Brent at $50 per barrel-

A new price ceiling or an old price floor?

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Abstract

The following paper complements the current discussion about the intermediate to long-term crude oil price outlook. To accomplish this, the paper conducts a qualitative and quantitative analysis of a time series of real, inflation-adjusted Brent crude prices in the context of OPEC's history of production and supply management. The paper identifies $50 per barrel (in 2014 dollars) as the key demarcation level between monopolistic and competitive pricing in a historical analysis and confirms the statistical significance of the differences in mean prices between monopolistic and competitive environments. As this key level of $50 per barrel has historically served either as a price floor or as a price ceiling, depending on the market's competitive dynamics, the paper also attempts to assess whether this level will be a price floor or a price ceiling in the intermediate to long-term future. Considering the nature of OPEC's supply management and examining the causes and origins of the current slump in crude oil prices, the paper therefore develops two potential scenarios for the future crude oil price environment and discusses their validity and respective likelihoods.

1. Introduction

In the nine months between July 2014 and March 2015, both Brent and WTI crude oil prices have dropped by more than 50%, falling from levels of over $100 per barrel to a 2015 trading range between $30 and $60 dollars per barrel. Such declines in price are rare in the modern history of oil prices, with oil prices having fallen in a comparable manner only once before, during the global financial crisis of 2008. In the time period between July and December 2008, Brent crude prices fell from $145 to $32 per barrel in a matter of 5 short months before quickly rebounding to previous levels of over $60 per barrel by mid-2009. As with any volatile price move in asset markets, the recent crude oil price activity has set off a far-ranging discussion about the future price levels in global oil markets, with some commentators expecting a near-term recovery of prices to previous levels and with others seeing oil prices as low as $10 per barrel in the near to intermediate term.

Most of the arguments regarding higher or lower oil prices revolve around different views of the global supply and demand balance in crude oil markets; more specifically, the discussions currently tend to focus on the levels of OPEC and North American crude oil production, the unsustainability of U.S. and non-Middle Eastern OPEC production below certain price levels, global economic activity as a demand driver, and geopolitical events as both supply and demand factors. More importantly, when considering historic crude oil price levels in order to draw conclusions about future price environments, the arguments tend to focus on nominal price levels, ignoring the history of real, inflation-adjusted Brent prices. Even the few analyses of the history of real, inflation-adjusted Brent prices remain entirely in the qualitative realm and lack any kind of statistical rigor (cf. Kaletsky 2014). Any argument for or against higher or lower oil prices in the intermediate to long-term future, however, remains incomplete without a serious qualitative and quantitative examination of historic real crude oil prices in the context of the history of the OPEC cartel. A qualitative and quantitative analysis of a time series of inflation-adjusted Brent crude prices, deflated by the U.S. Consumer Price Index, offers some key insights into different price environments under different forms of OPEC pricing behavior.

Such an analysis reveals $50 per barrel (inflation-adjusted 2014 dollars) as a key price level in the Brent crude market since the creation of OPEC in September 1960, a level which has historically served either as a price

floor or as a price ceiling for extended periods of time, depending on the market's competitive dynamics. In times of OPEC monopolistic or oligopolistic domination, Brent crude prices have traded between $50 and $120 per barrel in real terms with $50 per barrel serving as a price floor. In periods of low OPEC pricing power and a competitive pricing environment, Brent crude prices have traded between $10 and $50 per barrel in real terms with $50 per barrel serving as a price ceiling. Hence, the demarcation line between the monopolistic and competitive regimes lies around $50 per barrel in 2014 dollars. This key level stands out as a reasonable estimate of where one boundary of the future intermediate to long-term trading range could fall.

After the price activity in H2 2014 and Q1 2015, Brent crude is back at this key historical level of $50 in real 2014 dollars. The central question now is whether $50 per barrel will be a price floor or a price ceiling in the years ahead, i.e. whether the Brent crude market will be subject to a monopolistic or a competitive pricing environment in the future. It is unlikely that the price of Brent crude will move meaningfully above $50 per barrel at least in the intermediate term as it seems reasonable to suppose that OPEC has no incentives to return to the monopolistic pricing environment any time soon. However, in the long term, $50 per barrel may represent either a price floor or a price ceiling, with the latter scenario currently appearing more likely and with even the former scenario requiring prices to remain at or below the current levels for an extended period of time.

