Political Constraints on Government Cartelization: The Case of Oil Production Regulation in Texas and Saudi Arabia

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ABSTRACT

We examine government cartelization efforts in crude oil production. Texas and Saudi Arabia are alleged to act as swing producers to maintain the interstate (1933-1972) and OPEC (1973 on) oil cartels respectively. We analyze the political constraints that affected the ability of Texas and Saudi Arabia to act as residual producers within their respective cartels. In the case of Texas, political factors molded individual firm production quotas, advantaging high-cost producers and hence, reducing total cartel net profits. Further, Texas had limited range for adjusting total state production to maintain interstate output at levels consistent with target prices. Saudi Arabia's role as swing producer within OPEC raises similar questions regarding how cartel output is shared among members, and the extent to which domestic economic and political pressures coming from various member countries may undermine the effectiveness of the cartel. OPEC 's coordination problem has been more difficult than that faced by the interstate cartel for a variety of reasons that we explore. Even so, they have not kept the OPEC members in general, and Saudi Arabia in particular, from exerting a strong influence on the level of world oil prices.

JEL Classification K2, L1, N4, Q4

I. Introduction.

Cartels have long attracted attention because of their potential ability through producer coordination to reduce output and raise prices above competitive levels. If successful, cooperating parties can achieve monopoly profits. Cartelization, however, suffers from well-known problems. Agreeing on cartel output, prices, and individual firm quotas can be contentious, especially if firms are heterogeneous with respect to size, production cost, product characteristics, and assessments of the market. Honest disagreements among the parties may delay or block the formation of a cartel. Strategic behavior, whereby some parties hold out in order to achieve larger quotas or shares of cartel profits, also is a hazard. Additionally, once cartels are established, quota compliance among members and entry by new parties can threaten effective collusion. Cheating leads to greater production, lower prices, reduced collective profits, and potentially, the unraveling of the cartel. Even if the parties understand the effect cheating may have on the future of the agreement, they may still exceed their quotas if they have low production costs relative to the other parties, are very small, or have high discount rates.[1] Successful cartels attract new entrants, eager to earn cartel profits. New entry, however, requires recalculation of individual quotas if total production levels are to be maintained. Technological change that

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[1] If individual quotas differentially constrain low-cost firms to produce well below their profit maximizing level, they have greater incentive to cheat. For discussion, see Alexander and Libecap (2000). More generally, Alexander (1997) argues that firms with low production costs are more likely to defect because they can do better in a non-cooperative, non-collusive equilibrium, than under an agreement that higher-cost firms were attempting to impose. Further, Wiggins and Libecap (1987) argue that very small firms bear little or none of the industry-wide pecuniary losses as prices fall with the unraveling of the cartel and hence, have less incentive to maintain the agreement. Finally, a standard cartel problem is that firms with very high discount rates may value the short run profits of defecting and so discount the loss of future cartel profits that they take less care to maintain it.

differentially shifts production costs or changes product characteristics so that the industry is less homogeneous than before are additional obstacles.

For these reasons, colluding parties often turn to government to promote cartelization through price, production, and entry regulation. Governments also may be involved directly in collusion if production occurs across political jurisdictions, such that coordinated output within one jurisdiction is insufficient to effectively limit output to fix market prices. Through the coercive power of the state, negotiations can be speeded, holdouts blocked, prices fixed, entry barred, and quotas more effectively enforced. Even so, government assistance may not bring complete cartelization that maximizes collusive profits. Political constraints limit the prices that can be charged and mold individual quotas in ways that are inconsistent with group profit maximization. These political constraints and their effects on cartel structure and performance are the focus of this chapter.

We examine dominant firm arguments in crude oil production.[2] When one producer is much larger than the other parties, it can act to promote and maintain the cartel by taking unilateral production adjustments to sustain target cartel output and prices. According to the theory, the dominant firm sets its output after subtracting the production of fringe producers from estimated demand at the target price. If fringe producers expand their output, the dominant firm, as residual producer, reduces production, and if fringe producers

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[2] For discussion, see Libecap (1989). The sections concerning Texas in this chapter build on the analysis in that paper.

reduce output, the dominant firm increases its production. The residual or swing producer, then, acts as the balance to protect the cartel.[3]

Texas and Saudi Arabia are alleged to act as swing producers to maintain the interstate (1933-1972) and OPEC (1973 on) oil cartels respectively.[4] We analyze the political constraints that affected the ability of Texas and Saudi Arabia to act as residual producers within their respective cartels. In the case of Texas, we argue that political factors molded individual firm production quotas, advantaging high-cost producers and hence, reducing total cartel net profits. Further, Texas had limited range for adjusting total state production to maintain interstate output at levels consistent with target prices. Any large adjustment in state output required similar adjustments in individual firm production allowables with important political consequences. A large, temporary increase in Texas production to counter a shortfall elsewhere would be difficult to reduce subsequently. More problematical would be reductions in state output and firm (well) allowables to offset increases in other jurisdictions. Production cuts would impact not only royalty and lease owners (land owners and producing firms), but also oil field workers and equipment suppliers. These effects would not be favorably received among voters if the production adjustment were perceived as a response to overproduction elsewhere. Hence, the state

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[3] For discussion of various cartel models, including dominant firm behavior, see Stocking and Watkins (1946), Fog (1956), MacAvoy (1965), Hay and Kelly (1974), and for a summary of the large game-theoretic literature see Tirole (1988).

[4] A summary of views on OPEC is provided by Gately (1984), Griffin (1985), and Claes (2001). For Texas, see de Chazeau and Kahn (1959), Zimmermann (1957), Adelman (1972), and Lovejoy and Homan (1967).

3

regulatory body, the Texas Railroad Commission, would be reluctant to order sharp, sustained production cuts to balance cheating in other areas. There were limits to how far a state regulatory body could go to protect interstate oil coordination.

Saudi Arabia's role as swing producer within OPEC raises similar questions regarding how the "work" of the cartel in restraining output is shared among members, and the extent to which domestic economic and political pressures coming from various member countries may undermine the effectiveness of the cartel. These questions are surely as important to the Saudis as ever they were in Texas. Despite continuing (and expensive) attempts at diversification, crude oil and refined products accounted in 1999 for some 90 percent of total Saudi exports, down from 99 percent in the early 1980s. As shown in Table 1, this degree of dependence is high even by OPEC standards (the rest of OPEC derived only 59 percent of export revenues from crude oil and refined products in 1999). Thus, the success with which the Saudis are able to manage their relationship with the rest of OPEC ranks, alongside regional security issues, as the principal domestic challenge facing Saudi leaders.

