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OPEC in the Epoch of Globalization: An Event Study of Global Oil Prices

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Cyrus Bina and Minh Vo

Abstract

This article confirms that OPEC is neither a cartel nor exhibits any sign of market domination, market control, or monopoly. This confirmation is also in accord with the pioneering account of the competitive differential oil rents formed across the global industry since the crises of the 1970s. The methodology utilized in this study is known as the event-study, an innovative econometric method which attempts to investigate the possible influence of OPEC decisions on output upon the global oil spot and futures prices during the period of 1983-2005. The significance of this investigation is due to the fact that the apparent "lumpiness" of OPEC has to have no bearing on a priori acceptance of "perfect competition" as opposed to "imperfect competition"—a tautological hallmark of neoclassical theory utilized in the bulk of both orthodox and heterodox literature on oil. And, by implication, neither has the neoclassical parlance of rent, as "market imperfection" and/or "market power," any bearing on the globally competitive differential oil rents earned by the rentier states. OPEC is reflective of the competitive differential oil rents earned by its members; and, contrary to both the right and the left, and their obfuscating echo in the media, it rolls with the heavy-handed punches of global market in the present epoch. This study is rather a posteriori investigation that deals with the reality of competition in the Schumpeterian framework—a reality that, far from the fiction of textbook competition, is neither perfect nor imperfect.

KEYWORDS: cartel, competition, differential oil rent, event study, global oil market, OPEC, rentier state, volatility

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Erratum

Page 8, paragraph 1, line 11, which concludes the sentence as “its queue from the newly structured global market”, should read “its cue from the newly structured global oil market.”

Page 29, paragraph 1, line 11, which concludes the sentence as “(t-statistics is -3.3382 and p-value is 0.0206)”, should read “(t-statistic is -3.3382 and p-value is 0.0206).”

INTRODUCTION

This article is intended to shed some light on the meaning of globalization and market determination following the 1970s crises of restructuring in the oil industry. The focus here is upon the Organization of Petroleum Exporting Countries (OPEC)[1] whose characteristic (and action) has been the subject of ad hoc and often contradictory interpretation by the economists, historians, political scientists, and indeed journalists. At the more popular level, though, OPEC has been rendered synonymous with the word "cartel" in the minds of most policy makers and politicians, and been the subject of uncritical, if not sensational, rhetoric of the news media today. In a broader context, the majority of literature on OPEC is indeed reflective of the theoretical impasse and thus the crisis of Kuhnian proportion caused by the romanticized vision of competition associated with the neoclassical paradigm of "market structure," and its tortured application to the reality of capital accumulation and markets in capitalism.

OPEC was formed in response to the declining crude "posted" prices, imposed by the International Petroleum Cartel, in 1960, and rose to prominence when it took to center stage of restructuring and globalization of the industry during the 1973-1974 oil crisis. Since 1973 there has been a substantial public and private interest in the issues related to the purposes, nature, and the dynamics of OPEC both inside and outside the oil industry. There is also a substantial literature on the various aspects of the organization, such as, its pricing decision, capacity utilization, output decision, intra-organizational bargaining, and its pattern of revenue maximization. Specifically, a part of this literature has focused on the collective decisions and the economic impacts of OPEC as a whole. However, there is still no consensus among economists and oil analysts about the nature of the world oil market and the role of OPEC within it. Furthermore, there is hardly any agreement on the particularities of globalization of oil and energy.[2]

The larger literature on the political economy of petroleum can be divided into two distinct paradigms: (1) standard neoclassical economic theory,[3] particularly its idealized notion of competition and monopoly, that has

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[1] The present OPEC members are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.

[2] For critical examination of oil (and energy) as a decartelized global sector see Bina (1985, 1988, 1989a, 1992, 1994, 1997, 2006).

[3] Today, setting up competition and monopoly in their axiomatic and idealized forms in the opposite ends of the "market-structure" spectrum, and attempting to bridge the gap by negation of *real* competition through the method of *successive approximation*, is but the basic tenet of the industrial organization literature.

fundamental influence on the conventional literature on oil, and (2) not so standard political economy approach, motivated by the Classical, Marxian, and Schumpeterian theory of competition, and mutuality of capital accumulation and the ownership of sub-surface deposits in oil.[4] Given the apparent theoretical incompatibility of these two paradigms, there has been a minimal conversation between the two. For instance, the incompatibility of Schumpeterian (also Classical and Marxian) competition with the popular, yet idealized (perfect or pure) competition in the standard neoclassical models is perhaps a major source of disjunction in the broader literature on oil.[5] As the title of this article tends to imply, OPEC's lumpiness and its apparent (political) peculiarity alone might not be a reliable measure for endorsement OPEC's presumed market power. Since the fortitude in the formation of oil prices may reside not in the harmony of atomistic markets but in the quantum leap of disjuncture and turbulence, they have come to periodically wreak havoc in this newly globalized industry from the mid-1970s onward (Bina, 1985, 1988, 1989a, 1990, 1992, 1994, 1997, 2006).

Without belaboring much on the theoretical issues, this article attempts to shed light on the contemporary global oil market by focusing on OPEC as its constituent part. More specifically, we attempt to investigate whether OPEC is either a cartel (i.e., having an ability to affect the global oil prices) or an entity with significant market influence through manipulating its own output.

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[4] To date it would be difficult to find an adequate and judicious review of literature on oil. To our knowledge, Mabro (1998) presents the most recent review. Yet the author's constricted and unsystematic framework leaves hardly any room for recognition and thus references to literature on differential oil rents, beyond his own narrow and habitual understanding. Mabro writes: "Our purposes, however, are much wider: to inform readers about the publications that are *worthy of attention*, to assess their major contribution and to present in conclusion a brief *personal interpretation* of the nature and role of OPEC (p. 4, emphasis added). Another reviewer, an economist with steep neoclassical economic conviction and flat out ignorant of alternative literature on economic theory and oil, pretends: "In 1991 […] I published a book that took *stock of the knowledge thus accumulated*. This article brings up to date the findings of that earlier survey of the economic literature on models of the oil market [sic.]" (Salehi-Isfahani, 1995, p. 3, emphasis added). So it seems that the so-called *stock* of knowledge in this case is, once again, replicated in the *flow* of ignorance, if not in the sentiment of deliberate exclusion.

[5] For Schumpeterian theorists, competition is not an idealized rendition of perfect atomistic markets to be counter-posed to equally idealized "monopoly" or "imperfectly competitive" markets in a tautological manner. Rather, competition itself is internal to the process of "creative destruction," and dynamics of concentration and centralization of production. Hence the presence of integration does not necessarily negate competition. This is also generally true for the Classical, Marxian, and Austrian theories of competition (Schumpeter, 1942, Ch. 7; McNulty, 1967; Clifton, 1977; Shaikh, 1980, 1982; Weeks, 1981, Ch. 6; Semmler, 1984; Bina, 1985, Ch. 6, 1989a, 2006; Kirzner, 1987; Bina and Davis, 1996).

AN INCLUSIVE REVIEW OF LITERATURE

The literature on OPEC and the oil market alone is varied and vast. However, here, we intend to focus on the perceived neoclassical dichotomy of competition and integration, and the way in which it has been applied to OPEC and the contemporary oil market. In this specific literature, there are numerous models, with the various assumptions and hypothesized notions, about the OPEC's action and behavior. These models can be roughly divided into two groups: cartel (including the dominant-firm models) and non-cartel models. Cartel models consider OPEC as a profit-maximizing organization, seeking monopoly profits through the manipulation of its output. These models try to demonstrate the dominance of OPEC within the oil market resultant from collusion among its members. Non-cartel models, on the other hand, contend that the crude oil market is competitive as the variations in price of oil can be explained by factors other than cartelization. An early review of these models can be found in Fisher, Gately, and Kyle (1975) and Gately (1984, 1986).

Typical cartel models, for instance, by Bitzer, Meeraus, and Stoutjesdijk (1975), Pindyck (1978), Ezzati (1976), Adelman (1980, 1982), Salant (1982), and Aperjis (1982), all emphasize the dominant role of OPEC in the oil market and attempt to describe OPEC as a monopoly, oligopoly, and thus a cartel. These models assume that OPEC members have a unified goal and thus collectively set the price of oil at the global level. Hnyicza and Pindyck (1976) divide OPEC into two blocks, "spenders" and "savers," before seeking an optimal (game-theoretic) bargaining solution within the "cartel." Hill and Chichilnisky (1991) focus on intra-OPEC bargaining. Thomas (1992) looks at the "cartel stability" and "punishment strategies" via a common-pool exhaustible resource game. All these models, nevertheless, try to predict the future direction of oil prices by watching OPEC closely.

Crémer and Salehi-Isfahani (1980, 1989) and Teece (1982), among others, present a competitive view of the oil market.[6] These authors argue that the world oil supply curve is backward bending due to the hypothesized limited absorptive capacities of oil exporting countries within OPEC, particularly those in the Persian Gulf. It is said that these countries would produce enough oil to meet their target revenue as required by their internal disbursement. As a result, a large increase in the oil price may reduce their need for further production. Consequently, they argue, high oil prices during the crises of 1973-1974 and 1979-1980 could just as well be resulted from competitive equilibria, which might have eventually occurred without OPEC. However, the assumption of the so-called limited absorptive capacity, which is the analogue of "petrodollars"

[6] It may be noticed that Jacques Crémer appears to have one foot in the "competitive view" and another in "dominant-firm view" of OPEC (see Cremer & Weitzman, 1976).

recycling, has been proven wrong by the historical conduct and mere action of these oil exporters. As we have experienced in the 1970s and 1980s, these countries not only grabbed and spent their windfall share of oil rents but also engaged in so much in productive and unproductive investments that eventually had to borrow beyond their own "capacity." Therefore, on the empirical ground, resorting to "capacity constraint" does not get us far.

On a more conceptual level, however, the argument of "limited absorption capacity" boils down to an idealized notion of national economy in marginal transformation and free of uneven development, internal class competition, violent capital accumulation, and, above all, to a self-contained, idealized economy immune and isolated from the forces of globalization. Finally, undue emphasis on the limitation of "absorption capacity" would shift the attention from the sphere of production and (global) price formation to the sphere of circulation and distribution. Hence, methodologically, this "competitive view" of OPEC, like the dependence of the motion of Newton's Bucket on the *absolute space*, cannot stand on its own.[7]

Mabro (1975), MacAvoy (1982), Mead (1979), and Johany (1980) are among those who argue against the cartel theory by invoking other reasons for oil price variations than cartelization. Mabro (1975) ascribes the price hike of the early 1970s to the "less than perfectly elastic demand curve" facing OPEC and "the interdependence of [oil] production and future availabilities." His first point is basically an echo of "imperfect competition" in oil, his second point amounts to circular reasoning. MacAvoy (1982) attributes the increase in the price of oil to supply disruptions. In particular, he points out that the 1973-1974 oil embargo against the United States (and the Netherlands) led to the reduction of world oil supply, thus caused the oil price to rise. In the same manner, MacAvoy argues that the 1979 Iran Revolution and the 1980 war between Iran and Iraq reduced the OPEC oil supply and thus naturally raised the oil prices.

To extend MacAvoy's (1982) reasoning, this could be said about the period following the 1990 invasion of Kuwait by Iraq. Contrary to such reasoning, Adelman (1982) contends that Saudi Arabia alone had the capacity to compensate for most of the production loss in these periods, yet she did not so and consequently let the price increase. This reasoning is invalid, given the fact that, in another similar instance, the shortfall resulted from the Iranian Revolution has been compensated by other non-OPEC suppliers. Yet, MacAvoy's explanation falls short of explicating the cause of the price crash of 1986.

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[7] There is a fascinating story of *shifting the problem* of relative motion and time to the absolute space in Newtonian physics, and thus leaving the problem of time and space unresolved (see Greene, 2004, Ch.2). This book is a goldmine for methodological theorizing and has a broad implication for conceptualization in economics.

