

Oil Market Volatility: Is Macroeconomic Uncertainty Systematically Transmitted to Oil Prices?



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Abstract The aim of this contribution is to analyze the impact of macroeconomic uncertainty on the oil market. We rely on a robust measure of macroeconomic uncertainty based on a wide range of monthly macroeconomic and financial indicators, which is linked to predictability rather than to volatility. We estimate a structural threshold vector autoregressive (TVAR) model to account for the varying effect of macroeconomic uncertainty on oil price returns depending on the degree of uncertainty, from which we derive a robust proxy of oil market uncertainty. Our findings show that a significant component of oil price uncertainty can be explained by macroeconomic uncertainty. In addition, we find that the recent 2007–2009 recession has generated an unprecedented episode of high uncertainty in the oil market that is not necessarily accompanied by a subsequent volatility in the price of oil. This result highlights the relevance of our uncertainty measure in linking uncertainty to predictability rather than to volatility.

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1 Introduction

Uncertainty has been widely documented in the economics literature, particularly its transmission mechanism to activity, which has been extensively discussed both theoretically and empirically. For instance, theories of investment under uncertainty explain why under irreversibility condition or fixed costs, uncertainty over future returns reduces current investment, hiring, and consumption through an “option value to wait.”¹ At a micro level, increased uncertainty may diminish the willingness of firms to commit resources to irreversible investment and the readiness of consumers to spend or allocate their earning and wages. Such uncertainty at a micro level may also be transmitted to the macro level, as shown by Bernanke (1983), arguing that uncertainty about the return to investment at a micro level may create cyclical fluctuations in aggregate investment at a macro level. Regarding monetary theory, Prat (1988) investigates the effect of macroeconomic and financial uncertainty on the demand for money. He uses an indicator measuring the degree of economic uncertainty perceived by the agents, as revealed by the behavior of these agents on financial markets. Relying on data over the 1949–1982 period, he emphasizes the importance of uncertainty on the US demand for money.

In the wake of this literature, our aim in this chapter is to investigate the impact of uncertainty on the oil market. Regarding the previous literature, two classes of papers have highlighted the significance of uncertainty in oil prices in explaining economic fluctuations as well as its role in exacerbating asymmetry in the oil price–economic activity nexus.² The first strand of studies is based on the volatility of the real price of oil at medium- and long-term horizons, i.e., at horizons that are relevant to purchase and investment decisions. In this vein, the theoretical models of Bernanke (1983) and Pindyck (1991) suggest that oil price uncertainty was the main cause of the 1980 and 1982 recessions.³ The second strand of the literature is empirical and based on short-term uncertainty. Elder and Serletis (2009, 2010) were among the first to provide a fully specified model for the impact of oil price uncertainty on real GDP. Using a structural vector autoregressive (SVAR) model for post-1980 data, they find empirical evidence that uncertainty about oil price

¹See Henry (1974), Bernanke (1983), Brennan and Schwartz (1985), Majd and Pindyck (1987), Brennan (1990), Gibson and Schwartz (1990), Bloom et al. (2007), Bloom (2009), Edelstein and Kilian (2009), and Bredin et al. (2011) among others.

²Considering the uncertainty channel, the asymmetric responses of real output to oil price shocks may come from the fact that uncertainty tends to amplify the effect of unexpected oil price increases and offset the impact of unexpected oil price decreases (see Kilian, 2014). It is worth mentioning that Georges Prat is an internationally recognized specialist in the analysis of expectations. He has written several contributions on this topic, particularly on rational expectations (see Prat (1994, 1995) and Gardes and Prat (2000) among others). Among his numerous papers, his 2011’s article (see Prat and Uctum, 2011) deals with the modeling of expectations on the oil market.

³It should be noticed that Bernanke (1983) and Pindyck (1991) consider the oil price as exogenous with respect to the US economy, which is not consistent with the recent literature about the endogenous component of oil prices (see Kilian, 2008a).

evolution tends to depress output, investment, and consumption in the USA and the G-7 countries in an asymmetric way. They also show that the net effect of an unexpected drop in the real price of oil is to cause recessions, a result which is not in line with the economic theory.⁴ Relying on a quarterly vector autoregressive (VAR) model with stochastic volatility in the mean, Jo (2014) finds far much smaller uncertainty effect on world industrial production than Elder and Serletis (2010). The author points out that Elder and Serletis (2010)'s GARCH-in mean VAR is misspecified because the same model is driving both the conditional mean and the conditional variance. While providing interesting results, these models suffer from an important drawback regarding the supposed role of oil price shocks in explaining recessions. Indeed, as underlined by Kilian and Lewis (2011) and Kilian (2014), the empirical literature does not consider that recessionary episodes are driven by sequences of oil price shocks of different magnitude and sign. In addition, as argued by Kilian (2014), energy is not necessarily a key component of the cash flow of investment projects, making the effect of oil price uncertainty on output not plausible. Theoretically, the existent measures of price uncertainty also raise some important issues since they are constructed at short-run horizons (month-ahead) rather than at horizons relevant to purchase and investment decisions (years) (see Kilian and Vigfusson, 2011).

As can be seen, the previous literature has faced some limitations in explaining uncertainty in oil prices and its impact on economic activity. The reverse effect, namely, the influence of macroeconomic uncertainty on oil price fluctuations, has not been widely addressed through this question is of particular interest given the modern view that the price of oil is characterized by an important endogenous component. Some exceptions can, however, be mentioned. Regarding first the theoretical papers, (1) Pindyck (1980) discusses the theoretical implications of uncertainty associated with oil demand and reserves on the oil price behavior; (2) Litzenberger and Rabinowitz (1995) analyze backwardation behavior in oil futures contracts; and (3) Alquist and Kilian (2010) allow for endogenous convenience yield and endogenous inventories, and stress that it is uncertainty about the shortfall of supply relative to demand that matters. Turning to the empirical papers, one may refer to (1) Kilian (2009) and Kilian and Murphy (2014) who design as a precautionary demand shock a shock that reflects shifts in uncertainty and treat macroeconomic uncertainty as unobserved; and (2) Van Robays (2013) who investigates whether observed macroeconomic uncertainty changes the responsiveness of the oil price to shocks in oil demand and supply.

