Finance Research Letters 26 (2018) 150–155

Contents lists available at ScienceDirect

Finance Research Letters

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

Do all oil price shocks have the same impact? Evidence from the euro area

Anastasios Evgenidis

Newcastle University Business School, 102 Middlesex St, London E1 7EZ, United Kingdom

ARTICLE INFO

Keywords:
Oil price
Transmission mechanism
Macroeconomy
Bayesian threshold-VAR

JEL classification:
C30
E31
Q43

ABSTRACT

Oil price shocks have become one of the main sources of macroeconomic fluctuations such as economic activity and inflation. This paper investigates the asymmetric effects of oil price shocks in the euro area by using a threshold VAR model estimated by Bayesian techniques. This approach captures the dependence of the transmission mechanism of oil price shocks on a) the sign of the shock and b) different states of the economy. The results suggest that oil price shocks have a stronger effect on output during periods of heightened uncertainty compared with periods of lowered uncertainty. This is partly due to the fact that, particularly during stressed periods, stock market reacts negatively following a positive oil price shock. In addition, positive and negative, large and small oil price shocks affect inflation differently. The findings suggest that policymakers should take into account the asymmetric nature of the oil price transmission mechanism when they are choosing how to respond to oil price shocks.

1. Introduction

Oil price shocks have become one of the main sources of macroeconomic fluctuations such as economic activity and inflation (Hamilton, 1996, 2003, 2008). However, linear models have not been able to deal with the potential asymmetric relationship between the effects of oil price fluctuations and business cycle phases (Hamilton, 2011). Moreover, as Hamilton (1996, 2008) points out, while oil prices increases have preceded ten out of the past eleven recessions in the US, falling oil prices did not necessarily result in periods of high economic growth. This dependence of the transmission mechanism of oil price shocks on the sign of the shock and the states of economy, motivates our analysis.

This paper innovates and contributes in filling some existing gaps in the literature in the following directions. First, I study the effects of oil price shocks in the euro area economy during high uncertainty and low uncertainty periods. In contrast to previous studies, I use a threshold vector autoregression (TVAR) model to capture the asymmetric effects of the oil price transmission over different states of the economy. Second, standard VAR models estimated by the frequentist approach can only handle a small number of variables. This paper overcomes the curse of dimensionality by proposing a medium scale Bayesian TVAR framework. This approach allows us to handle a larger information set by shrinking the parameters via the imposition of priors; thus, better reflecting the information dataset of central banks and the private sector. Therefore, the analysis provides a rich picture on the transmission of oil price shocks in various dimensions of the euro area economy. Third, within this context, I extend the analysis by evaluating potential correlations between the sign (and the size) of an oil price shock and economic cycles asymmetries. This potential asymmetry in the euro area is motivated by the fact that negative oil price shocks experienced since mid-2014 for example, may have had a greater role in pushing down inflation, than the positive shocks experienced during the crisis had in keeping it up.

In light of the above discussion, this paper seeks to deal with several questions emerge. Specifically, do oil price shocks impact the

E-mail address: anastasios.evgenidis@newcastle.ac.uk.

https://doi.org/10.1016/j.frl.2017.12.013
Received 30 August 2017; Received in revised form 7 December 2017; Accepted 16 December 2017
Available online 18 December 2017

economy differently during high uncertainty periods, such as the financial and sovereign debt crisis, compared to more tranquil times? Further, do positive oil price shocks, impact inflation differently compared to the negative ones? Finally, do large shocks, like those experienced since mid-2014, have a different effect compared to smaller ones?

The remainder of this paper is organized as follows. Section 2 discusses the literature that motivates the asymmetry in the transmission of oil price shocks. Section 3 provides the empirical setup. Section 4 discusses the results and Section 5 concludes.