In the remainder of this paper, we will lay out the reasoning behind these conclusions. The next section will provide some context for our findings by examining the role of the Brent crude oil market in OPEC's history. The following section will then discuss the data and our statistical analysis within this context. The fourth section of the paper will explain possible future scenarios for the price of Brent crude and assess the respective likelihoods of the crude oil market adopting competitive or monopolistic pricing. The fifth and last section will conclude the discussion and outline areas for potential further research.

2. History of OPEC & Oil Prices

The Organization of Petroleum Exporting Countries (OPEC) was founded in Baghdad, Iraq in September 1960 by Iraq, Kuwait, Iran, Saudi Arabia and Venezuela in order to unify and coordinate the nations' petroleum

policies. Between 1960 and 1975, the organization expanded quickly to include Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), and Nigeria (1971). Ecuador was an early member of OPEC (joined 1973), but withdrew in 1992 before rejoining in 2007, Indonesia withdrew as a member in 2009, and Angola joined OPEC in January 2007, bringing total current membership in the organization to twelve nations. According to the organization's mission statement and statute, OPEC's objectives are to "coordinate and unify the petroleum policies" of its members and to "ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry"[2,3]. OPEC functions by setting production quotas for its member nations to control crude oil production and global supply, thus affecting global Brent crude prices. When OPEC production targets are reduced, oil prices generally rise; when OPEC production quotas are increased, oil prices generally tend to fall[4].

Absent any credible enforcement mechanism or other deterrent, OPEC, like any cartel, is inherently unstable as each member has incentives to exceed its assigned quota in order to sell a larger quantity of oil at temporarily higher prices. Without a cartel leader that accommodates over-suppliers by cutting its own production of crude oil, these incentives would constantly lead to an oversupply of crude oil, putting downward pressure on prices and thus defeating the intended purpose and objectives of the cartel. In the past, Saudi Arabia has most often served as the swing producer, i.e. the cartel leader, and has cut its own production in order to preserve prices and maintain OPEC's credibility on international markets. According to the EIA [Energy Information Agency], an analysis of OPEC's and Saudi Arabia's history of production and supply management reveals that the behavior of Saudi Arabia determines critically whether the global Brent market finds itself in a monopolistic or a competitive pricing environment.[5] If the cartel leader accommodates cheaters by cutting production, the cartel remains credible, OPEC maintains its market power, and Brent crude prices remain high; if the cartel leader refuses to accommodate

[2] Organization of the Petroleum Exporting Countries. "Our Mission."
[3] Organization of the Petroleum Exporting Countries. "Statute."
[4] Energy Information Agency. "WHAT DRIVES CRUDE OIL PRICES?"
[5] Energy Information Agency. "WHAT DRIVES CRUDE OIL PRICES?"

cheaters, OPEC's pricing power deteriorates, and the market enters a phase of competitive pricing and prices are significantly lower.

This phenomenon can be clearly observed as the past 55 years since the creation of OPEC can be divided into three distinct time periods with respect to OPEC's behavior and inflation-adjusted Brent prices, which will be discussed in the following three paragraphs:

Period	Time	Pricing Regime	Number of Months	Trading Range (Dec 2014 U.S. dollars per barrel)
1	1974 - 1985	OPEC monopoly	144	$50 - $105
2	1986 - 2004	Competitive pricing	228	$15 - $50
3	2005 - 2014	OPEC monopoly	120	$50 - $140

Exhibit 1. Trading ranges of real Brent crude prices under different pricing regimes

(Dec 2014 U.S. dollars)