Finally, Mead (1979) and Johany (1980) attribute the cause of higher oil prices to differential time-horizon, i.e., the transfer of property rights from foreign oil companies (with high discount rates) to host governments (with lower discount rates). In addition to all this, the disputes over the question of exhaustibility, intertemporal exploitation, and the extent to which "scarcity rent" may play in the cost and price of oil created additional points of contention among economists (Gray, 1914; Hotelling, 1931; *RES* Symposium, 1974; Pakravan, 1976; Dasgupta & Hill, 1979; Bina, 1985, Ch. 4; Adelman, 1986, 1990).[8] Despite the apparent differences, these models have their theoretical affinity with the familiar dichotomy of competition and monopoly embedded in the axiomatic (and indeed tautological) spectrum of competition-monopoly in the standard neoclassical market-structure theory.

In contrast, Bina (1985) shows that the oil crisis of 1973-1974 was a worldwide crisis of restructuring that had a pivotal importance for transformation of petroleum industry from cartelization through to decartelization and genuine globalization of oil. Bina (1988, 1989b, 1990, 1992, 2006) demonstrates that the post-1974 globalization of oil is a manifold combination of (1) emerging competitive spot (and futures) oil prices regardless of the (actual) differential finding and extraction costs[9] or differential quality of oil deposits, (2) rising global competition between the lowest-cost and highest-cost oil producers, (3)

[8] Given the eventual physical exhaustibility of oil and thus intertemporal opportunity cost of its present and future exploitation, neoclassical theory contends that some measure of "scarcity rent" must be added to the marginal cost of oil extraction. Hence: MC + Scarcity Rent = User Cost. Adelman (1986, 1990) believes that oil is produced at the time of discovery; hence reserves must be treated as "inventory." In addition, Adelman ignores the very distinction between the ownership of oil reserves from holding of such reserves through leases, which in turn separates oil rents from profits. Bina (1985) does not rely on the physical exhaustibility of oil but contends that the economic institution of modern landed property and the ownership of subsurface oil deposits are behind the distinction of categories of *rents* and *profits* in the oil industry. Hence, given the formation of competitive (general) rate of profit, differential productivities of the existing oilfields turn into differential oil rents across the globe. Theoretically, given the legendary debates within the classical school, these rents, while price-determined, not price-determining, are still dependent upon the property rights of sub-surface ownership. Thus, according to Bina, given the oil industry's high capital intensity, differential oil rents both for OPEC and non-OPEC producers are neither arbitrary sum nor monopoly rent, and OPEC should not be seen as a monopoly or a cartel. According to this framework, it is also inaccurate to call such rents "Ricardian," since they do not automatically correspond with the differential fertility of land (i.e., natural objects) but also capture the effects of the institution of ownership in conjunction with such differential fertilities (see Fine, 1979, 1983; Bina, 1989b, 1990, 1992, 2006). Besides, in addition to the rendition of Ricardo's theory of ground rent, the textbook (neoclassical) rendition of Ricardo's "comparative cost" theory is also mistaken on Ricardo's combined system of international trade and finance.

[9] Given the peculiarities of petroleum industry and specificity of its economic institutions, contrary to the conventional arguments—that rely on cost accounting of oil reserve alone (see Adelman and Shahi, 1989; Adelman, 1992)—oil costs must include differential oil rents.

formation of *differential oil rents* across the globe based on the differential productivity of competing oil regions, and (4) division of normal profit and differential rent according to differential application of capital to differential quality of subsurface (oil) deposits. The qualitative difference between the eras of pre-1973 and post-1973 is that in the latter period the *rentier* (in this case, state) has emerged as a *sui generis* (economic) category and intervened in the production of oil. The pre-1973 era was an epoch of long colonial contracts and leases with *nominal* royalty, and equally benign and *undeveloped* rentier under the auspices of International Petroleum Cartel ("Seven Sisters").[10]

Therefore, the modern economic category of rent (as the effect of ownership of the sub-surface deposits) was still in the developing stage and devoid of *de facto* ability to intervene in the accumulation of capital and production of oil. Contrary to Adelman (1991), Bina (1985, 1990), among others, argues the Seven Sisters have never owned the oil deposits in these colonial and semi-colonial lands; they merely owned the leases, i.e., the right to extract oil for a specified number of years. The distinction between ownership of leasehold and ownership of oil deposits is not only important in the distribution of revenue but also significant in the process of capital accumulation. Since the post-1973 global restructuring, *rent* has become a full-fledged economic category in the globalized oil production. Consequently, according to this view, OPEC is not a cartel but rather an association composed of rentier states whose very differential oil rents are subject to *real* global competition.[11]

In the neoclassical camp, the empirical tests of contending views seem to have yielded conflicting results. Griffin (1985) uses data for the period of 1971-1983 to test the "market-sharing cartel hypothesis" in conjunction with three different competitive counterparts, namely, target revenue, supply shock, and property rights models. His conclusion leads to rejection of all three competitive models so chosen but he confirms that the cartel model does the best job of fitting the data. Jones (1990), who extends Griffin's analysis to 1988, finds that the fall of prices during the 1980s is the consequence of OPEC output adjustment and market sharing. However, the conclusion reached by Griffin (1985) is reversed by

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[10] For distinction of rent and royalty see Fine (1982).

[11] Today in the global production of oil today, differential oil rents are a permanent economic category whose existence does not wash away with "cheating," lack of coordination and overproduction by OPEC and/or non-OPEC producers alike. Moreover, the magnitudes of these rents are not arbitrary, or subject to games theoretic bargaining by members, but are established through intra-regional and inter-regional competition. Also, these rents should not be mistaken with "taxes," just because they are being obtained by state. Thus, any contentious interactions, such as "bargaining" among OPEC members or between OPEC and non-OPEC producers, must be analyzed within the confines of such magnitudes (see Bina 1985, Ch. 5, 1989b, 1990, 1992, 2006). Consequently, it would not be sufficient to resort to "games theory" in this case.

Salehi-Isfahani (1987) due to the existence of model misspecification. Smith (2003) also detects similar ambiguities about a number of new OPEC studies, before rejecting quite a few conventional explanations of OPEC behavior (such as, competitive, Cournot, dominant-firm, etc.) and describing OPEC as a "bureaucratic cartel."

In the meantime, Alhajji and Huettner (2000) note that a monopolist would never choose to operate on the inelastic portion of its demand curve because, having monopoly power, it can do better on the elastic part. Thus, an estimated elasticity of demand (in absolute value) below 1 would constitute as evidence against the cartel hypothesis. Alhajji and Huettner thus reject the hypothesis that would identify OPEC as a cartel on the basis of the fact that OPEC does not normally operate on the elastic portion of its demand curve. However, Smith (2003) takes issue with the accuracy of such (elasticity) calculation. Such a test is also inconclusive on whether OPEC affects the market prices.

Loderer (1985) carries out the analysis at the aggregate level, treating OPEC as a cohesive whole. He tests whether OPEC is able to change the market price by adjusting its production and, if so, it would make it a candidate for an effective cartel. Loderer finds that OPEC does not influence oil prices during the 1974-1980 period of skyrocketing oil prices, but that it does so during the softening period of 1981-1983. However, there are some serious concerns about this study.

First, the dataset used in this study is Platt's Rotterdam spot quotations, reflecting the opinions of the market participants in a non-organized exchange rather than the actual market prices in an organized market exchange. Second, there is a strong evidence of heteroskedasticity in the oil price time-series,[12] which may have significant adverse impact on the test result. Yet he does not take this into account. Third, Loderer's sub-periods under study are too short (e.g., 7 years for skyrocketing price and 3 years for softening price). Consequently, the validity of the tests is doubtful and any conclusions based on them would be uncertain in this study. Finally, Wirl and Kujundzic (2004) examine the impact of OPEC conference outcomes on the world oil prices from 1984 to 2001. They find that the impact is weak and restricted to meetings recommending a price increase. However, they do not precisely separate the impacts that may have arisen from OPEC output decisions from the ones associated with the market trend. As in Loderer (1985), Wirl and Kujundzic (2004) also do not take into account the heteroskedastic tendency of the time series when conducting their tests. Lastly, neither study examines the possible impact of OPEC production decisions on market volatility.

[12] See Abosedra and Laopodis (1997), and Morana (2001), among others.

THE CONTEXT

This article proposes a new test in order to overcome the drawbacks in the study of OPEC by Loderer (1985) and Wirl and Kujundzic (2004). More specifically, it attempts to examine how OPEC output decisions affect the global oil market and how OPEC responds to global price change. Here, we are not concerned with the (subjective) intention of OPEC as a whole or how the decisions are made within OPEC. Rather, our aim is to investigate whether or not the result of OPEC announcements has any significant impact on the global oil market in the period under investigation. Also the reader should be cognizant of the fact that because of the development of spot and futures markets in oil OPEC abandoned "posted prices," the relic of yesteryears' cartelized arrangement and by necessity obtained its queue from the newly structured global market. We need to examine OPEC by separating the "unexpected" part of OPEC's decisions from the part which is "expected" and to see whether or not the "unexpected" part has any significant impact on market price and volatility. If OPEC were a cartel (or were an entity with any consequential "market power"), the unexpected parts of its decisions should have some impact on the market price or volatility.

The event-study technique is thus used to assess such impacts (see MacKinlay, 1997). We attempt to examine the fluctuations of the West Texas Intermediate (WTI) spot and futures contracts traded on the New York Mercantile Exchange (NYMEX). The contracts are denominated in 1,000 US barrels (i.e., 42,000 gallons) of light sweet crude oil for delivery in Cushing, Oklahoma. Given that nearly all oil prices (including OPEC's Basket) move together since the 1980s and NYMEX is one of the very early organized oil exchanges in the world, we study the impact of OPEC on both futures and spot markets on NYMEX. For futures, we consider contracts for delivery one month in the future. To confirm that the impact is of general phenomenon and not specific to the WTI oil, we also examine the impact on the (North Sea) Brent crude oil, another globally traded oil on the International Petroleum Exchange (IPE) in London.

Based on our preliminary analysis, we employ *GARCH(1,1)* with *AR(1)* in mean for oil returns and their volatility in order to take into account heteroskedasticity. We use both dummy variable and residual methods in order to detect abnormal changes in return and volatility due to the output decisions of OPEC. The dummy variable method investigates the average abnormal change around the announcement days and 30 trading days thereafter. The residual method, on the other hand, examines the behavior of the daily abnormal change around the announcement days. To test whether the price impact of the decisions is statistically significant, we use the regular t-test for dummy variables. For residuals, we apply the standardized cross-sectional test by Boehmer, Musumeci, and Poulsen (1991), which allows for event-induced variance change.

We find no evidence that OPEC has any sustained significant impact on price when it attempts to manipulate output. The impact, if any, is very weak and transient, at best, and essentially restricted to the event windows. OPEC decisions have no impact whatsoever within the 30-day period succeeding event windows. Contrary to its claim, we also find no evidence that OPEC is able to reduce the market volatility by manipulating its own output. This finding is in stark contrast with Adelman (1991), who asserts: "The highly volatile price of oil has not been created by 'the market,' but rather by unchecked monopoly power …" (p. 4). Given the fact that OPEC collectively is by far the largest supplier of oil—accounting for 40% of total world production—this finding is significant. To explain this, we examine the actual OPEC production along with the "assigned" production quotas.

We find that, on average, OPEC members produce about 7% more than their allocated quotas, regardless of the outcomes of OPEC conferences. In other words, it appears that OPEC quotas do not play as an obstacle to OPEC production in the sample period (see Table 10). Thus, OPEC members behave competitively under the guidance of market prices. The finding about OPEC's lack of control and influence over the market leads us to the conclusion that OPEC is not leading, but following, the market, and thus its alleged "price-stabilizing" ambition is unwarranted and devoid of any defensible empirical verification.

