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Implications for the  
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## **Abstract**

This paper analytically addresses the question, to which degree the market power of OPEC is the key reason for the world market price of crude oil to exceed marginal extraction costs. Describing the various determinants of both extraction costs and the oil price constitutes the basis for an in-depth discussion on the relative impact of these variables. We argue that despite OPEC's significant market power, other forces such as steadily increasing global demand, temporary supply constraints, or a growing importance of resource pragmatism and nationalism play a much greater role than OPEC's market power.

**Keywords:** OPEC; oil price determinants; Hotelling rule; market power

**JEL:** Q02; Q30; Q31

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## 1 Introduction

The Organization of Oil Exporting Countries (OPEC) is an intergovernmental group of 12 member states which was founded in Baghdad in 1960. Currently providing on average 35% of global oil production (OPEC, 2014) and owning 75% of proven global oil reserves (USEIA, 2014) allows the group to exert significant market power. But to which degree can OPEC translate its dominance into direct influence on the oil price and, more specifically, whether its market power is the key reason for the oil price to exceed marginal extraction costs in the long-run? In the following, the paper analyses the extraction costs of oil. Then, the various geological, economic, political, and financial factors influencing the oil price are examined. The final conclusion will provide a critical discussion of the linkage between the oil price, extraction costs, and OPEC.

## 2 Determinants and measurement of extraction costs of oil

The standard model for the optimal exploitation of a non-renewable resource has its roots in the seminal paper by Hotelling (1931) in which a relationship between the social discount rate and net resource rent over time is presented. The so called Hotelling rule states that only if both terms are equal, i.e. the present value of discounted net benefits is the same in each period, an optimal extraction path is derived from which no incentives to deviate exist (Grafton et al., 2004). Based on this important insight the standard model of resource exploitation specifies reserve size and technical change as the major determinants of unit extraction cost. Grafton et al., (2004) integrate these two terms in the following standard extraction cost function ( $x$  – rate of extraction,  $b$  – stock size,  $t$  – time):

$$c(x,b;t) \quad \text{with } c_x(x,b;t)>0, \quad c_{xx}(x,b;t)>0, \quad c_{xt}(x,b;t)<0, \quad c_{xb}(x,b;t)<0$$

The necessary criterion is that the unit cost are positive ( $c_x(x,b;t)>0$ ), though increasing with greater amounts of extraction ( $c_{xx}(x,b;t)>0$ ). Further, an inverse relationship is assumed between the unit cost and both time ( $c_{xt}(x,b;t)<0$ ), as a result of technological progress, and the resource stock ( $c_{xb}(x,b;t)<0$ ).

In the case of oil, the latter effect refers to drilling in greater depth which causes higher costs as well as lower well pressure (Lin & Wagner, 2007). This relates to the economically well-accepted notion that “high grade, low cost, mineral deposits are mined first” (Marvasti, 2000). In contrast, technological change is a more complex term. Agreement exists on its potential for exploration costs reduction due to a higher success probability of drilling activities and a more accurate quantification of the targeted oil field. Since there are difficulties to specify technological change, Stoneman (1983) splits the evolutionary process any successful technology faces into the three stages of invention, innovation, and diffusion. First, a prototype model is developed for a new technology which is then commercialized and eventually adopted at large scale within the industry. Existing literature proposes measurement proxies such as R&D spending or patenting activity. Yet both suffer from inaccuracies, e.g. the

problem that innovations are sometimes difficult to attribute to specific petroleum sector R&D spending. Further, the success rate of exploratory activities may vary greatly. Nevertheless, Forbes and Zampelli (2000) found significant proof that over the last decades such endeavors have become more successful on average. Therefore, the application of actual diffusions, i.e. the number of successfully commercialized technological innovations would result in a more accurate number, since it excludes R&D failures (Cuddington & Moss, 2001).

