Journal of Economics and Public Finance
ISSN 2377-1038 (Print) ISSN 2377-1046 (Online)
Vol. 6, No. 4, 2020
www.scholink.org/ojs/index.php/jepf

Original Paper

Testing for Causality between Oil Prices and Money Supply in Saudi Arabia

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Received: November 1, 2020 Accepted: November 15, 2020 Online Published: November 20, 2020

doi:10.22158/jepf.v6n4p58 URL: http://dx.doi.org/10.22158/jepf.v6n4p58

The views expressed in this article are those of the authors and do not necessarily reflect the position of their institution or its policies. The authors conducted this research paper while they are at SAMA. Some authors may have left SAMA for another work opportunity.

Abstract

The impact of oil price shocks on a country's economy has been well studied in the economic literature. However, until now, articles analyzing the impact of these shocks on the Saudi Arabian economy have been relatively sparse. This paper attempts to shed some light on this important topic by examining the causal relationship between oil prices and an important monetary variable, the M3 (broad-based) money supply. Monthly data going back to 1982 were used in this study, which employs unit root tests and Granger causality analysis to test whether there is a causal relationship or not. No discernable causality relationship was found; this lack of such link leads the authors to conclude that this may be due to the prudent and stable fiscal and monetary policy on the part of the Kingdom's government and its central bank, the Saudi Arabian Monetary Authority (SAMA).

Keywords

Oil price, money supply, causality, Saudi Arabia

1. Introduction

Since the pioneer work of Hamilton (1983), there has been a growing and concentrated literature probing the link between oil price shocks and various macroeconomic indicators such as economic growth (e.g., Hamilton, 1996, 2003, 2008, 2009, 2010; Mork, 1986; Hooker, 1986; Barsky & Kilian, 2004; Kilian, 2008a, 2009; Al Rasasi & Yilmaz, 2016), inflation (e.g., Bachmeier & Cha, 2011; Barsky & Kilian, 2001; Kilian, 2008b), monetary policy (e.g., Bernanke et al., 1997; Hamilton & Herrera,

2004), fiscal policy (e.g., El Anshasy & Bradley, 2012), exchange rates (e.g., Amano & Norden, 1998, Chen, S. S. & Chen, H. C., 2007; Al Rasasi, 2018a, 2018b), stock markets (e.g., Kilian, 2009; Naser & Alali, 2018), terms of trade (e.g., Backus & Crucini, 2000), and labor market (e.g., Davis & Haltiwanger, 2001). However, despite the large share of existing literature assessing the impacts of oil price shocks on various economies across the globe, there is still much less research focusing on the Saudi Arabian economy. Indeed, the literature analyzing the consequences of oil price swings on the Saudi economy is very scarce, and it mainly evaluates the impact of oil price shocks on some of the key macroeconomic variables – e.g., economic growth, inflation, the exchange rate, and the stock market (Note 1).

This in turn indicates the need for further research analyzing how changes in global oil prices impact the Saudi economy through various channels. Thus, the main purpose of this research paper is to investigate whether changes in oil prices are able to predict changes in a key economic variable, the M3 money supply, in the case of Saudi Arabia.

Before proceeding with our investigation, it is important to understand how changes in oil prices can influence the money supply in oil exporting economies. Typically, oil-exporting countries enjoy elevated oil export revenues, with a majority of such revenues being deposited in the governments' banks accounts. For instance, in the case of Saudi Arabia, oil revenues represented an average of 80.03 percent of total government revenues over the 2010-17 period; although, the recent decline in oil prices starting in mid-2014 resulted in lower oil revenues as shown in Table 1 and Figure 1. However, the real economic impact of these deposits (which are increases in the central bank's liabilities) on the domestic economy depends on whether or not these deposits are spent by the central government and how the government spends them – on domestic goods and services, or on imports. Thus, the fiscal stimulus of this spending determines the impact on both nominal and real economic growth, which in turn affects the money supply.

