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## **Do OPEC Members Know Something the Market Doesn't?**

### ***“Fair Price” Pronouncements and the Market Price of Crude Oil***

Celso Brunetti   Bahattin Büyükşahin   Michel A. Robe\*   Kirsten R. Soneson

#### **Abstract**

OPEC producers, individually or collectively, often make statements regarding the “fair price” of crude oil. In some cases, the officials commenting are merely affirming the price prevailing in the crude oil market at the time. In many cases, however, we document that they explicitly disagree with the contemporaneous futures price. A natural question is whether these “fair price” pronouncements contain information not already reflected in market prices. To find the answer, we collect “fair price” statements made between 2000 and 2009 by officials from OPEC or OPEC member countries. Visually, the “fair price” series looks like a sampling discretely drawn (with a lag) from the daily futures market price series. Formally, we use several methodologies to establish that “fair price” pronouncements have little influence on the market price of crude oil and that they supply little or no new news to oil futures market participants.

**Keywords:** Crude oil, OPEC, Fair price, Announcement, Market price, Event study, Kalman filter, Autoregressive Distributed Lag (ADL)

**JEL codes:** E31, Q4, G140.

\* **Brunetti:** Johns Hopkins University, 100 International Drive, Baltimore, MD 21202. Tel: (410) 234-9408. Email: celsob@jhu.edu. **Büyükşahin:** Commodity Futures Trading Commission (CFTC), 1155 21<sup>st</sup> Street NW, Washington, DC 20581. Tel: (202) 418-5123. Email: bbuyuksahin@cftc.gov. **Robe (corresponding author):** Kogod School of Business at American University, 4400 Massachusetts Avenue, NW, Washington, DC 20016. Tel: (202) 885-1880. Email: mrobe@american.edu. **Soneson:** CFTC. Tel: (202) 418-5304. Email: ksoneson@cftc.gov. We are grateful to Kevin Carey and David Reiffen for helpful discussions; Bob Buckley, Rasmus Fatum, Robert Hauswald, Robert L. Losey, Jim Moser, Adam Sieminski and Phil Verlegger for useful comments; Joe Konizeski for generously sharing his knowledge regarding the legal history of “fair price” concepts in U.S. commodity markets; and Emiko Kawagoshi and Joe Opron for excellent research assistance. This paper was written in part when Brunetti and Robe were resident scholars at the CFTC. This paper reflects the opinions of its authors only, and not those of the CFTC, the Commissioners, or any of the authors’ colleagues on the Commission staff. All errors and omissions, if any, are the authors’ sole responsibility.

“ ‘We expected at the start of the year oil prices between \$75 and \$80 a barrel, this is a **fair price**... Oil prices (...) might rise reasonably’, (Saudi Arabia's King Abdullah) said. On Thursday, U.S. oil crude futures rose \$1.38 to \$78.05.” *Reuters, December 26, 2009*

## **I. Introduction**

The extent to which the Organization of the Petroleum Exporting Countries (OPEC) is able to control the price of crude oil has long been a topic of debate. When oil prices go up, pundits and politicians in oil-consuming countries often point to OPEC in their search for a causal explanation. At the height of the oil price surge in 2008, however, a number of market commentators instead used statements by various OPEC members to the effect that prices were bafflingly high as evidence that forces other than physical demand and supply were affecting the energy market. Implicit in such use of OPEC statements about oil price levels is the assumption that they generally contain new information relevant to future market prices. The present paper investigates the validity of this assumption.

To our knowledge, since studies of OPEC official prices in the 1980's (e.g., Verlegger, 1982; Lowinger and Ram, 1984; Hubbard, 1986), little research has been conducted on declarations by senior officials from OPEC or OPEC member countries regarding oil prices. Little is known about the effects of statements that these officials sometimes make about what they see as the “just price” or “fair price” of crude oil at a given point in time.

In the course of the past decade, we document that OPEC members have, individually or collectively, made nearly one hundred references to a “fair price” or “just price” of oil. The precise meaning of these pronouncements is unclear, insofar as this term of art has no direct counterpart in classical economic theory.<sup>1</sup> In this paper, we interpret the “fair price” of oil as the

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<sup>1</sup> Since ancient times, many societies have addressed the issue of what constitutes a “just” or “fair” price through religious or legal lenses. What is viewed as “fair” or “just”, however, varies greatly across space and over time. For brief histories of religious, societal and legal “fair price” norms, see e.g. Markham (2005) and Brewer (2007).

price that a particular OPEC producer would like to see prevail in the market. We provide qualitative information on the sources and contexts of those statements and carry out statistical analyses of the connection between the “fair price” and the futures-market price of crude oil.

Our main objective is to discern how much influence OPEC members’ “fair price” statements have on the market-determined price. In other words, how much information content is fed to the market on “fair price” pronouncement days? If “fair price” statements have a significant impact on market prices (for example, if they slow down or even reverse recent price trends), then we may infer that OPEC does have some control on the market price of crude oil.

We start by providing descriptive information on the frequency with which officials from OPEC or OPEC members make “fair price” statements and on the extent to which they agree or disagree with the contemporaneous level of the nearby-futures price of crude oil. We also ask whether the nationality of the official making the statement matters in that officials from some OPEC member countries may disagree more often than others.

We then use three methodologies to test whether “fair price” announcements contain any new information that influences the crude oil futures price at various horizons. First, we utilize an event-study methodology to ascertain whether “fair price” proclamations contain information that affects the nearby-futures price of crude oil. Second, we apply a Kalman-filter methodology to find out how closely the “fair price” tracks the “true price” of crude oil (i.e., the signal extracted from the market price series). Third, we use an autoregressive distributed lag (ADL) model to forecast the next-period-ahead crude oil price (using lagged market values), and we compare the consistency of those fitted values with the “fair price” values.

The event study analysis indicates that “fair price” pronouncements have no discernable effect on the nearby-futures price. Precisely, we find no statistical evidence that they have a systematic impact on the direction of post-event market price changes. For the subset of “fair

price” pronouncements that can be classified as “leaning against the oil market winds”, our tests clearly reject the hypothesis that these statements are successful at reversing (or even just slowing down the pace of) prior market price changes.

A natural question is whether our finding that “fair price” pronouncements generally do not move the oil market could reflect the fact that some of these announcements might not really be news (and thus should not be expected to have an impact on market prices). Several robustness checks suggest otherwise. First, we find qualitatively similar results when we exclude a sub-period in 2007 and 2008 when it has been argued that OPEC pronouncements could not have had much of an impact on crude oil prices. Second, we find no statistically significant difference when we separate “fair price” pronouncements based on exogenous characteristics that might affect the newsworthiness of the statement (e.g., statements by “OPEC hawks” *vs.* other countries, OPEC consensus *vs.* country officials, statements that agree *vs.* disagree with the market price, etc.). Third, we find qualitatively similar results for “fair price” pronouncements that do not coincide with OPEC conferences and for pronouncements that overlap with OPEC meetings (approximately twenty percent of the sample). For the latter, the additional information we extract from statements released at official OPEC meetings about decisions to increase, decrease, or keep output constant is, with a single exception, directionally consistent with the “fair price” pronouncement. Yet, even for this subset, we find no statistical evidence of any short-term impact on prices. Rather, the information content of the “fair price” pronouncement has already been incorporated into the market through prior market expectations.

Our Kalman-filter results reinforce the impressions from the event study. For most events, the “fair price” is statistically indistinguishable from the filtered or “true price”, meaning that any information conveyed by the “fair price” has already been incorporated into the market prior to each “fair price” announcement. Prior to Fall 2007, we find virtually no instance when

the filtered price and “fair price” differ. In 2008 and 2009, in contrast, the “fair price” observations often fall outside of the confidence intervals around the filtered price series. Even in that period, however, the filtered price does not adjust toward the “fair price” level. This is supplementary evidence that the “fair price” announcements convey little or no new information.

The ADL model yields qualitatively similar findings in that “fair price” pronouncements are indistinguishable from a market price forecasted on the basis of past market price values. In sum, these pronouncements have little contribution to pre-existing information in the market. Our results do not support the claim that verbal interventions influence crude oil market prices.

The remainder of the paper proceeds as follows. Section II summarizes our contribution to the literature. Section III describes the data. Section IV introduces our formal hypotheses and methodologies. Section V discusses our findings. Section VI concludes.

## **II. Related Work**

The present paper contributes to the economics literature on oil markets in general and on OPEC’s ability to control the price of crude oil in particular.<sup>2</sup> It is also part of the finance literature on the efficiency of energy-derivatives markets. More broadly, insofar as it asks whether statements by key oil market participants about current market prices have an effect on the future levels of those oil prices, our paper is related to a rich literature on the impact of verbal interventions in interest rate and foreign exchange markets.<sup>3</sup>

OPEC’s influence on the price of crude oil has been the subject of much debate. OPEC oil ministers negotiate key policy issues (such as production levels, output quotas, etc.) at pre-

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<sup>2</sup> For a detailed discussion of the causes and consequences of oil price shocks, see e.g. Kilian (2008).

<sup>3</sup> For a thorough review of the research on the impact of central bank communications on interest rate expectations, see Blinder *et al* (2008); see also Sarno and Taylor (2001). More recent is the work on verbal Forex interventions by central banks (e.g., Jansen and De Haan 2005, Fratzscher 2008) or supra-national institutions (e.g., Fratzscher 2009).

announced conferences and meetings. How collective decisions made at those meetings vary from market expectations, and how the official announcements of those decisions to the public impact market prices, are thus questions important to market participants. The communiqués at OPEC conferences are, as a result, the main input of many empirical studies on the energy market's reaction to decisions made at OPEC conferences. Overall, those studies find only mixed evidence of OPEC influence on oil prices (e.g., Wirl and Kujundzic, 2004) and returns (e.g., Loderer, 1985; Demirer and Kutan, 2010) or on the implied volatility (Horan *et al*, 2004) and realized volatility (Wang *et al*, 2008) of oil futures returns.<sup>4</sup>

Unlike our paper, those studies concentrate on production-related announcements (e.g., production levels, quotas, or operable capacity) rather than on statements referring to a specific price for crude oil. This orientation of the extant literature reflects the heavy focus of OPEC conferences on decisions to increase, reduce, or keep production levels constant. OPEC's focus itself arguably reflects its decision in 1986 to “reinstitute quotas after changing its announced strategy from defending an official price to defending market share” (Kaufmann *et al*, 2004).

