ARTICLES

OIL PRICES – THEIR DETERMINANTS AND IMPACT ON EURO AREA INFLATION AND THE MACROECONOMY

In view of the high and volatile oil prices experienced over the past decade, this article reviews oil price developments and their impact on the euro area macroeconomy. Understanding the factors underlying oil price movements and their likely future developments is important, given the impact of oil price movements on euro area inflation and the macroeconomy. Since the first oil shock in the early 1970s, the evolution of oil prices has been determined mainly by the interplay of supply and demand developments. Whereas abrupt disruptions in the supply of oil by OPEC were instrumental in explaining sharp oil price movements in the 1970s, strongly rising oil demand, particularly from non-OECD countries, together with the supply policies of some producers, appears to have been the main driver of oil prices over the past decade. Financial factors may also have played a role, especially in the surge and subsequent decline in oil prices in 2008. Looking forward, the oil supply/demand balance is likely to be tight; oil supply may well be constrained by physical factors as well as by reduced investment, while demand, particularly from emerging economies, is likely to continue to grow.

Oil price shocks have an impact on economic activity mainly via the terms of trade and demand and supply channels, although confidence and uncertainty effects may also occur. The empirical evidence suggests that an increase in oil prices dampens activity gradually over the course of three years. However, it should be noted that the effect may vary across countries, depending not only on their oil dependency and oil intensity but more importantly on the flexibility of their economies. The source of the underlying oil price shock also plays a crucial role. An increase in oil prices stemming from a supply contraction is likely to have a more negative impact on activity than a similarly sized increase stemming from high oil demand.

The impact of oil price movements on inflation is considered using a stylised framework which breaks down the impact into direct and indirect first and second-round effects. The largest and most immediate impact comes from the direct first-round effects (i.e. on consumer energy prices). Given the importance of excise taxes and the fact that distribution and retailing costs and margins have been broadly constant, the elasticity of consumer energy prices with respect to oil prices increases as the oil price level rises. At the same time, there is some evidence that the indirect first and second-round effects may have declined, owing to a combination of structural changes in the economy as well as a change in wage and price-setting behaviour. As the euro area is heavily dependent on imported oil, first-round effects are largely unavoidable and essentially represent a transfer of income to oil exporting countries. However, appropriate wage and price-setting behaviour and well-anchored inflation expectations, along with a credible monetary policy, are necessary to avoid the materialisation of second-round effects and a sustained impact on inflation over a medium-term horizon.

1 INTRODUCTION

Oil prices have been high and volatile over the past decade. To understand how movements in oil prices propagate through the economy, monetary policy-makers need to consider not only the nature of these shocks, but also the structure of the energy sector, how oil is used in the economy more generally (i.e. in terms of its energy mix, dependency and intensity) and the degree of economic flexibility. An understanding of these factors is essential to be able to assess the impact of oil price movements on the economy, whether it has changed over time and what it may be in the future. Moreover, these factors, combined with the policy response of central banks, ultimately explain the transmission of oil price shocks to inflation and to the macroeconomy more generally. The purpose of this article is therefore to understand better the main factors behind the evolution of global oil prices and how these,

combined with the structural features of the euro area economy, affect euro area inflation and the macroeconomy.

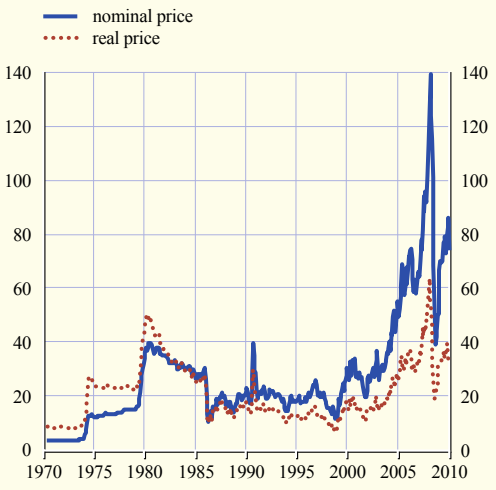
This article is structured as follows. Section 2 reviews the determinants of global oil price developments both over the longer term and the recent past. In particular, the relative contributions from demand, supply and other factors (including financial ones) are assessed, as the source of fluctuations in oil prices has strong implications for the resulting macroeconomic impact. Section 3, in the context of the high and volatile oil prices observed over the past ten years, analyses the impact of oil price movements on the euro area macroeconomy (i.e. output and prices). The possibility that this impact may change over time or may have been partially offset by other factors (such as, for example, oil bill recycling, through which increased exports to oil-producing countries partially offset the negative impact of higher oil prices) is also considered. Section 4 concludes.

2 THE DETERMINANTS OF OIL PRICES

The price of oil has risen sharply over the past decade, with new all-time highs recorded – in both nominal and real terms – in July 2008 (see Chart 1). This rise has no precedent during the previous 40 years, either in terms of magnitude or speed. The oil price surge came to an end in the second half of 2008, and the subsequent price fall was exacerbated by the intensification of the financial crisis and the steep decline in global economic activity. The fall in prices was sharp and fast, to a trough of USD 38 per barrel at the end of 2008. Oil prices, however, started rebounding in the second quarter of 2009 and experienced a strong upturn, almost doubling to reach around USD 75 per barrel in June 2010. Real oil prices (i.e. deflated by the US CPI) continue to be high by historical standards, although they are slightly below the previous peak levels temporarily recorded at the beginning of the 1980s. This section will analyse the main drivers of international oil price developments over recent years, and assess their medium and long-term prospects.

Chart 1 Nominal and real oil prices

(USD per barrel)



Sources: Global Financial Data, BLS.
Notes: Real prices are expressed in 1982-84 USD terms. Last observation for real prices refers to May 2010 and for nominal prices to June 2010.

SUPPLY AND DEMAND DEVELOPMENTS IN THE OIL MARKET

To understand the determinants and prospects for oil prices, it is useful to consider oil price shocks over the past 50 years. In the 1960s, the spare capacity in the United States, which had until then been the marginal supplier of oil,[1] began to erode. In parallel, OPEC started to test its newly acquired market power: the oil price shocks of 1973 and 1979 were associated with significant reductions in OPEC's supply and operable capacity. Higher prices led to a marked decline in global oil demand, especially in OECD countries, and generated incentives to increase oil supply in several non-OPEC countries. This weakened OPEC's control over the marginal supply of oil and created increasing

1 A marginal supplier is a producer which is able to influence prices and balance the market by changing the amount it supplies. Such producers generally have ample spare capacity and can change their production levels at relatively low additional cost.

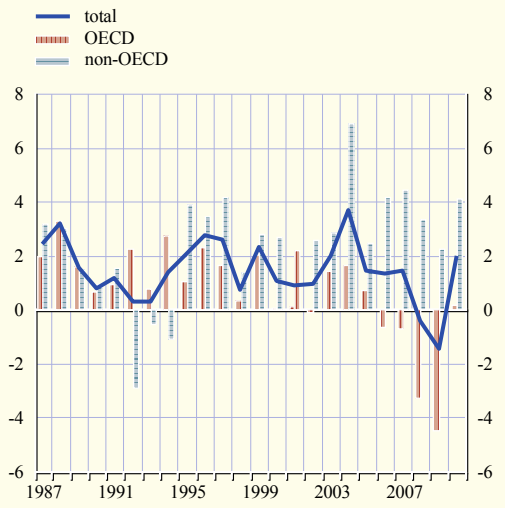
incentives for the cartel members to exceed the agreed quotas, which caused prices to progressively decline.

