

Macroeconomic Dynamics in the Oil Exporting Countries: A Panel VAR study

Mohsen Mehrara
Faculty of Economics
University of Tehran
Tehran, Iran

Mohsen Mohaghegh
MSc in Economics
University of Tehran
Iran

Abstract

This paper studies the macroeconomic dynamics in oil exporting countries using Panel VAR approach. This study in contrary with most other researches focuses on developing net oil exporters –instead of developed net importers- and in addition to investigating macroeconomic fluctuations, provides fresh insight into the impacts of oil shocks on macroeconomic variables. On the basis of Impulse Response and Variance Decompositions analysis in a system included economic output, money supply, price index and oil price, we found that: (1) oil shocks are not necessarily inflationary; (2) money is not neutral in these countries; (3) money is the main cause of macroeconomic fluctuations; (4) oil shocks significantly affect economic output and money supply; (5) though oil price is highly driven by its own shocks, domestic shocks, particularly output and money shocks, can sizably affect oil price in the world market.

Key Words: Macroeconomic fluctuations, Oil exporting countries, Panel data, VAR model

JEL Classification: C32, E34, F41

1. Introduction

Energy plays the central role in the world economy. In spite of considerable inclination to alternative renewable sources of energy like wind, water, nuclear and solar power, the role of crude oil in macroeconomic movements has not waned yet. So, oil shocks may have macroeconomic consequences in both oil exporting and oil importing countries. Because in the former group, oil is the major source of revenue and in the latter, it is a major input for production system. Despite – and maybe due to- this mutual strategic importance, oil price is highly variable; even more than any other commodity (Dehn, 2001). And its fluctuations are hardly predictable. These facts led to a great number of researches studying the effects of oil price changes on economic activity, identifying the mechanisms through which these effects transmit and proposing effective monetary and fiscal policies to prevent negative impacts of such shocks (e.g. Hamilton, 1983, 1996; Pindyck & Rotemberg, 1983; Bernanke et al., 1997; Bernanke, 2004; Devlin & Lewin, 2004; Cologni & Manera, 2007). These studies found that oil price change is an important source of macroeconomic fluctuations such that its increase worsens the economic situation in the sample countries. Of course, all the mentioned studies – like most of other papers in this body of literature - focused on industrialized oil importing economies and their results are valid only for such countries.

The story in oil exporting countries is totally different. In most of oil exporting countries, government which is considerably large in comparison with small private sector, directly receives the oil revenue. Spending this revenue, government's behavior becomes the most important characteristic of the economy. In other words, the funds needed for government's expenditure come from oil revenue. So, fiscal and monetary policies depend upon oil price (Rosser & Sheehan, 1995). In these economies, oil price fluctuations, if preventive actions do not take, transmit to real exchange rate. Since any rise or fall in the oil price is not permanent, oil revenue variation injects instability to the economy. In this situation, so called "resource curse" occurs. When oil price rises, the government has more money to spend. In other words, according to Chalk (1998), when the country's terms of trade are favorable, oil-dependent government's spending and even overspending can be easily financed through oil revenue. Though, this revenue can be used to finance developmental projects to increase the welfare, by inefficient public spending and fiscal expanding, considerably wastes. This destructive strategy, over time, makes economy more vulnerable to oil price volatility particularly in the presence of capital market imperfections (Hausmann & Rigobon, 2003).

The other side of this coin is even worse. When oil price depreciates large public sector expectedly, cannot reduce its spending immediately and proportionately; then faces huge deficits. The fiscal imbalances followed by an oil price decrease can be devastating if the country is highly dependent on oil revenues; which is the case in most of oil exporting countries. More disappointingly such falls are usually unpredictable. Several incomplete projects and huge debts are the main inheritances of this period for the following fruitful era. After some harsh experiences, nowadays, isolating the real sectors of economy from oil price volatility is accepted as one of the most important roles of government. Norway as a developed oil producer was the pioneer in setting economy securely far from volatile oil revenue. This successful experience, in addition to stylized facts and theoretical and empirical explanations urged oil producers to follow. Subsequently, Indonesia, Kuwait and after that, nearly all major oil exporters, in recent decades, has established institutional organizations in the form of national funds to restrict fiscal spending during oil price booms (Devlin & Lewin, 2004); of course, expectedly, they vary in their level of achievement.