Our findings also contribute to the finance literature on the informational efficiency of energy futures markets. Closest to the present one are the studies of Draper (1984) and Deaves and Krinsky (1992).<sup>5</sup> Draper (1984) uses an event-study methodology to analyze weekly heating oil futures returns around five “regular” and “special” OPEC meetings between Fall 1978 (when the New York Mercantile Exchange or NYMEX first introduced futures contracts on heating oil) and 1980. Deaves and Krinsky (1992) analyze crude oil as well as heating oil futures returns

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<sup>4</sup> Those papers are part of a large literature on the goals of OPEC and its effectiveness as an organization – including e.g. papers by Griffin (1985); Loderer (1985); Dahl and Yücel (1991); Gülen (1996); Alhajji and Huettner (2000); Kaufmann, Dees, Karadeloglou and Sanchez (2004); Smith (2005); and Kaufmann *et al* (2008). See Kaufmann *et al* (2008) for a concise review and Smith (2005) for a comprehensive one.

<sup>5</sup> Further afield from, but partly related to the present paper, are the literatures on oil price forecasting (see Coppola (2008) for a recent review) and on the relationship between energy prices and macroeconomic news (see Kilian and Vega (2010) and references cited therein).

using a much longer sample of OPEC conferences. They sort OPEC conferences based on the sign of oil futures returns on the day following the end of the conference. They find that crude oil prices react efficiently to “bearish” conferences but not to “bullish” ones (defined as meetings when next-day returns were positive). Precisely, they argue that futures traders taking long positions on the day after a bullish conference’s conclusion seem to earn economically and statistically significant subsequent excess returns. With a caveat related to the still-unsettled nature of accounting for commodity price risk in the computation of excess returns, Deaves and Krinsky conclude that their results do not support the market efficiency hypothesis.

In both of those related branches of the economics and finance literature, the information (if any) from OPEC statements is related to the *production* of oil, and the event is anticipated in that OPEC conferences and meetings are publicized ahead of time. In contrast, the pronouncements we analyze regard *prices* (whether made at OPEC conferences or not), and there is little reason to expect that non-OPEC energy market participants are able to forecast the timing of the statements. We also make a methodological contribution by applying Kalman-filter and ADL methodologies and by enhancing the event-study methodology used in previous work to help identify the information contained in the “fair price” pronouncements.

In short, if “fair price” pronouncements contain news for non-OPEC market participants (e.g., if the pronouncements are signals about physical market conditions or a country’s or OPEC’s strategies), then we should observe an impact on crude oil futures prices. We find little evidence of a price reaction. Altogether, our findings support the notion that “fair price” announcements add little to pre-existing information, and that these verbal interventions by OPEC or OPEC members generally have little impact on the futures market price of crude oil.

### **III. Data and Qualitative Analysis of the “Fair Price” Series**

This section describes the market price data, explains the construction of our “fair price” sample, and provides summary statistics and a graphical analysis of the “fair price” statements.

#### **A. Data**

##### ***1. Market Price Series***

The world’s most liquid crude oil contract is the nearby West Texas Intermediate (WTI) light sweet crude oil futures contract traded on the NYMEX (Büyükaahin *et al*, 2009). We therefore use the WTI nearby-futures price as the relevant market price of oil in our study.<sup>6</sup> We obtain settlement prices from the data-feed sent daily by NYMEX to the Exchange’s government regulator, the U.S. Commodity Futures Trading Commission (CFTC). Our sample period covers nearly ten years, from January 2000 through August 2009.

Like prior studies that require a continuous time series of nearby-futures prices, we define the nearby futures as the closest-to-delivery contract that has the highest open interest. The reason is as follows: WTI futures rarely involve physical delivery – approximately two to three weeks before a contract expires, almost all market participants exit the market by closing out their futures positions altogether or by rolling over the positions held in the expiring contract into the next-to-nearby futures (in the crude oil market, that contract is always the first-deferred futures in our sample period). This “roll” can entail price distortions due to liquidity issues and generates some type of seasonality in the data. To mitigate the resulting measurement issues, we create a continuous time series of nearby-futures prices by switching to the next-to-nearby

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<sup>6</sup> We carry out some robustness checks using the OPEC-basket prices instead, and obtain similar results. Hence, we only report results for WTI futures prices.



contract on the first date on which the open interest of the nearby contract is lower than the open interest of the next-to-nearby contract.

## 2. “Fair Price” Series

We construct a time series of quotes regarding the “fair price” of oil made by OPEC officials or by senior government officials from individual OPEC member countries at various points in time from January 2000 through the end of August 2009. We use the Lexis-Nexis Academic and Westlaw databases to identify stories, in major English-language U.S. and non-U.S. newspapers and newswires, mentioning a “fair price” or a “just price” in the context of oil markets.<sup>7</sup>

From the more than one thousand news stories and reports thus obtained, we identify 111 “fair price” events. We remove from the sample all stories in which we cannot verify the exact date of the announcement or cannot unambiguously link the use of the term “fair price” to a specific senior OPEC or OPEC-country official, leaving 81 episodes. When two pronouncements by the same or by different officials overlap within a 5-day event window, we set the event date as the date of the first “fair price” statement and omit the later statement(s). This approach is predicated upon the assumption that all of the information (if any) from a short-order succession of “fair price” pronouncement is conveyed by the first of those statements.<sup>8</sup>

Our final sample comprises 63 unique observations. The first is dated March 28, 2000; the last is from May 27, 2009. For each of the 63 observations, we have information on the

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<sup>7</sup> Precisely, in the content analysis of the articles returned by our search engine that contain the term “fair price”, we treat “just price” and “fair price” as synonyms. We did not search for articles containing only the term “just price”.

<sup>8</sup> Fatum and Hutchison (2003), whose event-study methodology we otherwise adapt to the context of “fair price” announcements, use a different approach to analyze the effectiveness of sterilized foreign exchange intervention. These authors define an “event” as a series of foreign-exchange intervention days in which two days of actual intervention may be separated in time (but by no more than a certain number of days). Their approach is consistent with the fact that, in contrast to our setting, actual (as opposed to verbal) Forex intervention routinely takes place over the course of more than one day and, hence, the full impact of an intervention cannot be known until it is over.

release date of the story, the date when the official actually proffered his statement, the country of origin or OPEC title of the official, and the “fair price” level or range mentioned. We also analyze additional information conveyed in the news stories, including information on whether the official agreed with the contemporaneous market price of oil and the crude oil benchmark he used as a reference (generally WTI or the OPEC basket, but sometimes Brent or Venezuelan). Appendix 1 provides descriptive statistics for each of the 63 “fair price” announcements.

### ***3. Control Variables***

In the event-study portion of our formal analysis, we use information pertaining to official OPEC production press releases (dates and whether production would increase, decrease, or remain constant) that are disclosed during ordinary (planned) and extraordinary (special) OPEC meetings. This allows us to control for the possible impact on market prices of production announcements concomitant with “fair price” pronouncements.

Only 13 of the 63 “fair price” events in the sample took place within a ten-day window surrounding (five days before or five days after) production-related OPEC announcements. Appendix 2 shows that, with the exception of the very first “fair price” event on March 28, 2000, the two overlapping announcements in each pair are always consistent with one another. When the “fair price” level exceeds the median market price ( $FP > MP$ ) prevailing in the two or five days prior to the announcement, one would expect OPEC to also announce a production cut to increase prices. This is indeed what we see on January 14, 2001, on March 11, 2002, and twice in 2008. When  $FP < MP$ , one would instead expect OPEC to announce a production increase in a bid to lower prices. This is what we see on September 4, 2000 and on seven other occasions.

When we analyze those 13 overlapping observations (in Section V.A), we include data on the direction of the OPEC production news, as well as information from a survey of 20

economists regarding their expectation of upcoming crude oil production announcements. Bloomberg is the source for this variable. We use it to gauge market surprises in terms of whether the commodity analysts correctly anticipated the actual OPEC production decisions.

## **B. Graphical Analysis of the “Fair Price” Series**

### ***1. “Fair price” vs. Market Price – Does OPEC Agree with the Current Market Price?***

Figure 1 plots the levels included in the 63 “fair price” pronouncements in our sample against the contemporaneous nearby-futures settlement price for WTI crude oil. When the “fair price” statement refers to a range rather than a specific level, we plot the mean of the stated “fair price” range. Figure 1 partitions the “fair price” statements into three groups: those in which the official explicitly agrees with the contemporaneous market price level (green triangles); those in which the official explicitly disagrees with that current level (red dots); and those for which the relevant news stories do not state whether the official agrees or disagrees with the market price of crude oil (purple squares).

In only 5 cases do the officials explicitly affirm the then-prevailing market price of crude oil. In 24 cases, the officials explicitly disagree with the price level determined by energy futures traders in the open market. Although the news articles about the remaining 34 “fair price” events do not directly state whether or not the official making the pronouncement agrees or disagrees with the current market price, Figure 1 hints strongly at disagreements with the market price in most cases – especially after 2003. As a whole, Figure 1 suggests that the officials making the statements either agree with the market price or view it as too high, with the interesting exception of the price collapse in late 2008 and the first half of 2009 – when “fair price” statements remained in the \$75-100 range despite a collapse in the nearby-futures price.

## 2. *Heterogeneity within OPEC?*

Of course, as in any cartel, not all OPEC members are alike (see, e.g., Smith 2008). In our setting, certain members of the group may desire different prices for crude oil depending on country-specific factors, such as the effective discount rates of the governments in place, crude oil reserves, spare capacity and cost structures for oil production.

