The price of crude oil and its impact on economic activity in the industrial countries

It is often pointed out that, both in historical terms and in comparison with the emerging market countries, the recovery in the advanced economies in recent years has been rather restrained. This is generally attributed to the efforts, first, of households and enterprises, and then of the public sector, to consolidate their finances. By contrast, the ongoing public debate about a double dip in the industrial countries has so far not really been seen in relation to the double peak in the price of crude oil. The peak level reached in summer 2008 was followed by a short but pronounced recession-induced easing, but oil was back to almost the same level again in April 2011. This price rebound was largely driven by the steep upturn in aggregate economic activity in the emerging market economies. Since the turn of 2010-11, supply-side factors have also been playing a major role, however.

The crises of the 1970s highlighted the economic disruptions that can stem from a cut in the oil supply as a result of events such as war, revolution or an embargo. Less obvious, however, are the dampening effects exerted by a demand-driven increase in the oil price. At the global level, the causal increase in economic activity outweighs possible retarding effects. At a national level, however, the potentially observable balance of positive and negative effects may differ considerably. This is likely to depend not least on how much an economy benefits from the relative shift in prices through its own oil production, is directly involved in the underlying increase in economic activity or participates in this indirectly through extensive external trade links. But irrespective of these particular constellations, a rising oil price per se – through various channels – may be expected to impair aggregate output in oil-importing countries.

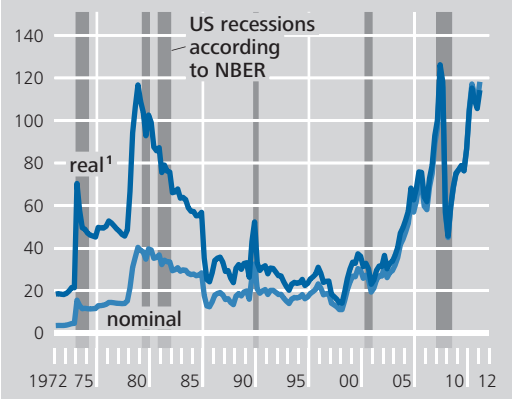
Against this backdrop, there is much to suggest that the oil price hikes of the past years have perceptibly held back economic growth in the industrial countries on the whole, albeit with the retarding effects differing from country to country. The German economy, in particular, has probably suffered comparatively little harm owing to its relatively low consumption intensity, its extensive trade links with oil-exporting countries as well as its generally stronger adaptability and resilience. By contrast, simulations – leaving aside the specific cause of the oil price increase – suggest considerable losses of output in the case of the United States, which possibly help to explain weak US growth, especially in the first half of 2011. Yet the recent robust recovery of the US economy also demonstrates the complexity of economic interlinkages and shows that a sharp oil price hike does not necessarily lead to a recession.

Empirical coincidence of oil price surges and recessions

Ever since the severe crises of the 1970s and early 1980s, if not earlier, the price of crude oil has been regarded as one of the key determinants of fluctuations in the level of economic activity. Since the end of World War II, almost all the recessions in the United States have been preceded by an oil price hike.[1] Furthermore, the evidence is by no means confined to the United States. Apart from the Asian crisis at the end of 1990s, the slumps in global economic growth in the past decades all coincided with sharp increases in the price of crude oil. Admittedly, the fact that the timing coincided does not necessarily imply causality. It is worth noting in this connection that the recent oil price surge, although it was definitely on a historical scale, was not followed by a renewed downturn in the US economy. This article investigates the impact of crude oil prices on international economic activity over the past few years. It first describes historical price developments in the context of the changing interplay of forces in the oil market. The academic literature and macroeconomic model calculations are then used as a basis for describing possible transmission channels, and, finally, an attempt is made to pinpoint specific effects in the past few years.

Price of Brent crude oil

US dollars per barrel, quarterly averages



Sources: Global insight, International Monetary Fund, and Bundesbank calculations. **1** Price of crude oil relative to US CPI excluding energy (seasonally adjusted, reference year 2010).

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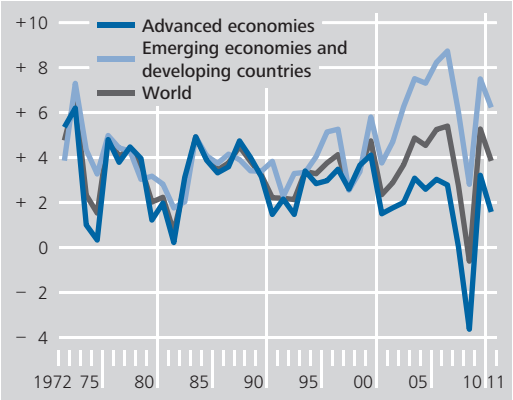
Real GDP*

Annual percentage change



* Up to 1980, according to Maddison (Historical Statistics of the World Economy), thereafter according to the IMF (weighted by purchasing power parity).

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The past evolution of crude oil prices in response to changing supply and demand dynamics

Shift in market dynamics owing to rapid economic growth of emerging markets and developing countries …

After several supply-side shocks, in conjunction with rapidly rising demand in the industrial countries, led to sharp price hikes in the crude oil market in the 1970s, prices subsequently eased in response to the resulting slump in demand in the advanced economies and the erosion of the market power of the Organization of the Petroleum Exporting Countries (OPEC) (see the box on pages 29 and 30). In the 1990s, temporary price increases were repeatedly occasioned by supply-side factors, such as Iraq's invasion of Kuwait and the cutting of OPEC oil production quotas in the wake of the Asian crisis. This was followed, however, by a fundamental shift in market dynamics on the demand side. The rapid economic growth that now began in the emerging markets and developing countries was accompanied by a steeply rising demand for energy. Since the start of the new millennium, the contribution made by this group of countries to the global increase in the demand for oil has – sometimes far – outstripped that of the advanced econ-

1 See J D Hamilton (1983), Oil and the Macroeconomy Since World War II, Journal of Political Economy, Vol 91, pp 228-248, and J D Hamilton (2011), Nonlinearities and the Macroeconomic Effects of Oil Prices, Macroeconomic Dynamics, Vol 15, pp 364-378.

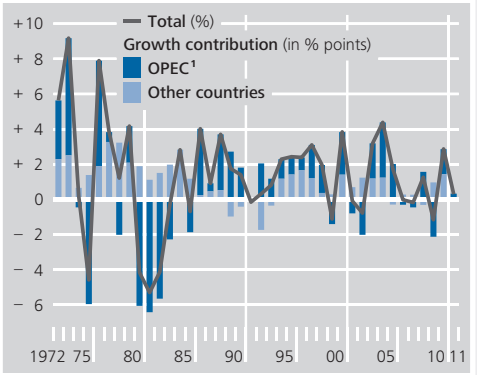
Oil crises of the 1970s

In the 1960s, the price of crude oil was quite stable at a comparatively low level. While industrial nations' demand for oil surged, mainly on account of increasing motorisation, US production in particular could still be expanded strongly. The Texas Railroad Commission, which was responsible for the regulation of the oil and gas industry in Texas and also set production quotas, played a key role in global crude oil prices. US oil production peaked in 1970, accompanied by an unrestrained demand. Over the next three years alone, consumption of refined petroleum products shot up by almost one-fifth in the US. The Texas Railroad Commission set production quotas to 100% as early as 1971, ultimately losing its influence on the oil prices. At the same time, the USA became increasingly dependent on oil imports, especially from the Organisation of the Petroleum Exporting Countries (OPEC).[1] This association was founded in 1960 with members mainly from countries in the Middle East and North Africa. Like the Texas Railroad Commission, it attempts to influence the price of oil by setting production quotas. The stage was therefore set for a fundamental revaluation of crude oil.[2]

A first specific occasion for this arose when several Arab countries imposed an oil embargo against the USA in 1973 in retaliation for its support of Israel in the Yom Kippur war.[3] Not least the price controls, put in place by the US government to keep inflation under control, subsequently probably led to supply shortages, however.[4] As a result of these scarcities, proliferating prices and lower economic activity, oil consumption in the USA fell sharply for a time. However, in 1978 it was markedly surpassing its 1973 level again. In the meantime, 40% of

Growth in global crude oil production

Year-on-year change



Sources: EIA, IEA and Bundesbank calculations. **1** Algeria, Angola, Iraq, Iran, Qatar, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates and Venezuela.

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the American economy's demand for oil was being quenched by imports. More than two-thirds of these came from the OPEC countries. Events took over again in 1979 following the Iranian revolution. Although the expansion of production in other OPEC countries more than offset the shortages in Iranian oil production resulting from the unrest, oil prices surged in the course of the

1 In 1970 no more than around one-fifth of the consumption of refined petroleum products was covered by net imports in the USA, whereas it was as much as one-third in 1973. OPEC's share of oil imports climbed by 10 percentage points to just under 50%. See US Energy Information Administration (EIA), Annual Energy Review 2009, pp 129 and 135.

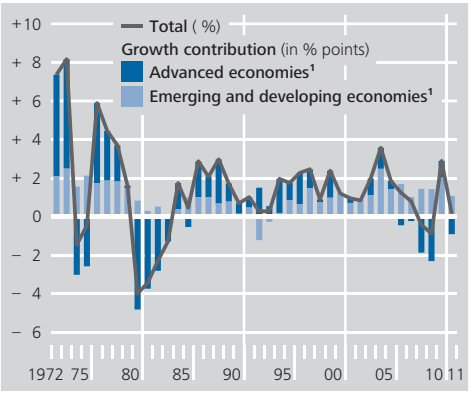
2 Barsky und Kilian (2002) und Kilian (2008) highlight the role of increased demand as preparing the ground for the first oil price surge of the 1970s. See R B Barsky und L Kilian (2002), Do We Really Know That Oil Caused the Great Stagflation?, NBER Macroeconomics Annual, Vol. 16, pp 137-183. Also L Kilian (2008), Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the US Economy?, Review of Economics and Statistics, Vol. 90, pp 216-240.