Considering the impact of macroeconomic uncertainty on the oil market, our work contributes to this literature and extends it in several ways. First of all and as previously mentioned, though most of the literature has focused on the incidence of oil price uncertainty on economic activity, we address the reverse effect by examining the influence of macroeconomic uncertainty on oil prices. Then, turning

⁴Other empirical papers exist in the literature, such as Favero et al. (1994), Lee et al. (1995), and Ferderer (1996), but they either treat oil as exogenous or use data from the pre-1973 period.

to methodological issues, our contribution is threefold. First, we retain a nonlinear, threshold vector autoregressive (TVAR) specification for modeling oil price returns to account for potentially different effects of macroeconomic uncertainty on the oil market depending on the environment. Second, because macroeconomic uncertainty is unobservable, assessing its effect on the oil market obviously requires us to find an adequate proxy. To this end, we rely on Jurado et al. (2015) and consider a robust approach to measuring macroeconomic uncertainty. The retained proxy uses a wide range of monthly macroeconomic and financial indicators and is based on the underlying idea of a link between uncertainty and predictability. In this sense, we go further than the previous literature⁵—particularly compared with Van Robays (2013)’s paper, which is the closest to ours—which generally relies on dispersion measures such as conditional volatility (e.g., conditional variance of world industrial production growth or of the US GDP growth estimated from a GARCH(1,1) process) or the popular VXO index proposed by Bloom (2009). An important drawback in using GARCH-type models to proxy uncertainty is that they are inherently backward-looking, whereas investors’ expectations tend to be forward-looking. Third, we provide a complete analysis by investigating how macroeconomic uncertainty can generate uncertainty in oil prices. To this end, we construct a robust proxy of oil market uncertainty based on macroeconomic uncertainty⁶ and provide a historical decomposition that allows us to determine the contribution of macroeconomic uncertainty to oil price uncertainty.

The rest of the chapter is organized as follows. Section 2 presents the methodology and data. Section 3 displays the results regarding the link between macroeconomic uncertainty and uncertainty on the oil market. Finally, Sect. 4 concludes the contribution.

2 Methodology and Data

2.1 *Macroeconomic Uncertainty*

2.1.1 Measuring Macroeconomic Uncertainty

Measuring uncertainty and examining its impact on market dynamics is a challenging question for economists because no objective measure exists. Although in a general sense uncertainty is defined as the conditional volatility of an unforecastable disturbance,⁷ the empirical literature to date has usually relied on proxies. The most

⁵See references in Sect. 2.

⁶This approach is therefore theoretically robust to the endogenous component of commodity prices, in line with the recent literature (see references in Sect. 2).

⁷See Bloom (2009), Bloom et al. (2010, 2012), Gilchrist et al. (2010), Arellano et al. (2011), Bachmann and Bayer (2011), Baker et al. (2011), Basu and Bundick (2011), Knotek and Khan

common measures used are the implied or realized volatility of stock market returns, the cross-sectional dispersion of firm profits, stock returns, or productivity, and the cross-sectional dispersion of survey-based forecasts.⁸ However, their adequacy to correctly proxy uncertainty is questionable, and such measures are even misspecified with regard to the theoretical notion of uncertainty, as highlighted by Jurado et al. (2015).

Indeed, stock market volatility, cross-sectional dispersion in stock returns and firm profits can vary over time due to several factors—such as risk aversion, the leverage effect, and heterogeneity between firms—even if there is no significant change in uncertainty. In other words, fluctuations that are actually predictable can be erroneously attributed to uncertainty, putting forward the importance of distinguishing between uncertainty in a series and its conditional volatility. Specifically, properly measuring uncertainty requires to remove the forecastable component of the considered series before computing the conditional volatility. In this sense, uncertainty in a series is not equivalent to the conditional volatility of the raw series.

Another important characteristic of Jurado et al. (2015)'s approach is that macroeconomic uncertainty is defined as the common variation in uncertainty across many series rather than uncertainty related to any single series. This is in line with the uncertainty-based business cycle theories which implicitly assume a common variation in uncertainty across a large number of series.

Accordingly, to provide a consistent measure of macroeconomic uncertainty, we follow the definition of Jurado et al. (2015) by linking uncertainty to predictability. Specifically, the h -period-ahead uncertainty in the variable $y_{jt} \in Y_t = (y_{1t}, \dots, y_{N_y t})'$ is defined as the conditional volatility $U_{jt}^y(h)$ of the purely unforecastable component of the future value of the series:

$$U_{jt}^y(h) \equiv \sqrt{E \left[(y_{jt+h} - E[y_{jt+h} | J_t])^2 | J_t \right]}, \quad (1)$$

where $j = 1, \dots, N_y$, $E(\cdot | J_t)$ is the conditional expectation of the considered variable, and J_t denotes the information set available at time t . Uncertainty related to the variable y_{jt+h} is therefore defined as the expectation of the squared error forecast. Aggregating over j individual uncertainty measures $U_{jt}^y(h)$ equally weighted by w_j leads to the following expression of aggregate or macroeconomic uncertainty:

$$U_t^y(h) \equiv \text{plim}_{N_y \rightarrow \infty} \sum_{j=1}^{N_y} w_j U_{jt}^y(h) \equiv E_w \left[U_{jt}^y(h) \right]. \quad (2)$$

(2011), Fernández-Villaverde et al. (2011), Schaal (2012), Leduc and Liu (2012), Nakamura et al. (2012), Bachmann et al. (2013), and Orlik and Veldkamp (2013) among others.

