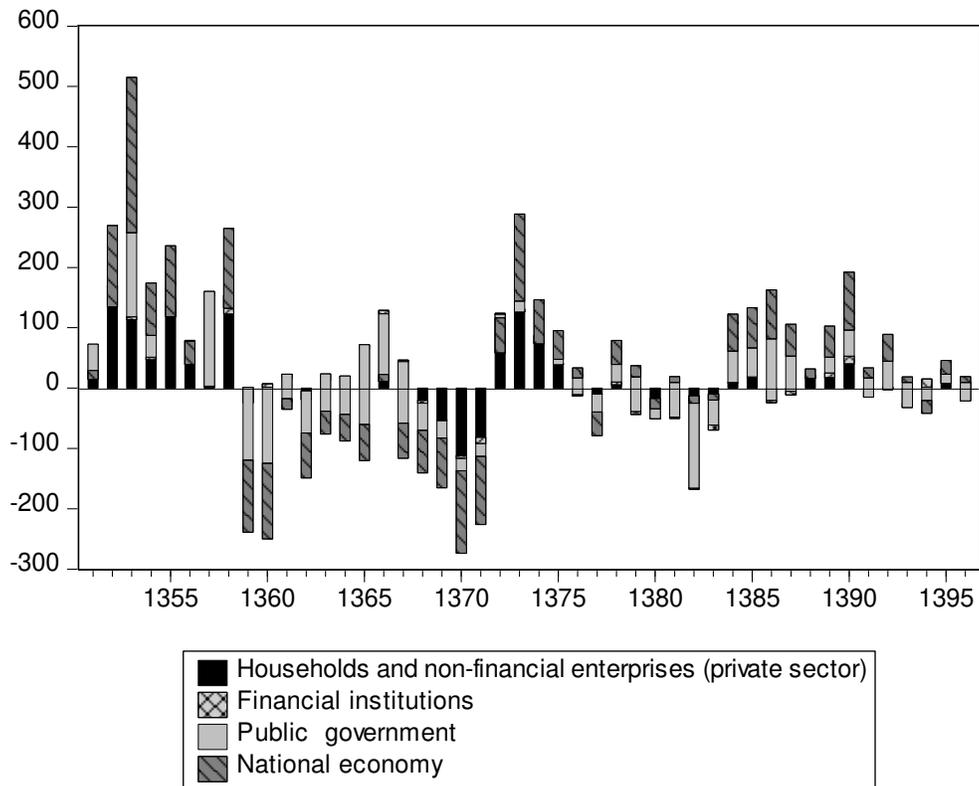
### **3 Data and research method**

#### ***3.1 Data***

Given the research objective which is to investigate the impacts of monetary shocks on the flow of funds account, annual data of flow of funds account (including 43 variables) which has been prepared for all economic sectors within 1973-2017 by the Central Bank's flow of funds department was used. Besides, data on macro variables (including 23 variables) were collected from the websites of the Central Bank of Iran and the Ministry of Economy for the same period. The reason for the selection of this period is that data on the flow of funds account are not continuously published in Iran and are updated every couple of years. The latest update of this data was on June 2020 encompassing the data of years 1973-2017. The trends of some of the variables in the flow of funds account will be elaborated on in the following.

##### ***3.1.1 Investigation of the trend of net financial investment in the economic sectors of the national economy***

As Figure 1 indicates, statistical data of the study throughout 1973-2017 suggests that the trend of net financial investment of the economy has been positive in most of the years. In other words, national economic sectors have had a financial surplus and their financial uses (assets) have exceeded their financial resources (liabilities).



**Fig 1** the trend of net financial investment in the economic sectors of the national economy

Examination of the national economic sectors in Figure 1 indicates that since 2011, financial institutions (including the Central Bank, public and private banks, and insurance companies) have dealt with financial deficits. As indicated in Table 2, the study of financial institutions over the years 2011-2017 demonstrates that the components of other sectors' long-run domestic currency deposits into financial institutions (the liabilities of financial institutions) has increased due to reasons such as the high interest rate of bank deposits, the growth of facilities granted by banks, and the expansion of non-bank credit institutions.

Over the mentioned period, the liabilities of financial institutions in the form of currencies and foreign currency demand deposits have also increased due to the 2012 currency crisis, the intensification of financial and economic sanctions, and reduced international banking relations.

In addition to the increase in domestic and foreign currency deposits of other sectors into financial institutions, it appears that the growth of financial institutions' financial liabilities in the form of capital instruments and participation in firms as well as the reduced financial assets in the form of participation bonds have resulted in the negative net financial investment of financial institutions over the years following 2011.

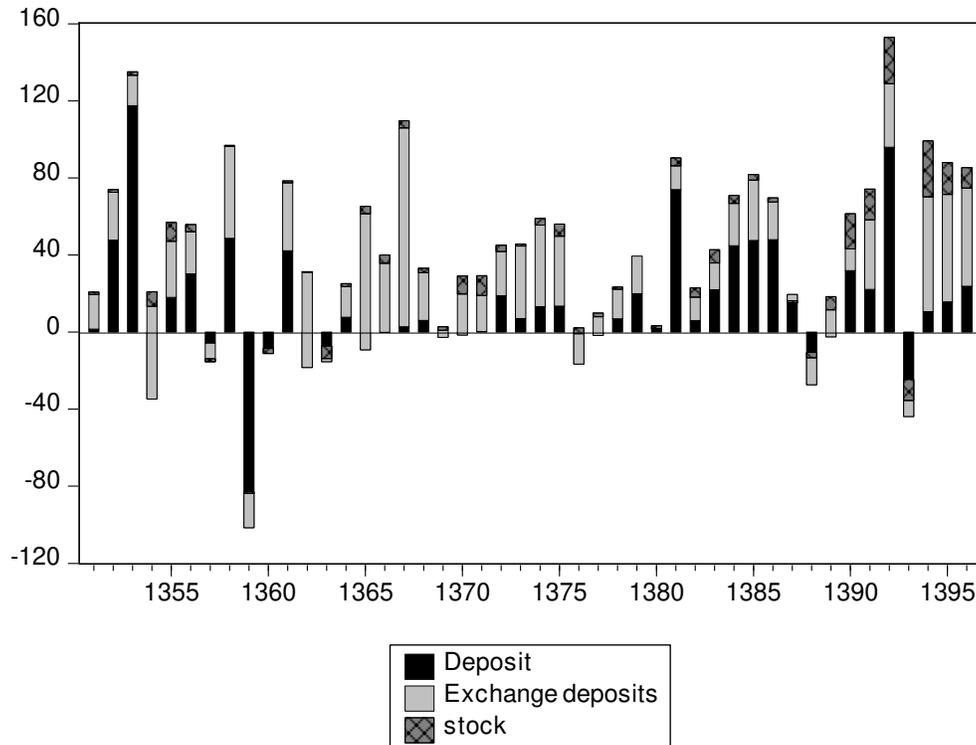


Fig.2 financial institutions' liabilities over 1973-2017. Source: authors' calculations