In sum, our findings are consistent with competitive behavior—not with those of monopoly, cartel-like, or "imperfectly" competitive garden variety—in view of OPEC's lack of control and influence on the market price and volatility during the sample period.[13]

THE HYPOTHESIS

OPEC is an international organization of eleven developing countries (rentier states[14]) that are heavily reliant on oil revenues as their main source of income and foreign exchange. OPEC members together possess about 75% proven world crude oil reserves and currently produce nearly 40% of the total world oil output. They are assumed to have a unified goal and thus collectively

[13] This finding is consistent with Schumpeterian (and Marxian) competition where the assumption of atomistic markets has no role in price formation, and neither lumpiness (of production) nor concentration of capital renders the market uncompetitive (Schumpeter, 1942, Ch. 7). Yet, certain rightwing neoclassical economists and their leftwing (radical) followers still refer to OPEC as monopoly and cartel.

[14] See Mahdavy (1970) for origin of the term and concept of rentier state in the oil exporting countries of Middle East.

participate in setting the price of oil. OPEC claims that its goal is to bring stability and harmony to the oil market by adjusting output, and to ensure that the market supply and demand are in balance. Toward this end, OPEC members meet at least twice a year to decide on their output level.

To control the oil price, in March 2000, OPEC devised a price-band mechanism, which was based on OPEC's Reference Basket,[15] in order to respond to extreme changes in the oil market. According to this mechanism, if the basket prices were above $28 per barrel for 20 consecutive trading days or below $22 per barrel for 10 consecutive trading days, OPEC would then adjust its production to bring the price back within the band. This adjustment was made automatically at the beginning of the period but was changed subsequently in order to give the organization a fine-tuning capability in adjusting its production. However, since December 2, 2003, the OPEC basket price had to remain consistently above the threshold of $28 per barrel without a hint of triggering the price-band mechanism. As a result, at its one hundred thirty-fourth extraordinary meeting in January 2005, OPEC was obliged to declare that market dynamics have rendered the band redundant and thus suspended the mechanism for good.

There is still no consensus among economists that whether OPEC has enough "market power" to accomplish its price-stabilizing goal. There are conflicting interpretations concerning the extent of OPEC's market influence and determination. As we have seen above, these interpretations cover different blends of market structures, ranging from competitiveness to collusiveness in the oil literature. Yet, in the final analysis, whether OPEC is indeed a benign or potent entity, or simply a market follower body, depends largely upon the empirical verification of competing theoretical perspectives employed. In this article, we treat OPEC as a cohesive whole and argue that a necessary condition for OPEC to be a cartel (or any entity in possession of "market power") is that the unexpected part of its output decision must have significant impact on either the oil market return or its volatility. This consideration leads us to:

Hypothesis: *OPEC output decision cannot affect the oil market.*

If this hypothesis is corroborated by data, we conclude that OPEC is neither a cartel nor any other of its variants. On the other hand, if the hypothesis is rejected, further investigation on the pattern of OPEC's quota distribution, collusion, if any, will be conducted in order to determine whether OPEC is either

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[15] OPEC Reference Basket of Crudes is the weighted average of the prices of eleven crude oils, including: Algeria's Saharan Blend, Indonesia's Minas, Nigeria's Bonny Light, Saudi Arabia's Arab Light, Dubai's Fateh, Venezuela's Tia Juana, and Mexico's Isthmus (non-OPEC oil). The magnitude of this reference basket exhibits near-perfect correlation with those of the global spot and futures prices.

a classic cartel or any other of its variants as described in typical economics textbooks.

As indicated above, OPEC claims to have been a market leader, thus simply adjusting its output to ensure that the oil market is stabilized and supply-and-demand are in balance. However, several studies, such as Verleger (1982), Fritzgerald and Pollio (1984), Lowinger and Ram (1984), Loderer (1985), Bina (1985, 1990), among others, contend that OPEC indeed follows, not leads, the market. We are interested in examining whether OPEC is actually engaging in market leadership, i.e., achieving the goal of price stability as it claims. This, of course, depends on the corroboration (or lack thereof) of our hypothesis.

DATA AND PRELIMINARY ANALYSIS

We focus on the impact of OPEC output decisions on the market of the light sweet crude oil, based on the West Texas Intermediate (WTI) Cushing, Oklahoma contracts traded on the NYMEX. In addition, we also attempt to analyze the impact on the (North Sea) Brent crude traded on the IPE. Our price dataset is obtained from the historical crude oil price database of the U.S. Department of Energy. The dataset contains a daily WTI spot price time-series, a daily Brent spot price time-series, and a daily WTI futures price time-series of contracts for delivery one month in the future. For futures price time-series, our sample is from April 4, 1983 to July 6, 2005, for total of 5,577 observations. For daily WTI and Brent spot price time-series, our sample extends from May 20, 1987 (the first day when the Brent contracts were started to trade on the IPE) to July 6, 2005, for total of 4,581 observations for WTI and 4,615 observations for Brent.[16] To calculate daily returns (i.e., daily percentage changes in price), we take the difference in logarithm of consecutive daily prices.[17] Figures 1 and 2 depict the price magnitude and its return over the sample period for WTI futures and spot contracts.

[16] The discrepancy is due to holidays and missing values in the dataset. Designating similar starting point for both time series would make the comparison of these spot markets straightforward.

[17] The prices are all nominal for all the stated reasons in Wirl and Kujundzic (2004, p. 48), including the fact that—for all intents and purposes—through the measure of differences in logarithm of daily price any inflationary bias proves negligible.

FIGURE 1.—DAILY FUTURES PRICE AND ITS RETURN
(April 03, 1983 - July 7, 2005)

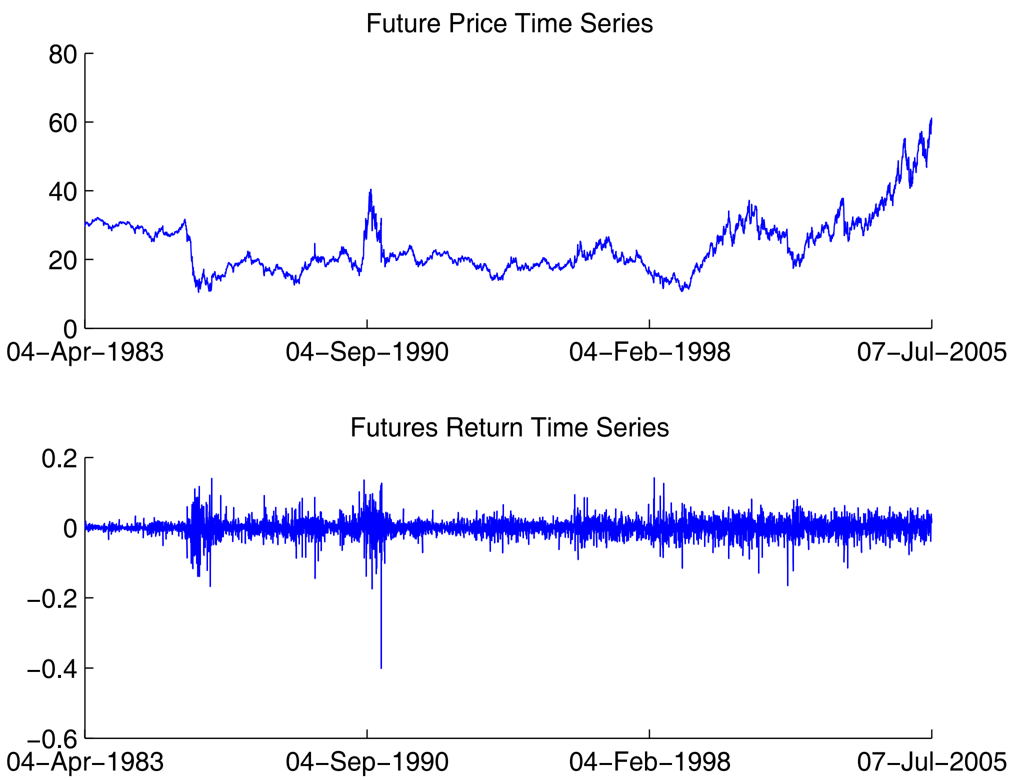
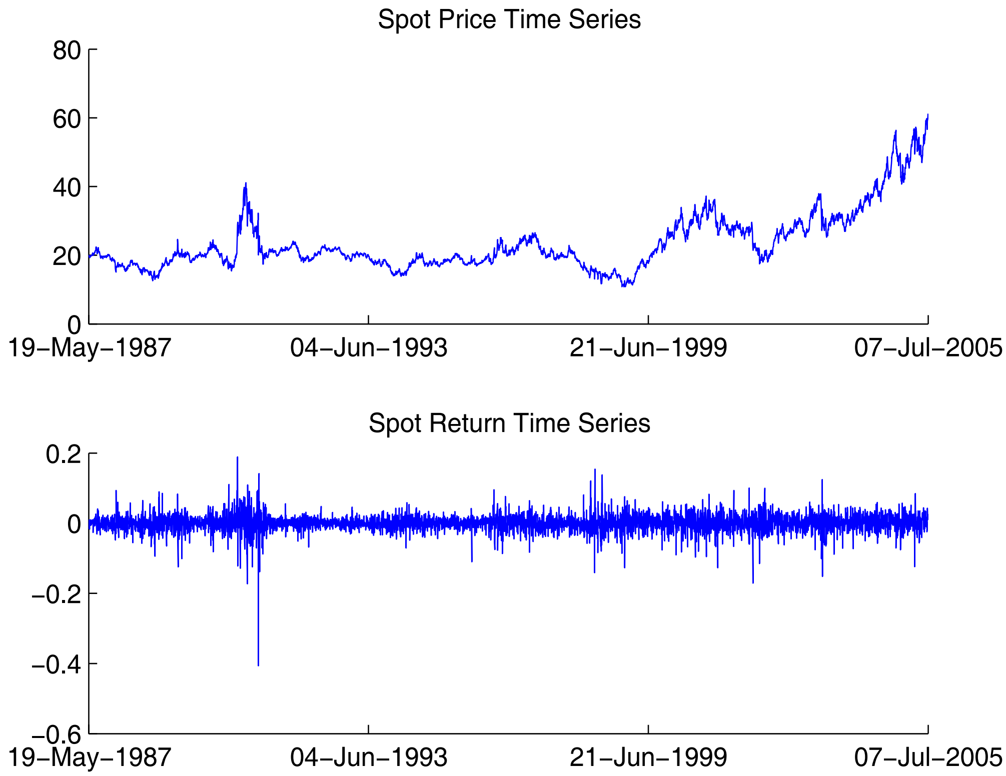


FIGURE 2.— DAILY SPOT PRICE AND ITS RETURN

(May 20, 1987 - July 7, 2005)



We observe, in Figures 1 and 2, two essential features of the time series. First, these oil price time-series do not display global but local trends. The price is consistently on the upward trend since 2002. Secondly, the corresponding return time series, all exhibit volatility clustering. That is to say, large changes tend to follow large changes, and small changes tend to follow small changes. However, typically, in neither case, the sign of the change from one period to the next is predictable.

Table 1 presents some descriptive statistics for the WTI futures (spot) data. The mean price is $23.72 ($23.49) while the median price is $21.07 ($20.53). The price is quite volatile, ranging from $10.42 ($10.82) to $61.28 ($61.24). Its standard deviation is $8.21 ($8.50). The mean daily return although positive is close to zero (0.0131% for futures and 0.0247% for spot). Daily return ranges from -40.05% (-40.64%) to 14.23% (18.87%). Median return is 0.0341% (0.0530%), larger than the mean. The small and negative skewness -1.19 (-1.18) indicates that the return distribution is slightly skewed to the left, while the kurtosis of 22.76 (23.23) suggests that the return distribution has thicker tails than normal distribution (kurtosis of the normal distribution is 3).