3 See EIA (2002), Petroleum Chronology of Events 1970-2000, available at http://www.eia.gov/pub/oil_gas/petroleum/analysis_publications/chronology/petroleumchronology2000.htm.

4 See, for instance, B S Bernanke, Remarks on Class Day 2008, Board of Governors of the Federal Reserve System, speech at Harvard University (Cambridge, Massachusetts), 4 June 2008.

Growth in global crude oil consumption

Year-on-year change



Sources: EIA, IEA and Bundesbank calculations. **1** Country grouping in accordance with IMF.

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year and there were fuel shortages again in the USA.[5] Towards the end of the year, the US government also decided to boycott Iranian oil. The invasion by neighbouring Iraq in 1980 had a major impact on crude oil production in both countries, but did not drive prices up beyond previous highs.

The industrial countries' demand for oil declined sharply in the wake of the price surge between 1980 and 1983 and, unlike the previous crisis, its recovery was sluggish. This may well have been one reason for the erosion of the oil price in the 1980s. In addition, on the supply side the power of the OPEC cartel was being undermined through the development of oil fields, for example, in Alaska and the North Sea, as well as by the expansion of production in Mexico. OPEC combated the decline in prices with cuts in production quotas. However, this led to losses of market share and revenue, which prompted some member states not to keep to their quotas. Saudi Arabia bore the brunt of adjustments; by 1985 it had reduced its production to just over one-third of its 1981 level. Owing to the massive loss in revenue, the kingdom finally liberated itself from this burden in the following year and the price of oil slumped again to its 1978 value. It is certainly striking that the decline in prices barely stimulated the depressed oil demand, indicating an asymmetry in its price elasticity. The sharp increase in prices in 1979-80 led to widespread displacement of oil from electricity production, reduced use as heating fuel, energy saving measures in households and industry as well as the development of more efficient motor vehicles. However, substitution and efficiency improvements were not reversed in the wake of the price decline.

5 The 1979 fuel shortage is sometimes seen as being linked to an unusually strong accumulation of stocks, in which a part may have been played by economic incentives in connection with the gradual shedding of price controls along with the policy of the US Department of Energy. See P K Verleger (1979), The US Petroleum Crisis of 1979, Brookings Papers on Economic Activity, Vol 1979:2, pp 463-476.

omies in each individual year.[2] In 2011, global oil consumption was split nearly 50-50 between these two groups of countries; ten years earlier, the industrial nations had accounted for 60%. The emerging economies' hunger for energy is widely seen as one of the key drivers of the gradual but continuous oil price rise between 2003 and 2008.[3] Consumption by China increased in this period by more than one-half. On the other hand, global oil production stagnated in 2006 and 2007 owing, among other things, to oil fields becoming exhausted and ageing installations in Mexico and the North Sea. It could therefore be argued that the additional demand from emerging economies and developing countries had to be met by savings elsewhere, which were enforced via the market through price increases.[4] Hence there is no need to attribute the observed price rises to a supposed major contribution made by the speculative activities of financial investors – an argument that has often been put forward – nor does the direct evidence suggest that speculation plays an important role (see the box on pages 32 and 33).

… and very low sensitivity of their oil demand to price changes …

A second factor is that the emerging and developing countries' demand for oil probably reacts even more sluggishly to price changes than that of the advanced economies (see box on pages 34 to 36). The price elasticity of the demand for crude oil is generally low in the industrial countries, too, especially in the short term. But in many emerging markets and developing countries price controls and subsidies additionally impede a pass-through of higher crude oil prices. Fuel subsidies in the OPEC countries are especially obvious; there, consumers have, in some cases, to pay the equivalent of just a few cents for a litre of petrol.[5] In conjunction with sharp increases in income and high population growth, this is likely to have driven up the demand for oil in these countries. In the early 1970s, the OPEC countries accounted for just 2½% of global consumption, compared with almost 4% by 1980 and as much as 10% in 2011.[6] Measured by the total costs involved, the subsidies in China, India and Indonesia are also considerable, however.[7] According to estimates by the International Energy Agency (IEA), without reforms such assistance could amount to more than US$630 billion worldwide this year. This would be roughly equivalent to half of the OPEC countries' revenues from oil exports.[8]

… leading to divergences in the global demand for oil …

All things considered, the furious pace of economic growth in the emerging markets and developing countries along with the extremely low price sensitivity of their demand for oil suggests that, given a finite supply, the advanced economies took most of the strain of making the necessary adjustments to clear the oil market in the past decade. In actual fact, consumption of oil by the advanced economies peaked as long ago as 2005; six years later, it was 9% lower despite economic growth of 7%. By contrast, oil consumption by the emerging markets and developing countries went up 21% on the back of an almost 50% expansion in their macroeconomic activity.

Expanding demand encountered supply-side squeeze in 2011 …

In view of the renewed resurgent recovery in the emerging market economies, it is not surprising that, following the global recession of 2008-09, the oil market was soon very tight again. Furthermore, the expansion of oil production in some regions, especially in the United States and Canada as a result of extraction from unconventional sources, contrasted

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2 The groups of countries are demarcated here in line with the definition of the International Monetary Fund (IMF).
3 See B Hicks and L Kilian (2012), Did Unexpectedly Strong Economic Growth Cause the Oil Price Shock of 2003-2008?, scheduled for publication in the Journal of Forecasting.
4 See J D Hamilton (2009), Causes and Consequences of the Oil Shock of 2007-08, Brookings Papers on Economic Activity, Vol 2009:1, pp 215-261.
5 See GIZ (2011), International Fuel Prices 2010/2011, Data Preview, January at http://www.gtz.de/de/dokumente/giz2011-international-fuel-prices-2010-2011-data-preview.pdf.
6 This is based on 11 OPEC member countries: Algeria, Angola, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.
7 See IEA Energy Subsidies Online Database at http://www.iea.org/subsidy/index.html.
8 See IEA (2012), World Energy Outlook – Impact of High Oil Prices on the Economy (Part 3) at http://iea.org/index_info.asp?id=2437.

The impact of speculation on the price of oil

Futures are standardised, exchange-traded contracts for goods to be delivered at a later date. The markets for commodities futures, in particular, perform at least two important economic functions. First, they allow producers and consumers of the relevant commodities to hedge price risks. This reduces the uncertainty surrounding the production of commodities, for example, and can therefore help to increase their supply, which *per se* tends to lower the price of commodities. Second, the futures markets play a key economic role in the price-setting process due to the high degree of standardisation and transparency of these markets. The large, liquid futures markets, in particular, perform a price-signalling function for the corresponding spot markets and over-the-counter derivatives markets.

Critics of futures trading and the futures markets regard this signalling function as problematic, however, and question whether the price signals emanating from the commodities markets really reflect the fundamentals. For example, if speculators were to "gamble" on the futures markets, regardless of the fundamentals, and were to dominate the price-setting process there, the markets' signalling function would indeed be impaired. Another point of criticism concerns the market power of individual speculators. The question is whether any single speculator or small group of speculators has the necessary market power to manipulate prices so as to profit from the resulting price movements. This, too, would constrain the ability of the relevant futures market to function properly – in extreme cases, to such an extent that the price set on this market would not transmit efficient signals to other markets.

The recent high price levels on the oil market have reawakened debate on this topic, focusing on whether the price of oil adequately reflects the fundamental supply and demand conditions. Particularly at times of sharp price fluctuations, fingers are frequently pointed at the financial markets, with critics highlighting and questioning the role of speculation on the futures markets.

In this situation, it is helpful to take a closer look at how a futures market is structured. The light sweet crude oil futures contract traded on the New York Mercantile Exchange is selected here by way of illustration. According to data on open trading positions, at between 10% and 20%, the market share of speculators (or actively managed funds) is relatively small and constant over time; it did not increase even during the financial crisis of 2007-08.[1] These figures strongly indicate that the volatile price developments on the crude oil markets are not due to corresponding changes in the market participation of speculators. A certain amount of caution is advised when interpreting these figures, however, as they only relate to one individual futures market and exclude activities on over-the-counter derivatives markets, for example.

The different groups of market participants usually act as both buyers and sellers, albeit to varying extents. Where buying/selling predominates, the trading portfolio is referred to as a net long/short position. In

1 The actively managed assets include open positions of hedge funds and commodity pool operators and are therefore considered speculative. By contrast, swap dealers may be banks that hedge their swap transactions in the futures market. Because of their hedging activities, swap dealers are also referred to as "non-traditional hedgers" by the US Commodity Futures Trading Commission (CFTC). See the information provided by the CFTC at http://www.cftc.gov.

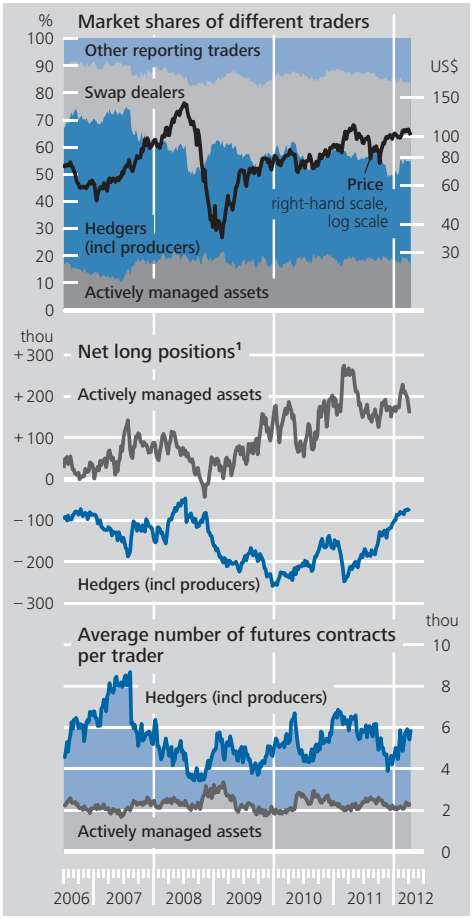
general it may be said that the net long positions held by actively managed funds generally counterbalance the net short positions held by risk managers (hedgers). This suggests that the speculators in this market are not "gambling" and therefore not ignoring the fundamentals. Instead, they perform an important economic function and help to stabilise the market by providing liquidity, thus enabling hedgers to manage risk in the first place. This interpretation is supported by the Keynesian theory that speculators on the futures markets act more as counterparties or insurers for hedgers.[2] Similarly, the Bundesbank's own studies on the relationship between open positions and price dynamics, carried out using causality tests and regression models, do not indicate that actively managed funds have a significant destabilising effect on price developments.[3]

It is also claimed that speculators have too much market clout and can manipulate prices. However, it is difficult to find any firm evidence of this. Instead, market data appear to indicate that speculators do not have any significant market power relative to the hedgers. The average size of the open positions per trader in the period 2006 to 2012 is some two to three times larger for hedgers than for speculators. In addition, the average sizes of the speculators' positions are constant over time. In light of this, the risk of price manipulation seems rather low.