⁸See Jurado et al. (2015). The papers cited in Sect. 1 related to the study of the relationship between uncertainty and oil prices have used such indicators.

As discussed by Jurado et al. (2015), the estimation of Eqs. (1) and (2) requires three fundamental steps. The first step is to replace the conditional expectation $E[y_{jt+h} | J_t]$ in Eq. (1) by a forecast in order to compute forecast errors. It is a crucial step since the forecastable component should be then removed from the conditional volatility computation.⁹ To do so, an as rich as possible predictive model based on factors from a large set of N predictors $\{X_{it}\}$, $i = 1, \dots, N$, is considered, taking the following approximated form:

$$X_{it} = \Lambda_i^{F'} F_t + e_{it}^X, \quad (3)$$

where F_t is an $r_f \times 1$ vector of latent common factors, Λ_i^F is the vector of latent factor loadings, and e_{it}^X is a vector of idiosyncratic errors which allows for some cross-sectional correlations. To account for time-varying omitted-information bias, Jurado et al. (2015) further include estimated factors, as well as nonlinear functions of these factors in the forecasting model through a diffusion forecast index. The second step consists of: (1) defining the h -step-ahead forecast error by $V_{jt+h}^y = y_{jt+h} - E[y_{jt+h} | J_t]$, and (2) estimating the related conditional volatility, namely $E[(V_{t+h}^y)^2 | J_t]$. To account for time-varying volatility in the errors of the predictor variables, $E[(V_{t+h}^y)^2 | J_t]$ is recursively multistep-ahead computed for $h > 1$. In the third, final step, macroeconomic uncertainty $U_t^y(h)$ is constructed from the individual uncertainty measures $U_{jt}^y(h)$ through an equally weighted average.

Using large datasets on economic activity, Jurado et al. (2015) provide two types of uncertainty measures that are as free as possible from both the restrictions of theoretical models and/or dependencies on a handful of economic indicators. The first one is the “common macroeconomic uncertainty” based on the information contained in hundreds of primarily macroeconomic and financial monthly indicators, and the second one is the “common microeconomic uncertainty” based on 155 quarterly firm-level observations on profit growth normalized by sales.¹⁰ Empirically, these measures have the advantage of providing far fewer important uncertainty episodes than do popular proxies. As an example, though Bloom (2009) identifies 17 uncertainty periods based on stock market volatility, Jurado et al. (2015) find evidence of only three episodes of uncertainty over the 1959–2011 period: the month surrounding the 1973–1974 and 1981–1982 recessions and the recent 2007–2009 great recession. As stressed above, this illustrates that popular uncertainty proxies based on volatility measures usually erroneously attribute to uncertainty fluctuations that are actually forecastable. In addition, with the proposed measures defined for different values of h , they allow us to investigate uncertainty transmission to the oil market for distinct maturities.

⁹Recall that removing the forecastable component of y_{jt} is crucial to avoid erroneously categorizing predictable variations as uncertain.

¹⁰Dealing with monthly data and focusing on macroeconomic uncertainty, we consider in this work the “common macroeconomic uncertainty” measure.

2.1.2 Endogenous and Exogenous Components of Uncertainty

One important issue when investigating the impact of macroeconomic uncertainty on oil prices is to understand the intrinsic nature of uncertainty with respect to prices. In other words, it is important to disentangle the endogenous and exogenous components of macroeconomic uncertainty (i.e., whether macroeconomic uncertainty is demand-driven or supply-driven with respect to oil prices). Since 1974, the price of oil—as the price of other commodities—has become endogenous with respect to global macroeconomic conditions (see Alquist et al., 2013).¹¹ Since then, the empirical literature has provided overwhelming evidence that commodity prices have been driven by global demand shocks.¹² As pointed out by Barsky and Kilian (2002), the 1973–1974 episode of dramatic surge in the price of oil and industrial commodities is the most striking example where the price increase was explained for 25% by exogenous events and for 75% by shifts in the demand side. With the predominant role of flow demand on prices, another important channel of transmission is the role of expectations in the physical market.¹³ The underlying idea is that anyone who expects the price to increase in the future will be prompted to store oil now for future use leading to a shock from the demand of oil inventories. Kilian and Murphy (2014) demonstrate that shifts in expectations through oil inventories have played an important role during the oil price surge in 1979 and 1990, and the price collapse in 1986.

The aggregate specification of our proxy has the particularity to be “global,” accounting for a lot of information regarding uncertainty in the supply and demand channels. While it is quite difficult in this framework to identify the proportion of unanticipated demand or supply, some reasonable assumptions about the effect of demand and supply shocks on prices may give us some insight about the mechanisms behind the relationship between macroeconomic uncertainty and oil prices. In our analysis, we follow the dominant view about the endogenous nature of oil prices with respect to macroeconomic conditions, considering the aggregate demand channel as a primary source of price fluctuations (see Mabro, 1998, Barsky and Kilian, 2002, 2004, Kilian, 2008a, and Hamilton, 2009). In line with the previous literature, we therefore assume that exogenous events coming from the supply channel—such as cartel decisions, oil embargoes, or the effects of political uncertainty from the Middle East—are secondary, being mainly an indirect consequence of the macroeconomic environment. By construction, our approach accounts for both channels, the demand channel being a direct effect of macroeconomic aggregate and the supply channel an indirect effect of macroeconomic conditions on exogenous events (see Barsky and Kilian, 2002, Alquist and Kilian, 2010, Kilian

¹¹Before this date, there was no global market for crude oil and the price of oil in the USA was regulated by the government.