Besides, it is observed that the public government sector (including the sectors of government, oil and gas, and government firms) have had surplus financial investments since 1996 except for the year 2015. This sector's financial investment deficit in 2015 has been mainly due to the increase of the government's liabilities in the form of loans and cooperation bonds.

In the flow of funds account's framework, the concept of government budget deficit or surplus resulting from the current operations of the government does not equal the government's net lending/ borrowing but is rather a part of it. If the government has a positive net financial investment, it does not necessarily mean there is a government budget surplus and the flow of funds account balance sheet might have a positive net financial investment while there is a deficit in the current budget.

The reason for this is that according to the 2000 budget, 20% of the value of oil exportations must be paid to the National Development Fund (this amount used to be deposited in the foreign exchange reserve account before 2000) but is not mentioned in the budget law's tables. 20% of the government's oil revenues enter the public government sector's balance sheet in the form of financial assets (foreign cash or other financial assets). Thus, this sector's net financial investment equals net acquisition of financial assets in addition to the cash in the treasury and net deposits into the National Development Fund and the foreign exchange reserve account (Javadi, 2011).

### 3.2 Research methodology

The VAR models' main weakness is that a large number of variables cannot enter them nudges the researcher toward the development of traditional VAR models and the use of one or several factors that encompass the data of multiple time series variables optimally, as well as the introduction of the FAVAR by Bernanke et al. (2005). In the present study, we used FAVAR model.

Suppose that  $X_t$  and  $Y_t$  with the dimensions of  $M \times 1$  are two vectors of economic variables and  $t=1, 2, 3 \dots T$  indicates the time dimension. In fact,  $Y_t$  consists of the exogenous variables and  $X_t$  is a large set of economic data on other economic variables. It is assumed that some invisible fundamental factors or forces exist that impact the dynamic of  $X_t$  over time. These factors are demonstrated as the  $F_t$  vector with a dimension of  $K \times 1$ , the mutual dynamics between  $F_t$  and  $Y_t$  could be demonstrated in the form of the following equation according to Bernanke et al (2005).

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi^*(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \gamma_t \quad (1)$$

Where  $L$  indicates the lag operator,  $\Phi^*(L)$  is the lag polynomial, and  $\gamma_t$  represents the disturbance term with the mean of zero and variance-covariance matrix of  $Q$ . equation 1 could be also written as:

$$\Phi(L) \begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \gamma_t \quad (2)$$

$$\Phi(L) = I - \Phi^*(L)L = I - \Phi_1 L - \dots - \Phi_p L^p \quad (3)$$

Where lag polynomials are from the degree of  $P$  and  $\Phi_i$  is the matrix of model coefficients. Given the use of  $F_t$  as the invisible factor, Bernanke et al. (2005) named Equation (1) as the FAVAR model.  $F_t$ s that are invisible could be interpreted as the driving forces of the economy. Meanwhile, the following relationship called the dynamic factor model stands between  $F_t$ ,  $X_t$ , and  $Y_t$ :

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \quad (4)$$

Where the  $\Lambda^f$  matrix with  $K$  columns and  $N$  rows is the factor coefficients,  $\Lambda^y$  matrix with  $M$  columns and  $N$  rows indicates the direct relationship between exogenous variables and

$X_t$  variables, and eventually,  $e_t$  is an N-row vector of the error components with a mean of zero and can have limited temporal and cross-sectional correlations as well. Considering that  $K+M \ll N$  (i.e. the number of  $X_t$  vector variables are large enough), more data is transferred from  $F_t$ s to the FAVAR model compared to the conventional VAR model. Besides, impulse-response functions could also be calculated for all the variables of  $X_t$  vector. The variables of  $F_t$ ,  $X_t$ , and  $Y_t$  vectors will be discussed in the following.

In the present study,  $Y_t$  vector includes the oil revenues variable which is considered to be exogenous. Given that oil revenues are dependent on the production and global crude oil price and the fact that production has remained almost steady over the years, it could be said that this variable is determined exogenously.

Oil shocks could result in monetary shocks due to the change in the revenues of the countries exporting oil since the exchange of oil revenues into domestic currency in these countries result in the increased monetary base, money supply, and ultimately, liquidity growth due to the increase in the Central Bank's net foreign asset growth.

The  $X_t$  vector includes 66 financial and macroeconomic variables (see Appendix A) such as net financial investment of various economic sectors and each of these sectors' financial assets and liabilities. Each of these sectors has subsectors, and the information and data of all economic subsectors have entered the  $X_t$  vector (43 variables<sup>1</sup>).

Besides, macroeconomic variables such as the inflation rate, exchange rate, added value of various economic sectors, etc. have entered the  $X_t$  vector to complete the data set and consider macroeconomic dimensions in the model (23 variable<sup>2</sup>).

In the case of the  $F_t$  vector, the direct estimation of Equation (1) is impossible since  $F_t$  is invisible.  $\Lambda$  matrixes and  $F_t$ s could be estimated using the principal component analysis (PC) technique (see Appendix B). After  $\hat{F}_t$  is estimated, it could be used to estimate Equation 1. In fact, Equation 1 is a standard unrestricted VAR equation that could be estimated through the conventional methods of ordinary least squares or maximum likelihood.