Oil prices, however, became substantially more volatile again from the second half of the 1990s, and surged with increasing momentum between 2004 and mid-2008. This hike in crude oil prices was mainly triggered by increasing demand from non-OECD emerging economies, particularly China, India and the Middle East (see Chart 2 and Box 1). In turn, future oil supply prospects increasingly became a matter of concern, as the growth in non-OPEC crude oil production broadly stagnated from the end of 2004 onwards (see Chart 3). The scope for increased non-OPEC production was constrained owing to geological restrictions, and the low level of spare capacity in most OPEC countries added to market tightness.

The oil price boom was disrupted by a combination of the slowing of economic growth in major advanced economies, the onset of the financial crisis and the subsequent very sharp decline in global economic activity, which also led oil demand growth to decline in emerging economies. Looking at the supply side, OPEC accompanied the slowdown in global oil demand by announcing a total reduction in production quotas of almost 5 million barrels per day. This served to limit the decline in oil prices. From spring 2009 oil prices started to recover and fluctuated around USD 75 per barrel in June, i.e. the level reached at the beginning of September 2007. On the demand side, amid a gradually stabilising global economy, market expectations of future oil demand have been an important factor behind the rebound in oil prices. In particular, higher than expected non-OECD oil demand – most notably stemming from higher demand in large emerging market economies such as China and India – put upward pressures on oil prices. Amid rising oil demand in early 2010, OPEC's (estimated) production moved higher above its target level and non-OPEC supply also increased, mainly because of higher output in Canada and Russia. Therefore, although oil demand seems to be recovering quickly, by

Chart 2 Changes in global oil demand by region

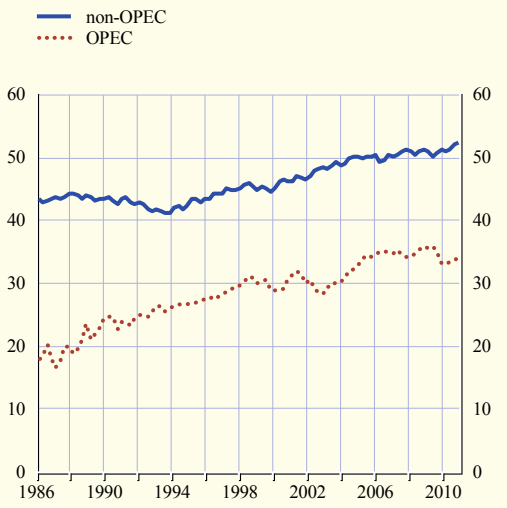
(annual percentage change)



Source: International Energy Agency.
Note: Last observation refers to 2010.

Chart 3 Global oil supply by producer

(millions of barrels per day)



Source: International Energy Agency.
Note: Last observation refers to 2010 Q1.

1.7 million barrels per day year on year in the first quarter of 2010, global supply has also increased, by almost 2.0 million barrels per day.

The speed and size of the recent movements in oil prices have led many to argue that there has been a decoupling of market prices from those warranted by fundamentals, and to discuss the potential role of speculative trading in driving oil price movements. The financialisation of commodity markets, particularly those for oil, has sharply increased in recent years: the volume of crude oil derivatives traded on NYMEX quintupled between 2000 and 2008. It is difficult to measure directly the extent to which movements in oil prices are related to speculative activity. Empirical studies report mixed results as regards possible systematic causality between investment positions held by non-commercial agents in oil futures markets and spot prices and the volatility of such prices. However, some research clearly suggests that a degree of overshooting of oil prices above their equilibrium level as determined by fundamentals took place in 2008, due in particular to a spike in financial investment. In any case, it is important to note that the price elasticity of demand and supply is rather low in oil markets, which means that relatively small changes in fundamentals can have a large impact on prices. Overall, the debate on speculation in commodity markets is still ongoing, as data limitations hamper more in-depth analyses.

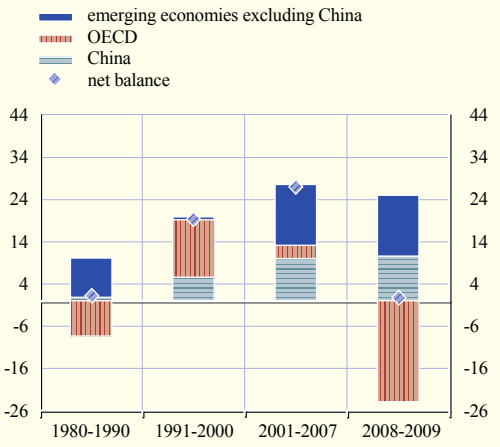
Box 1

EMERGING MARKET ECONOMIES AND OIL DEMAND

Owing in part to buoyant global economic growth, global oil consumption increased more rapidly in the period 2001-2007 than in the previous two decades (see Chart A). Most of this increase was driven by demand from several major emerging economies (notably China, India and the Middle East countries), resulting from a combination of industrialisation and a higher commodity intensity of growth, increases in per capita income, and rapid population growth. In some instances, the high demand also reflects the fact that domestic end-user prices are heavily subsidised and thus delinked from world market prices. This is especially the case in the oil-exporting economies but also in some of the emerging economies.[1] Since 2007, oil demand in emerging and developing economies has continued to increase - despite

Chart A Contribution of selected regions to the annual average consumption increase

(annual data; millions of tonnes; period averages)



Sources: International Energy Agency, British Petroleum and ECB staff calculations.

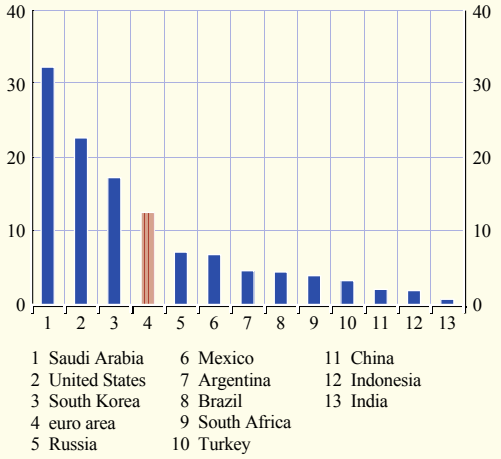
1 See Helbling, T., V. Mercer-Blackman and K. Cheng (2008), "Riding a wave" in IMF Finance and Development, March 2008, Volume 45, Number 1.

the global downturn in economic activity – albeit less strongly than in the first half of the decade.

Looking forward, as oil consumption per capita remains significantly lower in emerging and developing countries than in advanced economies, demand in these countries has strong growth potential, even though higher energy efficiency may partially counteract this. For example, in 2008 in the euro area, around 12 barrels of crude oil were consumed per person, compared with little more than two barrels in China and less than one barrel per person in India. The difference compared with the United States, where each person in 2008 consumed on average almost 23 barrels a year, is even greater (see Chart B).

Chart B Crude oil consumption per capita in selected countries in 2008

(barrels per year)



Sources: International Energy Agency, British Petroleum and ECB staff calculations.