Although OPEC has been compared on many occasions to the Texas Railroad Commission, Adelman (2001), Claes (2001) and Moran (1982) each argue that OPEC's task is the more difficult, with a lower chance of success. In the first place, the producers of OPEC oil are sovereign nations, not private firms, with no legal system in place to police or enforce their agreements. The production restraints that OPEC managers adopt are entirely voluntary in nature, without any counterpart to the Connally Hot Oil Act to

4

penalize cheaters and bring discipline to the group. Moreover, the OPEC producers maintain, in their individual roles as autonomous nation states, a wide range of political, social, and other non-economic interests that may at any time come to temporarily dominate or dissolve their common, but narrower, interest in the oil market. The idea that all OPEC members are constantly working toward the collective good overlooks the multi-dimensional nature of their relationship, which we explore later in this paper. Finally, the OPEC members are at a severe informational disadvantage, compared to the Texas Railroad Commission, with regard to the state of the oil market and the likely impacts of their actions to influence it. The type of information regarding current inventory levels and polling procedures to forecast monthly fluctuations in demand that allowed the Railroad Commission to anticipate market trends simply do not exist on the scale that is needed to manage world oil prices. Limitations in OPEC's ability to forecast market reactions to its initiatives might not matter so much, as noted by Adelman (2001) and Moran (1982), if the feedback loop of information on resulting inventory changes were not so weak and obscure.

While these tactical difficulties may have prevented OPEC from attaining the same degree of consistent success achieved by the Texas Railroad Commission, they have not kept the OPEC members in general, and Saudi Arabia in particular, from exerting a strong influence on the level of world oil prices.

II. Texas and the Interstate Oil Cartel.

Between 1933 and 1972, crude oil production in the United States was regulated by government prorationing of output among the states to fix prices. During that period crude

5

oil prices increased and stabilized relative to patterns prior to 1933. Texas, as the largest U.S. producer, played a pivotal role in interstate regulation. Erich Zimmermann (1957) and Melvin de Chazeau and Alfred Kahn (1959) argued that through the 1950s, the Texas Railroad Commission adjusted output to insure that U.S. production equaled estimated aggregate demand at targeted prices. Morris Adelman (1972) and Wallace Lovejoy and Paul Homan (1967), however, with a somewhat longer view, argued that interstate regulation was only loosely coordinated, with Texas primarily restraining its low-cost fields. Our analysis supports the latter view, but also shows that how political pressures limited the discretion available to the Railroad Commission and resulted in regulations that benefitted high-cost producers in all states.

By 1920 there was a national market in the United States for crude oil, with most producing regions connected by pipelines and railroads to domestic markets. The midcontinent region that included Kansas, Oklahoma, and Texas was the major producing area. California, another large producing state, was isolated from the national market until after World War II. Although there were limited efforts in the early part of the 20th century to regulate production in order to moderate price swings and mitigate common-pool losses, most extensive regulation began in 1933.[5] Prior to regulation, U.S. crude oil output and prices followed cycles with prices falling sharply as new fields were discovered and drained and then rising as supplies again became tight. Initial interstate efforts to regulate

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[5] Early regulatory efforts are described by Murphy (1949) and by Libecap and Wiggins (1984), and Bradley (1996).

production began in 1926, following the unprecedented clustering of major new oil discoveries that drove prices to their lowest levels in the 20th century. For example, the nominal Oklahoma price for 36-degree gravity oil fell from $2.29 per barrel in 1926 to $0.10 per barrel in 1933, far exceeding the depression-led decline in the consumer price index.

Oil production costs are largely a function of geology, technology, and time. Newly developed reservoirs provide oil at very low marginal extraction costs, since underground pressures are sufficient to expel the oil to the surface once the reservoir is punctured by a well. Over time those pressures are dissipated, particularly if the field is exploited rapidly, as was common in the early part of the century. Eventually, installation of pumping wells and the injection of natural gas, water, or other substances into the reservoir become necessary to extract the oil, but these actions raise marginal extraction costs.

In the 1930s low-cost oil from very productive new fields threatened high-cost older producers. Texas was the focus of attention. The state not only had the giant East Texas field, discovered in October 1930, but it also had by far the largest reserves of low-cost oil. In 1934 Texas had 45 percent of proved U.S. oil reserves and by 1940 had 56 percent. By contrast, Kansas and Oklahoma had 3 percent and 6 percent of U.S. reserves.[6] Oil production in Kansas and Oklahoma generally was from older reservoirs and more costly to extract than was much of Texas's production. Further, most production in those states came

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[6] Crude oil reserves data are from the <u>Oil and Gas Journal</u>, January 18, 1937; and the American Petroleum Institute (1980, 25-66).

from stripper wells, high-cost wells on old fields or older parts of fields that produced 10 barrels or less of oil per day. Stripper wells commonly were owned by small firms, and their large proportion of total wells in Kansas and Oklahoma, 65 percent and 87 percent in 1941, formed an influential political lobby in determining the stands of those two states in interstate prorationing negotiations. In Texas in 1941 stripper wells were 31 percent of total wells and were located in the high-cost regions of north and central Texas.[7]

Because of its reserves of low-cost oil, Texas was urged to disproportionately constrain its production. While the argument was phrased in terms of conservation the underlying political concern was the devastation to local economies and the careers of politicians if thousands of small, high-cost oil firms, refineries, and well service and supply companies were to fail. Following the discovery of the East Texas oil field, Oklahoma Governor William Murray organized the Oil States Advisory Committee to set total production quotas for Kansas, New Mexico, Oklahoma, and Texas. The quotas, however, were quickly violated by production from the East Texas and Oklahoma City fields, and they were struck down by the federal court.[8] In March 1933, as East Texas output approached one million barrels per day, despite a production quota from the Texas Railroad Commission of 400,000 barrels, the governors of the oil-producing states met with U.S. Interior Secretary Harold Ickes to discuss a new quota structure to control production and raise prices. At the same time, Kansas Senator George McGill introduced legislation in

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[7] Stripper wells are defined in Lovejoy and Homan (1967, 185). Stripper well data are provided in Libecap (1989, 837).

[8] *Constantin v. Smith*, 57 F. 2nd 227, February 1932.

Congress for federal enforcement of the proposed quotas. These efforts were shortly incorporated into the National Recovery Administration (NRA) Oil Code, which was established in September 1933.

Under the NRA, interstate regulation of oil production and shipment became much more effective. Quotas were assigned to each state, a target price of $ 1. 11 was selected, and a Federal Tender Board was set up to issue affidavits certifying that any oil shipped interstate was within prescribed quotas. The Bureau of Mines in the Interior Department provided monthly demand estimates, which were necessary for setting production targets commensurate with the target price. Further, from September 1933 through January 1935, Section 9(c) of the NRA Oil Code declared illegal any interstate shipment of hot oil, which was oil produced in excess of state authorizations.