Considering this background, oil price variation plays a significant role in macroeconomic fluctuations in oil exporting countries; so, studying this role and identifying the impacts of oil shocks on other macroeconomic indicators is of great importance. Despite this fact that oil-exporting countries have experienced large and major fluctuations as a result of oil shocks, great body of researches have analyzed the impacts of oil price variations in the developed country and specially US economy (Jimenez-Rodriguez & Sanchez, 2005); such that only a limited number of studies have focused on oil exporting countries (Berument et al., 2010). In this paper, we will study the sources of macroeconomic fluctuations in oil exporting countries using Panel Vector AutoRegressive (PVAR) method. This technique combines the traditional VAR approach developed by Sims (1980) with the panel data approach which allows for unobserved individual heterogeneity. In contrast with the previous individual-country level researches, this paper is one of the rare studies addressing this topic in developing oil exporters in a group setting and applying PVAR framework instead of standard VAR or SVARs. Lack of data is one of the main causes of scarcity of studies addressing macroeconomic fluctuations in these countries and a major threat for their validity. PVAR enables us to pool large number of observations from limited number of countries and reach more accurate results.

We will study the macroeconomic dynamics between economic output (GDP), domestic price level (CPI), money supply (M_2) and oil price over a set of main oil exporting countries. To evaluate the relative importance of these variables in the movements of other variables in both short- and long-run, Impulse Response Functions (IRFs) and Forecast Error Variance Decompositions (FEVDs) are used. Our sample covers the data from 1985 to 2009 in all OPEC members and other major non-OPEC developing oil exporting countries, namely Algeria, Angola, Azerbaijan, Bahrain, Ecuador, Indonesia, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen and Venezuela. The remainder of this paper organizes as follows. Section 2 briefly reviews some of the related works in the body of literature. Section 3 introduces data and the method. Section 4 reports our empirical results and finally, section 5 concludes.

2. Literature Review

Studying the role of oil price in macroeconomic dynamics came to the focal point of research since 1970s. Hamilton (1983) by claiming that seven out of eight economic recession in the US after WWII were preceded by oil price hikes, developed a new strand followed by several researchers. focusing on US economy, researchers argued that oil shocks lead to higher inflation and lower output. Some claimed that the role of oil price in cyclical movements of economy is even more important than fiscal and monetary policy (Gisser & Goodwin, 1986) while some believed that our policy responses to oil shock can considerably lessen its impacts. According to them, historical coincidence of oil shocks and economic recessions is not enough to conclude that there is a causal relationship between them. They suggested monetary policy as the third force responsible for this connection (Dotsey & Reid, 1992; Bernanke et al, 1997). Meanwhile, the idea of assymetric effects – of positive and negative shocks - on macro movements of economy is developed (e.g. Tatom, 1988, Mork, 1989; Mork et al., 1994 and Mory, 1993). Regardless of different approaches, in sum, researchers conclude that there is a negative correlation between increases in oil prices and the subsequent economic downturns in the US. In next decades the scope of research expanded to other countries, albeit oil importers in most cases. Among others, in group settings, Cunado et al. (2003) studied the correlation between oil price shocks and macroeconomic factors like the industrial production and consumer price indices in some 14 European countries.

Jimenez-Rodriguez and Sanchez (2005) investigated the effects of oil price shocks on economic output in G7 countries and Norway. Kilian (2005) and Cologni & Manera (2007) are two other studies focused on G7 countries. Expectedly, like previous studies, they concluded that oil price hikes result in economic recession.

