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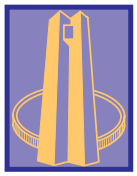

South African Reserve Bank

Price determination in international oil markets: developments and prospects

by G N Farrell, B Kahn and F J Visser

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1. Introduction

After falling at the end of 1998 to levels last seen before the oil crises of the 1970s, oil prices in late 2000 rose to their highest levels since the Gulf War. They remained high despite repeated sets of co-ordinated production increases by the Organisation of Petroleum Exporting Countries (OPEC). There were indications, however, that these increases had resulted in an oversupply that was not immediately reflected in prices, and by December 2000 it appeared that the oil price was returning to the target range set by OPEC. The intention in this paper is to provide a brief analysis of the functioning of the world oil market. Particular attention will be paid to the interaction among world supply and demand, and the spot, term and futures markets which together determine oil prices. This analysis supplies the background to a discussion of the current situation in world oil markets, and the future prospects for oil prices.

Since the late 1980s, world oil prices have been set by a market-related pricing system which links oil prices to the 'market price' of a particular reference crude (such as Brent, West Texas Intermediate or Dubai). A brief review of recent price trends is provided in Section 2. A fundamental determinant of these prices is the balance between supply and demand in the various markets. This supply-demand balance is in turn influenced by a complex set of factors which have undergone significant changes in the past 25 years. The factors influencing the supply of and demand for crude oil in world markets are reviewed in Sections 3 and 4, respectively.

In addition to these fundamental determinants, oil prices are the result of a complex interaction of relatively thin spot markets, a more liquid forward market (for Brent), and two very liquid futures markets. These more liquid futures markets play an important role in the price discovery process which is analysed in Section 5.

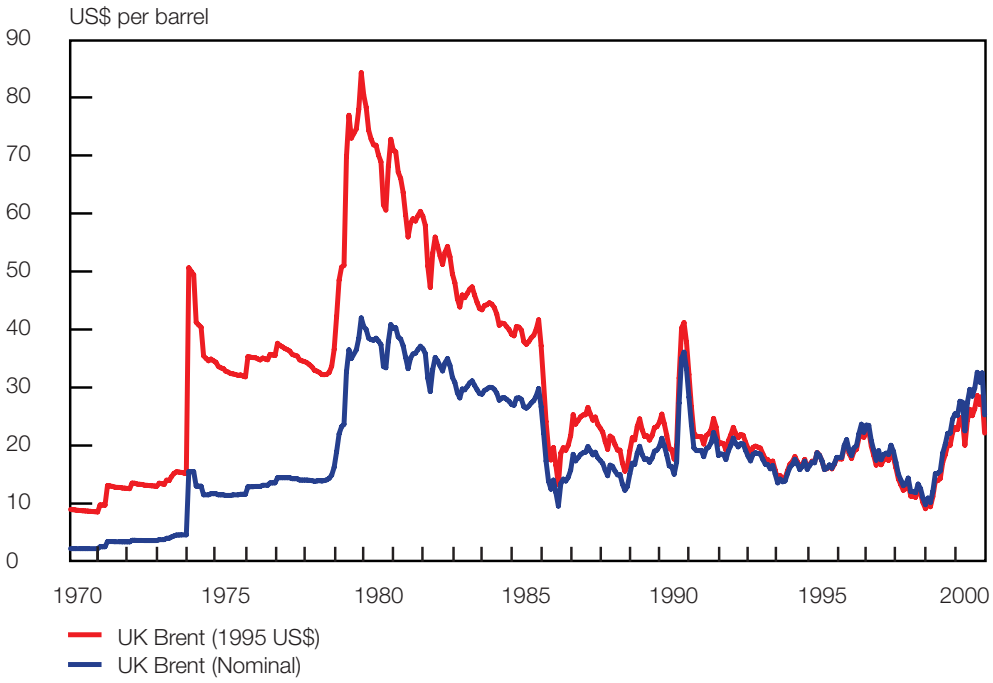
The current situation in world oil markets is discussed in Section 6, focusing on the interaction among supply and demand factors and the role of inventories. Section 7 concludes by reporting some current medium-term forecasts for oil prices.

2. Recent price developments

World oil prices declined sharply from late 1997 and remained extremely low through 1998 and early 1999 (see Graph 1). The monthly average price for Brent crude declined in December 1998 to US$10, the lowest level in more than a decade. These low oil prices were caused by several factors, including the following:

- The OPEC agreement in November 1997 to increase the group's production ceiling for the first time in four years by 10 per cent to 27,5 million barrels per day (b/d) for the first half of 1998;
- warmer-than-average winters in 1997-98 and 1998-99 in the northern hemisphere;
- increasing Iraqi oil exports under the United Nations (UN) 'oil-for-food' programme (see Section 3.4); and depressed demand for oil due to the financial crisis in East Asia.

Graph 1 Brent crude oil prices



Source: International Monetary Fund, *International Financial Statistics*

In an attempt to boost oil prices, OPEC members decided in March 1998 to reduce overall production by 1,245 million b/d. In June 1998, only three months later, OPEC again agreed to another round of production cuts of 1,355 million b/d as oil prices fell to their lowest levels in more than a decade. This cut in production brought the group's total reductions since March 1998 to 2,6 million b/d. If the promises of non-OPEC members such as Russia, Oman and Mexico are also taken into account, world oil producers at that stage had pledged to cut worldwide production by approximately 3,1 million b/d.

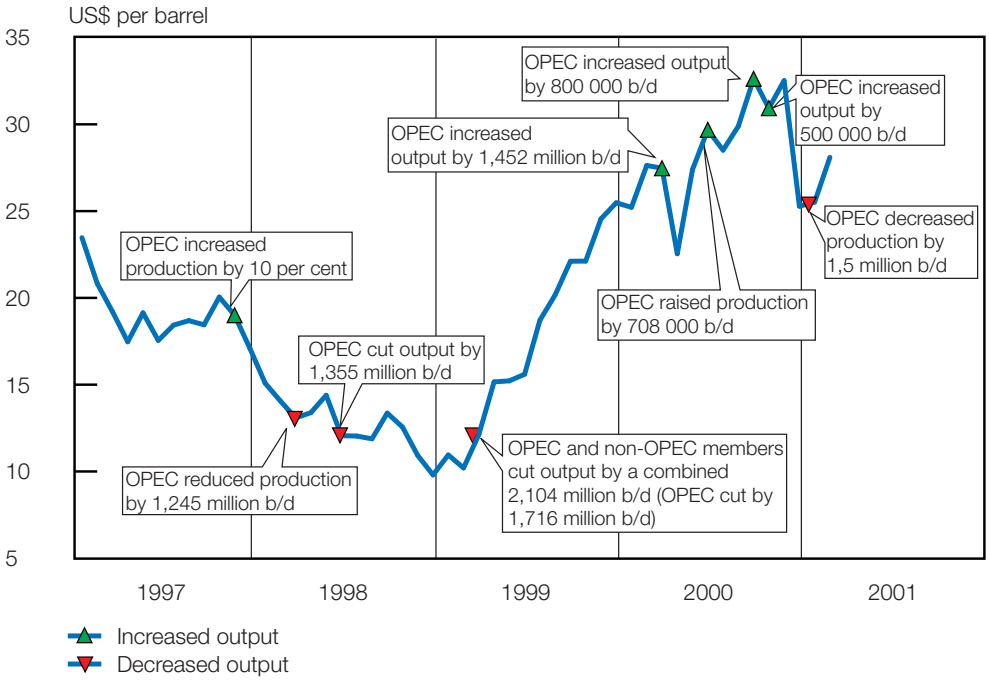
However, oil prices only started to rebound sharply from these levels after OPEC's agreement in March 1999 to cut oil production even further. This time OPEC agreed to reduce production quotas by 1,716 million b/d, while several non-OPEC members together pledged a reduction of 388 000 b/d. The monthly average Brent crude oil price rose from a low point in December 1998 to more than US$27 in March 2000. OPEC's announcements regarding production changes and the effect on the international oil price in recent years are shown in Graph 2.