Under the NRA, interstate prorationing of crude oil production worked extremely well, given the previous history of chaos in the industry. Total production was reduced, and crude oil prices quickly rebounded to over $1.00 per barrel. The allocation of total crude oil reductions, however, shows why Texas subsequently would resist the efforts of neighboring states to impose output controls in interstate regulation. Under NRA controls, the East Texas field bore almost all of the regional production cuts. By May 1934 East Texas was producing 509,000 barrels per day, less than half of its March 1933 output, and the rest of Texas was held to previous production levels. During the same period Oklahoma and Kansas increased output by 70,000 and 20,000 barrels per day, respectively. While total oil revenues in all three states rose with higher prices, Texas had no incentive to delegate quota

allocations to the federal government or an interstate body if it were to bear most of the constraints.[9]

In January 1935, the Supreme Court declared the Section 9 (c) of the NRA unconstitutional, threatening interstate production coordination.[10] The states were quick to respond. Within one month, in February 1935, the Connally Hot Oil Act, sponsored by Texas Senator Tom Connally, was passed prohibiting interstate shipment of any oil that exceeded the production totals set by state regulatory agencies. The law authorized the President to establish boards to issue certificates of clearance for the interstate shipment of oil. Oil shipped in violation of state authorizations could be seized by the government, and the individuals involved could be fined $2,000 and/or jailed for six months.[11] Importantly, however, the legislation maintained individual state regulation of oil production.

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[9] Libecap (1989, 839).

[10] *Panama Refining v. Ryan*, 293 U.S., January 1935.

[11] 49 *U.S. Statutes at Large* 30, February 1935.

This situation was fine for Texas, but worrying for Oklahoma and Kansas. Oklahoma Governor E. W. Marland and Kansas Governor Alf Landon renewed their efforts to negotiate an interstate oil compact. To pressure Texas, Oklahoma Senator Elmer Thomas sponsored legislation for federal regulation of oil production, and related bills were considered by Congress through 1941, after the Interstate Compact was signed. Nevertheless, Texas Governor James Allred opposed federal intervention beyond enforcement of restrictions on hot oil shipments. Allred called for a compact among the states that would serve as a loose advisory body for regulatory agencies in coordinating output decisions. The compact was to have no independent authority to set output levels or quotas. Under the Texas plan regulatory authority would rest with state agencies, which would set monthly production totals and allocate them statewide.

An Interstate Oil Compact was finally accepted along the lines desired by Texas. Under the compact the governors of member states and representatives of their regulatory agencies met quarterly to discuss prices, oil production plans, and other regulatory issues. But the compact had no explicit regulatory authority. With the signing of the Interstate Oil Compact in 1935, the essential elements for the interstate oil cartel were in place, and they remained through 1972.

Under the Interstate Oil Compact each state agency set monthly production levels and allocated the state total among regulated wells. The *Monthly Petroleum Statement* of the Bureau of Mines provided the Texas Railroad Commission and the other state agencies with market-demand estimates. These estimates included both total demand for domestic

11

production and demand for each state's output within that total. With this information, the Railroad Commission set the total monthly allowable production within the state and allocated it across regulated wells. In determining monthly output levels, the regulatory agencies of the compact states met approximately at the same time and shared information on production plans.

A major concern of the state regulatory agencies was maintaining the viability of high-cost wells. Their owners were numerous, and they formed powerful political constituencies in all of the states. This objective required output controls on low-cost producers so that total domestic crude oil production could be reduced to equal estimated demand at a targeted price able to sustain high-cost producers. While the commissioners received only modest state salaries and there is no evidence that they received payments from the oil industry, the prestige and influence of their office was enormous. By restraining low-cost oil production, the commissioners protected the interests of the thousands of small independent oil producers who were found throughout Texas. These actions paid off politically, since the Railroad Commissioners were routinely re-elected in statewide voting. One commissioner, Ernest Thompson, served for 33 years (1932 to 1965), and in all periods the agency was characterized by stable membership.

High-cost stripper wells, which accounted for about 40 percent of Texas production in 1931, were exempted by the Texas Legislature from output controls in that year.[12] For

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[12]Oil Weekly, July 17, 1931 and 42nd Texas Legislature, Acts, 1931, Regular Session, Chapter 50, Art. 6049.

the next 40 years, the Railroad Commission focused its production constraints on the state's low-cost wells. Once the monthly state production quota was set by the agency, it was prorated among all regulated wells. Since high-cost wells were exempt from regulation, their output had to be subtracted from the state total before individual well allocations could be made. After production from exempt wells was subtracted from the total state quota, the remaining proratable production was divided by the capacity output of the regulated wells in Texas to give a "market demand factor" (proratable production divided by capacity production). As such, the market-demand factor was the fraction of capacity production that would be allowed from all regulated wells in the upcoming month. Until late 1962 the market-demand factor was converted to a number of authorized producing days for the next month. After 1962 it was expressed as the authorized percentage of capacity production. To arrive at each well's monthly quota, the state market demand factor was multiplied by the top allowable or capacity production for the individual well.

In addition to the exemptions granted stripper wells, the Railroad Commission also gave preferential treatment in production quotas to small oil producing firms, even though this practice raised production costs. It encouraged the drilling of extra wells. Monthly quotas for regulated wells were based upon acreage and depth, but the commission placed more weight on depth than on acreage. The more deep wells a firm drilled, the greater its quota. Although all firms could take advantage of this arrangement, because the rules discounted acreage, they disadvantaged firms with more and larger leases. To further

13

promote drilling, the commission routinely granted exemptions to small firms to the 10-acre spacing rule to allow for denser drilling.

The internal political constraints on the Railroad Commission help to explain why the agency could not systematically regulate Texas production each month to be the residual producer within the Interstate Oil Compact. If output significantly expanded in the other states and Texas routinely cut back to maintain prices, at some point the restrictions upon low-cost Texas producers would be so great that they would resist and challenge the agency's political mandate. Further, given political pressures, the commission had limited degrees of freedom to fine-tune Texas output in response to production in the other states. Hence, the commission had incentive to seek coordinated output policies among the states to avoid having Texas bear the full costs of controlling crude oil output. The other members of the Interstate Oil Compact also had incentives to cooperate with Texas, since the Railroad Commission restrained the large reserves of low-cost Texas production. The clear beneficiaries were high-cost wells in the prorationing states.

