II.1. Revisiting the macroeconomic effects of oil price changes ([20])

Oil prices have fallen by around 40 % in euro terms since mid-2014, and are expected to remain relatively low in the medium term. With this situation in mind, this section assesses the effect of changes in oil prices on inflation and economic activity in the euro area. The analysis shows that the impact of low oil prices on GDP growth and inflation is likely to be substantial, with the largest change in both variables (0.6 percentage points and 0.3 percentage points, respectively) predicted to occur in 2015. The effect on employment is estimated to peak at around 1 %. The economic impact of oil prices does not seem to vary significantly depending on whether monetary policy is or is not constrained by the zero lower bound. However, the analysis also confirms that large oil price shocks have a nonlinear effect on output growth, especially in the context of the recent sharp fall in oil prices. The fall in output growth that results from a large rise in oil prices is greater in magnitude than the increase in output growth seen when there is a large fall in oil prices.

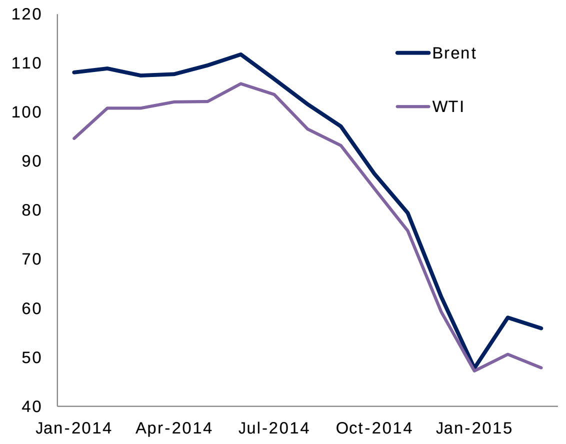
Introduction

Crude oil prices have fallen significantly since mid-2014. Prices per barrel fell by more than USD 50, i.e. more than 50 %, between June 2014 and March 2015 (Graph II.1.1).

The price fall in euro terms has been less pronounced, as a result of the depreciation of the euro against the dollar over the same period. Prices fell by around EUR 30 per barrel between June 2014 and March 2015, corresponding to a fall of around 40 % (Graph II.1.2).

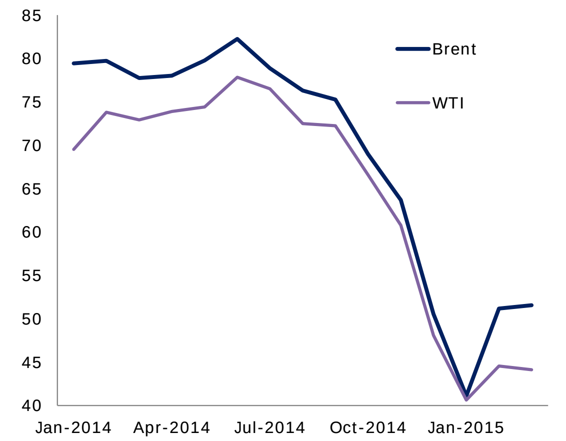
Graph II.1.3 plots the crude oil spot price relative to the Harmonised Index of Consumer Prices (HICP) for the euro area. Looking at a longer time period, it can be seen that oil prices have returned to their mid-2000s level.

Graph II.1.1: **Spot price of oil, USD / barrel**
(Jan 2014 – Mar 2015, monthly average)



Source: Thomson Reuters.

Graph II.1.2: **Spot price of oil, EUR / barrel**
(Jan 2014 – Mar 2015, monthly average)



Source: European Central Bank, Thomson Reuters.

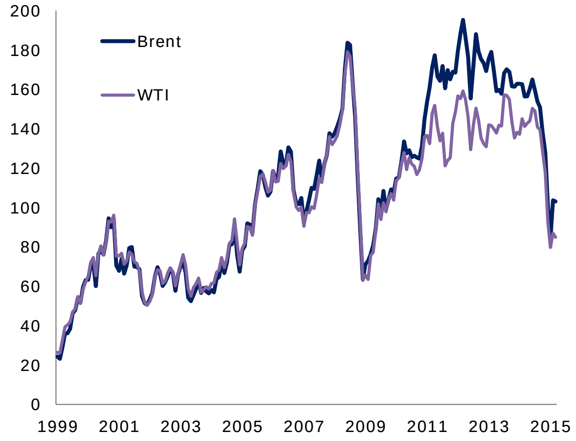
The fall in oil prices has caused all energy prices in the euro area to drop in recent months, as illustrated by the fall in the energy component of the HICP (Graph II.1.4). The fall in the energy component of this index has been less pronounced than the fall in the sub-component representing liquid fuels. This shows that prices of other sources of energy have not fallen to the same extent as the oil price.