Overall, with regard to the trade in crude oil, many factors suggest that speculators do not impair the functioning of the market, but instead have a positive influence on it, especially by providing liquidity for hedgers and therefore facilitating the price-setting process. To enable a more comprehensive assessment to be made, it is essential to collect and evaluate additional information about trading activities on over-the-counter derivatives markets. It is therefore important to press ahead with international initiatives to encourage higher levels of transparency on these markets.

Market structure and market shares on the New York crude oil futures market

Weekly values



1 Number of long futures contracts less short futures contracts. A negative value indicates that the short position is larger than the long position.

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2 See: J M Keynes (1930), A Treatise on Money, II: The Applied Theory of Money, MacMillan: London; and: J R Hicks (1939), Value and Capital, Oxford University Press: London.

3 A current overview of the literature on the connection between speculation and price developments can be found in S H Irwin, D R Sanders and R P Merrin (2009), Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust), Journal of Agricultural and Applied Economics, Vol 41, pp 377-391; and: D S Jacks (2007), Populists versus Theorists: Futures Markets and the Volatility of Prices, Explorations in Economic History, Vol 44, pp 342-362.

Price elasticity of demand for crude oil in the short term

In economics, elasticity is the relationship between the percentage change in a variable and the causal percentage change in another variable. Price elasticity of demand *(ε)* is thus a measure of how strongly the demanded quantity of a good *(x)* reacts to a change in its price *(p)*:

$$\varepsilon = \frac{\Delta x}{\Delta p}\frac{p}{x}.$$

Given that demand tends to decline as prices rise, elasticity is generally negative. In the short term, demand for crude oil is regarded as largely inelastic since substitution on a major scale is possible only in the medium to long term. If we additionally assume a perfectly inelastic oil supply in the short term, a given elasticity of demand can be used to determine the price reaction that occurs in the market, say, after a restriction of the quantity supplied.

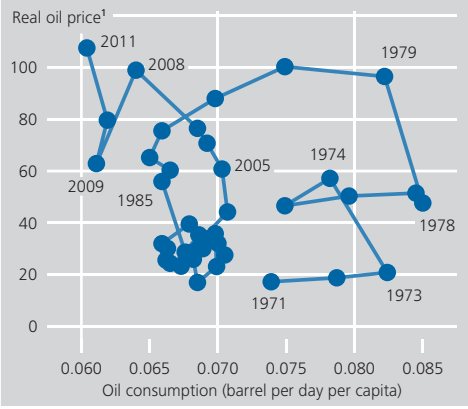
$$\frac{\Delta p}{p} = \frac{\Delta x}{x}\frac{1}{\varepsilon}.$$

Owing to the low sensitivity of demand, even minor supply cuts can trigger a significant shift in prices. For a price elasticity of demand of -0.10, for example, a 2½% reduction in the supply would drive up the price of oil by (-2.50%) / (-0.10) = 25%, and by as much as 50% given an elasticity of -0.05. This example also illustrates that, with a low level of elasticity, even small changes in its value are associated with major differences in the resulting price reaction.

Global oil demand consists of the demand of the individual regions. For the sake of simplicity, let it be assumed that the advanced economies, as one group of countries, and the emerging economies and developing countries, as the other, each consumes one-half of the global oil production volume. Owing to economic growth, let the demand of the latter group, irrespective of the price, grow by 5%, ie 2½% of the overall global supply. As it is assumed that the global supply cannot be expanded, a price increase should dampen demand to the same extent. How this adjustment burden is distributed among the two regions depends on the price elasticity of their demand. If the elasticity is identical, the regions bear the burden equally. If the regional and global elasticities are both -0.10, the price will go up by 25%, and the consumption of the advanced economies will decline by 2½%. The demand of the emerging economies and developing countries will likewise fall by 2½%; owing to the income-related stimulus, an increase of 2½% still remains, however. This clearly shows that even with identical price elasticity of demand, the economic emergence of other economies can lead – through price surges – to a displacement of the demand for oil in the industrial countries.

If it is additionally assumed that not just the supply, but also the demand of the emerging economies and developing countries is perfectly inelastic in the short term, rebalancing the oil market is a matter for the demand of the advanced economies alone. If consumption in the rest of the world rises again by 5% for income-related reasons,

Price elasticity of oil demand in the USA



1 In US dollar, relative to US CPI, reference year 2010.
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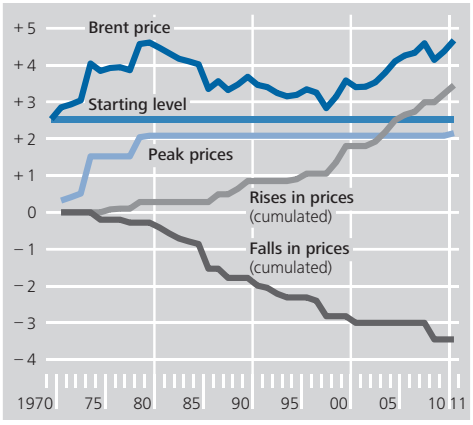
the demand of the industrial countries declines by the same amount. Given an elasticity of -0.10, this would require a 50% price increase and for an elasticity of -0.05, the price would have to be doubled. Incidentally, a 2½% cutback in the global supply would also have the same effect on the price and the volume of demand of the industrial countries, even though this scenario would, in fact, be completely different with regard to global economic growth. Nevertheless, it is clear that the price fluctuations on the oil market become larger along with the growing importance of a comparatively inelastic part of global demand.

Breakdown of the real oil price

Logarithmic index



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Ultimately, how high the short-term price elasticity of demand is has to be determined empirically. Logarithmic variables can be used to obtain an estimate from a simple regression in which annual data are used as a basis for explaining the oil demand (per capita) by a constant, the real price of oil, real GDP (per capita) and its own prior-year value.[1] Such an approach results in a short-term price elasticity, which, in part, is still somewhat lower than in our stylised examples.[2] However, this approach works on the assumption that demand generally reacts symmetrically to price rises and declines. In a diagram in which the real price of oil is plotted on the vertical axis and the demand for oil *(per capita)* on the horizontal axis, a relatively steeply falling curve would have to be shown, which repeatedly shifts to the right following increases in income. Especially in the case of the United States, marked shifts to the left can be observed in the wake of sharp price surges (1979 to 1983 and 2007 to 2011). The price increases led to sharp cutbacks in consumption, which were not reversed again by subsequent price decreases (1984 to 1986 and in 2009). It would appear that the demand for oil is more responsive to price rises than to price reductions. Since this is not taken into consideration in the above regression estimate, only an elasticity to an average price change is obtained and the responsiveness of demand to a price increase is possibly underestimated.

Following Gately and Huntington (2002), the simple symmetric regression approach can be corrected by decomposing the (logarithmic) real oil price as the explanatory variable into peak prices, the cumulative (remaining) price rises and the cumulative price declines.[3] If such an asymmetric model is estimated for the period from 1971 to 2011,[4] a considerably higher elasti-

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1 From the coefficient for the lagged demand, the corresponding long-term elasticities can be derived in conjunction with the estimated coefficients of price and income, ie the short-term elasticities. See J C B Cooper, Price Elasticity of Demand for Crude Oil: Estimates for 23 Countries, OPEC Review, March 2003, pp 1-8.

2 See IEA, World Energy Outlook 2006, p 286 f, as well as V Saporta, M Trott and M Tudela, What Can Be Said About the Rise and Fall in Oil Prices? Bank of England, Quarterly Bulletin, 2009 Q3, p 218.

3 Furthermore, Gately and Huntington (2002) also consider asymmetries in income elasticity. See D Gately and H G Huntington (2002), The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand, Energy Journal, Volume 23, pp 19-55.

4 The annual data used are from the following sources: EIA, IEA, IMF and Maddison (Historical Statistics of the World Economy). Owing to the small number of data points together with the imprecision of the relevant tests, the problem of non-stationarity and cointegration of the time series is disregarded here. In the equations for the world as a whole and for emerging economies and developing countries, the hypothesis that the residues are free of autocorrelation is rejected in the Breusch-Godfrey test, which is why AR(1) models are estimated.

Estimated short-term price elasticity of oil demand (per capita)[1]

Approach	World	Advanced economies	Emerging market economies and developing countries
Symmetric approach	– 0.02 * (0.01)	– 0.04 *** (0.01)	0.01 (0.01)
Asymmetric approach			
Peak prices	– 0.08 *** (0.02)	– 0.08 *** (0.01)	– 0.03 * (0.02)
Rises in prices	– 0.02 (0.03)	– 0.04 *** (0.01)	– 0.01 (0.03)
Falls in prices	0.01 (0.02)	0.00 (0.02)	0.02 ** (0.01)

1 Observation period (unadjusted) 1971 to 2011. ***, **, * = significant 1%, 5% and 10% level. Standard errors in parentheses.