2. Literature review

This section reviews the theoretical and empirical studies that motivate the asymmetric impact of oil price shocks on the economy. The effects of oil price innovations might be different in high and low uncertainty periods, much in the same way that monetary policy shocks have asymmetric effects in different states of the business cycle (Lo and Piger, 2005). In particular, the asymmetric transmission of oil price shocks in different states of the economy stem from the irreversibility of investment under the theoretical models developed by Bernanke (1983) and Pindyck (1991). The authors develop a model in which positive oil price shocks generate uncertainty in individuals and businesses. As a result, the former postpone their purchases of goods, while the latter are cautious about hiring and investing since it is expensive to reverse these decisions. As a result, firms postpone investment until the business climate becomes more certain. Therefore, for an oil importing economy, a highly uncertain environment amplifies the recessionary effects of an oil price increase. Recent empirical evidence for this type of asymmetry is provided by Van Robays (2016), who finds that the impact of oil shocks differs in times of high and low macroeconomic uncertainty.

Another type of asymmetry is based on the fact that the economy may respond differently to positive and negative oil price shocks. The theoretical studies of Davies (1987) and Davies and Haltiwanger (2001), for example, suggest that a change in oil price in oil importing countries causes sectoral shifts through the economy. Thus, an oil price rise leads to a reallocation of capital and labor away from the energy intensive sector. Since this takes time, unemployment rises, resulting in cutbacks in real output which amplifies the economic slowdown. In case of an oil price decline, the positive effect on economic activity is reduced by similar adjustment costs, dampening the economic expansion. More recently, Edelstein and Kilian (2007, 2009) suggest another theoretical model, according to which, this type of asymmetry arises because of precautionary savings. A positive oil price shock increases uncertainty regarding future economic conditions, thereby increasing precautionary savings. As a negative oil price shock for an oil importing economy is associated with lower uncertainty, positive and negative oil price shocks may have different effects on economic activity. The evidence from the empirical literature is mixed. Rodríguez and Sánchez (2006) and Herrera et al. (2011) find strong evidence of asymmetric effects on real GDP and inflation for G-7 countries, Norway and the euro area while, Kilian and Vigfusson (2011) and Herrera et al. (2015) suggest that there is no strong support for theoretical models with built-in asymmetries.

3. Data and model set-up

3.1. Model set-up

I examine the oil price transmission between different states of the economy by using a medium scale threshold VAR model of the following form:

$$
\begin{aligned}
&Y_t = A_1 Y_t + B_1(L)Y_{t-1} + \varepsilon_t, \quad var(\varepsilon_t) = \Sigma_1 \ \text{ if } \ T_t \le Y^* \\
&Y_t = A_2 Y_t + B_2(L)Y_{t-1} + \varepsilon_t, \quad var(\varepsilon_t) = \Sigma_2 \ \text{ if } \ T_t > Y^*
\end{aligned} \tag{1}
$$

where Y_t is the matrix of n endogenous variables, $T_t = Y_{t-d}$ is the threshold variable, d is the time lag which is assumed to be known and set equal to two, and Y^* is the threshold level. $B_1(L)$ and $B_2(L)$ are lag polynomial matrices and A_1Y_t, A_2Y_t represent the contemporaneous terms.

TVAR models have been recently used by the literature (Van Robays, 2016; Donayre and Wilmot, 2016) to examine the asymmetric impact of oil price shocks. The distinguishing feature of this approach is that it allows us to endogenously identify different regimes with respect to one endogenous transition variable. In this paper, I choose an index which measures the degree of uncertainty in equity markets and therefore, it separates the economy between high and low uncertainty periods. The two different states are determined by the value of this threshold variable with respect to a certain threshold which is estimated within the model.

The small size of the VARs typically used in these empirical applications potentially creates an omitted variable bias with adverse consequences for structural analysis (Banbura et al., 2010). In addition, the size limitation is problematic for applications which require the study of a larger set of variables than the core macroeconomic indicators.

This paper overcomes the curse of dimensionality by proposing a TVAR framework estimated by Bayesian techniques. According to Banbura et al. (2010), by applying Bayesian shrinkage one is able to handle a larger set of information than a handful of variables. The choice of this framework jointly addresses two issues. First, it provides a rich picture on the transmission of oil price shocks on a wide range of variables. Second, in contrast with most of the recent literature (Kilian, 2009; Peersman and Van Robays, 2009), I do not disentangle oil demand shocks from oil supply shocks as the focus of this study is to examine the effect of exogenous oil supply fluctuations (following other similar studies such as Fratzscher et al., 2014) on the euro area. As I control for several macroeconomic and financial variables, it is more likely to filter out the endogenous part in the oil price shock of the proposed model, and thereby capture exogenous oil supply shocks.