MEDIUM AND LONG-TERM PROSPECTS FOR THE OIL MARKET

Looking ahead, the International Energy Agency (IEA) projects oil supply to be ample in the medium term, although the risk of a tighter oil supply/demand balance remains significant. Following the substantial decline in oil demand, which has mainly been driven by the substantial decline in demand in OECD countries (see Chart 2) due to the financial crisis and subsequent recession, oil demand is expected to increase strongly as the world economy recovers. The IEA estimates that oil demand will increase by 1.2 million barrels per day per year on average between 2009 and 2015, particularly in emerging economies. Although supply prospects have also been negatively affected by the economic downturn, with investment in upstream capacity and maintenance declining substantially in 2009 [2], the IEA projects global supply capacity to be ample in the medium term. The increase in global supply capacity stems mainly from increased net production capacity in OPEC countries, of which an important share is projected to be supplied by Saudi Arabia (see Box 2). However, significant uncertainties surround both the oil demand and supply outlook. If global oil demand should recover more strongly than expected, and investment is not able to respond quickly, OPEC's spare capacity will decline again from next year on. In addition, the global production capacity base loses around 3.1 million barrels per day to mature field decline each year, which could tighten the outlook for the oil supply and demand balance in the medium term.

In the longer term, the physical ability to expand oil production capacity will depend on the global resource base, which will be an important determinant of future global oil supply and prices. There is considerable uncertainty surrounding the volume of oil reserves. The IEA does not envisage a peak in conventional oil production until 2030. Nevertheless, additional unconventional sources will be needed to match growing demand: the IEA forecasts that global supply from unconventional oil sources will increase four-fold by 2030, to 7.4 million barrels per day. Among the unconventional oil sources, the geological resource base for heavy oil such

2 Whilst nominal investment declined by 20%, the decline in investment in real terms – which is more difficult to quantify precisely – was smaller owing to falling development (in particular wage and drilling) costs.

as tar sands and oil shale is considerable.[3] However, the estimated costs of producing these alternative fuels are subject to wide uncertainty and the energy return is significantly less than for oil, as considerable amounts of energy are required to recover them. Apart from the environmental considerations, these new extraction technologies are also highly capital intensive, with long lead times of up to fifteen years. In addition, the uncertainty stemming from the high volatility observed in oil prices in recent years and the increased risk aversion in financial markets may have discouraged or postponed investment in this sector, even though higher prices should in theory stimulate investment in supply.

3 Tar sands represent a form of heavy oil which is present in Canada and Venezuela. Similarly, oil shale is a type of rock containing oil, of which a large resource base is available in the United States.

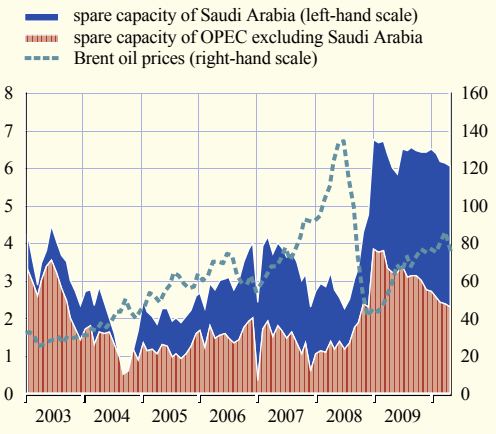
Box 2

SAUDI ARABIA'S OIL PRODUCTION CAPACITY – RECENT DEVELOPMENTS AND PROSPECTS

Spare capacity in oil production[1] – alongside spare capacity in refining and inventories – provides a cushion to absorb sudden upward shocks to oil demand and downward shocks to oil supply, such as geopolitical events or natural disasters. Low spare capacity tends to amplify price reactions to actual (or anticipated) supply or demand shocks and contributes to volatility in the oil market.

Chart A Developments in OPEC's spare crude oil production capacity

(millions of barrels per day; USD per barrel)



Sources: International Energy Agency and ECB staff calculations.

At 6.1 million barrels per day, estimated spare capacity stood in May 2010 above its levels in the period leading up to mid-2008, when it was relatively low and oil prices were rising steadily (see Chart A). This is mainly the result of cuts in OPEC's oil production, in view of the fall in oil prices in the second half of 2008 and weakening global demand, but also capacity expansion, which mainly took place in Saudi Arabia, the world's largest oil exporter. In May 2010, Saudi Arabia accounted for almost 62% of OPEC's total spare capacity. At current levels of production (8.25 million barrels per day), Saudi Arabia's spare capacity of 3.75 million barrels per day could offset a shortfall in oil supply from other large oil exporters, within a short period of time.

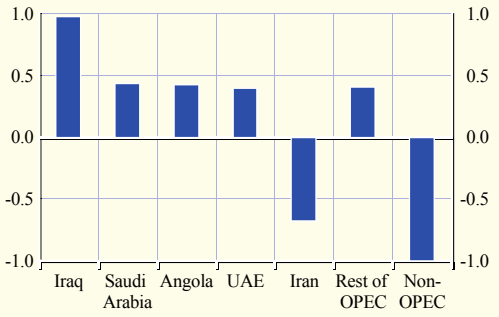
Saudi Arabia is likely to remain a key provider of spare capacity in the future, as the country plans significant investments to further increase its oil (and gas) production capacity. The IEA estimates that Saudi Arabia will increase its sustainable net oil production capacity in the period 2009-15 by 0.43 million barrels per day (see Chart B). This is the largest estimated capacity increase among OPEC members – with the exception of Iraq, where uncertainties surrounding

1 Spare capacity is defined by the IEA as the difference between current oil production and capacity levels that can be achieved within 30 days and sustained for 90 days.

capacity expansion are significant –, slightly ahead of Angola and the United Arab Emirates (UAE). Non-OPEC crude supply capacity is projected to decline by 1.0 million barrels per day over the same period.

Chart B Projected increase in OPEC's crude oil production capacity from 2009 to 2015

(millions of barrels per day)



Sources: International Energy Agency and ECB staff calculations.

In the short run, the recent increase in spare capacity in oil production should be a stabilising factor for oil markets, when demand recovers in the wake of a global economic recovery. Over the medium term, commitment by oil producers to expand production capacity is important to match a potentially stronger than currently expected rebound in global oil demand, in particular in emerging market economies. This is especially relevant for Saudi Arabia, given that the outlook for investment in production capacity in general has become more uncertain after the fall in oil prices in mid-2008 and in view of tighter financing conditions and the country's large oil reserves – estimated at 20% of global reserves – that can be lifted at relatively low costs. At the same time, investment in capacity in other countries and regions remains key, inter alia, to mitigate further regional concentration of prospective oil production and spare capacity.