¹²One exception for the case of oil is the 1990s, where the flow supply shocks have played an important role (see Kilian and Murphy, 2014).

¹³See Kilian (2014) for a review.

and Vega, 2011, and Kilian and Murphy, 2014). In other words, our macroeconomic uncertainty proxy primarily reflects uncertainty about the demand side.

2.2 *Measuring Oil Market Uncertainty*

To investigate how macroeconomic uncertainty can affect oil market uncertainty, we need to: (1) define an uncertainty measure for the oil market, and (2) assess the transmission mechanism of macroeconomic uncertainty to oil market uncertainty.

Let us first consider the determination of the oil market uncertainty proxy. We rely on Eq. (1) and proceed in two steps. In a first step, we account for the result that macroeconomic uncertainty nonlinearly affects the oil price behavior depending on the level of uncertainty (see Joëts et al., 2017). Indeed, we consider that uncertainty may be a nonlinear propagator of shocks across markets, a property which is captured by a structural threshold vector autoregressive model.¹⁴ In addition to providing an intuitive way to capture the nonlinear effects of uncertainty on markets, the TVAR model has the advantage of endogenously identifying different uncertainty states. Indeed, according to this specification, observations can be divided, for example, into two states delimited by a threshold reached by uncertainty, with estimated coefficients that vary depending on the considered state (low- and high-uncertainty states). In other words, the TVAR specification allows uncertainty states to switch as a result of shocks to the oil market.

From the estimation of the TVAR model,¹⁵ we generate the h -period-ahead forecast of the oil price return series, accounting for the information about macroeconomic uncertainty. Let $E[y_{t+h}/J_t, u_t^u]$ be the obtained forecast, where y is the oil price return series, J_t the information set available at time t , and u_t^u the macroeconomic uncertainty shock at time t . As seen, our forecast value accounts for information about macroeconomic uncertainty. Given this forecast, we define in a second step the h -period-ahead forecast error as the difference between y_{t+h} and $E[y_{t+h}/J_t, u_t^u]$, the forecast that accounts for information about macroeconomic uncertainty. The underlying idea is that a way to understand the transmission mechanism of macroeconomic uncertainty to the oil market is to assess how the forecast of our considered variable changes if we add information about macroeconomic uncertainty. The oil market uncertainty measure is then given by the volatility of this forecast error.

To account for the volatility-clustering phenomenon, which is a typical feature of commodity markets, we rely on time-varying volatility specifications and consider the moving average stochastic volatility model developed by Chan and Jeliazkov

¹⁴See Balke (2000) for a detailed presentation of TVAR processes as well as Tong (2010) and Hansen (2011) for general developments on threshold models. Van Robays (2013) uses the TVAR methodology to examine uncertainty on the oil market.

¹⁵See the detailed results in Joëts et al. (2017).

(2009) and Chan and Hsiao (2013) given by:

$$x_t = \lambda + v_t, \quad (4)$$

where x_t denotes the forecast error, i.e., the difference between the forecast of y that does not account for information about macroeconomic uncertainty and the forecast that accounts for such information. The error term v_t is assumed to be serially dependent, following an MA(q) process of the form:

$$v_t = \varepsilon_t + \psi_1 \varepsilon_{t-1} + \dots + \psi_q \varepsilon_{t-q}, \quad (5)$$

$$h_t = \lambda_h + \phi_h (h_{t-1} - \lambda_h) + \zeta_t, \quad (6)$$

where $\varepsilon_t \sim N(0, e^{h_t})$ and $\zeta_t \sim N(0, \sigma_h^2)$ are independent of each other, $\varepsilon_0 = \varepsilon_{-1} = \dots = \varepsilon_{-q+1} = 0$, and the roots of the polynomial associated with the MA coefficients $\psi = (\psi_1, \dots, \psi_q)'$ are assumed to be outside the unit circle. h_t is the log-volatility evolving as a stationary AR(1) process. Following Chan and Hsiao (2013), under the moving average extension, the conditional variance of the series x_t is given by:

$$V(x_t | \lambda, \psi, h) = e^{h_t} + \psi_1^2 e^{h_t-1} + \dots + \psi_q^2 e^{h_t-q}. \quad (7)$$

This specification allows us to capture two nonlinear channels of macroeconomic uncertainty: (1) the one coming from the moving average of the $q + 1$ most recent variances $e^{h_t} + \dots + e^{h_t-q}$, and (2) the other from the AR(1) log-volatility stationary process given by Eq. (6).

Given the challenge of estimating this kind of nonlinear model due to high-dimensional and nonstandard data—with the conditional density of the states being non-Gaussian, a Bayesian estimation using Markov chain Monte Carlo methods is hardly tractable. We follow Chan and Hsiao (2013) and estimate the conditional variance of forecast errors by band-matrix algorithms instead of using conventional methods based on the Kalman filter.¹⁶

¹⁶See Chan and Jeliazkov (2009) and Chan and Hsiao (2013) for more details. The Matlab code used to estimate the moving average stochastic volatility model is freely available from the website of Joshua Chan. We obtain 20,000 draws from the posterior distribution using the Gibbs sampler after a burn-in period of 1000.

2.3 Data

The oil price series is the monthly WTI crude oil spot price taken from NYMEX, spanning the period from October 1978 to December 2011. The series is transformed into first-logarithmic differences (i.e., price returns). Turning to data related to macroeconomic uncertainty measures for distinct maturities, they are freely available on Ludvigson's homepage.¹⁷ Recall that we rely on the macroeconomic uncertainty measure which is based on several macroeconomic and financial monthly indicators. Specifically, 132 macroeconomic time series are considered, including real output and income, employment and hours, real retail, manufacturing and trade sales, consumer spending, housing starts, inventories and inventory sales ratios, orders and unfilled orders, compensation and labor costs, capacity utilization measures, price indexes, bond and stock market indexes, and foreign exchange measures. Turning to the financial indicators, 147 time series are retained, including dividend–price and earning–price ratios, growth rates of aggregate dividends and prices, default and term spreads, yields on corporate bonds of different ratings grades, yields on Treasuries and yield spreads, and a broad cross-section of industry equity returns. Both sets of data are used to estimate the forecasting factors, but macroeconomic uncertainty is proxied using the 132 macroeconomic time series only.