3.2. Data description

The following variables are included in the vector of endogenous variables: industrial production (IP), HICP, 3-month interbank rate, crude oil price, producer price index, economic sentiment, Euro stoxx 50, nominal effective exchange rate, yield spread and the eur/usd exchange rate. Last, I choose Vstoxx as my threshold variable. This index measures the degree of uncertainty in equity markets and therefore it allows me to identify high and low stressed or uncertainty periods (in line with similar studies that have used Vstoxx to identify different stress periods, for example, Bonciani and Van Roye, 2015).[1]

Data are monthly from 2000:01 to 2016:12. All series are in log levels except for the variables that are already expressed in percentages for which no transformation is implemented. The oil price shock is identified through a standard Cholesky decomposition by assuming a conventional ordering of the variables (Rodríguez and Sánchez, 2006). In particular, IP is ordered first, followed by oil prices, inflation and interest rate. This ordering assumes that real output does not react contemporaneously on shocks to the rest of the variables; oil prices have an immediate impact on inflation rate, which is then allowed to feed into changes in interest rates; financial variables such as exchange rates and stock market indices are ordered last.

3.3. Estimation

Following Blake and Mumtaz (2012), I use a Gibbs algorithm to estimate the parameters A_i, B_i, Y^*. The threshold value Y^* is estimated by a Metropolis Hastings random walk algorithm within the Gibbs algorithm. I set a natural conjugate prior for the VAR parameters using dummy observations. For a detailed explanation of this prior implementation, see Banbura et al. (2010).

3.3.1. Posterior distributions

The conditional posterior distribution of $b_i = \{A_i, B_i\}$ in each regime $i = 1, 2$ is given by:

$$H(b_i \setminus \Sigma_i, Y_t, \ Y^*) \sim N\left[vec(B_i^*), \ \Sigma_i \otimes \left(X_i^{*'} X_i^*\right)^{-1}\right] \tag{2}$$

where:

$$X_i = [X_{i,t-1,\dots,}X_{i,t-p}]$$

The conditional posterior distribution of Σ_i is given by the inverse Wishart distribution:

$$H(\Sigma_i \setminus b_i, Y_t, \ Y^*) \sim IW(S_i^*, \ T_i^*) \tag{3}$$

where:

$B_i^* = \left(\left(X_i^{*'} X_i^*\right)^{-1} X_i^{*'} y_i^*\right)$, $S_i^* = (y_i^* - X_i^{**} b_i)'(y_i^* - X_i^{**} b_i)$, T_i^* denotes the number of rows in Y^*, while, y_i^*, X_i^* contain the data series Y_{it}, X_i, augmented with the dummy observations that define the prior of the VAR system.

I estimate generalized impulse responses (Koop et al., 1996), to examine the impact of oil price shocks on the macroeconomy. Standard impulse responses are constant over time and they are symmetric not only in the sign, but also in the magnitude of the structural shocks. On the contrary, generalized impulse responses by construction allow us to examine the effects of the shocks of different magnitudes and directions.

4. Results

4.1. Do oil price shocks matter more in periods of high financial uncertainty?

In this part, I aim to describe the impact of oil prices shocks to the whole economy. I focus my discussion on the variables that are shown to be mostly affected by a shock in oil prices. Accordingly, Figs. 1 and 2 present the effect of oil price shocks on industrial production, HICP, interest rates, the stock market and economic sentiment, in high and low stress periods.

Fig. 1 shows that, in a tranquil period, a 3% increase in oil price leads to an immediate increase of 0.06% in HICP, as it would be expected. Interest rates rise gradually to counteract the rise in inflation; after 10 months the increase is approximately 3 basis points. Despite remaining flat initially, output declines since the cost of production is higher. By the end of the forecasting horizon, output has fallen by 0.1%. Finally, financial markets re-evaluate the earnings prospects of firms, and the stock market begins to decline. Similarly, economic sentiment also declines.