### 3.2.1 Impulse response functions

If B is the matrix of structural constraints used to distinguish  $\varepsilon_t$  structural shocks from  $\vartheta_t$  shocks, the estimated form of Equation 2 using structural constraints would be as follows:

$$\widehat{\Psi}(L) \begin{bmatrix} \hat{F}_t \\ Y_t \end{bmatrix} = \varepsilon_t, \quad \varepsilon_t = Bv_t, \quad \widehat{\Psi}(L) = B\widehat{\Phi}(L) \quad (5)$$

<sup>1</sup> The flow of funds account data are nominal series and the consumer price index (CPI, 2004=100) has been used to deflate them.

<sup>2</sup> Macro variables are entered in the  $X_t$  vector as growth rate to eliminate nonstationary and all financial and macro variables are standardized.

In this case, the response functions resulting from structural shocks to the FAVAR equation could be written as the following equation:

$$\begin{bmatrix} \widehat{F}_t \\ \widehat{Y}_t \end{bmatrix} = \widehat{\delta}(L)\varepsilon_t \quad , \quad \widehat{\delta}(L) = \widehat{\Psi}(L)^{-1} \quad (6)$$

In this case, according to Equation (4), the response of  $X_t$  vector variables to the structural shocks could be written as the following equation:

$$X_t^{IRF} = [\widehat{\Lambda}^f, \widehat{\Lambda}^y] \begin{bmatrix} \widehat{F}_t \\ \widehat{Y}_t \end{bmatrix} = [\widehat{\Lambda}^f, \widehat{\Lambda}^y] \widehat{\delta}(L)\varepsilon_t \quad (7)$$

Bootstrapping (Killian and Lutkepohl, 2017) is mainly used to construct the confidence intervals of the impulse response functions in the model so that the significance of the response to a shock could be evaluated while the other shocks remain constant.

#### 4 Model estimation and its empirical results

Before estimating the model and specifying the impulse response functions, control and diagnostic tests of the FAVAR model including the test for determining the number of invisible factors (using the Eigenvalue criterion, the criteria of explanatory power and Bia and Ng (2003), 5 factors were selected), number of optimal lags, (using Schwartz & Hannan-Quinn information criterion, an optimal lag length of 1 was selected), auto-correlation test, and model residual normality must be carried out. Results of these tests have been presented in the Appendix C to H.

One of the advantages of the FAVAR model is that it provides the possibility of estimating response functions for all vector variables in addition to the factors. Various economic sectors' response functions resulting from the expansionary monetary shocks are discussed in the following.

##### 4.1 Households

Figure 3 demonstrates the response of financial assets and liabilities and net financial investment of the household sector to positive oil revenue shocks as large as one standard deviation. Gray lines indicate the 90% confidence interval and black lines indicate mean response size. As observed, positive oil revenue shocks have a positive and significant impact on this sector's financial assets and liabilities in the first year and increase them. The increase in both assets and liabilities do not offset each other completely and result in increased net financial investment of the household sector which is significant in the first two years. The increased net financial investment of the household sector means that this sector lends to other sectors following the expansionary monetary policy shocks.

The result of this section is consistent with the literature review. Money supply increases following expansionary monetary policy shocks, which results in increased household income and, in turn, increased deposits. Increased deposits eventually result in banks increased lending power<sup>1</sup> (Krylova, 2002). This result is also consistent with the results of studies conducted by Taghavi and Lotfi (2006); Shahbazi et al. (2018), and Komijani et al. (2009).

Financial assets and liabilities and net financial investments begin to drop after the first year, and the trend of assets –after two years- and liabilities –after one year- become initially inverse and then return to their equilibrium level gradually and after a few periods. The reason for the decline in financial assets (the major part of which is made up of term deposits) after one year and the subsequent negative impact of the shock on them appear to be since the interest ratio of deposits in Iran are determined by the Orders of the Central Bank. Fixed interest rates on deposits and expected inflation outlook due to increased money supply at the community level result in a decrease in the real interest of deposits and bank deposits are expected to decline over time.

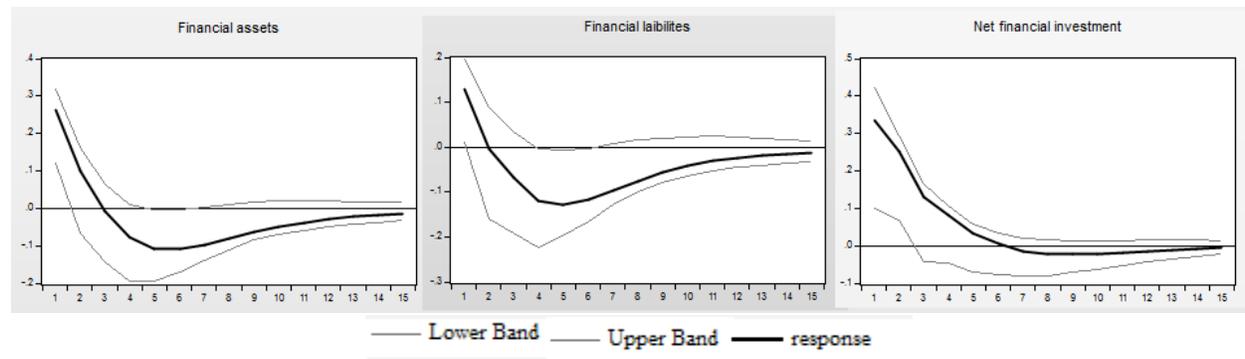


Fig.3 response functions of the household sector to monetary shocks. Source: authors' calculations

## 4.2 Nonfinancial enterprises

Figure 5 demonstrates the impulse response of nonfinancial enterprises (corporates and private institutions). The financial assets and liabilities of this sector increase after the expansionary monetary shock. The overall impact of the monetary shock on net financial investment is the approximate offset of assets and liabilities and an insignificant decrease in the first year. After the first year, the response of the net financial investment increases which indicates that this sector's net financial investment responds to the expansionary monetary impulse with a delay. Results obtained in this section are not statistically significant.

According to the literature and results of some empirical studies such as studies conducted by Shabbir (2012) and Ruslan et al. (2015), the amounts of facilities received by companies increase following the expansionary monetary shock and the increase in companies' net worth and their

<sup>1</sup> Given that over half of the financial assets of the household sector is made up of deposits and around half of their liabilities include loans and granted facilities. deposits and granted facilities appear to be an indicator of the household sectors' assets and liabilities

cash flow. The reason for this is companies' increased credit status and better assessment of financial suppliers from the financial situation of companies.