Although oil prices have recovered slightly since February, it is expected to be some time before they return to mid-2014 levels. This expectation is reflected in the Commission's spring 2015 forecast, which assumes only a limited recovery of the oil price to USD 67 per barrel by the end of 2016.

([20]) Section prepared by Rafal Raciborski, Anastasia Theofilakou and Lukas Vogel.

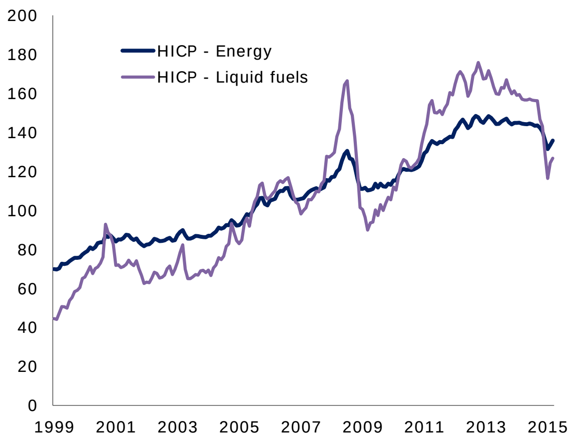
Low oil prices would normally be expected to have a positive effect on the economy of the euro area. This section presents the results of analysis carried out to quantify this effect and reassess the impact of changes in the oil price on the euro area economy.

Graph II.1.3: **Oil price relative to euro area HICP**
(Jan 1999 – Mar 2015, index: 2005 = 100)



Source: European Central Bank, Thomson Reuters.

Graph II.1.4: **Energy and fuel prices, euro area HICP**
(Jan 1999 — Mar 2015, index: 2005=100)



Source: European Central Bank.

The analysis draws on the results of model simulations and econometric evidence.

This section has three parts: the first discusses in general terms the transmission channels through which a change in oil prices affects overall prices and economic activity; the second part then presents the results of simulations carried out using a multi-region macroeconomic dynamic general equilibrium model designed to estimate the magnitude of the change in inflation and output caused by changes in oil prices; and the third part discusses estimates of the effect of an oil price shock generated using a threshold vector autoregression (TVAR) model. This model allows for nonlinearity in the effects of oil prices on economic activity. In particular, it takes account of the asymmetry between the effects of rising and falling oil prices.

Assessing the potential asymmetric effects of oil price shocks on economic activity is important for several reasons. First, asymmetry in the transmission of oil shocks could arise as a result of second-round effects on wages, savings or investment, which could amplify the effects of oil shocks beyond what would be expected were only direct demand and supply channels considered. Second, asymmetric effects may have implications for policy decisions, in particular in terms of how monetary policy is used to respond to oil shocks. Finally, the presence of asymmetric effects has implications for the ways in which oil prices should be modelled.

Transmission channels

The qualitative and quantitative effects of the oil price on inflation and economic activity depend on the relative strength of the various transmission channels. The oil price affects oil importers such as the euro area via three main channels: ([21])

- The real income effect: falling oil prices increase households' purchasing power by reducing the price of the oil/energy component in final demand. The complementarity between oil/energy and other items in final demand means that the real income effect is stronger than, and therefore outweighs, the substitution effect (associated with falling relative prices of oil/energy), leading to higher demand for non-oil goods and services.

- The production cost effect: a fall in oil prices reduces production costs in industries where oil is an intermediate input in production. Depending on the degree of competition, the fall in production costs may lead to higher profits or lower output prices. In the latter case,

([21]) Arezki, R. and O. Blanchard (2015), 'The 2014 oil price slump: seven key questions', *VOX*, 13 January 2015.

the real income effect (explained above) is amplified. Cheaper oil may also create a substitution effect in production, with manufacturers moving towards more oil-intensive technologies. This will also increase investment in these areas.

- The inflation effect: the fall in oil/energy prices and production costs creates downward pressure on the overall price level, i.e. leading to lower inflation. Inflation rates may even become negative (deflation) if inflation is already low.

The impact of falling inflation on economic activity depends on the response from policymakers. In particular, central banks would tend to cut benchmark interest rates if the economic situation is 'normal', thus stimulating demand and economic activity. If, however, monetary policy is already at, or close to, the zero lower bound, as is currently the case in the euro area, conventional monetary stimulus is no longer available to policymakers. Under this scenario, real interest rates may increase in response to downward pressure on prices, an effect which may partly offset the positive effects of gains in real disposable income.