Fig. 2 shows that, although the immediate increase in HICP is slightly lower compared with the tranquil period, the subsequent increase is stronger, reaching approximately 0.07% after 10 months. Interest rates also react more strongly immediately after the shock, increasing by 3 basis points, compared with the negligible initial increase in the tranquil period. Interestingly, economic sentiment and the stock market begin to decline much more quickly in the stressed period compared to the tranquil period.

[1] For robustness, I use the CISS index (composite indicator of systemic stress, see Holo et al., 2012 for details). I find that the main conclusions of this analysis are robust to the use of an alternative threshold variable.

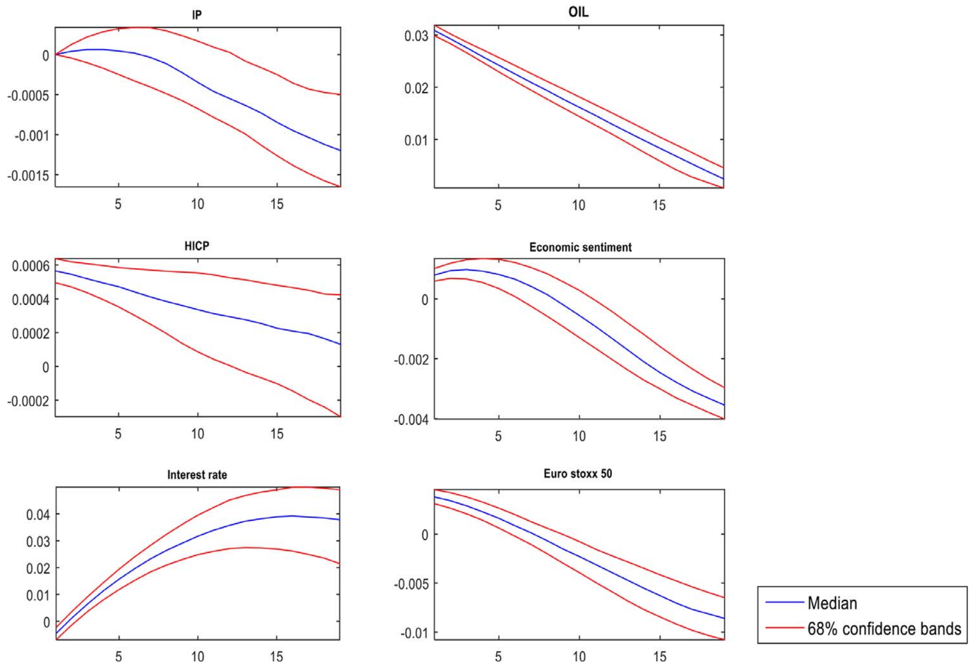

Fig. 1. Positive oil price shock in tranquil period.