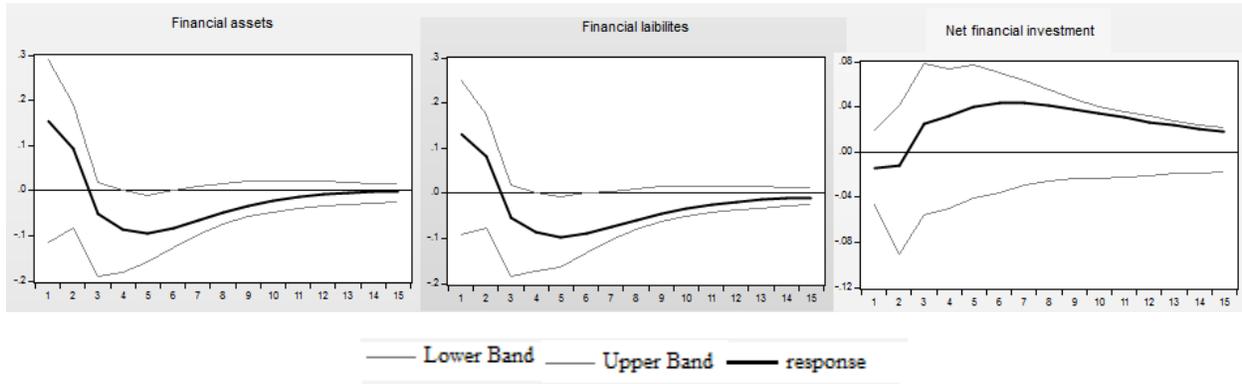


Fig.4 response functions of the nonfinancial enterprises sector to monetary shocks. *Source:* authors' calculations

### 4.3 The government

The occurrence of an expansionary monetary shock due to increased oil revenue results in a positive revenue shock for the government budget and increases the government's financial assets and liabilities, which is significant for the first year. After two years, this response is reversed and eventually returns to its equilibrium level.

The increase in assets and liabilities due not offset each other completely, and the reaction of the government sector's net financial investment is slightly increasing at first, which becomes a decreasing trend after two years and starts reacting in the opposite and negative direction. This indicates that the government sector could be the lender to other sectors in the short run but is the borrower from other sectors in the long run. The response of the government sector's net financial investment was not statistically significant.

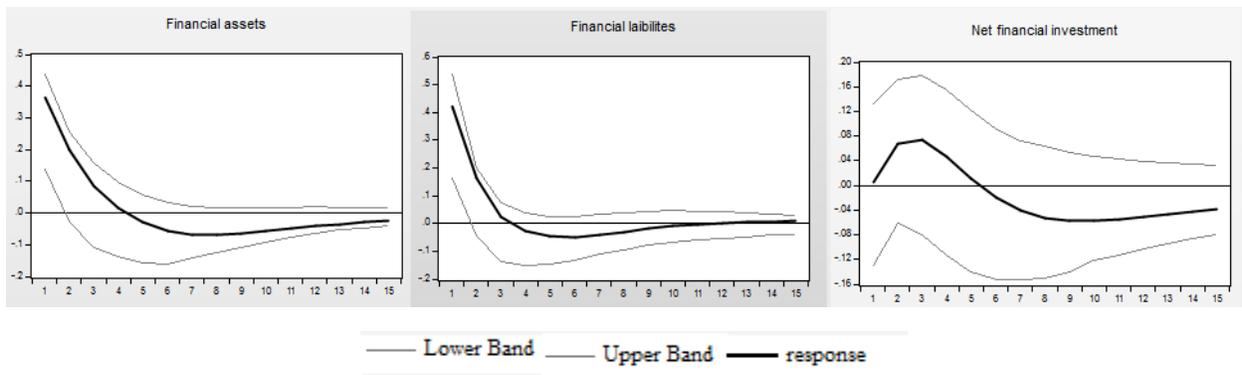


Fig.5 response functions of the government sector to monetary shocks. *Source:* authors' calculations

#### 4.4 Public and private banks

The response of public and private banks' financial assets and liabilities to expansionary monetary shocks is first increasing, but this trend reverses and becomes negative after two years, and eventually returns to its equilibrium level after a few periods.

This result is consistent with the literature and the viewpoint of Bernanke and Gertler (1995) who believed that the change in money supply impacts deposits and, in turn, banking facilities. The occurrence of expansionary monetary shocks increases households' real income and, as a result, their deposits in the form of banking deposits. This operation increases the free resource at the banks' disposal so they grant more facilities to their applicants.

The response of this sector's net financial investment is initially negative and significant for the first year, but this trend reverses immediately, becoming positive from the first year onwards, and then returns to its equilibrium level.

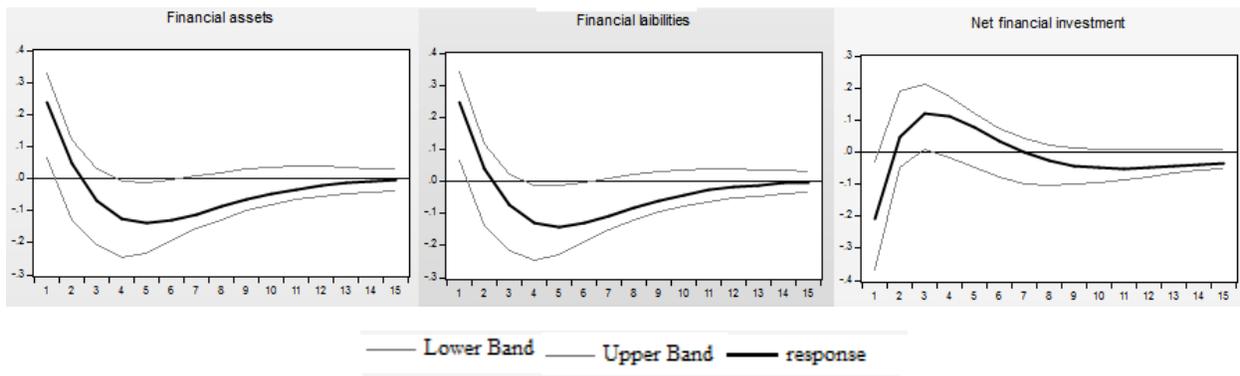


Fig.6 response function of the public and private banks sector to monetary shocks. *Source:* authors' calculations

#### 5.4 The Central Bank

The Central Bank's financial assets and liabilities increase as expected following an expansionary monetary shock resulting from increased oil revenues, this increase is significant for the first year, but declines gradually after the first year and returns to its equilibrium level after six periods. This sector's net financial investment after the monetary shock is positive and –over the first year– significant.