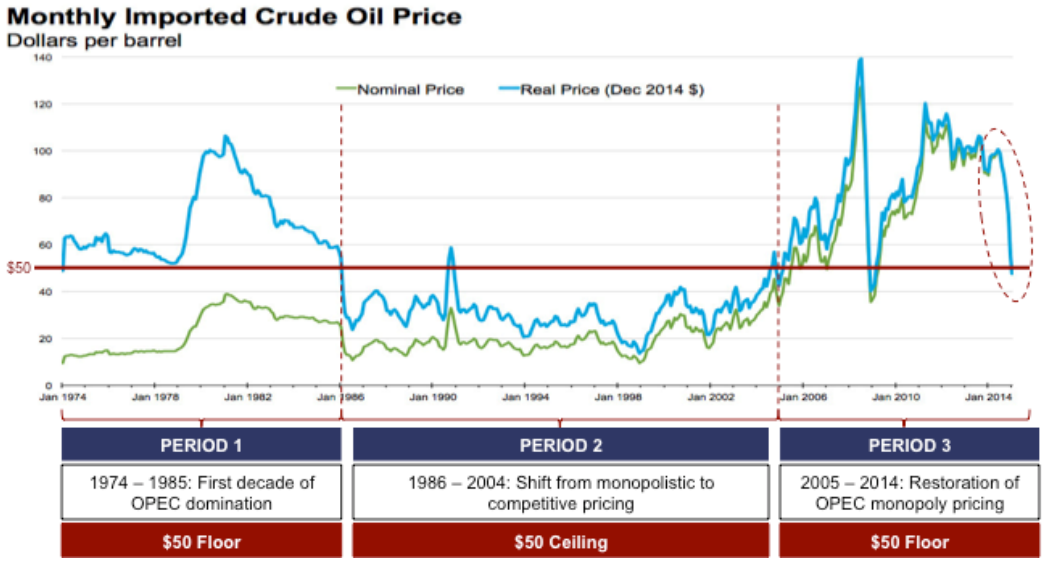

Exhibit 2. Inflation-adjusted crude oil prices since 1974 (Data Source: EIA)

This division illuminates the correlation between the level of OPEC market domination and the trading range for Brent crude oil. At first, between the creation of OPEC in 1960 and October 1973, the global oil market experienced stable annual growth of OPEC and non-OPEC production in line with quickly increasing global demand (Exhibit 3). The situation abruptly changed in October 1973 when the West's support of Israel in the Yom Kippur War provoked OPEC into imposing an oil embargo. As a result of the embargo, global Brent crude prices quadrupled between October 1973 and March 1974. While the embargo lasted for less than a year, it caused OPEC nations to recognize that their oil production could be used as an economic and geopolitical tool In 1974, OPEC began to significantly control crude oil output for the first time, causing the Brent crude oil market to enter a decade of OPEC domination and monopolistic pricing which lasted until 1985 (Period 1). Between 1974 and 1981, OPEC managed to control crude oil output and kept production stable while global oil demand continued to rise steadily, sending prices to over $100 per barrel in real terms despite increasing non-OPEC production. With global oil demand slowing in the early 1980s, OPEC began to significantly reduce crude production in order to control prices, but the price of Brent crude nevertheless embarked on a four-year decline between 1981 and 1985, eventually leading to the breakdown of OPEC supply management and monopoly power in 1985 (Exhibit 3). Nevertheless, during this first decade of OPEC market domination, Brent prices never fell below $50 per barrel in 2014 dollars and traded as high as $105 per barrel (Exhibit 2).

After the breakdown of OPEC monopoly power in 1985, global oil demand as well as OPEC production began to recover and the market entered a 20-year period of competitive pricing, during which both OPEC and non-OPEC supply grew in accordance with global demand (Exhibit 3). From 1986 until 2005 (Period 2), Brent crude oil traded between a floor of $15 per barrel and a ceiling of $50 per barrel, only briefly shooting above $50 per barrel in 1991, during the First Gulf War (Exhibit 2).

The third period in the history of crude oil prices since the formation of OPEC began in 2005 when OPEC again began to aggressively manage supply in order to profit from surging Chinese demand. This period lasted until mid-2014 when the cartel once more decided to abandon supply management, triggering the recent slump in Brent prices (Period 3). During this second decade of OPEC monopoly power, crude prices again traded in their 1974-1985 range and, with the exception of late 2008, fell between a floor of $50 per barrel and a ceiling of $140 per barrel in inflation-adjusted 2014 dollars (Exhibit 2).

