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A Test of the OPEC Cartel Hypothesis: 1974–1983

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ABSTRACT

This paper tests whether the higher oil prices of the last decade could have been the result of producer collusion. We find little evidence that OPEC influenced oil prices during the years of skyrocketing prices (1974–1980), but there is evidence that it did so during the recent years of softening prices (1981–1983).

In the April 14 (1969) floor debate, Senators Proxmire of Wisconsin and Long of Louisiana crossed swords thusly. Long: "Does the senator know what OPEC is?" Proxmire: "Would the senator from Louisiana like to say what it is?" Long: "First, I'd like to know if the senator knows. What is OPEC? Does the senator know" Proxmire: "Offhand, no, I do not." Long: "Well..." Proxmire: "What is OPEC? I'd be delighted to find out..." But find out he did not. Long: "Without burdening the senate further with the full name of this organization, which frankly escapes me at the moment, would the senator like to know who they are?" Proxmire: "I'm glad that neither the senator from Louisiana nor the senator from Wiscnsin know what OPEC means. That should be clear by now." Long: "May I tell the senator who they are?" Proxmire: "I should be delighted to hear." Long: "They are the Arab countries that sell us oil out of the Near East and Libya. That does not include Venezuela. But Venezuela does business with them. It works hand in hand with them."[1]

THIS ESSAY ASKS WHETHER the spectacular 1974–1980 oil price increase could have been the result of the collusive policies by the Organization of Petroleum Exporting Countries (OPEC)[2], and whether the price erosion that followed

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[1] *Oil and Gas Journal*, May 5, 1969, p. 93.

[2] OPEC was founded in 1960, but until 1973–1974 it was allegedly unable to affect market prices significantly. The members of OPEC and the year they joined the organization are: Saudi Arabia (1960); Kuwait (1960); Iran (1960); Iraq (1960); Venezuela (1960); Qatar (1961); Libya (1962); Indonesia (1962); Abu Dhabi (1967); Algeria (1969); Nigeria (1971); Ecuador (1973); Dubai and Sharjah (1974); Gabon (1973 Associate Member, 1975 Full Member).

reflects OPEC's unraveling. From 1949 until 1970, real world prices for oil more or less continuously declined. They soared dramatically thereafter, particularly in 1973–1974 and in 1979–1980, and then started declining again. In spite of this decline, at the end of 1983, spot prices for crude were still more than 13 times larger than at the end of 1972.

Many economists believe that the higher oil prices after 1974 are the result of the OPEC cartel. Consistent with that hypothesis, OPEC's output time-series leveled off at the time of the first abrupt oil price increase. Since OPEC's share of the oil produced by noncommunist countries was 65% during the 1970's, the change in OPEC's production pattern could be the cause of the upward revision in oil prices. These same facts, however, are used by other economists (Johany [7], Scott [11], and MacAvoy [9]) to argue that the higher oil prices of the 1970's are mainly the result of noncollusive market forces.

Various aspects of the oil market cannot be readily reconciled with a cartel explanation. For instance, substitution in consumption away from oil has not been extensive in 1974–1978, the years immediately following the alleged cartelization. Moreover, during those same years, physical production of natural gas and coal did not increase substantially, and neither did oil production by non-OPEC members.

Although one could claim that the oil market is competitive, there are few, if any, systematic attempts at finding out whether that market is in fact cartelized.[3] This paper contributes to this question by asking whether a necessary condition for the presence of an effective cartel is met. If OPEC is an effective cartel, its policy decisions must affect market prices. This implication is analyzed by examining whether spot and futures prices for oil products and stock market portfolio returns change at the time of OPEC producer meetings.

We consider the years 1974–1983. During 1974–1980, a period of increasing prices, OPEC never allocated output shares among its members, and typically only set a basic reference price, without apparently ever agreeing on what differentials to apply to reflect the different types, qualities, and locations (relative to consumer markets) of the crude oil produced by its members. It was only during 1981–1983, when prices began declining, that OPEC resorted to output quotas. The evidence found shows hardly any ability by OPEC to affect prices during the first subperiod, but some ability to do so in the second.

The essay is organized as follows. Part one briefly presents the proposition to be tested. Part two derives testable implications. Section three discusses the quality and source of the data. Section four illustrates the test methodology and the results, and the last section puts them in perspective.

I. The Null Hypothesis

The null hypothesis of the study is that OPEC is unable to affect market prices. The alternative hypothesis is that OPEC can affect market prices. Call the alternative hypothesis the *price impact hypothesis.*

[3] Empirical studies on OPEC mostly assume that it is an effective cartel. See, for example, Cremer and Weitzman [3], Danielsen [4], Ezzati [5], Hnyilicza and Pindyck [6], and Moran [10]. MacAvoy [9] is an exception.