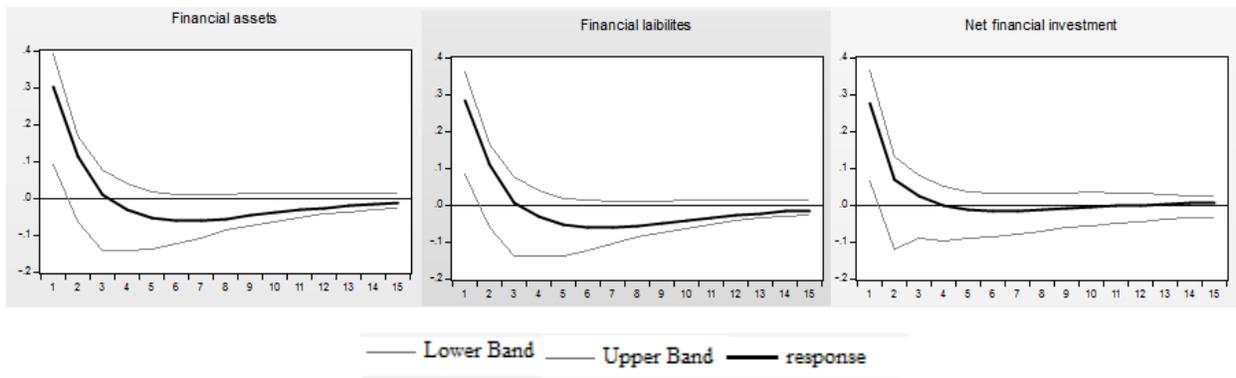


Fig.7 response functions of the Central Bank to monetary shocks. *Source:* authors' calculations

### 6.4 The foreign sector

Expansionary monetary shocks leave a negative impact on the foreign sector's financial assets and liabilities. The increased money supply and liquidity in the community will create the expectations that the nominal domestic interest rate will decrease compared to the real foreign interest rate, so net capital outflow occurs and financial liabilities of the foreign sector increase following an expansionary monetary shock. The foreign sector's financial liabilities then return to their equilibrium level with the diminishing of the results of oil dollars being deposited in the economy. This result is consistent with the literature.

According to the literature, the increase in foreign interest rates increases capital outflow from the country and increasing outflow will persist as long as the foreign interest rates increase in comparison with the domestic interest rates. However, increasing capital inflow occurs when domestic interest rates increase compared to foreign interest rates. (Mundel, 1960 and Fleming, 1962).

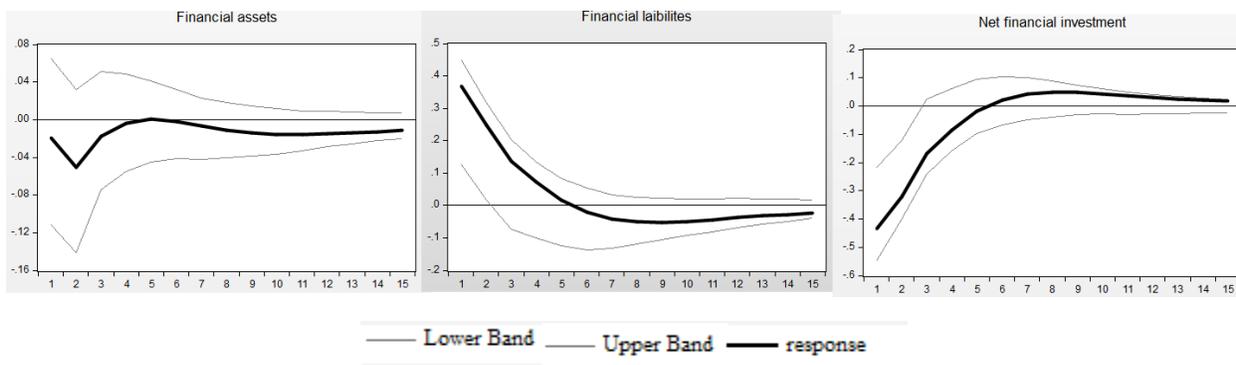


Fig.8 the response functions of the foreign sector to monetary shocks. *Source:* authors' calculations

The result of the foreign sector's reduced financial assets and increased financial liabilities is this sector's decreased net financial investment which is significant for the first two years and returns to its equilibrium level after five periods.

Overall, it could be concluded from the comparison of the dynamic responses of various economic sectors to expansionary monetary shocks that monetary shocks initially increase the national economic sectors' financial assets and liabilities, and public and private banks will be borrowers from others while other sectors will be lenders over the first year (except for the government and the nonfinancial enterprises' sectors that respond with a delay). However, the foreign sector becomes the borrower and all national economic sectors become lenders after the first years. The reason for this appears to be the difference between nominal domestic interest rate and real foreign interest rate, by considering covered arbitrage rate of interest theorem. Net capital outflow continues for about four years. A response that is only significant for the first two years.

## 5 Conclusion

Since it provides financial transaction data at a detailed level and has a broad coverage of various economic sectors, the flow of funds account is used as a basic data instrument in empirical research and to analyze the impact of fiscal and monetary policy shocks on the lending and borrowing activities of various economic sectors and other economic variables. Besides, this account could be used to analyze the impact of various fiscal and monetary shocks on different economic sectors; portfolios since it provides elaborated data on financial instruments.

Awareness of the side-effects of shocks on various sectors is imperative to compensate for their adverse effects and could help policy-makers adopt more accurate policies as well as providing the suitable context for the requirements of macroeconomic planning, prediction, and policy-making to be met. Besides, capital-savings and asset-liabilities flows could be controlled and supervised considering the response of each sector's resources and uses which will result in the optimal allocation of resources per economic sectors' efficiency and volume of activity.