3 Results

3.1 *Transmission of Macroeconomic Uncertainty to Oil Market Uncertainty*

Figure 1 depicts the evolution of uncertainty in the oil market for 1 month (blue line),¹⁸ together with the evolution of corresponding prices (black line) and volatility (green line). The horizontal bar corresponds to 1.65 standard deviation above the mean of oil uncertainty series. The gray bands correspond to episodes of important macroeconomic uncertainty: the months surrounding the 1981–1982 recession and the 2007–2009 great recession (see Joëts et al., 2017). When uncertainty in the oil market exceeds the horizontal bar, this refers to episodes of heightened uncertainty for the oil price return series. When oil price uncertainty coincides with the

¹⁷<http://www.econ.nyu.edu/user/ludvigsons/>. Since the submission of the present paper, an updated version of the database has been made available in February 2018 and can be downloaded at: <https://www.sydneyludvigson.com/data-and-appendixes/>.

¹⁸We focus on short-run uncertainty ($h = 1$) because the effects have been largely documented both theoretically and empirically in the literature (see Bloom, 2014, for a review). For the sake of completeness, we have also estimated uncertainty at longer horizons, namely, 3 and 12 months. The corresponding figures are available upon request to the authors.

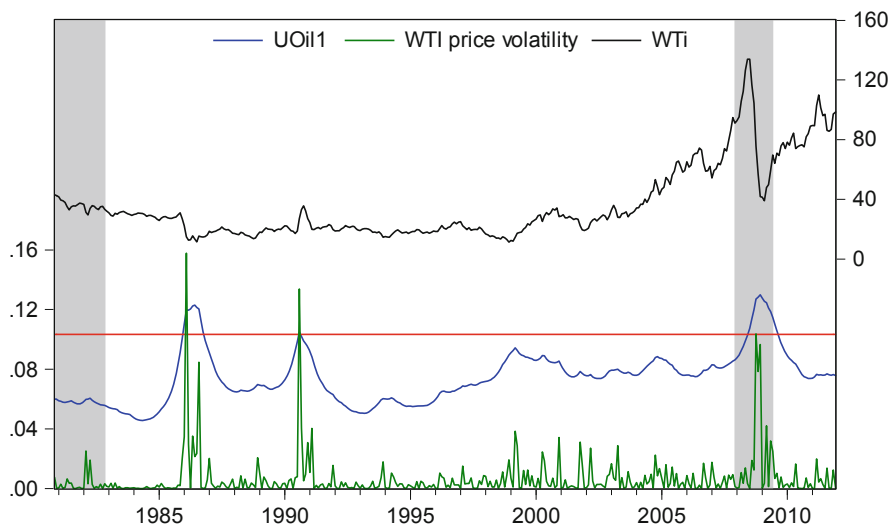


Fig. 1 Uncertainty in the oil market. Note: This figure depicts uncertainty proxy for the oil market at 1 month (left axis, blue line). The horizontal red bar corresponds to 1.65 standard deviation above the mean of the series (left axis). Vertical gray bands represent macroeconomic uncertainty periods. Volatility (green line) is proxied by the daily squared returns of oil prices (left axis). Black line refers to oil price series (right axis)

vertical gray bands, it indicates a potential transfer from macroeconomic to oil market uncertainty (with both uncertainty episodes occurring in the same period). Otherwise, uncertainty is attributable to the own characteristics of the oil market.

As shown in Fig. 1, the sensitivity of oil price uncertainty to macroeconomic uncertainty differs depending on the retained period, highlighting that oil shocks do not all follow the same pattern. For example, the period that just follows the invasion of Kuwait in 1990, the Afghan war in 2001, and the Iraq War in 2002–2003 are episodes characterized by sharp spikes in oil prices. The Iran–Iraq war in 1980 and the 1999 OPEC meeting are, in contrast, associated with small price movements. As stressed by Barsky and Kilian (2004), a simplistic view should be that major war episodes cause price uncertainty to increase through a rise in precautionary demand for oil. However, among all episodes of important fluctuations in oil prices, only two seem to be accompanied by uncertainty: (1) the 2007–2009 recession, and (2) the 1984–1986 period.

During the 2007–2009 recession, oil price uncertainty is indeed very sensitive to macroeconomic uncertainty, a result that is not surprising given the well-known relationship that exists between economic activity and the oil market.¹⁹ This episode of high oil price uncertainty is accompanied by the biggest oil price spike in the

¹⁹See Barsky and Kilian (2002, 2004), Kilian (2008a,b, 2009), Kilian and Murphy (2012, 2014), and Kilian and Hicks (2013) to name a few.

postwar experience and results from various macroeconomic factors. A common explanation lies in the global economic growth starting in 2003, as illustrated by the increase in real gross world product combined with the stagnant oil production from Saudi Arabia from 2005 to 2007.²⁰ Whatever the origin of price surges, this period of macroeconomic uncertainty is reflected in oil market uncertainty by an unprecedented oil price increase.

The 1984–1986 period is also characterized by heightened oil price uncertainty, but it does not coincide with macroeconomic uncertainty. This episode seems to be related to the conjunction of two events: (1) the production shutdown in Saudi Arabia between 1981 and 1985, which caused a strong price decrease²¹; and to a lesser extent (2) the OPEC collapse in 1986. On the whole, our results are in line with the literature that has recently stressed the limited impact of exogenous events on oil price fluctuations.