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city of global oil demand (-0.08) is obtained compared with the price surges which resulted in historical peaks in the real price of oil. Compared with other oil price changes, however, hardly any demand responses are apparent. Furthermore, in the case of the advanced economies, the sensitivity to other price increases (-0.04) additionally proves to be statistically significant. In the case of the emerging economies and developing countries, the demand responses to price increases appear to be generally weaker. The significance of the positive elasticity to price declines is also striking. However, it also has to be taken into account that this is the aggregate of a very heterogeneous group of countries. Owing to the dependency of their income on price fluctuations and the high level of subsidies for fuel consumption, the group of oil-exporting countries, in particular, generally shows a positive price elasticity, which outweighs the impact of the negative elasticity of other countries if the price goes up, and which is the sole factor that has an impact when the price goes down.

There was a rise especially in the frequency of record highs in the real price of oil at the beginning of the underlying observation period. According to the estimates, there was a very marked responsiveness of demand especially to these price increases, which might therefore be consistent with the results of some studies showing the oil demand to have become more inelastic over time.[5] One key reason for this could be that comparatively simple substitution possibilities for crude oil, say, in electricity production, are already exhausted and, hence, end products with a relatively low price elasticity of demand, such as transport fuels, have gained in importance. With regard to global demand, however, the regional shift in the weights towards the emerging economies and developing countries – and within the group itself towards the oil-exporting countries – is also likely to have played a part in this.[6]

All in all, the price fluctuations on the oil market are likely to have been tending to increase owing to a lower sensitivity of demand. What should also be highlighted in this connection is the imprecision of the estimates, which opens up a matching range of possible elasticities and implied price fluctuations.

5 In this connection, particular mention should be made of the studies of Baumeister and Peersman (2008, 2009), for example. Their methodology is criticised by Kilian and Murphy (2012), however. See C Baumeister and G Peersman (2008), Time-Varying Effects of Oil Supply Shocks on the US Economy, Ghent University, working paper; C Baumeister and G Peersman (2009), Sources of the Volatility Puzzle in the Crude Oil Market, Ghent University, working paper; L Kilian and D Murphy (2012), Why Agnostic Sign Restrictions Are Not Enough: Understanding the Dynamics of Oil Market VAR Models, scheduled for publication in the Journal of the European Economic Association.

6 See J M Dargay and D Gately (2010), World Oil Demand's Shift Toward Faster Growing and Less Price-Responsive Products and Regions, Energy Policy, Vol 38, pp 6261-6277.

with declining production from mature oil fields, say, in the North Sea. According to the US Energy Information Administration (EIA), Norwegian production last year was 18½% down on its 2008 level, while UK oil output tumbled by as much as 27%. Production levels were faltering in Venezuela, too. The combined decline in supply from these three countries alone compared with 2008 amounted to around one million barrels a day, which equates to 1¼% of the global supply. Besides these shifts with a medium-term impact, acute concerns about the stability of oil streams from North Africa and the Middle East emerged at the beginning of 2011 along with the struggle for political codetermination in the Arab world. At all events, 2011 saw Libyan production sink to one-quarter of its 2010 level in the wake of the military conflicts. Although global oil production increased last year owing to the fact that some countries, notably Saudi Arabia, sought to raise their oil output, the figures obscure the fact that the oil market is quite segmented both in terms of quality and regional distribution. Thus, high-quality Libyan crude could not simply be replaced by different grades of oil from Saudi Arabia. A temporary easing was brought about by the release of part of the industrial countries' strategic reserves. Regional imbalances were reflected mainly in the unusual price spread between the crude oils Brent und West Texas Intermediate (WTI).[9] One indication of the role played by supply-side shortages in the recent oil price increases might also be the persistence of the latter. Whereas industrial raw materials, for example, became much cheaper in the second half of 2011 in the wake of the slowdown in the world economy, the price of Brent barely eased. On an annual average, crude oil became 40% more expensive and was thus clearly up even on the previous record year of 2008.

… and 2012

Although Libyan production has since been stepped up again, there was a further hike in crude oil prices in the first few months of 2012. Against the backdrop of an escalating dispute with Iran concerning its nuclear capability, prices were being driven up by fears of a possible military confrontation in the Persian Gulf along with other factors. Existing purchasers of Iranian oil are likely to have been on the lookout for new sources even before an EU embargo came into force in July. It is expected that Iranian oil exports will ultimately be reduced by between ¾ and 1 million barrels per day. It should be noted that the expectation of a higher price of crude oil in the future is in itself a sufficient economic rationale for raising the price now. In addition to the smouldering conflict in the Persian Gulf, production losses occurred at the start of 2012 in the context of political conflicts, particularly in Yemen, Sudan and Syria. According to estimates, these totalled roughly ¾ million barrels per day.[10] Compared with this, the additional demand from Japan due to the stoppage of nuclear power plants which generate electricity is likely to

9 As WTI has a slightly higher quality, Brent is usually traded at a small discount to it. Yet Brent started fetching a premium of a few US dollars per barrel in the second half of 2010. This premium rapidly expanded in the first few months of 2011 and peaked in the summer months above the US$20 mark. WTI is extracted within the continental borders of the United States, where the supply has broadened in the past few years owing to the inflow of Canadian oil and where storage capacities were largely exhausted in the wake of restrained demand. On the other side of the Atlantic, however, the Libyan production losses were added to declining North Sea production and rising demand from Asia. The sharp differences in the supply-demand equation were also reflected in the respective term structures. While forward deliveries of WTI were still carrying a premium (contango), short-term deliveries of Brent were dearer than longer-term forward deliveries (backwardation). As the available pipelines led only into the interior of the USA, the lack of a convenient transportation option ultimately prevented an adjustment between the markets. The decoupling from the world market is also shown by the price spread between WTI and other crudes. Furthermore, even in the United States, petrol prices at the consumer level appear to have followed the pattern of Brent prices. Moreover, as Brent and WTI prices have shown little divergence historically, the Brent price is used throughout this article as a measure of the world market price for crude oil. See EIA, Market Response to the WTI-Brent Spread Is Constrained by Logistical Challenges, This Week In Petroleum, 24 February 2011; EIA, The Latest Twist in Oil Price Patterns, This Week In Petroleum, 8 September 2011; K L Kliesen and M T Owyang, Using Brent and WTI Oil Prices to Predict Gasoline Prices, Federal Reserve Bank of St. Louis, National Economic Trends, November 2011.
10 See IEA, Oil Market Report, March 2012, p 15ff. and p 33.

have played no more than a minor role.[11] In light of a larger supply, especially following Saudi Arabia's expansion of production, and the gloomier outlook for the global economy, the price of oil went down again in spring.

Oil demand of advanced economies ultimately crowded out via price hikes

On balance, it can be said that the economic rise of the emerging and developing countries has brought about a significant shift in the dynamics of the oil market. The responsiveness of global oil demand to price changes is likely to have decreased as a result and the fluctuation margin of oil prices to have increased in line with this. As the supply of oil is not very elastic, the market equilibrium could only be preserved by ultimately crowding out the advanced economies' demand for oil through sharp price hikes.

Possible impacts of an oil price hike on the real economy

Lower oil consumption …

Economists generally assume that oil price hikes have an impact on both aggregate supply and demand.[12] The impact on the supply side results from firms' need to employ oil or energy alongside their capital and labour inputs in order to produce their output. A higher (relative) price then reduces the crude oil input and thus also output.[13] The magnitude of this effect can be derived from simple logic. Assuming an optimal factor input, in which the marginal product of energy matches its relative price, it follows that the elasticity of output to the change in the energy input corresponds to its cost share. The elasticity of output to changes in the relative price of energy then reduces to the product of its cost share and the price elasticity of energy consumption.[14] As the latter is small in the short run, output response even to large price changes should be rather small.

… and other supply-side strains

Other mechanisms could further magnify the impact of a price surge, however. It is also possible that other factor inputs might be scaled back. For example, the heightened uncertainty triggered by a price rise could prompt enterprises to cut back their investment.[15] Moreover, the assumption of homogeneous aggregate output represents a considerable simplification. In reality, an increase in the price of energy is likely to affect individual sectors to varying extents and thus bring about a reallocation of the production factors among the economic sectors.[16] Such shifts are certainly associated with higher costs in the form of output losses.[17] Common assumptions, such as that of perfect competition are, after all, not sustainable and price-setting by enterprises by means of cost surcharges likewise implies a higher output response.[18]

Income outflows for consumers …

On the demand side, a dampening effect is exerted through the narrowing of households' (real) scope of income. Assuming that their energy consumption is unchanged, which is quite

11 The latest estimate by the IEA puts Japan's additional demand for oil last year at no more than 145,000 barrels per day, roughly half as much as in earlier assessments. But as other consumption was tending to decline – due not least to price inflation – the EAI data show that Japan's actual total oil consumption in the second half of 2011 was around 100,000 barrels per day (+2½%) higher than in 2010. For 2012, the IEA still assumes an additional oil demand of ¼ million barrels per day. See IEA, Japanese Power Sector Demand: One Year After Fukushima, Oil Market Report, April 2012, p 11.
12 See R B Barsky and L Kilian (2004), Oil and the Macroeconomy Since the 1970s, Journal of Economic Perspectives, Vol 18, pp 115-134 and J D Hamilton (2005), Oil and the Macroeconomy, published in S N Durlauf and L E Blume (eds), The New Palgrave Dictionary of Economics, Palgrave Macmillan, second edition, 2008.
13 If changes in the inputs of other production factors are taken into account, the demand for labour and capital rises accordingly. This substitution mitigates the output losses.
14 See, for example, J D Hamilton (2011), Nonlinearities and the Macroeconomic Effects of Oil Prices, Macroeconomic Dynamics, Vol 15, p 364f.
15 See B S Bernanke (1983), Irreversibility, Uncertainty, and Cyclical Investment, Quarterly Journal of Economics, Vol 98, pp 85-106.
16 See Deutsche Bundesbank, Growth effects of permanently high energy prices: recent evidence for Germany, Monthly Report, June 2009, pp 29-44, and T A Knetsch and A Molzahn, Supply-Side Effects of Strong Energy Price Hikes in German Industry and Transportation, Empirical Economics, published online, September 2011.
17 See J D Hamilton (1988), A Neoclassical Model of Unemployment and the Business Cycle, Journal of Political Economy, Vol 96, pp 593-617.
18 See J J Rotemberg and M Woodford (1996), Imperfect Competition and the Effects of Energy Price Increases on Economic Activity, Journal of Money, Credit and Banking, Vol 28, pp 550-577.

plausible in the very short term, consumers have to cover their additional costs by cutting their spending on other goods or by saving less. How far they prefer one alternative to the other is likely to hinge on their broader economic environment. The maximum percentage share of the cutbacks needed elsewhere is, at all events, given by the product of the share of spending on energy and the percentage change in its relative price. The ceiling for the elasticity of consumers' (real) demand to relative price changes is thus formed by the percentage of petroleum products in total expenditure.[19] This means that the demand effect could be of a higher order than the simple supply-side effect, which depends on a reduction in oil input and is therefore additionally restricted by the low price elasticity of energy consumption.