It should be noted, however, that although the oil price has risen strongly since 1999, Graph 1 shows that in real terms[1] the Brent crude oil price has not risen significantly higher than the average real levels prevailing since 1987, apart from the period around the Gulf War. Had real oil prices risen to the levels of the 1980 shock, current prices would have been around US$85.

As oil prices rose strongly, OPEC ministers decided on 28 March 2000 to restore production to pre-March 1999 levels. As a result, OPEC's oil production increased by 1,452 million b/d (excluding Iran and Iraq). Iraq has not been subject to OPEC

1 This is measured by deflating the US dollar price of Brent crude oil by the US consumer price index (1995=100).

Graph 2 Recent oil supply changes and developments in the price of Brent crude



production agreements while it is still under the UN Security Council sanctions (see Section 3.4). Iran opted not to sign the March agreement, although it decided to raise production in order to maintain market share. Together, therefore, OPEC production increased by about 1,7 million b/d. Several other major non-OPEC producers, including Mexico and Norway, also raised production.

Despite these increases in output, prices remained high and OPEC consequently agreed in June 2000 to raise crude oil production quotas by a total of 708 000 b/d. OPEC's total production quota (excluding Iraq) rose to 25,4 million b/d. The next day, however, crude oil futures rose even further. In September 2000, OPEC reviewed oil market developments and agreed to increase overall production by an additional 800 000 b/d from 1 October 2000.[2] On 31 October 2000, OPEC raised production by a further 500 000 b/d as its price band mechanism had been triggered (see Section 3.3).

After soaring to record highs in November, crude oil prices fell back in December 2000 to their lowest levels in eight months. Oil prices, however, rebounded in January as talks of new production cuts gained momentum ahead of OPEC's meeting on 17 January 2001. As expected, OPEC's members (excluding Iraq) agreed to cut production quotas by 1,5 million b/d from 1 February 2001. OPEC's early decision to cut output – when the OPEC basket price[3] was trading within its target range – was a signal to markets that it is serious about defending the prices that members received for their crude oils (EIA: 2001). According to the January agreement, individual member countries' target output levels decreased as indicated in Table 1.

2 OPEC emphasised at its conference that the confusion in the oil market was the result of shortages in product markets caused by bottlenecks in the refining industry, speculation in the futures market, manipulation of the Brent market due to the dwindling volumes of this crude and widening differentials between light (sweet) and heavy (sour) crudes.

3 The OPEC basket price consists of seven crude oil prices: Algeria's Saharan Blend, Indonesia's Minas, Nigeria's Bonny Light, Saudi Arabia's Arab Light, Dubai's Fateh, Venezuela's Tia Juana Light and Mexico's Isthmus.

Table 1 OPEC-10 new production levels
Barrels per day

Member countries	31 October 2000 target	Output decrease	1 February 2001 target
Algeria	853 000	48 000	805 000
Indonesia	1 385 000	78 000	1 307 000
Iran	3 917 000	219 000	3 698 000
Kuwait	2 141 000	120 000	2 021 000
Libya	1 431 000	81 000	1 350 000
Nigeria	2 198 000	123 000	2 075 000
Qatar	692 000	39 000	653 000
Saudi Arabia	8 674 000	486 000	8 188 000
UAE*	2 333 000	132 000	2 201 000
Venezuela	3 076 000	174 000	2 902 000
Total OPEC-10	**26 700 000**	**1 500 000**	**25 200 000**

* United Arab Emirates

Source: OPEC *Press Release* No. 2/2001 (17 January 2001)

3. The world supply of oil

On the supply side of the world market for crude oil, conditions are determined in the first instance by the levels of production of oil-producing countries. These levels themselves, however, are the outcome of a number of geological, economic and political economy factors. This section reviews current production levels in producing countries, and analyses the existing spare production capacity as well as the costs of developing new capacity. Other factors which currently have the potential to affect world supply and are discussed here, include the operation of OPEC's price band mechanism, the role played by Iraq in the world oil market and the release of oil from the United States (US) Strategic Petroleum Reserve.

3.1 World oil production

Particularly relevant to any discussion of world oil production is the role of OPEC,[4] which has attempted from time to time and with varying degrees of success to restrict the world supply of oil and maximise revenues for its members.[5] Since OPEC members account for approximately 40 per cent of the world's oil production, the cartel has the potential to exert a significant influence over world oil prices (provided member countries adhere to production quotas). This is particularly evident when the distribution of the world's proved oil reserves and excess oil production capacity are taken into account (see Section 3.2).

3.1.1 OPEC production

OPEC's crude oil production in 2000 averaged 27,93 million b/d (including Iraq), which was 1,32 million b/d higher than the 1999 average of 26,61 million b/d (see Table 2). The increase was largely attributable to the fact that OPEC increased output on four occasions during 2000, as discussed in Section 2. As indicated in Table 1, the decline in production during 1999 was only temporary and the previous trend of production increases from 1994 to 1998 was again continued in 2000. Preliminary estimates, however, indicate that OPEC's crude oil production in December 2000, including Iraq, averaged 27,86 million b/d, a decrease of 1,68 million b/d compared with the

4 OPEC was created in 1960 by several oil-producing countries which are substantial net exporters of oil in order to co-ordinate oil production policies to help stabilise the oil market and to help oil producers achieve a reasonable rate of return on their investments.

5 OPEC members are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela.

Table 2 OPEC members' oil production
Millions of barrels per day

	1994	1995	1996	1997	1998	1999	2000	Oct	Nov	Dec
									2000	
Saudi Arabia	8,01	8,05	8,06	8,30	8,25	7,52	8,00	8,35	8,50	8,35
Iran	3,60	3,61	3,67	3,64	3,59	3,50	3,68	3,81	3,80	3,80
Iraq	0,56	0,59	0,61	1,19	2,11	2,52	2,57	3,00	2,90	1,32
UAE*	2,19	2,19	2,20	2,25	2,27	2,07	2,24	2,34	2,34	2,36
Kuwait	2,02	2,04	2,05	2,09	2,08	1,65	1,77	1,88	1,88	1,88
Neutral Zone	...	...	...	...	...	0.59	0,63	0,66	0,68	0,68
Qatar	0,41	0,44	0,48	0,62	0,66	0,63	0,69	0,71	0,74	0,73
Nigeria	1,89	1,90	2,07	2,23	2,09	1,95	2,04	2,13	2,16	2,15
Libya	1,38	1,39	1,40	1,43	1,40	1,38	1,41	1,44	1,45	1,46
Algeria	0,75	0,77	0,81	0,85	0,82	0,76	0,81	0,84	0,85	0,85
Venezuela	2,46	2,67	2,98	3,23	3,14	2,79	2,89	2,95	3,00	3,03
Indonesia	1,33	1,35	1,39	1,39	1,35	1,27	1,21	1,25	1,26	1,26
Total crude oil	**24,58**	**24,99**	**25,71**	**27,22**	**27,75**	**26,61**	**27,93**	**29,35**	**29,54**	**27,86**

* United Arab Emirates
... Not available

Sources: OPEC *Annual Report (1999)* and International Energy Agency *Monthly Market Report* (January 2001)

November figure of 29,54 million b/d. This sharp drop in OPEC crude production was, however, caused mainly by lower output from Iraq (see Section 3.4).

3.1.2 Non-OPEC production

Although non-OPEC members have less than one-quarter of the world's proved oil reserves, they produce nearly 60 per cent of the world's crude oil (EIA, 2000: 1). Non-OPEC supply in 2000 averaged 45,9 million b/d, which was slightly higher than the 1999 average of 44,7 million b/d. Current non-OPEC production is concentrated in seven countries (Canada, the United Kingdom (UK), Mexico, Norway, China, the US and Russia), each of which produced between 2,7 million and 8,1 million barrels of crude oil per day in 2000. These countries jointly account for about 66 per cent of non-OPEC production, with the US and Russia being the largest producers.

Russia, Mexico, Norway, the UK and Canada are net exporters of crude oil to the world market, whereas the US and China are net importers of crude oil. It is interesting to note in this regard that the US has much greater energy security than the euro area. The US was approximately 45 per cent self-sufficient in oil supply in 1997, as opposed to countries in the euro area which were self-sufficient in only 3 per cent of their oil requirements (Noreng, 1999: 39). In addition to this, countries in the euro area are subject to currency risk since oil is denominated in US dollars.