Table 1. Changes in Money Supply, Oil Prices and Oil Revenues

	Percent change in oil price	Percent change in oil Revenues	Percent change in Money Supply
2010	29.1%	54.3%	5.0%
2011	39.9%	54.3%	13.3%
2012	0.2%	10.7%	13.9%
2013	-2.7%	-9.6%	10.9%
2014	-8.8%	-11.8%	11.9%
2015	-47.1%	-51.1%	2.5%
2016	-16.5%	-25.3%	0.8%
2017	23.8%	30.6%	0.2%

Source: SAMA Annual Statistics 2017.

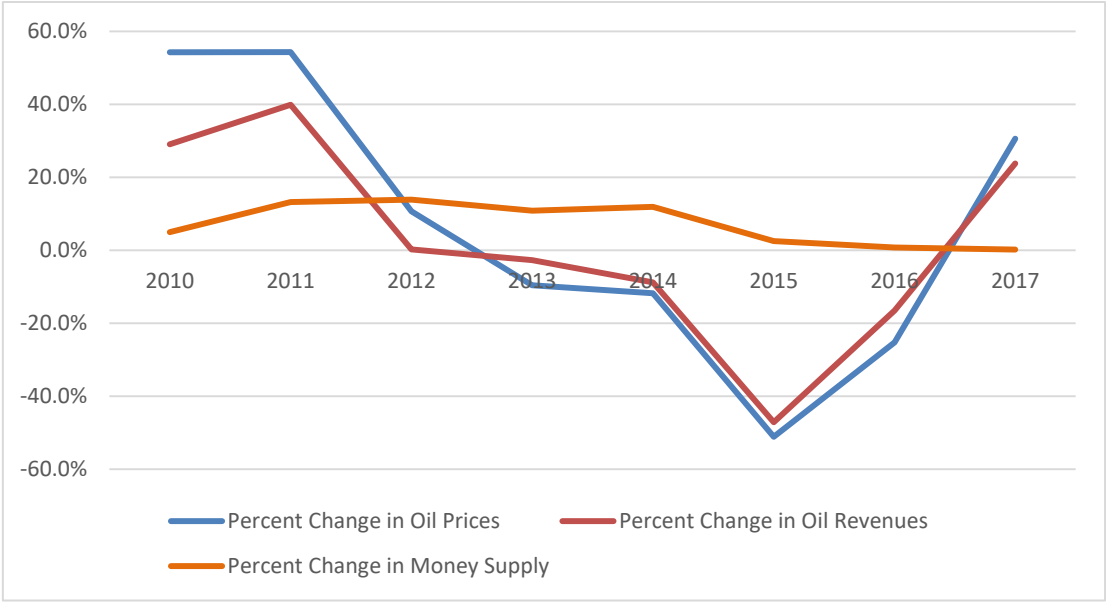

Figure 1. Changes in Oil Revenues, Oil Prices and Money Supply

If the government does not spend the increased oil receipts resulting from higher oil prices, then the government balances with the central bank would increase, and the impact of the higher oil export revenues would not immediately influence the liquidity in the country's financial system. If the central bank (the Saudi Arabian Monetary Authority, SAMA) was to recycle the proceeds by purchasing domestic debt instruments (open market operations), then the money supply would be expected to grow. In the case of Saudi Arabia, this money creation could take place via the central bank's purchase or sale of repurchase agreements and not necessarily though the purchase of government debt, at least at the present time.

However, this process of high-powered monetary base creation does not automatically take place. It depends on what the central bank (in the case of Saudi Arabia, SAMA) does with the government deposit. If the central bank choses to "sterilize" the deposit for instance by moving it offshore (e.g., by the purchase of foreign securities or by deposit in a foreign bank), then the liquidity of the Saudi financial system would be unaffected.

Against this background, this paper attempts to enrich the prevailing literature on the Saudi economy by assessing whether oil price volatility causes changes in the M3 money supply. In addition, this paper relies on the method introduced by Qualls et al. (2017) to convert money supply data from the Hijra calendar to the Gregorian calendar – an important addition to the pre-1988 monetary data available to SAMA for analytical purposes (Note 2).