Even though the effects of reserve size and technological progress are well accepted in natural resource economics, they do not yield an entirely realistic picture of unit extraction costs. Thus, recent research questions the standard model in arguing that characteristics of the resource stock may not be neglected as an influential determinant of extraction costs. Marvasti (2000) proposes that specific attention should be paid to geological features of oil reserves, e.g. its composition and depth underneath the earth crust. The validity of this argumentation becomes obvious by comparing the accessibility and, similarly, cost of exploitation of oil reserves in the arctic region around Spitzbergen (i.e., offshore) with the ones on the Saudi Arabian peninsula. Resource quality can be neglected here, since the various lead commodities West Texas Intermediate (WTI), Brent, Dubai, and Maya roughly follow a long-run equilibrium price path, even though they differ in terms of viscosity and sulphur content (Hammoudeh et al., 2008). Reserve characteristics have not played a major role in theory so far, but their cost implications are unquestioned in reality and may reveal increasing competitive advantages, if the easily accessible resource stocks decline further. Consequently, countries such as Saudi Arabia, Iran or Kuwait have the potential to exploit their cost advantages in order to strengthen their market positions in the future (Birol & Davie, 2001). In order to understand OPEC's degree of influence on the oil price, it is crucial to shed light on the key price factors as well.

### **3 Analysis of crude oil price determinants**

Despite a sharp decline recently, the oil price has steadily increased on average over the last 28 years (see Appendix 1). Numerous influencing factors occur on a geological, economic, financial, and political level. In addition, worldwide supply and demand, i.e. the fundamental driving forces, have an enormous impact on the oil price. In general, demand for oil is driven both by population growth and increasing per capita consumption as a consequence of economic growth and increases in welfare foremost among emerging countries. Representative examples from the last decade are China and India which mainly accounted for the temporarily skyrocketing market price in 2008 (Matutinovic, 2009). Even though the last financial crisis slowed down global economic development, it is undoubted that developing countries will continue their quest for closing the welfare gap to the developed world. Hence, oil demand is likely to increase further over the upcoming decades.

In contrast, the supply side is more multifaceted. One needs to distinguish between reserves on the one hand and the capacity to utilize the resource stock, i.e. the processes from extraction to selling the refined products on the market, on the other hand. Despite ample exploitation in

the past, from a geological perspective countries still own vast oil reserves, e.g. in addition to commercial reserves Canada's tar sand comprises a greater net oil potential than Saudi Arabia's stated conventional reserves (DiPeso, 2005). At current extraction rates, worldwide demand can be satisfied for decades, however at rising cost. Announcements of governments about their proven reserve size deserve special caution, since strategic behavior can be used to bias financial market opinions. For instance, understating the true amount today gives a government room for cooling down market price roars by declaring new exploitable reserves at strategically appropriate points in time.

Cost differences in production are reflected in the three stages related to commercial oil supply. First, in the upstream segment the technological level of exploration and production activities is the key price determining factor (Möbert, 2007). Empirical figures show significant differences in the extraction cost per barrel ranging from US\$4 in the Middle East and up to US\$12 in other parts of the world (Birol & Davie, 2001). Second, the midstream segment is dominated by the availability of Very Large Crude Oil Carriers (VLCC). In the last years, new tonnage capacity could not keep pace with the sharp increase in worldwide demand for oil leading to strong price increases of shipping rates. Third, downstream activities such as cracking heavy oil into gasoline, heating oil, or other intermediate products depend on available refineries. Möbert (2007) concludes that there was a shortage in refining capacity in 2004 partially being responsible for an increase in the price of WTI oil in the following years.

As a consequence of global access to state-of-the-art information technology, spot and future markets make actors' behavior immediately visible and therefore the role of financial markets for the oil industry has increased dramatically over the past decade. On the one side trading on spot markets solves short-term supply and demand disequilibria, while on the other hand the exchange of specific certificates, e.g. forward contracts with a predefined volume, date, and price, reduces the risk exposure of up- and downstream producers in the future. Despite its growing influence on short-term changes of the oil price, financial activities cannot explain market price trends alone. Kauffmann and Ullman (2009) explain the oil price bubble in 2008 as a consequence of an imbalance of fundamental values, namely an excess demand from China and India and constraints in supply capacities in oil exporting countries. The supply shortage already visible on the futures market was eventually translated into the spot market and led to rising prices. Since traders recognized liquid energy certificates as investment alternatives, the price race was further accelerated. In general, they note that speculative elements underlying price trends first become visible on the futures market, since future contracts do not require a serious interest of taking actual delivery (Kauffmann and Ullman 2009).