Do differences among OPEC members manifest themselves through their “fair price” pronouncements? For example, do countries that many market commentators view as OPEC “hawks” (Algeria, Iran, Libya and Venezuela) tend, more than others, to assert that the “fair price” of oil is higher than the contemporaneous market level?<sup>9</sup> Does the pattern of Saudi Arabia’s “fair price” statements suggest that it, with its ample energy reserves, tries to dampen price movements by issuing soothing statements about lower-than-market “fair price” levels? To consider these possibilities, Table 1 and Figure 2 separate the statements by (i) Saudi Arabia; (ii) Algeria, Iran, Libya and Venezuela; and (iii) other member countries or a “consensus” by OPEC.

Table 1 and Figure 2 do not highlight obvious differences between the three groups. In particular, Figure 2 suggests that officials from “hawkish” members (red) do not seem to make price statements that are systematically more bullish or optimistic (from the perspective of oil producers) than officials from Saudi Arabia (green), OPEC, or other member countries (purple). To wit, although Venezuela favored production cuts through much of the sample period and made “fair price” statements supporting each of the successively higher price peaks until 2007, it viewed \$100 as a “fair price” in the first half of 2008 despite much higher market prices. Still, it is worth noting that OPEC “hawks” seem to have been more vocal in support of higher oil prices after market prices fell significantly in late 2008 and early 2009.

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<sup>9</sup> Nigeria is another country with low *per capita* oil reserves that, for this reason, is sometimes viewed as a “hawk”. Our sample, however, contains only one “fair price” pronouncement that we can unambiguously trace to a Nigerian senior official. Because the other (several) other Nigerian statements appear in news reports that also mention contemporaneous statements by OPEC officials, we do not include Nigerian statements in the “hawkish” group.

### 3. *“Fair Price” or Market Price -- which moves first?*

A natural question, and the main focus of our paper, is whether “fair price” statements lead market prices or whether the “fair price” level is merely a function of lagged (i.e., stale) market prices. Figure 3 strongly suggests the latter, with the “fair price” series virtually indistinguishable from a step function whose steps would be anchored by the market price series some time prior to the relevant “fair price” pronouncement.<sup>10</sup> We therefore turn to formal analyses to test this apparent relationship between the “fair price” and market price time series.

## IV. Hypotheses and Methodology

In this Section, we use several methods to formally test, and subsequently confirm, the visual impressions gleaned from Figure 3. We do so by using, in turn, an event-study methodology (Section IV.A), two Kalman filters (Section IV.B), and an autoregressive distributed lag model (Section IV.C).

### A. Event Study

The first technique that we utilize is the event-study methodology, which has a long history and has seen many applications in finance and economics (MacKinlay, 1997). Common to all of these studies is the arrival of “true news”. In this study, our interest is in information content that has an impact (whether temporary or longer-lasting) on crude oil market prices.

To study the effect of “fair price” pronouncements on the market price of crude oil, we compare the behavior of the nearby WTI oil futures price before and after a reported pronouncement. For each pronouncement, we form an “event window” where the statement report day serves as the event separating all preceding and all succeeding observations.

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<sup>10</sup> Appendix 3 provides a textual summary of the time sequence of “fair price” pronouncement depicted in Figure 3.

The length of the pre- and post-event windows is set to capture the normal performance of the price of crude oil and the after-announcement performance of the price of oil. We use pre- and post-event window lengths of two, three, four and five days to guarantee robustness. Our findings indicate that the results do not vary qualitatively depending on the window length chosen. Hence, we only report results for the two- and five-day estimation windows.

After creating our windows for the pre-event, event, and post-event, we choose a criterion to identify the effect of the “fair price” pronouncement on price movements. We use two different non-parametric tests for the purpose of comparing pre- and post-event prices, drawing on prior empirical work on the effectiveness of central bank interventions in the foreign exchange market (see Humpage (1999), Fatum and Hutchison (2003), and references therein).

Criterion (1) is a simple “direction criterion” that tests the “fair price” pronouncement’s success by simply asking whether, in the post-announcement window, the nearby-futures price of crude oil moves in the same direction as the “fair price” pronouncement. More formally, this first criterion states that a pronouncement is successful if:

$$\text{either } [FP_i > \bar{P}_{i-} \text{ and } \Delta\bar{P}_{i+} > 0] \text{ or } [FP_i < \bar{P}_{i-} \text{ and } \Delta\bar{P}_{i+} < 0] \quad (1)$$

where  $FP_i$  is the “fair price” during the  $i^{\text{th}}$  event or announcement ( $i=1, \dots, 63$ ),  $\bar{P}_{i-}$  is the median market price in the pre-event window, and  $\Delta\bar{P}_{i+}$  is the median daily market price change in the post-event window. In essence, if the stated “fair price” is greater (*lower*) than the lagged price and if the announcement is effective, then we should observe an upward (*downward*) movement in the market price in the post-event window.

To test whether the direction of crude oil futures prices is random or systematic following “fair price” pronouncements, we run a non-parametric sign test. Under the null hypothesis that the direction is random, it is equally probable that the cumulative post-event return  $\Delta\bar{P}_{i+}$  is

positive or negative. Hence, letting  $X^+$  stand for the number of successes (defined according to condition (1)) among  $X$  sample observations:

$$\theta = \left[ \frac{X^+}{X} - 0.5 \right] \frac{\sqrt{X}}{0.5} \sim N(0,1)$$

The second criterion we utilize defines a successful “fair price” pronouncement as one associated with a smoothing of prior market-price movements after the event. We adapt this “smoothing criterion” to the oil-market setting by classifying a pronouncement as a success if it is successful according to the “direction criterion” (1) or if one of the following conditions holds:

$$\text{either } [FP_i > \bar{P}_{i-} \text{ and } \Delta\bar{P}_{i+} > \Delta\bar{P}_{i-}] \text{ or } [FP_i < \bar{P}_{i-} \text{ and } \Delta\bar{P}_{i+} < \Delta\bar{P}_{i-}] \quad (2)$$

where  $\Delta\bar{P}_{i-}$  is the median daily market price change in the pre-event window.

Of course, judging the success of a “fair price” pronouncement according to this criterion is meaningful only if the official making the statement is “leaning against the wind” (i.e., if he is trying to reverse or to slow a prior market price trend). Accordingly, we must test for success conditional on the sign of the pre-announcement return  $\Delta\bar{P}_{i-}$ .<sup>11</sup>

Formally, if the officials’ statement is “leaning against the oil futures market wind”, then it must be the case that either  $[\Delta\bar{P}_{i-} > 0 \text{ but } FP_i < \bar{P}_{i-}]$  or  $[\Delta\bar{P}_{i-} < 0 \text{ but } FP_i > \bar{P}_{i-}]$ . In the first case, the official is trying to signal that prices are too high or are increasing too fast, so success is defined as either  $[FP_i < \bar{P}_{i-} \text{ and } \Delta\bar{P}_{i+} < 0]$  (i.e., the “fair price” statement reverses the previous direction of market prices) or  $[FP_i < \bar{P}_{i-} \text{ and } \Delta\bar{P}_{i+} < \Delta\bar{P}_{i-}]$  (i.e., it either reverses

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<sup>11</sup> This conditioning also tackles an issue of endogeneity stemming from the possibility that officials may take their cue to issue “fair price” statements from observed oil-market price levels or movements (see Fatum and Hutchinson (2003) for a similar point in the context of central bank interventions). Put differently, although the manner in which OPEC and member countries’ officials determine the “fair price” is unclear, our premise is that assumptions can be made regarding its determination based on the timing of their announcements in relation to the current market prices at the times of the announcements.

the course or slows down the pace of increase). In the second case, the signal is that prices are too low and should not be falling, so success is defined as either [ $FP_i > \bar{P}_{i-}$  and  $\Delta\bar{P}_{i+} > 0$ ] (reversal criterion) or [ $FP_i > \bar{P}_{i-}$  and  $\Delta\bar{P}_{i+} > \Delta\bar{P}_{i-}$ ].

When we define success under this broader “smoothing” criterion, the null hypothesis for the non-parametric test is that “fair price” pronouncements should be successful 75 percent of the time. With the stricter “reversal” criterion, we naturally retain the 50 percent level.

## B. Kalman Filter

The second methodology we apply is the Kalman filter, which allows us to separate the “true price” from the noise component in the market price by estimating the state of a linear dynamic system from a series of noisy measurements. Like the ADL technique that will be described in Section IV.C, this methodology allows us to answer the question of how close the “fair price” is to the filtered (“true”) market price of crude oil.

In our setup, the noisy measurements are given by the observed nearby-futures prices for WTI light sweet crude oil. We adopt the following state-space representation:

$$\begin{aligned}
 y_t &= \alpha_0 + \alpha_1 x_t + \varepsilon_{1,t} \\
 x_t &= \alpha_2 x_{t-1} + \varepsilon_{2,t} \\
 \varepsilon &\sim \mathbf{N}(\mathbf{0}, \mathbf{\Omega})
 \end{aligned}
 \tag{3}$$

where  $\mathbf{\Omega}$  is the covariance matrix of the two error terms,  $y_t$  is the rate of return computed from the crude oil nearby-futures prices, and  $x_t$  is the latent “true” process (or filtered market price). We use rate of returns rather than prices in (3) because non-stationarity tests show that crude oil futures prices are I(1) in our sample period. In Section V.B, we will also utilize those returns to draw an instructive plot of the filtered market price *vs.* the “fair price” series.



### C. ADL Model

Intuitively, we are interested in the relationship between the “fair price” series and prices that can be forecasted based on prior information. If the crude oil futures market truly embeds all of the extant information before “fair price” events, then “fair price” pronouncements by OPEC-linked officials should not provide additional news to futures traders and the forecasted price should be very close to the “fair price”.

