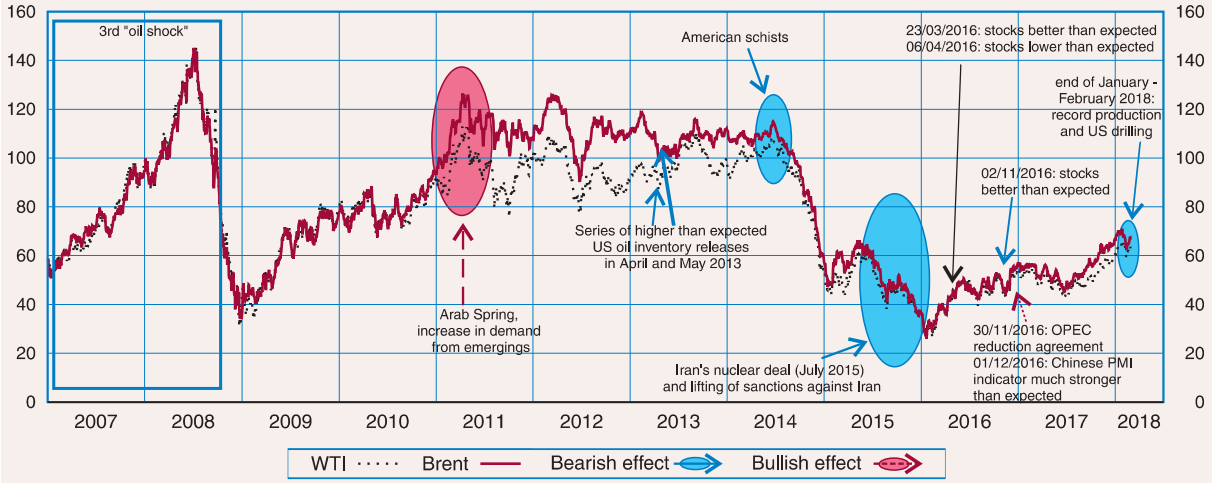
Macroeconomic publications on short-term trends have little influence on variations in oil prices

The price of oil is subject to strong fluctuations. It declined almost fourfold from $115 in August 2013 to under $30 in January 2016, before rising again to $64 by mid-February 2018. Oil prices have a significant impact on economic activity, affecting household purchasing power and hence household consumption and it also influences companies' production costs. Although forecasting the price of a barrel can prove difficult, its determinants can nevertheless be studied, whether they are impacted mainly by supply or demand.

Many factors can affect the supply of oil, such as geopolitical tensions and the arrival of new producers on the market, such as shale oil in the United States. The economic situation and the short-term outlook in importing countries influence world demand and hence prices. Once long-term factors have been isolated, the price of oil still remains very volatile in the short term. Since financial operators pay close attention to the macroeconomic calendar and publications of short-term trends, some of this volatility could perhaps be explained by recent news of this kind. However, the short-term impact on oil prices of publishing short-term macroeconomic indicators, such as the Purchasing Managers Index (PMI) or GDP growth, appears to be very small.

Oil prices since 2007 in US dollars



Source: INSEE

Some notable macroeconomic or geopolitical events and announcements are shown on the graph, in red for bullish events and in blue for bearish events. For example, the Arab spring and the sharp rise in oil demand from the emerging countries in 2011, the announcement by OPEC on 30 November 2016 of an agreement to cut oil production and the publication of a much higher China Manufacturing PMI than expected on 1st December 2016 all put upward pressure on oil prices. In contrast, the prospect of lifting sanctions against Iran at the end of 2015 and hence of a recovery in Iranian oil exports led to a significant fall in prices. In spring 2016, the sharp upward trend in oil prices was halted briefly by the announcement on 23 March 2016 of larger-than-expected inventories. The price of a barrel also plummeted after US production topped the 10 million barrels a day milestone at the end of January and beginning of February 2018. Some macroeconomic announcements that are out of step with expectations seem to have taken the markets by surprise and to have had an impact on oil prices. However, isolated incidents are not sufficient to produce statistical regularity; it is therefore necessary to study whether the effects of these surprises can be identified and estimated statistically.