In oil exporting countries, on the other hand, macroeconomic fluctuations and the role of oil price as a major source of them have been subject to some studies focused on one individual country. For instance, Al-Mutairi (1993) claimed that dependence of the fiscal policy on oil price significantly affects output movements in Kuwait. Eltony (2001) approved the causal relationship from oil revenues towards other macroeconomic variables in Kuwait. He also identified the government's fiscal stimuli as the main determinant of domestic prices. Dibooğlu & Aleisa (2004), investigating the sources of macroeconomic fluctuations in Saudi Arabia using Structural VAR method, showed that "price level, real exchange rate, and to a lesser extent output is vulnerable to terms of trade shocks" which are driven by "output, trade balance, and aggregate demand shocks".

In the case of Venezuela, Anshasy et al. (2005) investigated the relationship between oil prices, governmental revenues, government consumption spending, GDP and investment by a VAR/VECM model and concluded that fiscal balance in both short and long run affects economic growth. Olomola & Adejumo (2006) examined the effects of oil price shocks on output, inflation, real exchange rate and money supply in Nigeria in a VAR framework and argued that oil price shocks significantly determine the real exchange rate and in the long run money supply which may lead to "Dutch Disease". Similar works have been implemented for Indonesia (Ward & siregar, 2001), Ecuador (Boye, 2001), Mexico (Boye, 2002) and Iran (Farzanegan & Markwardt 2009). Moreover, some researchers analyzed macroeconomic fluctuations in oil-based economies by estimating and comparing the results of individual equations for each country. Among others, Berument et al. (2010), using several individual SVAR models, studied the effects of oil price shocks on the output growth of selected Middle East and North African (MENA) countries that are either exporters or net importers of oil commodities. Their impulse response analysis suggested that the effects of the world oil price on GDP in most of oil exporters, namely Algeria, Iran, Iraq, Jordan, Kuwait, Oman, Qatar, Syria and UAE as well as one oil importing country, Tunisia, are positive and significant. However, for Bahrain, Egypt, Lebanon, Morocco and Yemen they did not find a significant impact on oil price shocks.

Alotaibi (2006) investigates the interactions between oil price variations, real exchange rate and price level in the members of Persian Gulf Cooperation Council. Using SVAR model, he concludes that real shocks do not affect oil price and nominal shocks do not affect both oil price and GDP. His results support Real Business Cycle (RBC) theory by proving that supply shocks have greater impacts than demand shocks rooted in oil revenue. Finally, Alotaibi claims that oil price shocks directly affect price level while have inverse effects on real exchange rate.

Mehrra & Oskui (2007) study the sources of macroeconomic fluctuations in four oil-exporting countries – Indonesia, Iran, Kuwait and Saudi Arabia- using a structural VAR approach. On the basis of Variance Decomposition and Impulse Response analysis, oil price shocks are shown to be the main source of output fluctuations in Saudi Arabia and Iran. But in Kuwait and Indonesia, output fluctuations were mainly found due to aggregate supply shocks. Moreover, their results show that oil price shocks in Saudi Arabia steadily expand prices while such impact on the long run prices in Iran, Kuwait and Indonesia is not approved.

Lescaroux & Migno (2008) in three panels of OPEC members, other major oil exporting countries and some oil importing countries investigated the links between oil prices and various macroeconomic and financial variables including GDP, CPI, unemployment rate and bond price. Using causality tests, evaluation of cross-correlations between the cyclical components of the series and cointegration analysis, they found various relationships between oil prices and macroeconomic variables in short and long run. In long run, specifically, "the causality generally running from oil prices to the other variables". And, finally, Kireyev (2000), using the mean-group estimator in a PVAR approach, analyzed the effects of both internal and external shocks on macroeconomic movements in 18 Arab countries. In his study based on the data for last three decades of 20th century, Kireyev classified sample countries to various groups and compared the pattern of dynamic adjustments between these groups.