… and oil-importing economies as a whole

There is a corresponding outflow of income also at the macroeconomic level for countries that are net importers of oil. It is true that income may flow back into an oil-importing country to a certain extent since oil-exporting countries spend part of their extra revenues on higher imports of goods and services.[20] The extent of this income recycling depends on spending behaviour in the exporting country, however, and on its external trade links with the importing country in question.

Significance of initial level for impact of oil price changes

The importance of oil's share in overall spending for the demand effect, which was established above, already implies that the (short-term) effect on aggregate output also depends on the oil price's initial level. Thus, an increase of, say, 10% given an initial price of US$100 results in a steeper fall in output than if the price is initially only half as high. Furthermore, taxation based on quantity ensures, at least at the consumer level, that the share of spending ultimately does not increase exactly in proportion to the price. These interrelationships are also simulated in common macroeconomic models which are otherwise linear in construction, like NiGEM (see Annex on pages 48 and 49). This fact alone means that common rules of thumb that automatically infer a given output response from a given percentage or absolute change in the price of oil should be interpreted merely as approximations.

Doubts about the stimulus effect of lower oil prices

The relationship between changes in the price of oil and output growth seems to have weakened over time. A large part of the relevant literature has therefore been devoted to the question of how far this phenomenon can be reconciled with the earlier transmission mechanisms.[21] For instance, one major strand of research has highlighted non-linearities and asymmetries of the impact of oil price changes on the real economy. The first doubts concerning the supposed stimulating effect of a fall in oil prices emerged in the second half of the 1980s, when US economic growth failed to strengthen following the oil price collapse.[22] The fact that structural dislocations generally occur in the wake of oil price shifts, thus neutralising the potential positive demand effects of a lower price, has been cited as the foremost cause of such an asymmetry.[23] Furthermore, heightened uncertainty, which may lead to the deferment of investment, is probably associated with price fluctuations in the oil market *per se,* not with price changes in a particular direction.[24] Finally, the asymmetric reaction of the demand for oil is also likely to exert a

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19 See, for example, J D Hamilton (2011), Nonlinearities and the Macroeconomic Effects of Oil Prices, Macroeconomic Dynamics, Vol 15, p 366.

20 Insofar as the additional revenues are not reflected in higher expenditure, the exporting countries acquire assets. This brings about a change in asset prices, which ultimately likewise influences aggregate demand in the importing country. Income recycling via this channel takes place much more slowly, however.

21 See, in particular, M A Hooker (1996), What Happened to the Oil Price-Macroeconomy Relationship?, Journal of Monetary Economics, Vol 38, pp 195-213, and also O J Blanchard and J Galí (2007), The Macroeconomic Effects of Oil Price Shocks: Why Are the 2000s So Different from the 1970s? published in J Galí and M J Gertler (eds), International Dimensions of Monetary Policy, University of Chicago Press.

22 See K A Mork (1989), Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results, Journal of Political Economy, Vol 97, pp 740-744.

23 See K Sill, The Macroeconomics of Oil Shocks, Federal Reserve Bank of Philadelphia, Business Review Q1 2007, pp 21-31.

24 See H Guo und K L Kliesen (2005), Oil Price Volatility and U. S. Macroeconomic Activity, Federal Reserve Bank of St. Louis Review, Vol. 87, pp 669-683.

matching one-sided impact on aggregate supply. Economists who focus primarily on the impact on aggregate demand do indeed dispute that there is such an imbalance in the way higher or lower crude oil prices affect overall economic activity.[25] Nevertheless, a non-linear measure of oil price changes appears to show a quite stable relationship with real GDP growth to date (see box on pages 41 to 43).

Have recessions been triggered by higher oil prices or a tighter monetary policy?

A further debate in the academic literature centres on how far the observed output losses following an oil price shock should perhaps rather be ascribed to a more restrictive monetary policy. In actual fact, recessions in the United States have been regularly preceded not only by oil price hikes but also by a rise in the federal funds rate. Using a counterfactual experiment in an empirical model, Bernanke *et al* (1997), notably, have attempted to show that the US economy's output losses following the oil price shocks in the 1970s and early 1980s would have been much more muted if key interest rates had remained unchanged.[26] Such an approach is extremely problematic, however.[27] First, it is assumed that the actual interest rate rises were ultimately solely a monetary policy response to the oil price hikes. It is more likely, however, that the tightening of monetary policy was, at least partly, a response to the general upward surge in prices and a reflection of the Fed's striving for credibility. Second, it is implicitly assumed that a neutral monetary policy stance in the event of an oil price shock is to keep the key interest rate unchanged.

Unchanged policy rate as a monetary policy stimulus in macroeconomic models

The problematic nature of this assumption can be demonstrated by an analogous experiment using a macroeconomic model like NiGEM (see Annex on pages 48 and 49). In this case, too, it seems natural to model the supposedly standalone effect of an oil price shock, ie excluding the impact of monetary policy, by linking this price increase in a simulation with the additional assumption of constant policy rates. In actual fact, however, a quite different question is answered by an experiment of this kind. This is due to the fact that, in the initial situation, the monetary policy stance is neutral in terms of a predefined rule. But if the central bank's target variable is subsequently affected by a change to the data, such as an oil price hike, the same key interest rate can no longer imply a neutral monetary policy stance. This is because private market players anticipate higher inflation following an oil price shock and an interest rate rise in response to it. If interest rates are left on hold, this is a case – measured by the underlying rule – of unexpected monetary policy easing. The smaller losses of aggregate output in the wake of unchanged key rates compared with a simulation in which only a higher oil price is assumed therefore reflect the impact of a monetary policy shock. In economic reality, however, private market players' ability to learn means it is unlikely that such surprises can be repeated an infinite number of times.

Systematic impact of rule-based monetary policy on the price level and output effects of an oil price hike

It is therefore very hard to isolate the effects of systematic monetary policy reactions from the impact of higher oil prices that triggered them. Nevertheless, model simulations show clearly that the macroeconomic trade-off between lower economic activity and a higher price level following a permanent increase in oil prices can indeed be controlled to a certain extent by a central bank. For example, a central bank that stabilises only the price level may tolerate a sharper decline in output in the wake of an oil price hike than a central bank which has an in-

25 Kilian und Vigfusson (2011), in particular, have pointed to methodological problems in investigating asymmetric effects. However, Hamilton (2011) has rejected criticism of earlier studies. See L Kilian and R J Vigfusson (2011), Nonlinearities in the Oil Price-Output Relationship, Macroeconomic Dynamics, Vol 15, pp 337-363, and J D Hamilton (2011), Nonlinearities and the Macroeconomic Effects of Oil Prices, Macroeconomic Dynamics, Vol 15, pp 364-378.
26 See B S Bernanke, M Gertler and M Watson (1997), Systematic Monetary Policy and the Effects of Oil Price Shocks, Brookings Papers on Economic Activity, Vol 1997:1, pp 91-142.
27 As explained in detail by Carlstrom and Fuerst (2005), this is ultimately an application of the Lucas critique. See C T Carlstrom and T S Fuerst (2005), Oil Prices, Monetary Policy, and the Macroeconomy, Federal Reserve Bank of Cleveland, Policy Discussion Paper, No 10, and R E Lucas (1976), Econometric Policy Evaluation: A Critique, Carnegie-Rochester Conference Series on Public Policy, Vol 1, pp 19-46.

Empirical relationship between crude oil price changes and real GDP growth

Despite the temporal proximity of strong oil price surges to macroeconomic downturns, it is not easy to prove econometrically that changes in the price of crude oil have a negative impact on real GDP growth. An initial problem concerns the stability of a possible (linear) relationship.[1] Studies often come to the conclusion that, generally, the impact of oil price changes has declined over time. Such findings are partly ascribed to the price declines in the 1980s, the stimulating impact of which on economic activity is being called into question.[2] Furthermore, subsequent price rises have possibly been interpreted by economic agents as no more than a return to normal following the declines in prices and therefore have not led to a comparable cutback in aggregate demand like price increases without a preceding decline in prices. A 10% rise in the price of oil, for example, would not discourage consumers from buying a car with a high fuel consumption if the oil price had fallen by 20% immediately beforehand. As an explanatory variable, Hamilton (1996) therefore proposed a non-linear measurement, which is based on a comparison of the (nominal) oil price in a given quarter with the peak level in the preceding four quarters. If the current price climbs to a new peak, the percentage increase on the previous peak is calculated. In all other cases, the resulting "net price increase" is set to zero. For this measurement, Hamilton shows a stable relationship with real GDP growth in the USA, although he extended the underlying time-frame from one to three years in later studies.[3]

A further problem is presented by the reciprocity of the relationship between the oil price and economic activity. Given that not only supply but also demand plays a key role on the market, a rise in crude oil prices could also be due to sharp GDP growth in a major economy such as the USA. A subsequent recession would then not necessarily be the outcome of a more symptomatic oil price rise, but would be more likely attributable to a preceding period of cyclical overheating. In order to be able to derive a clear-cut cause and effect relationship, a price change has to be used which is independent of economic growth in the country in question. This should be fulfilled given exogenous influences on the price of oil such as those exerted historically by political conflicts flaring up in the Middle East. According to Hamilton, the net oil price increase has accurately modelled the significant crisis episodes in this region in the past.