3 THE IMPACT OF OIL PRICES ON THE EURO AREA MACROECONOMY [4]

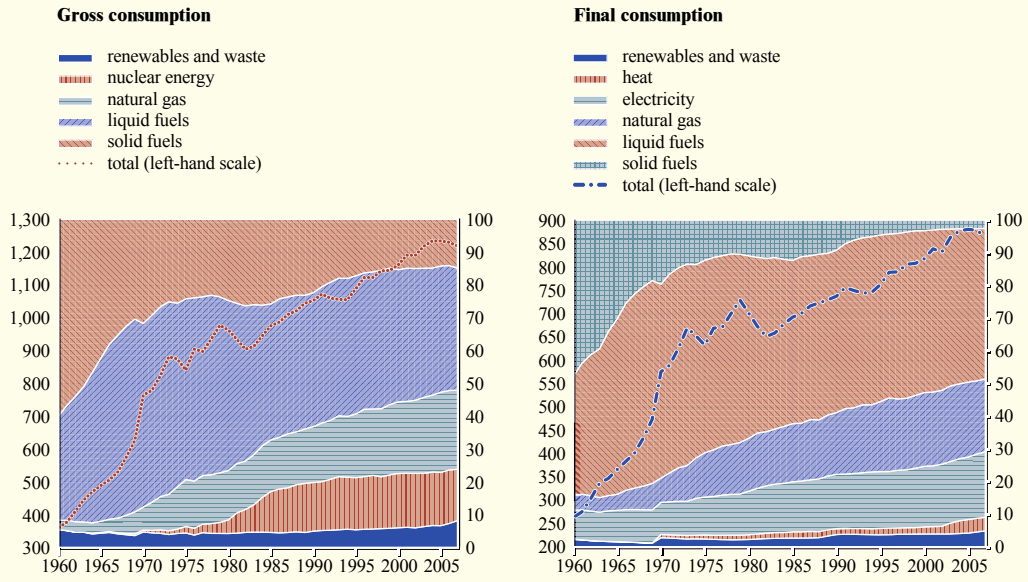
Oil has remained the principal source of energy in the euro area countries – whether measured as a percentage of total gross (46%) or final (37%) inland consumption of energy – ever since it "overtook" coal and other solid fuels in the mid-1960s. This is notwithstanding the increased use of natural gas, nuclear and renewable energies (see Chart 4). Oil derives its importance both from its direct role in private consumption (for transport and heating fuel) and from its indirect role as a factor of production (e.g. via logistics and distribution, as well as its use in the production of chemicals). However, owing to a lack of natural endowments, very little oil is produced in the euro area and consequently the dependency ratio (i.e. net imports to total supply) is high (at close to 100%). Oil is a particularly crucial source of fuel for transport, accounting for over 95% of energy consumption in that sector.[5] Oil prices also have an additional impact via their influence on other energy prices, in particular those of natural gas and coal, since for certain purposes, especially electricity generation, oil, natural gas and coal are substitutes for one another. Nonetheless, despite its primary role, both the share of oil in overall energy consumption and the oil intensity of economic activity have declined since the early 1970s – sharply during the late-1970s following the oil crises and more gradually, and continuously, since the 1980s. This decline, which has implications for the economic impact of oil price fluctuations, is attributable to a combination of factors, including the substitution of other energy sources for oil (e.g. the use of natural gas and nuclear power in electricity generation), increased efficiency (more fuel efficient cars), and the changing structure of the economy.

4 This section draws extensively from the ECB Structural Issues Report 2010 on energy markets and the euro area macroeconomy, available on the ECB's website at www.ecb.europa.eu.

5 However, this overall figure masks an important distinction between household transport (in particular passenger cars) and commercial transport (freight). Approximately two-thirds of private passenger cars in the euro area are petrol powered, although around half of new passenger car registrations are for diesel powered vehicles (according to the European Automobile Manufacturers' Association). The commercial freight sector however is almost completely diesel powered. This distinction is relevant when one considers the impact on prices of refining margins for petrol/gasoline and diesel/gas oil.

Chart 4 Decomposition of euro area energy consumption

(thousands of tonnes of oil equivalent; percentages)



Sources: Eurostat, International Energy Agency and Eurosystem staff calculations.
Notes: Energy consumption may be viewed either in "gross" terms (i.e. the combination of domestic primary production and net imports) or in "final" terms (i.e. after the transformation of primary energy sources into usable forms of energy). A key difference arises from the transformation of primary energy sources (nuclear, gas, solid fuels and oil) into electricity.

THE IMPACT ON ECONOMIC ACTIVITY

Oil price shocks have an impact on economic activity in the euro area mainly via the terms of trade and demand and supply channels, although confidence and uncertainty effects may also occur. The impact of oil price shocks may also vary depending on the state of the business cycle and the underlying nature of the oil price shock – whether it is driven by demand, supply or other factors.

Terms-of-trade effects arise from the increases in oil import prices, which lead to a rise in average import prices relative to average export prices. The deterioration in the terms of trade may trigger adverse real income and wealth effects in net oil-importing economies like the euro area. Unless savings are reduced or borrowing increases, this translates into lower domestic consumption. Demand effects arise from the inflationary effects of oil prices on consumer prices, which lower real disposable income and, therefore, consumption. Supply effects reflect the importance of oil as an input in the production process. In the short term, the ability of firms to react to oil price increases by substituting another source of energy for oil is limited, so a rise in the price of oil inevitably leads to higher production costs. Firms may respond to this by changing either their pricing or production behaviour, which can have adverse implications for profits, investment, employment and wages. In the long run, increases in the relative price of energy may lead to substitution effects and to a reduction in the overall energy intensity of production and consumption.

The empirical evidence from a set of macroeconometric models available at the ESCB suggests that a 10% increase in oil prices gradually dampens euro area activity, reducing real GDP by 0.24% after three years (see Table 1), assuming no monetary or fiscal

Table 1 Effect of a 10% oil price increase on euro area activity

(cumulative percentage deviations, annual averages)

	Year 1	Year 2	Year 3
Real GDP	-0.08	-0.19	-0.24
Private consumption	-0.14	-0.27	-0.33
Investment	-0.09	-0.24	-0.35
Exports (goods and services)	-0.03	-0.09	-0.12
Imports (goods and services)	-0.10	-0.15	-0.19
Net trade contribution	0.03	0.02	0.02
Employment	0.01	-0.04	-0.11

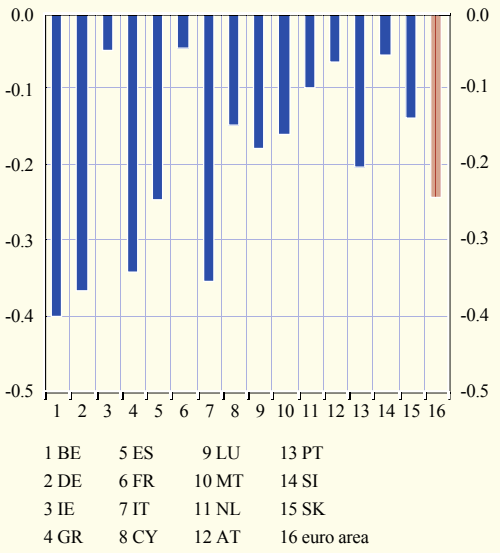
Source: Eurosystem staff calculations.
Note: net trade contribution is in percentage points.

policy reaction.[6] Most of the effect stems from the negative impact of an oil price increase on real private consumption, which is caused by a fall in real disposable income, related to the impact on inflation, and, from the second year onwards, by lower employment. Notwithstanding lower real interest rates,[7] real investment is dampened, reflecting lower demand. While both imports and exports are also dampened by the oil price shock, the contribution of net exports to GDP is estimated to be slightly positive, as the dampening impact on imports is slightly larger. It should be noted that oil bill recycling (see Box 3), which is not explicitly included in the simulation results but may be substantial, reinforces the positive impact on net trade.

The simulation results using the macroeconometric models suggest considerable variation across euro area countries in the impact of a 10% increase in oil prices, ranging from close to zero to -0.4% of real GDP (see Chart 5). These differing effects are partly due to structural differences across the countries, such as the degree of dependence on oil imports, the energy intensity of production and consumption, and trade patterns. In addition, the degree of nominal rigidity in the economy, its sector structure and openness can also be drivers of cross-country variation.[8] It should be noted that most of these models do not incorporate inflation expectations. Incorporating expectations might result in a somewhat smaller dampening effect on economic activity as agents react to expected future policy actions.

Chart 5 Effect of a 10% oil price increase on real GDP in the euro area countries

(cumulative percentage deviation in year 3 from baseline scenario)



Source: Eurosystem staff calculations.

