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Article

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Weekly Report

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Weekly Report

World Crude Oil Markets: OPEC's Supplier Power Remains Unchallenged

In spite of the sharp decline of crude oil prices since the fall of 2008, the current price level of approximately \$65 per barrel is significantly higher than the long-term average. The market power of the Organization of Petroleum Exporting Countries (OPEC), which is partially responsible for this price level, remains strong. While market prices for commodities such as coal are typically reflecting production costs, in the case of oil, market power combined with significant variations in demand leads to erratic price fluctuations. DIW Berlin's model calculations show that although OPEC cannot operate as a standard cartel, its individual members can significantly influence prices by acting as powerful oligopolists. Furthermore, over the mid-term the OPEC countries will attain even greater significance because of the size of their oil reserves.

Crude oil is the world's most important primary energy source. Currently, more than one third of world demand for primary energy is met by oil (Figure 1). Despite a decline in the second half of 2008, crude oil prices remain quite high by historical standards.

As a result of the economic crisis, current production levels are adequate in the short term to meet the reduced demand for crude oil. Once the world economy recovers, however, shortages in capacity and price spikes could return. A critical factor is that planned investments in new oil fields are currently being scaled back. Many of the world's large oil fields are already past their peak output and new investment will be required just to maintain production at current levels. The IEA estimates that by 2013 a lack of investment will lead to supply bottlenecks on the oil markets.¹ The IEA also estimates that \$6.3 trillion will need to be invested in the oil industry by 2030, with 80% of this figure devoted to the development of new production capacity.

OPEC has considerable market power in world oil markets. The OPEC countries account for over 40% of world production and over 75% of the known oil reserves. In addition, the most easily exploitable oil reserves are located in OPEC countries. By reaching agreements with Russia, a major producer of crude oil, OPEC has further increased its importance in price formation. While the unexpected price movements

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¹ Interview with IEA director Nobuo Tanaka: Energieagentur warnt vor Engpass. Süddeutsche Zeitung, February 27, 2009.

in 2008 have raised doubts about OPEC's ability to control oil prices, its dominant market position remains undisputed (Figure 2).²

A Non-Competitive Market

OPEC is a cartel that aims at reducing competition through supplier collusion. However, it has had limited success maximizing joint profits, as cartel theory would suggest. OPEC member countries often view production quotas as flexible targets rather than absolute production limits.

Lax compliance with the production quotas on the part of OPEC members is partially attributable to the fact that the OPEC member countries have diverse premises and policy goals. Saudi Arabia, for example, because of its foreign currency reserves can afford to increase or reduce production to match current demand. This allows it to compensate for fluctuations in demand and prevent excessively volatile price fluctuations. Venezuela, on the other hand, can hardly afford a temporary fall in oil income as this would restrict the social welfare expenditures of the state-owned oil company *Petróleos de Venezuela SA*. Therefore, OPEC's diverse membership partially explains its inconsistent strategy regarding production quantities and pricing.

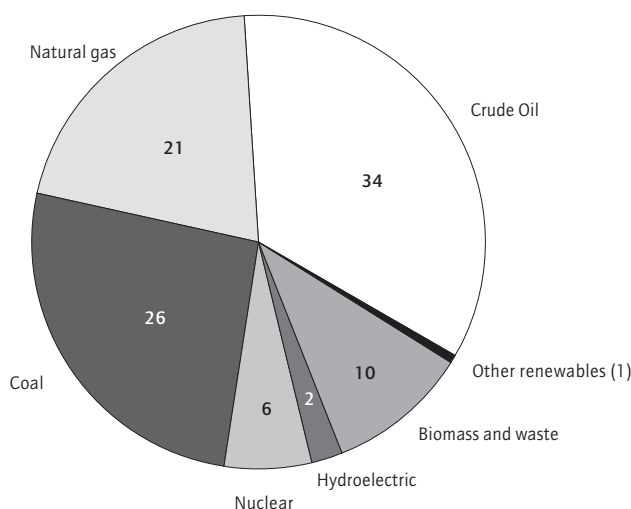
There is also no effective mechanism within the organization to sanction countries that exceed production quotas. While Saudi Arabia can threaten to push other countries with higher production costs out of the market by drastically increasing its oil production and pushing down international oil prices, this threat is not a credible tool for dissuading individual members from marginally exceeding production quotas. As a result, OPEC has often been studied in terms of its stability as a cartel.³ In particular, the question has been raised whether compensation payments or incentive mechanisms within OPEC could or should be implemented to punish those that do not comply with the organization's official strategy and production quotas.

Other economic analyses have concluded that OPEC's importance in influencing crude oil prices has been overestimated.⁴ Most producers do not release detailed data about production quantities or production costs. The precise volume of available reserves is also unclear: while modern exploration

Figure 1

Worldwide Primary Energy Consumption by Source, 2006

In percentage



Source: IEA.