The last technique we apply to forecast crude oil futures prices is an Auto-Regressive Distributed Lag (ADL) process. This methodology allows us to directly model non-stationary time-series data without pre-filtering. ADL models have been successfully implemented in econometrics to model the dynamic behavior of different macroeconomic and financial variables.

This class of models can generally be written as follows:

$$P_t = \gamma + \sum_{i=1}^q \alpha_i P_{t-i} + \sum_{i=1}^p \beta_i Z_{t-i} + \epsilon_t \quad (4)$$

where  $P$  is the nearby-futures price of crude oil and  $Z$  is a set of other explanatory variables.

In the case at hand, we use lagged price values of the market price,  $P_{t-i}$  (to account for the non-stationarity of the crude oil nearby-futures price series in our sample period), but do not include any additional explanatory variables,  $Z_{t-i}$ . From a practical perspective, adding other variables would make it difficult to disentangle the effects of those other variables versus the effects of the price itself. In essence, by choosing a model-free version of (4), we assume that all relevant past information is incorporated in the price process and, thus, we model futures prices as a function of past prices only. Our goal, then, is to identify the signal, in a forecasting sense: are these forecasts, based only on the information contained in the price, in line with the “fair price”?

The ADL model accommodates non-stationary time series, so we estimate (4) using simple OLS. We use weekly data (every Wednesday) and monthly data (the last observation day of every month) and use rolling windows of a year (52 weeks) or three years (36 months). We focus on one-step-ahead forecasts of weekly or monthly crude oil futures prices. The optimal lag length ( $q$ ) is selected using the Akaike Information Criterion (AIC) and likelihood ratio tests.

## V. Analyses and Results

In this Section, we apply the three methodologies described in Section IV to test whether, in the last decade, “fair price” announcements contained information that, at various horizons, influenced the nearby-futures price of crude oil.

### A. Event study

In order to test the effectiveness of “fair price” pronouncements on the current price of crude oil, we employ nonparametric tests for the median. These tests tell us whether, in the days following the “fair price” announcements, the direction and/or the magnitude of crude oil futures prices are random or systematic. Figure 4 and Tables 2 to 5 summarize our results.

#### *1. Results*

Our event studies all support the claim that “fair price” pronouncements are not successful at either affecting the direction of the market or at slowing down the pace of prior market price movements. We find qualitatively similar results regardless of whether or not we split the 63 “fair price” events (see Figure 4) based on whether there is not (Tables 2 and 4) or is (Tables 3 and 5) a concomitant OPEC oil-production announcement. Tables 2 and 3 use two-day windows to compute the pre- and post-event returns around the “fair price” day. Tables 4 and 5

repeat the tests of Tables 2 and 3, respectively, using five-day windows.

In each of these four tables, Panel A uses the “directional criterion” (1) to assess the randomness of the post-event price change; Panels B and C use the “smoothing criterion” to evaluate the success of pronouncements that appear to “lean against the oil futures market winds”. Panel B focuses on reversals (applying criterion (1) to those pronouncements classified as “leaning against the wind”), while Panel C judges success more broadly as announcements that either reverse the prior market course (as in Panel B) or at least slow it down.

Figure 4 and Tables 2 to 5 show that, regardless of the criterion used, in *none* of the experiments can we reject (at *any* standard level of significance) the hypothesis that the post-pronouncement oil-market return is random. Figure 4 and Tables 3 and 5, by identifying the “fair price” statement taking place within two or five days of (before or after) an OPEC meeting at which a production cut or increase is announced, complement extant research on the (weak) effects of OPEC-sourced production news. Figure 4 and Tables 3 and 5 show that adding a “fair price” pronouncement to production related news does not systematically affect the market.<sup>12</sup>

## ***2. Discussion***

These results suggest that the information content of the “fair price” pronouncement has already been incorporated into the market through prior market expectations. A natural question, then, is whether the finding that “fair price” pronouncements generally do not move the oil market could partly reflect the possibility that some of these announcements might not really be news (and thus should not be expected to have an impact on market prices).

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<sup>12</sup> Wirl and Kujundzic (2004) show that, between 1984 and 2001, production-related announcements had at best a “weak impact” on subsequent market developments, and “if at all then restricted to meetings recommending a price increase”. In our more recent sample (2000-2009), we find that, after conditioning the nonparametric tests on the direction of the production change, we still cannot reject the randomness hypothesis at any level of significant for any of the criteria. That is, even for those events when a “fair price” statement is backed by production-related OPEC news, we find no statistical evidence of an impact on nearby-futures prices.

The fact that our results hold for “fair price” statements that do not coincide with OPEC conferences, as well as for “fair price” statements that overlap with official OPEC meetings suggests otherwise. Two additional sets of tests further support the robustness of our results. First, we find no statistically significant difference when we separate “fair price” statements based on exogenous characteristics that might affect the newsworthiness of the statement (e.g., statements by “OPEC hawks” *vs.* other countries, OPEC consensus *vs.* country officials, statements that agree *vs.* disagree with the market price, etc.). Second, we find qualitatively similar results when we exclude a sub-period from August 2007 to July 2008 when it has been argued that environmental regulations may have had an inordinate impact on oil prices and, hence, that OPEC actions or pronouncements may not have had much of an impact on crude oil prices (Verlegger, 2009). In sum, the event study does not support the idea that verbal interventions influence crude oil market prices.

## **B. Kalman filter**

We use daily, weekly, and monthly data for the Kalman filter analysis. The results are qualitatively similar regardless of the frequency adopted, so to conserve space we only report results for the monthly observations.

The rates of returns on crude oil futures ( $y_t$  in system (3)) are characterized by low volatility in the first part of our sample (cash returns behave in a very similar way). However, this volatility was dramatically higher between Fall 2007 and Spring 2009. We therefore test two different Kalman filters. In the first filter, we allow the covariance matrix to be time-varying so as to account for the different behaviors of the volatility of  $y_t$ . In the second filter, we estimate the above system for two different subsamples: the first sub-period covers January 4,

2000 to September 13, 2007; the second begins on September 14, 2007 and ends on July 31, 2009. The two estimations produce similar results, so we focus on the first one.

We plot the filtered price *vs.* the “fair price” series in Figure 5. The latter depicts the one-step-ahead forecast of the signal (filtered or “true price”) process in red and the standard errors (confidence band) from the state-space model in dotted lines.

Figure 5 shows that the “fair price” series closely mimics the signal extracted from market data – even if, at times, it steps outside of the confidence band (especially from mid-2007 onwards). With regard to our initial question (“How close is the “fair price” to the filtered price?”), Figure 5 suggests that any information content in the “fair price” is incorporated into the market prior to the “fair price” statement. Indeed, even in the instances when the filtered price and the “fair price” are further apart, the filtered price does not move toward the “fair price” level. This is supplementary evidence that the “fair price” pronouncements have little or no new information content.

### **C. Autoregressive distributed lag (ADL) model**

Figure 6 graphs the actual crude oil prices, forecasted prices, and confidence bands for the monthly time series ( $\pm 2 \text{RMSE}$ ) estimated with the ADL model (4). Figure 6 focuses on monthly data (rather than, say, weekly data) to account for the possibility that “fair price” pronouncements may not relate to the price of crude oil a mere few days ahead but, rather, may be forecasting supply and demand conditions over a longer time period.

The plot starts in 2003 because of the initial 36-month sample needed to estimate the ADL model.<sup>13</sup> The actual price and the forecasted price are nearly indistinguishable. The ADL

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<sup>13</sup> For the monthly data, we use the end of month observations from daily data and a rolling window of 36 months (three years) for the one-step ahead forecasts.

model, in other words, fits the data well.

Until mid-2008, most of the “fair price” levels fall within the confidence band around the forecast (in the monthly context). When the “fair prices” fall within the ADL-based confidence intervals, the logical conclusion is that the “fair prices” reflect the same information as do the current market prices. In mid-2008, however, Figure 6 shows an apparent structural break, with one observation of the “fair price” level under the confidence band in mid-2008 followed by several “fair price” statements well above the confidence band in late 2008 and early 2009. These observations suggest that the “fair price” statements during that period were worse forecasts of one-month-ahead prices than were market-based forecasts. Again, the conclusion is that taking “fair price” statements into account would not help improve market-price based forecasts.

## **VI. Conclusion**

OPEC producers, individually or collectively, often make statements regarding the “fair price” of crude oil. In some cases, the officials commenting are merely affirming the price prevailing in the crude oil market at the time. In many cases, however, they explicitly disagree with the contemporaneous market price.

A natural question is whether these “fair price” pronouncements contain information not already reflected in crude oil futures prices. This question is all the more relevant that, in the last couple of years, a number of market commentators have used such statements as evidence that forces other than physical demand and supply were likely affecting the energy market. This fact in turn raises the possibility that some policy makers in oil-consuming countries might treat “fair price” pronouncements as informative.

The present paper does not speak to what forces may ultimately affect energy prices. Rather, it uses a number of model-free statistical techniques to ask whether, in fact, these “fair price” pronouncements are informative and affect crude oil market prices.

We collect “fair price” statements made from 2000 to 2009 by officials from OPEC or OPEC member countries. Visually, we show that the “fair price” series looks like a sampling discretely drawn (with a lag) from the daily market price series. Formally, we use several methodologies to establish that “fair price” pronouncements have little influence on the market price of crude oil and that they supply little or no extra news to oil futures market participants. Our results hold regardless of whether or not the “fair price” pronouncement is made within a ten-day window of consistent production announcements by OPEC. Altogether, our findings do not support the notion that these verbal interventions contain new information regarding crude oil market prices.