Overall, the recent 2007–09 recession generated an unprecedented episode of uncertainty in the oil price. A key result is that, as clearly shown by Fig. 1, uncertainty episodes are not necessarily accompanied by high volatility in the price of oil. This major finding illustrates the interest of our retained measure of uncertainty, underlining that uncertainty is more related to predictability than to volatility.

3.2 *Historical Decomposition Analysis*

To assess the contribution of macroeconomic uncertainty to oil price uncertainty, we perform a historical decomposition analysis of oil market uncertainty with respect to macroeconomic uncertainty. Based on the estimation of a VAR model,²² Fig. 2 reports the historical decomposition associated with oil price uncertainty. Our previous results are confirmed. Indeed, we find a strong proportion of macroeconomic uncertainty in oil price uncertainty during the recent 2007–2009 financial crisis (around 35% of oil price uncertainty is explained by macroeconomic uncertainty during this period). Recalling that our proxy of macroeconomic uncertainty is demand-driven, these conclusions are in line with the literature. During the 1986–1987 episode, oil price uncertainty is not explained by macroeconomic uncertainty and the proportion of macroeconomic uncertainty appears to be negative. This

²⁰According to the US Energy Information Administration, the total Saudi Arabia crude oil production significantly decreases from 9550.136 thousand barrels per day in 2005 to 8721.5068 thousand barrels per day in 2007.

²¹At the beginning of the 1980s, the strategy of Saudi Arabia to shut down production (compensating higher oil production elsewhere in the world) was initiated to prevent an oil price decline, without success. Saudi Arabia finally decided to ramp production back up in 1986, causing an oil shock from \$27/barrel in 1985 to \$12/barrel in 1986 (see Kilian and Murphy, 2014).

²²The lag order of the VAR specification is 3, as selected by usual information criteria.

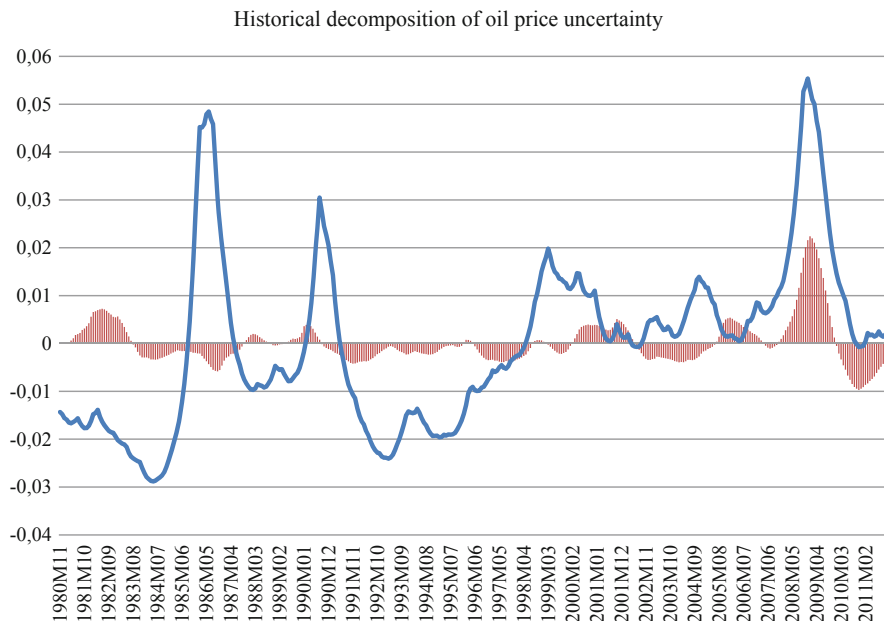


Fig. 2 Historical decomposition of oil price uncertainty with respect to macroeconomic uncertainty. Note: Oil price uncertainty corresponds to the blue line, the proportion of macroeconomic uncertainty is in red

suggests that other shocks not related to economic activity have been at play during this period.

Overall, these results show that a significant component of oil price uncertainty can be explained by macroeconomic uncertainty. A key finding is that the recent oil price movements in 2005–2008 associated with a rise in oil price uncertainty appear to be mainly the consequence of macroeconomic uncertainty, confirming the endogeneity of the oil price with respect to economic activity (i.e., the demand-driven characteristic).²³

3.3 Distinguishing Between Different Types of Shocks

As stressed above, macroeconomic uncertainty contributes to a large extent to price uncertainty. This result is of primary importance since it shows that oil price uncertainty during the 2005–2008 period can be partly explained by macroeconomic uncertainty. Besides, as stressed by the literature on oil prices, four types of shocks

²³See Kilian (2008a, 2009), and Kilian and Murphy (2012, 2014) among others.

can be distinguished²⁴: (1) shocks to the flow supply of oil, (2) shocks to the flow demand for crude oil reflecting the state of the global business cycle, (3) shocks to the speculative demand for oil stocks above the ground, and (4) other idiosyncratic oil demand shocks. These different shocks may also be reflected in oil price uncertainty movements. Specifically, we aim here at investigating which type of shock contributes the most to oil price uncertainty.