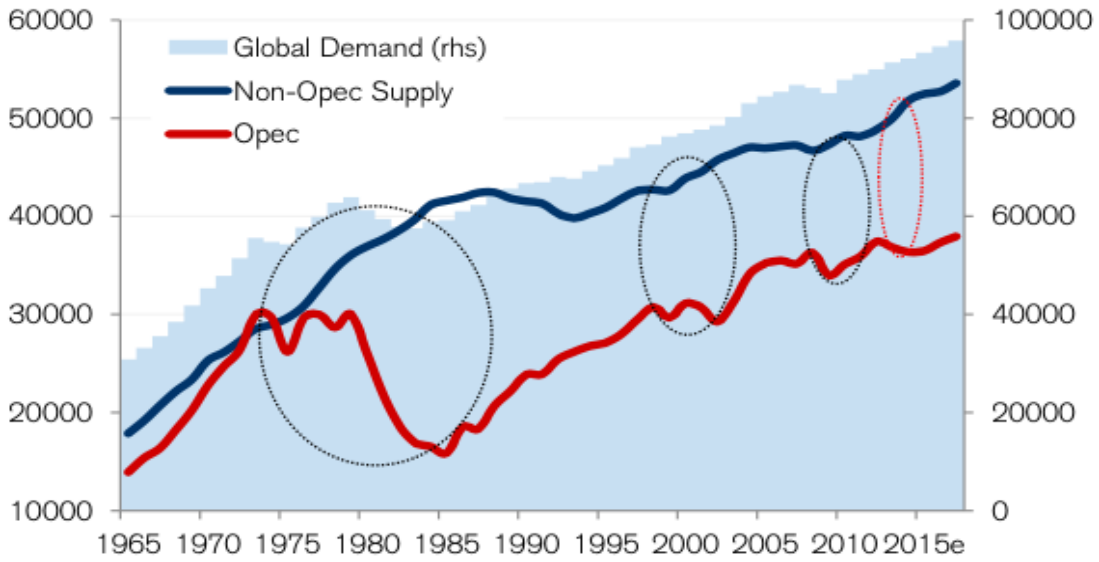

Exhibit 3. Global oil production vs. demand in thousand barrels per day (Source: Credit Suisse)

This historical view of inflation-adjusted Brent crude prices, considered in the context of OPEC's history of production and supply management, offers compelling evidence that the level of $50 per barrel (Dec 2014 dollars) has tended to serve either as a price floor or as a price ceiling in Brent crude markets, depending on the market's competitive dynamics. Thus, as we have seen above, times of OPEC monopolistic domination are characterized by a Brent crude trading range between $50 and $120 per barrel with $50 per barrel serving as a price floor; periods of low OPEC pricing power and a competitive pricing environment, on the other hand, are characterized by a Brent crude trading range between $10 and $50 per barrel with $50 per barrel serving as a price ceiling. Consequently, this analysis, which identifies $50 per barrel (2014 dollars) as the demarcation line between monopolistic and competitive pricing regimes, has clear implications for the possible trading range of Brent crude

under different levels of OPEC market domination because the question of interest in the analysis of future price levels in crude oil markets is now whether the Brent crude market will enter a renewed period of competitive pricing ($50 per barrel as "a new price ceiling") or whether the market will return to OPEC domination and monopolistic pricing in the intermediate term ($50 per barrel as "an old price floor"). This will be discussed in Section 4 below.

3. Statistical Analysis

The above conclusions, thus far based on the qualitative assessment of historical facts and on the visual examination of the time series plot above, are further supported by a statistical analysis of the time series of inflation-adjusted Brent crude prices displayed in Exhibit 2. The data for the following analyses consists of real monthly Brent crude oil prices in December 2014 U.S. dollars between January 1974 and December 2014, obtained from the EIA[6]. The prices of energy commodities, such as crude oil, can be reasonably assumed to follow mean reverting processes. As the price of an energy source increases, production usually ramps up and consumption decreases, leading to renewed downward pressure on prices; as the price of an energy source decreases, consumption increases and production falls, leading to renewed upward pressure on prices. As a result, a comparison of mean Brent crude prices for the different time periods identified above should show whether or not there are statistically significant differences in mean prices under different competitive dynamics in the global crude oil market. We begin by calculating the means and standard deviations of real monthly Brent crude oil prices (2014 U.S. dollars) for the different time periods discussed above and obtain the following results:

[6] Energy Information Agency. "Short-Term Energy Outlook." Energy Information Agency. 29 Mar. 2015 <http://www.eia.gov/forecasts/steo/realprices/>.