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**Table 1: Sources of the “Fair Price” Pronouncements**

	<b>OPEC “Hawks”</b>	<b>Saudi Arabia</b>	<b>Others &amp; OPEC</b>	<b>Total</b>
Agree	3	1	1	<b>5</b>
Disagree	10	3	11	<b>24</b>
Unclear	15	5	14	<b>34</b>
<b>Total</b>	<b>28</b>	<b>9</b>	<b>26</b>	<b>63</b>

Notes: Table 1 is based on the authors’ textual analysis of the news articles relating the “fair price” announcement (Source: Lexis-Nexis, Westlaw). The Table provides information on the source of the pronouncement, and whether it agrees with the level of crude oil prices then prevailing in the marketplace. Table 1 differentiates between the announcements by officials hailing from countries often viewed as OPEC “hawks” during the 2000-2009 period (Algeria, Iran, Libya and Venezuela), Saudi officials, and officials from OPEC itself or from other OPEC member countries. Table 1 complements Figure 2.

**Table 2: Event Study (2-day returns; no concomitant production news)**

Panel A

Nonparametric Sign Test – Direction Criteria: No production cut or increase (2 Day)				
	# of Events	# of Successes	z-value	p-value
FP>P-	18	9	0.0000	0.5000
FP<P-	32	15	-0.3536	0.6382
Total	50	24	-0.2828	0.6114

Panel B

Reversal Criteria Test – Leaning Against the Wind: No production cut or increase (2 Day)				
	# of Events	# of Successes	z-value	p-value
FP>P-	8	3	-0.7071	0.7602
FP<P-	15	5	-1.2910	0.9016
Total	23	8	-1.4596	0.9278

Panel C

Smoothing Criteria Test - Leaning Against the Wind: No production cut or increase (2 Day)				
	# of Events	# of Successes	z-value	p-value
FP>P-	8	6	0	0.5
FP<P-	15	10	-0.4303	0.6665
Total	23	16	-0.3475	0.6359

Notes: Table 2 tests whether the median price change in a two (2) day window following a “fair price” pronouncement is systematic or random. Table 2 focuses on the 50 pronouncements (in a sample of 63; see Figure 4) that took place either at least 5 days before or at least 5 days after an OPEC production-related announcement. Panel A defines the success of a “fair price” pronouncement according to the simple directional criterion (1): “If the ‘fair price’ is higher [*lower*] than the pre-announcement median market price, is the post-announcement return positive [*negative*]?” Panels B and C focus on the “fair price” pronouncements that we classify as “leaning against the crude oil market winds” (i.e., those for which the “fair price” level is higher [*lower*] than the pre-pronouncement median market price when the pre-event two-day return was negative [*positive*]). Panel B looks for price reversals by applying the directional criterion (1) to those episodes; Panel C tests for pronouncement success more broadly, looking for price smoothing according to either the reversal criterion (1) or the weaker “slowdown” criterion (2).

**Table 3: Event Study (2-day returns amid news of production changes)**

Panel A

Nonparametric Sign Test - Direction Criteria: With production cut or increase (2 Day)				
	# of Events	# of Successes	z-value	p-value
FP>P-	4	2	0.0000	0.5000
FP<P-	9	2	-1.6667	0.9522
Total	13	4	-1.3868	0.9172

Panel B

Reversal Criteria Test - Leaning Against the Wind: With production cut or increase (2 Day)				
	# of Events	# of Successes	z-value	p-value
FP>P-	1	1	1.0000	0.1587
FP<P-	6	1	-1.6330	0.9488
Total	7	2	-1.1339	0.8716

Panel C

Smoothing Criteria Test - Leaning Against the wind: With production cut or increase (2 Day)				
	# of Events	# of Successes	z-value	p-value
FP>P-	1	1	0.3333	0.3694
FP<P-	6	3	-0.8165	0.7929
Total	7	4	-0.6299	0.7356

Notes: Table 3 is similar to Table 2, except that it focuses on the 13 pronouncements (in a sample of 63; see Figure 4) that took place within five days (before or after) an OPEC production-related announcement.

**Table 4: Event Study (5-day returns; no concomitant production news)**

Panel A

Nonparametric Sign Test – Direction Criteria: No production cut or increase (5 Day)					
	# of Events	# of Successes		z-value	p-value
FP>P-	18	8		-0.4714	0.6813
FP<P-	32	17		0.3536	0.3618
Total	50	25		0.0000	0.5000

Panel B

Reversal Criteria Test – Leaning Against the Wind: No production cut or increase (5 Day)					
	# of Events	# of Successes		z-value	p-value
FP>P-	7	2		-1.1339	0.8716
FP<P-	13	7		0.2774	0.3908
Total	20	9		-0.4472	0.6726

Panel C

Smoothing Criteria Test - Leaning Against the Wind: No production cut or increase (5 Day)					
	# of Events	# of Successes		z-value	p-value
FP>P-	7	5		-0.1260	0.5501
FP<P-	13	11		0.4623	0.3220
Total	20	16		0.2981	0.3828

Notes: Table 4 is similar to Table 2, except that the window used to compute pre- and post-announcement median oil-market returns is five days rather than two days.

**Table 5: Event Study (5-day returns amid news of production changes)**

Panel A

Nonparametric Sign Test - Direction Criteria: With production cut or increase (5 Day)					
	# of Events	# of Success		z-value	p-value
FP>P-	4	1		-1.0000	0.8413
FP<P-	9	3		-1.0000	0.8413
Total	13	4		-1.3868	0.9172

Panel B

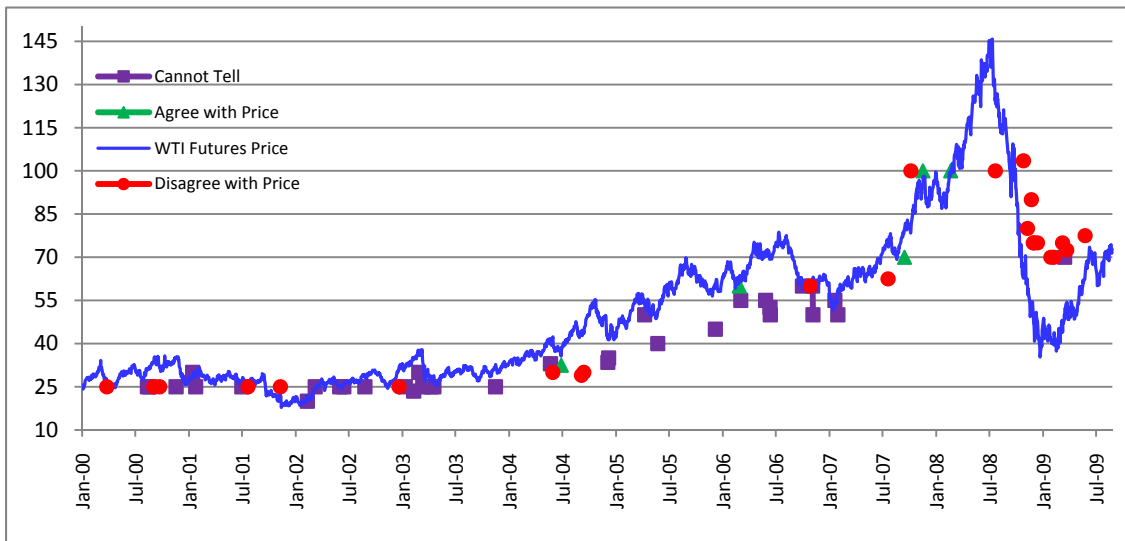
Reversal Criteria Test - Leaning Against the Wind: With production cut or increase (5 Day)					
	# of Events	# of Success		z-value	p-value
FP>P-	1	1		1.0000	0.1587
FP<P-	6	1		-1.6330	0.9488
Total	7	2		-1.1339	0.8716

Panel C

Smoothing Criteria Test - Leaning Against the Wind: With production cut or increase (5 Day)					
	# of Events	# of Success		z-value	p-value
FP>P-	1	1		0.3333	0.3694
FP<P-	6	2		-1.3608	0.9132
Total	7	3		-1.1339	0.8716

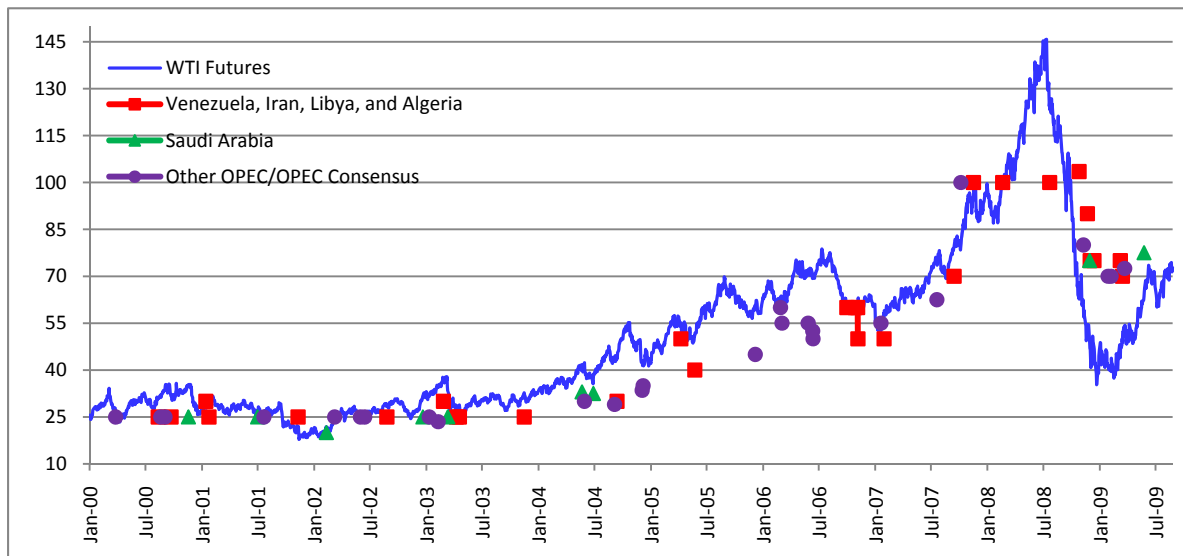
Notes: Table 5 is similar to Table 4, except that it focuses on the 13 pronouncements (in a sample of 63) that took place within five days (before or after) an OPEC production-related announcement.

