5. The impact of an increase in oil prices on economic activity

The price of oil has risen in the recent year due to more optimistic growth expectations for emerging economies and on the back of supply risks and disruptions in the Middle East and North Africa. Against this background, Section 5 presents model scenarios of endogenously driven oil price shocks using a recently constructed disaggregated version of the Commission's QUEST model. These simulations show that a proper assessment of the economic effect of a rise in oil prices requires a good understanding of the underlying causes of these price changes. Oil supply shocks generally have negative growth effects, raising costs in particular in energy intensive sectors and this spilling over to the whole economy. Oil demand shocks (i.e. those due to fast growth in the global economy) on the other hand lead to gradual but more persistent increases in the price of oil. This also has a negative impact on growth but the stimulus from higher global demand to exports can initially outweigh the negative impact from higher energy costs and the net effect on output can be positive. While these scenarios show the differences between supply and demand driven oil price shocks are significant, it is always difficult to disentangle the causes of changes in the price of crude oil in real time. At present, a combination of factors, i.e. supply disruptions as well as higher world demand for oil, are most likely playing a role, suggesting that the overall impact on growth should remain limited.

Given the expected sluggishness of the euro area's economic recovery, the evolution of oil prices forms a major concern. Oil is the most important source of energy and its price determines to a large extent other energy prices. Renewed increases in oil prices constitute a major downside risk to growth and an upside risk to inflation. Large oil price changes have been the driving force behind major recessions in recent history, and according to some also played a key role in the recent recession. ([24]) But what is of crucial importance is the underlying cause of oil price changes. Supply-driven oil price shocks have real effects that differ from those of oil price increases stemming from higher global demand. Against this background, this article presents model scenarios of endogenously driven oil price shocks using a disaggregated version of the Commission's QUEST model. It finds that in contrast to supply-driven oil price shocks, which have generally negative growth effects, the macroeconomic impact of oil price changes associated with higher global demand could be less adverse.

Oil price developments

Historically, oil price shocks have primarily been caused by physical disruptions in the supply of oil. This holds particularly for the shocks in the 1970s, which were associated with significant reductions in OPEC's oil supply. Following these price hikes, higher energy costs provided an incentive to reduce oil dependency and raise investment in energy-saving technologies. They also made other sources of energy more profitable, and led to an increase in supply. As a result, oil prices were in a general decline in the following two decades. However, faster growth in emerging economies in the 2000s raised demand for oil (and other commodities) and led to a surge in oil prices. The price of oil has risen sharply over the last decade and reached historic heights in the summer of 2008, peaking at USD 145 per barrel. With the onset of the crisis and the sharp decline in global economic activity, oil prices collapsed and fell back to below USD 40 per barrel by the end of 2008 (Graph 5.1). However, since then, global oil markets have started to tighten again, as demand growth has outstripped supply. More optimistic growth expectations for emerging economies have led to a rebound in the price of oil. In 2011, the oil price has risen further on the back of supply risks and disruptions in the Middle East and North Africa. Following the loss of 1.3 mb/d of Libyan exports, spare capacity has fallen to its lowest level since late 2008, although this loss has been partly offset by increased production by other OPEC members such as Saudi Arabia. In addition to tight fundamentals, markets have concerns over unrest spreading to other regional producers, which has triggered a 'geopolitical' risk premium. The price of crude oil has hovered around USD 110-120 per barrel (EUR 80 per barrel) in recent months, and there remain widespread concerns about future price developments. ([25])

([24]) Hamilton (2009) argues that the 2007-08 oil price shock was a major factor in causing the current recession and its impact was magnified by the rising energy share in expenditure. Hamilton, J. (2009), 'Causes and consequences of the oil shock of 2007-08', *Brookings Papers on Economic Activity* Vol. 40(1), pp. 215-83.