Texas does not appear to have acted as a residual or swing producer within the Interstate Compact. Libecap (1989) analyzed the variation in monthly output for the various states relative to the variation in demand for domestic production between 1941 and 1972.[13] If Texas acted primarily as a residual producer and absorbed most of the

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[13] Libecap examined four time periods according to different regulatory and production regimes, 1933-1941 (a period of organized market-demand prorationing), 1933-1935 (a subperiod when Texas was disproportionately constrained by the NRA Oil Code), 1946-1958 (the post-war period

fluctuations in total U.S. demand so as to maintain nominal prices while the other states (fringe producers) maintained their output, the coefficient of variation for monthly Texas production should have been larger than for the other states and approached or exceeded the coefficient of variation for U.S. demand. This condition, however, was not observed. Rather, the results point to considerable coordination among the states in monthly production decisions to maintain crude oil prices. There is no evidence that Texas adjusted its output more than the other states in response to monthly fluctuations in U.S. demand. The coefficient of variation for Texas production is larger than that for the other states only during the NRA period, 1933-35, when Texas output was under strict federal control. In the remaining time periods the coefficient of variation for the other states exceeded that for Texas and for U.S. demand. This suggests that all of the prorationing states within the framework of the Interstate Oil Compact adjusted their monthly authorized output to offset fluctuations in demand and that Texas did not assume the role of a swing producer on a monthly basis.

Libecap also used time-series analysis to further test for residual or swing production by Texas. Residual production by Texas to maintain nominal crude oil prices would have involved a long-term relationship between Texas output and U.S. market demand, whereby the two time series would have been cointegrated as a stationary time series. Further, residual production suggests that if U.S. demand unexpectedly increased

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when price controls were removed), and 1958-1972 (a crises period involving Louisiana production and the gradual rise of OPEC).

during a period, Texas would have raised production the next period as an "error correction" to bring total crude oil supply into line with demand at the target price. The analysis, however, found that the two series were not cointigrated, again supporting the view that Texas did not routinely regulate its output to counter production in other states.[14]

Although Texas did not act systematically as a residual producer within the interstate oil cartel, it did play a central role in interstate production coordination. Texas maintained the viability of high-cost producers in all states by restraining its large, low-cost fields. In return, all of the prorationing states shared monthly production adjustments to maintain crude oil prices so that the responsibility was not left solely to the Railroad Commission. Further, during crises, Texas was critical in adjusting production to protect the Interstate Compact.

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[14] Libecap (1989, 844-47).

The first crisis period between 1938 and 1941 involved rapid increases in output by Illinois, which threatened the structure of crude oil prices. New oil discoveries in Illinois in 1937 led to production that at least temporarily was not regulated in that state. Illinois left the Interstate Compact, and its production began displacing that of Kansas and Oklahoma in midwestern markets. By January 1938 Illinois's share of prorationed output was 1 percent, up from 0.4 percent in May 1937, and by June 1940 its share was 15 percent. At the same time, Kansas and Oklahoma shares declined from 6 and 21 percent in May 1937, to 5 and 13 percent, respectively, in June 1940. In response, Kansas representatives at the Interstate Compact threatened to leave the agreement and demanded tighter federal control of production unless each state was granted a minimum market share. Moreover, increases in Illinois production contributed to a 16 percent fall in nominal crude oil prices from $1.22 in 1937 to $1.02 per barrel by October 1938. As the states threatened to retaliate against Illinois by raising their own output, the interstate oil cartel seemed close to collapse.

In an emergency meeting of the Interstate Oil Compact in August 1939, Texas took the lead in cutting its production. Texas was concerned that the failure of interstate prorationing would lead to federal intervention and regulation of the industry, forcing it to bear more pemanent cutbacks. Representatives of the other states followed Texas' lead, and the results were dramatic. Total output among the compact states fell by 29 percent, from 98,070,000 barrels in July to 69,893,000 barrels of crude oil in August. This evidence of state cooperation reduced the downward pressure on crude oil prices and, importantly, weakened prospects for new federal regulation. Additionally, the flush period for Illinois

fields quickly passed, reducing the state's production. By 1941 increased oil demand for World War II and greater controls on Illinois output brought an increase in crude oil prices.

A second crisis period faced the interstate oil cartel in the late 1950s and early 1960s, this time due to major increases in production in Louisiana. Between 1958 and 1963, Louisiana crude oil output rose by 62 percent from 26,276,000 barrels to 42,512,000 barrels. Correspondingly, nominal U.S. crude oil prices began to fall in 1958 for only the second time since 1933. They declined from $3.07 per barrel in 1957 to $2.97 by March 1959 and to $2.92 per barrel by February 1963. Prices did not recover until September 1966, when they rose to $2.97 and then continued to rise to $3.50 per barrel by December 1972. In 1958 the other compact states lowered production by an average of 1,034,000 barrels per day for the first half of the year, and the Railroad Commission continued to reduce authorized Texas output. Allowable monthly production, which was approximately 48 percent of capacity output in October 1956, was lowered to 30 percent by September 1959 and to 27 percent by June 1962. The cutting of Texas output by the Railroad Commission, however, brought criticism from the regulated oil firms in Texas, and they mounted a political offensive to have the Texas Legislature re-evaluate the Railroad Commission's regulatory mandate. In February 1961 the Texas Legislature considered a bill to fix minimum well production allowables, removing quota discretion from the Railroad Commission. In December 1962 Texas firms called on the legislature to force increases in state production and "not permit Texas to continue much longer its disproportionate share

of the burden of curtailment to market demand .... ".[15] More seriously, in April 1963 the legislature considered creating a new agency to assume oil and gas regulation from the Railroad Commission. As adept politicians, the Railroad Commissioners soon began to slowly raise Texas output. Louisiana production gradually declined, prices rebounded, and Texas' allowables were increased. This political maneuvering, however, illustrates the limits on how far the Railroad Commission could go in reducing Texas's low-cost production to maintain U.S. nominal crude oil prices in face of production increases elsewhere.

III. Saudi Arabia within OPEC.

Although OPEC gained broad public notice only with the first oil price shock of 1973, the organization was formed thirteen years earlier by the governments of several oil-producing states who had grown dissatisfied with the dwindling stream of revenues derived from their crude oil production. Tax provisions put in place during the 1950s were designed to capture 50 percent of all profits from the production and sale of their resources. However, growing competition in the world oil industry since 1947 threatened to steadily erode the price of oil, and with it the potential size of government tax receipts.[16] Amuzegar (1999) summarizes the manner by which deteriorating relations between the producing companies and host governments finally gave birth to OPEC in September 1960. Saudi Arabia and Venezuela are generally regarded as the founding fathers, and the organization

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[15] Oil and Gas Journal, December 17, 1962.
[16] Griffin and Teece (1982: 8).