**Figure 1: “Fair Price” versus Market Price of Crude Oil, 2000 – 2009**



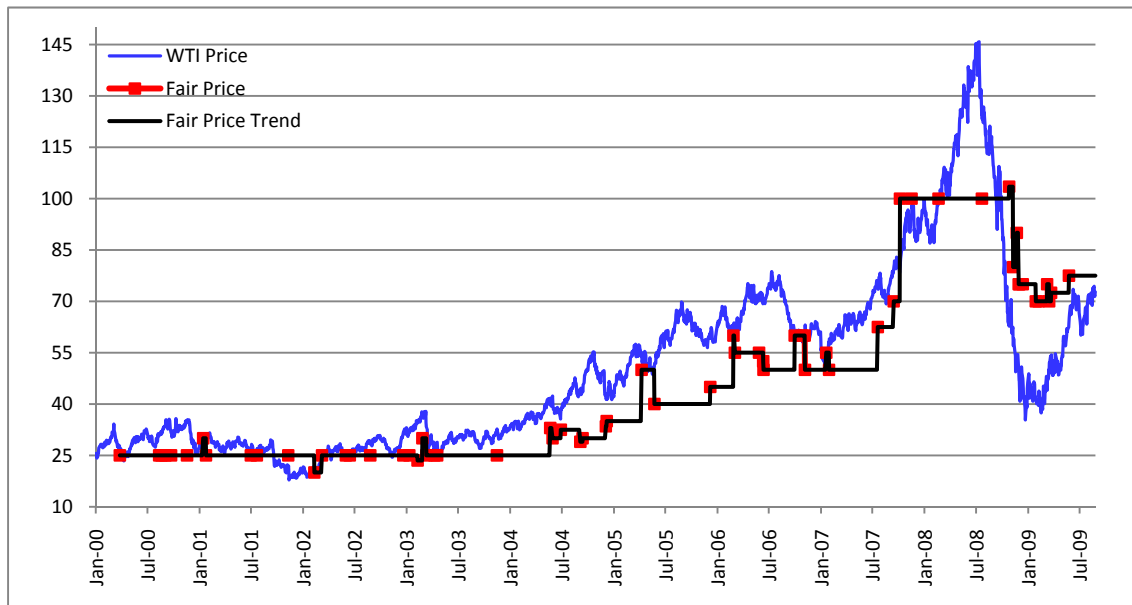
Notes: Figure 1 plots the levels included in the 63 “fair price” pronouncements against the contemporaneous nearby-futures settlement price for WTI crude oil (Source: NYMEX). When the “fair price” statement refers to a range rather than a specific level, we plot the mean of the stated “fair price” range. Figure 1 partitions the statements into three groups: those in which the official explicitly agrees with the current level of oil prices (green triangles); those in which the official explicitly disagrees with the current level of oil prices (red dots); and those statements in which the textual analysis of the news story(ies) reporting the statement do not state whether the official agrees or disagrees with the market price level (purple squares).

**Figure 2: “Fair Price” Statements sorted by Source**



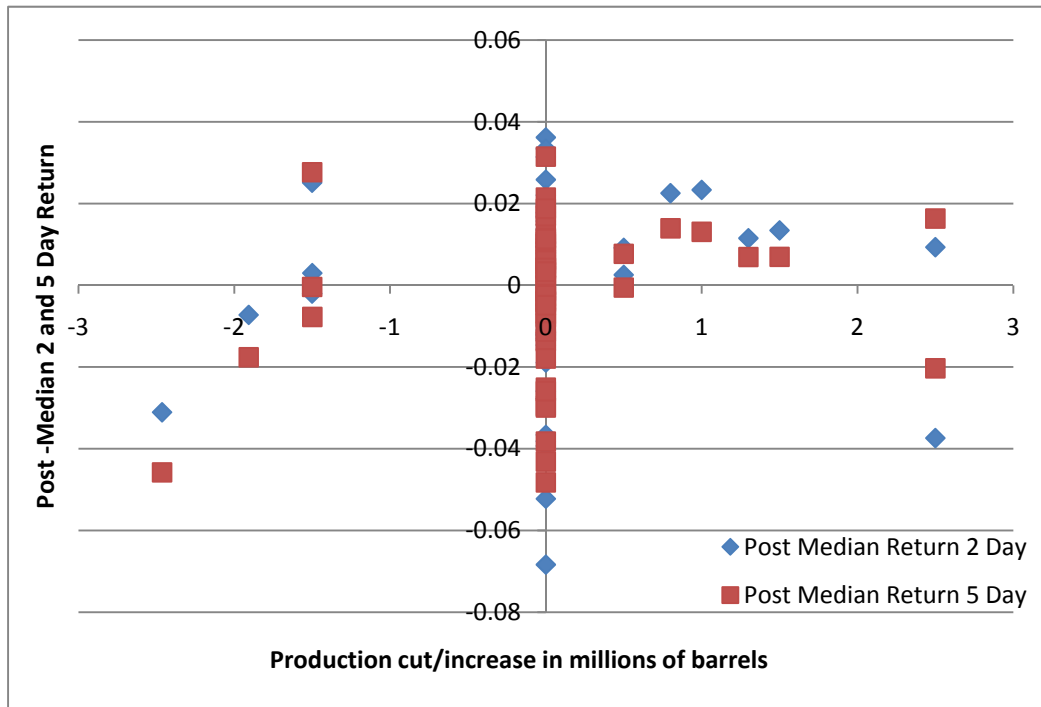
Notes: Figure 2 complements Table 1. It differentiates between the announcements by officials hailing from countries often viewed as OPEC “hawks” during the 2000-2009 period (Algeria, Iran, Libya and Venezuela; red squares), Saudi officials (green triangles), and officials from other OPEC members or OPEC as a whole (purple circles).

**Figure 3: Does the Market Price Lead or Follow the “Fair Price”?**



Notes: Figure 3 plots the “fair price” levels against the contemporaneous nearby-futures settlement price for WTI crude oil (Source: NYMEX). It depicts the “fair price” series as virtually indistinguishable from a step function whose steps are anchored by the market price series some time prior to the relevant “fair price” pronouncement.

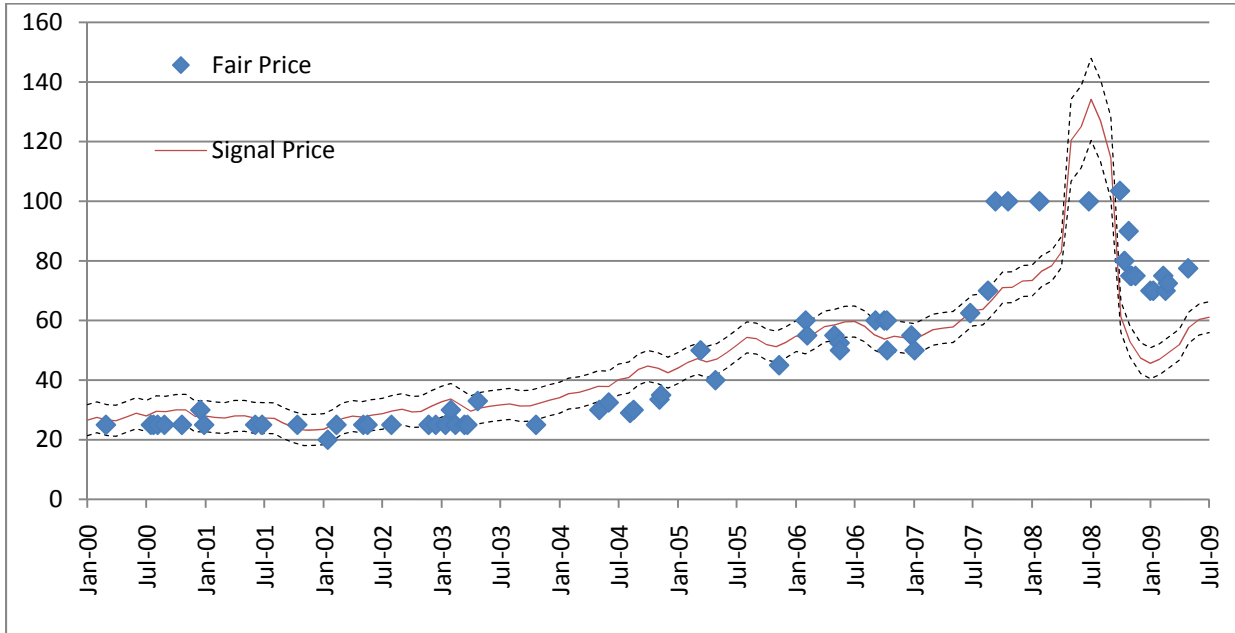
**Figure 4: Production News and Median Returns after all “Fair Price” Events, 2000-2009**



Notes: Figure 4 displays the post median two-day and five-day rates of return (in percent) on WTI crude oil nearby-futures for the entire sample of 63 “fair price” pronouncements between January 2000 and August 2009. The median rate of return is plotted against the production change (in millions of barrels per day) announced at any OPEC meeting taking place within ten days of a “fair price” pronouncement. Complementing Panel A in Tables 2 to 5, Figure 4 shows no evidence of a systematic impact of “fair price” pronouncements on the nearby-futures price of WTI crude oil. Interestingly, production cut announcements are accompanied by negative post two (2) and five (5) day returns. Intuitively, we would expect a price decline when increase in production statements are made and vice versa.