Though widely neglected, the exposure of the crude oil price to the US dollar exchange rate volatility is another major price determinant. Being the global invoicing currency, the comparative strength of the US dollar has a major impact on demand and, thus, on price developments. Empirically, a cointegrating relationship between the crude oil price and the Euro-US dollar exchange rate was empirically found (Zhang et al., 2008). As a consequence, changes in the monetary policy of the Federal Reserve System as well as the European

Central Bank have an indirect influence on the oil price. The magnitude of exchange rate volatility exposure for an individual country depends, first, on its demand for foreign oil supplies and, second, on its heterogeneity of international trade activities. In total, spillover effects from the dollar exchange rate are limited, even though financial investors may capitalize on the linkage between the two markets in the short-term (Zhang et al., 2008).

A less tangible concept is uncertainty about the future. As it is the case for all tradable commodities, a higher risk demands a premium on the price. In the case of crude oil, there are various indicators which serve as proxies for a future outlook. First, the higher the ratio of investment spending of oil companies on maintenance and expansion of production in comparison to exploration activities, the more secure is short-term supply. This certainly yields a simplified picture, yet it may serve as a broad trend. Further, the declaration of new proven reserves is to increase supply security among market participants and, hence, calms down any upward price race. Nevertheless, since the greatest reserves are in few hands of mostly autocratically governed countries, oil reserves may be misused as an instrument in a highly political game of international power (see Appendix 2). Consequently, trusting solely the amount of proven reserves is not sufficient for an assessment of supply uncertainty. To give a final example, experts can only vaguely predict economic growth. As the recent financial crisis shows, unforeseeable events distort stable long-term development paths and have a significant impact on the spot market price. In the light of shrinking basic natural resource stocks such as fertile land and freshwater economists have no doubt that soon violent conflicts will occur between population groups who do not fight for cheap energy, but for survival. Even though most western civilizations are unable to grasp or are ignorant to accept (or both), the limits to growth are becoming more and more visible in the developing regions in the world and will inevitably lead to conflicts influencing markets worldwide.

Another important price determinant is the political environment of oil, which is currently undergoing a dramatic transition. In the 80s and 90s, supply could easily satisfy demand and prices were relatively stable. Oil exporting countries provided fairly stable extraction rates and the amount of proven reserves increased constantly. The turn of the century made the new era of the global political economy visible, as there are two major trends, which have the potential to dominate the oil price in the future and being discussed on the political agenda of oil importing nations. One concept is resource pragmatism which refers to the strategy of oil exporting countries to satisfy their domestic demand first before considering third parties. Even though the transformation of mineral wealth into financial wealth at an earlier point in time may promise significant profits, governments are wise enough not to trade short-term financial gain against future physical supply to inland firms and households with oil and intermediary products (Matutinovic, 2009). The other concept is resource nationalism which emphasizes the fact that most oil reserves are in the hands of national oil companies. This linkage often translates political objectives into the country's resource strategy. As could be witnessed in Winter 2007-08, Russia exploited its European market power over natural gas to charge extraordinary transmission fees to Ukraine in order to demonstrate its leading political role in Europe. The risk prevails that other oil exporting countries, especially under autocratic governments such as Iran or Saudi Arabia, enter a similar path of striving for regional

predominance. A closer look at the current distribution of proven oil reserves confirms this statement (see Appendix 2).

The development of substitutes for oil products is a further price determining factor, however it can cause ambivalent effects. If alternative sources for energy and fuel production continue to grow, the dependence on oil declines. This intuitively relaxes the market price, which, in turn, bears incentives to increase oil demand at the same time. Ample evidence can be seen in the heavy investments of Europe, the US, China, and Japan into energy generation from renewable resources including solar, wind, and geothermal power. In terms of fuel and gasoline, agricultural land is transformed into sugar cane plantations in Brazil, whereas Malaysia and Indonesia evolve to become the major palm oil producers in the world. These countries clearly accepted the tradeoff between preserving valuable natural resources, here primary rain forests including an unmatched level of biodiversity, and short-term economic incentives.