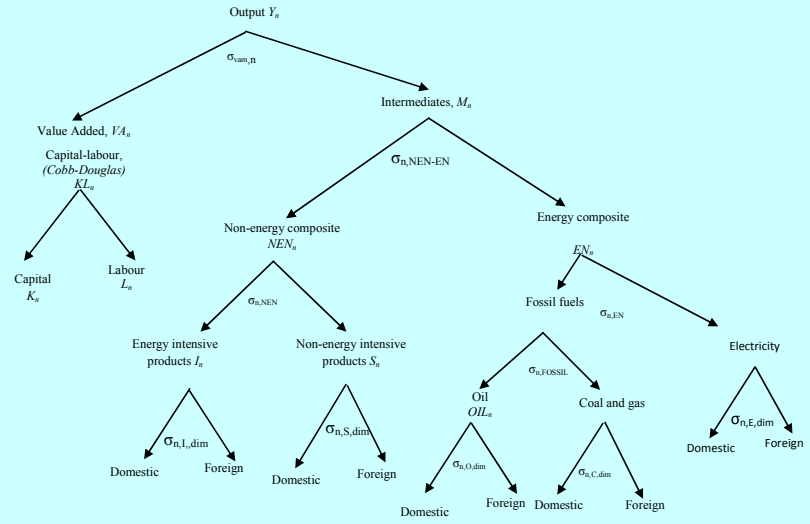
([25]) The IMF (2011) analyses the long-term implications of oil scarcity, caused by unresolved tensions between expected rapid growth in oil demand in emerging markets and the downward shift in oil supply trends. IMF (2011), 'Oil scarcity, growth and global imbalances', *World Economic Outlook*, Chapter 3 (April).

Box 5.1: A DSGE model with energy sectors

The QUEST model with energy sectors is a multi-sector version of DG ECFIN's standard open economy DSGE model. The model consists of three regions, the European Union (EU-27), the group of fossil fuel exporting countries (OEX) and the rest of the world (R). In each region, the model economy is populated by liquidity-constrained and non-constrained households, five sectors of producing firms, a monetary and a fiscal authority. We distinguish two sectors of non-energy goods and services and three energy-related sectors. Each firm in each sector produces differentiated goods which are imperfect substitutes for domestic and foreign goods. Firms use a capital and labour composite (value added VA) and a material and energy composite of intermediate goods (M). Interest rates are endogenous and the monetary authorities follow a standard Taylor rule in each region. The fiscal authority receives its revenue from taxes on factor incomes and consumption. The consumption, labour supply, fiscal and monetary authority settings closely follow those of the standard QUEST3 model (see Roeger et al., 2009 ([1])), so we focus on the main difference, which is the production structure in a multi-sector setting (see also Conte et al., 2010 ([2])).

The nested CES production structure of each sector can be generalised as shown in the figure below. Firms use a capital and labour composite (*VA*) and an energy and non-energy composite of intermediate goods (*M*), where energy (*EN*) itself is composed of an oil, coal and gas composite and electricity sources. Electricity itself is produced from fossil fuels (oil, coal and gas), other intermediates, labour and capital inputs. We distinguish two non-energy sectors, an energy-intensive ((e.g. transport and mining sectors, *I*) and a non-energy intensive sector (*S*). Figure 1 also shows the corresponding elasticities of substitutions between the production function composites. The calibrated values for these elasticities are shown in Table 1. These values are based on a combination of studies on energy-related CGE models (Bovenberg and Goulder, 1996; Goulder and Schneider, 1999; Sue Wing, 2003 ([3])). The sectoral composition is calibrated on the GTAP 7 database, which is primarily based on 2004 data ([4]). The 2004 price of oil was USD 40 per barrel; a 20% oil price increase in our simulation exercise corresponds to a USD 8 increase.

Technology of sectoral production



([1]) Ratto M., W. Roeger and J. in 't Veld (2009), 'QUEST III: An estimated open-economy DSGE model of the euro area with fiscal and monetary policy', *Economic Modelling*, Vol. 26 (1), pp. 222-233.