To highlight the relationship between the real economy and the price of oil, we use Hamilton's regression model, where real GDP growth (y_t) in quarter t on the preceding period is determined by a constant (β_0), its own lags (y_{t-i} for $i = 1, \ldots, 4$) and the lagged net price increase (o^+_{t-i}). We do,

1 See, for instance, M A Hooker (1996), What Happened to the Oil Price-Macroeconomy Relationship?, Journal of Monetary Economics, Vol 38, pp 195-213.
2 See K A Mork (1989), Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results, Journal of Political Economy, Vol 91, pp 740-744.
3 With a reference period of less than three years, a net price increase is shown in 1999, without this resulting in a weakening of the US economy in the following year. Furthermore, the net price rise on the basis of the longer reference period shows favourable statistical properties. See J D Hamilton (1996), This is What Happened to the Oil Price-Macroeconomy Relationship, Journal of Monetary Economics, Vol 38, pp 215-220, as well as J D Hamilton (2003), What Is an Oil Shock?, Journal of Econometrics, Vol 113, pp 363-398.

Estimated coefficients of the impact on the real GDP growth of major industrial countries[1]

Item	USA	Japan	Germany	France	Italy	UK	Total
Constant	0.699 ***	0.408 **	0.474 ***	0.293 ***	0.288 ***	0.491 ***	0.453 ***
GDP change rate in							
t-1	0.243 **	0.105	0.018	0.370 ***	0.537 ***	0.137	0.415 ***
t-2	0.050	0.112	0.068	0.380 ***	– 0.024	0.125	0.053
t-3	– 0.062	0.217 *	0.111	– 0.069	0.111	0.153	0.005
t-4	– 0.014	– 0.078	0.124	– 0.116	– 0.150	– 0.197 *	– 0.086
Net oil price increase in							
t-1	– 0.009	– 0.001	– 0.005	– 0.005	0.008	0.000	0.001
t-2	– 0.020 *	– 0.005	– 0.008	– 0.005	– 0.002	– 0.004	– 0.013 *
t-3	– 0.015	– 0.005	– 0.038 **	– 0.025 ***	– 0.035 ***	– 0.031 **	– 0.019 **
t-4	– 0.031 ***	– 0.005	– 0.021	– 0.008	– 0.002	– 0.015	– 0.014 *
Net oil price decline in							
t-1	– 0.022	0.043	0.001	– 0.022 *	0.005	– 0.013	– 0.009
t-2	0.021	– 0.043	0.004	0.008	– 0.025	0.008	– 0.001
t-3	0.012	0.007	– 0.023	0.015	0.011	– 0.041	0.001
t-4	– 0.004	– 0.023	0.042 *	– 0.005	0.000	0.027	0.004
Memo item:							
Number of observations	157	157	157	157	157	157	157
Standard deviation of the dependent variables	0.85	1.13	0.95	0.58	0.88	0.98	0.65
Coefficient of determination	0.30	0.14	0.16	0.51	0.42	0.20	0.42
F test for joint insignificance (p values)							
Net oil price increases	0.000	0.914	0.003	0.000	0.000	0.015	0.000
Net oil price declines	0.691	0.222	0.399	0.207	0.653	0.519	0.955

1 ***, **, * = significant at the level of 0.1%, 1% and 5%.

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however, deviate from his approach in some respects. For example, we do not consider the nominal price, but rather the real price adjusted using the consumer price index, which should ultimately be the decisive factor for rational economic agents. We calculate the net price increase in each case over a period of two years so that the episode in the fourth quarter of 2010 and the first quarter of 2011 can be considered as an autonomous shock. Given that macroeconomic model calculations show the output effect of a percentage increase in the price of oil as being largely dependent on the original level, we also use the absolute change in the real price of oil – measured against an index – as a basis for our calculation. Furthermore, we also use the net oil price decline (o^-_{t-i}), calculated using the same method, as an explanatory variable in order to highlight asymmetries and to prevent biases in the estimation. We therefore estimate the equation

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \beta_4 y_{t-4} + \beta_5 o^+_{t-1} + \beta_6 o^+_{t-2} + \beta_7 o^+_{t-3} + \beta_8 o^+_{t-4} + \beta_9 o^-_{t-1} + \beta_{10} o^-_{t-2} + \beta_{11} o^-_{t-3} + \beta_{12} o^-_{t-4}$$

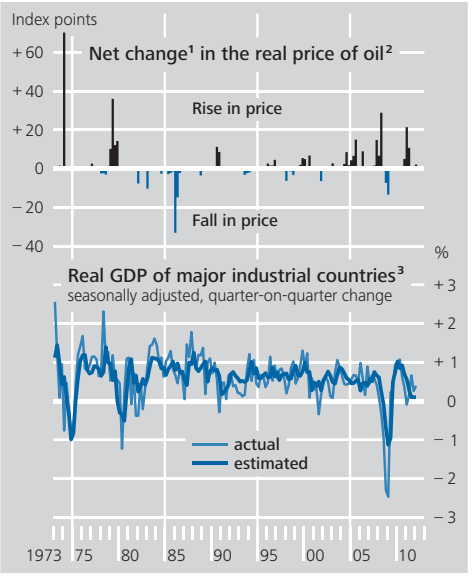
over the period from 1973:1 to 2012:1 for a number of advanced economies and their aggregate.[4]

Owing to the rather high idiosyncratic volatility of the quarterly growth rates, the explanatory power of the model is sometimes fairly small. Nevertheless, the hypothesis that the lags in the net oil price rise have no collective impact on the pace of growth of aggregate economic output can generally

4 Here, the national variables are aggregated with the nominal GDP weights (at market exchange rates).

Impact of oil price changes on real GDP growth

Quarterly



1 Absolute increase (or decline) compared with the maximum (or minimum) of the two preceding years. **2** Index (2010 = 100), GDP-weighted aggregate of national indices for major industrial countries (Brent price relative to national consumer price indices). **3** USA, Japan, Germany, France, Italy and United Kingdom.

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be clearly rejected.[5] A net price increase seems to have the strongest dampening impact on economic growth only after three to four quarters. By contrast, the collective influence of net price declines is generally statistically insignificant. These results prove to be robust across various modifications, for instance when, instead of the absolute change in the real price of oil, changes in the nominal price or percentage price changes are used. Furthermore, these results are also in line with the literature, the focus of which is generally on the US economy.[6]

All in all, oil price rises that are not directly preceded by a corresponding price decrease have a certain predictive power for real GDP growth. This is probably a reflection, first and foremost, of the fact that, historically, economic activity in advanced economies has been perceptibly weakened following crises in the Middle East. The oil price surges in late 2010 and early 2011 as well as in the first quarter of 2012, which are to be seen in the context of the "Arab Spring" and the nuclear conflict with Iran, are likely to have dampened macroeconomic growth in industrial countries again recently.

5 The only exception to this is Japan, where GDP growth rates fluctuate particularly strongly. If contemporary influences are also included, however, a rather close direct relationship can be seen between the net price increase and GDP growth.
6 See also K Sill, The Macroeconomics of Oil Shocks, Federal Reserve Bank of Philadelphia, Business Review, 2007 Q1, pp 21-31.

flation target. The reason for this is that a monetary policy geared to stabilising the general price level must depress the prices of other goods by means of a more restrictive stance, while inflation targeting allows the price level to drift upwards. Admittedly, such results are not independent of the underlying model.[28]

Recent impact of the price of crude oil on economic activity in the industrial countries

Has the impact of oil price hikes on the real economy decreased over time?

One of the key issues during the past few years, not only in the academic debate but also in the terms of the practical assessment of cyclical developments, has been whether and to what extent the relationship between oil prices and real activity has weakened. The fact that central banks no longer need first to establish the credibility of their stability policy by strongly "leaning against the wind" is just one aspect of this. Given anchored inflation expectations, a central bank that was prepared to tolerate the direct and indirect effects of persistently higher energy prices on the general price level has been able to set its policy rates largely independently of developments in the oil market. In actual fact, monetary policy in the most important advanced economies has been decidedly expansionary in the past few years.

Differing causes of higher oil prices

Especially in the period preceding the global economic downturn of 2008-09, it was often claimed that recessionary tendencies following oil price shocks would not occur if the shocks were caused by accelerating demand. Behind this lies the argument that a primary increase in real GDP has to be greater than the secondary dampening effects that it itself generates through an expansion in demand for crude oil and a resulting price increase. This does not necessarily mean that the retarding effects of an oil price hike on real activity themselves vary depending on its causes. It is possible that the underlying factors create additional effects above and beyond the rise in prices which are then conflated with the impact of the price shock.[29] Moreover, the predominance of a shock-triggering rise in aggregate demand on aggregate output is clear only from a global perspective. If income growth is concentrated on a certain region, the positive effects on other economies depend on how much more is imported by this group of countries. Which of the indirect effects on an individual economy ultimately predominates is then likely to be determined by both the extent of its external trade links and the share of its expenditure on energy. Furthermore, the relative weights of the opposing factors may change over time.[30] All things considered, it is striking that the divergence in oil demand between the advanced economies, as one group of countries, and the emerging and developing countries, as another, has been accompanied in the past few years by a significant growth lead on the part of the latter.[31]