3. Data and Methodology

To investigate the sources of macroeconomic fluctuations in developing oil-exporting countries, we focused our analysis on twelve OPEC members and eight other developing non-OPEC oil producers. In an unbalanced panel framework, we used the data from 1985 to 2009. Our variables include logarithm of gross domestic product (GDP), money supply (M_2), consumer price index (CPI) and the yearly average of crude oil price (OILPRICE).

All the data gathered from World Development Indicators (WDI)'s online database but the CPI of United Arab Emirate which its values obtained from the webpage of UAE's central bank. Table 1 summarizes the statistical features of the pooled data. We have used these data to construct a VAR model based on panel data. Our analysis is based on impulse response functions (IRFs) to generalized shocks and forecasted error variance decompositions (FEVDs). IRFs of generalized shocks to the endogenous variables can be constructed to track the adjustment path of the response of each endogenous variable to a one-standard-deviation shock to another variable in the system. Moreover, the decomposition of variance evaluates the relative importance of each of the structural innovations in the fluctuations of the variables at different time horizons.

Table 1: Oil Exporting Countries: Summary Statistics, 1985-2009

	Mean	Maximum	Minimum	Std. Deviation	JB stat. ¹
CPI	69.78	228.03	4.41e-0.8	42.96	6.54
GDP	1.18 e+14	5.61 e+15	190.16	5.53 e+14	43650
Money Supply	5.12 e+13	2.14 e+15	1860280	2.31 e+14	28451
Oil Price	30.72	91.48	11.91	20.46	223.13

CPI (2005=100); GDP and Money Supply (M_2) in Current LCU; Oil Price in US \$

According to panel unit root tests, all variables are non-stationary in level and stationarity is obtainable by taking the first differences -i.e. variables are $I(1)$. Besides, as tests show, these $I(1)$ variables are not cointegrated². Some famous specialists like Sims (1980) and Doan (1992) noted that differencing a variable may throw information away while producing no valuable gain. Thus, following them and some recent empirical studies like Farzanegan & Markwardt (2009) and Iwayemi & Fowowe (2011), although variables in the level have unit roots, the level rather than the difference was preferred.

4. Empirical Results

This section presents the main empirical evidence on macroeconomic variables (oil price, output, real money supply and domestic price level) for our sample of oil exporting economies by discussing the relative importance of external (oil price) and internal (demand, money and price) shocks.

Price Index

Figure 1 depicts the accumulated responses of price index to generalized one S.D. innovation –described by Pesaran and Shin, 1998- of all variables up to ten periods. As Fig. 1 portrays, price level positively and significantly responds to price, monetary and output shocks. Price shocks have the dominant effects on price index movements. Moreover, innovations in aggregate demand and money supply lead to enduring increase in domestic prices which is consistent with Mehrara & Oskui (2001) for Iran, Indonesia and Saudi Arabia and is contrary to Dibooglu & Aleisa (2004) for Saudi Arabia, especially with regard to the effect of nominal shocks. These increases reach their maximum value in the third period and then, gradually decline in the long run.

The positive impact of demand shocks on price index, in addition to usual interpretations, is possibly dependent on the strong interaction between economic output, government expenditure and oil revenue in oil exporting countries. In other words, oil revenue jumps usually are followed by expansions in both fiscal and monetary policies which although increase GDP, lead to higher prices. This indirect effect of oil price on domestic prices in oil exporters is one of the special mechanisms of “resource curse” which oil exporting countries usually suffer from. Besides, in both short and long time horizons, monetary shocks dominate demand shocks in mitigating price level. According to variance decompositions³, monetary shocks in the first period explain 38 % of price fluctuations and after 10 years this share rises to more than 52 %; the fact makes monetary shocks the main cause of price changes. Moreover, both impulse responses and FEVDs, suggest that variations in aggregate demand affect price level less than monetary factors. So, one can conclude that in these countries, inflation has monetary roots. Considering the interaction between money supply and oil shocks, this finding emphasizes the importance of appropriate -monetary- policy responses to oil shocks.