In addition to experiencing the direct effects of lower prices of imported oil/energy on domestic activity, open economies, such as the euro area, are also exposed to spillover effects resulting from the consequences of changes in oil prices on other regions of the world economy.

Cross-border spillover effects from falling oil prices can be expected to be positive for the euro area, as export demand benefits from increases in real income and the resulting higher demand in other oil-importing countries. These positive effects are partly offset by the negative spillover effect of reduced demand from oil-exporting countries.

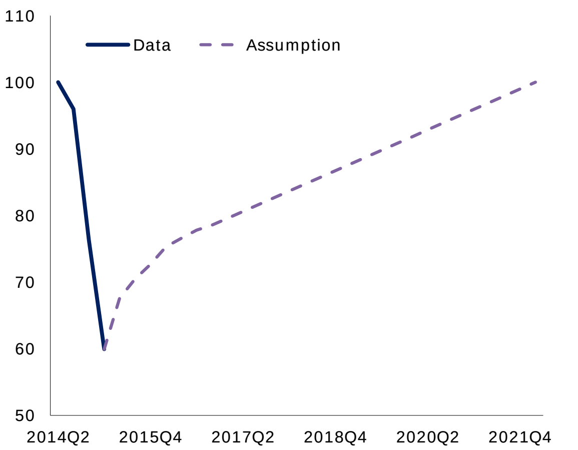
Model simulations

Changes in the oil price have a significant effect on economic activity and inflation in the euro area, and are therefore given significant consideration in forecasting. This section discusses these effects on the basis of the results of simulations generated using a three-region version of the global multi-country model, a dynamic general equilibrium model being developed by the Directorate-General for Economic and Financial Affairs and the Joint Research Centre of the European Commission. The three regions are the euro area, the US, and the rest of the world. The euro area is modelled as an oil importer.

The model includes oil as an intermediate input in the production of final output. The combination of oil and value-added (created by capital and labour) being used to produce total output follows the logic of input-output accounts, in which total output is decomposed into intermediate inputs and value-added.

An important determinant of the impact of oil price shocks is the substitutability between value-added and oil in demand. Empirical evidence suggests that the elasticity of substitution varies depending on the time period being considered. ([22]) The model therefore assumes a gradual adjustment of oil demand to relative price changes, so that the price elasticity of demand for oil is low in the short term and higher in the longer term.

Graph II.1.5: **Oil price path in the simulation (in EUR)**
(2014Q2 – 2022Q1, index: 2014Q2 = 100)



Source: Thomson Reuters, European Central Bank, DG ECFIN calculations.

The oil prices used in the simulated scenario are: the observed prices from 2014Q2 to 2015Q1 (thus a fall in the oil price); the oil price assumption used in the Commission's Spring 2015 Forecast for the period up to 2016Q4; and prices based on the

([22]) See the summary of estimates in Hamilton, J. (2008), 'Understanding crude oil prices', *NBER Working Papers*, No 14492, and Hamilton, J. (2009), 'Causes and consequences of the oil shock of 2007-08', *Brookings Papers on Economic Activity*, Spring 2009, pp. 215-283.

assumption of a continuation of the gradual recovery for the period after 2016Q4. In particular, oil prices are assumed to return to the level seen in 2014Q2 by 2022. The oil price shock is therefore being assumed to be very persistent but not permanent. Graph II.1.5 shows the underlying change in the oil price assumed for the simulation.

The oil price path reflects the effect of two shocks: a pure world oil price shock (expressed in dollar terms) and the recent euro depreciation, which is thought to have been driven by other factors. Using the oil price in USD, i.e. treating the countervailing effect of the simultaneous depreciation of the euro against the dollar as a separate factor, would amplify the negative effect of the oil price shock on inflation and its positive effect on economic activity. The model treats the fall in the oil price as if it were a pure price shock, although the effect of the euro depreciation is actually also included in the figures.

The model also assumes the price shock to have been caused by an expansion in world oil supply, in line with the empirical evidence. ([23]) Oil prices have also fallen, on various occasions in the past, as a result of slowing world demand for oil. Were lower oil prices assumed to be a consequence of slowing world demand, additional, negative spillover effects would also need to be accounted for in the model? These would cause euro area growth to slow, through the trade channel, and would increase deflationary pressures.

The model includes an excise tax on oil. This represents the non-proportional taxes levied on fossil fuels by euro area Member States. ([24]) An excise tax on oil lessens the fall seen in the price paid by consumers for oil products for any given fall in the price of oil on the world market.