There is some evidence that the impact of oil prices on activity may have become more muted since the 1990s relative to that observed in the 1970s and early 1980s.[9] This attenuation may be attributable to the complex interaction of a number of factors, including the lower energy intensity of developed economies, changes in wage-setting behaviour and the role of monetary policy in stabilising inflation expectations. As mentioned above, the nature of the underlying oil shocks is an important factor shaping their impact on real GDP. In general, shocks to the oil supply have a larger negative impact on

6 The results stem from a largely harmonised simulation exercise using macroeconometric models available at the ESCB. Results for Finland are not available. For further details on the technical description of the exercise and the results, see the Structural Issues Report on "Energy markets and the euro area macroeconomy", ECB, June 2010.

7 As mentioned above, nominal interest rates were kept constant in the simulations.

8 Peersman and Van Robays, using a different modelling approach, also find evidence of substantial cross-country heterogeneity. See "Oil and the euro area economy", in *Economic Policy*, Vol. 24, Issue 60, October 2009, pp. 603-651.

9 See the Structural Issues Report (Annex 2.2), ECB, June 2010 for a more detailed discussion.

activity than oil price increases generated by rising oil demand, which are usually accompanied by stronger global activity. In the macroeconometric model simulations the nature of the oil price shock is generally not explicitly specified, but given that the underlying models are based on historical data going back to the 1980s for most countries, the oil price shock can be viewed as a global shock resulting from both oil supply and demand disturbances and reflecting also external adjustments. The differing nature of underlying oil price shocks may explain why there is some disagreement in the economic literature regarding the possible asymmetric effects of oil price increases and decreases on economic activity, as the relative importance of the supply and demand factors behind the oil price movements may have varied over time.

In addition to the short and medium-term effects, energy price developments may also have an impact on the long-run potential output of the economy. Model estimates suggest that a 10% increase in oil prices has a negative impact of approximately 0.1% on the level of output in the long run. These long-term losses are higher when considering the long-term levels of consumption and investment. Key factors affecting the long-run vulnerability of the economy to oil prices are the intensity and, in particular, substitutability of oil. The more flexible the economy in substituting relatively expensive energy sources, the less vulnerable it is to energy price fluctuations. Moreover, wage and price rigidities exacerbate the adjustment costs following an energy price shock. In particular the losses of output and labour input into the production process would be less pronounced if prices and wages adjusted more rapidly.

When considering model-based estimates of the impact of energy prices on economic activity, it is important to bear in mind that macroeconometric models are, by necessity, simplifications of the underlying economic structure. Even if model builders incorporate expectations formation and (monetary and fiscal) policy responses into their toolkit, these are impossible to capture in their entirety and may change over time. Thus the estimates reported here should be considered as merely indicative.

Box 3

OIL BILL RECYCLING

Energy products represent an important share of international trade and large movements in oil prices can have a significant impact on external balances. In 2008, for example, the net external energy deficit of the euro area reached 2.1% of GDP after oil prices climbed to almost USD 100 per barrel on average. This box focuses on the international trade effects through which oil price changes have an impact on the external accounts of oil-importing economies, such as the euro area, in the short run. A rise in oil prices directly increases the cost of imported oil, which decreases the current account balance (the direct trade effect). However, higher oil prices increase oil revenues and the demand for goods and services by oil exporters, leading in principle to higher foreign demand and counteracting increases in the current account balances of oil-importing countries (the indirect trade or "oil bill recycling" effect).

Empirical evidence from past episodes of oil price increases suggests that roughly half of the overall "petrodollar" windfall gain for oil-producing countries was spent on foreign goods, while the remainder was invested in foreign assets. However, there are significant differences across countries in the extent to which may benefit from this spending. In the period between

Combined direct and indirect trade effect of an oil price increase on the current account

(change in oil-exporters' import demand as a share of the increase in their oil export revenues (scenarios 1-4); as a percentage of GDP)

	Scenario 1 0%		Scenario 2 20%		Scenario 3 60%		Scenario 4 100%	
Oil price increases to:	USD 70 per barrel	USD 100 per barrel	USD 70 per barrel	USD 100 per barrel	USD 70 per barrel	USD 100 per barrel	USD 70 per barrel	USD 100 per barrel
Euro area	-0.7	-1.8	-0.6	-1.5	-0.3	-0.9	-0.1	-0.4
"max-min"	*-0.1 to -1.9*	*-0.2 to -5.2*	*0.1 to -1.8*	*0.3 to -4.7*	*0.4 to -1.4*	*1.1 to -3.8*	*0.8 to -1.1*	*2.0 to -3.0*
United States	-0.7	-1.8	-0.6	-1.7	-0.6	-1.6	-0.5	-1.4
China	-0.4	-1.1	-0.3	-0.8	-0.1	-0.3	0.1	0.3

Sources: Eurosystem staff estimates based on the IMF World Economic Outlook and IMF Direction of Trade Statistics.
Note: "max-min" denotes the range of maximum to minimum impacts of an oil price increase on the current account across euro area countries.

2002 and 2006, estimates suggest that 41% of the increase in the euro area's oil deficit, and 60% of the increase in China's oil bill, were compensated for by higher purchases of domestically-produced goods in the oil-exporting countries, as against only 20% for the United States and 18% for Japan.[1] Geographic proximity, historical ties and the sectoral specialisation of exports are likely to account for the higher initial sales base of euro area goods to oil exporters, compared with that of the United States. In China, the high amount of exports to the oil-producing countries seems to be in line with the significant gains in China's export market shares worldwide. At the same time, OPEC countries have significantly increased their net holdings of foreign assets as a percentage of GDP in recent years. Evidence suggests that the bulk was invested in the United States.

The table above shows the results of a simple benchmark calculation of the combined direct and indirect trade channels for two variants of an oil price increase: an increase of roughly 40% (from USD 52 per barrel – the average price level that prevailed in the second half of 2009 – to USD 70 per barrel) and a stronger increase of 100% (to USD 100 per barrel) in 2009. Results are shown for four alternative scenarios regarding the extent to which petrodollars are recycled: 0%, 20%, 60% and 100%. The results of the simulations broadly confirm the findings of previous empirical research.

First, as would be expected, the largest net oil importers, i.e. the euro area and the United States, experience the most pronounced deterioration in their oil balances in the short term (as illustrated by the first scenario in the table, which assumes no "oil bill recycling", and thus captures only the "direct" effect of higher oil prices on oil balances). The deterioration ranges from 0.7% to 1.8% of GDP, depending on the size of the change in oil prices. The overall euro area impact conceals considerable variation across countries, which is primarily a result of differences in their trade patterns (i.e. both their energy import dependence and export specialisation).

Second, the economies with the largest export activity towards the oil-exporting countries, i.e. the euro area and China, significantly benefit from the "indirect" effect of increased import demand by the oil exporters, although in most cases it only partly offsets the negative direct effect. As long as the propensity of oil exporters to import does not decline in favour of more saving, euro area countries should benefit from higher exports to oil-exporting economies. As mentioned above, geographical proximity to most major oil exporters and historical ties seem to partly explain the closer trade links between euro area countries and oil exporters and the

1 See Higgins, M., T. Klitgaard and R. Lerman (2006), "Recycling Petrodollars", Current Issues in Economics and Finance, Federal Reserve Bank of New York, Vol. 12, No 9, December 2006.