The remaining sources of non-OPEC oil are highly diversified and include 14 countries producing between 310 000 and 1,5 million b/d in 2000. These 14 countries represent more than 20 per cent of non-OPEC crude oil production. Angola falls into this category, with total production in 2000 averaging 740 000 b/d. Several other non-OPEC members also have oil industries, but produce less than 100 000 b/d.

3.2 The extent of spare capacity and the development costs of new production

Increases in the world supply of oil are constrained in the short term by the extent of spare production capacity, and in the medium term by unexploited reserves and the cost of exploiting these reserves. By contrast, the potential for supply decreases tends to be related to natural disasters and wars in the short term and to structural factors in the longer term (i.e. to issues of the long-term sustainability of production as utilisation outstrips probable additions to the world oil resource base).[6] Given the current situation in world oil markets, more attention is paid here to factors which have the potential to increase world supply.

In the shorter term, the extent and distribution of spare capacity are particularly important. The OPEC members have most of the spare capacity. According to the International Energy Agency (IEA), OPEC spare capacity fell as crude output rose in 2000. When compared to the December 2000 output of 27,9 million b/d (including Iraq), current OPEC capacity of 31,4 million b/d leaves 3,5 million b/d as spare capacity. The lower output from Iraq in December 2000, however, resulted in this substantial improvement in the crude oil spare capacity. If Iraq's production is included at the output level of the previous month, the spare capacity would be only 2,0 million b/d, significantly less than in previous years. However, OPEC's spare capacity increased again as a result of the latest cut in crude oil production which became effective on 1 February 2001. If the sustainable production capacity is compared with the new output target, this would result in spare capacity of 4,9 million b/d (see Table 3).

6 This is a complex issue. As Yergin (2000) notes, 'the world has been running out of oil since the industry was founded'. This statement is true not only in the sense that oil is a non-renewable resource, but also in the sense that it has been believed at various stages that the exhaustion of the resource was imminent. In 1885, for example, John D Rockefeller's successor at Standard Oil, John Archbold, is held to have begun selling his shares at a discount following expert advice that the odds of replacing the declining oil fields in Pennsylvania were slim. In 1920, the US Geological Service warned that US reserves would be depleted in exactly 9 years and 3 months; the huge East Texas field was then discovered in 1930. Similar fears of depletion after World War II were allayed by the opening of fields in the Middle East, and after the crises of the 1970s by the use of new technologies to extract oil and the opening of new, non-OPEC, fields.

Table 3 OPEC's spare capacity
Millions of barrels per day

Member countries	December 2000 production	1 February 2001 targets	Sustainable production capacity	Spare capacity relative to 1 February 2001 targets
Algeria	0,85	0,81	0,90	0,09
Indonesia	1,26	1,31	1,35	0,04
Iran	3,80	3,70	3,73	0,03
Kuwait*	2,22	2,02	2,20	0,18
Libya	1,46	1,35	1,45	0,10
Nigeria	2,15	2,08	2,20	0,12
Qatar	0,73	0,65	0,75	0,10
Saudi Arabia*	8,69	8,19	10,50	2,31
UAE**	2,36	2,20	2,40	0,20
Venezuela	3,03	2,90	2,95	0,05
Iraq	1,32	-	3,00	1,68***
Total OPEC	27,87	25,20	31,43	4,90

* Including 50 per cent of the Neutral Zone production
** United Arab Emirates
*** Capacity relative to December 2000 production

Source: International Energy Agency *Monthly Oil Market Report* (various)

Spare capacity is also heavily concentrated in only a few OPEC members and this could complicate the allocation of any volume increases (see Table 3). Only three members have more than 150 000 b/d of spare capacity: Saudi Arabia, Kuwait [7] and

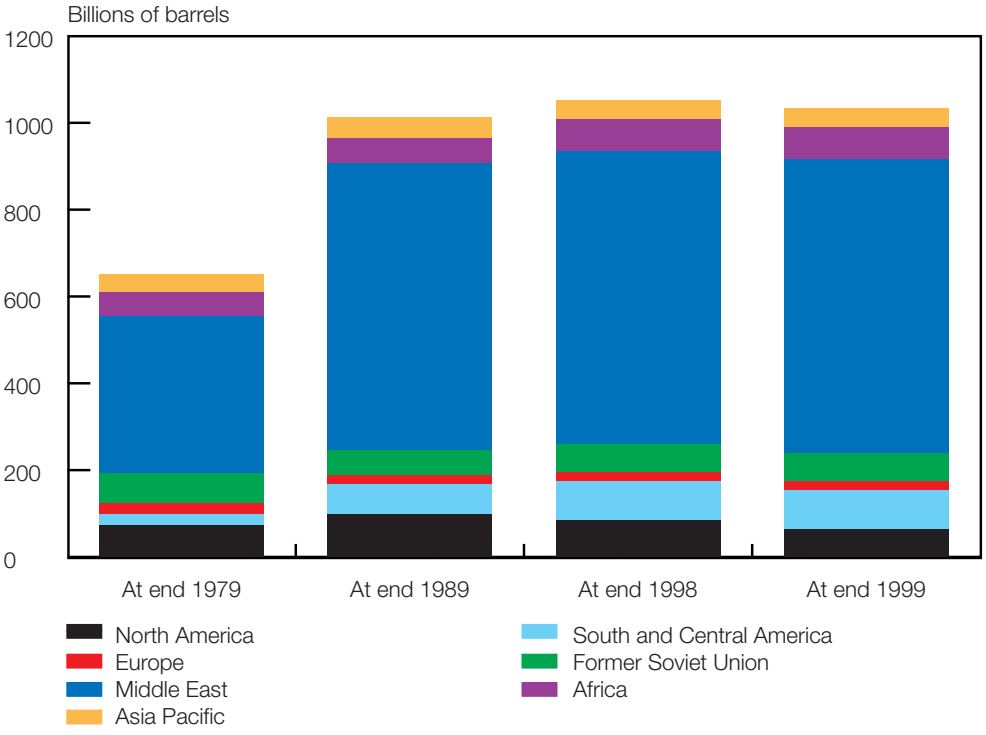
7 Kuwait's capacity was increased to 2,4 million b/d at the beginning of July 2000 with the commissioning of a new gathering centre at the Raudhatain field.

the United Arab Emirates (UAE). With 2,31 million b/d, Saudi Arabia alone has more than 70 per cent of OPEC's (excluding Iraq) total spare capacity. Another complicating factor is that countries with limited spare capacity have little to gain (in terms of immediate revenue increases) from an overall output increase, since they would not be able to raise their production to compensate for the lower prices that would presumably result.

As regards the future supply of oil, it is important to note that, on the one hand, OPEC members held over 77 per cent of the world's proved oil reserves at the end of 1999 (Graph 3). Non-OPEC members, on the other hand, not only have smaller reserves but, as noted in Section 3.1, they also produce a disproportionately high percentage of the world's output. Their reserves are therefore being depleted more rapidly than those in OPEC; the reserves-to-production ratio[8] at the end of 1999 was about 14 years for non-OPEC as opposed to 77 years for OPEC *(BP Statistical Review,* 2000). This is because the Middle East region has a much higher reserves-to-production ratio than other areas, as indicated in Graph 4. In the longer term, then, production is likely to become more concentrated in OPEC members if the status quo of reserves is maintained.

8 The reserves-to-production ratio is an indicator of how long the proved reserves would last at current production rates.