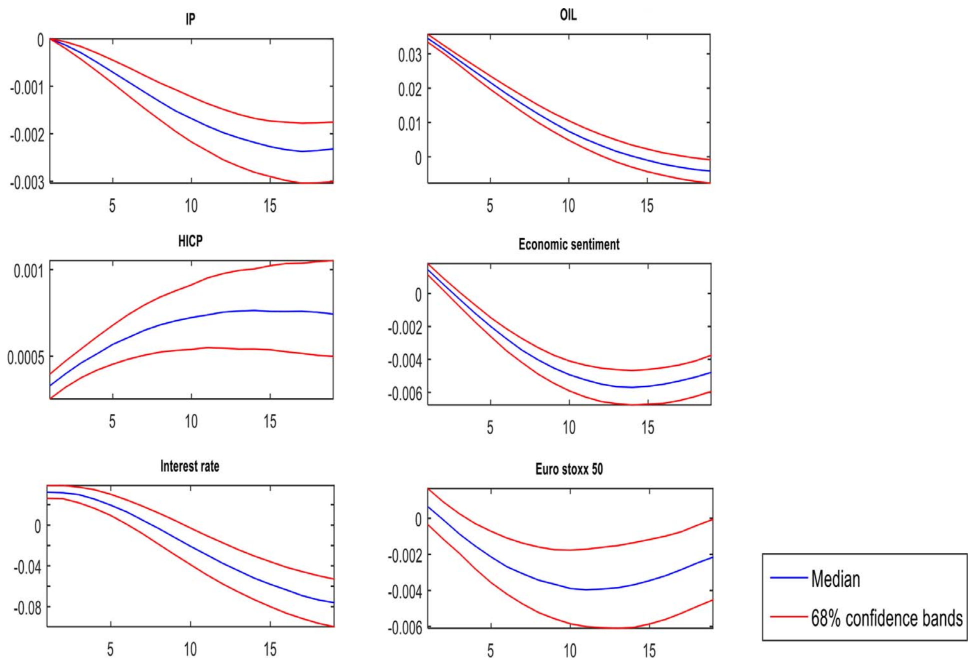

Fig. 2. Positive oil price shock in a high stress period.

The results imply that the sentiment is more fragile when there is increased financial uncertainty. This result is in line with other empirical studies regarding the impact of uncertainty on economic sentiment. For example, Denis and Kannan (2013) find persistently negative effects of uncertainty on monthly economic sentiment indicators. In addition, the finding that stock market reacts negatively following a positive oil price shock, indicates that the model does capture oil supply shocks more closely, as demand shocks should be associated with a positive reaction of stock market (Kilian and Park, 2009; Bernanke, 2016). Overall, output declines much more quickly when the economy is stressed than when it is tranquil, mainly due to the deterioration of stock market returns and the investor sentiment.

Overall then, there is a significant difference between the impact of oil price shocks in uncertain and tranquil periods. However,

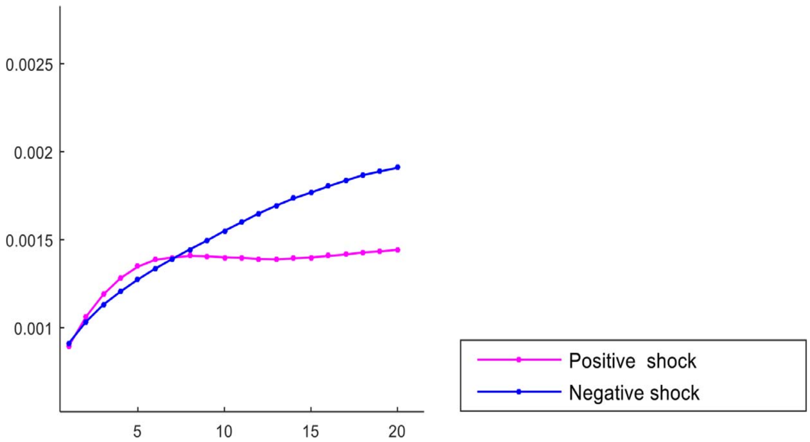

Fig. 3. Positive and negative oil price shocks on HICP in high stress periods.

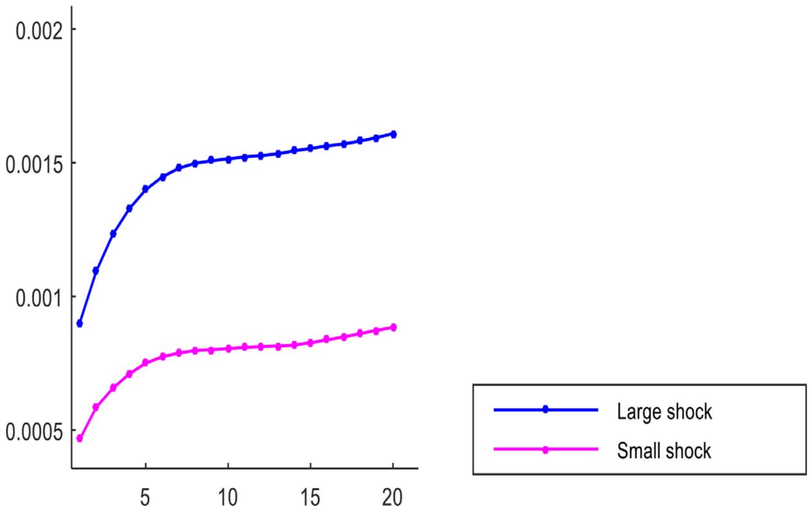

Fig. 4. Large and small positive oil price shocks on HICP in high stress periods.