The following results have been obtained regarding the dynamic responses of various economic sectors to expansionary monetary policy and their interactions with one another.

The response on the side of assets, liabilities, and net financial investment have been summarized in the following figures. According to Figure 10, the greatest response on the side of assets is attributed to the governments, followed by the Central Bank, households, banks, nonfinancial enterprises, and the foreign sector (the response of the nonfinancial enterprises and foreign sector is not significant).

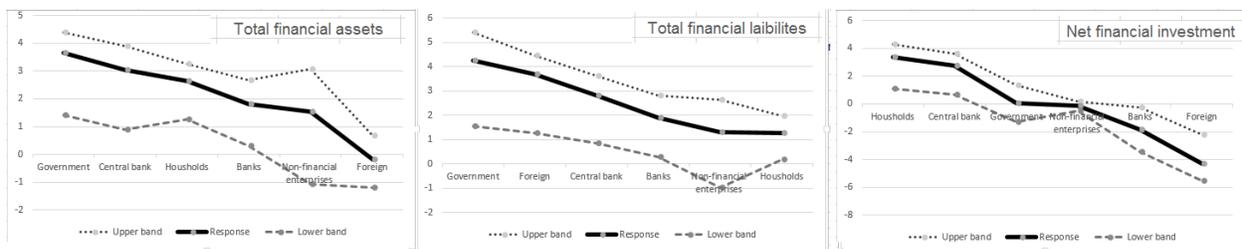


Fig.9 the response functions of economic sectors to monetary shocks in the first year. Source: authors' calculations

The greatest response on the side of liabilities is attributed to the foreign sector followed by the Central bank, banks, nonfinancial enterprises, and households (the response of the nonfinancial enterprises is not significant).

The positive response of net financial investment in the first year is attributed to the sectors of households, Central Bank, and nonfinancial firms, respectively, while the negative response is attributed to the foreign sector, banks, and the government, respectively. We discard the response of government and nonfinancial firms' net financial investment to their insignificant value in the first year, and it is concluded that the sectors of households and Central Bank are lenders while banks and the foreign sector are borrowers.

From the second year onwards, all national economic sectors are lenders and the foreign sector becomes the borrower. Net capital outflow continues for about four years which is only significant over the first two years. The reason for this appears to be the difference between nominal domestic interest rate and real foreign interest rate, by considering covered arbitrage rate of interest theorem.

The results show that the lack of a significance response to the net financial investment in the nonfinancial enterprises against the expansionary monetary shock, due to an increase Iran oil revenues, indicates that there is no a widespread private sector.

The significance negative response in foreign sector net financial investment to the shock appears that net capital outflow was occurred as a consequence of the shock. Therefore, development in financial performances is recommended.

## Appendix A:

(See table 6).

No	Variables	Source
1	Net financial investment of household	CBI
2	Total financial assets of household	CBI
3	Total financial liabilities of household	CBI
4	Total nonfinancial assets of household	CBI
5	Total non- financial liabilities of household	CBI
6	Net financial investment of nonfinancial firms	CBI
7	Total financial assets of nonfinancial firms	CBI
8	Total financial liabilities of nonfinancial firms	CBI
9	Total nonfinancial assets of nonfinancial firms	CBI
10	Total non- financial liabilities of nonfinancial firms	CBI
11	Net financial investment of banks	CBI
12	Total financial assets of banks	CBI
13	Total financial liabilities of banks	CBI
14	Total nonfinancial assets of banks	CBI
15	Total non- financial liabilities of banks	CBI
16	Net financial investment of central banks	CBI
17	Total financial assets of central banks	CBI
18	Total financial liabilities of central banks	CBI
19	Total nonfinancial assets of central banks	CBI
20	Total non- financial liabilities of central banks	CBI
21	Net financial investment of insurances	CBI
22	Total financial assets of insurances	CBI
23	Total financial liabilities of insurances	CBI
24	Total nonfinancial assets of insurances	CBI
25	Total non- financial liabilities of insurances	CBI
26	Net financial investment of government	CBI
27	Total financial assets of government	CBI
28	Total financial liabilities of government	CBI
29	Total nonfinancial assets of government	CBI
30	Total non- financial liabilities of government	CBI
31	Net financial investment of government firms	CBI
32	Total financial assets of government firms	CBI
33	Total financial liabilities of government firms	CBI
34	Total nonfinancial assets of government firms	CBI
35	Total non- financial liabilities of government firms	CBI
36	Net financial investment of oil and GAZ sector	CBI
37	Total financial assets of oil and GAZ sector	CBI
38	Total financial liabilities of oil and GAZ sector	CBI
39	Total nonfinancial assets of oil and GAZ sector	CBI
40	Total non- financial liabilities of oil and GAZ sector	CBI
41	Net financial investment of foreign sector	CBI
42	Total financial assets of foreign sector	CBI
43	Total financial liabilities of foreign sector	CBI
44	Value added of agricultural group, 2004 = 100	CBI
45	Value added of industrial group, 2004 = 100	CBI
46	Value added of the mining group, 2004 = 100	CBI
47	Value added of the oil group, 2004 = 100	CBI
48	Value added of water, electricity and Gaz, 2004 = 100	CBI
49	Value added of the building, 2004 = 100	CBI
50	Value added of the service group, 2004 = 100	CBI
51	Accrual fee, 2004 = 100	CBI
52	Private consumption expenditures, 2004 = 100	CBI
53	Public consumption expenditures, 2004 = 100	CBI
54	Export of goods and services, 2004 = 100	CBI
55	Import of goods and services, 2004 = 100	CBI
56	Liquidity	CBI
57	Exchange rate	CBI
58	Inflation rate	CBI
59	Gold coin (old design)	CBI
60	Tax revenue	MEFA
61	Other income except tax and oil revenue	MEFA
62	Current payment	MEFA
63	Construction payment	MEFA
64	Deficit(-)/surplus(+)	MEFA
65	Crude oil export	MEFA
66	Non-oil GDP, , 2004 = 100	MEFA
67	Real oil revenue	MEFA
68	Consumer price index (CPI), 2004 = 100	CBI

**Table 6** Variables information

Table 6 (continued)

All variables except real oil revenue are used for drawing out latent factors in FAVAR model. CBI is the abbreviation for Central Bank of Iran, MEFA is the Ministry of Economic and Finance Affairs of Iran.