Graph 3 Proved reserves

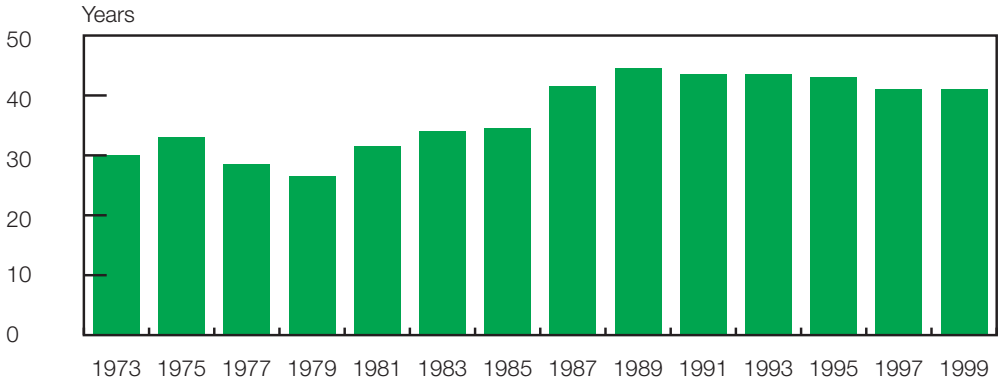


Source: BP *Statistical Review 2000*

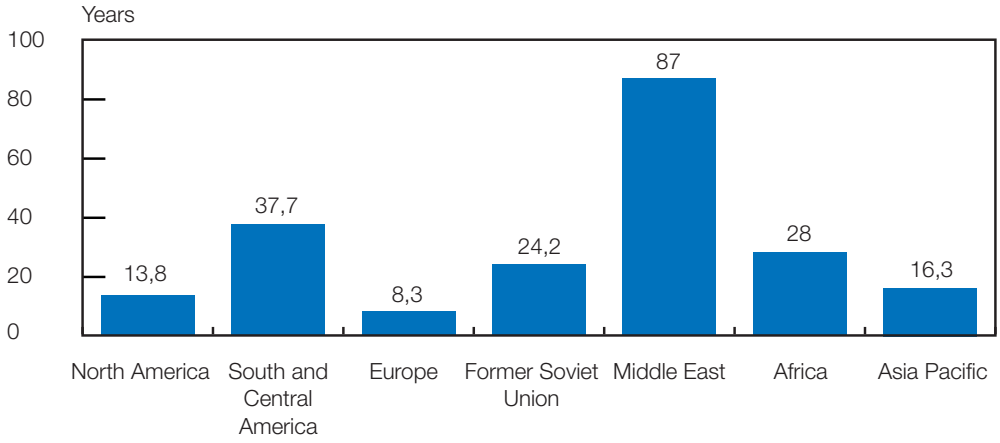
An additional factor reinforcing this concentration of production in OPEC is that non-OPEC oil reserves tend to cost more to develop and produce than OPEC reserves. Chapman and Khanna (2000: 3), using an applied discounting methodology to estimate crude oil production costs, estimate the cost of crude oil for Saudi Arabia to

Graph 4 Reserves to production ratios

World reserves to production ratio



Reserves to production ratio by area (1999)



Source: BP *Statistical Review* 2000

be US$2,30 per barrel (55 cents development cost, 25 cents operations cost, and US$1,50 per barrel shipping). For the UK and Alaskan oil fields, however, they estimate the cost of crude oil at around US$15 per barrel.

3.3 The OPEC price band mechanism and the supply of oil

A technical factor related to OPEC's role in the world oil market is the price band mechanism introduced in 2000. In response to adverse consumer-country reaction to rising world oil prices, OPEC members introduced a mechanism which sets a target range for the OPEC basket price of oil of between US$22 and US$28 per barrel. Automatic increases (cuts) of 500 000 b/d would be implemented by OPEC if prices exceeded (were below) the target range for 20 (10) consecutive trading days. This mechanism was triggered for the first time when OPEC's output, excluding that of Iraq, was increased by 500 000 b/d on 31 October 2000. The price band mechanism was formally ratified at OPEC's meeting in January 2001. OPEC's secretary-general confirmed the cartel's commitment to the price band, but added that the group could still adjust production at any time.

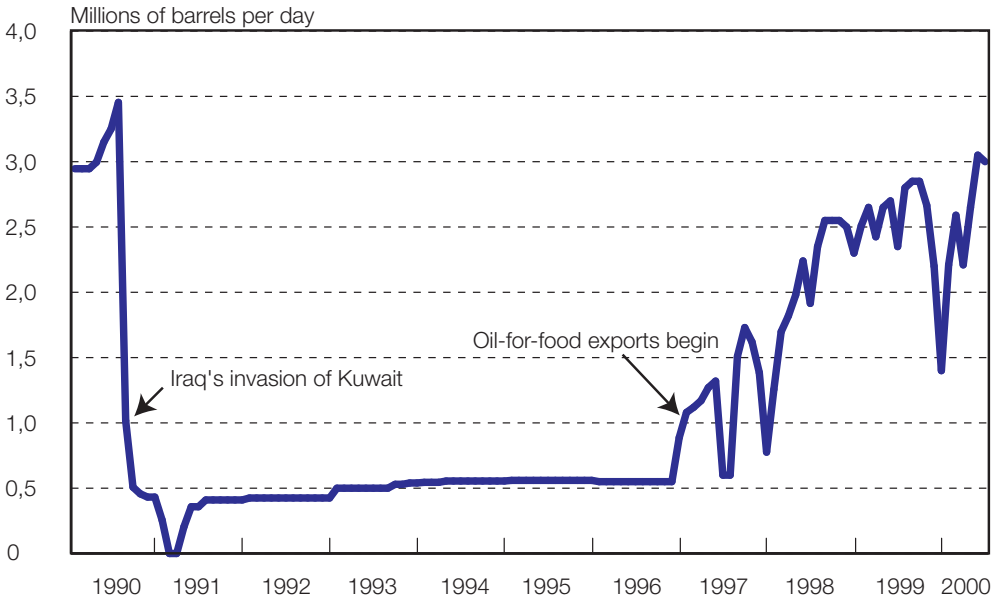
3.4 The role of Iraq in world oil markets

Following Iraq's invasion of Kuwait in 1990, Iraqi exports of oil were prohibited in terms of UN Resolution 661. In April 1995, however, the UN passed Resolution 986, allowing exports of oil to provide humanitarian relief for Iraq. The oil-for-food programme, agreed to by Iraq in May 1996 and extended in 180-day phases several times since then (the programme is currently in Phase IX), provides for the use of oil export proceeds to fund imports of food and medical supplies under UN supervision. From 5 December 2000, around 72 per cent of the export proceeds have been available for this purpose, and approximately 25 per cent has been earmarked for the payment of compensation and damage claims from the 1990-91 war.[9]

9 Iraq also has an arrangement to supply oil to Jordan which is exempted from the UN sanctions. Despite the UN sanctions, Iraq appears to have also agreed with Syria to reopen the petroleum pipeline between the two countries in November 2000.

The impact of these events on the volume of Iraqi oil exports in the post-1997 period is clearly visible in Graph 5. After initially setting a ceiling of US$2 billion on oil exports for the first three phases, increases were approved which raised the value of exports to US$2,14 billion and to US$5,265 billion in Phases IV and V, and to US$8,3 billion in Phase VI. In December 1999, the UN Security Council voted to remove the ceiling on Iraqi oil exports under the scheme (Resolution 1284).

Graph 5 Iraqi oil exports



Source: Macintyre (2000)

Although estimates suggest that Iraq was producing at close to its sustainable capacity of 2,9-3 million b/d for much of 2000, the situation remains volatile. In September, for example, Iraq made it known that from 1 November it wished to be paid in euros for its oil exports. Although the UN agreed to this demand on 31 October, it did cause some concern in the market. This concern was exacerbated when Iraq suspended the loading of crude oil on 7 November at the Turkish port of Ceyhan which handles more than one-third of Iraqi oil exports, until letters of credit for the purchase of oil were converted from US dollars into euros. More recently, oil exports were suspended in early December 2000 following a dispute over Iraq's plan

to bypass the oil-for-food programme by levying a surcharge on its exports and compensating customers with prices below market prices, by approximately the same amount (initially, the surcharge requested was fifty US cents per barrel). As a result, Iraqi oil exports fell to just 1,32 million b/d in December, and were only expected to return to their full potential in February 2001.

3.5 The US Strategic Petroleum Reserve

The US Strategic Petroleum Reserve (SPR) was set up by President Ford in the wake of the first oil crisis in the 1970s. On 22 December 1975 he signed the Energy Policy and Conservation Act, which provides for a reserve of up to 1 billion barrels of petroleum and for the incumbent US President to make withdrawals during an energy emergency. In December 2000, the SPR held an estimated 541 million barrels of crude oil. Using the US Energy Information Administration's (EIA's) estimated US average daily demand of approximately 19,56 million barrels in 2000, this gives a demand cover of approximately 27½ days.