The effect of the oil price shock shown in Graph II.1.5 on the main macroeconomic variables in the euro area is summarised in Table II.1.1. The results are annualised figures for each calendar year and are expressed as deviations from a no-shock, i.e. no oil price decline, baseline.

Table II.1.1: **Model simulation results: deviations from the no-shock baseline, euro area**[(1)]

(%)

	2014	2015	2016
Energy price (EUR, after tax)	-2.3	-10.6	-7.8
Oil imports (volume)	0.2	2.3	3.5
Real GDP	0.2	0.8	0.7
Employment	0.2	1.0	0.9
Private consumption	0.1	0.6	0.6
Private investment	0.4	1.0	0.8
Real GDP growth	0.2	0.6	-0.2
CPI inflation	-0.1	-0.3	0.1
Trade balance (% of GDP)	0.1	0.6	0.3

(1) Results in the upper part of the table are deviations from the baseline, in %; results in the lower part of the table (GDP growth, CPI inflation and trade balance) are deviations from the baseline in percentage points.
Source: DG ECFIN calculations.

Imposing a constant excise duty on oil products (notably fuel) moderates the effect of the fall in oil prices on domestic prices. The after-tax price of domestically consumed oil is expected to fall by only 11 % in 2015 (relative to the average price over 2014).

The demand for oil increases when the oil price falls as a result of, firstly, oil being substituted for value-added in the production of final output, i.e. the substitution effect, and, secondly, higher demand for oil resulting from higher demand for final output, i.e. the income effect. The adjustment in demand is gradual, however, delaying the increase in the demand for oil. The model simulations show demand for oil to be 2 % and 3 % above the baseline in the years 2015 and 2016 respectively.

The positive income effect resulting from lower oil prices, together with the limited substitutability between oil and non-oil goods, also increases the demand for non-oil output. The demand for domestic value-added and the demand for non-oil imports therefore increase. The simulation results estimate the fall in the oil price to make a positive

([23]) Arezki, R. and O. Blanchard (2015), 'The 2014 oil price slump: seven key questions', *VOX*, 13 January 2015. Simulating a combination of oil supply and demand shocks would require an additional shock to the scenario, namely a decline in global economic activity and oil demand. Such decline in global activity would deteriorate the situation in the euro area. With regard to the oil price effect itself, however, demand-driven and supply-driven oil price reductions should have very similar effects as they constitute a positive supply shock for the oil-importing euro area. The scenario in the article can hence be interpreted as illustrating the isolated effect of an oil price decline, whether supply- or demand-driven, without taking into account developments such as a slowdown in global activity that may have contributed to the fall in oil prices.

([24]) Taxation currently accounts for around 50-60% of the price of transport fuels in the EU. Data on energy taxation are provided by the European Commission's Directorate-General for Energy at http://ec.europa.eu/energy/en/statistics/weekly-oil-bulletin.

contribution to GDP growth in 2015 of 0.6 percentage points. In 2016, the effect on growth becomes negative, as oil prices are assumed to gradually recover. It should, however, be noted, that GDP itself remains above the baseline, due to the fact that the oil price stays below its baseline level.

The fall in the oil price initially reduces consumer prices, as shown by the negative effect on CPI inflation in 2014 and 2015. The results of the model simulation suggest that the fall in oil prices will slow CPI inflation by 0.3 percentage points in 2015. The deflationary effect remains temporary, however, as oil prices are assumed to gradually recover over the period being considered.

The euro area trade balance improves when oil prices fall, as a result of lower expenditure on oil imports. The price effect is, however, mitigated by higher import volumes, including of non-oil products. In the simulations, the trade balance, in % of GDP, is seen to peak at 0.6 percentage points above its baseline level in 2015.

The model used to produce the simulation results shown in Table II.1.1 assumes that monetary policy is operating close to the zero lower bound on nominal interest rates during the period being considered. This assumption reflects the current situation, euro area monetary policy rates being close to zero, and assumes benchmark interest rates will not be cut in response to the deflationary impact of falling oil prices. Simulations generated using models that do not assume a binding zero lower bound provide similar results. The reason for this is that the policy rule used in the model reflects a delayed and muted response to the oil shock, i.e. it assumes that there will be a moderate degree of monetary easing in response to a fall in the oil price.