## Appendix B

### *Principle component analysis (PCA)*

Two methods have been introduced in the economic literature to estimate the FAVAR model. The first method is a two-step nonparametric principle component analysis (PCA) and the second approach is the one-step Bayesian likelihood approach based on Gibbs sampling. . Bernanke et al. (2005) demonstrated that the results of both estimation methods are generally similar, so the present study only uses the first method for a model estimation which is the PCA method.

PCA method among multivariate data analysis methods is used for combining highly correlated variables with the main purpose of reducing the dimension of the problem under study. To use PCA method, a large number of correlated explanatory (independent) variables could be replaced with a limited number of new uncorrelated explanatory variables. Thus not only reducing the problem dimension but also eliminating the issue of collinearity. The components (factors) in the PCA method are calculated as a linear combination of the main variables (Sadeghi et al., 2017).

The principal component vectors of the  $X_t$  matrix are extracted from it by using the PC technique. Among these principal components, K number of components corresponding to K specific values of the  $X_t$  matrix sorted from smallest to largest are selected. In fact, the  $F_{it}$  vectors corresponding to K specific values of the  $X_t$  matrix sorted from smallest to largest are selected. It must be noted that the constraint of  $\Lambda' \Lambda = I$  must be imposed on the system so that matrix F and its corresponding  $\Lambda$  are detectable. The PC estimation techniques have this capability and the matrix of factors could be estimated as  $\hat{F}_t = \hat{\Lambda} X_t$  using the estimation of  $\Lambda$  as its result (Heydari, 2018).

## Appendix C

(See table 7,8).

	IC1	IC2	IC3	PC1	PC2	PC3	BIC3	AIC3
0	27.3794	27.3794	27.3794	1.5430	1.5513	1.5266	7.7756	7.7756
1	25.8502	25.8697	25.5783	1.5430	1.2060	1.5266	1.6174	1.5221
2	25.6547	25.6936	25.5783	1.1894	1.2060	1.1566	1.3358	1.1470
3	25.4648	25.5231	25.3501	0.9510	0.9760	0.9017	1.1671	0.8865
4	25.2871	25.3649	25.1342	0.7979	0.8312	0.7322	1.0814	0.7107
5	25.0964*	25.1935*	24.9051*	0.692*	0.7342*	0.6105*	1.0412*	0.5821*

**Table 7** the results of determining the number of factors in FAVAR model using Bai and Ng (2003) criterion.

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	17.16841	7.943332	0.2601	17.16841	0.2601
2	9.225080	3.351855	0.1398	26.39349	0.3999
3	5.873225	1.325301	0.0890	32.26672	0.4889
4	4.547924	0.961717	0.0689	36.81464	0.5578
5	3.586207	0.649617	0.0543	40.40085	0.6121

**Table 8** the results of determining the number of factors in FAVAR model using cumulative proportion

## Determination of the number of principal components

Several computational criteria are used to determine the optimal number of factors.

### 1 The Eigenvalue criterion

According to this criterion, only factors with eigenvalues larger than one are statistically significant (Kaiser 1960), so we eliminate other components.

### 2 The explanatory power

Several factors explaining a higher percentage of the total variance are sufficient to continue the work. It must be mentioned that the percentage of total variance explained by the factors in economic analysis is by far lower than other sciences due to the large number of variables used, and 40% of the total variance being explained by the factors is considered an acceptable fit (Breitung and Eickmeier, 2005)

### 3 Bai and Ng criteria

Bai and Ng (2003) have proposed criteria to determine the number of factors using  $X_t$  vector's variables. The two criteria widely used in simulations of such models are derived from the following equations:

$$IC_{p1}(k) = ((k, \hat{F}^k)) + \left(\frac{N+T}{NT}\right) \ln \left(\frac{N+T}{NT}\right) \quad (8)$$

$$IC_{p2}(k) = ((k, \hat{F}^k)) + k \left(\frac{N+T}{NT}\right) \ln (C_{NT}^2) \quad (9)$$

In the equations above, N, T, and k represent the numbers of variables, observations, and factors, respectively.  $(k, \hat{F}^k)$  indicates mean squared error in factor estimation and  $C_{NT}^2 = \min\{N, T\}$  in the next criterion.

Using the Eigenvalue criterion, the criteria of explanatory power and Bia and Ng (2003), the optimal number of factors are 5.

## Appendix E

(See table 9).

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-783.4754	NA	8.55e+08	37.59407	37.84230	37.68505
1	-646.7102	227.9419	7183498.	32.79573	34.53340*	33.43265*
2	-604.1070	58.83303*	5838371.	32.48129	35.70839	33.66415
3	-560.4097	47.85893	5450366.*	32.11475*	36.83128	33.84354

Table 9 the results of lag order selection

## Appendix F

(See table 10).

Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	44.47166	36	0.1571	1.289849	(36, 86.2)	0.1694

Null hypothesis: No serial correlation at lags 1 to h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	44.47166	36	0.1571	1.289849	(36, 86.2)	0.1694

\*Edgeworth expansion corrected likelihood ratio statistic.

Table 10 the results of autocorrelation LM test

## Appendix G

(See table 11).

Component	Skewness	Chi-sq	df	Prob.*
1	0.039898	0.014551	1	0.9040
2	0.273263	0.667333	1	0.4140
3	0.032452	0.009628	1	0.9218
4	0.204078	0.375959	1	0.5398
5	0.141591	0.182191	1	0.6695
6	0.381315	1.272626	1	0.2593
Joint		2.522288	6	0.8660

Component	Kurtosis	Chi-sq	df	Prob.
1	3.063569	0.833535	1	0.3613
2	2.991859	0.268199	1	0.6045
3	3.894529	4.845632	1	0.0277
4	2.303164	0.630875	1	0.4270
5	2.423959	0.175238	1	0.6755
6	2.768117	0.035607	1	0.8503
Joint		6.789085	6	0.3408

Component	Jarque-Bera	df	Prob.
1	0.848085	2	0.6544
2	0.935532	2	0.6264
3	4.855260	2	0.0882
4	1.006834	2	0.6045
5	0.357429	2	0.8363
6	1.308233	2	0.5199
Joint	9.311373	12	0.6761