([2]) Conte, A., A. Labat, J. Varga and Ž. Žarnić (2010), 'What is the growth potential of green innovation? An assessment of EU climate policy options', *European Economy Economic Papers*, No 413.

([3]) Bovenberg, A. L. and L. H. Goulder (1996), 'Optimal environmental taxation in the presence of other taxes: General equilibrium analyses', *American Economic Review*, Vol. 86 (4), pp. 985-1000. Goulder, L. H. and S. H. Schneider (1999), 'Induced technological change and the attractiveness of CO2 abatement policies', *Resource and Energy Economics*, Vol. 21 (3-4), pp. 211-253. Sue Wing, I. (2003), 'Induced technical change and the cost of climate policy', *MIT Global Science and Policy Change Report,* No 102.

([4]) The share of net oil imports is calibrated at 2.26% of GDP for the EU-27. We also account for the quantity taxes/excise duties on fuel, which amounts to 1.4% of EU GDP on the baseline (DG TAXUD, 2010).

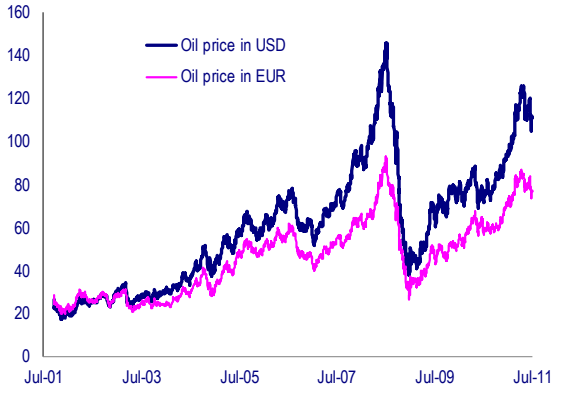
(Continued on the next page)

Box (continued)

Calibration of sectoral elasticities

Elasticity	Elasticity of substitution between	Sector			
		Energy-intensive	Non-energy intensive	Energy sectors	Final consumption
$\sigma_{vam,n}$	Value added and intermediates	0.5	0.5	0.5	-
$\sigma_{n,NEN-EN}$	Non-energy and energy products/services	0.15	0.15	0.15	0.15
$\sigma_{n,NEN}$	Non-energy products/services	0.5	0.5	0.5	0.5
$\sigma_{n,EN}$	Energy products/services	0.3	0.3	0.3	0.3
$\sigma_{n,FOSSIL}$	Fossil fuel products/services	0.3	0.3	0.3	0.3
$\sigma_{n,DIM}$	Domestic and imported products/services	1.5	1.5	1.5	1.5
$\sigma_{n,F}$	Imported goods	1.5	1.5	1.5	1.5

Graph 5.1: **Oil price developments (July 2001 to July 2011)**



Source: Reuters ECOWIN.

Impact on economic activity

Oil price shocks affect the economy through supply and demand channels. As terms-of-trade shocks they have an impact on the economy through their effect on production decisions and relative prices. Oil price shocks represent a shift in purchasing power between oil-exporting countries and oil-importing countries. As demand for energy is relatively inelastic, an increase in energy prices leads to a loss in real income (wealth transfer) and so affects consumers' and firms' spending on goods and services other than energy. The demand effects through this income channel are important to explain the major impact of oil price changes on the economy. Supply-side effects arise from the use of oil as an input factor in the production process. With limited short-term substitution possibilities, an increase in the price of oil inputs increases production costs and affects prices and output.

Disentangling demand and supply shocks in oil markets

It is impossible to predict the macroeconomic implications of higher oil prices without knowing the underlying causes. Assuming exogeneity, i.e. allowing for the price of oil to change while keeping everything else constant, is not a valid assumption for two main reasons. First, there is the issue of reverse causality. Macroeconomic aggregates also affect oil prices and hence cause and effects are not well defined when relating changes in the price of oil to macroeconomic outcomes. ([26]) Second, the price of oil can be driven by supply or demand shocks in the market for crude oil. These shocks have different dynamic effects on future oil prices and different macroeconomic impacts.