The null hypothesis is inconsistent with *any* cartel model. A price impact is a *necessary* condition for any effective cartel organization, whether it operates as a central sales agency, imposes output quotas, allocates markets, or uses any other control mechanism. On the other hand, evidence against the null hypothesis is consistent with several explanations of the nature of OPEC. It could, for instance, be an effective cartel, or it could be an organization of noncooperative oligopolists. To simplify the argument of the following sections, the price impact hypothesis will be identified as the case of an effective cartel.[4]

II. Testable Implications

OPEC holds two ordinary members' conferences a year. In addition, from time to time, it holds extraordinary conference meetings. If the null hypothesis is correct, OPEC announcements of pricing or production policy changes made at these meetings will not affect market prices. On the other hand, if OPEC is an effective cartel and its decisions cannot be perfectly anticipated, its policy announcements will affect market prices. For these decisions to be at least partly unanticipated, it is sufficient that the cartel has a different perception than the market of random changes in current and future demand and supply conditions.

Consider the time-series of the market price of crude oil, or the price of a directly related item—say a refined product or the stock price of a corporation in the energy sector. Suppose you can identify the time-series generating process of this price, and that its error term is a component of the vector $\tilde{\mathbf{e}} \sim N(\mathbf{0}, s^2D)$, where D is an identity matrix. Consider a particular OPEC meeting at time t, and partition the set of possible conference outcomes with a continuous variable y measuring the announced price (or output) change. Assume market efficiency, and, exclusive of y, define the information set used by the market to set prices at time $t-1$ as A_{t-1}. The null hypothesis implies:

$$E_{t-1}(\tilde{e}_t \mid A_{t-1}, y) = E_{t-1}(\tilde{e}_t \mid A_{t-1}) = 0 \ \forall \ y, \tag{1}$$

while the price impact hypothesis implies:

$$E_{t-1}(\tilde{e}_t \mid A_{t-1}, y) \neq 0 \quad \text{for at least some values of } y. \tag{2}$$

III. The Data

Proposition (1) is tested using spot and futures prices of oil products, and stock returns of corporations in the energy industry. We consider daily and weekly spot prices for gas-oil (53 d.i.min.) in the form of barge quotations FOB Rotterdam ($ per metric ton) over the period 1973–1983. These quotations are from *Platt's Oil Price Handbook and Oilmanac* (McGraw-Hill). All tests are performed using the average between high and low quotations. For the period 1973–1979, we also consider daily spot prices for gasoline (91/92 octane), kerosene, and

[4] An alternative and equally general test would be to measure whether cartel members spend real recources to collude: recurrent costs of collusion will be borne only if there are offsetting benefits. Unfortunately, that methodology makes a critical assumption, namely that government officials of OPEC countries maximize the monetary value of oil reserves rather than their own utility.

heavy fuel listed in the same source as gas-oil. For the period 1980–1983, we use weekly settlement prices for Heating Oil No. 2 Futures traded on the New York Mercantile Exchange as reported in the *Wall Street Journal* beginning with October 1980. Daily stock returns are from the tapes of the Center for Research in Security Prices at the University of Chicago for the 1974–1980 period.

The OPEC meetings considered are those that reportedly considered oil production and pricing issues with the intent of reaching binding decisions. The source of information used is the *Wall Street Journal.* Table I lists the meetings in question, their duration dates, and their *reported* decisions for the period 1974–1983.

IV. Methodology and Test Results

The first section below presents methodology and test results for the subperiod 1974–1980. The following section will consider the subperiod 1981–1983. The two subperiods were (arbitrarily) chosen because they had different price patterns.

A. Subperiod 1974–1980

Proposition (1) is tested for all 1974–1980 meetings using weekly spot prices for gas-oil. A model that fits the data well for most of the subperiods considered is an ARIMA (1, 1, 0) model in the logarithm of prices.

Define the week of a particular OPEC meeting as the event week 0. For each meeting separately, an ARIMA (1, 1, 0) model is estimated over a period of 60 weeks preceding wek −1. One-step ahead forecasts are then generated for weeks −1, 0, and +1, based on 60 observations preceding the forecast week.[5] If the meeting week falls into two weeks (0 and +1), forecasts are calculated for weeks −1, 0, +1, and +2. The difference between the actual price increase and its forecast is an estimator of $E_{t-1}(\tilde{e}_t \mid A_{t-1}, y)$.[6] Since information about the meeting could reach the market before the meeting itself or could be fully understood only thereafter, weeks −1 and +1 (+2) are considered event weeks as well. Statistical significance tests are performed with a t-test.

Table II presents the results. Column 1 identifies the meeting. The second column gives the estimates of the first-order autoregressive parameter b and of the intercept a. Numbers in parentheses are estimated standard deviations. The next column gives the adjusted R^2. Column 4 shows the probability value of the Box-Pierce statistic for lags 1–12, 1–24, and 1–36. Column 5 presents 95% confidence forecast intervals. Actual data are in column 6. Forecasted and actual data shown are $ figures per metric ton. The last column lists the results of an F-test to check if the forecast errors made are jointly significantly different from zero.[7] Asterisked values are statistically significant with confidence 0.95.

[5] Forecasts based on a fixed 60-week period preceding week −1 yield consistent results.

[6] Since estimation is performed ex post facto, the estimation procedure will produce estimates of the *conditional* expected value of $\tilde{e}_t$.

[7] The sum of the square of these original one-step ahead forecast errors over the m relevant conference weeks, divided by m times the estimated error variance of the ARIMA model used, is approximately F-distributed with m and $(n - p)$ degrees of freedom. The number m of conference weeks is 3 for some conferences, 4 for the rest. The number n of observations used to estimate the model is 60, and the number p of estimated parameters is 2 (see Box and Tiao [1], pp. 196–97).