the euro area economy has experienced a wide variety of oil price shocks over the period since the start of the financial and sovereign debt crisis. Throughout much of the crisis up to mid-2014 oil price shocks were positive. These shocks were relatively small, however, compared to the negative shocks that have been experienced since then. In both instances, movements in inflation have been attributed to these changes in oil prices. It is therefore interesting to consider the impact of different types of oil price shocks on HICP in the next section.

4.2. Does the type of oil price shock matter?

In this section, I focus on the asymmetric nature of different types of oil price shocks on inflation.[2] Figs. 3 and 4 show the impact of shocks in high stressed periods. I first consider the impact of positive and negative oil price shocks on HICP as summarized in Fig. 3 (note that the negative shock has been inverted for comparison). For the first periods following oil price shocks, there is a negligible difference in the size of the effect on HICP. However, after that period, the negative shock has a bigger impact on HICP such that, after 20 months the impact of the negative shock is 0.20% compared with the 0.15% in the case of positive shock. Overall, this suggests that the negative shocks experienced since mid-2014, may have had a greater role in driving down inflation, than the positive shocks experienced during the crisis had in keeping it up.

Next, Fig. 4 shows the impact of large and small positive shocks. Here a large shock is twice as big as a small shock. Initially, a large shock has almost twice the effect on HICP compared to a small shock; approximately 0.09% compared to 0.045% in the first

[2] In relation to output effects, consistent with the literature (see for example Jiménez-Rodríguez and Sánchez, 2015), I find evidence on the asymmetric response of output to oil price shocks. In particular, impulse response analysis shows that positive oil price shocks have a stronger effect on output compared with negative oil price shocks. In addition, the effect is much bigger in high uncertainty periods than low uncertainty periods. Results are available upon request.

month. However, over time, the large shock has a slightly bigger impact on HICP, such that after 10 months, it is 0.15% higher following a large shock compared with approximately 0.07% following a small shock. This finding implies that if policymakers worry about the impact of oil prices on HICP, they will have to respond more strongly to larger oil price shocks, whether positive or negative.

5. Conclusion

This paper uses a Bayesian threshold VAR model to examine potential asymmetries on the transmission of oil price shocks. This approach captures the dependence of the transmission mechanism on the sign (and the size) of the shock and different states of the economy. The results suggest that there is a considerable difference between the impact of oil price shocks in uncertain and tranquil periods. In particular, in response to positive oil price shocks, output declines much more quickly when the economy is stressed than when it is tranquil. Further examination of the results suggests that this asymmetry is due to the fact that stock market returns and economic sentiment decline much more quickly in the stressed period compared to the tranquil period. Considering the type of the shock and focusing on the effects of oil price shocks on inflation; the analysis shows that larger oil price shocks have a disproportionally bigger effect on HICP than smaller shocks. Similarly, negative oil price shocks have a bigger effect on HICP compared with positive shocks. Overall, the findings suggest that policymakers need to consider not just the economic situation, in which an oil price shock is occurring, but also the size and direction of the shock, when choosing a policy response. Extending the analysis by disentangling oil demand and oil supply shocks may generate interesting results regarding the asymmetric impact of oil price shocks on the economy. This extension is left for future research.

Acknowledgements

The paper benefited from discussions in the Central Bank of Ireland's economic seminars. I am particularly grateful for helpful comments from Rebecca Stuart. The views expressed in this paper are those of the author and not necessarily reflect the views of the affiliated institutions.