1. Jarque-Bera Statistics for normality

2. The assumptions of stationarity and no cointegration are verified empirically and are available on request.

3. The FEVDs are not reported here but are available upon request.

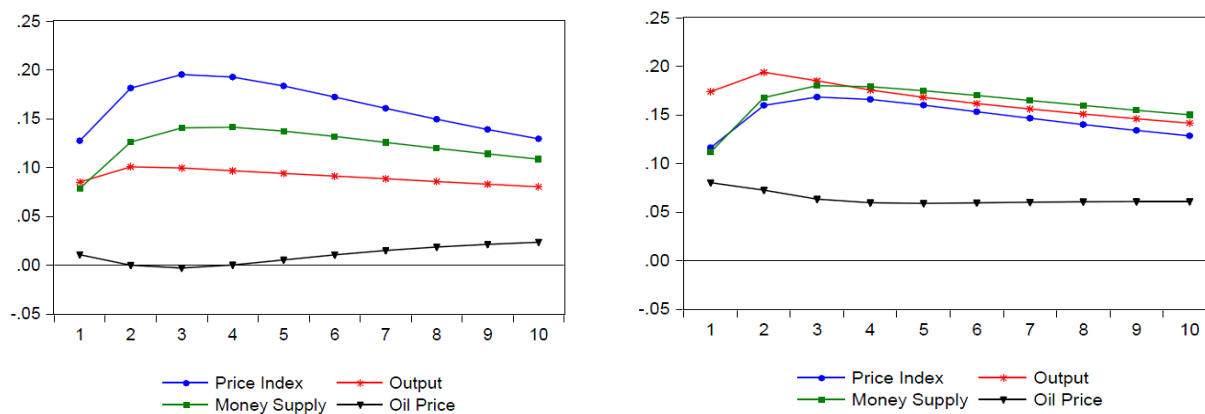


Fig. 2: Response of Economic Output

Finally, oil shocks have a very small and negligible impact on price level. This finding, contrary to Hooker (2002) and Jimenez-Rodriguez & Sanchez (2005) for some developed oil importing countries and Dibooglu & Aleisa (2004) for Saudi Arabia, confirms that oil price hikes are not necessarily inflationary. Eltony (2001), Olomola & Adejumo (2006) and Iwayemi & Fowowe (2011) have reported similar results for Kuwait and Nigeria, respectively. In some, we can conclude that in oil exporting countries, domestic – not external – shocks are responsible for price instability. This result suggests –if any– indirect relation between oil revenue and inflation.

Output

Fig. 2 depicts the adjustment dynamics of economic output in response to all four structural shocks. First of all, demand shocks, expectedly, increase aggregate demand. According to FEVDs, demand shocks explain 48% of output fluctuations in first year while this share decreases to nearly one fifth in long run. This result supports the New Keynesian approach to macroeconomic fluctuations who claims that, if we assume nominal rigidities, aggregate demand shocks could affect not only nominal variables but also real variables, such as output. Moreover, money interestingly is not neutral in oil exporting countries. FEDVs suggest that monetary shocks are significantly positive motivations to economic output such that in long run they are responsible for the majority of output fluctuations; more than 60 % after 5 years and more than 67 % after 10 years. This result is consistent with variance decompositions of Boye (2001) for Ecuador which approves the significant role of money supply in explaining future movements of GDP. As IRFs show, when a shock in aggregate demand or money supply occurs, in first three years, economic output increases with an accelerating rate. But after that, these effects approximately remain constant in the long run. These results about output and monetary shocks, again, highlights the role of government as the agent who widely affects aggregate demand and money base in oil-based economies and approves that in such countries keeping the real sector of economy far from volatile oil price fluctuations is very important.