DIW Berlin 2009

Figure 2

Spot Prices for Brent Crude

In US-dollars/barrel



Source: IEA.

DIW Berlin 2009

² See IEA: World Energy Outlook. Paris 2008.

³ See Griffin, J. M., Steele, H.: Energy Economics and Policy. Orlando 1986. Böckem, S.: Cartel Formation and Oligopoly Structure: A New Assessment of the Crude Oil Market. *Applied Economics*, 36(12), 2004, 1355-1369.

⁴ Alhajji, A. F., Huettner, D.: OPEC and Other Commodity Cartels: A Comparison. *Energy Policy*, 28, 2000, 1151-1164.

and production methods allow the exploitation of new oil fields (as proven by recent discoveries off the coast of Brazil), national oil companies' publicly available reserve estimates should be considered

somewhat exaggerated.⁵ Due to incomplete information, OPEC itself can only have a limited impact on the price formation. Consequently, the crude oil market is neither cartel-dominated nor perfectly competitive, but somewhere in between.

More Objectives than Pure Profit Maximization

Because of the unique influence exerted by OPEC, the economic modeling of the oil market is more complex than for other commodity markets. A straightforward approach often chosen assumes that all producers seek to maximize profits. Yet instead of increasing production when oil prices are high, some countries reduce production output. This sort of unexpected behavior can, for example, be explained with a “target revenue model”.⁶

Another model developed by the Colorado School of Mines views the oil market from Saudi Arabia’s perspective.⁷ This model investigates whether Saudi Arabia (the world’s largest oil producer) determines its production such as to maximize profits. In the model, Saudi Arabia acts as a market leader that can anticipate the competitors’ reaction to its production decisions and adjust its planning accordingly. The modeling results suggest that Saudi Arabia could increase its profits by reducing production quantities. The fact that Saudi Arabia does not in reality pursue such a strategy can be explained by the fact that a state-owned oil company like Saudi Aramco must also pursue other goals aside from profit earning for the state. These include domestic fuel price subsidies and social projects. As a result, state-owned oil companies in general produce more oil than is ideal from a profit maximization perspective.⁸

Model Simulation Illustrates the Market Power of OPEC Producers

There are a number of regional spot markets where crude oil types such as West Texas Intermediate (USA) or Brent (North-Western Europe) are sold.

⁵ Besides „conventional” reserves, i.e. those that can be exploited using fully developed production techniques, „unconventional” reserves are becoming increasingly important. Unconventional reserves of oil are mainly oil sands, heavy crude and oil shale. In the future, oil products produced from biomass or by liquefying natural gas that can substitute for crude oil must also be taken into account. See IEA, *ibid*.

⁶ See Dahl, C. A.: *International Energy Markets: Understanding Pricing, Policies and Profits*. Tulsa, OK, 2004.

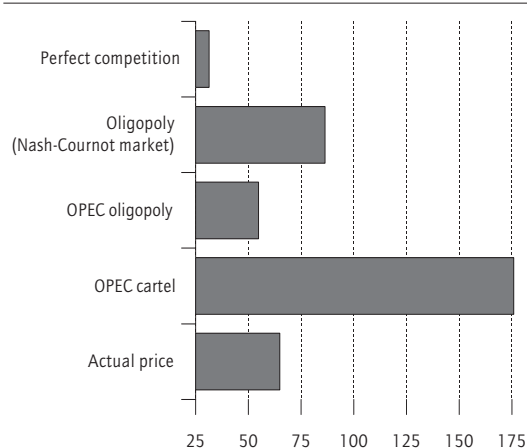
⁷ Al-Qahtani, A., Balistreri, E., Dahl, C. A.: *A Model for the Global Oil Market: Optimal Oil Production Levels for Saudi Arabia*. Presented at the 2008 IAEE Conference, Istanbul.

⁸ Vgl. Hartley, P., Medlock III., K. B.: *A Model of the Operation and Development of a National Oil Company*. *Energy Economics*, 30, 2008, 2459-2485.

Figure 3

Model Results for Brent Spot Prices, 2006

In US-dollars/barrel



Sources: IEA; calculations by DIW Berlin.

DIW Berlin 2009

Economists generally describe the global crude oil market as an integrated market in which no price differences exist when one excludes transport costs and certain variations in quality.