References

Banbura, M., Giannone, D., Reichlin, L., 2010. Large Bayesian VARs. J. Appl. Econom. 25 (1), 71–92.
Bernanke, B.S., 1983. Irreversibility, uncertainty, and cyclical investment. Q. J. Econ. 98, 85–106.
Bernanke, B.S., 2016. The relationship between stocks and oil prices. https://www.brookings.edu/blog/ben-bernanke/2016/02/19/the-relationship-between-stocks-and-oil-prices/.
Blake, A., Mumtaz, H., 2012. Applied Bayesian econometrics for central bankers. Technical Books. Centre for Central Banking Studies, Bank of England edition 1.
Bonciani, D., Van Roye, B., 2015. Uncertainty shocks, banking frictions and economic activity, Working Paper Series 1825, European Central Bank.
Davies, S.J., 1987. Allocative disturbances and specific capital in real business cycle theories. Am. Econ. Rev. 77 (2), 326–332.
Davies, S.J., Haltiwanger, J., 2001. Sectoral job creation and destruction responses to oil price changes. J. Monet. Econ. 48 (3), 465–512.
Denis, S., Kannan, P., 2013. The impact of uncertainty shocks on the UK economy, IMF Working Paper, 66.
Donayre, L., Wilmot, N.A., 2016. The asymmetric effects of oil price shocks on the Canadian economy. Int. J. Energy Econ. Policy 6 (2), 167–182.
Edelstein, P., Kilian, L., 2007. The response of business fixed investment to changes in energy prices. A test of some hypotheses about the transmission of energy price shocks. B.E. J. Macroecon. 7 (1), 1–41.
Edelstein, P., Kilian, L., 2009. How sensitive are consumer expenditures to retail energy prices. J. Monet. Econ. 56 (6), 766–779.
Fratzscher, M., Schneider, D., Van Robays, I., 2014. Oil prices, exchange rates and asset prices, Working Paper Series 1689, European Central Bank.
Hamilton, J.D., 1996. This is what happened to the oil price macroeconomy relationship. J. Monet. Econ. 38, 215–220.
Hamilton, J.D., 2003. What is an oil shock. J. Econom. 113 (2), 363–398.
Hamilton, J.D., 2008. Oil and the macroeconomy. In: Durlauf, S., Blume, L. (Eds.), The New Palgrave Dictionary of Economics, vol. 1 Palgrave McMillan, New York.
Hamilton, J.D., 2011. Nonlinearities and the macroeconomic effects of oil prices. Macroecon. Dyn. 15 (3), 364–378.
Herrera, A.M., Lagalo, L.G., Wada, T., 2011. Oil price shocks and industrial production: is the relationship linear? Macroecon. Dyn. 15 (3), 472–497.
Herrera, A.M., Lagalo, L.G., Wada, T., 2015. Asymmetries in the response of economic activity to oil price increases and decreases? J. Int. Money Finance 50, 108–133.
Holó, D., Kremer, M., Duca, M.L., 2012. CISS—a composite indicator of systemic stress in the financial system, Working Paper Series 1426, European Central Bank.
Kilian, L., 2009. Not all oil price shocks are alike: disentangling demand and supply shocks in the crude oil market. Am. Econ. Rev. 99 (3), 1053–1069.
Kilian, L., Park, C., 2009. The impact of oil price shocks on the U.S. stock market. Int. Econ. Rev. 50 (4), 1267–1287.
Kilian, L, Vigfusson, R.J., 2011. Are the responses of the U.S. economy asymmetric in energy price increases and decreases? Quant. Econ. 2 (3), 419–453.
Koop, G., Pesaran, M.H., Potter, S.M., 1996. Impulse response analysis in nonlinear multivariate models. J. Econom. 74 (1), 119–147.
Lo, M.C., Piger, J., 2005. Is the response of output to monetary policy asymmetric? Evidence from a regime-switching coefficients model. J. Money Credit Banking 37, 865–887.
Peersman, G., Van Robays, I., 2009. Oil and the Euro area economy. Econ. Policy 24 (60), 603–651.
Pindyck, R.S., 1991. Irreversibility, uncertainty, investment. J. Econ. Lit. 29 (3), 1110–1148.
Rodríguez, J.R., Sánchez, M., 2006. Oil price shocks and real GDP growth: empirical evidence for some OECD countries. Appl. Econ. 37, 201–228.
Van Robays, I., 2016. Macroeconomic uncertainty and oil price volatility. Oxford Bull. Econ. Stat. 78, 671–693.