19

numbered 13 members at its peak. The departures of two relatively small exporters in the 1990s brought membership down to the current level of 11.[17]

The single thread that binds all OPEC members together is their status as oil exporting countries. Some are major producers located in the Persian Gulf, others are relatively minor producers located abroad. Some member countries are predominantly Arabic, others are not.[18] Some have low population densities with relatively high per capita income levels and modernized infrastructure, others are overcrowded and poor. In summary, the members are a heterogeneous lot who face distinct social, economic, and political challenges in their home countries.[19] Table 1 summarizes some of the country differences that are most relevant to our analysis.

The history of OPEC can be divided into three main periods that are distinguished by changes in the organization's goals and modus operandi. During the first phase, 1960-1969, the organization mostly restricted its efforts to winning a larger *share* of the oil profits that private companies generated within their territory, the stated goal being to hike government take from 50 to 80 percent. This was to be achieved through steady increase in

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[17] Current members are Saudi Arabia, Venezuela, Iran, Iraq, Kuwait, the United Arab Emirates, Qatar, Libya, Algeria, Nigeria, and Indonesia. Former members Ecuador and Gabon departed at the ends of 1992 and 1995, respectively.

[18] The Arabic members of OPEC have constituted a separate organization known as OAPEC, the Organization of Arabic Petroleum Exporting Countries. It was OAPEC, not OPEC, that declared the 1973 oil embargo against the United States and the Netherlands in response to those countries support for Israel in the 1973 Arab-Israeli War.

[19] Amuzegar (1999: 1-9) provides a revealing portrait of the social, cultural, and economic contrasts that exist among OPEC members.

tax reference prices—the basis by which excise taxes were levied on the companies.[20] There was no direct attempt by OPEC during this first stage of its history to lift the overall level of world oil prices.

OPEC's second phase, 1970-1981, was a period of coordinated action and collective deliberations designed to reverse the long period of decline and raise world oil prices to a higher level. This period was ushered in by a series of dictated agreements (the so-called Teheran-Tripoli agreements) by which the OPEC members unilaterally raised their posted prices 21 percent, reaching finally the level of $2.18 per barrel for Saudi crude oil by April, 1972.[21] It was understood that further increases could and would be imposed by the OPEC members, as they saw fit, under the doctrine of "changing circumstances." Indeed, a special OPEC conference called for that purpose was interrupted in October 1973 by the outbreak of the Arab-Israeli war. The Arabic members (OAPEC) immediately announced that all crude oil shipments to the U.S. and the Netherlands would be embargoed, and further announced plans to trim oil exports by 5 percent per month until Israel retreated and restored Palestinian rights.[22] Although the production cuts were soon rescinded, and the embargo never had much effect, these announcements panicked the market and fueled a speculative demand for crude oil inventories, which ultimately lifted spot oil prices to unprecedented heights.

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[20] See Adelman (1972: 207-208), Griffin and Teece (1982: 7), and Amuzegar (1999: 29) for further discussion.
[21] Adelman (1972: 250-256) and Claes (2001: 63).
[22] Claes (2001: 64).

Even if the various OPEC members had not envisioned such a dramatic rise in the price level, they were quick to observe how much consumers were willing to pay, at least in the short run, to avoid being cut off. This epiphany translated into increases that pushed the "official" OPEC price to $11.25 per barrel by 1975. Prices were further adjusted throughout the 1970s by collective agreement of the OPEC ministers, but hardly enough to offset the rate of inflation. The real price of oil actually declined until the onset of the Iranian Revolution, when expulsion of foreign oil companies from Iran and a wave of national strikes caused involuntary production cuts in 1978 and 1979—causing the market to panic again. This pattern was soon repeated at the outbreak of the Iran-Iraq war in 1980. Each panic brought fresh and dramatic demonstrations of consumers' willingness to pay, which induced OPEC to push the official price of Saudi crude oil up to $34 by October, 1981.[23] During this second phase of OPEC's history, no production allocation or export quota was imposed on any member. Each country was free to export as much oil as it could, as long as sales were made at the official price.[24]

The third phase in OPEC's history, lasting from 1982 to date, was triggered by growing surplus in the marketplace (the product of reduced consumption coupled with rising non-OPEC oil supplies, both spurred by the price shocks of the 1970s), which was registered in sharply falling spot market crude oil price levels. OPEC's system of freely

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[23] Griffin and Teece (1982: 12)

[24] Due to physical differences in the quality of various crude oil streams, OPEC adopted official price differentials relative to the benchmark Saudi crude, and members were allowed to make sales at the official quality-adjusted price level.

exporting at official prices was abandoned and replaced by a formal system of export quotas designed to take oil out of the market and support the price level. This is the phase of OPEC's history that most resembles the classic textbook example of a cartel, at least outwardly.

Much debate surrounds the question of when, if ever, OPEC has actually behaved as the classic textbook cartel. There is no question that total output has been restricted, and this is not due to any underlying scarcity of the resource. Total OPEC production fell from 30.6 million barrels per day (mbd) in 1973 to a low of 16.2 mbd in 1985. During that same interval, however, the volume of proved oil reserves of the OPEC members rose from 418 to 471 billion barrels. OPEC production today stands near 29 mbd, still below its 1973 level, although reserves have risen to 814 billion barrels. [25] There can be no doubt that the OPEC members have been up to something. The debate focuses, however, not so much on what has happened, but on why and how. In particular, there is the question of whether output restrictions have resulted from the coordinated actions of cartel members acting in concert or perhaps simply reflect the independent decisions of separate producers coping individually with their own domestic problems and political agendas.

One school of thought, represented by Moran (1978) and Teece (1982), takes the view that the limited domestic revenue needs of some OPEC members, particularly those with low "absorptive capacity," imposed an indirect restriction on the volume of their

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[25] Production data are from U.S. Energy Information Administration (2001). Proved reserve data are from various year-end issues of the *Oil and Gas Journal*.

23

individual exports. The higher the price, the lower the volume of oil exports required to achieve a revenue target sufficient to carry out the planned level of national spending. Accumulation of foreign assets (real or financial) was deemed to be risky and undesirable, so better to leave the oil in the ground than to produce at levels that would generate a financial surplus. The result is a backward-bending supply curve that links lower oil output to higher prices in a manner that requires no coordination among the OPEC members.