TABLE 1.—DESCRIPTIVE STATISTICS FORWTI FUTURES (April 4, 1983 to July 6, 2005) AND WTI SPOT (May 20, 1987 to July 6, 2005) SAMPLES

	WTI Futures	WTI Spot
	PRICE ($)	
Mean	23.72	23.49
Median	21.07	20.53
Min.	10.42	10.82
Max.	61.28	61.24
Standard Deviation	8.21	8.50
	RETURN (%)	
Mean	0.0131	0.0247
Median	0.0341	0.0530
Min.	-40.05	-40.64
Max.	14.23	18.87
Standard Deviation	2.39	2.50
Skewness	-1.19	-1.18
Kurtosis	22.76	23.23

As for the daily futures returns, they display a mild degree of autocorrelations; however, the squared returns are much more correlated. The autocorrelation coefficients of returns at 5, 10, and 20 lags are -0.0458, 0.0229, and -0.0011, respectively; while those of squared returns at the same lags are 0.0968, 0.0983, and 0.0881, respectively. This is consistent with the volatility clustering illustrated in Figures1 and 2.

To formally examine for heteroskedasticity in the return time-series, we use the model *AR(n)* to fit the return time-series and then apply the Engle's procedure to test whether the residuals from the *AR(n)* regression exhibit time-varying heteroskedasticity. We conducted the test at 1, 5, 10 and 20 lags. In all cases, we reject the null hypothesis of homoskedastic returns. For the sake of brevity, we do not present the test results here. Local trends in the price level, volatility clustering, fat tails in return distribution and heteroskedasticity are all common characteristics of speculative asset returns, which suggest that it is appropriate to model oil returns as a random walk process with *GARCH* process in variance. We conducted the same analysis for the WTI spot and Brent spot time-series. The results are remarkably similar.

The data on OPEC conference meetings are extracted from the OPEC Press Releases. From April 4, 1983 to July 6, 2005, OPEC held 69 conference meetings (and 2 consultative meetings during the US invasion of Iraq in 2003) in order to determine its output. Of these meetings, 44 are ordinary meetings, which were normally convened twice a year, and 27 are extraordinary meetings, which are convened in response to the extremely low or extremely high market price. In terms of output decision, 20 meetings in our sample corresponds with decreasing output, 18 meetings with an increase in output, while the remaining 33 meetings result in no change in output at all. If we further classify the extraordinary meetings in terms of output decision, from 27 extraordinary meetings, 6 meetings led to an increase in output, 10 meetings lead to a decrease in output, and 11 meetings led to the maintenance of current production. In the ordinary meeting group, 10 meetings corresponded to a decrease of output, 12 meetings to an increase of output, and 22 meetings led to keeping output at the same level.[18]

METHODOLOGY AND EMPIRICAL RESULTS

We employ the event-study technique to test our hypothesis. In this case, an "event" is defined as a meeting to adjust output. If OPEC were a cartel and its decisions were not fully anticipated by the market, the unexpected component of

[18] We did not have enough data to assess the impact of OPEC's last conference (i.e., the 136th) at the completion of the original draft of this article (August 2005); hence, we excluded this meeting from our sample.

such decisions would certainly affect the market price. More specifically, higher (lower) than expected output decisions would be associated with negative (positive) abnormal changes in price. To capture this relation, depending on the surprised (unanticipated) part of the decision, each meeting (event) is assigned to one of three groups. If the decision is to increase (decrease) output exceeds the expected level, it is assigned to the increased (decreased) group. If the decision is expected by the market, then it is assigned to the unchanged group.

We assume that meetings with large output change (5% or higher) are the ones that must be poorly anticipated by the market. Oftentimes we observe that OPEC announces an increase in output, yet it may fail to raise output as announced *ex-post.* Such failures can be attributed to the lack of adequate spare capacity to fulfill the new quota on the part of some of its members. To take this into account, we include such meetings within the category of increasing output when the decision is to raise output by more than 5%, in conjunction with the remaining OPEC spare capacity at 10% or more. We choose a 10% threshold here because, given OPEC's overall spare capacity and its distribution among members, some OPEC members simply do not have enough spare capacity to produce even at much lower than this threshold. Likewise, we assign to the decreased group the meetings that lead to decreased output by more than 5%. The remainder of the meetings is naturally assigned to the unchanged group.

Sometimes, before OPEC conferences, representative of certain member country, for example, Saudi Arabia, might disclose its preference concerning the market and comments about the magnitude of oil price to the public. Such public pronouncements, however, are not presumably in total accord with what may transpire as the definitive OPEC decision on the output. Nevertheless, we suspect that the market, in advance of OPEC's announcement of its formal decision, might learn some information about the possible outcome of the meeting (most information prompts learning by the market effectively well within a short period of time, normally in a week from the actual meeting).

To capture this, we include 5 pre-event trading days in the event window, consistent with the usual and effective timing of such pronouncements. We also extend the event window to include 5 post-event trading days, following the OPEC (output decision) announcements, in order to provide adequate time for the market to fully internalize the information. As a result, the event window consists of a total of 11 days, including 5 trading days before the announcement, the announcement day, and 5 trading days after the announcement.

We are interested in the abnormal changes in the oil market that result from OPEC's output decisions. To that end, we first compare the return and its volatility within the 30-day period before event windows with the return and volatility associated both with event windows and within the 30-day period after event windows. Then, finally, we examine closely the daily abnormal movements of the market in the event windows.

THE IMPACT OF OPEC OUTPUT DECISIONS ON THE CRUDE OIL MARKET

Based on the preliminary analysis of the oil return time-series and in the view of empirical evidence documented in the literature, such as Abosedra and Laopodis (1997) and Morana (2001), we employ the *GARCH(1,1)* with *AR(1)* in mean to model oil return and its volatility. We also introduce dummy variables into the mean and variance equations to capture the impact of the decisions within and subsequent to the event windows. More specifically, let r_t and σ_t be the return and its volatility at date *t,* conditioned on the information set at date *t-1*, we have:

$$\begin{aligned} r_t &= \mu + \varphi_1 D_1 + \varphi_2 D_2 + \delta r_{t-1} + \varepsilon_t, \\ \sigma_t^2 &= \kappa + \rho_1 D_1 + \rho_2 D_2 + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2, \end{aligned} \qquad (1)$$

where ε_t is the error term, $\mu, \varphi_1, \varphi_2, \delta, \kappa, \rho_1, \rho_2, \alpha, \beta$ are regression coefficients. D_1 and D_2 are dummy variables as follows:

$D_1 = 1$, when date *t* is within event windows, 0 otherwise;
$D_2 = 1$, when date *t* is within 30 days subsequent to event-windows, 0 otherwise.

Thus, μ conveys information about the mean return 30 days preceding event windows (μ is proportional to the mean), φ_1 conveys information about the difference between mean return in event windows and that of 30 days preceding event windows. φ_2 conveys information about the difference between mean return 30 days preceding event windows and that of 30 days succeeding event windows. Thus, φ_1 and φ_2 measure the price impact of OPEC decisions. Similarly, in the variance equation of (1), ρ_1 measures the volatility impact of the decisions in event windows and ρ_2 measures the volatility impact of the decisions 30 days succeeding event windows.

We use the daily WTI oil futures and spot time-series in our dataset to estimate (1). Our sample includes the returns in the event windows, 30 trading days preceding and 30 trading days succeeding each event window. The estimation results are given in Table 2.

TABLE 2.— REGRESSION RESULT FOR ENTIRE SAMPLE OF WTI FUTURES AND WTI SPOT TIME SERIES

Coefficient	Estimate	Std. Error	z-Statistic	p-Value
		FUTURES TIME SERIES		
		Mean Equation		
μ	-0.034588	0.031957	-1.082336	0.2791
φ_1	0.007134	0.068308	0.104436	0.9168
φ_2	0.026992	0.049202	0.548593	0.5833
δ	0.020202	0.016816	1.201350	0.2296
		Variance Equation		
κ	0.027168	0.014774	1.838867	0.0659
α	0.090868	0.009199	9.878171	0.0000
β	0.915436	0.006530	140.1991	0.0000
ρ_1	-0.001502	0.027661	-0.054289	0.9567
ρ_2	-0.026106	0.015980	-1.633711	0.1023
		SPOT TIME SERIES		
		Mean Equation		
μ	-0.036533	0.046501	-0.785643	0.4321
φ_1	0.049230	0.102476	0.480405	0.6309
φ_2	-0.021882	0.070695	-0.309529	0.7569
δ	-0.015364	0.018356	-0.836974	0.4026
		Variance Equation		
κ	0.077343	0.022740	3.401234	0.0007
α	0.117245	0.017399	6.738457	0.0000
β	0.878366	0.011812	74.36497	0.0000
ρ_1	0.217135	0.111880	1.940782	0.0523
ρ_2	-0.008392	0.031480	-0.266588	0.7898

This Table presents the estimates of the following GARCH (1, 1) model for the whole sample of:

$$r_t = \mu + \varphi_1 D_1 + \varphi_2 D_2 + \delta r_{t-1} + \varepsilon_t,$$

$$\sigma_t^2 = \kappa + \rho_1 D_1 + \rho_2 D_2 + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2,$$

where r_t and σ_t are the return and its volatility at date *t,* conditioned on the information set at date *t-1*, D_1 and D_2 are dummy variables: $D_1 = 1$ when date *t* is within event windows and 0 otherwise; $D_2 = 1$ when date *t* is within 30 days after event windows and 0 otherwise.

For futures, at 5% level of significance, φ_1 and φ_2 are not significantly different from zero (p-values are 0.9168 and 0.5833, respectively), indicating that, on average, OPEC decisions have no impact on returns and therefore no impact on oil price. Similarly, in the variance equation, ρ_1 and ρ_2 do not significantly differ from zero (p-values equal 0.9567 and 0.1023, respectively). Thus, our result indicates that OPEC decisions do not have any significant impact on oil returns and their volatility. The result is remarkably similar for the spot time series as well. One could argue, however, that some decisions may have positive impact while others may have negative impact on returns, depending upon particular actions of OPEC. Therefore, if model (1) were estimated for the whole sample, positive and negative impacts may cancel each other out; hence, it is impossible to detect any specific impact during the sample period. To explore this possibility, we estimate (1) for all the three decision groups separately. Table 3 presents the estimation for the WTI futures.

At 5% level of significance, $\varphi_1, \varphi_2, \rho_1, \rho_2$ are not significantly different from zero for all 3 groups, thus confirming our earlier result for the whole sample. In other words, on average, OPEC output decisions do not have any statistically significant impact on the WTI oil futures market. Table 4 presents the estimation for the WTI oil spot. The result is similar in both (spot and futures) cases.

TABLE 3.—REGRESSION RESULTS FOR WTI FUTURES: INDIVIDUAL GROUPS

Coefficient	Estimate	Std. Error	z-Statistic	p-Value
INCREASED GROUP				
Mean Equation				
μ	-0.065461	0.130993	-0.499729	0.6173
φ_1	-0.007827	0.245512	-0.031879	0.9746
φ_2	0.311874	0.179984	1.732794	0.0831
δ	-0.070353	0.055712	-1.262794	0.2067
Variance Equation				
κ	0.504165	0.191550	2.632028	0.0085
α	0.325695	0.091480	3.560288	0.0004
β	0.599860	0.077056	7.784740	0.0000
ρ_1	0.223388	0.380315	0.587376	0.5570
ρ_2	0.251354	0.256564	0.979694	0.3272
UNCHANGED GROUP				
Mean Equation				
μ	-0.017680	0.034673	-0.509905	0.6101
φ_1	-0.058496	0.071087	-0.822879	0.4106
φ_2	0.027237	0.054873	0.496364	0.6196
δ	0.020884	0.018966	1.101121	0.2708
Variance Equation				
κ	0.026941	0.018211	1.479414	0.1390
α	0.106070	0.011818	8.975172	0.0000
β	0.903690	0.007837	115.3035	0.0000
ρ_1	-0.025126	0.029446	-0.853294	0.3935
ρ_2	-0.021949	0.018923	-1.159902	0.2461
DECREASED GROUP				
Mean Equation				
μ	-0.107980	0.085986	-1.255792	0.2092
φ_1	0.507069	0.261761	1.937141	0.0527
φ_2	0.009400	0.126684	0.074203	0.9408
δ	0.061011	0.048730	1.252008	0.2106
Variance Equation				
κ	0.182696	0.088228	2.070730	0.0384
α	0.238869	0.056799	4.205484	0.0000
β	0.782431	0.039275	19.92195	0.0000
ρ_1	0.106156	0.229390	0.462776	0.6435
ρ_2	-0.095942	0.082180	-1.167459	0.2430

This Table presents the estimates of the following GARCH (1, 1) model for each group:

$$r_t = \mu + \varphi_1 D_1 + \varphi_2 D_2 + \delta r_{t-1} + \varepsilon_t,$$
$$\sigma_t^2 = \kappa + \rho_1 D_1 + \rho_2 D_2 + \alpha \sigma_{t-1}^2 + \beta \varepsilon_{t-1}^2,$$

where r_t and σ_t are the return and its volatility at date *t,* conditioned on the information set at date *t-1*, D_1 and D_2 are dummy variables: $D_1 = 1$ when date *t* is within event windows and 0 otherwise; $D_2 = 1$ when date *t* is within 30 days succeeding event windows and 0 otherwise.