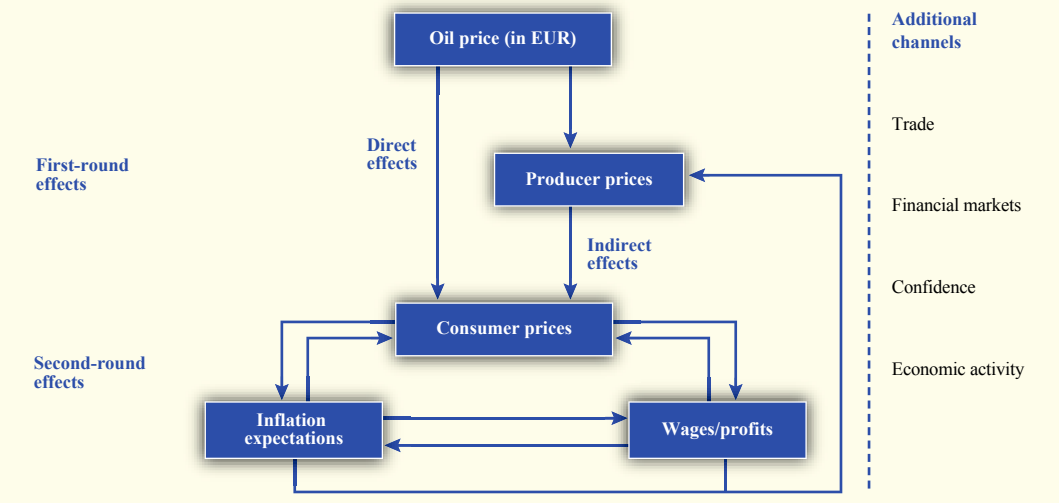
relatively weaker export ties of the United States. Furthermore, the structure of import demand from oil-exporting countries, largely determined by an infrastructure and construction-led pattern of growth, seems to create a comparative advantage for those euro area countries that specialise in the production of capital goods, like Germany with its specialisation in transport equipment and machinery. The euro area as a whole has been gaining import market shares in a number of oil-exporting countries over the last decade, notably in Algeria, Saudi Arabia, the United Arab Emirates and Russia.

THE IMPACT ON INFLATION

A stylised overview of the main transmission mechanisms through which oil prices affect consumer price developments is presented in Chart 6. In terms of price effects, the impact of energy price changes is often broken down into direct and indirect first and second-round effects.[10] The direct first-round effects refer to the impact of changes in oil prices on consumer energy prices. The indirect first-round effects refer to changes in consumer prices that occur as a result of the impact of oil prices on production costs (e.g. an oil price increase that affects through higher input costs the prices of goods which have a significant oil input, such as some chemical goods, or the prices of transport services). In principle, first-round effects of a one-off change in the oil price, whether direct or indirect, only generate a rise in the price level but no lasting inflationary effects. Second-round effects capture the reaction of wage and price-setters to the first-round effects of a price shock. Attempts by economic agents to compensate for the loss of real income caused by past inflation shocks may affect inflation expectations and further influence price and wage-setting behaviour. A transitory shock may thereby become entrenched and more costly to eradicate. The likelihood of a commodity price shock leading to second-round effects depends on several factors, including the cyclical position of the economy, the flexibility of goods and labour markets (particularly the presence of indexation

10 This taxonomy of the breakdown of oil price pass-through into different effects is drawn from the article entitled "Oil prices and the euro area economy", in the November 2004 issue of the Monthly Bulletin.

Chart 6 Stylised overview of oil price pass-through channels



Source: ECB.

mechanisms affecting wage bargaining and price setting), the formation of inflation expectations and, crucially, the credibility of the central bank.

DIRECT FIRST-ROUND EFFECTS

Oil price fluctuations have a direct impact on HICP inflation via the HICP energy component. Energy products account for approximately 10% of the overall euro area HICP, of which around half is liquid fuels, i.e. transport (4%) and home heating fuel (0.7%). The remainder relates to electricity (2.3%), natural gas (1.8%), heat energy (0.6%) and solid fuels (0.1%).[11] Owing to the volatility of oil prices, energy is also by far the most volatile of the main HICP sub-components, with a standard deviation of month-on-month changes of 1.5% – compared with 0.2% for the seasonally adjusted HICP, and 0.1% for the seasonally adjusted HICP excluding energy. Given this high volatility it is particularly useful to understand the response of consumer energy prices to movements in oil prices.

In the first instance, the pass-through into consumer liquid fuel prices (i.e. transport – petrol and diesel – and heating fuel) is considered, as these are generally the most rapidly affected by oil price movements. Understanding this pass-through can be facilitated by considering a simplified representation of the pricing chain for liquid fuel products. In particular, the key steps between the extraction of crude oil and the purchase of liquid fuels by consumers are: refining, distribution and taxation.[12]

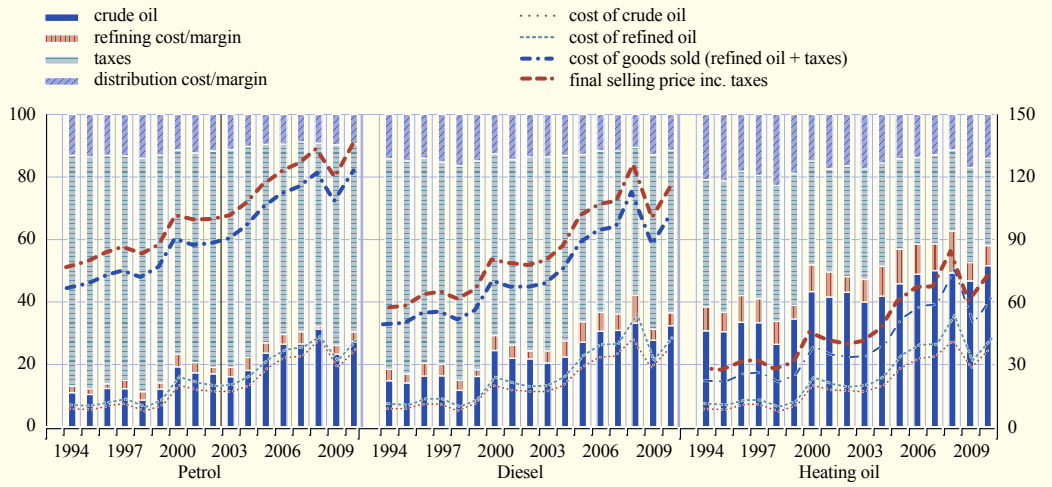
Chart 7 illustrates the evolution of euro area consumer liquid fuel prices since 1994. There are a number of noteworthy features. First, taxes (excise taxes and VAT combined) account for more than half of the final selling prices of petrol and diesel (on average 60% and 52% respectively in the first half of 2010), but for a much smaller portion of heating fuel prices

11 The share and composition of energy products in the HICP varies substantially across euro area countries; the share ranges from 15.7% in Slovakia to 6.3% in Malta, whilst natural gas, solid fuels and heat energy have little or no weight in consumption in a number of countries.

12 Excise taxes are levied as a fixed amount per unit volume (e.g. the average level of excise tax on petrol in the euro area is around 59 euro cent per litre compared with around 8 euro cent per litre for home heating fuel), whereas VAT is levied as a percentage of the pre-tax price plus excise taxes (e.g. the average VAT rate on petrol in the euro area is around 19%).

Chart 7 Decomposition of euro area consumer liquid fuel prices

(as a percentage of total final selling price; euro cent per litre)



Sources: European Commission (Eurostat), Bloomberg, Reuters and Eurosystem calculations.
Notes: Line series (in euro cent per litre) are shown on the right-hand scale, whereas column series (percentage of final selling price including taxes) are shown on the left-hand scale. 2010 refers to the first six months of the year.