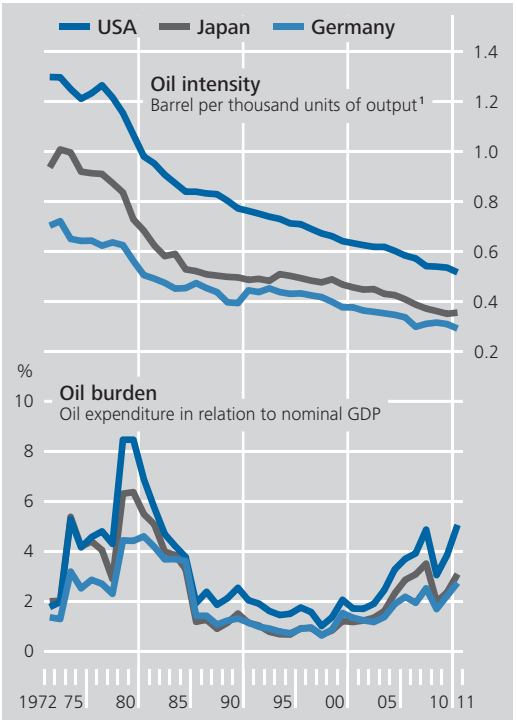
Low oil intensity versus large share of expenditure

Furthermore, it is often argued that the real economic effects of oil price hikes have decreased because the advanced economies' oil intensity has declined sharply over the past decades. Indeed, to produce one unit of aggregate output, the largest industrial economies United States, Japan and Germany needed only half as much oil in 2011 as they did in the early 1980s. Compared with the early 1970s, the improvement in efficiency is even greater. How-

28 See S Leduc, Oil Prices Strike Back, Federal Reserve Bank of Philadelphia, Business Review Q1 2002, pp 21-30, and S Leduc and K Sill (2004), A Quantitative Analysis of Oil-Price Shocks, Systematic Monetary Policy, and Economic Downturns, Journal of Monetary Economics, Vol 51, pp 781-808.
29 From the point of view of the oil producers, a cutback in the supply implies lower revenues than a higher demand that can generate the same price increase.
30 According to Kilian (2009), higher global demand boosts US real GDP in the short term. In time, however, the dampening effects of the oil price increase predominate, leading to the lagged appearance of recessionary effects. See L Kilian (2009), Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market, American Economic Review, Vol 99, pp 1053-1069.
31 See also Deutsche Bundesbank, Have the business cycles of emerging economies decoupled from those of advanced economies?, Deutsche Bundesbank, Monthly Report, May 2012, pp 12-14.

ever, this intensity is only one factor determining the ultimately nominal burden on an economy. Consideration also has to be given to how much dearer oil has become in relation to aggregate output. Last year, the (thus defined) real price of oil climbed to near the historical peaks of 2008 and the early 1980s or even higher. Taken together, the ratio of nominal expenditure on oil to GDP (oil burden) in the United States and Germany in 2011, at 5% and 2¾% respectively, matched the level of the mid-1970s. Only Japan performs better in historical terms, at 3%, owing to the long-term appreciation of the yen. Even so, the record levels of 1979-80 were still clearly undershot. Nevertheless, the burden on the advanced economies as measured by GDP has increased considerably in the space of two years, ie by 2 percentage points in the USA and by 1 percentage point in both Japan and Germany. Since the winter of 2011, US households have had to spend 3½% of their disposable incomes on fuels, compared with 2¼% at the beginning of 2009.

Burden on major economies due to the cost of crude oil



1 Levels in accordance with market exchange rates of 2005.
Deutsche Bundesbank

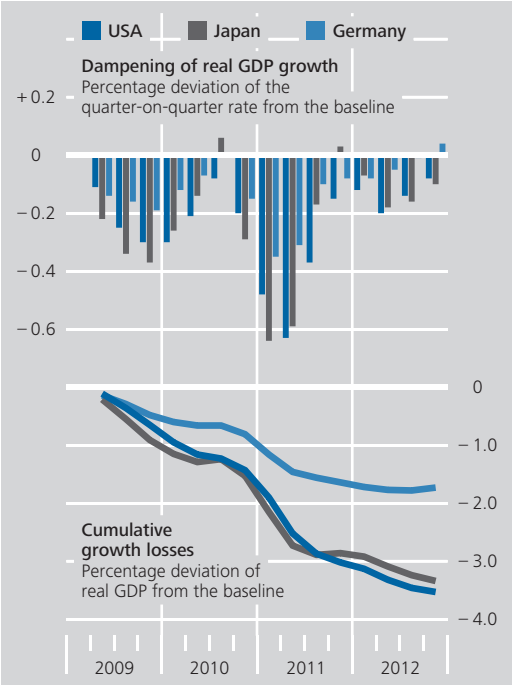
Dependence on oil imports, and return flow of oil expenditures via foreign trade

When looking at a country's income outflows, it is also important to know the degree to which it is dependent on oil imports. Thanks to a considerable and expanding volume of domestic oil production in the United States, the increase in the share of nominal oil imports in US GDP between 2009 and 2011, at 1 percentage point, was roughly the same as in Japan and Germany – despite the USA's higher consumption intensity. Another factor that needs to be considered is the backflow from abroad due to increased exports. In this connection, it has been argued that the dampening effects of an oil price hike on the real economy have possibly been weakened by a greater propensity to spend on the part of the oil-exporting countries.[32] Another factor to be considered is that the group of sourcing countries itself has changed, sometimes considerably, over time. For example, the United States now imports a large part of its crude oil from Canada and Mexico, with which it already has close trade links. OPEC's share in US oil imports has been reduced from a peak of 70% in the 1970s to 40% now. For Germany, it is, above all, Russia that has taken on a major role as a supplier. It is only Japan that is still largely dependent on imports from the OPEC countries. It is possible to verify the contribution that aggregate external trade with the group of oil-exporting countries has made to nominal GDP growth in each of the largest advanced economies.[33] According to the corresponding data, the value of US output growth in 2010-11 was retarded by ¼ percentage point annually – the same as in the period from 2003 to 2007. In Japan, how-

32 See National Institute of Economic and Social Research, Oil Price Shocks and the World Economy Today, National Institute Economic Review 189, July 2004, pp 14-17, and Deutsche Bundesbank, Has the recycling of oil revenues to the consumer countries accelerated?, Monthly Report May 2005, pp 12-13.

33 IMF Direction of Trade Statistics (DOTS) data are used here. Oil-exporting countries are defined as the Middle East and North Africa, Commonwealth of Independent States, Angola, Nigeria, Venezuela, Brazil, Mexico, Canada, United Kingdom and Norway. Provisional estimates are used for 2011.

Aggregate growth losses due to shifts in the oil price path since spring 2009 according to NiGEM* simulations



* National Institute Global Econometric Model.
Deutsche Bundesbank

ever, the dampening effect has nearly trebled to ¾ percentage point, although the dip in Japanese exports due to the natural disasters last year played a role in this. For Germany, the retarding effect was no more than a moderate ¼ percentage point, although, on an average of the period from 2003 to 2007, the German economy in fact experienced a positive stimulus of almost the same size. It should be noted, however, that this rough calculation reflects all external trade with the defined group of countries and is not conditioned on an increase in the price of crude oil.

NiGEM simulation suggests strong dampening effect of 2010-11 oil price hike

The global economy model NiGEM can also be used to estimate the aggregated macroeconomic impact of the oil price hikes of the past few years. As the price shock occurred in several stages rather than all at once and expectations for the future also changed, the assumed underlying oil price path is shifted in cumulative simulations from quarter to quarter, beginning in spring 2009. The outcome is that aggregate output in the advanced economies is sometimes lowered significantly. Real GDP up to the start of 2012 is 3% down on the original baseline in both the United States and Japan,[34] and still as much as 1¾% down in Germany. The dampening effect is considerable overall, especially in relation to the rather moderate pace of expansion – real US GDP actually accelerated by 6½% within these three years. Added to this is the fact that the impact by no means builds up evenly over time, but instead dampens most strongly immediately after the price hike. Thus the simulations suggest that the macroeconomic growth rates in the USA and Japan were lowered by ½ percentage point in the first and second quarters of 2011. Although these simulations rest on a whole series of assumptions (see the Annex on pages 48 and 49), they illustrate that the oil price shocks of the past few years at least had the potential to leave a significant dent on the real economy. Specifically, the slowdown in US growth in the first half of 2011 appears to be explainable even without consideration of the implications of the natural disasters in Japan. On the other side, there is evidently no direct relationship with the recessions suffered by some European economies in late 2011 and early 2012.

Significance of additional shocks for periods of severe macroeconomic downturn

What is striking is that the macroeconomic model simulations show the dampening effect of an oil price hike on real GDP growth peaking as soon as one to two quarters after the price increase. By contrast, empirical estimates, specifically for the US economy, suggest a time lag of three to four quarters (see box on pages 41 to 43). Such an outcome is likely to be shaped very much by developments in 1974, 1980 and 2008. In each of these instances, the state of the US economy deteriorated with a considerable time lag after a preceding oil price shock, but then did so abruptly. Uncertainty about the

34 Holland (2012), on the basis of an analogous simulation in NiGEM, estimates that the shift in the oil price path since 2007 has reduced the US economy's potential output by up to 4%. See D Holland (2012), Reassessing Productive Capacity in the United States, National Institute Economic Review, No 220, pp F38-F44.

persistence of the observed price increase might be one explanation for initially deferred adjustments. Moreover, the economy was probably still buoyed by its inherent momentum and there thus had to be additional shocks to trigger a severe recession. Sales of automobiles are likely to have played a major part in this. Motor vehicles generally have fairly high acquisition costs and their purchase can easily be deferred. As a result, cutbacks in this area are often on a very large scale. On the part of the producers, such strong shifts in demand lead to matching adjustments of their investment in inventories, plant and equipment as well as in their employment – which pulls on the whole economy. Since real consumer spending on motor vehicles is also sensitive to increases in the cost of fuel, however, the oil price hikes may have weakened demand in advance sufficiently to make it susceptible to further shocks, such as the sudden rise in uncertainty and the drying-up of credit flows in the late summer and autumn of 2008.