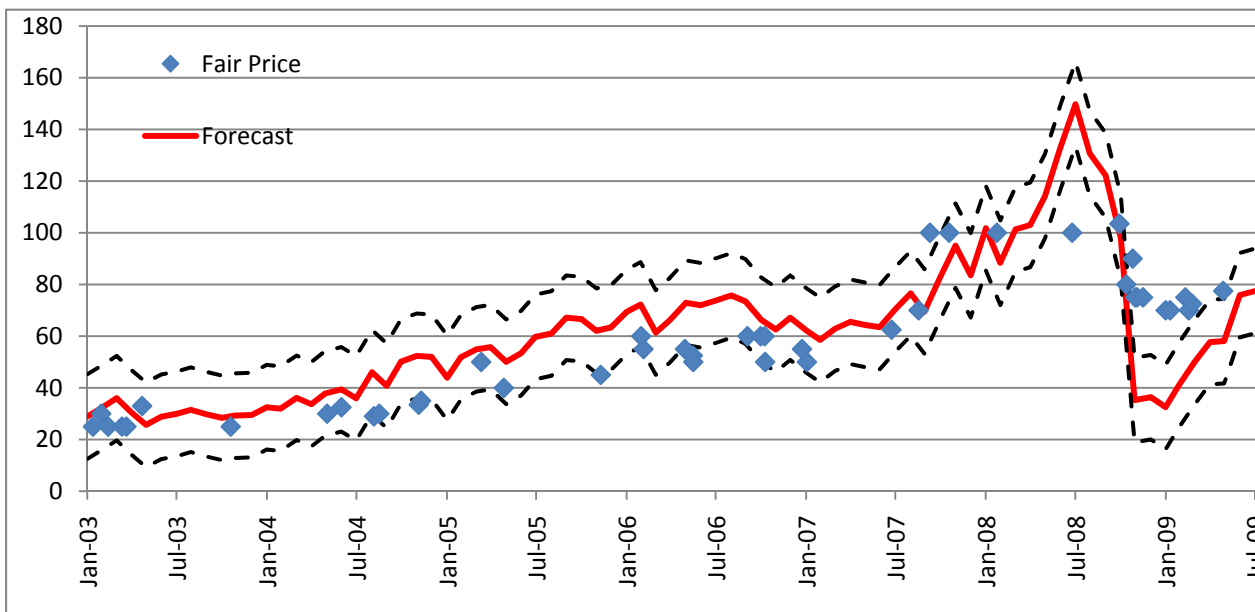


**Figure 5: “Fair Price” Levels *versus* Filtered (“True”) Market Prices**



Notes: We apply a Kalman filter to the monthly returns on nearby WTI crude oil futures, to separate the “true price” from the noise component in the market price of oil. Because the nearby-futures WTI price series is non-stationary, we analyze rates of return rather than prices. Figure 5 uses these filtered rates of return to reconstruct a plot of the “true” price series. It displays “fair price” levels atop the one-step-ahead forecast of the signal (“true price”) process in red, and the confidence bands from the state-space model (black broken lines).

**Figure 6: ADL-based Market Price Forecasts *versus* “Fair Price” Levels**



Notes: Figure 6 graphs the “fair price” levels (blue diamonds) against the forecasted crude oil price (in red) estimated with ADL model (4) and confidence bands for the monthly time series ( $\pm 2 \cdot \text{RMSE}$ , black broken lines).

## Appendix 1: “Fair Prices”, Nearby Futures Prices, and Nearby Futures Returns

Episode	Date	Fair Price Level	Pre-median price (2 Day)	Pre-median return (2 Day)	Post-median price (2 Day)	Post-median return (2 Day)	Pre-median price (5 Day)	Pre-median return (5 Day)	Post-median price (5 Day)	Post-median return (5 Day)
1	28-Mar-00	25	27.91	0.0087	26.58	-0.0073	27.79	-0.0055	26.45	-0.0176
2	14-Aug-00	25	30.96	0.0113	30.97	-0.0016	30.35	0.0072	31.33	0.0073
3	22-Aug-00	25	31.77	0.0103	31.83	0.0065	31.33	0.0073	32.03	0.0126
4	4-Sep-00	25	33.25	0.0009	35.15	0.0225	33.12	0.0078	34.90	0.0139
5	25-Sep-00	25	33.34	-0.0377	31.48	-0.0017	35.01	-0.0153	31.46	-0.0013
6	18-Nov-00	25	34.75	0.0006	35.28	0.0025	34.46	0.0150	35.16	-0.0006
7	14-Jan-01	30	28.49	0.0097	28.24	0.0030	28.21	0.0116	29.57	-0.0077
8	26-Jan-01	25	29.21	-0.0036	29.06	-0.0121	29.57	-0.0077	29.06	0.0000
9	3-Jul-01	25	26.10	0.0076	27.62	0.0362	25.95	-0.0100	27.49	-0.0036
10	24-Jul-01	25	26.03	0.0263	26.79	0.0079	25.59	-0.0060	26.73	-0.0041
11	10-Nov-01	25	21.70	0.0504	20.96	-0.0366	20.09	0.0085	18.43	0.0033
12	12-Feb-02	20	21.04	0.0436	21.52	0.0094	20.07	0.0000	21.52	0.0000
13	11-Mar-02	25	23.78	0.0147	24.55	-0.0020	23.17	0.0055	24.85	-0.0004
14	2-Jun-02	25	24.99	-0.0088	25.11	-0.0038	25.31	-0.0104	24.79	-0.0040
15	15-Jun-02	25	26.01	0.0249	25.62	-0.0146	24.87	0.0104	25.82	-0.0027
16	28-Aug-02	25	29.06	0.0035	28.95	0.0112	28.84	-0.0073	28.92	0.0171
17	21-Dec-02	25	30.25	-0.0021	32.23	0.0115	30.19	0.0036	31.97	0.0069
18	12-Jan-03	25	31.84	0.0180	32.12	0.0134	31.68	-0.0169	32.81	0.0070
19	11-Feb-03	25	34.80	0.0047	34.86	0.0102	34.16	0.0104	35.36	0.0042
20	28-Feb-03	30	37.45	0.0156	36.39	0.0039	36.48	0.0239	36.89	0.0084
21	14-Mar-03	25	36.25	-0.0088	31.30	-0.0522	37.27	-0.0136	29.36	-0.0432

Notes: Appendix 1 provides descriptive statistics for each of the 63 “fair price” announcements in our sample (2000-2009). For example, episode #2 indicates that the “fair price” was \$25, with the crude oil nearby-futures median price and return two (2) days prior to the event day at \$30.96 and 1.13%, respectively. The two (2) day post-median price and return were \$30.97 and -0.16%, respectively. The five (5) day pre- and post- median prices and returns are shown in subsequent columns. Figures 1 to 3 provide additional information on the directional content of the “fair price” pronouncements and their origin, and depict their relationship with the market price series.

**Appendix 1 (continued)**

Episode	Date	Fair Price	Pre-median price (2 Day)	Pre-median return (2 Day)	Post-median price (2 Day)	Post-median return (2 Day)	Pre-median price (5 Day)	Pre-median return (5 Day)	Post-median price (5 Day)	Post-median return (5 Day)
22	11-Apr-03	25	27.80	-0.0032	27.30	0.0077	28.00	-0.0122	27.53	0.0101
23	20-Apr-03	25	28.04	0.0180	27.32	-0.0393	27.53	0.0137	26.64	-0.0296
24	22-May-03	25	31.53	-0.0026	31.97	-0.0130	31.27	0.0091	31.61	-0.0079
25	18-Nov-03	33	28.72	0.0129	29.26	0.0086	28.41	0.0042	29.16	0.0107
26	1-Jun-04	30	39.66	-0.0102	39.62	-0.0374	40.70	-0.0108	38.66	-0.0203
27	30-Jun-04	32.5	35.95	-0.0258	38.57	0.0178	37.55	-0.0161	39.08	0.0315
28	4-Sep-04	29	44.03	-0.0001	43.69	0.0148	43.99	-0.0016	43.83	0.0116
29	15-Sep-04	30	44.09	0.0172	44.76	0.0233	43.83	0.0116	46.19	0.0131
30	4-Dec-04	33.5	42.90	-0.0335	41.70	-0.0122	45.49	-0.0166	41.83	0.0113
31	9-Dec-04	35	41.70	-0.0122	41.60	-0.0134	42.54	-0.0166	42.45	0.0113
32	10-Apr-05	50	54.38	-0.0220	52.83	-0.0277	55.85	-0.0124	52.13	-0.0137
33	26-May-05	40	50.33	0.0182	51.91	0.0093	49.16	0.0103	53.63	0.0163
34	9-Dec-05	45	59.94	0.0060	62.29	0.0157	59.91	0.0099	61.87	-0.0071
35	1-Mar-06	60	61.21	-0.0121	63.52	0.0135	61.01	-0.0077	62.41	-0.0134
36	6-Mar-06	55	63.52	0.0135	61.69	-0.0189	61.97	0.0067	61.84	-0.0093
37	29-May-06	55	71.35	0.0107	70.82	-0.0119	71.32	0.0096	72.33	-0.0014
38	14-Jun-06	52.5	70.19	-0.0213	70.07	0.0041	70.82	-0.0170	69.93	0.0039
39	15-Jun-06	50	69.46	-0.0104	69.88	-0.0027	70.35	-0.0067	70.20	0.0039
40	3-Oct-06	60	61.97	-0.0140	59.72	0.0114	62.76	-0.0032	60.26	0.0052
41	30-Oct-06	60	60.56	-0.0053	58.72	0.0030	60.36	0.0064	58.73	0.0063
42	7-Nov-06	60	59.58	0.0182	61.45	0.0197	58.73	0.0063	60.59	-0.0068