2. Data

The data utilized in the analysis of the causal link between money supply and oil prices in Saudi Arabia are based on monthly frequencies spanning from January 1982 to April 2018. The data for the money

supply, measured by M3 (the broad measure of money supply), and the oil price, measured by the Arab Light price for crude oil, are extracted from SAMA databases (Note 3). It is also important to emphasize that we have converted the money supply data prior to June 1988 from a Hijra calendar basis to that of the Gregorian calendar based on the methodology employed by Qualls et al. (2017). Furthermore, it is vital to note that all variables are expressed in natural logarithms.

3. Empirical Analysis

3.1 Unit Root Tests

Testing economic time series for unit roots is a requirement to ensure the stationarity of these economic variables and to avoid spurious results. To do so, the common unit root tests were conducted; namely, the Augmented Dickey- Fuller (1984) and Phillips-Perron (1988). The null hypothesis of both tests is the presence of a unit root against the alternative hypothesis stating the stationarity of the data. The results of both tests are summarized in Table 2 and confirm the non-stationarity of the employed data; in other words, the variables used in the analysis are integrated of order one, I (1).

Table 2. Augmented Dickey–Fuller (1984) and Phillip Perron (1988) Unit Root Tests

	ADF Test						PP Test			
	Level Data			First Difference			Level Data		First Difference	
	None	Trend	Drift	None	Trend	Drift	Constant	Trend	Constant	Trend
Oil	0.02	-3.00	-1.68	-12.45	-12.44	-12.44	-1.48	-2.88	-15.02	-15.01
M3	8.36	-1.07	0.86	-11.34	-14.28	-14.21	0.72	-1.04	-20.00	-20.02

Note. The ADF 5% critical values are for None= -1.95, Trend= -3.43, and Drift= -2.88. The PP 5% critical values for constant= -2.87 and Trend= -3.43.

3.2 Granger Causality Analysis

To assess whether changes in oil prices cause changes in the M3 money supply in Saudi Arabia, the most popular causality test, which was developed by Granger (1969) was implemented. The basic intuition behind this test is that the past changes in values of one of the bivariate variables, in this case the price of oil, in predicting the current changes of the other variable, the money supply.

Put simply, the vector autoregressive (VAR) framework is the suitable model regressing a certain variable to its own past values and the past values of other variables. Therefore, to evaluate if changes in oil prices are able to predict the movement of money supply, we estimate the following bivariate model:

$$\Delta Oil_t = \delta_0 + \sum_{i=1}^{s} \delta_{1i}\, \Delta Oil_{t-i} + \sum_{i=1}^{s} \delta_{2i}\, \Delta M_{t-i} + \epsilon_{1t} \quad (1)$$

$$\Delta M_t = \varphi_0 + \sum_{i=1}^{s} \varphi_{1i}\, \Delta Oil_{t-i} + \sum_{i=1}^{s} \varphi_{2i}\, \Delta M_{t-i} + \epsilon_{2t} \quad (2)$$

where ΔOil_t and ΔM_t represent the changes in oil prices and money supply respectively at time t,

while $\epsilon_{1t}$and ϵ_{2t} are the error terms in both equations. The coefficients needed to be estimated are δ_{1i} and φ_{1i} where $i = 1, \ldots, s$, in which s is the lag length to be determined based on the Akaike information criterion (AIC) for the VAR model.

Once we estimated the VAR model with difference data, we would be able to test whether changes in the oil price cause changes in money supply. If we found evidence suggesting that variations in the money supply would be captured by past variations in oil prices, then we would have a unidirectional causality running from oil prices to money supply. The null hypothesis needs to be tested stating that changes in oil prices do not "granger cause" changes in the money supply; in other words, we need to test $\delta_{1i} = \delta_{2i} = 0$.

Table 3 presents the Granger causality results revealing the absence of not only the bidirectional causality running from changes in oil prices to changes in money supply, but also the unidirectional causality running from both variables to each other. As can be seen, there is no statistically discernable causal relationship between the oil price and the Saudi M3 money supply.