In addition to all other factors, OPEC serves as another influencing variable on the oil price. Its two goals of sufficient supply and stable prices are to be achieved by a quota system which allows each member an annual production in relation to its proven reserves. Regulating the individual quotas can impact the world market price. Successful applications of the system could be seen during the oil price shocks in the 1970s. Interestingly, OPEC appeared unable to prevent the 2008 price race, even though it increased its production quotas to the highest levels in history.

## **4 Discussion and conclusion**

Summarizing, empirical data shows that there are two major factors which drive the oil price in the long-run: first, global demand, which increases due to constant population growth and increasing per capita consumption primarily in emerging countries; second, future supply, which is highly uncertain to remain stable, since oil exporting countries manage their oil reserves more and more independently from the needs of third parties.

Now, the following three fundamental arguments will make clear why the world market price of oil can never fall below the extraction cost of the marginal oil producer. First, oil is traded on an imperfectly competitive market. The number of oil providers is limited and OPEC's cartel-like structure represents a large share of the oil market. Second, a rational investor claims a resource rent which exceeds the comparable interest rate as a premium for risky exploitation of oil. If a natural resource is not able to yield this excess return, the investor would transfer the funds to a less risky business opportunity. Hotelling's rule still holds, although its narrow argumentation is expanded by various other influencing factors outlined in Chapter 2. Third, oil is a nonrenewable resource with a backstop technology, i.e. at a certain price other technologies become economical, although profits have not turned negative. This can already be seen in the development of renewable energies such as wind, solar, and geothermal power, and the increasing usage of biofuels.

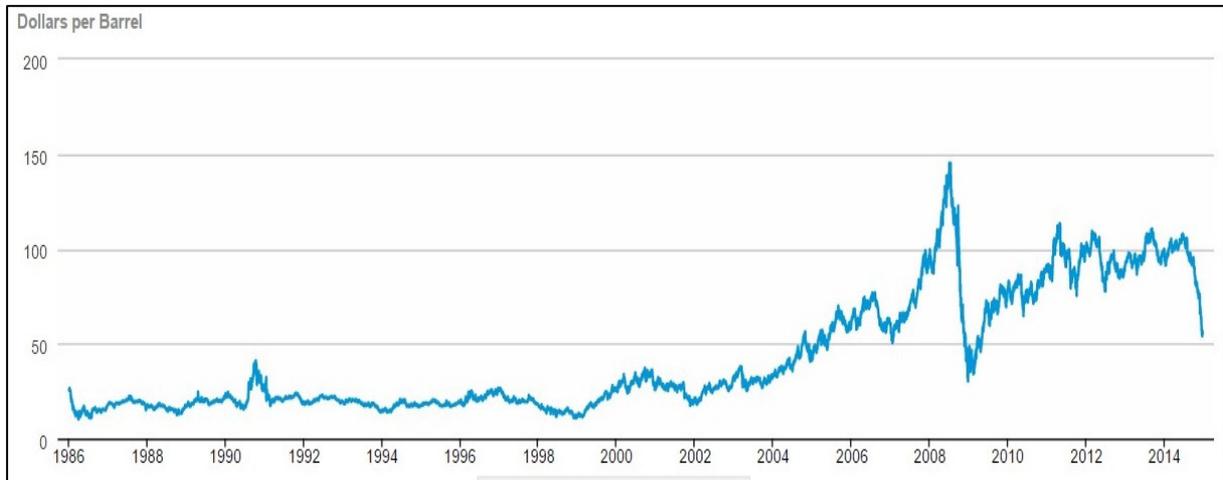
In total, OPEC's market power contributes only marginally to the gap between the oil price and the extraction cost. On the one hand, the costs per barrel of oil are fairly independent of OPEC, since they are driven by technological progress and characteristics of the resource stock. On the other hand, the oil price may be indirectly influenced by OPEC, since its existence leads to an imperfectly competitive market. Even in the absence of the group, other drivers might rather serve as a guarantee for persistent profits for the marginal oil producer. A far more dominant impact on the oil price originates from resource pragmatism and nationalism which cause severe uncertainty of supply. It is unquestioned that sovereign nations who possess the largest oil reserves will strategically exploit them, since there is no rationale for them to respond to the needs of oil importing countries and establish a low price level per se. Thus, OPEC can be simply characterized as a group of countries serving as a vehicle or lever to augment the interests of its member states. However, the individual market power of countries such as Saudi Arabia might likely lead to a breakdown of the cartel-like structure and end up in independent activities. There is ample proof that member states already deviate from the agreed production quotas (Dibooglu & AlGudhea, 2007) which signals the growing instability of the group. Concluding, OPEC is a dominant player on the world's oil market, but fails to be the guarantee for extraction costs of the marginal oil producer to stay below the crude oil price for reasons more sensitive and central than its present market power.

