Energy Economics 45 (2014) 268–279

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

# Oil price shocks in a data-rich environment☆

Knut Are Aastveit

*Norges Bank, University of Oslo, Norway*

ARTICLE INFO

*Article history:*
Received 16 May 2013
Received in revised form 24 April 2014
Accepted 13 July 2014
Available online 7 August 2014

*JEL classification:*
C3
E31
E32
E4
E5
Q43

*Keywords:*
Oil demand shocks
Oil supply shocks
Business cycle
Monetary policy
Factor model
FAVAR

ABSTRACT

This paper examines the impact of different types of oil price shocks on the U.S. economy, using a factor-augmented VAR (FAVAR) approach. The results indicate that when examining the effects of oil price shocks, it is important to account for the interaction between the oil market and the macroeconomy. I find that oil demand shocks are more important than oil supply shocks in driving several macroeconomic variables, and that the origin of demand shocks matters. Specifically, the U.S. economy and monetary policy respond differently to global demand shocks that have the effect of raising the price of oil and to oil-specific demand shocks.



## 1. Introduction

Since the large oil price shocks in the 1970s, changes in the price of oil have been widely seen as an important source of macroeconomic fluctuations. Hamilton (1983) showed that all U.S. recessions except one since World War II were preceded by a spike in oil prices. Subsequent to Hamilton's work, a large body of research has suggested that oil price variations have strong and negative effects on both the U.S. economy and those of other oil importing countries (see, e.g., Burbidge and Harrison (1984), Mork et al. (1994), Bjørnland (2000), Jiménez-Rodriguez and Sanchez (2005) and Hamilton (1996, 2003, 2009), among many others).

The most common approach in studies of oil price shocks is to evaluate responses of macroeconomic variables to exogenous changes in the price of oil (see Hamilton (1996, 2003)). An implicit assumption of such studies is that oil price innovations result from oil supply shocks.[1] More recently, this view has been challenged by Barsky and Kilian (2002, 2004) and Kilian (2009). Fluctuations in the price of oil, like those of any other price, are driven by both demand shocks and supply shocks.

Kilian (2009) proposes a structural vectorautoregressive (SVAR) model of the global crude oil market and its interaction with global real economic activity. Assuming a recursive structure, he identifies three different kinds of shocks to the global crude oil market: a crude oil supply shock, a global demand shock and a global demand shock specific to the crude oil market.[2] His results suggest that the

☆ I have received helpful comments from Anindya Banerjee, Michael Bergman, Hilde C. Bjørnland, Fabio Canova, Vasco Carvalho, Jordi Gali, Anne Sofie Jore, Lutz Kilian, Kristoffer Nimark, Ragnar Nymoen, Gonçalo Pina, Francesco Ravazzolo, Terje Skjerpen, Thijs Van Rens and Ine Van Robays as well as conference participants at The 14th Spring Meeting of Young Economists in Istanbul, The 5th NHH-UiO Workshop on Economic Dynamics in Bergen, The 5th Conference on Growth and Business Cycles in Theory and Practice in Manchester, The 5th Dynare Conference in Oslo, The 25th Annual Congress of the European Economic Association in Glasgow and seminar participants at BI Norwegian School of Management, Federal Reserve Bank of New York, University of Oslo and Universitat Pompeu Fabra. The views expressed in this paper are those of the author and should not be attributed to Norges Bank.

*E-mail address:* Knut-Are.Aastveit@norges-bank.no.

[1] The effect of oil supply shocks has been studied extensively in the literature. Recent research by Kilian (2008a,b) documents that oil supply shocks (measured in terms of disruption to global crude oil production) alone cannot explain the bulk of oil price fluctuations. His results also suggest that this type of shock does not have a substantial effect on real economic growth in any of the G7 countries.

[2] Baumeister and Peersman (2013b) and Peersman and Van Robays (2009, 2012) suggest an alternative identification approach in which the different kinds of oil price shocks are identified by applying sign restrictions on the implied impulse responses of the different variables.

http://dx.doi.org/10.1016/j.eneco.2014.07.006
0140-9883/

implications of higher oil prices for U.S. real GDP and CPI inflation depend on the cause of the oil price increase. However, his model does not account for feedback from the U.S. macro economy to the global oil market.

As first argued by Sims (1980), it is crucial, when studying the response of macroeconomic variables to various structural shocks, to jointly model the interactions among endogenous variables. The different oil price shocks are not the only relevant sources of macroeconomic fluctuations. Hence, if the main focus of the study is how macroeconomic variables are affected by different types of oil price shocks, one should control for other macroeconomic variables. This becomes especially important when studying the response of monetary policy, as monetary policy does not react to oil price movements per se, but to how the macro economy responds to different oil price shocks. If other shocks that are important to macroeconomic fluctuations are ignored, the identified monetary policy response to the different oil price shocks is likely to be contaminated.

In this paper, I study the impact of different types of oil price shocks on the U.S. macro economy and monetary policy. I jointly model the interaction between the oil market, the U.S. macro economy and monetary policy, by extending the factor-augmented VAR (FAVAR) model in Bernanke et al. (2005) to explicitly include measures of global oil production, an index of global real activity and the real price of oil.[3] The advantages of using a FAVAR model are two-fold. First, it incorporates the large information set typically monitored by policy makers. As argued by Sims (1992), this ensures a proper identification of the monetary policy response. Second, impulse responses of a wide range of U.S. macroeconomic variables, following different types of oil price shocks, can be analyzed. This ensures a broad understanding of the potentially heterogenous effects of different types of oil price shocks.[4] I apply the model to a large dataset of 116 monthly U.S. macroeconomic variables, over the sample period 1974M1–2008M6.