Table 3. Granger Causality Test

Null Hypothesis	F-statistics	P-value	Decision
$\Delta Oil \nrightarrow \Delta Money$	1.1072	0.3505	Fail to reject the null Hypothesis
$\Delta Money \nrightarrow \Delta Oil$	1.2656	0.2340	Fail to reject the null Hypothesis

The lack of a causal relationship between the oil price and the M3 money supply could be due to several factors. First of all, if the oil revenues are not spent immediately, the transmission mechanism of domestic government spending would be absent. It is important to note that the impact on liquidity can be neutralized by appropriate liquidity measures on the part of SAMA (e.g., the liquidity injection operations). In other words, a combination of fiscal policy on the part of the government and appropriate liquidity measures on the part of SAMA can also effectively decouple oil prices and the M3 money supply (Note 4).

Thus, the lack of a discernable causal relationship between oil prices and the broad money supply may be evidence of the success of prudent and stable fiscal and monetary policy on the part of the Kingdom's government and its central bank. Indeed, the success of such macroeconomic policies has led to maintaining the stability of its exchange rate participating in stabilizing price levels during the previous decade as well as having a financial sector that is resilient to external shocks such as those stemming from the oil market.

4. Conclusion

The main objective of this research paper is to evaluate whether changes in oil prices can result in money supply volatility in an oil-exporting economy such as Saudi Arabia. To do so, we utilize

monthly observations for the broad money supply (M3) and the Arab Light crude oil price from January 1982 to April 2018. It is important to note that this paper has utilized revised money supply data prior to June 1988, which corrects the distortions resulting from the old Hijra data by adopting the approach of Qualls et al. (2017), in order to convert the data from a Hijra calendar basis to that of the Gregorian calendar basis. By doing this, our analysis should be more accurate and robust. Once the issue of data calendar compatibility has been dealt with, we are able to apply the most popular causality test known as Granger's (1986) causality test, using a VAR framework. The empirical results reveal the absence of causality between the two variables. The lack of causality running between these variables can be attributed to several reasons, as discussed in the previous section. Nonetheless, some credit should be given to the prudent and stable fiscal and monetary policy on the part of the Kingdom's government and its central bank.

The empirical findings of this research paper open the door for future research that could explore the application of new econometric techniques such as non-linear causality tests or non-linear cointegration tests. In the same vein, it provides an opportunity to investigate whether the financial sector is resilient to oil price shocks or not; for instance, this could be reached by assessing the impact of oil shocks on financial markets or banking system profitability in Saudi Arabia.

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Notes

Note 1. Some studies evaluate the response of key macroeconomic variables to oil price volatility include Mehrara and Oskoui (2007), Mehrara (2008, 2009), Alkhathlan (2013), Arouri et al. (2011), Al Rasasi and Banafea (2015), Al Rasasi et al. (2017, 2019), and Al Rasasi (2017).

Note 2. Previous studies using pre-1988 Saudi monetary data can be called to question, due to the severe distortion caused by using the published Hijra data. For monthly data prior to 1988, data are based on the Hijra fiscal calendar, consisting of 12 Hijra months and 354-355 day year, whereas the Gregorian calendar uses a 365-366 day year. For more information, see Qualls et al (2017).

Note 3. The Arab Light oil price is the transaction price for the largest volume of a single grade of oil actually sold in the world oil market. It is based on all of the major benchmark oils used around the world, including WTI and the Argus Sour Crude Index (US), Brent (Northern Europe and the Mediterranean), and the Oman/Dubai average price (Asia and the Pacific), using a formula based on price differentials that are posted monthly by Saudi Aramco. It is the price that best tracks the average oil export price for Saudi Arabia. For more information on Aramco's price formula, see: https://www.eia.gov/todayinenergy/detail.php?id=17471

Note 4. In fact, this took place during the 2015-2016 decline in oil prices, when SAMA stepped in with appropriate liquidity measures to ensure that the Saudi financial system was sufficiently funded.