Table I

OPEC Meeting Dates and Decisions Taken: 1974–1983

Meeting No.	Date	Decisions Taken
1	January 7–9, 1974	No price change until April.
2	March 16–17, 1974	Price cuts before July ruled out.
3	June 15–17, 1974	With the exception of Saudi Arabia, OPEC raised royalty rates 2%.
4	September 12–13, 1974	OPEC increased royalty rates and taxes by about .33¢ a barrel.
5	December 12–13, 1974	Oil prices lifted by about 4%.
6	February 25–27, 1975	Prices to remain stable until June. Some discounts permitted.
7	June 9–11, 1975	OPEC to drop dollar as unit of account. Decision could mean 3% price hike.
8	September 24–27, 1975	Oil prices raised by 10%.
9	December 20–21, 1975	Meeting disrupted by terrorists.
10	May 27–28, 1976	OPEC failed to agree on changing basic price of benchmark crude.
11	December 15–17, 1976	Price increase: 5% for Saudi Arabia and Abu Dhabi, 15% for others.
12	July 12–13, 1977	Failure to settle issue of price disparities for heavier crudes.
13	December 20–21, 1977	Accord on 1978 prices failed.
14	June 17–19, 1978	OPEC left prices frozen, probably until the end of 1978.
15	December 16–17, 1978	Prices to increase 14.5% by October 1 in four stages.
16	March 26–27, 1979	OPEC raised price for benchmark crude 9%.
17	June 26–28, 1979	OPEC established a new benchmark price of $18, up 23.7%.
18	December 17–20, 1979	Failure to set a uniform pricing policy.
19	May 7–8, 1980	Automatic pricing formula approved in principle.
20	June 9–11, 1980	Benchmark price ceiling raised 14.3%.
21	September 17, 1980	Saudi Arabia increased price 7.1%, other members froze theirs.
22	December 15–16, 1980	Benchmark price lifted by 6.7%, price ceiling by 10.8%.
23	May 25–26, 1981	Disagreement on prices. With the exception of Saudi Arabia, members voted 10% output cut.
24	August 19–21, 1981	OPEC failed to unify prices. Meeting called most divisive.
25	October 29, 1981	Benchmark price increased 6.3%, other prices reduced 5.6%.
26	December 9–11, 1981	Minor price cuts.
27	March 19–21, 1982	For the first time since the 1960's, OPEC decided individual output shares.
28	May 20–21, 1982	OPEC decided to continue limiting oil production. Prices unchanged.
29	July 9–10, 1982	Meeting to cope with cheating on output quotas and price discounting failed.
30	December 19–20, 1982	Attempt to shuffle production quotas failed.
31	January 23–24, 1983	Failure to agree on common strategy. Most traumatizing meeting.
32	March 7–14, 1983	OPEC cut benchmark price 14.7%. Output quotas shuffled.
33	July 18–19, 1983	OPEC kept prices and production unaltered.
34	December 7–9, 1983	OPEC kept prices and production unaltered.

Although the model performs fairly well as compared to alternative specifications, it never explains more than 32% of the variance of price growth, and the autoregressive parameter does not seem to be stable.

To see whether OPEC is able to affect oil prices, we could average the prediction

Table II

Forecast Errors of Spot Market (Rotterdam) Gas-Oil Prices at the Time of OPEC Meetings: 1974–1980