One problem with this line of argument is that the "absorptive capacities" of OPEC nations seemed, after the first few years of bounty, to increase faster than export revenues.[26] According to Teece (1982: 84), the combined government expenditure of all OPEC members grew by nearly 34 percent per year during 1972-79. The OPEC nations, taken as a group, were in deficit on current account by 1982. Even Saudi Arabia was running in arrears by 1983 (see Table 1).[27] Whatever merits the backward-bending supply theory may have held earlier, it hardly seems applicable anymore.

Even before the appearance of current account deficits, however, there were grounds for doubting the target revenue theory. For example, the theory would not have predicted that OPEC members with the greatest absorptive capacities would have significantly restricted their oil exports, yet at the peak of the 1981 price explosion, the

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[26] Adelman (1982: 44-45), for example, points out that the Saudis' state budget grew by a factor of twenty-two over a period of eight years, rising from $4 billion in 1973 to $88 billion by 1981.

[27] Amuzegar (1999: 48-115) evaluates in detail the manner in which each OPEC member handled the windfall gains that were earned as oil prices escalated.

extent of shut-in capacity (measured as the unused percentage of a country's sustainable production) was nearly identical at 10 percent for both the low absorption (Group I) and high absorption (Group III) members of OPEC.[28]

Griffin (1985) finds considerably more empirical support for the cartel model than for the hypothesis of backward-bending supply. To say that the OPEC members desired or attempted a collusive restriction of supply does not, of course, carry any implication regarding the success of that enterprise. To succeed OPEC must, like any cartel, settle on a common view of appropriate market price and output; and then fashion an acceptable division of the spoils. Both undertakings have been fraught with difficulties that stem from OPEC's heterogeneous composition, diverse political and social goals, and basic notions of equity.

Where production costs differ significantly among cartel members, the first-best principles of wealth maximization require that production be concentrated in the hands of low-cost suppliers. In OPEC's case, this would mean that only Persian Gulf countries would be permitted to produce.[29] That outcome is not acceptable to the peoples of Nigeria, Venezuela, or Indonesia who aspire to economic development. Output restrictions within OPEC therefore have to be shared on an "equitable" basis; and each member brings its own sense of equity to the table. The resulting compromise produces a paradox that would

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[28] These numbers reflect our calculations based on Teece's (1982:72) data.

[29] Estimates by Adelman (1993) show development costs in Indonesia, for example, to be fifteen times higher than in Saudi Arabia for the 1989-90 period; while Nigeria and Algeria are put at multiples of 7.0 and 9.5 times the level of Saudi costs, respectively.

never arise in monopoly or competition: higher cost units are produced before lower cost units, reducing in absolute terms the size of the producers' surplus. It would be an interesting calculation, one that we have not performed, to figure the burden that avoidable production costs have imposed on OPEC members during the past thirty years.[30]

Coordination among OPEC members has been shaped, but also jeopardized, by political rivalries among members and the vagaries of domestic policy agendas within the individual states. Moran (1982) and Amuzegar (1999: 44-46) discuss the degree to which the posture of Saudi Arabia, in particular, was influenced (not always in a consistent direction) by domestic political issues and regional alliances. Although not originating from the oil sector, these factors have often spilled over to impact the production and pricing of petroleum.[31] The heavy oil-dependence of each OPEC country almost ensures this result because oil makes a potent tool and/or vulnerable scapegoat simply by virtue of its size. Iraq, for example, openly renounced its export quota in 1982 by invoking the need for money with which to execute the war against Iran. Claes (2001) cites forty-six entries in the database of *Militarized Interstate Disputes* which place two or more OPEC members on opposite sides since World War II. In the domestic arena, macroeconomic goals have dictated Venezuela's oil export level, which significantly exceeded its OPEC quota throughout the 1990s, until President Chavez was elected in 1998 and abruptly changed the direction of all social policy—including the budget of the state oil company. The 1979

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[30] An explanation for the lack of side payments, which would largely circumvent the problem discussed in this paragraph, is beyond the scope of our present analysis.

[31] Claes (2001) provides an insightful analysis of individual incidents and their resolution.

revolution in Iran is perhaps the most prominent example of how oil market repercussions of an abrupt internal change in one member's social policy pushed OPEC off its "planned" course and onto a new path. Kohl (2001) addresses some of the key domestic issues that have most recently influenced cohesion within OPEC.

We believe there is room for (and evidence of) serious disagreement among OPEC members even regarding the most central aspect of their common enterprise: the appropriate target level for world oil prices. By luck of the draw, those members who hold the most extensive reserves also enjoy the lowest production costs. It would be remarkable, indeed, if the Saudis' preferences regarding current and future pricing of crude oil were to match those of their poorer counterparts who must spend much more to produce each barrel and will run out sooner. The basic calculus of inter temporal wealth maximization shows why: To illustrate, we contrast the position of Indonesia with that of the Saudis. Our numbers, although realistic, are intended only to be indicative of the relative positions of the two countries, not an authoritative statement of facts. The Indonesians, whose current reserves are sufficient to last only 10 more years, should be content to shut-in a barrel of current production only if the profit foregone today was expected to grow at the rate of interest during the interim.[32] If we take today's price to be $26.50 (the midpoint of the current OPEC "price band" mechanism), and the marginal cost of a barrel of Indonesian oil to be $10, then the profit foregone today would amount to $16.50 (here we are assuming

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[32] The ten-year life is based on the reserve to production ratio for Indonesia, reported as 9.7 years by BP (2000).

27

that because Indonesia is a relatively small producer, its decision to produce or withhold a barrel of oil has only a negligible impact on market price; thus marginal revenue equals price). Holding that barrel in the ground for ten years (while remaining reserves continue to be depleted) makes sense only if the price appreciates significantly in the meantime. Assuming a discount rate of 10 percent, the price would have to reach $52.80 ten years hence for Indonesia's sacrifice to be adequately repaid. That is, the NPV of 52.80 minus 10.00 equals 16.50, given ten years wait at 10 percent per annum.

Given the variety of views regarding future oil prices expressed recently in the media, the prospect of $50 oil by the year 2011 may not seem unreasonable, and current Indonesian reserves will last only that long anyway, so it is not necessary to look farther into the future. On this logic, an OPEC strategy of greater withholding of current production may not seem ill advised to the Indonesians. [33]

From the Saudi perspective, however, several elements of this calculation must be revised. The first takes account of the much lower cost of Saudi production, which we take as $2.25 per barrel, although it might be lower. The second takes account of the Saudi's larger market share, which means their decision to produce or withhold a barrel of oil does have a perceptible impact on the market price. We will assume, perhaps not unrealistically, that the elasticity of demand for Saudi oil is –2. It may be greater but is probably not less— neither possibility would affect the point of our illustration. Based on an elasticity of –2, in

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[33] There is a "free-rider" problem to be dealt with as well. Here we focus only on the potential for disagreement over the desired price target, and postpone discussion of disagreements over who should do the work required to achieve that target.

conjunction with a current market price of $26.50, the Saudi's marginal revenue from a barrel sold today would then be ½*$26.50, or $13.25, which gives, after deducting the marginal cost of production, a net present value of current production of $11.00. Holding that barrel in the ground for ten years makes sense only if prices are expected to appreciate significantly. Assuming a 10 percent discount rate, as before, and holding the elasticity of demand constant, the price would have to be expected to reach $61.56 by year 2011 for additional withholding to be attractive to the Saudis.