Period	Time	Pricing Regime	Mean Price of Brent Crude	Number of Months	Standard Error of Mean
Overall	1974 - 2014	Mixed	55.08346	492	1.223712
1	1974 - 1985	OPEC monopoly	68.45344	144	1.271082
2	1986 - 2004	Competitive	30.96704	228	.4913622
3	2005 - 2014	OPEC monopoly	84.86069	120	1.894152

Exhibit 4. Means and standard deviations of real Brent prices (Dec 2014 U.S. dollars)

Assuming that prices are distributed normally, that the variances of prices are homogenous for all periods, and that prices are sampled independently over time, we further conduct difference in means tests to assess the statistical significance of the differences in mean prices between the different periods, which we have observed in the table above (Exhibit 3). t statistics and p values for the difference in means tests between the different periods are in the table below:

Differences-in-means tests between	Overall	Period 1	Period 2	Period 3
Overall	---	*-7.4033* *(0.0000)*	*32.5035* *(0.0000)*	*-17.6631* *(0.0000)*
Period 1	*tstat* *(p value)*	---	*31.6653* *(0.0000)*	*-7.3913* *(0.0000)*
Period 2	*t stat* *(p value)*	*t stat* *(p value)*	---	*-35.2106* *(0.0000)*
Period 3	*t stat* *(p value)*	*t stat* *(p value)*	*t stat* *(p-value)*	---

Exhibit 5. Differences-in-means test results

We first note the high statistical significance of the differences in means across the board, suggesting that the different pricing regimes (monopolistic vs. competitive) in fact produce significantly different pricing environments in global crude oil markets. Additionally, the first row of Exhibit 4 is informative as it shows a statistically significant deviation of the means of each of the three identified periods from the mean price across the entire time period between 1974 and 2014. While the overall mean price falls around $55 per barrel, close to the $50 per barrel level identified previously as the demarcation line between monopolistic and competitive pricing regimes, the mean price in period 2, the competitive pricing environment, was significantly lower, at $31 per barrel, while the mean prices in periods 1 and 3, the periods of OPEC domination, were significantly higher, at $68 and $85 per barrel respectively. The statistical significance of the difference in means during period 2 provides evidence for the conclusion that the mean price under the competitive pricing regime was lower than the mean prices in the periods of high OPEC monopoly power. Lastly, it is also notable that the mean prices in periods 1 and 3, the two periods of monopolistic OPEC pricing regimes, were significantly different from each other as shown by the results in Exhibit 4 above, which runs counter to our previous intuition.

4. Future Scenarios

Having identified $50 per barrel as the key demarcation level between monopolistic and competitive pricing in our historical analysis in section 2 and having further confirmed the statistical significance of the different pricing environments in the preceding section, our central question now is whether $50 per barrel will serve as a price floor or a price ceiling in the years ahead. A multitude of factors currently point to the latter scenario, making a future trading range of less than $50 per barrel appear more and more likely. However, as discussed briefly in section 2, the answer to this question depends critically on the behavior of the cartel leader, i.e. Saudi Arabia, and on the Brent crude market's resulting competitive dynamics.

In order to understand the respective likelihoods of different price ranges in the future of Brent crude, one first has to examine the causes and origin of the 2014-2015 decline in oil prices. Unlike the 2008-2009 slump,

the 2014-2015 crude oil price activity has not been demand-driven, but has resulted from structural shifts on the supply side of the crude oil market. First and foremost, Saudi Arabia and its closest OPEC partners, Kuwait, Qatar, and the UAE, have abandoned OPEC's supply management in order to achieve several economic and geopolitical goals. One such goal is to maintain and expand market share amid increasing global competition, a goal which they are attempting to accomplish by forcing out higher-cost North American shale and tar sand producers and by forcing financially weaker OPEC members to cut output and cede market share in order to restore prices. Other objectives include preventing or breaking a potential Moscow-Teheran axis, containing Russia and regional rival Iran, and punishing Putin for his support of the Syrian Assad regime. The second significant structural shift on the supply side of the crude oil market has occurred on the North American continent as U.S. and Canadian crude production has increased significantly in recent years due to a shale boom and the exploration of Canadian tar sands. These developments have led to significantly lower U.S. crude oil imports and have left spare global supply compared to previous years, contributing to the global supply glut. Third and lastly, current crude oil supply and demand imbalances are further exacerbated by higher-than-expected stable oil production in crisis-ridden Iraq and Libya.