In the long term, oil prices balance out according to supply and demand

To estimate the effects of macroeconomic surprises on short-term variations in oil prices, the long-term relations that determine prices need to be identified. The aim here is not to produce a forecasting model but rather to isolate the variables that influence the price of oil in the long term. These variables are used to evaluate oil supply and demand: US oil inventories, the PMI Manufacturing indices in the United States, China and Russia, average US oil production over the last six months, the International Energy Agency (IEA) forecast for non-OPEC global oil supply and the euro/US dollar exchange rate, expressed in US dollars to the euro.

The results confirm the existence of a long-term relationship between the price of oil and the selected variables. Supply variables (Russia PMI, inventories, production, supply forecasts) have a negative effect on oil prices, while demand variables (China and United States PMI, euro/dollar exchange rate) have a positive effect on price formation.
The impact of macroeconomic surprises on short-term oil price variations can then be isolated and estimated by taking into account the main determinants of the price of a barrel within the long-term relationship.

Publications on short-term trends may have a short-term impact if they differ from expectations

The financial markets anticipate the values given in short-term publications. Thus the effect on oil prices of new macroeconomic data in line with these expectations is basically zero, as the price already includes the anticipated information. Macroeconomic surprises, on the other hand, defined as deviations between published values and what was anticipated by the financial markets, may have an impact on the price of oil.

Like long-term variations, short-term variations in oil prices may be influenced by surprises in supply and demand variables. For example, changes in inventories and revisions to the IEA forecasts of global oil supply provide new information on supply. On the demand side, PMI indicators, industrial production and the GDP of certain countries as well as revisions to IEA estimates and forecasts of global oil supply are also to be taken into consideration. Some of these variables describe economic activity over a period in the past when they are published. They provide financial players with a concise knowledge of recent economic developments and may surprise observers.

In addition to the effect of macroeconomic news, the difference between the observed price of oil and its theoretical level in the long term may also account for some of the daily variations in the price of a barrel. For example, if this price is higher than its long-term level in respect of its fundamental determinants, it will tend to decrease in order to reach this level.

Unexpected variations in oil inventories account for some price variations

According to estimates, upward surprises in inventories (i.e. when the level of inventories is higher than anticipated) have a significant downward effect on oil prices, both Brent[1] and WTI.[2] If annual growth in industrial production in the Eurozone is different from expected growth, this also has an significant impact on Brent, just as growth in annual American GDP that differs from what was expected has a significant impact on the WTI. Surprises related to the publication of other macroeconomic data, however, and revisions to the supply forecasts do not have a significant effect. Revisions by the IEA to its global oil demand forecasts have a substantial positive effect on changes in WTI oil prices but not in the case of Brent.

According to the model used, if the Brent or WTI prices are one dollar higher than their long-term equilibrium level, then, all other things being equal, their variations will be reduced by $0.03. This is a callback mechanism specific to the macroeconomic equilibria between the variables considered. As there is a long-term relationship between the price of a barrel and its fundamental determinants, short-term divergences between the price and its determinants have a tendency to diminish.

Looking at data from 25 June 2014 to 13 February 2018, it can be seen that the difference between the real variation in commercial oil inventories in the United States and market anticipations is around the standard deviation (or around 4.8 million barrels). This reduces prices by an average of $0.20 for Brent and $0.24 for WTI.

In addition, all other things being equal, an upward revision of one million barrels per day to the IEA global oil demand forecast for the following quarter generates an increase in the price of WTI oil of $2.10. The price of Brent probably increases by the same amount after such a revision, but its daily variations seem to be influenced more by other factors or specific features of the local market: this revision is not significant and is therefore not used in the equation.

Lastly, when annual growth in industrial production in the Eurozone is less than the standard deviation (0.8 points) of what was expected, the price of Brent increases by $0.36, and when quarterly GDP growth in the United States is less than the standard deviation of what was expected (0.5 percentage points), this increases the price of WTI by $0.40. This latter effect may be explained by an expectation of a backlash: since growth in production was not as high as expected, it may return to its trend levels the following quarter, and hence demand increases by a catch-up effect. In addition, if production growth was higher than expected, it is less likely that it will increase further and that demand will grow further and exceed its level of the previous quarter, which was already particularly high compared to expectations. On 30 January 2015 and 29 May 2015 for example, US GDP growth was less than expected, at +2.6% instead of 3.3% and –0.7% instead of +0.2% respectively, in other words, negative surprises of standard deviations of around –1.3 and –1.7 respectively. They coincided with a rise in the price of WTI oil by $3.7 between 29 and 30 January 2015, and $2.6 between 28 and 29 May 2015.