Meeting No.	Parameter Estimates	$\bar{R}^2$	*P*-value of Box-Pierce Statistics	95% Forecast Bounds		Actual Value	*F*-Test
1	$a =$ 0.4511	0.17	1–12: 0.53	W−1: 129.46	164.51	152.33	3.23*
	(0.1254)		1–24: 0.74	W−0: 137.02	174.11	138.23	
	$b =$ 0.0138		1–36: 0.92	W+1: 119.00	151.22	138.23	
	(0.0087)			W+2: 124.33	157.99	116.81*	
2	$a =$ 0.3822	0.13	1–12: 0.19	W+1: 89.66	118.32	104.37	0.25
	(0.1227)		1–24: 0.31	W−0: 92.38	121.91	103.74	
	$b =$ 0.0105		1–36: 0.55	W+1: 91.05	120.16	102.62	
	(0.0094)			W+2: 89.91	118.64	96.91	
3	$a =$ 0.3476	0.10	1–12: 0.70	W−1: 76.03	103.28	88.51	0.02
	(0.1241)		1–24: 0.81	W−0; 77.01	104.61	89.11	
	$b =$ 0.0079		1–36: 0.90	W+1: 77.24	104.93	88.33	
	(0.0102)			W+2: 76.16	103.46	89.04	
4	$a =$ 0.3470	0.10	1–12: 0.54	W−1: 81.01	108.54	94.10	0.02
	(0.1242)		1–24: 0.65	W−0: 81.97	109.82	93.80	
	$b =$ 0.0031		1–36: 0.88	W+1: 81.20	108.79	92.65	
	(0.0096)			W+2: 79.94	107.11	91.56	
5	$a =$ 0.3283	0.07	1–12: 0.89	W−1: 75.11	99.79	88.63	0.15
	(0.1122)		1–24: 0.84	W−0: 77.24	102.61	93.68	
	$b =$ −0.0002		1–36: 0.96	W+1: 82.75	109.94	95.14	
	(0.0095)			W+2: 82.94	110.20	95.76	
6	$a =$ 0.0083	0:0	1–12: 0.70	W−1: 76.76	92.88	84.09	0.08
	(0.1290)		1–24: 0.71	W−0: 75.69	91.58	84.92	
	$b =$ −0.0091		1–36: 0.95	W+1: 76.56	92.64	82.58	
	(0.0065)						
7	$a =$ 0.0959	0.0	1–12: 0.28	W−1: 90.68	103.63	102.28	0.68
	(0.1308)		1–24: 0.78	W−0: 96.44	110.21	104.42	
	$b =$ 0.0022		1–36: 0.87	W+1: 98.09	112.09	104.84	
	(0.0044)			W+2: 98.33	112.37	103.97	
8	$a =$ 0.5861	0.32	1–12: 0.12	W−1: 109.35	118.82	113.83	0.25
	(0.1060)		1–24: 0.37	W−0: 108.81	118.23	114.72	
	$b =$ 0.0010		1–36: 0.24	W+1: 110.67	120.25	117.11	
	(0.0027)			W+2: 113.83	123.68	119.77	
9	$a =$ 0.5712	0.31	1–12: 0.31	W−1: 97.56	106.49	103.01	0.86
	(0.1105)		1–24: 0.72	W−0: 98.36	107.36	105.73	
	$a =$ 0.0005		1–36: 0.31	W+1: 102.77	112.17	105.73	
	(0.0029)			W+2: 101.25	110.52	108.30	
10	$a =$ 0.4867	0.22	1–12: 0.35	W−1: 99.11	107.87	103.33	0.35
	(0.1157)		1–24: 0.17	W−0: 98.90	107.64	105.20	
	$b =$ 0.0019		1–36: 0.27	W+1: 101.91	110.92	107.27	
	(0.0028)			W+2: 104.00	113.20	107.00	

Table II—*Continued*

Meeting No.	Parameter Estimates	$\bar{R}^2$	*P*-value of Box-Pierce Statistics	95% Forecast Bounds		Actual Value	*F*-Test
11	$a =$ 0.2714	0.05	1–12: 0.63	W−1: 107.57	116.22	116.25*	0.21
	(0.1304)		1–24: 0.69	W−0: 107.54	116.19	112.60	
	$b =$ − 0.0008		1–36: 0.88	W+1: 108.50	117.22	113.48	
	(0.0026)			W+2: 109.32	118.11	115.34	
12	$a =$ 0.3292	0.09	1–12: 0.52	W−1: 115.95	122.11	119.59	0.49
	(0.1246)		1–24: 0.18	W−0: 117.02	123.25	119.29	
	$b =$ 0.0015		1–36: 0.37	W+1: 116.31	122.50	120.07	
	(0.0017)			W+2: 117.43	123.67	118.67	
13	$a =$ 0.3089	0.08	1–12: 0.53	W−1: 117.72	123.24	120.97	2.30
	(0.1260)		1–24: 0.86	W−0: 118.58	124.13	118.90	
	$b =$ 0.0013)		1–36: 0.95	W+1: 115.75	121.17	121.14	
	(0.0015)						
14	$a =$ 0.0245	0.0	1–12: 0.03	W−1: 118.07	122.74	120.01	0.06
	(0.1329)		1–24: 0.07	W−0: 117.73	122.39	119.85	
	$b =$ 0.0003		1–36: 0.27	W+1: 117.58	122.23	120.13	
	(0.0013)			W+2: 117.87	122.53	120.46	
15	$a =$ 0.2684	0.06	1–12: 0.70	W−1: 141.03	149.26	145.69	6.27*
	(0.1276)		1–24: 0.85	W−0: 142.26	150.56	143.80	
	$b =$ 0.0026		1–36: 0.55	W+1: 139.65	147.80	145.69	
	(0.0019)			W+2: 142.48	150.80	157.00*	
16	$a =$ 0.6723	0.31	1–12: 0.51	W−1: 199.10	232.21	235.42*	1.98
	(0.1276)		1–24: 0.93	W−0: 214.67	250.38	241.90	
	$b =$ 0.0020		1–36: 0.99	W+1: 228.57	266.58	243.89	
	(0.0053)			W+2: 227.54	265.38	257.11	
17	$a =$ 0.5242	0.26	1–12: 0.10	W−1: 324.23	389.39	345.51	0.67
	(0.1132)		1–24: 0.06	W−0: 312.95	375.84	363.87	
	$b =$ 0.0080		1–36: 0.32	W+1: 343.90	413.02	379.99	
	(0.0063)						
18	$a =$ 0.5059	0.24	1–12: 0.09	W−1: 335.19	407.79	358.73	0.17
	(0.1143)		1–24: 0.03	W−0: 324.74	395.08	351.06	
	$b =$ 0.0085		1–36: 0.19	W+1: 317.51	386.28	354.84	
	(0.0067)			W+2: 326.22	396.88	365.64	
19	$a =$ 0.4243	0.16	1–12: 0.16	W−1: 326.30	384.65	354.34	0.91
	(0.1194)		1–24: 0.60	W−0: 327.97	386.62	332.41	
	$b =$ 0.0034		1–36: 0.57	W+1: 298.99	352.46	321.46	
	(0.0055)						
20	$a =$ 0.4384	0.18	1–12: 0.16	W−1: 296.63	349.83	313.23	0.20
	(0.1190)		1–24: 0.58	W−0: 285.78	337.03	316.20	
	$b =$ 0.0021		1–36: 0.55	W+1: 292.99	345.53	317.91	
	(0.0054)			W+2: 294.06	346.80	313.84	
21	$a =$ 0.3702	0.12	1–12: 0.37	W−1: 260.50	297.56	279.25	1.31
	(0.1227)		1–24: 0.85	W−0: 260.50	297.56	280.21	