TABLE 4.—REGRESSION RESULTS FOR WTI SPOT: INDIVIDUAL GROUPS

Coefficient	Estimate	Std. Error	z-Statistic	p-Value
		INCREASED GROUP		
		Mean Equation		
μ	-0.040479	0.125234	-0.323229	0.7465
φ_1	-0.084136	0.263126	-0.319757	0.7492
φ_2	0.299466	0.198358	1.509724	0.1311
δ	-0.066427	0.057088	-1.163581	0.2446
		Variance Equation		
κ	0.702024	0.244062	2.876415	0.0040
α	0.342548	0.121048	2.829852	0.0047
β	0.553625	0.100628	5.501681	0.0000
ρ_1	0.174794	0.389929	0.448270	0.6540
ρ_2	0.405651	0.354579	1.144037	0.2526
		UNCHANGED GROUP		
		Mean Equation		
μ	-0.027680	0.057156	-0.484295	0.6282
φ_1	-0.008297	0.121029	-0.068556	0.9453
φ_2	-0.050410	0.090248	-0.558573	0.5765
δ	-0.023569	0.021666	-1.087828	0.2767
		Variance Equation		
κ	0.147437	0.047411	3.109782	0.0019
α	0.126823	0.027958	4.536141	0.0000
β	0.855326	0.018399	46.48655	0.0000
ρ_1	0.254779	0.164062	1.552939	0.1204
ρ_2	0.013708	0.048809	0.280859	0.7788
		Decreased GROUP		
		Mean Equation		
μ	-0.239624	0.135107	-1.773580	0.0761
φ_1	0.678858	0.365309	1.858311	0.0631
φ_2	0.250677	0.200439	1.250638	0.2111
δ	0.022153	0.051583	0.429469	0.6676
		Variance Equation		
κ	0.250407	0.097766	2.561281	0.0104
α	0.152787	0.047000	3.250764	0.0012
β	0.837220	0.043286	19.34155	0.0000
ρ_1	0.216801	0.382117	0.567368	0.5705
ρ_2	-0.172431	0.102631	-1.680107	0.0929

This Table presents the estimates of the following GARCH(1,1) model for each group:

$$r_t = \mu + \varphi_1 D_1 + \varphi_2 D_2 + \delta r_{t-1} + \varepsilon_t,$$
$$\sigma_t^2 = \kappa + \rho_1 D_1 + \rho_2 D_2 + \alpha \sigma_{t-1}^2 + \beta \varepsilon_{t-1}^2,$$

where r_t and σ_t are the return and its volatility at date *t,* conditioned on the information set at date *t-1*, D_1 and D_2 are dummy variables: $D_1 = 1$ when date *t* is within event windows and 0 otherwise; $D_2 = 1$ when date *t* is within 30 days succeeding event windows and 0 otherwise.

THE IMPACT OF OPEC OUTPUT DECISIONS ON THE DAILY CRUDE OIL PRICE AROUND THE ANNOUNCEMENT DAYS

Here, we extend our analysis to examine the impact of OPEC decisions, if any, upon each trading day in the event windows. We appraise the decision impact of output decision for each meeting on daily oil return, using a measure of abnormal return—the difference between the actual return and normal return. Normal return is defined as the expected return without conditioning on the decision taken. As in the previous subsection, we use the *GARCH(1,1)* with *AR(1)* in mean to model normal returns. The model is estimated using data prior to event windows. In the literature, there is no precise procedure on the selection of appropriate length of time series used in the estimation of such models. However, the time series should not be too long. Otherwise, the model will fail to reflect the existing trend of oil returns before the meetings and thus would lead to imprecise estimation. But, if the time series were too short, simply, there would not be adequate number of observations for estimation of the model. Yet, in the final analysis, this depends on the concrete history of the industry and the question under investigation. With these caveats in mind, we have carefully chosen to estimate the model using data for a period of 30 days preceding the event window. The model is then utilized to generate one-step-ahead forecast for each day in the event window. The difference between the actual return and its forecast, which is the error term of the model, is an estimate of abnormal returns. Finally, statistical tests of significance are conducted, using the standardized cross-sectional approach by Boehmer, Musumeci, and Poulsen (1991), which allows for event-induced variance change. The model for normal return is as follows:

$$\begin{aligned} r_t &= \mu + \delta r_{t-1} + \varepsilon_t, \\ \sigma_t^2 &= \kappa + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2, \end{aligned} \tag{2}$$

where ε_t stands for the error term, and $\alpha, \beta, \delta, \mu, \kappa$ are constants.

In order to separate the impact of the event on return and its volatility, we estimate model (2) for each event in each group over a period of 30 trading days prior to the event window. We then use (2) to generate one-step-ahead forecasts of the return for each day in the event window.

Abnormal return in an event window AR_t at date t is defined as the difference between the realized return and the forecasted normal return. Thus, AR_t represents the impact on price from OPEC output decision. Specifically,

$$AR_t = r_t - E\left(r_t \middle| I_t\right) = \varepsilon_t, \tag{3}$$

where I_t is the conditioning information set in the normal return model (system (2)) and r_t is the realized return. We define cumulative abnormal return CAR_t between the first date in the event window (date -5) and date t as the sum of the included abnormal returns. Specifically,

$$CAR_t = \sum_{i=-5}^{t} AR_i. \tag{4}$$

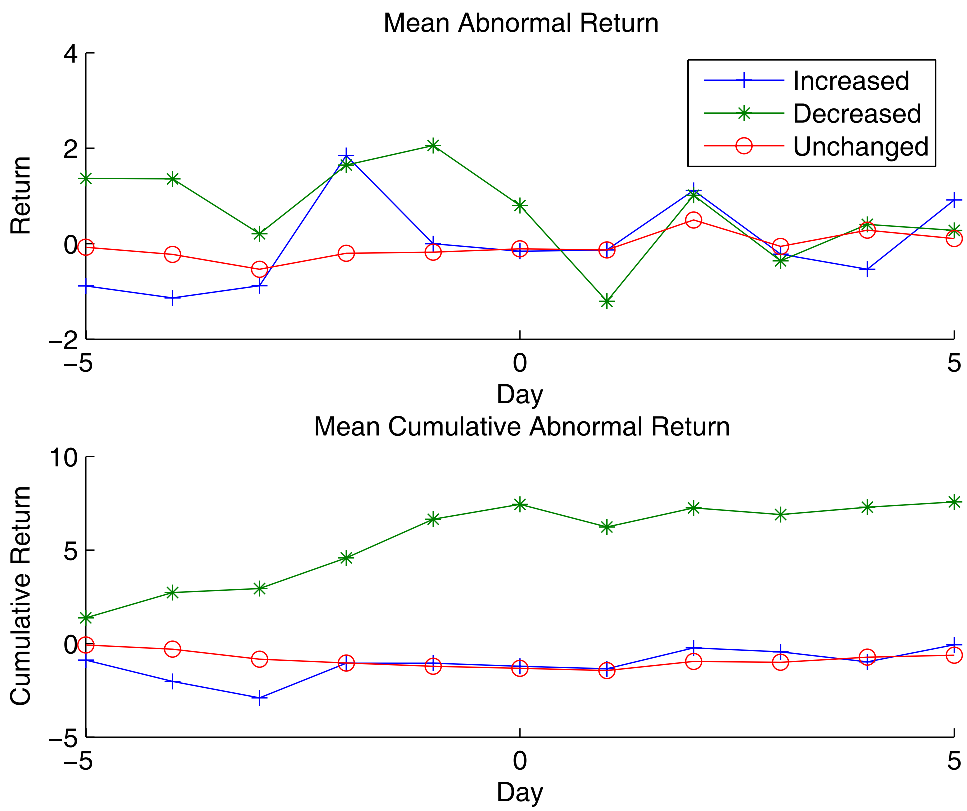
Table 5 presents the average abnormal returns of oil futures for each day and the average cumulative abnormal returns for each group**.** Figures 3 and 4 illustrate the behavior of abnormal returns and cumulative abnormal returns in event windows for each group over time for both futures and spot time series. Average daily abnormal returns deviate from zero at the beginning of the event window but tend to converge to zero at the end of event window. For futures (spot), abnormal returns in the decreasing group are consistently positive on and before day 0 (day -1), then become negative and converge to zero thereafter. On the other hand, in the increasing group, they fluctuate around zero, first, before approaching zero. Abnormal returns in the unchanged group do not fluctuate much and remain very close to zero within the entire event window. Cumulative abnormal returns exhibit clearer patterns in each group. We observe that when output is decreased more than expected, the price tends to increase (positive return). On the other hand, when OPEC keeps output unchanged or boosts output more than expected, the price slightly decreases (negative return). Thus, it appears that OPEC is achieving its objective. However, whether such an impact is significant needs to be tested.

TABLE 5.—AVERAGE ABNORMAL RETURNS (*AR*) AND AVERAGE CUMULATIVE ABNORMAL RETURNS (*CAR*) FOR FUTURS AND SPOT RETURNS IN EVENT WINDOWS IN EACH GROUP

Event Day	Decreased Group		Unchanged Group		Increased Group	
	AR(%)	CAR(%)	AR(%)	CAR(%)	AR(%)	CAR(%)
			WTI Futures			
-5	1.3695	1.3695	-0.0749	-0.0749	-0.8832	-0.8832
-4	1.3565	2.7259	-0.2225	-0.2974	-1.1385	-2.0217
-3	0.2081	2.9341	-0.5364	-0.8338	-0.8795	-2.9011
-2	1.6492	4.5833	-0.2021	-1.0360	1.8476	-1.0535
-1	2.0569	6.6401	-0.1756	-1.2116	0.0003	-1.0532
0	0.8015	7.4416	-0.1070	-1.3186	-0.1592	-1.2124
1	-1.2073	6.2342	-0.1300	-1.4486	-0.1309	-1.3433
2	1.0145	7.2488	0.4971	-0.9515	1.1177	-0.2256
3	-0.3603	6.8885	-0.0563	-1.0078	-0.2195	-0.4452
4	0.4027	7.2912	0.2811	-0.7268	-0.5364	-0.9816
5	0.2773	7.5685	0.1048	-0.6220	0.9151	-0.0665
			WTI Spot			
-5	0.2896	0.2896	0.0644	0.0644	-0.4042	-0.4042
-4	1.6100	1.8996	-0.1478	-0.0835	-0.3679	-0.7721
-3	1.9990	3.8986	-0.6008	-0.6843	-0.7155	-1.4876
-2	1.8949	5.7935	-0.3682	-1.0525	0.8322	-0.6555
-1	0.2348	6.0283	-0.2526	-1.3051	0.7352	0.0798
0	-2.9042	3.1241	0.3309	-0.9742	-1.9993	-1.9195
1	-2.7977	0.3264	-0.0726	-1.0469	0.3308	-1.5887
2	1.3433	1.6697	0.6422	-0.4046	0.9914	-0.5973
3	0.5363	2.2060	0.1041	-0.3005	-0.4850	-1.0823
4	1.2582	3.4641	0.2908	-0.0097	-0.3645	-1.4468
5	-0.0199	3.4442	-0.3797	-0.3893	0.9962	-0.4506