Kilian (2009) employs a structural VAR model and distinguishes three types of shocks: crude oil supply shocks, defined as unpredictable innovations to global oil production; shocks to the global demand for industrial commodities, defined as innovations to global real activity; and oil-specific demand shocks, reflecting fluctuations in precautionary demand for oil driven by uncertainties about future oil supply shortfalls. He finds that an increase in precautionary demand for oil causes an immediate, persistent and large increase in the real price of oil; global demand shocks for all commodities cause delayed, but sustained price increases; while crude oil

([26]) Barsky, R. and L. Kilian (2004), 'Oil and the macroeconomy since the 1970s', *Journal of Economic Perspectives* Vol. 18(4), pp. 115-34.

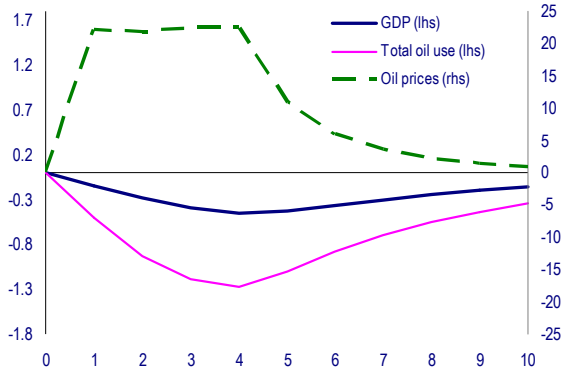
production disruptions typically cause small and transitory increases in the short run. ([27])

Historical decompositions of oil price fluctuations show that oil price shocks have generally been driven by combinations of global aggregate demand shocks and precautionary demand shocks associated with market concerns about the availability of future oil supplies. Direct oil supply shocks have generally played a smaller role. However, there are now widespread concerns about future oil supplies and about a general downshift in the trend growth of oil supply due to rising scarcity in oil resources (peak oil).

Model simulations

We employ a sector-disaggregated version of the Commission's QUEST model to analyse the different impacts of oil price shocks depending on whether they are caused by demand or supply factors. The model includes high and low energy-intensive sectors and different energy production sectors (see Box 5.1 for details). ([28]) The model captures both supply and demand channels as energy serves as an input in the production process and is consumed directly by households.

Graph 5.2: **Temporary oil production shock: impact on EU GDP, oil use and oil prices (in%)**



Source: QUEST simulations.

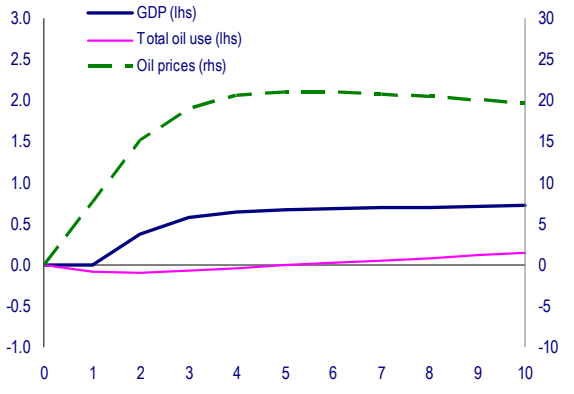
The first scenario shows the impact of a severe disruption in oil production of 5% that lasts for a four-year period, after which oil production is gradually restored again (Graph 5.2). This shock leads to an increase in the price of oil of around 20% for the duration of the supply disruption, after which the oil price gradually returns to base again. ([29]) This supply shock has negative implications for growth in the EU. Output falls by 0.15% and consumption by 0.27% in the first year relative to the baseline. Total oil use of the EU economy drops by 0.5-1.3% in the first four years.