Table II—*Continued*

Meeting No.	Parameter Estimates	$\bar{R}^2$	*P*-value of Box-Pierce Statistics	95% Forecast Bounds		Actual Value	*F*-Test
	$b = -0.0030$		1–36: 0.90	W+1: 261.73	298.97	280.21	
				W+2: 261.40	298.59	280.21	
22	$a =$ 0.3663	0.12	1–12: 0.52	W−1: 290.94	333.99	311.13	0.50
	(0.1239)		1–24: 0.90	W−0: 28.87	331.61	297.27	
	$b = -$ 0.0004		1–36: 0.65	W+1: 272.75	313.10	299.86	
	(0.0045)			W+2: 280.66	322.18	304.59	

Notes: Numbers in parentheses are estimated standard errors. W−1 is the week preceding the week(s) of the OPEC meeting; W−0 is the week of the meeting; and W+1 is the week thereafter. If the meeting days occurred in two trading weeks, W−0 and W+1 are the meeting weeks, and W+2 is the week following the meeting.

* Price forecasts outside the 95% forecast bounds or *F*-statistics with confidence larger than 0.95.

errors across meetings. Yet, this would bias the test in favor of the null hypothesis, as the outcome of some meetings had been anticipated, and because other meetings made only marginal decisions. Fortunately, however, the null hypothesis implies that, no matter how one sorts the meetings in question, the resulting classes should have the same frequency of estimated values of $E_{t-1}(\tilde{e}_t \mid A_{t-1}, y)$ different from zero. According to the price impact hypothesis, instead, meetings that ended with unexpected OPEC decisions should have a larger frequency of prediction errors significantly different from zero.

Assuming that meetings where large price changes were announced were the meetings less well anticipated by the market, we put those meetings into one group (a large price change is defined as a change of plus or minus 5%).[8] The *test sample* therefore includes meetings #8, 11, 15, 16, 17, 20, and 22. All other meetings are assigned to a *control sample.*

As one can see from Table II, the set of forecast errors is jointly significantly different from zero for meeting #1 (control sample) and meeting #15 (test sample) only. Hence, the *F*-test is unable to reveal evidence that meetings associated with the announcement of large price changes generate abnormal prices more frequently than other meetings. This evidence is consistent with the hypothesis that the announcement of OPEC decisions has no information value for the market.

The *F*-test examines whether the set of price changes observed during the meeting weeks is generated by a different ARIMA process. Yet, the announced OPEC decisions might cause only individual weekly price changes to be abnormal. To check for this possibility, we consider the weekly forecasts in Table II.

Actual data are significantly different from their forecasts for meetings #1, 11, 15, and 16. Consequently, three (#11, 15, and 16) of seven conferences in the test sample have observations significantly different from their predicted values. For the control sample, that proportion is one of 15. These results can be summarized

[8] Notice from Table I that OPEC did not set output quotas until 1982. If any collusive mechanism existed before that, it was by setting common prices and letting demand clear the market.

in the following contingency table:

	Conferences with Large Pricing Decisions	Other Conferences	Total
Significant abnormal gas-oil price performance	3	1	4
Normal gas-oil price performance	4	14	18
Total	7	15	22

The above can be used to test if an abnormal gas-oil price behavior occurs more frequently during conferences with large pricing decisions than during others. Given the small sample size, the usual chi-square test could be imprecise. We therefore compute Fisher's exact test statistic.[9] Consider the following experiment. From a population of 22 meetings, 4 of which have an abnormal gas-oil price performance, we randomly draw a sample of 7 without replacement, and count the meetings with an abnormal price behavior. If the drawings were random and independent, the experiment outcome would have a hypergeometric probability distribution. The probability of drawing 3 or more meetings with an abnormal gas-oil price pattern in a sample of 7 would then be less than 7.7%.[10] Hence, OPEC meetings more likely to have unanticipated results seem to affect the spot market for refined products more than other meetings, i.e., there is some evidence that OPEC was able to affect market prices in 1974–1980.

This finding is not fully convincing for several reasons. For instance, if the test sample is restricted to meetings that announced benchmark price changes of 14% or more, only one of three meetings has prediction errors significantly different from zero: the probability of observing an equal or larger number by pure chance is 47%. In addition, and perhaps more importantly, not one single significant prediction error in Table II occurs during the meeting week itself.