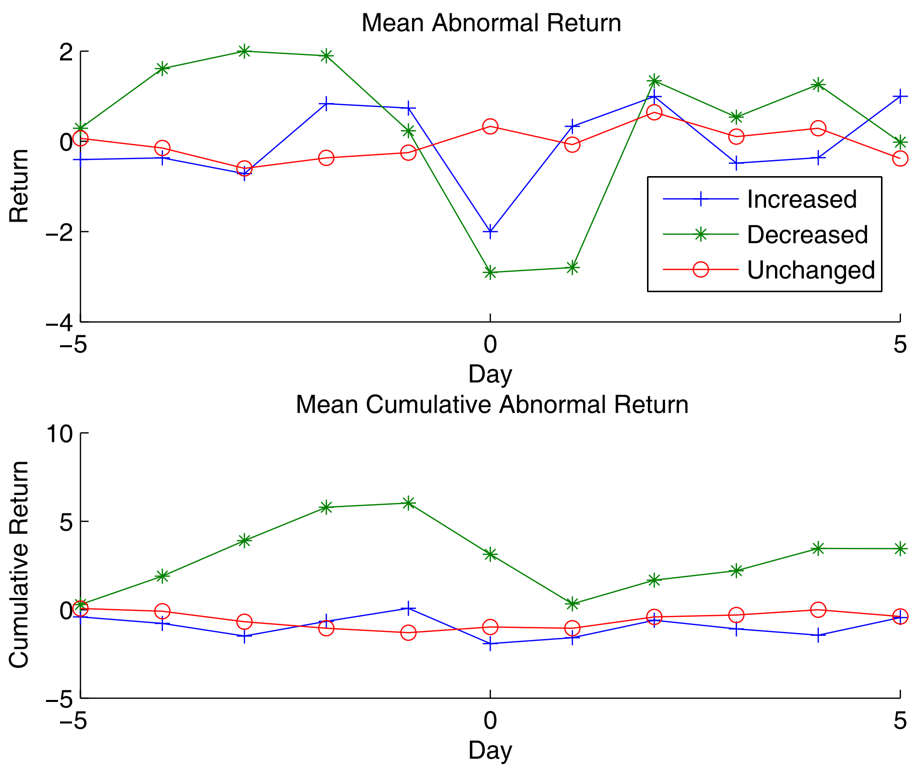
Abnormal return AR_t at date t in an event window is defined as the difference between the realized return and the forecasted normal return based on the normal return model. Cumulative abnormal return at date t is defined as $CAR_t = \sum_{i=-5}^{t} AR_i$.

FIGURE 3.—MEAN ABNORMAL FUTURES RETURNS AND MEAN CUMULATIVE ABNORMAL FUTURES RETURNS IN EVENT WINDOWS



Abnormal return AR_t at date t in an event window is defined as the difference between the realized return and the forecasted normal return. Cumulative abnormal return at date i is defined as $CAR_i = \sum_{i=-5}^{i} AR_i$.

FIGURE 4.—MEAN ABNORMAL FUTURES RETURNS AND MEAN CUMULATIVE ABNORMAL SPOT RETURNS IN EVENT WINDOWS



Abnormal return AR_t at date t in an event window is defined as the difference between the realized return and the forecasted normal return. Cumulative abnormal return at date i is defined as $CAR_i = \sum_{i=-5}^{i} AR_i$.

We next conduct the statistical significant tests of OPEC's price impact. We perform the test for each group. Our null hypothesis is that OPEC output decisions have no impact on price, which implies that for each day in the event window abnormal returns and cumulative abnormal returns do not significantly differ from zero. To take into account heteroskedasticity and event-induced variance changes, we employ the standardized cross-sectional test approach proposed by Boehmer, Musumeci, and Poulsen (1991). This is the hybrid of the ordinary cross-sectional and the standardized-residual approaches. The standardized cross-sectional test approach does eliminate the misspecification problem of heteroskedasticity associated with the ordinary cross-sectional approach and, at the same time, allows for event-induced variance change. To conduct the statistical significant tests of abnormal return (for each group), we first standardize the abnormal returns in the event-windows with the one-step-ahead forecasts of standard deviation using (2). The t-test statistic is calculated by dividing the average standardized abnormal return by its contemporaneous cross-sectional standard error. Formally,

$$T_i = \frac{\frac{1}{N}\sum_{j=1}^{N}\frac{AR_{ij}}{\sigma_{ij}}}{\sqrt{\frac{1}{N(N-1)}\sum_{j=1}^{N}\left(\frac{AR_{ij}}{\sigma_{ij}} - \frac{1}{N}\sum_{k=1}^{N}\frac{AR_{ik}}{\sigma_{ik}}\right)^2}}, \quad (5)$$

where T_i is the t-statistic for date i in the event windows, N is the total number of events in the group, AR_{ij} is the date i abnormal return in event window j, σ_{ij} is the forecast standard deviation of AR_{ij}. The test results are presented in Table 6.

TABLE 6.—THE RESULT OF THE STATISTICAL SIGNIFICANT TESTS OF ABNORMAL RETURNS FOR EACH DAY IN THE EVENT WINDOWS FOR WTI FUTURES AND SPOT RETURNS

Event Day	Decreased Group		Unchanged Group		Increased Group	
	p-Value	Statistic	p-Value	Statistic	p-Value	Statistic
			WTI Futures			
-5	0.3221	1.0416	0.9597	-0.0507	0.6922	-0.4155
-4	0.3941	0.8905	0.5517	-0.5991	0.2583	-1.2488
-3	0.7865	0.2782	0.5746	-0.5649	0.2399	-1.3044
-2	0.3488	0.9829	0.3105	-1.0244	0.0479	2.4793
-1	0.4068	0.8659	0.4330	-0.7902	0.8182	0.2402
0	0.8637	-0.1762	0.4548	-0.7532	0.3490	-1.0157
1	0.6891	-0.4119	0.4522	-0.7576	0.6705	-0.4470
2	0.6929	0.4066	0.3350	0.9732	0.1468	1.6657
3	0.6758	-0.4307	0.3528	-0.9378	0.9014	-0.1292
4	0.6373	0.4863	0.6170	0.5032	0.5128	-0.6954
5	0.9457	-0.0698	0.9827	-0.0218	0.3617	0.9871
			WTI Spot			
-5	0.9422	0.0756	0.8431	0.1992	0.8091	0.2547
-4	0.3487	1.0163	0.7273	-0.3511	0.5119	-0.7057
-3	0.3591	0.9929	0.3052	-1.0379	0.8110	-0.2521
-2	0.5333	0.6608	0.3273	-0.9911	0.1649	1.6261
-1	0.6724	0.4442	0.5844	-0.5512	0.8892	0.1466
0	0.1040	-1.9148	0.4227	0.8097	0.0206	-3.3382
1	0.6433	-0.4874	0.9017	-0.1242	0.8638	-0.1805
2	0.4152	0.8751	0.0679	1.8742	0.3382	1.0586
3	0.4295	0.8470	0.7219	-0.3584	0.6412	-0.4955
4	0.5955	0.5604	0.3692	0.9077	0.3761	-0.9712
5	0.6521	-0.4743	0.3507	-0.9438	0.3069	1.1374

The null hypothesis is that the abnormal return for each day in the event windows equals to zero. The t-statistic for date *i* is:

$$T_i = \frac{\frac{1}{N}\sum_{j=1}^{N}\frac{AR_{ij}}{\sigma_{ij}}}{\sqrt{\frac{1}{N(N-1)}\sum_{j=1}^{N}\left(\frac{AR_{ij}}{\sigma_{ij}} - \frac{1}{N}\sum_{k=1}^{N}\frac{AR_{ik}}{\sigma_{ik}}\right)^2}},$$

where N is the total number of events in the group, AR_{ij} is the date i abnormal return in event window j, σ_{ij} is the forecast standard deviation of AR_{ij}, based on the normal return model.

For the futures, at 5% significance level, we accept the null hypothesis for any date in the event windows for both the decreased and unchanged groups. In the increased group, however, we find that the abnormal return is significantly positive on dates -2 (t-statistic is 2.4793 and p-value is 0.0479). Thus, our result indicates that OPEC decisions in both the decreased and unchanged groups do not have statistically significant impact on individual days in event windows. However, OPEC decisions in the increased group have some transient impact on price two days before the announcement. Nevertheless, while OPEC raises output to reduce the price, its decision moves the price in the opposite direction. The result for the WTI spot is similar except that the abnormal return is significantly negative on the announcement day (t-statistics is -3.3382 and p-value is 0.0206).

The impact on individual daily prices does not paint a complete picture about OPEC's actions. We are more interested in examining the cumulative impact to see how far OPEC can affect the oil prices. To that end, we now formally test whether the cumulative abnormal returns in the event windows follow the directions at which OPEC aims. As in the abnormal return tests, we use the standardized cross-sectional approach. The standardized cumulative abnormal return at date i in event window j is given by:

$$SCAR_{ij} = \sum_{k=-5}^{i} \frac{AR_{kj}}{\sigma_{kj}}, \tag{6}$$

where AR_{ij} is the date i abnormal return in event window j, σ_{ij} is the forecasted standard deviation of AR_{ij} based on model (2).

We conduct the test for each group. The t-statistic for cumulative abnormal return at date i is given by

$$TC_i = \frac{\frac{1}{N}\sum_{j=1}^{N} SCAR_{ij}}{\sqrt{\frac{1}{N(N-1)}\sum_{j=1}^{N}\left(SCAR_{ij} - \frac{1}{N}\sum_{k=1}^{N} SCAR_{ik}\right)^2}}, \tag{7}$$

where N is the number of event in the group. Table 7 presents the test result.

TABLE 7.—THE RESULT OF THE STATISTICAL SIGNIFICANT TESTS OF CUMULATIVE ABNORMAL RETURN FOR EACH DAY IN THE EVENT WINDOWS FOR WTI FUTURES AND OPOT RETURNS

Event Day	Decreased Group		Unchanged Group		Increased Group	
	p-Value	Statistic	p-Value	Statistic	p-Value	Statistic
			WTI Futures			
-5	0.3221	1.0416	0.9597	-0.0507	0.6922	-0.4155
-4	0.2323	1.2716	0.6447	-0.4639	0.3230	-1.0767
-3	0.2916	1.1133	0.5358	-0.6234	0.2172	-1.3788
-2	0.0657	2.0659	0.2704	-1.1142	0.4084	-0.8887
-1	0.0620	2.1012	0.2150	-1.2555	0.3955	-0.9149
0	0.1366	1.6186	0.1826	-1.3512	0.1556	-1.6233
1	0.4003	0.8785	0.1954	-1.3119	0.0816	-2.0900
2	0.4167	0.8471	0.2773	-1.0982	0.2686	-1.2191
3	0.4637	0.7618	0.2233	-1.2327	0.3472	-1.0197
4	0.4100	0.8598	0.2894	-1.0705	0.2913	-1.1568
5	0.4620	0.7649	0.2917	-1.0653	0.5041	-0.7105
			WTI Spot			
-5	0.9422	0.0756	0.8431	0.1992	0.8091	0.2547
-4	0.4572	0.7944	0.9089	-0.1151	0.6037	-0.5536
-3	0.2913	1.1569	0.5055	-0.6717	0.5657	-0.6146
-2	0.1190	1.8177	0.2907	-1.0702	0.8711	-0.1708
-1	0.0716	2.1848	0.2103	-1.2721	0.9572	-0.0564
0	0.6338	0.5017	0.4090	-0.8339	0.4509	-0.8173
1	0.9983	0.0022	0.4724	-0.7251	0.4290	-0.8601
2	0.8417	0.2086	0.8120	-0.2394	0.6382	-0.5002
3	0.7870	0.2826	0.7290	-0.3488	0.5777	-0.5951
4	0.7195	0.3765	0.9350	-0.0821	0.5176	-0.6957
5	0.7862	0.2836	0.6576	-0.4464	0.6385	-0.4996

The null hypothesis is that the cumulative abnormal return for each day (from the first day in the event window) equals to zero. The t-statistic for date *i* in event window is:

$$TC_i = \frac{\frac{1}{N}\sum_{j=1}^{N} SCAR_{ij}}{\sqrt{\frac{1}{N(N-1)}\sum_{j=1}^{N}\left(SCAR_{ij} - \frac{1}{N}\sum_{k=1}^{N} SCAR_{ik}\right)^2}},$$

where N is the total number of events in the group, $SCAR_{ij}$ is the date i cumulative abnormal return in event window j, is the forecast standard deviation of AR_{ij}.