As it is common in the literature, we proxy the flow supply in two ways: by the data on Saudi Arabia crude oil production, and by the global crude oil production—both series being from the Energy Information Agency (EIA).²⁵ Our measure of fluctuations in global real activity is the dry cargo shipping rate index developed by Kilian (2009). Finally, turning to the speculative component of the oil demand, we rely on data for the US crude oil inventories provided by the EIA.²⁶ Figures 3, 4, and 5 allow us to assess the quantitative importance of each type of shock (supply, demand, and speculation) on oil price uncertainty. Results show that the contribution of each shock to price uncertainty varies depending on the period, and that the nature of the shock matters in explaining oil price uncertainty. For instance, while Kilian (2009) identified the invasion of Kuwait in 1990 and the Iraq War in 2002–2003 as episodes of surges in speculative demand for oil responsible for sharp price increases, we find that these events are not associated with important oil price uncertainty. More importantly, the contribution of the speculative shocks appears to be very limited or even negative compared to the contribution of flow supply (around 17%) and flow demand (4%) shocks in 1990.

Several events in the oil market history have appeared during the period 1986–1987. The two most important are the decision of Saudi Arabia to shut down the crude oil production to prop up the price of oil, and the OPEC collapse. While the latter is known to have limited impact on the crude oil price (see Barsky and Kilian, 2004), the former created a major positive shock to the flow supply driving down the price of oil. As we have seen, this period has led to an important movement in oil price uncertainty. Figures 3, 4, and 5 show that this event is mainly supply-driven: around 18% of oil price uncertainty is explained by the shut down of Saudi Arabia crude oil production against less than 4% by the flow demand.

The most interesting episode over the last decades is obviously the unprecedented price surge after 2003 and, in particular, in 2007–2008, which led to the most heightened period of oil price uncertainty. According to a popular view, this price increase was the consequence of speculative behaviors on the market (i.e., growing financialization of oil futures markets) and could not be explained by changes in economic fundamentals (see Fattouh et al., 2013, for a discussion). The standard interpretation is that oil traders in spot markets buy crude oil now and store it in

²⁴See Kilian (2009), Baumeister and Peersman (2013), and Kilian and Murphy (2012).

²⁵We only report the results with Saudi Arabia crude oil production because they are more significant. Results from the global crude oil production are available upon request to the authors.

²⁶Similar to Kilian and Murphy (2014), we scaled the data on crude oil inventories by the ratio of OECD petroleum stocks over the US petroleum stocks for each time period.

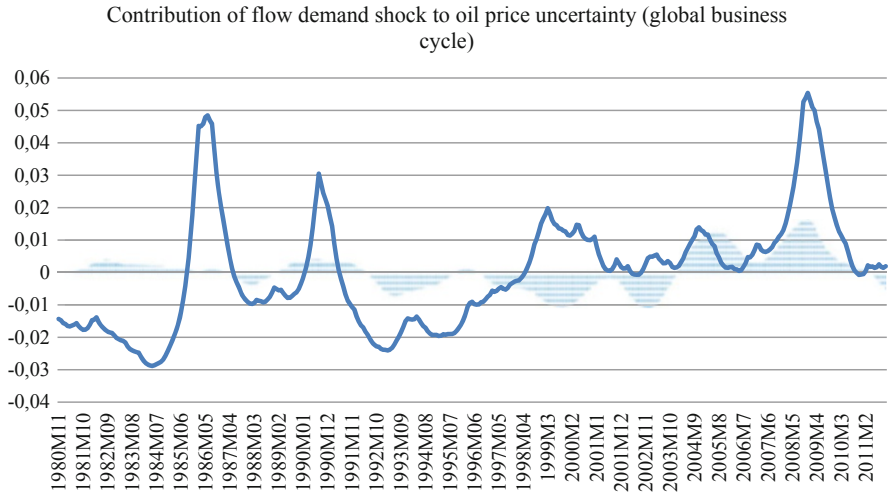


Fig. 3 Historical decomposition of oil price uncertainty with respect to supply and demand shocks. Case of demand shock. Note: This figure depicts the contribution (in blue) of the flow demand (global business cycle) shock to oil price uncertainty. The blue line corresponds to oil price uncertainty at 1 month

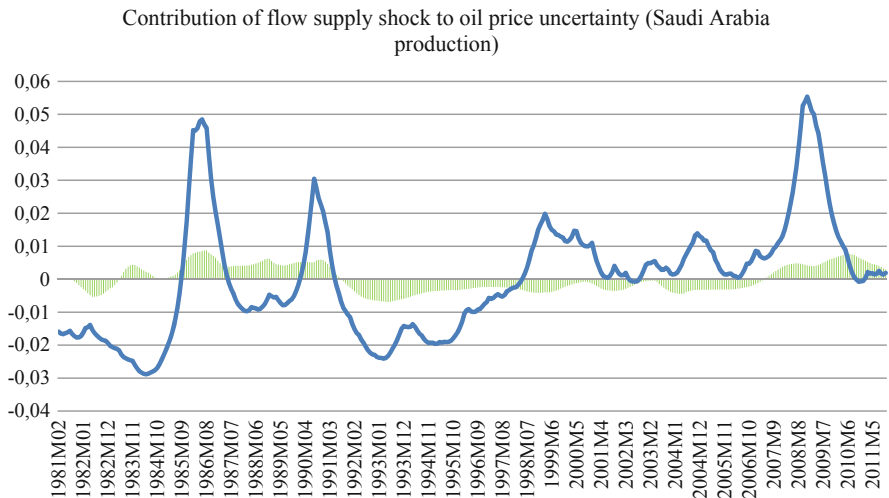


Fig. 4 Historical decomposition of oil price uncertainty with respect to supply and demand shocks. Case of supply shock. Note: This figure depicts the contribution (in green) of the flow supply shock (Saudi Arabia crude oil production) to oil price uncertainty. The blue line corresponds to oil price uncertainty at 1 month