To the best of my knowledge, this is the first paper to examine the effects of different types of oil price shocks on a wide range of U.S. macroeconomic variables. While Lippi and Nobili (2012) and Peersman and Van Robays (2009, 2012) also study the impact of different types of oil price shocks on the U.S. economy, they study the responses of only a few macroeconomic variables. By contrast, I study the impact of oil supply and oil demand shocks on a broad range of U.S. macroeconomic variables, including disaggregated measures of industrial production and prices, a wide selection of labor market variables and financial variables. Such an approach yields a broad understanding of how different types of oil price shocks affect the U.S. macroeconomy.

Furthermore, oil price movements have historically posed a difficult challenge for policy makers seeking to balance the trade-off between higher inflation and higher unemployment. Bernanke et al. (1997, 2004) suggest that monetary policy makers have historically leaned towards keeping inflation low at the cost of greater slowdowns in economic activity. That is, the systematic component of monetary policy accounts for a large portion of the decline in GDP growth following an oil price shock. This view was challenged by Hamilton and Herrera (2004) and Bachmeier (2008), and more recently by Kilian and Lewis (2011).[5] Only the latter paper takes into account the endogeneity of the real price of oil and allows policy responses to depend on the underlying cause of an oil price shock. They find no evidence that endogenous monetary policy responses have caused large aggregate fluctuations in the U.S. economy.

I find considerable differences in the responses of both nominal and real variables to the different types of oil price shocks, robust to numerous checks. First, I show that positive oil-specific demand shocks strongly increase the real price of oil and various price measures, and have a broad negative effect on the labor market and the production side of the economy. These findings are consistent with the negative effect on GDP and the positive effect on CPI inflation, reported in Peersman and Van Robays (2009, 2012) and Lippi and Nobili (2012). My results indicate that oil-specific demand shocks yield the well-known trade-off between higher unemployment and higher inflation, often associated with negative supply shocks. Hence, oil-specific demand shocks have an effect on the macroeconomy similar to that of an aggregate supply shock. Kilian and Lewis (2011) and Peersman and Van Robays (2009, 2012) find strong but conflicting monetary policy responses to oil-specific demand shocks. While Kilian and Lewis (2011) find that such a shock causes a significant monetary tightening, Peersman and Van Robays (2009, 2012) find the opposite, namely, a significant monetary loosening following a positive oil-specific demand shock. When controlling for a large set of macroeconomic variables, I show that the federal funds rate remains almost unchanged after an oil-specific demand shock, which indicates that the Federal Reserve (Fed) has not systematically responded to oil-specific demand shocks.

Second, I find that positive global demand shocks have a large and persistent positive effect both on the real price of oil and on various price measures. I find empirically that this causes a monetary tightening in the short run, in line with the findings of Kilian and Lewis (2011) and Peersman and Van Robays (2009). The effect on the U.S. labor market and on the production side of the economy is almost negligible during the first year, but becomes significantly negative after approximately two years. In other words, shocks to global aggregate demand that increase the real price of oil also negatively affect the U.S. economy. However, in contrast to an oil-specific demand shock or an oil supply shock, the negative effect on the real economy is delayed.

Third, the estimated effect of a negative oil supply shock on the U.S. economy is rather small. While such a shock increases the price of oil in the short run, I find only a weak negative effect on the real economy and that prices are almost unaffected. This is in line with responses for GDP and CPI inflation in Kilian (2009), but contrasts with the findings of a significant negative impact on the real economy in Lippi and Nobili (2012) and Peersman and Van Robays (2009, 2012). Consequently, I also find that an oil supply shock has a negligible effect on the federal funds rate, while Peersman and Van Robays (2009, 2012) find indications of a monetary tightening. A possible reason for the conflicting findings may be that Peersman and Van Robays (2009, 2012) identifies the different types of oil price shocks by applying sign restrictions, while I follow Kilian (2009) and Kilian and Lewis (2011) in using a recursive identification scheme. The former approach has been criticized by Kilian and Murphy (2012), who show that imposing sign restrictions alone, as opposed to applying a recursive identification scheme, is not sufficient to resolve the question of the relative importance of different types of oil price shocks.

To illustrate the implications of the FAVAR model, I compare impulse responses in the preferred FAVAR model to impulse responses in a three-variable SVAR model (similar to Kilian (2009)) and a six-variable SVAR model. The latter model includes industrial production, the consumer price index and the federal funds rate, in addition to the variables related to the oil market (see Kilian (2009)). The comparison shows considerable differences in the responses of macroeconomic variables between the three-variable SVAR model and the FAVAR model. Such differences show that it is important to account for interactions between the oil market, the U.S. macro economy and monetary policy. The differences between the six-variable SVAR model and the FAVAR model are smaller.

[3] The FAVAR model was first introduced by Bernanke et al. (2005) to study the transmission of monetary policy shocks. Other and more recent applications include, e.g., Eickmeier et al. (2011) and Eickmeier and Hofmann (2013) studying financial shocks, Mumtaz and Surico (2009) and Aastveit et al. (forthcoming) studying international shocks and Lombardi et al. (2012) studying the linkages across non-energy commodity price developments.

[4] Few papers have examined the impact of oil price shocks on a broad selection of U.S. macroeconomic variables. One exception is Lee and Ni (2002), who studied the effects of exogenous oil price shocks, using U.S. industry level data.

[5] Kilian and Vigfusson (2011) also argue that the impulse response estimates obtained by Bernanke et al. (1997) are inconsistent because their model includes censored changes in the nominal oil price, which implies that the underlying structural model cannot be represented as a VAR.