Table 5.1: **Impact of oil supply shock (in %)**

Years	1	2	3	4	5
GDP EU	-0.2	-0.3	-0.4	-0.5	-0.4
Total.oil.use	-0.5	-0.9	-1.2	-1.3	-1.1
Price oil	22.1	21.8	22.5	22.5	10.9
Output energy int. sector	-0.5	-0.8	-1.1	-1.2	-1.0
Output non-int. sector	-0.2	-0.4	-0.5	-0.6	-0.6
Employment	-0.1	-0.2	-0.3	-0.3	-0.3
Consumption	-0.3	-0.3	-0.3	-0.2	-0.1
GDP RoW	-0.3	-0.5	-0.6	-0.6	-0.5

Source: QUEST simulations.

Graph 5.3: **Oil demand shock: impact on EU GDP, oil use and oil prices (in%)**



Source: QUEST simulations.

The second scenario shown in Graph 5.3 describes the impact of a demand-driven oil price shock, in which higher consumption demand in emerging markets boosts global economic activity. In this case, rising oil prices are due to higher global demand for oil. Rising oil prices are a drag on growth but this effect is relatively minor in relation to the positive impact of higher global demand. The EU even experiences a small positive GDP effect for the first 10 years of the simulation as the stimulus from higher global demand to exports initially outweighs the negative impact from higher energy prices. In the long term

([27]) Kilian, L. (2009), 'Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market', *American Economic Review* Vol. 99(3), pp. 1053-69.

([28]) The model simulations do not account for possible changes in 'autonomous' (i.e. technology-driven) energy efficiency, but does capture substitution effects due to higher oil prices.

([29]) The calibration of this disaggregated version of the model is based on the EU social accounting matrix for 2004, the most recent year for which detailed sectoral data are available. As oil prices averaged around USD 40 per barrel in 2004, a 20% increase in the price corresponds to USD 8 per barrel.

the latter effect comes to dominate and the output effect turns negative.

These two scenarios illustrate the different effects demand- and supply-driven shocks can have on economic activity. Both shocks lead to a similar increase in the price of oil, but this is more gradual in the case of the demand-driven shock. As shown in Table 5.1, for a supply shock, an increase in the price of oil hits particularly strongly the energy-intensive sector and leads to an economy-wide fall in employment. Total oil use declines as costs increase, but the decline is much smaller in the demand-driven oil price shock, as higher economic activity leads to more energy use. In the oil demand shock, output in the energy-intensive sector declines on impact, but recovers in later years as global demand increases (Table 5.2). In the oil supply shock, there are spillovers to the non-energy intensive sector and output in this sector declines as well, while in the oil demand shock output in the non-energy intensive sector increases as global growth rises.

Table 5.2: **Impact of oil demand shock (in %)**

Years	1	2	3	4	5
GDP EU	0.0	0.4	0.6	0.6	0.7
Total.oil.use	-0.1	-0.1	-0.1	0.0	0.0
Price oil	7.6	15.1	19.0	20.5	21.0
Output energy int. sector	-0.8	-0.6	-0.3	-0.2	0.0
Output non-int. sector	0.2	0.5	0.6	0.6	0.6
Employment	-0.1	0.2	0.4	0.5	0.5
Consumption	3.6	3.0	2.5	2.2	2.0
GDP RoW	5.7	7.9	9.2	10.1	10.8

Source: QUEST simulations.

Summing up, these two scenarios show the impact of oil price changes depends crucially on the underlying causes. While supply-driven oil price shocks have a significant negative impact on economic activity, the overall impact from demand driven shocks could still be positive. Of course, in real time it is always difficult to disentangle the causes of changes in the price of crude oil. At present, a combination of factors, i.e. supply disruptions as well as higher world demand for oil, are most likely playing a role, suggesting that the overall impact of recent rises in oil prices on growth should remain limited.