In response to the surge in oil prices in 2000, President Clinton decided on 22 September to release 30 million barrels of oil from the SPR on a swap basis. The US Energy Department offered the crude oil in exchange for the same amount plus a bonus percentage which are to be returned to the SPR in 2001. Only one emergency withdrawal had previously been made during Operation Desert Storm in 1991.

4. The world demand for oil

The global demand for oil in 2000 averaged approximately 75,6 million b/d, up by 1,1 per cent from 74,8 million b/d in 1999 (see Table 4). Demand originating in the OECD countries contributed 47,8 million b/d (63,2 per cent) to the 2000 total. In general, this demand for oil is related to the level of global GDP. Increases in global GDP generate a greater demand for oil, although the relationship has changed over time, because earlier oil price shocks have resulted in a substitution of other forms of energy for oil in production and a decline in oil usage relative to GDP.

Table 4 World oil demand
Millions of barrels per day

	1974	1997	1998	1999	2000
North America	19,8	22,7	23,1	23,9	24,1
Western Europe	14,6	15,0	15,3	15,1	15,1
Pacific	6,3	9,0	8,4	8,6	8,6
Total OECD	**40,7**	**46,7**	**46,8**	**47,6**	**47,8**
Former Soviet Union	6,7	3,8	3,7	3,5	3,5
Europe	1,0	0,8	0,8	0,7	0,8
China	1,2	4,2	4,2	4,5	4,8
Other Asia	1,8	6,7	6,8	7,1	7,2
Latin America	2,7	4,7	4,8	4,8	4,8
Middle East	1,4	4,0	4,2	4,3	4,4
Africa	1,0	2,3	2,3	2,3	2,4
Total non-OECD	**15,7**	**26,5**	**26,7**	**27,2**	**27,8**
Total world demand	**56,4**	**73,1**	**73,5**	**74,8**	**75,6**

Source: International Energy Agency *Monthly Oil Market Report* (January 2001)

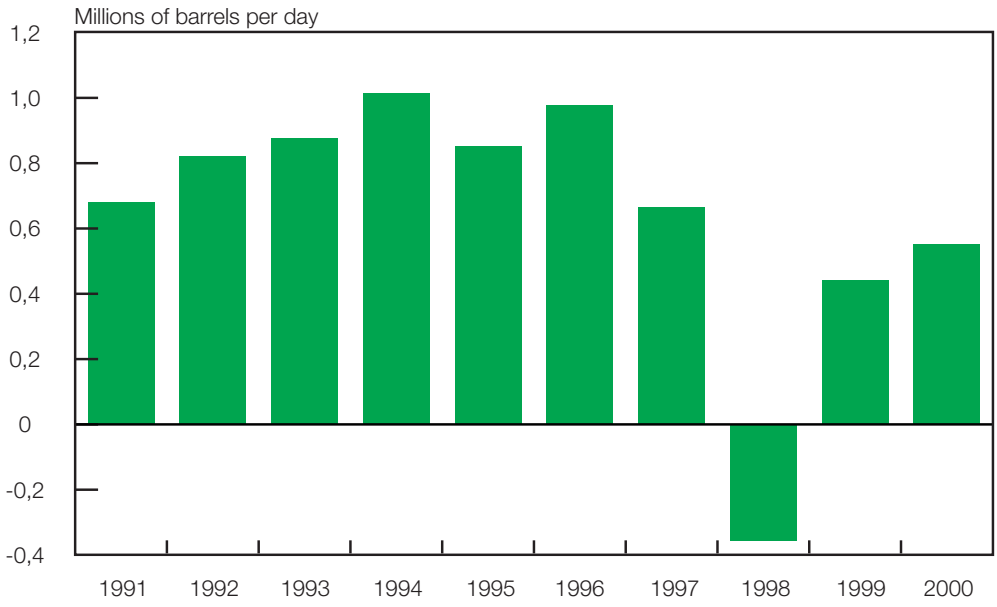
Largely in response to the earlier oil price shocks of the 1970s and 1980s, the dependence of OECD economies on oil has undoubtedly declined over time. As noted above, this is the natural result of efficiency-driven conservation and of a shift away from oil in production. One aspect of the latter effect derives from the changes in OECD industrial structures; industries with high price elasticities of demand for oil tended to decline following the shocks, and these economies shifted towards services production in the 1990s.

As a corollary to this restructuring, however, the remaining oil-dependent industries in OECD countries tend to have relatively low price elasticities of demand for oil. The transportation sector, for example, now accounts for approximately 67 per cent of oil usage in Western Europe and the US compared with 45 per cent in 1970. With demand therefore having become more inelastic, supply shortfalls in the world oil market tend to result in proportionately greater price increases.

A further implication of the restructuring in developed countries is that a relatively larger proportion of world oil demand emanates from developing countries. As shown in Table 4, the proportion of world demand originating in the non-OECD countries increased from 27,8 per cent in 1974 to 36,8 per cent in 2000. These economies depend relatively more on manufacturing than developed countries, and therefore tend to use more oil per unit of GDP. Oil consumption in South Africa in 1998, for example, was estimated at 2,2 per cent of GDP, and at 6,3 per cent and 4,1 per cent in Indonesia and Thailand, respectively. By contrast, in the OECD as a whole, the figure was just 0,8 per cent (Davies and Strongin, 2000: s.11 and s.14).

In this sense, developing countries are more vulnerable to oil shocks than developed countries. At the same time, however, it follows that events in developing countries, such as the 1997-98 crisis originating in East Asia, can have a significant impact on

Graph 6 Asian oil demand growth, 1991-2000



Source: EIA *Short-term Energy Outlook*, August 2000

world oil demand. The volatility induced by these events is evident in Graph 6, which shows that Asian oil demand growth slowed in 1997 and declined in 1998 by almost 400 000 barrels per day before increasing again in 1999 by just over 400 000 barrels per day.

5. The role of futures markets in determining the world price of oil

5.1 The development of crude oil futures markets

Until the late 1970s, almost 90 per cent of the world's crude oil was sold under long-term contracts at prices set by the major oil companies. In the late 1970s and early 1980s, as producing countries exercised greater control over their resources and the major oil companies were free to bid for crude oil wherever it was sourced, market-based spot trading gained in importance.[10]

The move to market-based pricing resulted in greater volatility in spot crude oil prices. This volatility, coupled with the impact of the high real interest rates charged in the early 1980s on oil storage costs, encouraged the development of the oil futures market.[11] This market serves two interrelated purposes. First, it provides an organised forum which allows producers and refiners to hedge the price risk (and speculators to take positions on future oil prices). Second, and particularly relevant here, the futures market plays an important role in price discovery in the oil market.

Two benchmark types of crude oil dominate world crude oil futures trading, namely West Texas Intermediate (WTI) and Brent Blend.[12] The former has been traded on the New York Mercantile Exchange (NYMEX) since April 1983, and remains the most actively traded crude oil future. Contracts traded on NYMEX specify WTI crude for delivery by pipeline in the town of Cushing, Oklahoma, although the exchange's rules allow for the delivery of six other types of crude against the WTI contract.[13] Trade in Brent futures contracts (for pipeline-exported Brent Blend supplied at the Sullom Voe terminal in the North Sea) was successfully launched on the International Petroleum Exchange (IPE) in London in June 1988.[14]

5.2 The theoretical relationship between spot and futures prices in oil markets

The crude oil futures markets described above may provide useful information for forecasting the spot price of oil. For a commodity requiring storage, such as oil, it might be expected that the no-arbitrage future price (F) is given by

$$F = S\, e^{(r+w)t} \qquad (1)$$

where S is the spot price of the commodity, r is the risk-free interest rate, and w is the cost of storage (r, w expressed in continuous form). The logic here is that arbitrage will ensure that the future price of oil is the same as the cost of borrowing funds, buying oil in the spot market and storing it over the same period. Since nominal interest rates and storage costs (together the 'cost-of-carry') are positive, this relationship suggests that the future price of oil should be above that of the spot price. In this case the market is said to be in 'contango'.