At 5% significance level, we accept the null hypothesis for any date in all groups, which implies that OPEC decisions have no significant impact on price whatsoever around the announcement days. One may wonder whether the findings thus far are also true for other global oil markets. To confirm these results, we conducted the same tests on WTI spot price (New York) and the Brent spot price (London). As expected, our results show that OPEC output decisions have no significant impact whatsoever on the WTI and Brent spot prices either.

THE IMPACT OF OPEC OUTPUT DECISIONS ON RETURN VOLATILITY

We now investigate how and whether OPEC output decisions affect the market volatility in event windows. To that end, we first generate one-step-ahead forecasts of the normal return volatility, using model (2) for each day in each event window. Here, squared realized daily return is used as a proxy for realized volatility. To test whether the realized volatility in event windows differs significantly from the forecasted normal volatility, we employ the non-parametric Wilcoxon signed rank test. This test requires no particular assumption about the distribution of volatility. To conduct the test for each date in each event window, we calculate the abnormal change in volatility (ABV), which is the difference between realized volatility and forecasted volatility. We then rank the absolute value of ABV from the lowest rank (rank 1) to the highest (rank N). Zero ABVs are excluded from the test sample, and tied absolute values receive ranks equal to the average of the ranks they would have received if they had not been equal. We next calculate the rank sums T+ of positive ABVs and T- of negative ABVs. The test statistic W is the smaller of T+ and T-. Our null hypothesis is that realized volatility does not significantly differ from the forecasted normal volatility, implying that ABV is not significantly different from zero. Under the null hypothesis, then, critical values of the test statistic W are tabulated. However, with large sample size, W approaches a normal distribution with mean $N(N+1)/4$ and variance $N(N+1)(2N+1)/24$, where N is the sample size. We conduct the test for each date in each decision group. The results are shown in Table 8.

TABLE 8.—TEST RESULTS OF THE VOLITILITY IMPACT OF OPEC OUTPUT DECISIONS FOR WTI FUTURES AND SPOT RETURNS

Event	Decreased Group		Unchanged Group		Increased Group	
Day	p-Value	Statistic	p-Value	Statistic	p-Value	Statistic
			WTI FUTURES			
-5	0.1230	15	0.0020	350	0.8125	12
-4	0.2783	20	0.1151	516	0.6875	11
-3	0.3203	21	0.1031	510	0.8125	12
-2	0.5195	25	0.0481	472	1.0000	14
-1	0.8311	30	0.0594	482	0.4688	9
0	0.8984	31	0.9347	680	0.2969	7
1	0.7646	29	0.8412	667	0.0781	3
2	0.5771	26	0.0804	497	0.2969	7
3	0.1748	17	0.0116	412	0.9375	13
4	0.4648	24	0.0143	420	0.3750	8
5	0.1016	14	0.1260	521	0.5781	10
			WTI SPOT			
-5	0.0098	3	0.0435	322	0.5781	10
-4	0.8457	25	0.4343	428	0.3750	8
-3	0.3223	17	0.1614	375	0.0156	0
-2	0.5566	21	0.0157	288	0.2969	7
-1	0.8457	25	0.5362	442	0.4688	9
0	0.3223	17	0.6574	457	0.9375	13
1	0.7695	24	0.2626	399	0.1094	4
2	0.6953	23	0.0208	297	0.2969	7
3	0.0645	9	0.0096	273	1.0000	14
4	0.1934	14	0.0652	337	0.1094	4
5	0.0840	10	0.1545	373	0.9375	13

The null hypothesis is that there is no abnormal volatility change on each day in the event windows due to events. The non-parametric Wilcoxon signed rank test is used to test the hypothesis.

For WTI futures, in the increased and decreased groups, there is no evidence that output decisions have any significant impact on volatility in event windows. In the unchanged group, we find evidence that the volatility decreases below normal 2 dates before the announcement date (dates -5 and -2) and 2 dates after (dates 3 and 4). We find no consistent evidence that OPEC can reduce volatility. The results are similar for both WTI spot and Brent spot during the entire sample period.

In short, we find no evidence that OPEC can reduce the volatility by manipulating its output as it invariably claims. The volatility impact of OPEC decisions is often patchy and transitory. When OPEC raises or lowers output more than expected, the volatility is virtually normal. When OPEC changes output as expected, volatility fluctuates a little before quickly returns to normal.

OPEC'S PRODUCTION DECISIONS IN RESPONSE TO VOLATILE GLOBAL OIL MARKET

In this subsection, we examine OPEC's production decisions in response to the price fluctuation in the global oil market. More specifically, we test whether OPEC raises output when price displays an uptrend, cuts output when price displays a downtrend, and finally keeps output unchanged when price is stable. To test this, each meeting event is assigned to one of three groups, depending on the corresponding OPEC output decision. If the decision is to increase output, the event is assigned to the increased group. If the decision is to decrease output, the event is assigned to the decreased group. And, finally, if the decision is to keep output at the current level, the event is assigned to the unchanged group. For WTI Futures price, given this criterion, we have 20 meetings in the decreased group, 17 meetings in the increased group, and 33 meetings in the unchanged group. Whereas for both WTI spot and Brent spot prices, we have 16 meetings in the decreased group, 15 meetings in the increased group, and 25 meetings in the unchanged group. As in the previous sections, let r_t and σ_t be the return and its volatility at date *t,* conditioned on the information set at date *t-1*. To estimate the market trend before the meetings, we employ the following model:

$$\begin{aligned} r_t &= \mu + \varepsilon_t, \\ \sigma_t^2 &= \kappa + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2, \end{aligned} \tag{8}$$

where $\mu, \kappa, \alpha, \beta$ are constant.

The price trend is represented by μ. If μ is positive, the price time-series displays an upward trend. If μ is negative, the price time-series displays a downward trend. If μ is not significantly different from zero, the price is stable. If OPEC were consistent with its production decision response to market price, we expect that it would raise output when price exhibits an uptrend, it would cut output when price exhibits a downtrend, and it would keep output unchanged when price does not exhibit a clear trend. That is to say, if OPEC were consistent in its response to the market, μ is significantly positive, significantly negative, and not significantly different from zero in the increased, decreased, and the unchanged groups in our sample, correspondingly. To test this, for each meeting in each group, we estimate model (8) using daily futures and spot data from 30 trading days preceding the event window. We then test the significance of μ using non-parametric Wilcoxon signed-rank test as described in the previous subsection.

For all three groups, our null hypothesis is that the price does not display an upward or a downward trend, implying that μ is not significantly different from zero. However, there are different alternative hypotheses for these different groupings. These are: the price displays a downward trend ($\mu < 0$) in the decreased group, an upward trend ($\mu > 0$) in the increased group and some trend ($\mu \neq 0$) in the unchanged group.

Table 9 exhibits the summary statistics and test results. For the WTI futures, in the decreased group, 65% of the times OPEC cuts output when the price is falling ($\mu < 0$), and 35% of the times it cuts output when the price is rising ($\mu > 0$). The mean of μ is negative and equals to -0.2566%. In the increased group, 58.82% of the times OPEC increases output when the price is rising, and 41.18% of the times it increases output when the price is falling. The mean of μ is positive and equals to 0.1457%. In the unchanged group, however, 45.45% of the times OPEC keeps output unchanged when the price is rising, while 54.55% of the times it keeps output unchanged when the price is falling. The mean of μ is very close to zero and equals to 0.0060% in this group.

For WTI spot (Brent spot) price, in the decreased group, 68.75% (81.25%) of the times OPEC cuts output when the price is falling ($\mu < 0$), and 31.25% (18.75%) of the times it cuts output when the price is rising ($\mu > 0$). The mean of μ is negative and equals to -0.27274% (-0.3656%). In the increased group, 73.33% (66.67%) of the times OPEC increases output when the WTI spot (Brent spot) price is rising, and 26.67% (33.33%) of the times it increases output when the WTI spot (Brent spot) price is falling. The mean of μ is positive and equals to 0.17096% (0.2126%). In the unchanged group, however, 48% (44%) of the times OPEC keeps output unchanged when WTI spot (Brent spot) price is rising, while

52% (56%) of the times it keeps output unchanged when WTI spot (Brent spot) price is falling. The mean of μ is very close to zero and equals to 0.02390% (0.0529%) in this group.

At 5% level of significance, we reject the null hypothesis in the decreased group (p-value is 0.0056 for WTI futures, 0.0010 for WTI spot, and 0.0065 for Brent spot). That is to say, there is evidence that OPEC cuts output when both futures price and spot prices trend downward. However, the null hypothesis cannot be rejected in the unchanged group for all three price trends. Therefore, there is evidence that OPEC keeps output unchanged when both futures price and spot prices are steady. Finally, for the increased group, OPEC production decision is not statistically significant in response to futures price. Therefore, the null hypothesis cannot be rejected for the WTI futures returns (p-value is 0.2037). However, for Brent and WTI spot returns, we reject the null hypothesis (p-values for Brent and WTI equal 0.0442 and 0.0498, respectively) at 5% significance level. Therefore, there is evidence that OPEC increases its output when both WTI and Brent spot prices trend upward.

TABLE 9.—TEST RESULTS OF OPEC'S CONSISTENT BEHAVIOR WITH THE COMPETITIVE GLOBAL OIL MARKET

	WTI Futures		
	Decreased (20 obs)	Increased (17obs)	Unchanged (33 obs)
Number of Meetings	20	17	33
Number of positive μ	7	10	15
Positive μ (%)	35	58.82	45.45
Number of negative μ	13	7	18
Negative μ (%)	65	41.18	54.55
Mean μ (%)	-0.2566	0.1457	0.0060
Statistic	37	47	261
p-Value	0.0056	0.2037	0.7275
	WTI Spot		
	Decreased (16 obs)	Increased (15 obs)	Unchanged (25 obs)
Number of Meetings	16	15	25
Number of positive μ	5	11	12
Positive μ (%)	31.25	73.33	48
Number of negative μ	11	4	13
Negative μ (%)	68.75	26.67	52
Mean μ (%)	-0.27274	0.17096	0.02390
Statistic	23	31	154
p-Value	0.010	0.0498	0.8191
	Brent Spot		
	Decreased (16 obs)	Increased (15 obs)	Unchanged (25 obs)
Number of Meetings	16	15	25
Number of positive μ	3	10	11
Positive μ (%)	18.75	66.67	44
Number of negative μ	13	5	14
Negative μ (%)	81.25	33.33	56
Mean μ (%)	-0.3656	0.2126	0.0529
Statistic	20	30	151
p-Value	0.0065	0.0442	0.7570

For each event, the following normal return mode is estimated:

$$r_t = \mu + \varepsilon_t,$$
$$\sigma_t^2 = \kappa + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2.$$

The null hypothesis is that μ is not significantly different from zero for all 3 groups. Non-parametric Wilcoxon signed rank test is used to test the hypothesis.

Thus, we conclude that OPEC's response to the market takes the pattern that is predictable in a competitive industry, given the fact that OPEC has no influence over price. Our evidence shows that, in respect to both spot and futures markets, when the price falls, OPEC tends to cut output and when the price is stable, it tends to keep output steady. However, OPEC's production is more responsive to spot prices than futures price. The probable reason might be that futures oil markets are more speculative than their spot counterparts. We have found that OPEC output decisions have no impact on the crude oil market. This is a significant finding; given the fact that OPEC is the largest supplier in the world oil market with nearly 40% total world production and 75% of the proven oil reserves. Now, let us look at the history of OPEC's quotas and its actual production in the sample period. Table 10 presents OPEC's average actual production and daily quotas for all the three groups in our sample.