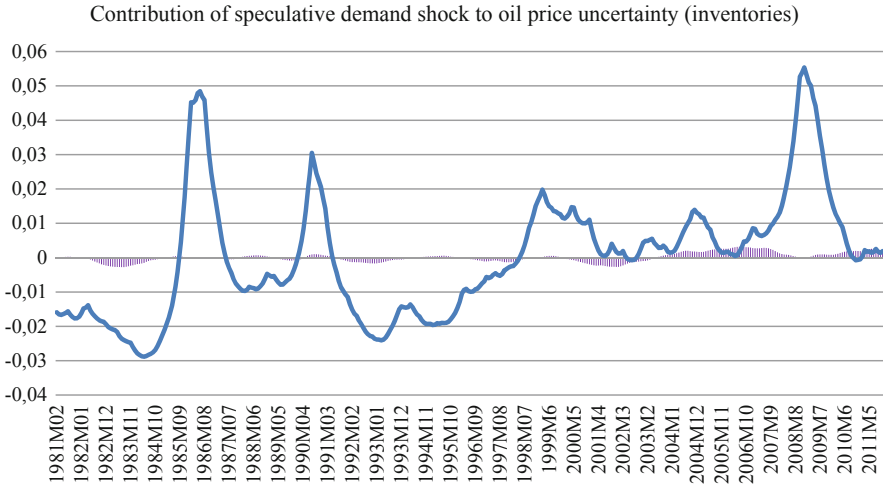


Fig. 5 Historical decomposition of oil price uncertainty with respect to supply and demand shocks. Case of speculative demand shock. Note: This figure depicts the contribution (in purple) of the speculative oil demand shock (inventories) to oil price uncertainty. The blue line corresponds to oil price uncertainty at 1 month

anticipation of higher future oil prices. On the contrary, the recent literature supports the conclusion that the surge in the oil price during this period was mainly caused by shifts in the flow demand driven by the global business cycle (see Kilian, 2009 and Kilian and Hicks, 2013). Our findings corroborate this view that oil price uncertainty has been primarily driven by global macroeconomic conditions. Indeed, as shown in Figs. 3, 4, and 5, the contribution of speculative demand to price uncertainty is very small (around 5%) compared to the proportion of the flow demand from the global business cycle in 2008 (around 40%). An alternative view regarding speculation is that OPEC held back its production by using oil below ground in anticipation of higher oil prices. As discussed by Kilian and Murphy (2014), this behavior would be classified as a negative oil supply shock. Our results provide no evidence that such negative oil supply shocks have significantly contributed to oil price uncertainty, contrary to demand shocks.

Finally, looking at Fig. 6, which reports the simultaneous contribution of each shock (flow demand, flow supply, speculative demand, and macroeconomic uncertainty) to oil price uncertainty, we find that the 2007–2008 period of heightened oil price uncertainty is mainly the consequence of shocks coming from the global business cycle and macroeconomic uncertainty.

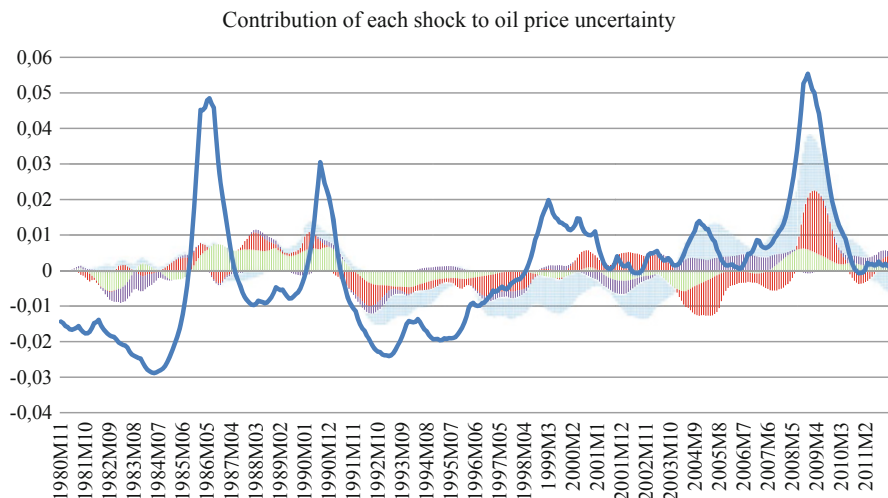


Fig. 6 Historical decomposition of oil price uncertainty with respect to supply and demand, macroeconomic uncertainty shocks. Note: This figure depicts the contribution of each shock to oil price uncertainty. The blue line corresponds to oil price uncertainty at 1 month. The contribution of the flow demand (global business cycle) is in blue, the contribution of the macroeconomic uncertainty at 1 month is in red, the contribution of the flow supply shock (Saudi Arabia crude oil production) is in green, and the contribution of speculative oil demand shock (inventories) is in purple

4 Conclusion

The aim of this contribution is to analyze the impact of macroeconomic uncertainty on the oil market. To this end, we rely on a robust measure of macroeconomic uncertainty based on a wide range of monthly macroeconomic and financial indicators. We also account for nonlinear effects of macroeconomic uncertainty on oil price returns depending on the degree of uncertainty, through the estimation of a threshold VAR model from which we derive a robust measure of oil market uncertainty. We show that the recent 2007–2009 recession generated an unprecedented episode of high uncertainty in the price of oil. In addition, our analysis puts forward that macroeconomic uncertainty episodes are not necessarily accompanied by high volatility in the oil price. This major finding illustrates the interest of our measure of uncertainty, underlining that uncertainty is more related to predictability than to volatility. The relevance of the predictability-based approach could be explained by some specific properties of the oil market. In particular, this market is known to be characterized by a low elastic demand together with a strong inertial supply, making any unexpected adjustment difficult and costly. This importance of factors that are specific to the oil market is in line with the conclusions of the recent World Economic Outlook published by IMF (IMF, 2015) underlining that greater than expected oil supply and some weakness in the demand for oil linked to

improvements in energy efficiency have played a key role in explaining the recent oil price collapse.

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