10 The supply management strategy under the administered pricing system came under increasing strain in the 1980s as Saudi Arabia, the *de facto* swing producer in the OPEC cartel, was forced to cut production in the face of increases in world production and modest demand. When Saudi Arabia attempted to regain market share in early 1986, a sharp decline in oil prices resulted. The current market-based system emerged in 1987-88.

11 Spot and forward trades are bilateral transactions (contracts) which are not conducted on organised exchanges, as opposed to futures contracts which are. Though forward contracts can be used for hedging purposes, they lack some of the advantages of futures contracts traded on formal, regulated exchanges with clearing houses

12 The weight and the sulphur content of the type of crude are particularly important for the refining process. The lighter the oil and the lower the sulphur content the easier it is to refine; WTI is lighter and has a lower sulphur content, for example, than UK Brent Blend and therefore tends to trade at a premium to the latter.

13 The six comprise UK Brent Blend, two Nigerian crudes, a Norwegian crude and two Algerian crudes. An adjustment factor is added by NYMEX to the WTI price to ensure that the substitute crudes are acceptable to buyers.

14 Trading is not restricted to NYMEX and the IPE. In 1995, in an attempt to increase the number of hours of trading, the IPE entered into an agreement with the Singapore International Monetary Exchange (SIMEX) allowing Brent futures to be traded there, and NYMEX has allowed computer trading of its futures on the Sydney Futures Exchange.

In the oil market, however, futures prices are often observed to be below the spot price (the futures curve slopes downward). This is known as (strong) 'backwardation',[15] and it suggests that the cost-of-carry of oil is not the only determinant of the price of the future. An explanation which is often used to account for this backwardation relies on the notion of a 'convenience yield' suggested by Kaldor (1939) and Working (1948). This convenience yield arises from the services that accrue to the owner of a physical commodity but not to the owner of a contract for future delivery of the commodity (Brennan and Schwartz, 1985), and requires the purchaser of the futures contract to be compensated by a lower price.

15 A distinction may be drawn between strong backwardation as defined here, and weak backwardation where discounted futures prices are below those of current spot prices (Litzenberger and Rabinowitz, 1995).

In the oil market, inventories are generally held by refiners, distributors and end-users. The convenience that these companies derive from inventories is related to the fact that they cannot afford to have their oil supply disrupted. This suggests that the size of the convenience yield in the market should be related to the level of inventories; when inventory levels are high (low), the convenience yield in the market should be low (high). This negative relationship is indeed borne out by empirical studies.

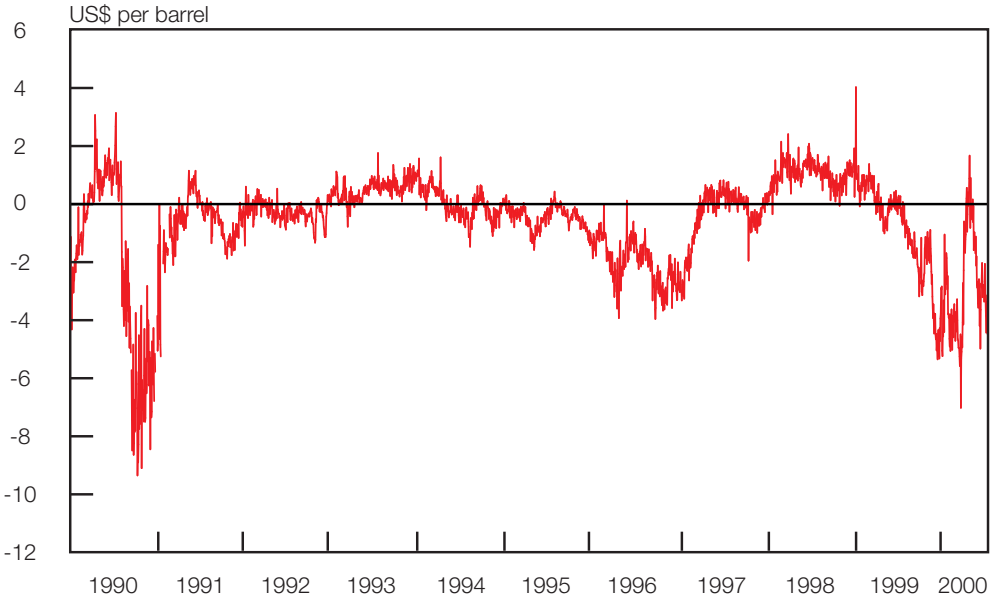
If the convenience yield of holding inventories is modelled as a premium which is included in the spot price, denoted γ here, then equation (1) above may be written as

$$F = S\, e^{(r+w-\gamma)t} \qquad (1')$$

For a sufficiently high value of the convenience yield γ, it is clear from equation (1′) that the forward price may lie below the spot price. In this case, the market will be in backwardation.

Evidence of the state of the Brent crude oil futures market in the period since 1990 is provided in Graph 7. This graph plots the spread between the Brent spot and 6-month futures prices which held at particular times. It is clear from Graph 7 that this

Graph 7 Spread between Brent spot and 6-month futures prices



spread is not constant over time; the graph shows clearly when the oil market was in contango and when it was in backwardation. The market was in contango, for example, just before the Gulf War in 1990, and moved strongly into backwardation during the latter stages of the war. The oil market was also in backwardation during the temporary oil price increase in 1996. More recently, the oil market moved from contango to backwardation in early 1999 as oil prices began to rise.

The discussion above suggests that the level of inventories will play an important role in the oil futures market. Theoretically, the framework set out above suggests that 'cash-and-carry' arbitrages will limit the size of the contango in the market. If the futures price is 'too high' relative to the spot price, oil can be purchased spot and inventories built up, thereby easing the contango. This relationship is complicated in practice by market frictions such as the availability and the marginal costs of storage, and also by the effects of different types of crude on the market, but theoretically it does place limits on the extent of the contango.

More difficult to determine are the limits to backwardation. When oil inventories are low, purchasers may be willing to pay almost any price to ensure current supply. Furthermore, the ability to undertake reverse cash-and-carry arbitrages (which involve 'borrowing' significant volumes of supply from the future) is very limited. These features suggest that spot and short-term futures prices can rise dramatically when supply disruptions occur and inventories are low. This type of market is discussed in more detail in Section 6, when the current situation in the world oil market is analysed.

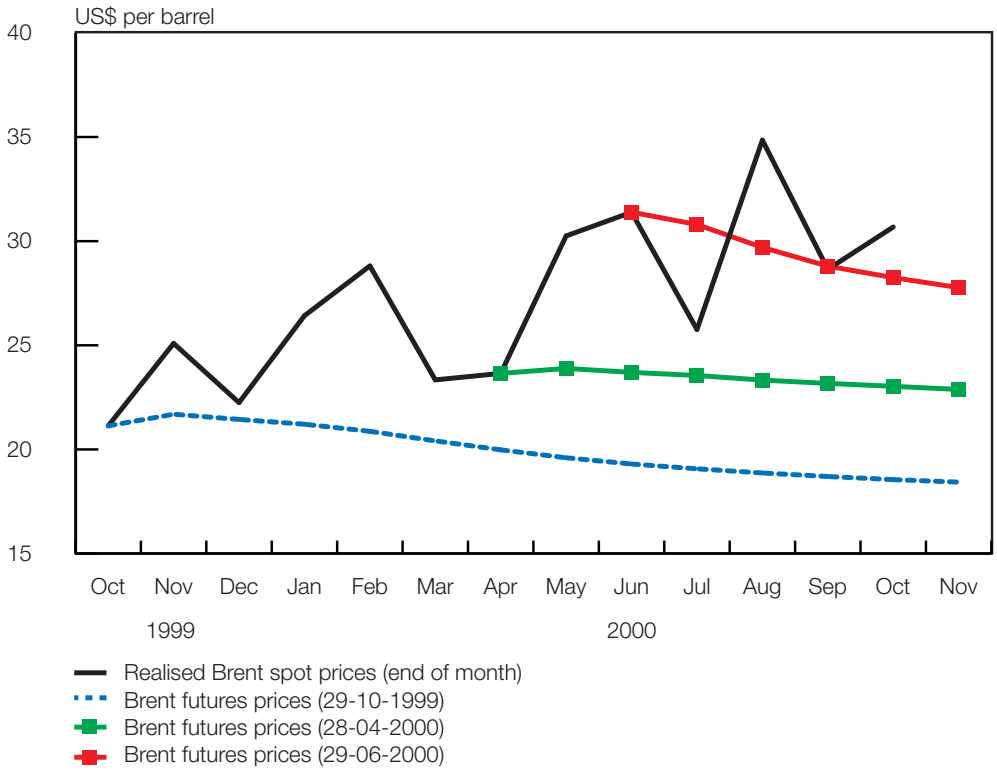
The operation of futures markets for crude oil described here has led some commentators to argue that the market is characterised by unstable equilibria, which help to explain periods of extreme price movements in the market. When the market is in backwardation, it does not make sense to increase inventories, whereas during periods of contango stocks are augmented. According to Mabro (2000), the behaviour of inventories is a key to the response of hedgers. Falling inventories are interpreted as a signal of falling supply relative to demand, and rising inventories as a signal of excess supply. Falling inventories therefore cause spot prices to rise which in turn causes the backwardation to steepen, discouraging inventory accumulation. By contrast, rising stocks push down spot prices, the contango steepens and this in turn encourages further inventory accumulation. As Mabro (2000) notes: 'Backwardation could lead to prices rising and rising, contango to prices falling and falling. Only big shocks can stop these movements. But big shocks do not only arrest the price movement. They can reverse it, recreating the problem of relentless rise or fall until the next shock.'