Asymmetric effects of oil price shocks

The recent period of low oil prices has generated a heated debate on the asymmetric effects of oil price shocks on real economic activity. The issue has featured in a number of empirical papers, whose main focus, reflecting that of the public debate, has been on whether the effect of falling oil prices differs from that of rising oil prices in absolute value terms. (25)

There are known to be mechanisms that could generate this type of asymmetry in the effects of oil shocks. One such mechanism is the zero lower bound constraint on monetary policy. In periods when nominal benchmark interest rates are close to zero, policymakers can still use monetary policy in response to rising oil prices and inflation pressure, by increasing interest rates. They cannot, however, lower interest rates in response to falling oil prices. Nonetheless, as has been shown in the previous sub-section, this type of nonlinearity is not likely to be very strong. Another potential channel through which an asymmetric effect on economic activity may be caused is price and wage adjustment. In particular, downward nominal price and/or wage rigidity leads to asymmetry in the respective second-round effects of falling and rising oil prices. (26)

Empirical evidence on the asymmetric effects of oil price shocks on real economic activity in the euro area is scarce. (27) This section assesses the potential asymmetric effects of rising and falling oil prices on real output growth in the euro area using a nonlinear, threshold VAR model (see Box II.1.1 for details of this methodology). Stylised evidence suggests there has been an overall rising trend in oil prices in recent decades, with gradual increases followed by sharp corrections. In addition to the usual effects of demand and supply, a number of new factors, such as the growing financialisation of the energy market, seem to have contributed to the 'boom and bust' trend seen in the oil market and to the

(25) See among others, Herrera, A. M., L. G. Lagalo and T. Wada (2015), 'Asymmetries in the response of economic activity to oil price increases and decreases?', *Journal of International Money and Finance*, Vol. 50, pp. 108-133. Herrera, A. M., L. G. Lagalo and T. Wada (2011), 'Oil price shocks and industrial production: Is the relationship linear?', *Macroeconomic Dynamics*, Vol. 15, No 3, pp. 472-497. Kilian, L. and R. J., Vigfusson (2011), 'Are the responses of the U.S. economy asymmetric in energy price increases and decreases?', *Quantitative Economics*, Vol. 2, No 3, pp. 419-453.

(26) Theoretical models suggest that asymmetric effects could also be caused by costly sectoral reallocation of capital and labour from contracting to expanding sectors. In oil-importing countries, allocative disturbances (e.g. mismatches of factor inputs across sectors) would amplify the recessionary effects of rising oil prices and mitigate the expansionary effects of falling oil prices. Nonlinearities could also arise as a result of an asymmetric monetary policy response to rises and falls in oil prices, and an increase in precautionary saving amid concerns about income and employment prospects. Uncertainty related to oil price fluctuations may weaken investment irrespective of whether prices are rising or falling. Nonetheless, theoretical models emphasise the irreversibility of investment, arguing that rising oil prices could increase uncertainty, forcing firms to postpone purchases of capital goods.

(27) See, for example, Jiménez-Rodríguez, R. and M. Sánchez (2005), 'Oil price shocks and real GDP growth: empirical evidence for some OECD countries', *Applied Economics*, Vol. 37, No 2, pp. 201-228.

Box II.1.1: The threshold vector autoregression (TVAR) methodology

The threshold VAR model allows to capture potential nonlinearities in the relationship between oil prices and real economic activity. Nonlinearities can occur for a number of different reasons: first, the effect of rising and falling oil prices on real output may be asymmetric; and second, the effect of any particular oil price shock on the economy may vary according to whether it occurs in an environment where there is a general strong upward trend in oil prices, or in an environment where there is a downward trend (regime-switching effects).

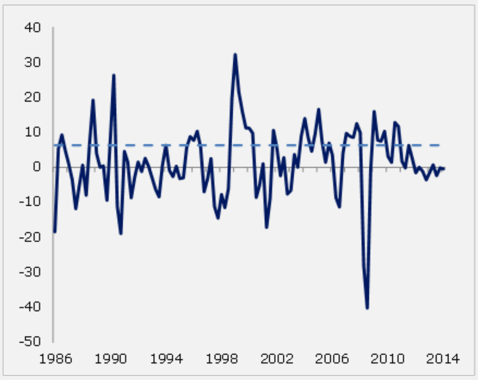
Following the approach used by Balke (2000) for estimating TVAR models, the asymmetric effects of oil price shocks on real economic activity in the euro area were analysed on the basis of the following structural TVAR model:

$$\Delta \mathbf{y}_t=(\mathbf{A}_0+\sum_{i=1}^{p}\boldsymbol{B}_{1,i}\Delta \mathbf{y}_{t-i})+(\mathbf{A}_1+\sum_{i=1}^{p}\boldsymbol{B}_{2,i}\Delta \mathbf{y}_{t-i})\mathrm{I}(\delta_{t-d}>\gamma)+\mathbf{U}_t \qquad (1)$$

where y_t is a vector of the model's variables, which include the oil price (in euros), real GDP, the HICP index, the three-month interest rate and the real wage. A and B represent matrices of coefficients, p is a lag length of order three of the endogenous variables and U_t defines the structural disturbances. A recursive identification scheme is used for identifying the structural contemporaneous relationships between the variables. The variables are ordered as listed above in this scheme. The results are, however, sufficiently robust that the same conclusion would be reached using an alternative ordering scheme. All variables are expressed in logarithms, with the exception of the interest rate which is defined in levels. The sample covers quarterly data for the euro area over the period 1986Q1 to 2014Q3.