The OILMOD model developed by DIW Berlin (see Box) simulates the international oil market using an equilibrium model. Producers seek to maximize their profits in a variety of market power scenarios:

- Perfect competition, meaning the export price is equal to the producer’s marginal costs.
- Oligopoly (Nash-Cournot market), in which all producers exert market power, i.e. drive up the price by reducing production, in turn generating larger profits.
- OPEC oligopoly, in which only OPEC countries exert market power, but maximize their profits independently; the other market participants form a “competitive fringe.”
- OPEC cartel, in which OPEC members exert market power and maximize their joint profits.⁹

The results show that a functioning OPEC cartel would have been in a position to nearly triple prices above their actual levels. In a market characterized by perfect competition, by contrast, prices would have been about half their actual levels (Figure 3). The actual market figures generally fall between the simulation results for oligopoly (Nash-Cournot

⁹ The cartel scenario assumes that production quotas are not exceeded by any OPEC members.

DIW Berlin's Oil Market Model OILMOD

The OILMOD model developed by DIW Berlin is a computable partial equilibrium model that simulates the production, consumption and trade flows of crude oil on the international market.¹ The model includes all OPEC and OECD countries such as Brazil, China, India, Kazakhstan, Russia and Taiwan. 2006 is used as the baseline year for actual production and consumption quantities, import prices and production costs.

Producing and consuming countries connected by oil tankers and pipelines are simulated in the model. Production costs are modeled using quadratic functions and consumption is modeled using linear inverse demand functions. The sources for the reference data are the IEA and BP, for production costs Aguilera et al., and for trans-

port costs the German Federal Institute for Geosciences and Natural Resources.²

In contrast to other equilibrium and optimization models, this model takes into account regional spot markets such as those for West Texas Intermediate (WTI) and Brent. Import countries can buy crude oil on a spot market instead of buying directly from the producers, preventing price discrimination by the producers. In particular, this model includes arbitrageurs who offset price differences between import destinations that would not be justified by transport costs. This means other market players cannot use price discrimination to their advantage.

¹ Huppmann, D., F. Holz: A Model for the Global Crude Oil Market Using a Multi-Pool MCP Approach. DIW Berlin Discussion Paper Nr. 869, 2009.

² BP: Statistical Review of World Energy. 2008; IEA: World Energy Outlook 2008. Paris 2008; Aguilera, R. F., R.G. Eggert, G.C.C. Lagos, J.E. Tilton: Depletion and Future Availability of Petroleum Resources. The Energy Journal, 30(1), 2009, 141-174; BGR: Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 2002. Volume 28 of Rohstoffwirtschaftliche Länderstudien. Hannover 2003.

market) and OPEC oligopoly. This suggests that OPEC members and possibly some other producers exert market power, but that OPEC cannot operate as a standard cartel when it comes to maximizing joint profits for its members.

The Table shows the simulation results for consumption and production in the scenarios and, for the purpose of comparison, the actual figures for 2006. Regarding production quantities, the model results also suggest an OPEC oligopoly. The only

Table

Model Results for Selected Countries, 2006

In millions of barrels per year

	Perfect competition	Oligopoly (Nash-Cournot market)	OPEC oligopoly	OPEC cartel	Actual volumes
Crude oil consumption					
Germany	966	886	932	756	920
Russia	991	906	955	768	946
Spain	478	437	460	370	456
Netherlands	630	576	607	489	601
China	2,702	2,481	2,604	2,117	2,575
Japan	1,564	1,435	1,507	1,225	1,490
Saudi-Arabia	715	654	688	553	682
Brazil	708	649	681	542	678
USA	6,398	5,867	6,153	4,903	6,108
World total¹	23,815	21,757	22,935	18,478	22,712
Crude oil production					
China	1,133	1,182	1,420	1,420	1,352
Iran	1,621	1,621	1,608	1,357	1,544
Norway	962	962	962	962	917
Russia	2,883	2,004	3,713	3,713	3,536
Saudi Arabia	3,787	2,536	1,635	1,702	3,787
USA	1,791	1,893	1,958	1,958	1,865
World total¹	23,815	21,757	22,935	18,478	24,087

¹ All countries included in the model.

Sources: IEA; calculations by DIW Berlin.

exception is Saudi Arabia where actual production is above the optimal volume for an OPEC oligopolist. This observation more or less conforms to the results of the Colorado School of Mines model.

Conclusion

Crude oil price trends in recent years have been characterized by a long-term upward movement and high volatility. After hitting a record high in 2008 of over \$140 a barrel, prices fell swiftly to under \$40 and since have climbed again to more than \$60. These price movements reflect uncertain expectations regarding the demand for oil, among other factors. OPEC's behavior continues to play a significant role in price formation. DIW Berlin's model calculations show that although OPEC cannot operate as a standard cartel, its individual members can significantly influence prices by acting as powerful oligopolists.

Since the majority of known oil reserves are in the Middle East, OPEC's market power will tend to grow in the coming years. OPEC's diverse membership makes a full cartelization of the market unlikely in the future. However, OPEC's role in driving up prices is likely to expand.

The sharp drop in oil prices has resulted in decreased investment activity. This means that in coming years, available capacity will not be adequate to meet spikes in demand. For this reason, volatile price increases must be expected.

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