Similar conclusions follow if one calculates the announced price changes as the percentage deviation of the new OPEC price from the average spot price for crude oil during the three preceding months (weekly spot prices for crude are unavailable for the whole period): there is very weak evidence, if any, to support the claim that meetings which announced new prices extremely different from the prevailing spot prices had a larger frequency of prediction errors significantly different from zero.

The impression that the null hypothesis cannot be rejected is further reinforced by additional findings. The preceding test was originally performed using daily gasoline (91/92 octane) spot prices for the period 1974–1979. Forecasts based on a 200-day estimation period (not one-step ahead forecasts) were estimated for the meeting days, one day before and one day after the meeting. In no case were the prediction errors significantly different from zero with confidence 0.95, independently whether we imposed a common ARIMA structure or we estimated a separate ARIMA model for every single meeting. Daily data, however, are not available for all trading days, which calls for some caution in taking these results at face value.

[9] See Brownlee [2], pp. 163–66.

[10] See Lieberman and Owen [8].

Furthermore, to make sure that the preceding findings are not caused by a low sensitivity of spot prices to unanticipated future market developments, or by the possibility that Platt's spot quotations have measurement error, we considered the daily stock returns on a portfolio of firms in the Petroleum and Natural Gas Industry (SIC code = 1311) and a portfolio of firms in the Coal Mining Industry (SIC code = 1211).[11] Event tests were performed for every single meeting in 1974–1980, assuming stock returns follow a random walk. Abnormal returns were calculated for the meeting days, one day before and one day after. Significant abnormal returns on individual days were observed during OPEC meetings #1, 4, and 10 in the case of petroleum producing firms, and during meetings #1, 4, 6, 16, and 17 in the case of coal producing firms. Hence, significant abnormal returns occurred only during two (meetings #16 and 17) of the original test sample meetings, and only for coal producers, as if in reaction to coal-specific events as opposed to an unexpected oil price change. Hardly evidence contradicting the null hypothesis.

Finally, we also conducted the following test. The relevance of OPEC conferences for the spot market of oil products or for the stock market could show up in the form of an increased variability of prices around the days of a particular meeting. In other words, if 0 is the month of the meeting, the variance of oil product prices could increase in that month relative to months −1 and +1. We tested for this possibility using daily data for four oil products (gasoline, kerosene, gas-oil, and heavy fuel) for the period 1974–1979. In no case could we reject the hypothesis of no variance increase with 0.95 confidence, no matter whether we used the variance of the rate of growth of prices corrected for the systematic components of their ARIMA models or not.[12] Similarly, we found no evidence of a significant increase in the return variance of our two stock portfolios of crude oil and coal producers during 1974–1979.

Taken together, the results fail to support the claim that the announcement of OPEC decisions affected market prices in 1974–1980, which is inconsistent with the notion that OPEC was an effective cartel during that period.

B. Subperiod 1981–1983

To analyze the market reaction to OPEC announcements during the 1981–1983 period of softening oil prices, we were able to use weekly settlement prices for futures contracts on heating oil traded on the New York Mercantile Exchange. Prices are measured on the first trading day of each week. These settlement prices should be a closer representation of actual market prices than Platt's Rotterdam spot quotations, which are based on the opinion of various market participants in a nonorganized exchange. In addition, futures prices may be more sensitive to the longer-run consequences of cartel policy than spot prices.

Since the sample autocorrelations and partial autocorrelations for the logarithmic price changes of the heating oil contracts considered are consistent with

[11] The portfolios are equally weighted and include all firms on the CRSP tapes that belong to industry 1311 and 1211, respectively.

[12] The test using variances corrected for the autoregressive and moving average components of the ARIMA model was only run with gasoline prices.

white noise, the impact of OPEC meetings can be measured by regressing the price changes of a certain contract over its life on dummy variables equal to one during the conference weeks and zero otherwise. Conference weeks are the weeks that include the days of a particular OPEC meeting, one trading day preceding the meeting and one trading day following it.

Regression results by contract are shown in Table III, which reports the estimated regression coefficients (t-values are in parentheses) for the dummy variables that correspond to the OPEC meetings considered. Two dummy variables are also introduced to measure the effect of two announcements by a "Market Monitoring Committee" of OPEC. The first one (April 21, 1982) came following the formal allocation of output quotas among OPEC members in March 1982 and said that OPEC's production was running below the total limit set by OPEC. The second one (April 18, 1983) came after output quotas had been shuffled in March 1983, and reported that all OPEC members were adhering to the new agreement.[13] According to the null hypothesis, these announcements should have left market prices unaffected, while the cartel version of the price impact hypothesis, henceforth referred to as the cartel hypothesis, would have predicted a price increase. Since the first futures contract used (July 1981) covers a period which includes meeting #22 of December 1980, that meeting is part of the analysis as well.

As shown in Table III, not all the meetings have a significant effect on futures prices, which is not surprising because some meetings made only marginal, if any, policy changes, and the conclusion of other meetings was widely anticipated. Unlike in the 1974–1980 period, however, the meetings of 1981–1983 also made output policy decisions. Hence, to test the null hypothesis, we sorted the meetings in different categories depending on whether they ended with good or bad news for the alleged cartel.