Despite strong oil price hike, US economy withstanding recessionary tendencies to date

One key reason why the US economy managed to buck the recessionary trends elsewhere in late 2011 and early 2012 is thus likely to be that a robust recovery had become established in the car market notwithstanding the fact that petrol was more costly. In this connection, it was perhaps also significant that the US government did not introduce extensive support measures for car sales in the preceding crisis.[35] Given the country's by now very old vehicle fleet, the pent-up demand could not be put off any longer. In many European countries, by contrast, this reservoir had been tapped and exhausted by means of generous vehicle scrappage schemes back in 2009[36]. Altogether, it was probably a combination of oil price hikes, more rigorous fiscal consolidation and private agents' uncertainty that pushed some European economies into or to the edge of a further recession. Although its direct macroeconomic impact is quite considerable, an oil price shock does not normally suffice on its own to bring about a cyclical downturn. However, it does make an economy vulnerable to additional negative shocks, which then tip the balance. Such a role in paving the way to a recession would help to explain not only the observed time lags but also the asymmetry that is often ascribed to the impact of oil price shocks on the real economy.

Summary

With the economic ascent of the emerging and developing countries, an era of cheap crude oil came to an end. This is likely to have dampened aggregate potential output in the advanced economies. Moreover, crises in the oil market that open up the prospect of severe cyclical setbacks may have become more probable. Given past changes, further shifts in oil market dynamics cannot be ruled out, say, owing to the exploitation of new deposits, a slowdown in economic growth in the emerging market economies or a change in the demand elasticities of these countries. It may be that, with the extraction of shale gas, such a major change in the oil market has already started. For the time being, however, households and enterprises in the advanced economies are left with no choice but to adjust their behaviour to the higher price of oil. While central banks cannot – and should not – seek to prevent such a shift in relative prices, they have to act in the event of an increase in the general price level that extends beyond the short-term direct effects of higher energy prices.

35 The comparatively modest "cash for clunkers" programme – officially known as the Car Allowance Rebate System – noticeably increased car sales only in August 2009.

36 Moreover, such assistance may have led to a failure to make necessary adjustments in the automotive industry, which are only now being implemented.

Annex

The macroeconomic impact of oil price hikes in NiGEM simulations

Abstracting from the causes of oil price rises

NiGEM, the macroeconomic model of the National Institute of Economic and Social Research (NIESR), completely models the global economy in regional terms, but does not include a special module for the crude oil market. Therefore simulations can only be used to study the macroeconomic effects of an oil price change that occurs exogenously. This is similar to a price increase which could result from a contraction of the oil supply due to external events such as natural disasters, wars, embargoes or the exploitation of monopolistic market power. However, in such situations the revenue and ultimately the imports of oil-producing countries would be lower than in a NiGEM scenario with unchanged supply and a higher price. Consequently, only the macroeconomic impact of an oil price rise *per se* can be derived, irrespective of its actual cause, which may trigger additional effects. As NiGEM is an estimated model, the simulations reflect the responses of economies as they occurred on average in the past. Hence the applicability of the results is based on the standard assumption that the previously observed interrelationships have not changed.

Temporary versus permanent oil price rise

A key determinant of the macroeconomic impact of an increase in oil prices is its specified duration. A permanent price increase lastingly pushes aggregate output in oil-importing countries under the baseline. In the case of temporary price surges, not only is this long-term impact absent but the short-term dampening effects are also smaller. This is probably mainly due to the forward-looking behaviour of players on the financial and labour markets who, judging the rise to be temporary, initially forgo making adjustments. But the longer the assumed price increase persists, the closer the output losses come to those following a permanent price rise. As in economic reality the nature of an observed price change is generally likely to be unknown, and the evolution of oil prices can be interpreted as a sequence of persistent shocks, permanent price rises are assumed below.

Significance of initial level for impact of higher oil price

Although NiGEM has a (log-) linear construction, the impact of an increase in the crude oil price on the real economy is not solely dependent on its size. Owing to the importance of the share of oil or energy in total expenditure, the oil price's initial level also determines the extent to which it depresses macroeconomic activity following an oil price rise. Thus in the eighth quarter of a simulation, in which the crude oil price is raised permanently by 10% from US$50, real US GDP falls ½% below the baseline. However, in the case of an initial level of US$100 it dips by ¾%, and at a starting price of US$200 by as much as 1¼%. When absolute price rises are considered, the effect likewise varies across the initial level. Thus an increase in the oil price of US$10 reduces aggregate output in the USA in the eighth quarter by more than ¾% if the initial level is US$50. However, at an initial price level of US$200, the loss in output is a little more than ½%. That the percentage losses in macroeconomic activity decline in line with a rising level of the oil price is probably due to the fact that the fixed absolute price increase becomes less significant in the ratio. In this context, rules of thumb which assume that a given change in the oil price will have a given impact on GDP are to be viewed with caution. In addition, the clear rise in the share of costs of energy consumption seen in recent years casts doubt on the theory that the drag on the real economy of a (percentage) oil price hike has supposedly become weaker over time. With regard to the direction of the assumed change in oil price, NiGEM posits symmetrical effects. It should be noted in this connection that aggregate output is homogeneous in the model; structural dislocations between sectors are not explicitly captured.

Dampening of potential output

Keynesian factors mean that in NiGEM real GDP is determined by aggregate demand in the short term. In the long term, the level of macroeconomic activity is determined by a production function into which oil is directly factored as an input. If the (relative) oil price increases, demand for oil falls in relation to the other production factors. If the previously used input volumes were optimal, the potential output of the economy is reduced.[37] In order to estimate the magnitude of this effect, it makes sense to combine an oil price hike with a fixing of the economy's oil intensity and to compare the results with those of a simulation excluding this additional supposition. It becomes clear that the losses in output resulting from a reduction in oil intensity are built up only slowly and relatively evenly, but their cumulative impact in

37 See R Barrell, A Delannoy und D Holland (2011), Monetary Policy, Output Growth and Oil Prices, National Institute Economic Review, No 215, pp F37-F43.

the medium to long term is of real relevance. In the short term, however, the negative effects predominate via the demand side. Even if energy is not explicitly included in the production function, an oil price hike would permanently reduce overall economic activity because the terms of trade of oil-consuming countries deteriorate, with corresponding negative repercussions for saving and investment decisions.[38]

International discrepancies

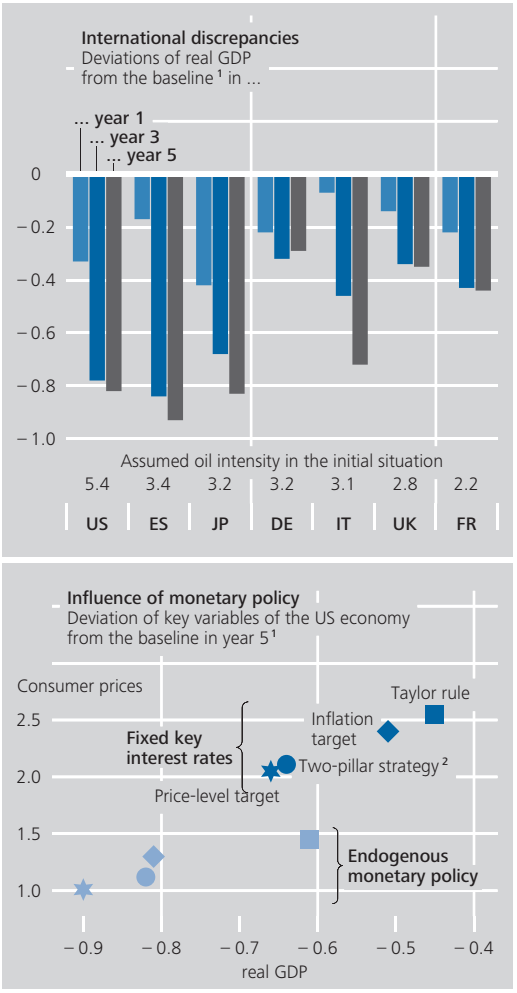
If the basic theoretical structure of the individual country modules is the same, there are international discrepancies in the macroeconomic impact of an oil price rise on account of different manifestations of parameters and economic variables. A key factor in this connection is the economy's oil intensity. The significantly higher use of fossil fuels in the USA, for example, could explain why an oil price increase squeezes US real GDP much more than, say, in Germany. On the other hand, Japan also sustains perceptible output losses despite its fairly low oil intensity.[39] In Italy and Spain the simulation indicates small losses in the short term which, however, rise considerably in the medium term. This may well owe something to price and wage rigidities, as well as further factors that have a bearing on an economy's resilience.

Role of monetary policy

Interest rate paths are derived endogenously in NiGEM. Thus long-term interest rates are taken from expected future short-term rates, which are subject to the influence of monetary policy. This is not stipulated exogenously but is determined within the model framework in accordance with prespecified rules. Forward-looking players on the financial and labour markets are familiar with these rules and align their expectations for relevant variables accordingly, in particular with regard to inflation. In NiGEM simulations, (nominal) central bank interest rates generally rise in response to an oil price increase because actual and expected inflation accelerates. Therefore the (nominal) key interest rates must be raised in order to keep monetary policy neutral based on the customary rules. Simulations of an oil price increase across various rules show that the macroeconomic impact depends on the central bank's objective. Central banks can dampen the aggregate output losses if they are prepared to tolerate a stronger rise in the price level in return. Thus when applying a Taylor rule, according to which monetary policy reacts not only to deviations in (expected) inflation from a target level, the contraction in GDP is smaller than in situations in which the central bank solely stabilises the inflation rate or even the price level.

Macroeconomic effects of a permanent oil price rise in NiGEM* simulations

in %



* National Institute Global Econometric Model. **1** Following a permanent oil price increase from US$100 to US$110. **2** Targets are inflation and nominal output (NiGEM default setting).
Deutsche Bundesbank

38 See R Barrell and O Pomerantz, Oil Prices and the World Economy, Focus on European Economic Integration, Oesterreichische Nationalbank, I/2004, pp 153-178.
39 One reason for this might be the comparatively small return flow of additional oil expenditure to Japan. This is suggested by an alternative simulation, in which an oil price hike is combined with the fixing of real domestic demand in those countries and regions where domestic demand is otherwise raised by an oil price hike. Thus the dampening of Japanese GDP in this case is almost identical to the result of a normal simulation of an oil price increase, whereas US economic output is squeezed 1/10 percentage point more.