In equation (1), δ_{t-d} is a threshold variable determining which of the two regimes the economy is in at any point in time, and d is the time lag of this variable, which is set to one. The threshold variable is the two-quarter moving average of the percentage change in the oil price, which is a rough measure of oil price fluctuations and boom-bust trends in oil prices. $I(\delta_{t-d}>\gamma)$ is an indicator function that is equal to 1 when changes in the oil price exceed an estimated value, γ, and 0 otherwise. In the TVAR model, the threshold parameter, γ, is not known *a priori* and is estimated from the threshold model for all possible threshold values. Tests of a linear VAR against a threshold alternative show the threshold value to be statistically significant, thus indicating the existence of nonlinearities in the model. The estimated threshold value ($\hat{\gamma}$ = 6.3%) splits the sample into two regimes: one being an environment characterised by steep upward moves in the oil price, which may signal a boom in the market, and the other being an environment where oil prices are rising less quickly, or falling, which may suggest a period of market correction or a bust phase. Graph 1 shows the threshold variable over time and the estimated threshold value. The division between the two states appears to well capture both types of phase, with periods of upward spikes in the oil price accounting, in total, for less time than those where oil prices are more slowly rising or falling.

Graph 1: Threshold variable and estimated threshold value



(1) The vertical axis represents the threshold variable defined as the two-quarter moving average of the percentage change in the oil price. The dashed line corresponds to the estimated threshold value ($\hat{\gamma}$ = 6.3%). Where the series is above the threshold value, this indicates a state characterised by large rises in oil prices. Where the series is below the threshold value, this indicates more slowly rising or falling prices.
Source: DG ECFIN calculations.

(Continued on the next page)

Box (continued)

Following the methodology set out in Koop *et al.* (1996), nonlinear impulse response function (NIRF) analysis was performed in order to assess the dynamic nonlinear propagation of oil shocks. Nonlinear IRFs and standard IRFs vary in a number of ways. First, standard IRFs are used in linear models and model the effects of an initial shock assuming that the economy is not affected by any other shocks. Second, nonlinear IRFs, unlike linear ones, are determined by the sign and size of the shock as well as by the initial condition of the system (for example, whether the environment is characterised by large rises in oil prices). This implies that the estimated responses generated by nonlinear IRFs are not symmetric in terms of the size and sign of the structural shocks. In this context, the potential asymmetry in how output growth in the euro area responds to oil price shocks was assessed by modelling shocks with different signs (positive and negative) and sizes (one and two standard deviations).

References

Balke, N. (2000), 'Credit and economic activity: credit regimes and nonlinear propagation of shocks', *Review of Economics and Statistics*, Vol. 82, No 2, pp. 344-349.

Koop, G., M. H. Pesaran and S. Potter (1996), 'Impulse response analysis in nonlinear multivariate models', *Journal of Econometrics*, Vol. 74, pp. 119-148.

increased volatility of oil prices. (28) In this context, the model is used to analyse the effects of oil price shocks on output growth under two different 'regimes' for the oil price: an environment characterised by sharp upward moves in the oil price, which may signal a boom in the market (denoted as the 'upper regime'), and an environment where the oil price is rising less quickly, or falling, which may suggest a period of market correction, or a bust phase (denoted as the 'lower regime'). (29)

Graph II.1.6(a) plots the responses of real output growth to positive and negative oil price shocks of a magnitude of one standard deviation, in each of the environments described above (the 'upper' and 'lower' regimes as defined above). Graph II.1.6(b) shows the responses of output growth to larger shocks (of magnitude two standard deviations), both positive and negative, and in the two environments. The response of output growth following a fall in oil prices is plotted with the sign reversed (i.e. positive values plotted as negative and vice-versa), so as to facilitate comparison with the equivalent response following a rise in oil prices. A 'large' (two standard deviation) oil shock is estimated to correspond to a price change of around 19 % of the oil price in absolute terms, and a 'small' (one standard deviation) shock to around 9 %. The size of the shock is roughly similar in both regimes.