The good news category includes the meeting that established output quotas for the first time (meeting #27), the meetings that led to an agreement after two preceding failures (meetings #25 and 32), and the two announcements by the Market Monitoring Committee. Bad news meetings are meetings where no consensus could be reached (meetings #23, 24, 29, 30, and 31). All the remaining meetings are put in a neutral category (meetings #22, 26, 28, 33, and 34). A sign test can discriminate between the null and the cartel hypothesis: if OPEC is an effective cartel, and if there is some residual uncertainty about its decisions before each meeting, good news should lead to higher prices and bad news to lower prices, whereas the null hypothesis predicts no difference. The findings are inconsistent with the null hypothesis: good news meetings are systematically price increasing; bad news meetings always reduce prices; and neutral meetings have no distinct influence on prices (three have a positive and two a negative sign). With the exception of meeting #24, which has a positive coefficient, similar results, in terms of the sign of the estimated coefficients, are obtained by replicating the regressions with weekly spot prices for gasoil.

To make a comparison with the years 1974–1980 easier, ARIMA (1, 1, 0)

[13] In both cases, the relevant announcement day is the day the news was reported in the Wall Street Journal, i.e., April 22, 1982 and April 19, 1983, respectively.

Table III

Impact of OPEC Meetings' Pricing Announcements on the Growth Rate of Prices for Heating Oil Futures Contracts (New York Mercantile Exchange): 1980–1983

	July 1981 Contract	December 1981 Contract	September 1982 Contract	December 1982 Contract	March 1983 Contract	May 1983 Contract	May 1984 Contract
Intercept	−1.634E-03	−1.146E-03	−3.268E-03	−2.601E-03	−1.515E-03	−3.241E-03	8.786E-04
	(0.354)	(−0.452)	(−0.727)	(−0.518)	(−0.287)	(−0.608)	(0.248)
Meeting #22	1.063E-02						
	(0.559)						
Meeting #23	−3.667E-03	−9.450E-03					
	(−0.193)	(−0.867)					
Meeting #24		−2.619E-02	−2.665E-02				
		(−1.723)	(−0.838)				
Meeting #25		9.894E-03	8.060E-03				
		(0.651)	(0.253)				
Meeting #26			−2.60E-02				
			(−0.818)				
Meeting #27			1.767E-02	2.858E-02			
			(0.556)	(0.868)			
Marketing Monitoring Committee Announcement #1[a]			6.036E-02	5.484E-02	6.450E-02		
			(1.898)	(1.667)	(1.954)		
Meeting #28			1.219E-02	6.856E-03	4.472E-03	−1.649E-03	
			(0.383)	(0.208)	(0.135)	(−0.049)	

Meeting #29			−1.782E-02	−1.974E-02	−2.356E-02	−2.736E-02	
			(−0.560)	(−0.600)	(−0.714)	(−0.811)	
Meeting #30					−4.793E-02	−4.813E-02	
					(−2.028)	(−1.993)	
Meeting #31					−5.062E-02	−5.357E-02	
					(−2.141)	(−2.219)	
Meeting #32						5.020E-02	3.569E-02
						(2.516)	(2.333)
Market Monitoring Committee Announcement #2[b]						4.799E-02	4.162E-02
						(1.423)	(1.600)
Meeting #33							3.062E-03
							(0.165)
Meeting #34							−1.160E-02
							(−0.624)
F	0.18	1.38	0.84	0.98	2.63	3.15	2.09
$\bar{R}^2$	0.0	0.171	0.0	0.0	0.395	0.460	0.260
No. of observations	36	39	56	46	45	49	61

[a] OPEC's Market Monitoring Committee reported the organization's production was running around 15.85 million barrels a day, lower than the 17.5 million barrels a day set by OPEC (April 21, 1982).

[b] OPEC's Market Monitoring Committee reported all 13 OPEC members were adhering to the group's new agreement (April 18, 1983).

Notes: Numbers in parentheses are t-values.

models using weekly gas-oil prices were estimated for nonoverlapping 2-year intervals in the 1973–1980 period, with dummy variables proxying for the effect of OPEC meetings. No coefficient was significantly different from zero. Good news meetings were, somewhat arbitrarily, defined as meetings where there was a consensus to increase prices, and bad news meetings were meetings where OPEC members failed to agree on a common policy. Eight meetings (#3, 5, 8, 12, 13, 15, 16, and 17) had the sign predicted by the cartel hypothesis, but seven meetings (#4, 10, 11, 18, 20, 21, and 22) had an opposite sign. More importantly, given that their definition should be less controversial, bad news meetings were evenly split between correct and wrong sign (meetings #3, 12, and 13 had the correct negative sign, while meetings #10, 11, and 18 had a positive sign). Again, the evidence from the 1974–1980 period is consistent with the notion that OPEC decisions did not affect market prices.