(28%). Second, reflecting the strong increase in crude oil prices, the portion accounted for by the crude oil cost has increased greatly since the late 1990s. Third, although refining margins are relatively small in relation to the crude oil price, they can fluctuate substantially. For example, refining margins for diesel and heating fuel reached a level of USD 40 per barrel in mid-2008, compared with historical averages (since 1986) of around USD 5 per barrel. Thus, fluctuations in refining margins can result, at least in the short term, in movements in consumer prices that do not reflect those in crude oil prices. Lastly, the contribution from distribution costs and margins to final selling prices has been relatively constant over time, implying that mark-ups in this sector are not set as a percentage of input costs.

The combination of relatively constant distribution costs and margins, the important role of excise taxes and the strong increase observed in crude oil prices has significant implications for the elasticity of consumer liquid fuel prices with respect to oil prices. Table 2 illustrates the role of indirect taxes in determining the elasticity of consumer oil prices with respect to crude oil prices: the elasticity of heating fuel prices is much higher than that of petrol and diesel prices, owing to the relatively low level of excise taxes. The table also shows that the elasticity of consumer energy prices is a function of the level of crude oil prices: the elasticity of consumer prices is substantially higher when crude oil is at €60 per barrel than at €20 per barrel. For petrol the elasticity increases from 15% to 35%, for diesel from 19% to 41%, and for heating fuel from 39% to 66%.

In view of the high and volatile oil prices observed in recent years, numerous studies have examined the speed of pass-through to liquid fuel prices in Europe. Generally these studies show that the direct pass-through of oil price shocks into pre-tax consumer energy prices is complete (i.e. an increase in crude oil prices equivalent to 10 euro cent per litre results in an increase in pre-tax consumer prices of 10 euro cent per litre) and quick (with most of the increase being passed through within three to five weeks). Moreover, there is little significant evidence of substantial asymmetry between the pass-through of oil price increases and oil price decreases.[13]

Turning to natural gas prices, one of their key and well-known features is their strong co-movement with crude oil prices, albeit with some lag (see Chart 8). This mainly reflects the substitutability of, and competition between, gas and oil for certain purposes (such as electricity generation), as well as institutional arrangements,

13 See, for example, Meyler A., "The pass through of oil prices into euro area consumer liquid fuel prices in an environment of high and volatile oil prices" in *Energy Economics*, Issue 6, Energy Sector Pricing and Macroeconomic Dynamics, November 1990, pp. 867-881.

Table 2 Elasticity of HICP energy with respect to crude oil prices

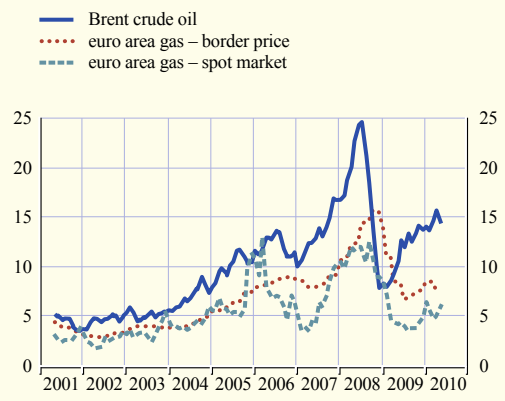
(percentages)

Crude oil (€ per barrel)	Weighted average pass-through to HICP energy 1)	Petrol (2.6%) 2)	Diesel (1.4%) 2)	Heating fuel (0.7%) 2)	Natural gas (1.8%) 2)
20	16	15	19	39	24
40	26	26	32	56	39
60	33	35	41	66	49
80	38	41	48	72	56
100	42	47	54	76	61

Source: Eurosystem staff calculations.
Notes: Based on taxes (VAT, excise and other) as at end-2009 and median refining and distribution costs and margins since 1999.
1) Estimated assuming HICP heat energy (0.6% weight) co-moves with natural gas. Weighted average slightly underestimates extent of pass-through as it assumes zero pass-through for electricity and solid fuels.
2) Denotes weight in overall HICP.

Chart 8 Oil and gas prices (contracted border[1] and spot market[2])

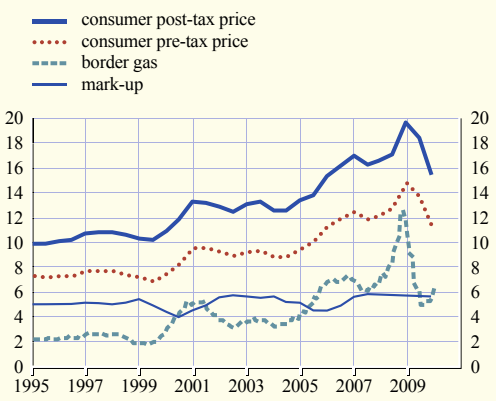
(USD/MMBtu[3])



Sources: Eurostat, Haver Analytics, Reuters, Bloomberg and Eurosystem staff calculations.
1) Unweighted average of border gas prices for Belgium, Germany, Spain, France, Italy and the Netherlands.
2) Unweighted average of the Belgian Zeebrugge and Dutch Title Transfer Facility hub prices.
3) MMBtu denotes one million British thermal units.

Chart 9 Consumer gas prices

(euro per gigajoule)



Sources: Eurostat, Haver Analytics, Reuters, Bloomberg and Eurosystem staff calculations.

particularly in Europe, whereby many long-term gas supply contracts are explicitly linked to oil prices.[14]

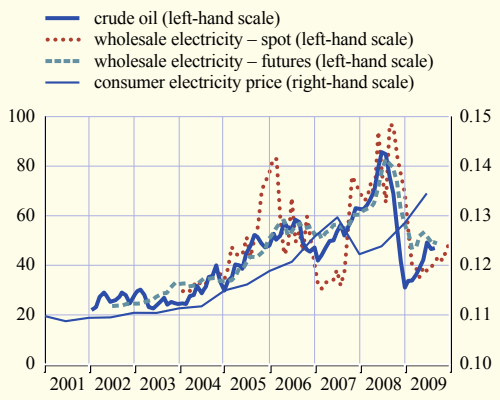
Oil prices impact relatively quickly on gas border (i.e. import) prices, whilst the gap between the border and the pre-tax consumer price (here referred to as the "mark-up") reflects the costs of processing, transmitting, storing and distributing gas to consumers as well as the margins of the various operators along the gas chain. Notwithstanding the large increase in gas border prices since the late 1990s, the mark-up has remained relatively stable, at around €5/gigajoule (see Chart 9). This suggests that movements in gas border prices are passed through fully into consumer prices, albeit with some lag, and that as international gas prices have increased, the share of consumer prices accounted for by raw inputs has increased. One implication of this is that as the price level increases, the elasticity (i.e. percentage response) of consumer gas prices with respect to oil prices increases, although the absolute pass-through remains the same (i.e. complete). Given the historical relationship between oil and border gas prices, a crude oil price level of €20 per barrel would result in an elasticity of consumer gas prices with respect to oil prices of around 25%, but this elasticity would be twice as high at €60 per barrel.