After a careful consideration of the causes and origin of the recent decline in oil prices, two different scenarios emerge as likely in the intermediate future. In the first scenario, Saudi Arabia returns as the global swing producer and restores OPEC's monopoly pricing after it has accomplished the economic and geopolitical objectives that led the country and its partners to trigger the slump. In the second scenario, Saudi Arabia continues to refuse acting as the global swing producer and once again allows a breakdown of OPEC monopoly power, leading to a renewed transition of the market to competitive pricing.

Regardless of whichever scenario eventually transpires, it appears unlikely that the price of Brent crude will move meaningfully above $50 per barrel in the intermediate term. Even if the first scenario were to occur in the long term and Saudi Arabia were to return as the cartel leader and restore OPEC's monopoly pricing power and supply management at some point in the future, this process would take a significant amount of time to unfold and would not necessarily result in a near to intermediate-term correction of Brent prices. It is unlikely that a few months of falling oil prices give Saudi Arabia enough time to achieve its economic and geopolitical goals, and,

given that crude prices have been at inflated levels for more than half a decade, it is evident that oil prices will have to remain at or below current levels for a prolonged period of time in order to break Moscow and Teheran and to reverse the North American and Canadian shale and tar sand boom.

Nevertheless, a multitude of factors are currently pointing to an eventual occurrence of the second scenario, making a future trading range of less than $50 per barrel appear as more and more likely. First, Saudi Arabia does not have particularly strong incentives to pursue the occurrence of the first scenario as its past production cutbacks as the cartel leader and global swing producer have led to market share losses caused by the inherent instability and unenforceability of cartel agreements. Second, the nature of the U.S. shale boom itself is one of the strongest economic arguments for an eventual return to competitive pricing instead of the OPEC-dominated monopoly pricing. While U.S. shale and Canadian tar sand production is certainly costly, these production technologies can be switched on and off much more easily and cheaply than conventional Middle-Eastern production. For this technological reason, it makes sense to suppose that shale producers, rather than Saudi Arabia, should become the new global swing producers, conveniently decreasing production when demand is weak and increasing supply when demand is strong. In a truly competitive market, Saudi Arabia and other low-cost Middle-Eastern OPEC producers would at all times produce at maximum output, while market entry of higher marginal cost producers, such as U.S. shale and Canadian tar sand producers, would only occur when prices increased due to increasing demand. In this market structure, prices are set by marginal production costs and competitive logic suggests that the marginal production costs of the highest-cost market entrant, e.g. of U.S. shale producers with a breakeven cost of approximately $50 per barrel, should in the future represent a ceiling for global crude prices. Third, structural shifts on the demand side of the crude oil market are also contributing to the prospects of lower crude oil prices in the future, with the International Energy Agency regularly revising future demand outlooks downward. For example, China, one of the world's largest consumers of crude oil in the recent past, is embarking on a transformation of its economy and is attempting to "deindustrialize," with its envisioned consumption-driven and service-based economic model requiring significantly less fossil fuel than its former manufacturing-based and export-driven economic model. Additionally, global economic growth has been sluggish and economic activity is projected to remain subdued in the Eurozone, China, and Japan. Furthermore, increased

fossil fuel efficiency along with technological and environmental pressures are meaningfully reducing longer term oil demand, representing developments that have the potential to turn high-cost oil into a "stranded asset" along with the earth's vast unwanted coal reserves. Fourth and lastly, several countries, including Saudi Arabia, China, and the U.S. have been building up crude oil inventories and stocks to record levels, which has the potential to put further downward pressure on global crude prices in two main ways. The first is that it allows oil producers such as the U.S. and Saudi Arabia to increase or maintain production covertly. Once inventories stop being built up, however, oil demand should decrease, putting pressure on prices. The second possibility is that these countries could release some of their stocks to the market as an economic or geopolitical pressure tool, which, given the on-going and developing situations in the Middle East, in Russia's near abroad, and in the South and East China Sea, are not entirely unreasonable scenarios. This would also put downward pressure on prices.