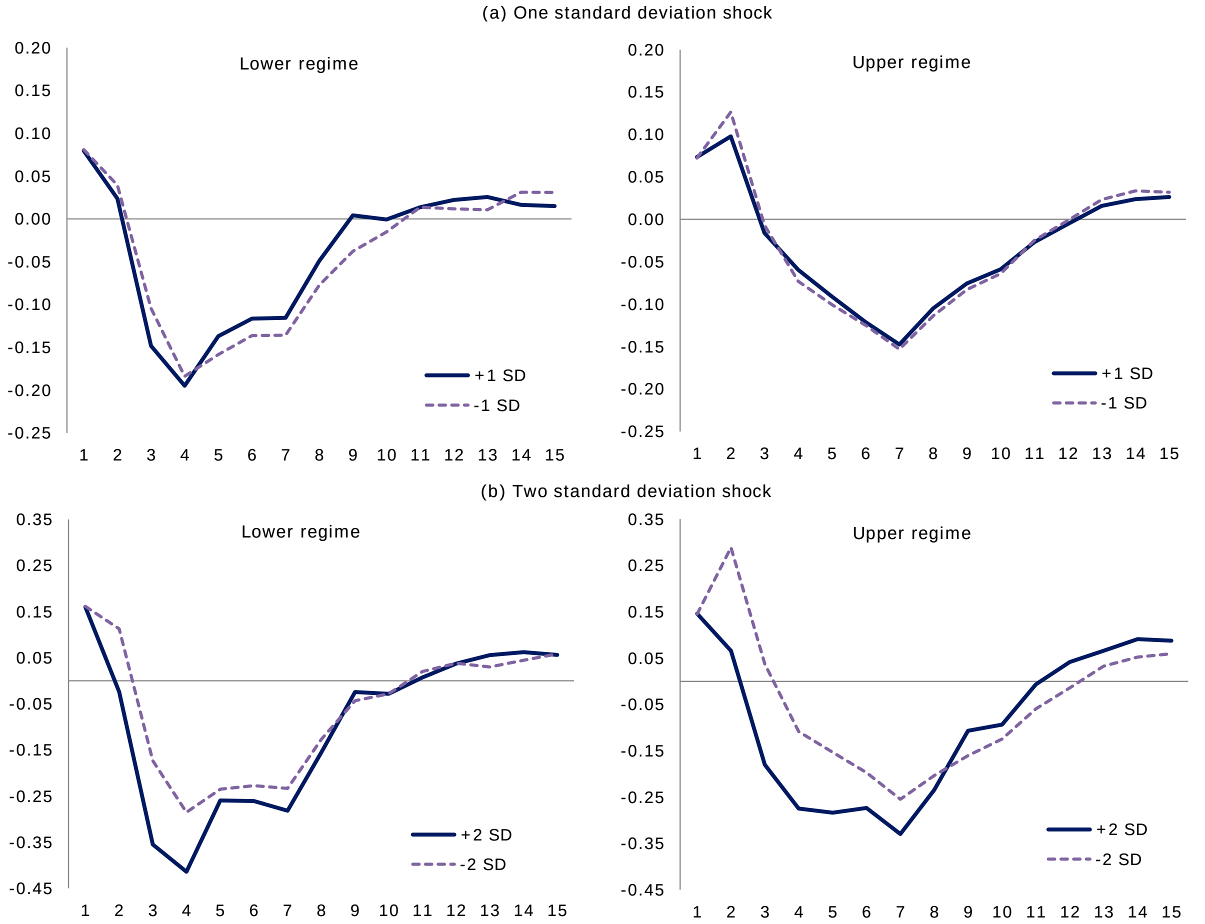
As can be seen from the graphs, the results produced by the nonlinear VAR model do suggest that rising and falling oil prices have asymmetric effects on output growth in the euro area.

First, the effect of a large oil price shock (modelled as a two standard deviation shock) on output growth can be seen to be of a different magnitude according to the direction of the shock. The fall in output growth that results from a large rise in oil prices (a two standard deviation positive shock) is greater in magnitude than the increase in output growth seen when there is a large fall in oil prices (a two standard deviation negative shock). When oil prices are rising only slowly or falling (the 'lower regime'), as is currently the case for the world economy, a large positive oil shock would cause output to fall, at its steepest point, by 0.42 % over a quarter (equivalent to an annual change of 1.7 %). By contrast, a negative oil shock of the same magnitude would cause a rise in output, with output growth peaking at 0.28 % over a quarter (equivalent to an annual change of 1.1 %).