Evidently, the burden of withholding is much higher on the Saudis than on the Indonesians and is justified only by much higher future price expectations. The illustration is hypothetical, but the point is not: differences in costs and demand elasticities among the cartel members create systematic differences in the perceived wisdom of shutting in production. The fact that the Saudis also have larger reserves than Indonesia, sufficient to sustain current production for 80 years, only compounds the problem. Withholding a barrel of Saudi production for 40 years could only be justified (again assuming a 10 percent discount rate and no change in demand elasticity) if prices are expected to reach $1,000 per barrel by the year 2041. It does not seem a likely prospect. Lower prices would help the Saudis (not the Indonesians) exploit their massive reserves before development of lower cost or more desirable alternatives (natural gas, hydrogen fuel cells, etc.) has pushed oil aside.

Thus, heterogeneity in reserves, costs, politics, social pressures, and public policy all have the potential to breed disagreement and dissension within OPEC. With a strong

29

dose of the free-rider problem thrown in for good measure, and lack of any enforcement mechanism, it is fair to ask whether OPEC has maintained enough unity of purpose and cooperative effort to achieve much of anything. An alternative view is that a special subset of the OPEC members, the so-called "cartel core," has acted as the residual supplier, compensating for the undisciplined and volatile production flows coming from opportunistic members of the "cartel fringe" by regulating their own output accordingly. This is a common assumption in economic models of OPEC behavior, although the selection of countries who belong in the "core" is sometimes larger and sometimes smaller—in the extreme shrinking to include only Saudi Arabia, as discussed by Moran (1978: 2).

The distinction between core and fringe is that members of the fringe tend to abide by cartel restraints only when it is in their individual interest to do so; i.e. the fringe are members of the cartel in name only. During the 1970-81 phase of OPEC's history, before the regime of individual export quotas came into use, opportunistic behavior by the fringe would take the form of unauthorized price discounts offered to expand the market for one country's output—at the expense of all others. Although the terms of all sales were confidential, and the complicated matrix of quality differentials tended to obscure cheating, there is no shortage of evidence that individual OPEC members repeatedly undersold the "official" OPEC price in this fashion.[34] At certain times, the difficulty of holding all OPEC producers to a single price became simply insurmountable, and then price differences were

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[34] See Adelman (1982: 47) and Claes (2001: 181) for examples.

given "official" status, as when the "two-tier" pricing structure temporarily emerged during 1976-77.[35]

Since the advent of formal export quotas in 1982, we can use each member's official quota to judge compliance. The extent of opportunistic behavior does not appear to have subsided, despite this change in regime. Over the whole 1982-90 interval, for example, Saudi Arabia is the only member whose cumulative exports did not exceed their assigned quota. Since 1990, even the Saudis have crossed that line, if only to a small extent.[36] Figure 1 illustrates annual OPEC production relative to the official ceiling, for the period 1982-2000.

Although widespread cheating is not unexpected, it can lead to the rapid demise of the cartel. In OPEC's case this has not happened, and the market price continues to be elevated considerably above anyone's best estimate of what would be the competitive price of crude oil. We recognize two factors that may be responsible for this apparent anomaly.

First, the serendipitous timing of oil market disruptions that we attribute to the intrusion of politics and domestic affairs has largely worked in OPEC's favor. The initial oil price shock of 1973 (which was precipitated by the Arab-Israeli War) is one example. It has been succeeded, by the Iranian Revolution in 1979 (which removed about 2 mbd of production capacity from the market and came just as secret price discounting was becoming more prevalent), the outbreak of the Iran-Iraq war in 1980 (which removed an

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[35] Moran (1982: 107).
[36] Claes (2001: 259-263).

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additional 4 mbd of OPEC capacity from the market and brought a new sense of panic), U.S. sanctions against Iran (which until very recently have discouraged investment needed to rebuild Iran's pre-revolution export capacity), the Iraqi invasion of Kuwait in 1989 (which removed nearly all Kuwaiti capacity from the market, although not by accident in this instance), and the ensuing U.N. sanctions against Iraq (which to this day prevent Iraq from fully restoring its pre-1990 export capability). When one considers that the hardest job of any cartel is to allocate idle capacity, and then considers how much extraneous help OPEC has received in this regard, perhaps it is no wonder that free riders have not sunk OPEC's boat.

The second factor worth noting is the Saudis' special role as "dominant firm." Even if there were no cartel, the dominant reserve position and relatively low costs of Saudi Arabia would dictate its role as a "swing" producer. As in the textbook model of a dominant firm's behavior, it would be in Saudi Arabia's interest to regulate its own output based on the residual demand for its product. According to this view, the primary determinants of Saudi production would be the strength of overall market demand and the propensity of "fringe" producers to satisfy it. If the supply behavior of the fringe is erratic—expanding and contracting in response to myriad other factors—then we would expect the output of the dominant firm to fluctuate as well, but in the *opposite* direction. If monthly output adjustments by the dominant firm were charted against those of the fringe producers, a pattern of countervailing changes should be visible, and quite distinct from the relationship one expects from a disciplined cartel in which member outputs tend to expand

and contract more or less in concert, according to fluctuations in the overall level of shared demand.

We have plotted this series of monthly output adjustments, for Saudi Arabia versus the rest of OPEC, over the entire interval 1973-2000. The results (see Figure 2) provide rather strong support for the dominant firm model and cast doubt on the hypothesis of cooperative cartel behavior. Over the entire period, we find that the contemporaneous monthly production changes by the Saudis and the rest of OPEC went in opposite directions 35.5 percent of the time (119 countervailing changes out of a total 335 months). The frequency of countervailing adjustments seems high, certainly more than would be expected of a disciplined cartel.[37] We should emphasize that even a dominant firm will, *ceteris paribus*, adjust output in the *same* direction as the fringe whenever there are shifts in aggregate demand, and in some months there may be no change in output at all. Therefore, the dominant firm model hardly implies that countervailing adjustments should occur in every month. Depending on the volatility of cartel demand relative to the volatility of supply from the fringe, the dominant firm would be expected to make countervailing adjustments in output anywhere between 0 and 100 percent of the time. No such movements would be expected within a disciplined cartel.[38]

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[37] When the same test is applied to annual output levels, the results are even stronger, with countervailing adjustments taken by the Saudis in 15 of the 27 years (56%) of the sample period.