5. Conclusion & Outlook

In conclusion, $50 per barrel has been identified as the key demarcation level between monopolistic and competitive pricing in Brent crude oil markets through the qualitative and quantitative analysis of real, inflation-adjusted Brent crude prices in the context of OPEC's history of production and supply management. The statistical significance of the differences in mean prices between monopolistic and competitive pricing environments has been confirmed. The paper has shown that this level of $50 has historically served either as a price floor or as a price ceiling, depending on the market's competitive dynamics. Thus, as we have shown above, periods of OPEC monopolistic domination are characterized by a Brent crude trading range between $50 and $120 per barrel with $50 per barrel serving as a price floor. Periods of low OPEC pricing power and a competitive pricing environment, on the other hand, are characterized by a Brent crude trading range between $10 and $50 per barrel with $50 per barrel serving as a price ceiling.

As this key level of $50 per barrel has historically served either as a price floor or as a price ceiling, depending on the market's competitive dynamics, the paper also assessed whether this level will be a price floor or a price ceiling in the intermediate to long-term future. By examining the causes and origins of the current slump

in crude oil prices and considering the structure and dynamics of OPEC, we found that two different potential scenarios for the long-term future of crude oil prices appear possible. In scenario 1, Saudi Arabia returns as the cartel leader and restores OPEC's monopoly pricing after accomplishing its economic and geopolitical objectives, leading to a long term trading range of $50 per barrel and above. In scenario 2, Saudi Arabia continues to refuse acting as the cartel leader and once again allows a breakdown of OPEC monopoly power, leading to a renewed transition of the market to competitive pricing and a trading range of below $50 per barrel. While $50 per barrel may, in the long-term, represent either a price floor or a price ceiling for Brent prices, with the latter scenario currently appearing more likely due to Saudi Arabia's economic incentives, the nature of the U.S. shale boom, and other global demand and supply realities in crude markets, it is unlikely that Brent prices will move meaningfully above $50 per barrel in the intermediate term as even the former scenario requires prices to stay at or below current levels for an extended period of time.

Further potential research into this subject matter should include a more rigorous statistical and econometric discussion of the time series of real, inflation-adjusted Brent crude oil prices. For example, it would be important to discuss and evaluate the assumptions underlying the differences-in-means test and to verify that real Brent crude prices are distributed normally, that the variances of prices are homogeneous for all periods, and that prices are sampled independently over time. Violations of any of these assumptions may then require a reevaluation and adjustment of the results presented here.

Works Cited

http://www.economist.com/blogs/economist-explains/2014/12/economist-explains-4

http://www.economist.com/news/leaders/21635472-economics-oil-have-changed-some-businesses-will-go-bust-market-will-be

http://www.economist.com/news/finance-and-economics/21596986-higher-production-elsewhere-undermining-cartel-leaky-barrels

Organization of the Petroleum Exporting Countries. "Our Mission." OPEC. 29 Mar. 2015 <http://www.opec.org/opec_web/en/about_us/23.htm>.

Organization of the Petroleum Exporting Countries. "Statute." 2012. OPEC. 29 Mar. 2015 <http://www.opec.org/opec_web/static_files_project/media/downloads/publications/OPEC_Statute.pdf>.

Energy Information Agency. "WHAT DRIVES CRUDE OIL PRICES?" Energy Information Agency. 29 Mar. 2015 <http://www.eia.gov/finance/markets/supply-opec.cfm>.

Shilling, Gary. "Get Ready for $10 Oil." 2015. Bloomberg. 26 Feb. 2015 <http://www.bloombergview.com/articles/2015-02-16/oil-prices-likely-to-fall-as-supplies-rise-demand-falls>.

Kaletsky, Anatole. "The reason oil could drop as low as $20 per barrel." 2014. Reuters. 26 Feb. 2015 < http://blogs.reuters.com/anatole-kaletsky/2014/12/19/the-reason-oil-could-drop-as-low-as-20-per-barrel/>.