These results could be explained by the asymmetric second-round effects of falling and rising oil prices, including downward price and/or wage rigidity,

(28) COM(2011) 25. 'Tackling the challenges in commodity markets and on raw materials'.
(29) A period of generally rising (falling) commodity prices can be described as a boom (bust) period in commodity markets. See also Kashin, P., C. J. McDermott and A. Scott (1999), 'Boom and slumps in world commodity markets', *IMF Working Papers*, WP/99/155.

Graph II.1.6: **Effect of oil price shocks on output growth**



(1) The vertical axis measures the effect that an oil price shock has on output growth over a 15-quarter window. The graphs show the effects of rises and falls in the oil price, and of shocks of different sizes (one or two standard deviations), i.e. the series labelled '-1 SD' illustrates the effect of a fall in the oil price, of magnitude one standard deviation. The response of output growth following a fall in oil prices is plotted with the sign reversed. 'Upper' and 'lower' regime denote, respectively, a state where the oil price is rising steeply, which may signal a boom in the market, and a state where it is rising slowly or falling, which may suggest market corrections or a bust phase in oil prices.
Source: DG ECFIN calculations.

asymmetric monetary policy responses, and a zero lower bound constraint on monetary policy. ([30])

Second, the asymmetry in the effects of large positive and negative oil price shocks is somewhat less pronounced when the economy is in a state where oil prices are generally moving strongly upwards ('upper regime'). The decline in output resulting from a large positive oil shock is at its steepest at a fall in output of 0.32 % over a quarter, whilst the rise in output following a negative oil shock of the same magnitude sees the change in output reach 0.25 % quarter-on-quarter. When oil prices are rising, with frequent sharp upward spikes, economic agents may find it more difficult to interpret the information about the state of the economy contained in oil price variations. They will therefore be more reluctant to reallocate resources across sectors, given the high costs associated with such adjustments. ([31]) Asymmetric second-round effects will therefore be less marked and the overall effect on the economy more muted

([30]) The non-linear impulse response functions suggest that there would be an initial decrease (increase) in output growth following a negative (positive) oil price shock. Oil price shocks could cause shifts in demand across goods depending on the intensity of oil use in different sectors. Allocative disturbances, including idle labour and capital, could cause a fall in the oil price to have a contractionary effect on the economy in the short run. See, also, Hamilton, J. D. (2003), 'What is an oil shock?', *Journal of Econometrics*, Vol. 113, No 2, pp. 363-398. Rahman, S. and A. Serletis (2010), 'The asymmetric effects of oil price and monetary policy shocks: A nonlinear VAR approach', *Energy Economics*, Vol. 32, pp. 1460-1466.

([31]) See among others, Lee, K., S. Ni and R. Ratti (1995), 'Oil shocks and the macroeconomy: the role of price variability', *Energy Journal*, Vol.16, pp. 39–56.

compared to that seen during a period where the oil price is generally changing less or falling. (32)

Finally, the effect of rising and falling oil prices on the euro area economy seems to be symmetric when the size of the oil shock is smaller (one standard deviation), with quarterly output growth peaking at 0.18 % (equivalent to an annual growth rate of 0.7 %). The effect of a small oil price shock on output growth is also broadly similar in the two economic environments considered - states of high and lower (or negative) oil price changes ('upper' and 'lower' regime). Economic agents appear to act similarly in response to small positive and negative oil price fluctuations.

Conclusions

Crude oil prices have fallen significantly since mid-2014 and are expected to remain low for an extended period of time. Changes in oil prices are likely to have a significant and positive impact on the economy of the euro area. According to the simulations generated using a three-region version of the global multi-country model, the positive contribution to GDP growth from falling oil prices will peak in 2015 at around 0.6 percentage points. Employment will also benefit, with the positive effect of falling oil prices reaching a peak of 1 %, again in 2015. The fall in oil prices is also predicted to reduce consumer prices, with CPI inflation slowing to 0.3 percentage points below the baseline rate in 2015.

The findings on the asymmetric effects of oil price shocks suggest that only large oil price shocks have an asymmetric effect on real output growth. Furthermore, the asymmetric effect of a large oil price shock on the economy is found to be somewhat more pronounced if it occurs in an environment of lower (or negative) oil price changes, as it is observed currently. Smaller positive and negative oil price shocks do not appear to have asymmetric effects on output growth.

The results of the simulation demonstrate that the empirically observed nonlinearities cannot be attributed to the binding zero lower bound constraint. Further analysis is needed to investigate the factors causing the asymmetries observed.

(32) Differences in market strategies for hedging energy prices in times of boom and bust in oil prices could be an additional reason for the differences between the response of output growth to changes in the oil price in the two regimes.