Consider now the results in Table III again. A more powerful test than the one discussed can be performed by predicting the significance of the dummy variable coefficients under the cartel hypothesis. According to the press, the meetings with the most surprising good news were the ones where output quotas were set (meetings #27 and 32). The associated announcements of the Market Monitoring Committee also represented unanticipated good news. The dummy variables for these four events should have positive and significant signs. Meetings that ended in acrimonious dissent were meetings #24, 29, 30, and 31, while meetings #25, 26, 28, 33, and 34 were uneventful. One-sided significance tests with confidence 0.95 reveal that 5 (6 if we count Announcement #2, which is marginally insignificant) of 8 extreme cartel-related events have significant coefficients with the sign predicted by the cartel hypothesis, and that uneventful meetings never have significant coefficients. Contingency table tests indicate that the probability of randomly observing these results is virtually zero.

Regressions using weekly spot prices for gas-oil yield only two significant coefficients: the one associated with the Market Monitoring Committee's announcement of April 1982, which is positive, and the coefficient associated with meeting #31, which is negative. Although weaker, these results are consistent with the ones above, in that only surprising OPEC-related events affect the spot market significantly, and with the sign predicted by the cartel hypothesis.

A disturbing finding, however, is that meeting #27, where output quotas were first established, led to an upward revision of prices, but not a significant one. One possible reason, which is consistent with the results from the years 1974–1980, is that the market was skeptical about OPEC's ability to effectively collude. Over time, however, the market should have recognized whether or not OPEC's efforts were successful. Consistent with this explanation, daily prices for heating oil futures (September 1982 contract) almost continuously decreased by 23.1% from January 5, 1982 until March 17, 1982, the day OPEC ministers gathered for meeting #27, but prices rebounded by 33.4% between then and May 25, 1982. Both changes are statistically significant with confidence 0.95.

Taken together the evidence from the years 1981–1983 contradicts the null hypothesis and supports the cartel hypothesis.

V. Conclusions

This paper tests whether the announcement of OPEC policy decisions affected prices during 1974–1983. We are unable to find convincing evidence of such an influence for the years 1974–1980, while, for the years 1981–1983, the evidence is much more favorable. Hence, quite contrary to general opinion, it is not for the years of runaway oil prices that the results support the cartel hypothesis, but for the recent years of softening prices. If western economies ever were the victims of the OPEC cartel, then more probably so during the recent years than during the 1970's.

These conclusions could be questioned by arguing that OPEC has been effective all along, but that there was little uncertainty about OPEC's policies during 1974–1980. This reasoning is difficult to believe, however, if one considers that prices experienced an unprecedented and quite erratic increase of more than 1500% during those years. Either these prices were the result of collusion, in which case uncertainty about cartel policy must have been substantial, or else they increased independently of OPEC.

Alternatively, one could claim that the results do not prove the existence of a cartel but simply indicate that OPEC is a trade association whose members meet to exchange market relevant information without colluding. Yet, if this is true, why did these meetings have a market effect in 1981–1983 but not in 1974–1980, and why did OPEC's decision to allocate output in a cartel-like fashion influence prices?

Further insights into the question of whether OPEC was an effective cartel can probably be gained from an analysis of the output time-series of OPEC, of Saudi Arabia (the cartel's alleged swing producer), and of non-OPEC oil-producing countries. For instance, while the output time-series of OPEC (exclusive of Iran and Iraq) and the output time-series of major non-OPEC producers (excluding new producers Egypt, Norway, and the United Kingdom) were positively correlated during the years 1977–1980, they were negatively correlated during 1981–1983: an observation consistent with the findings of this paper.

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DISCUSSION

RICHARD P. CASTANIAS*: The Loderer paper addresses the question of whether OPEC nations have been able to effectively cartelize the international petroleum market. Loderer argues that the policy decisions of an effective cartel affect spot market oil (or related) prices. This hypothesis is tested by examining the correlation between OPEC policy changes and changes in spot oil (and future market contract and stock portfolio) prices during the period 1974 through 1983. A significant correlation is argued to be consistent with an effective cartel, whereas the finding of no correlation between OPEC policy changes and prices is argued to be inconsistent with any cartel model but consistent with the market for oil being competitive. Loderer finds that there is no significant relationship between OPEC policy changes and spot oil (and other) prices during the period 1974–1980, but finds a significant relationship for the years 1981–1983. He concludes that the evidence is consistent with the notion that OPEC is an effective cartel during the latter years but not during the period 1974–1980.

These conclusions are especially interesting in that they clash with conventional wisdom that holds the OPEC cartel responsible for the runaway oil prices of the early 1970's and with the generally high and increasing oil prices of the late 1970's. Loderer's findings are also in contrast with the prevailing belief that the effectiveness of the cartel has lessened in the 1980's relative to the 1970's. Clearly, the Loderer results suggest the possibility that widely held perceptions of the effectiveness of the OPEC cartel are unjustified.

The Loderer findings and conventional wisdom might be reconciled in two ways: either there may be some question about the interpretation of the results of the study, or the results themselves may be suspect due to econometric problems that are obscuring a correlation that actually exists between spot (and other) prices and OPEC policy changes.

As for the interpretation of the results of the study, does it necessarily follow that a competitive market for oil will be characterized by no correlation between OPEC official pricing policy changes and spot prices? The existence of an official price is not in itself evidence of effective cartel. In recent years both Britain and Norway have discussed setting official prices at the average of previous month spot prices, and it has been rumored that Britain will adopt such a policy officially in early 1985. Obviously, such a pricing policy would lead to official price changes being correlated with changes in the market price, even when the market is

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