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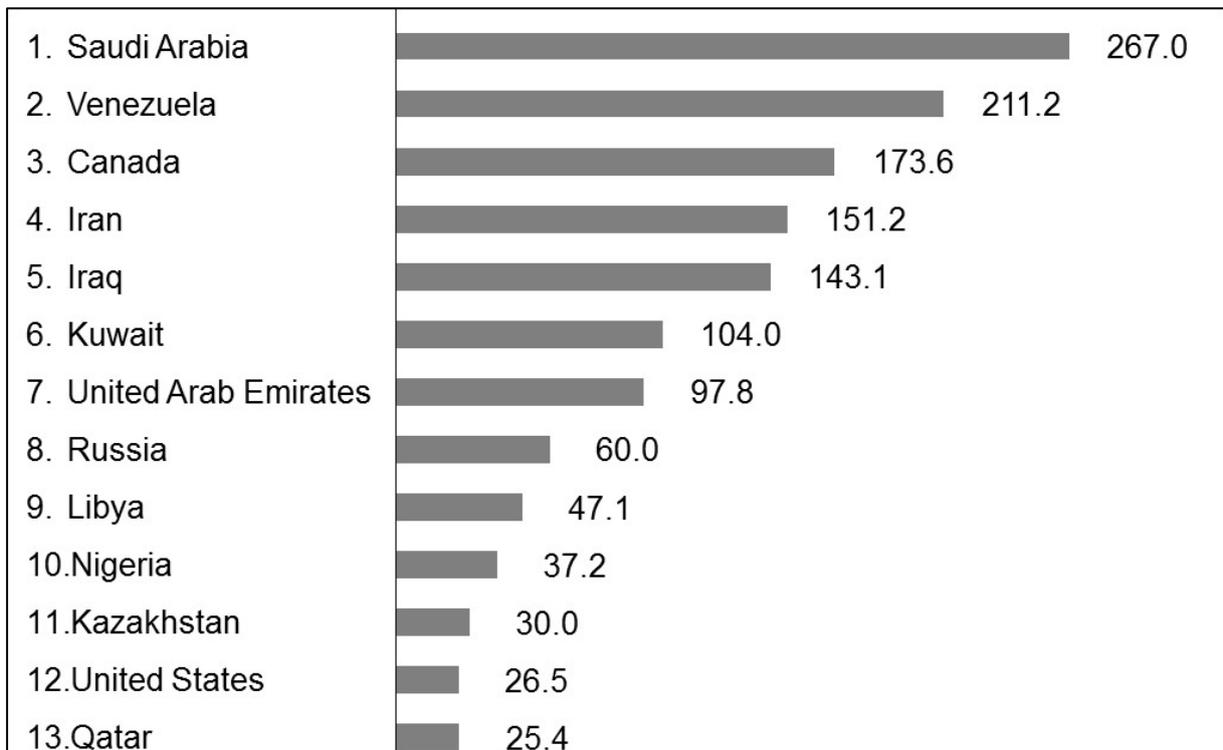
## Appendix

### Appendix 1: Monthly average values for the West Texas Intermediate crude oil spot prices, in USD/barrel



Source: <http://www.eia.doe.gov> (Dec 27, 2014)

### Appendix 2: Countries with proven oil reserves of more than 25 billion of barrels in 2012



Source: Own graphic, based on <http://www.eia.gov> (Dec 27, 2014)

## About the author

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