Another possible channel is the anticipation of monetary policy: higher-than-expected growth may increase inflationary tensions, and thus lead to monetary tightening, reducing anticipated demand and hence the price of oil.

1. Brent is oil from the North Sea, a benchmark for European supplies.
2. WTI (West Texas Intermediate) is a light oil, produced and refined in North America.

However, explained volatility remains very low: most variations in oil prices depend on other factors

Long-term oil price differentials and inventory surprises account for only about 3.6% of the volatility of Brent oil prices and about 2.5% for WTI oil prices. Over 96% of daily variations are therefore unexplained by the factors considered here. This result is consistent with several conclusions on this subject in the literature, for example the work by Kilian and Vega (2011). Thus, macroeconomic news has virtually no immediate effect on oil prices, which reinforces the theoretical and empirical methods used elsewhere for forecasting and which are based on this hypothesis. ■

Bibliography

Coffinet J. and **Gouteron S.** (2009), "Euro-Area Yield Curve Reaction to Monetary News", *German Economic Review*, 11(2), p. 208-224.

Jess N., Roucher D., Bernard J.-B. and **Cléaud G.** (2013), "Comment prévoir le prix du pétrole?", *Conjoncture in France*, INSEE, June, p. 41-58.

Kilian L. and **Vega C.** (2011), "Do Energy Prices Respond to U.S. Macroeconomic News? A Test of the Hypothesis of Predetermined Energy Prices", *The Review of Economics and Statistics*, 93 (2), May, p. 660-671.

King K., Deng A. and **Metz D.** (2012), "An Econometric Analysis of Oil Price Movements: The Role of Political Events and Economic News, Financial Trading and Market Fundamentals", *Bates White Economic Report*, January. ■

Methodology

The collected data are based on general macroeconomic indicators or variables concerning the oil market (rig count and output in the United States published every Friday, commercial oil inventories in the United States, forecasts of oil supply and demand published by the International Energy Agency, IEA). Data relating to economic indicators are taken from the tradingeconomics.com website, which consolidates the latest published value, the consensus of analysts (average of expectations of a number of market economists) and the previous value.

The period of analysis selected runs from 25 June 2014 to 13 February 2018, taking into account price levels and their daily variations in order to estimate the impact of a surprise event on the variation in oil prices between the day of the announcement and the day before. This exercise was inspired by the method used by several authors, such as Kilian and Vega (2011) and Coffinet and Gouteron (2009), but who studied sub-daily variations, looking at a few minutes before the announcement and a few minutes after. Only daily, not hourly variations are studied here, because of data availability and the economic focus of the analysis.

The surprise (difference between the figure actually published and the consensus of the analysts) was calculated either as a percentage, or standardised by its standard deviation, as in Kilian and Vega (2011).

A standard assumption when using vector autoregressive models (VAR) is the absence of an immediate effect of macroeconomic aggregates on the price of oil. However, oil can be seen as a storable and homogeneous asset; its price, determined by supply and demand, can react to any news that provides information or indices on anticipated supply and demand, and hence to macroeconomic news, such as stock prices or exchange rates (e.g. see Kilian and Vega, 2011). For example, a positive surprise in values for current or future production or employment could be associated with a positive variation in the price of oil, due to demand being greater than expected. In their article, Kilian and Vega found that macroeconomic surprises had only a small effect on the price of WTI oil.

Long-term relationships between price levels and their determinants are as follows:

$$WTI_t = \underset{(-15.0)}{-204.5} - \underset{(-9.1)}{0.00031} * \Delta stocks_t + \underset{(32.6)}{4.12} * PMI_{USA,t} + \underset{(13.9)}{5.53} * PMI_{China,t} - \underset{(-11.5)}{1.8} * PMI_{Russie,t}$$
$$- \underset{(-6.7)}{0.0075} * Prodmoyenne_{USA,t} + \underset{(27.5)}{86.0} * tx_{EUR/USD,t} - \underset{(-6.3)}{3.1} * Offre\_prévue\_proc$$
$$- \underset{(-3.4)}{0.12} * Offre\_prévue\_cur + Résidus_{WTI,t}$$

$$\text{Adjusted } R^2 = 0.91$$

$$Brent_t = \underset{(-20.9)}{-298} - \underset{(-5.0)}{0.0058}^{*}\, Prodmoyenne_{USA,t} - \underset{(-7.3)}{0.00026}^{*}\, \Delta stocks_t + \underset{(15.3)}{6.29}^{*}\, PMI_{China,t}$$

$$+ \underset{(37.5)}{4.9}^{*}\, PMI_{USA,t} + \underset{(27.3)}{89.1}^{*}\, tx_{EUR/USD,t} - \underset{(-6.1)}{3.1}^{*}\, Offre\_prévue\_proc + Résidus_{Brent,t}$$

Adjusted $R^2 = 0.92$

For these two equations, the period of estimation is the same, from 25 June 2014 to 13 February 2018 (920 observations).