Turning to electricity prices, the reaction of consumer prices to oil price changes is much less clear. However, there are notable differences between wholesale and consumer electricity price developments. Chart 10 shows that there is a considerable degree of co-movement between crude oil and exchange-based (spot and one-year-ahead futures) wholesale electricity prices. This co-movement stems from the co-movement of gas and oil prices and the key role of gas power plants as the "swing" or marginal generator. Notwithstanding the link between crude oil and exchange-based wholesale electricity prices, the link between electricity

14 Such institutional arrangements are a crucial determinant of these co-movements since gas, being less storable and shippable than oil, is still primarily transmitted by pipeline. In the absence of explicit indexing to oil prices, regional supply and demand developments would have more impact on gas price movements. The growing importance of spot markets and liquefied natural gas has put some pressure on these indexing arrangements.

Chart 10 Consumer electricity prices

(euro per barrel/MWh; euro cent per kWh)



Sources: EEX, Eurostat, Haver Analytics, Reuters, Bloomberg and Eurosystem staff calculations.
Note: MWh denotes megawatt hour and kWh denotes kilowatt hour.

and oil prices at the consumer level is very weak (see Chart 10). This is due to a variety of factors including taxes, the possibility of using different sources of power for electricity generation and network costs, but may also in part reflect price regulation.

Although European gas and electricity markets have undergone a sustained process of deregulation and liberalisation dating back to the mid-1990s, the process is not complete[15] and there is a substantial wedge between the degree of de jure and de facto competition. For example, although all gas and electricity markets are now open to competition, more than half of the Member States have regulated end-user prices and the large majority of consumers in those markets are being supplied at regulated prices.

Owing to the full pass-through into pre-tax prices, and the broad constancy of margins and indirect taxes, the elasticity of consumer energy prices (i.e. the percentage response to a given percentage change in oil prices) is a function of the crude oil price level (see Table 2). The elasticity of consumer energy prices doubles from around 16% when crude oil prices are €20 per barrel, to around 33% when prices rise to €60 per barrel (i.e. around the average level which prevailed in the first half of 2010). If oil prices were to increase to €100 per barrel, the elasticity (assuming broadly constant refining and distribution margins and excise taxes) would rise to above 40%.

INDIRECT FIRST AND SECOND-ROUND EFFECTS

Estimating the indirect first and second-round effects of energy prices is more challenging, and surrounded by more uncertainty, than is the case for direct effects. Moreover, indirect effects may differ at various stages of the production chain and across different sectors of the economy.[16] Therefore, evidence should be drawn from a range of analyses. Table 3 reports the estimated impact of oil prices on inflation using a range of different approaches, including input-output tables and dynamic simulations of various model specifications (such as structural vector autoregression (VAR) models and macroeconometric models). Despite some differences across approaches, they generally provide a consistent picture. The cumulative indirect first and second-round effects on the price level of a 10% oil price increase after three years is estimated to range from 0.20% to 0.29%, about half of which represents a second-round effect from the endogenous reaction of wages. There is also some evidence (e.g. from the structural VAR analysis) that indirect first and second-round effects have declined since the mid-1980s owing to changes in the structural features of economic activity and changes in wage and price-setting behaviour. In this regard, models where expectations play an important role point to a somewhat milder reaction of core inflation to commodity prices, as agents react to expected future policy actions.

15 In June 2009 the European Commission initiated infringement procedures against Member States for not complying with the EU legislation on the internal market for electricity (25 Member States) and gas (21 Member States). The key grounds for complaint were lack of transparency, insufficient coordination efforts by transmission system operators to make maximum interconnection capacity available, absence of regional cooperation, lack of enforcement action by the national competent authorities and lack of adequate dispute settlement procedures.

16 See, for example, Landau, B. and F. Skudelny "Pass-through of external shocks along the pricing chain: A panel estimation approach for the euro area", ECB Working Paper Series No 1104, November 2009.

Table 3 Decomposition of the impact of a 10% increase in crude oil prices on the HICP level using different approaches

(percentages)

Approach	Specification	Direct	Indirect	Second round	Total
Disaggregated energy components [1]	€20	0.15	N/A	N/A	N/A
	€50	0.29	N/A	N/A	N/A
Input-output tables [2]		0.22	0.14	N/A	N/A
Structural VARs (SVARs) [3]	1971-2009	0.20	0.25		0.45
	1971-2000	0.39	0.29		0.68
	1980-2009	0.16	0.20		0.36
Large-scale macroeconometric models [4]	wage reaction on	0.25	0.20		0.45
	wage reaction off	0.26	0.10		0.36

Source: Eurosystem staff calculations.
Notes: See the ECB's 2010 Structural Issues Report for more details.
1) Pass-through is a function of the oil price level – estimates calculated on the basis of constant refining and distribution costs and margins and of indirect taxes at end-2009.
2) Based on 2005 input-output tables. Input-output methodology implicitly assumes constant margins and no second-round effects.
3) Results reported for SVARs estimated over three different sample periods (1971-2009, 1971-2000 and 1980-2009).
4) Results reported for two variants: one allows wages to react to the oil price increase, the other blocks this reaction.

Overall, the pass-through of oil prices into consumer prices is complex, typically a function of many factors, and may vary over time. Key factors comprise the price level of oil, the amount of indirect taxation (excise taxes), and other structural aspects of the economy, including the sector specialisation of activity and wage and price-setting institutions. Wage and price-setting behaviour and monetary policy have a key role to play in determining whether the direct and indirect effects arising from oil price changes translate into inflation over a medium-term horizon. In particular, whilst there is little monetary policy can do about the first-round effects of oil price shocks, it can largely avoid second-round effects. If oil price fluctuations strongly affect wage and price expectations, more vigorous monetary policy action is required to restore price stability. Thus, monetary policy best counteracts the price and output volatility induced by oil price fluctuations by implementing a credible medium-term-oriented monetary policy strategy that stabilises inflation expectations.

4 CONCLUSION

The outlook for oil prices is surrounded by a high degree of uncertainty linked to both demand and supply-side factors. On the supply side, investment in oil production and processing capacity may have been adversely impacted by the financial crisis and subsequent recession. Furthermore, there is considerable uncertainty about the overall available energy resource base. However, technological advances and the discovery of alternative sources of energy (such as shale gas) could imply that the overall supply of energy is greater than currently estimated. On the demand side, although affected by the recession, demand is likely to increase again as the global economy picks up and energy consumption in emerging economies converges with that of developed economies. Climate change polices, such as carbon pricing and the encouragement of alternative renewable energy sources, and increased energy efficiency may attenuate demand. Nonetheless, on balance, the most likely scenario is that the oil supply/demand balance will tighten over time, putting further upward pressure on oil prices in the medium term.

The impact of future oil price movements on the euro area macroeconomy depends on a number of factors including the nature of such movements, the level of oil prices and associated excise taxes, structural features of energy use and energy markets, the degree of economic flexibility and wage and price-setting behaviour. This article has analysed the impact of oil price movements on euro area inflation using a stylised framework which breaks down the impact into direct and indirect first and second-round effects. The largest and most immediate impact comes

from direct first-round effects (i.e. on consumer energy prices). Owing to the important role of excise taxes and broadly constant distribution and retailing costs and margins, the elasticity of consumer energy prices with respect to oil prices increases as the oil price level rises. At the same time, there is some evidence that the indirect first and second-round effects may have declined, owing to a combination of structural changes in the economy and a change in wage and price-setting behaviour. As the euro area is heavily dependent on imported oil, ultimately there is little that can be done to avoid the first-round effects. However, wage and price-setting behaviour, and well-anchored inflation expectations with a credible monetary policy are key determinants of whether inflationary pressures stemming from energy prices translate into inflation over a medium-term horizon.