TABLE 10.—SUMMARY OF OPEC QUOTAS AND ACTUAL PRODUCTION (1983-2005)

Meeting	New Quota (1.000 barrels per day)	Change in Quota (%)	Actual Output (1,000 barrels per day)	Change in Actual Output (%)	Over Quota (1,000 barrels per day)	Over Quota (%)
105	24387	-9.63	25898	-4.25	1511	6.19
82	15060	-9.28	18840	-4.80	3780	25.10
71	16000	-8.57	16574	-0.56	574	3.58
80	15800	-7.6	17215	-3.90	1415	8.95
78	16000	-7.5	17205	-12.82	1205	7.53
Consultative	25400	-7.3	27120	-2.32	1720	6.77
79	15000	-6.25	17914	4.12	2914	19.42
118	22701	-6.2	23970	-4.14	1269	5.59
107	22976	-5.79	24654	-5.36	1678	7.31
113	25200	-5.62	26791	-3.38	1591	6.31
91	22868	5.03	24378	2.33	1510	6.60
104	26255	-4.53	27048	-2.23	793	3.02
129	23500	-4.08	27628	0.67	4128	17.57
114	24200	-3.97	25930	-3.21	1730	7.15
127	24500	-3.54	27022	1.24	2522	10.29
122	23000	-3.13	24214	-2.60	1214	5.28
133	27000	-2.72	27765	-2.50	765	2.83
94	24500	-2.41	24871	-0.78	371	1.51
93	24000	-2.37	25066	0.85	1066	0.00
89	22300	-0.85	23307	3.53	1007	4.51
Ave. for Decreased	**22032**	**-5.32**	**23670**	**-2.01**	**1638**	**8.00**
68	17500	0	18924	-0.19	1424	8.14
69	17500	0	18029	-4.73	529	3.02
70	17500	0	16668	-7.55	-832	-4.76
72	16000	0	15698	-5.28	-302	-1.89
73	16000	0	15656	-0.27	-344	-2.15
74	16000	0	16092	2.79	92	0.58
75	16000	0	18156	12.82	2156	13.48
76	16000	0	17505	-3.59	1505	9.41
83	15060	0	21479	14.01	6419	42.62
88	22491	0	22511	2.77	20	0.09
90	22300	0	23823	2.22	1523	6.83
95	24500	0	24949	0.31	449	1.83
96	24500	0	24958	0.04	458	1.87
97	24500	0	25245	1.15	745	3.04
98	24500	0	25623	1.50	1123	4.58
99	24500	0	25699	0.29	1199	4.89

TABLE 10.— continued

Meeting	New Quota (1,000 barrels per day)	Change in Quota (%)	Actual Output (1,000 barrels per day)	Change in Actual Output (%)	Over Quota (thousand barrels per day)	Over Quota (%)
101	25033	0	26336	1.32	1303	5.20
102	25033	0	26767	1.64	1734	6.93
106	24387	0	26050	0.59	4139	6.82
108	22976	0	25172	2.10	2196	9.56
112	26200	0	27728	0.20	1528	5.83
115	24200	0	26259	1.27	2059	8.51
116	24200	0	25695	-2.15	1495	6.18
117	24200	0	25005	-2.69	805	3.33
119	22701	0	24068	0.41	1367	6.02
120	22701	0	24749	2.83	2048	9.02
121	22701	0	24861	0.45	2160	9.51
124	27400	0	27765	4.86	365	1.33
125	25400	0	26645	-1.75	1245	4.90
126	25400	0	26690	0.17	1290	5.08
128	24500	0	27445	1.57	2945	12.02
130	23500	0	27628	0.00	4128	17.57
134	27,000	0	27955	0.68	955	3.54
Ave. for Unchanged	**22193**	**0**	**23571**	**0.84**	**1452**	**6.45**
135	27500	1.85	28155	0.72	655	2.38
100	25033	2.18	25993	1.15	960	3.84
87	22491	2.23	21904	-7.66	-587	-2.61
111	26200	3.15	27672	1.68	1472	5.62
132	26,667	3.85	28478	-0.95	1,811	6.84
110	25400	4.15	27215	3.11	1815	7.14
77	16700	4.38	19735	12.74	3035	18.18
81	16600	5.06	19790	14.96	3190	19.22
85	19500	5.4	22828	8.15	3328	17.07
109	24387	6.14	26394	4.86	2007	8.23
92	24582	6.96	24854	1.95	272	1.11
123	24500	9.52	26478	9.35	1978	8.07
103	27500	9.86	27666	3.36	166	0.60
131	25167	10.64	28750	4.06	3583	14.50
Consultative	27400	11.84	27765	0.00	365	1.33
86	22000	12.82	23721	3.91	1721	7.82

TABLE 10.— continued

Meeting	New Quota (1,000 barrels per day)	Change in Quota (%)	Actual Output (1,000 barrels per day)	Change in Actual Output (%)	Over Quota (1,000 barrels per day)	Over Quota (%)
84	18500	22.84	21109	-1.72	2609	14.10
Ave. for Increased	**23537**	**7.23**	**25206**	**3.51**	**1669**	**7.85**
AVERAGE TOTAL	**22474**	**0.24**	**23996**	**0.68**	**1558**	**7.17**

Source: *OPEC Press Releases* and *U.S. Monthly Energy Review*, various issues. The Figures are compiled by the authors.

- New Quota: new quota set at the meeting.
- Change in Quota: percentage change in quota relative to the one designated in the last meeting.
- Actual Output: The average daily OPEC output from the day the new quota is in effect until the next meeting. Since the 1990 Persian Gulf War, Iraq has not been included when OPEC decides on new quotas. Therefore, we do not include Iraq's actual output since the 1990.
- Change in Actual Output: the percentage change in actual output.
- Over Quota: the amount overproduced.
- Percentage over Quota: the amount overproduced relative to the quota.
- Percentage over Quota: the amount overproduced relative to the quota.

On average, OPEC's quota, set at each meeting, is 22.474 million barrels a day. However, OPEC's actual output is 23.996 million barrels a day, with an average overproduction of 7.17% or 1.558 million barrels a day.[19] Each meeting recommends an average quota increase of 0.24%. However, the average actual increase in production is 0.68%. In other words, aside from 7.17% average over-production, the average growth rate of actual output is also higher than that of quota. In addition, there is little correlation between the recommended percentage change in quota and the actual percentage change in production (the correlation coefficient between them is 0.38). It seems that OPEC members do not actually restrain output to control the price, but behave competitively under the guidance of the price set by the market. This explains why the market does not react in a significant way to OPEC announcements.

We now need to look at all three groups of meetings separately. Our group categorization is as in the subsection above. In the increased (decreased) group, the recommended percentage increase (decrease) in production is 7.23% (-5.32%), while the actual production is 3.51% (-2.01%), with over quota of 7.85% (8.00%). Similarly, the average actual production in the unchanged group remains virtually unchanged (0.84%), while the average over quota in this category is 6.45%, not too far from the level of the two remaining groups. Thus, even though the actual trend of output follows the direction OPEC suggests, it is much less in magnitude than the suggested (less than half in the increased and the decreased groups). In addition, there is little correlation between the suggested percentage change and that of the actual (the correlation coefficient between them is 0.48 in the decreased group and -0.07 in the increased group).

Thus, our statistics indicate that OPEC members do not observe their quotas. Their production is higher than their quota most of the time and does not co-vary with the meeting's outcome. This is indeed strong evidence that OPEC members behave competitively in the global market and are not constrained by quotas.

CONCLUSION

This article investigates whether OPEC is a cartel (or an entity with any consequential "market power"), which indeed affects the global oil market by manipulating its output. Our objective is not a short-run but a systematic (long-

[19] The "over production" figure is calculated from the pre-average figures. Therefore, it is not identical with the difference between the average actual output and the average quota. The same is true for its percentage.

run) analysis of possible impact of OPEC on the global oil prices. In other words, we are not interested in the exceptional circumstances in which *any producer* (including OPEC) might be able to charge above or below market prices. Our interest here lies in the long-run price formation in which market expectations and OPEC actions have indeed come to grips with each other. Moreover, in reality, even in the short run (i.e., beyond the narrow and transient limit of windows), the presumption of OPEC control (or influence) over the global oil price is doubtful. The case in point is OPEC's designation of the so-called lower-and-upper price-bands ($22 and $28, respectively) vis-à-vis the volatile global oil prices in the early 2000s, the futility of which had become abundantly clear and thus rendered useless by the end of 2003.

We have shown that despite the fictional rendition of competition by mainstream theory—and noted radical followers—OPEC is not a cartel nor does it possess any "market power" which resembles the imagination of orthodoxy.[20] This investigation has also a sobering implication for the oil and energy policy in the United States, despite the demagogic characterization of OPEC by desperate politicians and the acquiescence of sloppy media. We treat OPEC as a cohesive whole and argue that a necessary condition for OPEC to be a cartel (or an entity with any consequential "market power") is that the unexpected parts of its output-decisions should have some impact on the market.

Utilizing the event-study technique and the *GARCH(1,1)* model with *AR(1)* in mean to model abnormal returns and volatility, we find no evidence that OPEC is able to control or affect either the spot or futures crude markets. The price impact is very weak and transitory, if at all, within event windows. We also find no evidence that OPEC can reduce the oil market volatility by manipulating its output. Nor is it warranted to claim that OPEC is the source of volatility and turbulence in the global oil market during the entire sample period. The volatility

[20] The fictional (i.e., speculative) characterization of capitalist competition (and tautological rendition of monopoly) is not only a hallmark of mainstream economic theory but also has taken on an epidemic proportion among the radical and liberal left, particularly by those in the *monopoly capital* crowd, whose today's hue and cry ascribe the cause of oil to the illegal, immoral, embarrassingly self-defeating, and certainly impeachable U.S. invasion and occupation of Iraq (see, among others, Klare, 2003, 2004; Bellamy-Foster, 2006; for critical response see Bina, 1991, 1993, 1995, 2004a, 2004b, 2006). It is noteworthy to identify, in passing, another serious blunder especially by self-proclaimed Marxists on the radical (antiwar) left on this issue. A typical example is an elaborate tautology on the deceptive slogan of "No Blood for Oil," at four different levels of rhetoric, by Caffentzis (2005; see particularly pp. 97-106, interview with Sara Burke: pp. 107-112, and pp. 153-165). The author keeps shifting the problem throughout by ad hoc mischaracterization of oil as a "basic commodity," misreading of Marxian rent, mischaracterization of the "organic composition of capital," and finally misuse of *globalization* as merely a "neoliberal agenda" (see Bina, 1985, 1989b, 1994, 1997, 2004a, 2004b, 2006 for further examination of these issues).

impact of the OPEC output decisions is also transitory and confined strictly within event windows. As a result, we conclude that global oil market is the prime mover and OPEC indeed follows its trajectory accordingly and consistently.

When market price (both spot and futures) is falling, OPEC decreases its output; when market price is rising, OPEC attempts to increase its output; and when market price is steady, OPEC keeps its output unchanged. Indeed, this is exactly a kind of behavior expected of a competitive producer. And, this is a kind of oil market we have experienced after the dust settled following the crises of de-cartelization and globalization of oil industry in the 1970s. OPEC is the collection of (rentier) oil exporting countries not because of the alleged appetite for "market power," but because of the possession of substantial differential productivity (with regards to the oil deposits by its members), which, within global competition provides its members with substantial revenue in terms of differential oil rents. This study confirms the prediction of earlier studies (see Bina 1985, 1989a, 1989b, 1990, 1992, 1994, 2006) that what is holding OPEC together is not the facade of alleged market power but a much fundamental phenomenon of differential oil rents, embedded in the dynamics of the decartelized and truly globalized oil industry since the 1973-74 oil crisis.

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