**Appendix 1 (continued)**

Episode	Date	Fair Price	Pre-median price (2 Day)	Pre-median return (2 Day)	Post-median price (2 Day)	Post-median return (2 Day)	Pre-median price (5 Day)	Pre-median return (5 Day)	Post-median price (5 Day)	Post-median return (5 Day)
43	8-Nov-06	50	59.48	-0.0018	62.30	-0.0001	58.93	-0.0003	60.72	-0.0068
44	22-Jan-07	55	52.61	0.0025	55.21	0.0259	53.13	0.0193	55.04	0.0060
45	1-Feb-07	50	57.56	0.0368	58.88	0.0124	55.42	0.0203	58.88	0.0024
46	23-Jul-07	62.5	75.93	0.0032	74.72	0.0066	75.30	0.0013	75.88	-0.0025
47	16-Sep-07	70	78.44	-0.0029	80.54	0.0092	78.09	0.0097	80.95	0.0077
48	9-Oct-07	100	79.51	-0.0141	81.44	0.0168	80.05	-0.0014	82.74	0.0169
49	17-Nov-07	100	92.96	0.0054	97.66	0.0138	92.83	-0.0082	97.70	-0.0049
50	22-Feb-08	100	98.97	-0.0074	100.06	0.0104	98.23	0.0000	100.88	0.0042
51	24-Jul-08	100	126.43	-0.0288	124.00	-0.0030	129.47	-0.0261	124.08	-0.0179
52	28-Oct-08	103.5	63.69	-0.0353	66.73	0.0251	66.75	-0.0302	67.50	0.0277
53	11-Nov-08	80	61.73	0.0133	58.05	-0.0097	62.41	0.0044	57.03	-0.0250
54	24-Nov-08	90	49.68	-0.0401	52.61	-0.0006	54.10	-0.0132	50.77	-0.0482
55	29-Nov-08	75	54.44	0.0348	46.88	-0.0259	54.43	0.0103	43.71	-0.0482
56	3-Dec-08	75	48.12	-0.0738	42.24	-0.0684	50.77	-0.0482	43.67	-0.0382
57	15-Dec-08	75	49.98	0.0326	45.66	-0.0311	46.02	0.0300	42.36	-0.0458
58	30-Jan-09	70	41.80	-0.0017	40.43	-0.0109	42.16	-0.0161	40.32	-0.0113
59	8-Feb-09	70	40.67	-0.0019	43.12	-0.0382	40.32	-0.0113	42.17	-0.0299
60	11-Mar-09	75	47.52	-0.0078	47.50	0.0334	45.52	0.0071	48.05	0.0215
61	18-Mar-09	70	49.05	0.0310	52.06	0.0314	47.97	0.0215	52.77	0.0033
62	25-Mar-09	72.5	53.89	0.0180	53.36	-0.0037	52.07	0.0033	49.66	-0.0259
63	27-May-09	77.5	62.06	0.0113	65.70	0.0220	61.67	0.0101	66.31	0.0187

**Appendix 2:**  
**“Fair Price” Pronouncements around OPEC Production Announcements**

Episode	Fair Price Level (USD)	Production Level ↑ or ↓ (in millions)	Previous median price (2 day)	Previous median price (5 day)	FP>MP and prod. ↓ or FP<MP and prod. ↑
3/28/2000	25	-1.907	27.905	27.79	No
9/4/2000	25	0.8	33.25	33.12	Yes
11/18/2000	25	0.5	34.745	34.46	Yes
1/14/2001	30	-1.499	28.49	28.21	Yes
3/11/2002	25	-1.5	23.775	23.17	Yes
12/21/2002	25	1.3	30.245	30.19	Yes
1/12/2003	25	1.5	31.835	31.68	Yes
6/1/2004	30	2.5	39.66	40.7	Yes
9/15/2004	30	1	44.085	43.83	Yes
5/26/2005	40	2.5	50.325	49.16	Yes
9/16/2007	70	0.5	78.435	78.09	Yes
10/28/2008	103.5	-1.5	63.685	66.75	Yes
12/15/2008	75	-2.463	49.98	46.02	Yes

Notes: Appendix 2 provides information on the 13 “fair price” events that overlap with OPEC announcements of production cuts or increases and the previous median price using a two (2) day or five (5) day window. Except for the very first observation on March 28, 2000, the directions of the “fair price” and production announcements are consistent with one another. On the one hand, one would expect that, if the “fair price” exceeds the previous median price (FP>MP), then OPEC would implement a production cut to increase prices; this is what we see on January 14, 2001, March 11, 2002, and twice in 2008. On the other hand, when FP<MP, one would expect OPEC to implement a production increase to lower prices. This is what we see on September 4, 2000 and on seven other occasions.

### **Appendix 3: Narrative of News Stories behind Figures 1-3**

Appendix 3 provides additional information regarding the news stories underlying the above note and rationalizes the drawing of the step function in Figure 3. OPEC established an official policy in March 2000, declaring their target band for oil prices to be between \$22-28 per barrel (*New York Times*). With this price band in place, a mechanism would be triggered to cut output by 500,000 barrels per day if prices remained below \$22 for more than 10 consecutive days in order to bring prices back within the range. In similar fashion, production would be raised by this same amount if prices remained above \$28 per barrel for more than 20 consecutive days (*AAP, The Australian*). This set range remained the target of the cartel from March 2000 through part of 2004, with reports from *CNBC, AFP, BBC, AP*, and other news agencies consistently quoting OPEC members as considering \$25 a barrel to be a “fair price”. This consistency is easily discerned in Figures 1-3, with only a few observations deviating from the \$25 level. Though market prices exceeded the target range during mid-December 2002 to mid-March 2003 with escalating tensions between the United States and Iraq, it seems OPEC members remained convinced that the “fair price” of crude fell within their set price band. However, although the cartel stated throughout much of 2004 that the price band remained their target, in actuality, the mechanism did not appear to be enforced after 2003.

As a rather sharp increase in oil prices took place in the first half of 2004, Saudi Arabia’s oil minister declared that \$32-34 a barrel was a “fair price” in May 2004. This price was well above the extant target range (*Financial Times*). The *Financial Times* again reported at the beginning of July 2004 that Saudi Arabia was satisfied with current market prices around \$35 a barrel, “the strongest signal so far that the kingdom has abandoned its support for the old Organization of Oil Exporting Countries price band of \$22-\$28 and is targeting prices above \$30”. Venezuela and Iran at the time were said to support pushing the band floor up to \$28 with a ceiling of \$30 (*AP Worldstream*), while Saudi Arabia “wanted to adjust it for inflation and dollar depreciation in the last four years, to a floor of around \$26” (*Financial Times*). In January 2005, The *New York Times* reported that Saudi Arabia had “over the last year, quietly endorsed a shift in strategy that was once championed by only a handful of OPEC’s more radical members, like Iran and Venezuela, who were pushing for prices higher than those of the last two decades”. Saudi Arabia was acting “to nudge the group’s reference price closer to \$40 a barrel”, clearly a substantially higher price than that of the original target band or the more recently proposed modifications to the target range. Because of Saudi Arabia’s position as the largest (and, arguably, most influential oil producer), commentators argued that a change in the Saudi perception of the “fair price” of oil may have been critical to both other oil producing countries, as well as oil consuming nations.

By April 2005, crude prices had reached \$50 a barrel, a price level Venezuelan President Hugo Chavez stated was “fair” and one in which OPEC’s Secretary General said was a “realistic upper limit for the new price corridor of the cartel” (*Economic News*). Crude prices hit an all time high after the devastation of Hurricane Katrina at the end of August 2005. Though no OPEC announcements seem to have been made during that time or in subsequent months, oil ministers from Venezuela and Kuwait stated that current price levels at around \$50 per barrel were desirable and considered “fair” in December 2005, after prices had retreated from their August peak (*Agence France Presse* and *AP Financial Wire*). In March of 2006, the Nigerian oil minister believed \$60 a barrel was a “fair price” for oil (*AP Online*). In late May 2006, as

reported by the *Associated Press* and *Deutsche Presse-Agentur*, the United Arab Emirates' oil minister agreed that the rate of demand growth for oil in 2006 should be the same as 2005 with a "fair price" ranging from \$50 - \$60 per barrel.

As crude oil prices approached the \$100 mark in the latter half of 2007, Qatar's oil minister stated in October of that year that "\$100 per barrel or more would be fair to account for the weaker U.S. dollar and inflation" (*Platts Oilgram Price Report*). Shortly thereafter, as crude neared \$100 a barrel in November 2007, Venezuelan President Chavez, along with Iranian President Mahmoud Ahmadi-Nejad, advocated at an OPEC summit that "a fair price [and] just price" for oil was in fact \$100 a barrel (*Financial Times*). Though this sentiment was not necessarily shared by all OPEC members at that time, King Abdullah of Saudi Arabia stated that the market prices at the end of 2007, when taking into consideration inflation, were not at unprecedented levels (*Financial Times*). Formal comments by OPEC members on the "fair price" of crude oil did not appear frequently throughout much of the extraordinary prices experienced in the beginning to mid part of 2008, besides those statements made by Mr. Chavez reiterating that \$100 was a "fair price" for oil. He explicitly stated, "Venezuela has never wanted oil to cost more than \$100US" at the end of July and blamed prices above \$125 on "a speculative impact" (*National Post's Financial Post-Canada*).

More recently, on November 29, 2008, the king of Saudi Arabia stated at an OPEC meeting in Cairo that \$75 a barrel was the "fair price" for oil (*Fox News, New York Times, Financial Times, Wall Street Journal*). As negotiations were then taking place between OPEC countries regarding production cuts to counter recent low prices in crude oil, the stated "fair price" was nearly double the determined market price. In January 2009, prices in the realm of \$75 per barrel were mentioned by other OPEC countries as being "fair", with the sole exception being Libya that stated the "fair price" should be \$100 at the end of January 2009 (*Greenwire*).

In sum, based on these stated "fair prices" from OPEC members from Winter 2000 to Summer 2009, it appears that the quoted "fair price" was relatively near the actual market price until 2008, especially during the period of March 2000 to the beginning of 2004 when the OPEC price band was enforced. From mid-2004 to the end of 2007, "fair prices" seem to move in step with the market price. However, the proximity of the stated "fair price" and actual market price decreased substantially amid extraordinarily high oil prices in early-to-mid 2008 and then extremely low prices in late 2008 and early 2009. The "fair price" announcements seem to follow (and attempt to justify or refute) the markets prices, rather than being declared prior to any substantial price movements in the market.