5.3 Do oil futures predict the oil price?

In the theoretical framework set out above, the future price of crude oil is determined by the spot price and the costs and benefits of storing oil. In this sense, an indication is given of the spot price at maturity, and indeed of the term structure of prices. A market in contango (backwardation) implies that the future spot price of oil will be above (below) the current spot price. The question, however, is whether futures prices have forecasting power for spot crude oil prices.

Unfortunately, this does not always appear to be the case. As Graph 8 shows, futures prices at a given time often seem to provide poor forecasts of realised spot prices. Between October 1999 and November 2000, consecutive futures-generated forecasts of the Brent crude price on the IPE failed to predict the increase in the

Graph 8 Predicted Brent futures and realised spot prices



Source: International Petroleum Exchange

spot price realised over the period. Forecasts at 30 October 1999, 28 April 2000 and 29 June 2000 all predicted that Brent prices would fall, albeit from progressively higher initial price levels.

Although more formal empirical work, which tests for bias in the forecasts of crude oil futures markets, tends to support the doubts raised by the findings shown in Graph 8, there is nevertheless some evidence that these forecasts can outperform other forecasting models. Using end-of-month data for the 1983-90 period, Kumar (1991) shows that forecasts from futures prices for delivery up to 10 months ahead not only invariably outperform a simple random walk model,[16] they also generally improve upon the accuracy of certain more sophisticated econometric and time series models.

16 In terms of mean absolute error, root mean square error and Theil's 'U' statistic.

Despite the problems noted here, it is not clear that a superior forecast of spot prices is readily available. It is perhaps for this reason that a recent Bank of England *Inflation Report* (November 2000: 15) states that 'the MPC judges that the futures curve continues to offer the best indication of the prospective path for oil prices'.

6. The current situation in the world oil market

After reaching their highest levels in a decade in the third quarter of 2000, and threatening the 'new economy' with an old-fashioned energy crisis, world oil prices fell back to their lowest levels in 8 months in December. Despite this, oil inventories are

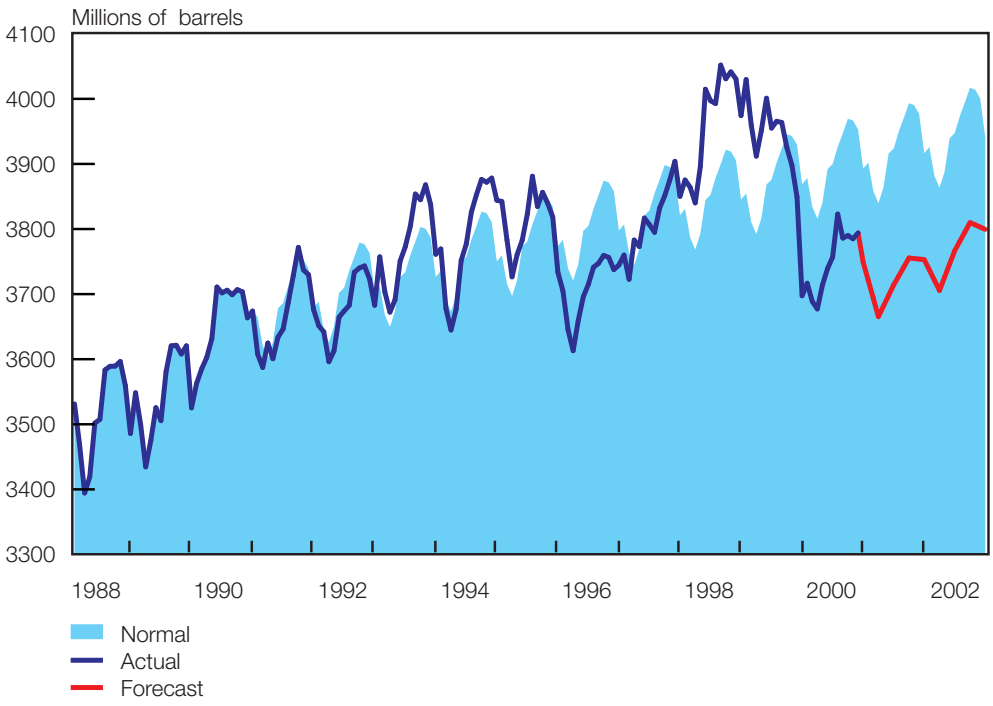
low and the potential for instability in the market is still present. An analysis of the current situation requires a balanced perspective which distinguishes carefully between short-term, cyclical and longer-term issues.

At the moment it is clear that the world oil market is 'tight', in the sense that it lacks flexibility to respond quickly to shocks which may impact upon it. Available data suggest that inventories of crude oil and also of product stocks remain low; stocks did not build up significantly in 2000 despite the OPEC supply increases and the SPR release.[17] Recent EIA data, reproduced in Graph 9, show that total OECD oil stocks have fallen sharply below what they regard as normal since the northern hemisphere winter of 1999.[18] These stocks are projected by the EIA to follow a seasonal pattern to the end of 2002, with little build-up in inventories. Furthermore, the weekly American Petroleum Institute (API) data, which are closely watched by market participants, has US inventories at twenty-year lows (Graph 10).

17 Some commentators, e.g. Matthies (2000: 253) argue that this is also because the oil industry is increasingly adopting a 'just-in-time' delivery policy. This offers significant cost reductions, but increases the risk of production disruptions.

18 The EIA estimate of the 'normal' level of stocks allows for both historical averages and a trend related to increasing inventory requirements associated with increases in world demand (EIA *Short-term Energy Outlook,* February 2001). The inclusion of the latter component means that 'normal' inventories here are higher than if a straight historical average was used.