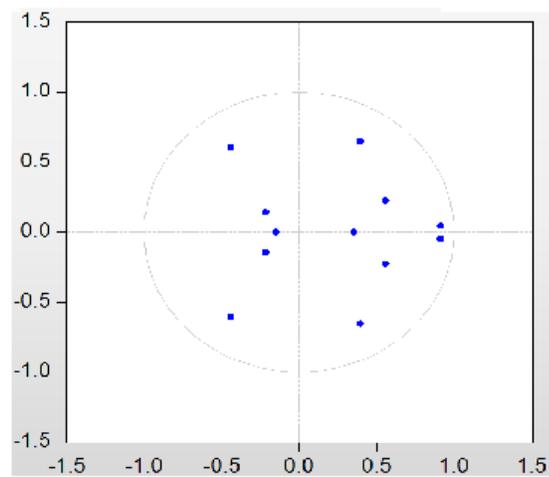
**Table 11** the results of residual normality test based on Durnick Hansen method

## Appendix H

(See table 12).

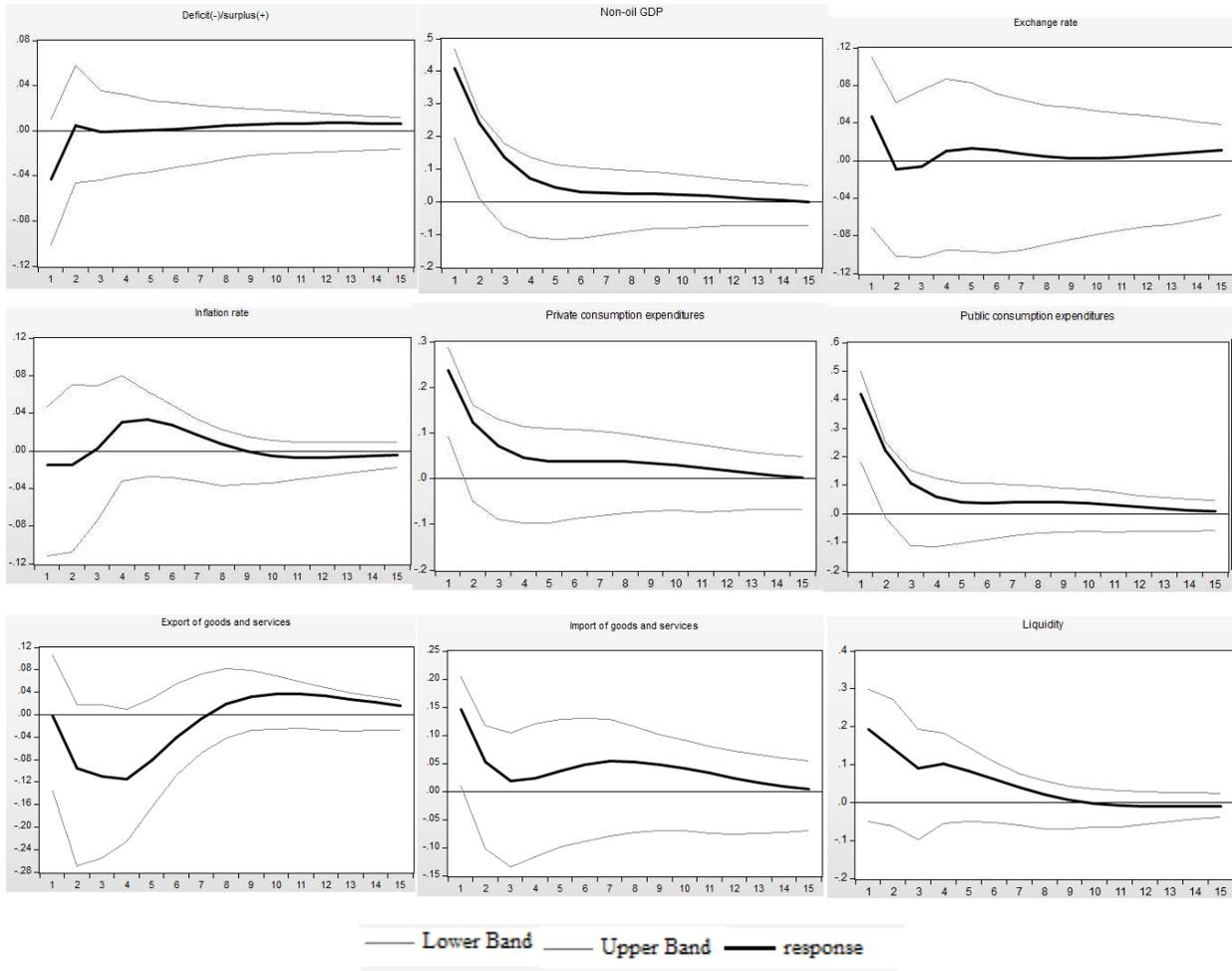
Root	Modulus
0.913612 - 0.047324i	0.914837
0.913612 + 0.047324i	0.914837
0.393759 - 0.652594i	0.762184
0.393759 + 0.652594i	0.762184
-0.440732 - 0.606466i	0.749697
-0.440732 + 0.606466i	0.749697
0.561222 - 0.225549i	0.604850
0.561222 + 0.225549i	0.604850
0.353240	0.353240
-0.215391 - 0.142675i	0.258359
-0.215391 + 0.142675i	0.258359
-0.148067	0.148067

No root lies outside the unit circle.  
VAR satisfies the stability condition.



**Table 12** The results of AR Roots graph and table

**Appendix I**  
(See fig 10).



**Fig.10** the response functions of main macroeconomic variables to monetary shocks. *Source:* authors' calculations

## **Declaration**

### 1. Conflict of Interest

- ✓  No conflict of interest exists.

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

### 2. Funding

- ✓  No funding was received for this work.

### 3. Intellectual Property

- ✓  We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

### 4. Research Ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

### 5. Authorship

The International Committee of Medical Journal Editors (ICMJE) recommends that authorship be based on the following four criteria:

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  2. Drafting the work or revising it critically for important intellectual content; AND
  3. Final approval of the version to be published; AND
  4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
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- ✓  We confirm that the manuscript has been read and approved by all named authors.
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