The notations are as follows:
- WTI_t and $Brent_t$ represent the prices of WTI oil and Brent (North Sea oil), respectively, on date t;
- $\Delta stocks_t$ represents the latest available inventory change published by the EIA (Energy Information Administration), an agency attached to the American Department of Energy, on date t;
- $PMI_{USA,t}$, $PMI_{China,t}$ and $PMI_{Russie,t}$ represent respectively the latest available manufacturing PMI on date t for the United States (published by Markit), China (published by the National Bureau of Statistics of China) and Russia (published by Markit);
- $Prodmoyenne_{USA,t}$ represents average US oil production calculated over the last 6 months;
- $tx_{EUR/USD,t}$ represents the EUR/USD exchange rate on date t, expressed in dollars to the euro;
- *Offre_prévue_cur* and *Offre_prévue_proc* represent the latest available IEA (International Energy Agency) forecasts for global non-OPEC production for the current quarter and the following quarter, respectively;
- $Résidus_{WTI,t}$ and $Résidus_{Brent,t}$ represent the residual components not explained by the variables above, i.e. the difference between the values predicted by these variables and the prices observed on date t.

The short-term equations for variations in oil prices are the following:

$$\Delta brent_t = \underset{(-2.7)}{-0.20}^{*}\, Surprise\_Stocks_t - \underset{(-1.9)}{0.36}^{*}\, Surprise\_prodindus\_ZE_t - \underset{(-4.5)}{0.03}^{*}\, Résidus_{Brent,(t-2)}$$

Adjusted $R^2 = 0.030$
Estimation period : 27 June 2014 to 13 February 2018 (918 observations)

$$\Delta WTI_t = \underset{(-1.4)}{-0.05} - \underset{(-2.9)}{0.24} \times Surprise\_Stocks_t - \underset{(-1.9)}{0.43}^{*}\, Surprise\_USAgrowth_t$$

$$+ \underset{(3.4)}{2.1}^{*}\, RevDemande\_prochainTrimestre - \underset{(-3.6)}{0.029}^{*}\, Résidus_{WTI,(t-1)}$$

Adjusted $R^2 = 0.029$
Estimation period : 27 June 2014 to 13 February 2018 (918 observations)

With the following notations:
- $\Delta brent_t$ and ΔWTI_t represent the arithmetic differences in the price of Brent and WTI respectively from one day to the next (between t–1 and t);
- $Surprise\_Stocks_t$ represents the surprise introduced by the EIA's publication of the variation in the level of stocks. This variable is 0 on the days when there is no publication. On days when the variation is published, it equals the ratio of, on the one hand, the difference between the value published by the EIA and market expectations, and on the other hand, the standard deviation of this difference calculated across all the days when the sample is published;
- $Surprise\_prodindus\_ZE_t$ represents the surprise on date t introduced by the monthly publication of annual growth in industrial production in the Eurozone (month-on-month over a 12-month period), calculated in the same way as the surprise over stocks;
- in the same way, $Surprise\_USAgrowth_t$ represents the surprise on date t introduced by the publication of the US GDP;
- *RevDemande_prochainTrimestre* represents the revision by the IEA of its forecasts for world demand for oil for the next quarter, in millions of barrels per day. This variable is 0 on the days when the IEA does not publish an Oil market report and on days when it is published the variable is equal to the revision percentage over the quarter under consideration;
- $Résidus_{WTI,(t-1)}$ and $Résidus_{Brent,(t-2)}$ represent the residuals of the long-run equations for WTI and Brent respectively, as presented above, one day before (in the case of the WTI) and 2 days before (in the case of Brent), respectively, i.e. the difference observed the previous day (WTI) or two days previously (Brent) between the level observed and the long-run equilibrium level simulated by these variables and the corresponding equation. ■