Besides, oil shocks expectedly affect GDP positively. This result is consistent with our expectations and approves most other studies findings for oil exporting countries (e.g. Saptafora & Warner, 1995; as Dibooglu & Aleisa, 2004; Mehrara & Oskui, 2007; Farzanegan & Markwardt, 2009 and Berument et al., 2010). Oil price hike means more funds for government to initiate or fulfill unfinished developmental projects. Although in most cases this windfall is used ineffectively, we cannot reject this hypothesis that oil shocks facilitate economic activities in oil exporting countries. Of course, suggesting that proper policies lead to better results, the direct magnitude of effects of an oil shock on GDP - as an external shock - is less than the role of domestic shocks derived by behavior of economic agents, specifically government. Our results are in line with Brown and Yücel (1999) who found that internal shocks – in comparison with oil shocks - explain larger portion of the output fluctuation.

Of course, it should be noted that the degree of dependancy of oil exporting countries to oil revenue varies in different countries. In other words, various countries response differently to oil shocks (see Lescaoux & Mignon, 2008 and Berument et al., 2010). So, leaving any general conclusion about individual countries, one may conclude that oil exporting countries, on average, are deriving a benefit from oil price hikes. According to our FEVDs oil price in long run explains 11 % of future output movements. Although this modest effect does not rank oil revenue as the dominant determinant of output fluctuations in oil exporting countries, in comparison with developed countries, the magnitude of this effect is still large (for example, see Cologni & Manera, 2008 for G7).

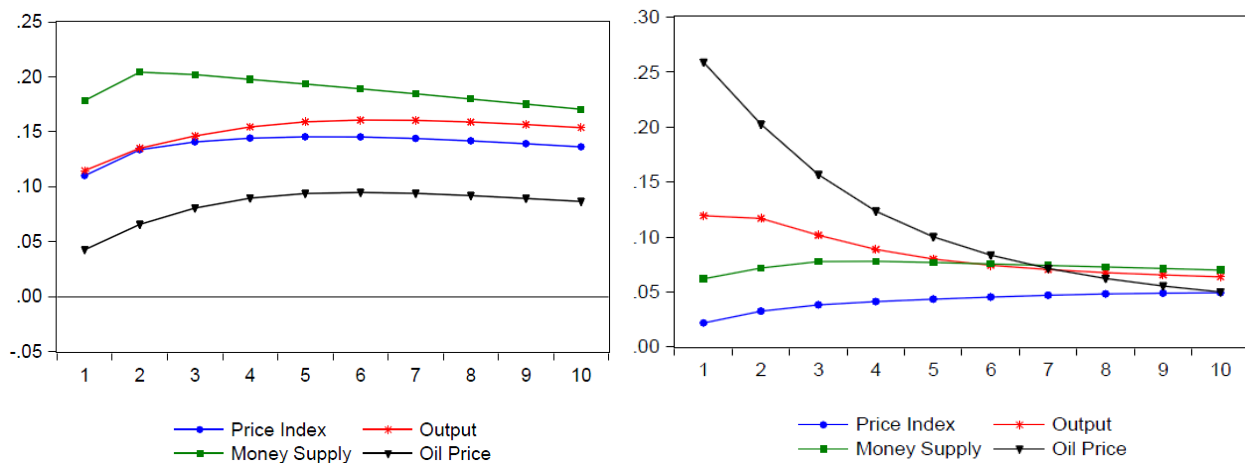
Money

Adjustment dynamics of Money supply in response to different shocks are portrayed in figure 3. As expected money shocks have the greatest impact on money base in all time horizons. When such a shock occurs, money supply increases in the first period and after reaching its maximum in the following year, smoothly decreases. Similarly, according to FEVDs, in long run, money shocks are responsible for nearly 78 percents of money supply fluctuations. This result highlights the role of monetary policy making process in that countries because these shocks not only have permanent effects on money movements, but actuate both output and price fluctuations. In some, one can conclude that monetary factors are the main cause of macroeconomic variations in oil exporting countries.