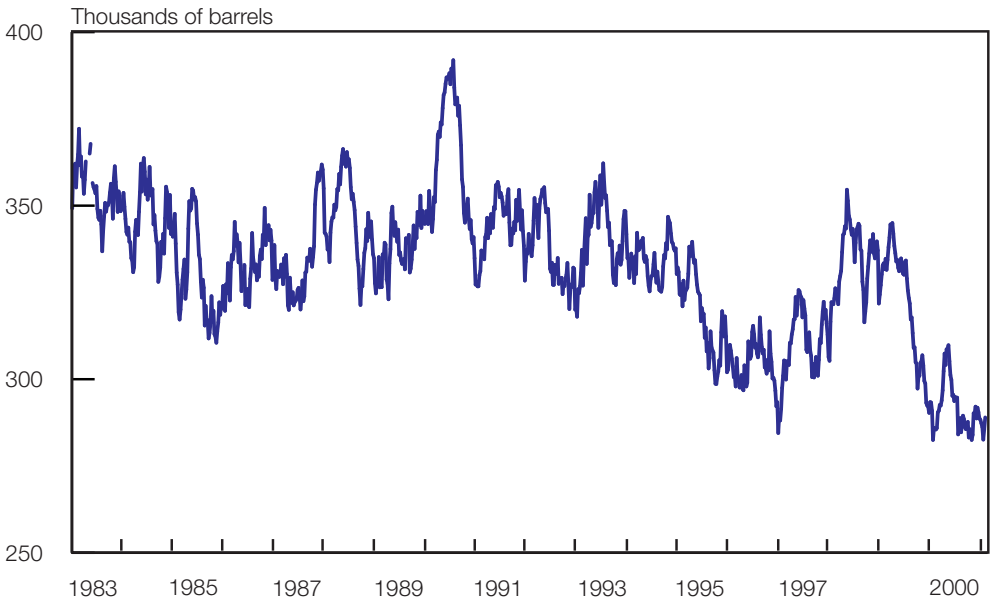
Graph 9 Total OECD oil stocks



Source: EIA *Short-term Energy Outlook,* February 2001

The current situation regarding inventories is generating a great deal of uncertainty in the oil market. Unfortunately, such uncertainty is virtually a fact of life in a market where accurate information about production, stocks and demand is difficult to obtain. Various explanations have been put forward. One discusses the possibility of 'missing barrels', which preoccupied some analysts in 1998 when production cuts failed to appear in the data. Whereas in 1998 inventories remained high and this view kept prices low and contributed to production cuts that were perhaps too severe, the situation now is that inventory data may overstate the tightness of the market.

Graph 10 API US weekly crude oil ending stocks (excluding SPR)



Source: American Petroleum Institute

Indeed, consensus data have for some time indicated that the world oil market is in surplus. The IEA data, for example, indicate that world supply outstripped world demand from the second to the fourth quarters of 2000 *(IEA Monthly Oil Market Report, January 2001: 39)*. Furthermore, it seems likely that the growth in demand for OPEC production in 2001 will fall as a result of slower world GDP growth. The recent production cuts by OPEC are clearly consistent with maintaining prices in these conditions, although in the longer term the sustainability of such a strategy has been questioned *(*IEA *Monthly Oil Market Report, February 2001: 3).*

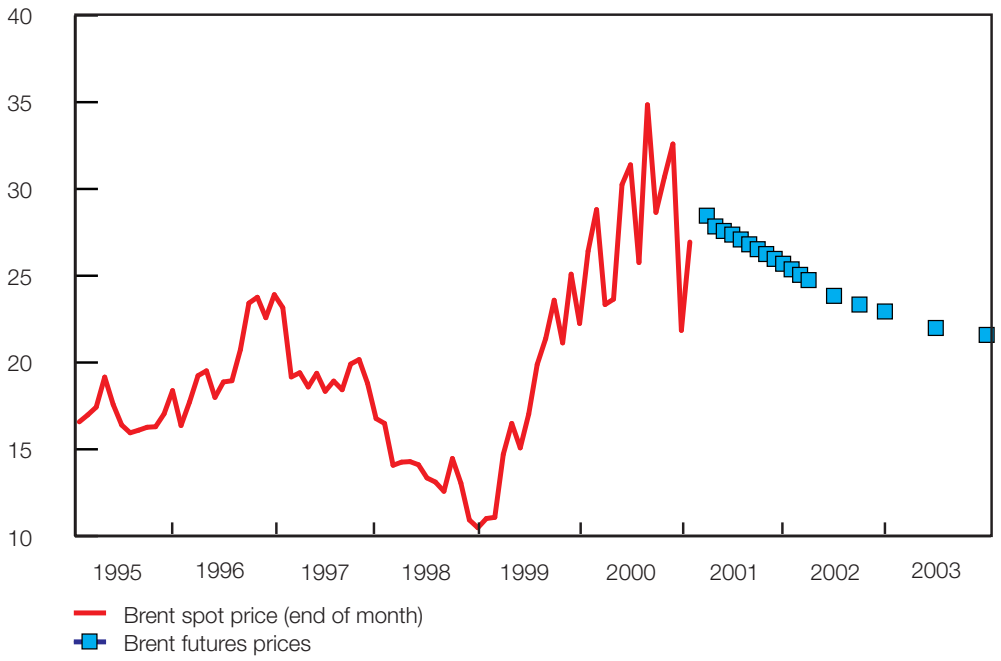
It appears, therefore, that tight conditions in world oil markets combined with OPEC production cuts will support prices in the short term. The market seems likely to continue to be characterised by backwardation, and the potential for instability remains significant. As the balance between supply and demand in world oil markets results in the rebuilding of global inventory levels, the problem for OPEC will be to co-ordinate production cuts so as to ensure a soft landing for oil prices, rather than face the alternative of a crash.

7. Summary of recent forecasts

The discussion so far has emphasised that crude oil prices are determined by a complex interaction of underlying supply and demand factors, political dynamics and increasingly developed spot, term and futures trading. Needless to say, forecasts made in this environment are liable to change rather frequently as new information is processed. In general, two types of forecasts may be identified for the world crude oil market: one type focuses on forecasting supply and demand, and the other provides a forecast of the oil price itself (usually for a particular benchmark grade of oil). This section reviews some recent forecasts of the latter type.

Section 5 suggests that futures prices may have some predictive power for spot oil prices, although this has often been found to be limited. To begin with, then, the for-

Graph 11 The Brent forward curve (as at 13 February 2001)



ward curve for Brent futures as at 13 February 2001 is presented in Graph 11. As Graph 11 indicates, the oil market on 13 February 2001 was in backwardation. The futures prices at this time suggest that the end-of-quarter price of Brent crude would average US$23,72 in 2002 (US$24,75, US$23,84, US$23,34 and US$22,94 in March, June, September, and December, respectively) before decreasing further to US$22 in June 2003.

Forecasters relying on a combination of factors tend to agree that crude oil prices will fall over time. The forecasts presented in Table 5 all predict that oil prices will be lower in 2002 than in 2001, although there is some evidence of volatility in the quarterly forecasts for 2001. For 2002, the forecasts reported in this table straddle the end-of-quarter average of US$23,72 generated from the forward curve in Graph 11, even once a rough allowance is made for the premium which WTI enjoys over Brent in the market.

Table 5 Oil price forecasts
US$, period averages

Forecaster	As at:	Type	2001					2002
			1st qr	2nd qr	3rd qr	4th qr	Year	
EIA*	February 2001	WTI	30,15	29,31	29,97	30,62	30,01	29,18
Lehman Bros	6 October 2000	Brent	30,7	30,2	29,7	29,2	29,9	
Goldman Sachs	March 2001	WTI	29,0	21,5	22,0	24,0	24,1	
ABN AMRO	February 2001	Brent					24,0	21,0
ABN AMRO	February 2001	WTI					25,5	22,5
JP Morgan	23 February 2001	WTI	27,0	28,0	27,0	26,0	27,0	21,5
Merrill Lynch	24 January 2001	WTI	27,0	24,0	24,0	25,0	27,0	24,0

* Energy Information Administration *Short-term Energy Outlook*, February 2001

8. Conclusion

It is generally felt that the oil prices will remain in the range indicated as desirable by OPEC. There are differences of opinion about how long this will be maintained. Although there is a strong view that the market is in a period of oversupply, inventories remain low. The impact of the recent production cuts is also not yet clear. Furthermore, it should be borne in mind that the quality of information about stocks, supply and demand is poor, and therefore the consensus view on the numbers is the factor determining consumer and producer behaviour, rather than the actual numbers. This means that the current consensus view of oversupply could result in a sharp rise in prices if OPEC does indeed cut back further on production and if this consensus view overestimates the degree of oversupply.

The behaviour of the OPEC cartel is often the key to price developments in the world crude oil market. Last year there was little short-term benefit for the individual members, apart from Saudi Arabia, in increasing their output, given their lack of surplus capacity. In the current environment, the cartel is faced with the even more difficult task of co-ordinating production cuts by members to ensure a soft landing for oil prices. As in the past, future prospects will be dominated by the conflicts within OPEC between short-term and long-term needs.

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