Moreover, in response to the output shocks, money supply continuously increases in both short and long run. This result in addition to previous findings about the impacts of money shocks on output suggests a bi-directional causal relationship between money and economic output in oil exporting countries. To compare the magnitude of this mutual causal relation, one can compare variance decomposition results. The FEVDs indicate that the causal relationship from money to output expectedly is more powerful than the opposite direction. This strong correlation between money supply and aggregate demand, possibly relates to the role of large government and its fiscal policy implications.

Oil shocks also increase money base. Considering FEVDs, in the short run oil shocks by explaining approximately 5.5 % of money fluctuations do not have a huge impact on money supply but their share steadily increase and in long run reaches to more than 18 percents. This result is another sign of dependency of these countries to oil revenue. In oil exporting countries, big government receives oil revenue and when oil price hikes, spends this additional fund through financing industrial projects or welfare-oriented public spendings. Of course, the modest impacts of oil shocks on monetary policy possibly relates to recent programs aimed in isolating the oil-based economies of oil exporting countries from oil variations.

If we focus on the long run, according to FEVDs, oil shocks explain nearly 11 % of output fluctuations, less than 1 % of price variations and more than 18 % of money supply movements. So, oil shocks’ impacts on money are greater than other macroeconomic variables. Considering significant effects of monetary shocks on price level and output, one may conclude that oil shocks through monetary channels transmit to oil exporting economies. This indirect relation highlights the importance of monetary policy – and consequently, the independency of central banks from government- in limiting oil shocks’ impacts on macroeconomy.



Oil Price

Fig. 4 represents the accumulated response of oil price to a shocks in all macroeconomic variables. The IRF graphs show that oil shocks more than any other variable affect oil price. Following oil shocks, output and, to a lesser degree, monetary shocks have small but significant impacts on oil price. This is in line with previous studies. Mehrara & oskoui (2007) as well as Dibooglu & Aleisa (2004) found that domestic macroeconomic variable in Saudi Arabia and to a lesser degree, in Kuwait have sizable impacts on world oil price. Moreover, Barsky & Kilian (2004) have suggested that macroeconomic variables may cause oil price movements.

The variance decompositions for real oil price suggest that approximately 90% of the forecast error variance of oil prices is explained by its own shocks. This result confirms our prior expectations that these economies are not big enough to largely affect world oil market. Of course, in long run the share of domestic shocks, in particular output and money increase while price shocks are of no importance in explaining oil price fluctuations. This considerable power of net oil exporters provides a reasonable explanation for the growing importance of international agreements between oil exporting countries like OPEC production shares.

5. Conclusion

This paper investigated the sources of macroeconomic fluctuations in oil exporting countries. So, in addition to price level, economic output and money supply, oil price shocks were studied. Despite the large body of literature on the effects of oil shocks on developed oil importers, this study focused on developing oil exporters in a group consisted of OPEC members and other big oil exporters. Our IRFs and FEVDs suggest that domestic policies – instead of oil booms- should be blamed for inflation. Among other studies shocks, money shocks, specifically in long run, are the most important one if we focus on price level. Besides, although oil shocks have significant positive impacts on economic output, money shocks are the main cause of GDP fluctuations. To explain money movements, money shocks and external oil shocks have greater shares.

Finally, oil price variations are driven mostly by oil shocks. However, domestic shocks are responsible for a reasonable portion of oil price variations. Considering these results, money supply driven by its own shocks and oil price changes, is the main cause of macroeconomic fluctuations in developing oil exporting countries. This finding that money is not neutral in these countries is of great policy implications. Besides, oil shocks have moderate direct impact on money supply and GDP, and no significant impact on price level. Considering recent studies like Devlin & Lewin (2004) and Iwayemi & Fowowe (2011), one can say that most oil producers are isolating real sectors of their economies from volatile oil price. But, since oil shocks are the second important cause of money supply as the most important cause of macroeconomic fluctuations, one can conclude that oil still has very important indirect impact on these economies and the monetary policy is the channel through which this indirect impact transmits. Finally, we have found that oil producers' coordination is an effective policy for stabilizing oil prices in the world market.

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