[38] Even Griffin's (1985) model of a loosely bound OPEC cartel, which recognizes that members' cutbacks need not be proportional, does not anticipate countervailing movements in production.

Our interpretation of the evidence therefore tends to fall on the side of a market structure in which the Saudis exhibit dominant firm behavior. The same pattern emerges when we examine just the subinterval during which OPEC assigned formal quotas to each member (April 1982 through December 2000). During that subinterval, the Saudis made countervailing output adjustments 36 percent of the time (see Table 2). Thus, although OPEC's working mode changed from unstructured support of an official price target (1973-81) to mandated compliance with official export quotas (1982-2000), the Saudi tendency to compensate for the excesses of its OPEC peers does not appear to have changed much at all. The only time the Saudis tended to refrain from making countervailing adjustments for a span of more than twelve months was during 1979-80, when the production facilities of Iran first, then Iraq, were unexpectedly taken out of service due to force majeure.[39]

When comparing this evidence to the Texas Railroad Commission experience discussed earlier, we find much stronger indications that Saudi Arabia has played the role of dominant firm and swing producer within a relatively undisciplined cartel, whereas the pattern of production regulation achieved by the Railroad Commission and its IOCC counterparts bears a stronger resemblance to the cooperative behavior of a cohesive cartel.

IV. Concluding Remarks.

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[39] Even during this two-year span, some countervailing adjustments are observed, but they occur at an unusually low rate.

This chapter has examined the ability of the Texas Railroad Commission and Saudi Arabia to act as residual producers to maintain oil prices within their respective oil production cartels. In the case of the interstate production coordination that existed for 40 years from 1933 through 1972, the evidence is that Texas played a central role. This is understandable since the state had the largest share of low-cost oil reserves in the country. At the same time, however, the state regulatory agency, the Texas Railroad Commission, could not systematically and unilaterally adjust Texas production to offset production increases in other states. It could differentially constrain production from time to time to protect the cartel from crises, but it could not do so routinely without being subjected to a political backlash within the state. It could, and did, regulate low-cost production to protect high-cost producers throughout the U.S., but this action was politically popular in Texas because of the political influence of the thousands of high-cost small producers in the state. While Texas does not appear to have acted as a residual or swing producer within the cartel, the state was a leader in more loosely coordinating output to maintain comparatively stable nominal prices.

Indications that Saudi Arabia has played the role of swing producer within OPEC are much stronger. Despite continuous attempts, at least since the quota system was formally adopted in 1982, to achieve cooperative reductions and expansions of OPEC supply to match fluctuations in market demand, Saudi Arabia's own production adjustments have tended to be in a countervailing direction: cutting back as the rest of the

cartel expands and vice versa. In fact, the Saudi role as swing producer was established in OPEC's earlier phase, before individual export quotas were imposed on the group.

Both OPEC and the Interstate Oil Compact Commission are government-sponsored, rather than private, cartels. However, sharp contrast in their political structures has led to significant differences in cartel behavior and success. In the case of Texas and the IOCC, individual states exercised sovereign regulation of production by private firms within their own jurisdictions, but were aided by the superior authority of the federal government to monitor and penalize cheating. That larger governmental framework also provided the individual states with an integrated and efficient information feedback system by which regional demand and inventory levels could be monitored. Moreover, the dominant political position of small, high-cost producers within each of the major producing states tended to create uniform support for common regulatory actions. Thus, Texas did not fully exploit its status as the dominant, low-cost producer because that would have harmed an important in-state constituency as well as other members of the IOCC.

OPEC, in contrast, might better be viewed as a private cartel. There is no central government authority to monitor and enforce cartel agreements. Compliance with output restrictions is voluntary and unenforceable, just like the collusive agreements among firms that act in defiance of antitrust laws. The political aspects of OPEC seem to have splintered the group and distracted it, at least intermittently, from a disciplined and unified oil strategy, perhaps to a greater extent than any alliance of private firms might have

experienced. Thus, with regard to the contribution that government sponsorship has made toward achieving cartel cohesion, OPEC and the IOCC are quite distinct.

Although the interstate oil cartel and OPEC differ in certain respects, together they illustrate how government involvement can make public cartels behave differently than private ones. Government cartels can sometimes better police output limits, quota compliance, and restrictions on entry, but they involve political trade-offs that lower monopoly rents through higher production costs or nonoptimal production patterns. Because explicit monetary side payments are either illegal or politically difficult to negotiate, a consensus on regulatory policies involves other forms of compensation, such as preferential production quotas, even if they lead to lower collusive profits. In principle, at least, the parties within private cartels could negotiate monetary side payments to compensate those firms whose output was being differentially constrained in order to raise cartel profits. In this way, quotas and production patterns could be more optimally designed within private cartels. But history shows that private cartels suffer from cheating by members or from entry by nonmembers if prices are raised above competitive levels. Hence, to be more successful, cartels require government intervention, but their policies will be molded by political conditions and may not closely follow those predicted by economic theory.

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Table 1: Economic and Demographic Data
(Saudi Arabia vs. Rest of OPEC)

Year	Population Density (per square km)		Per Capita GDP ($thousand)		Petroleum Concentration		Current Account Balance ($million)	
	Saudi	Other OPEC	Saudi	Other OPEC	Saudi	Other OPEC	Saudi	Other OPEC
1979	4.15	30.03	12.855	1.358	.991	.886	10206	48799
1980	4.36	30.94	16.701	1.648	.992	.913	41503	61459
1981	4.56	31.8	15.815	1.628	.993	.881	39627	4331
1982	4.77	32.66	11.820	1.645	.988	.884	7575	-11673
1983	5.2	33.57	9.641	1.654	.978	.869	-16852	1364
1984	5.57	34.5	8.324	1.556	.967	.840	-18401	14112
1985	5.88	35.43	6.853	1.641	.944	.826	-12932	15206
1986	6.17	36.4	5.519	1.592	.899	.747	-11795	-8738
1987	6.47	37.33	5.287	1.275	.881	.741	-9773	4262
1988	6.79	38.22	5.218	1.294	.829	.698	-7340	-6504
1989	7.12	39.18	5.424	1.282	.849	.700	-9538	16376
1990	7.46	39.84	6.522	1.339	.904	.720	-4152	24150
1991	7.63	40.54	7.198	1.158	.916	.649	-27546	-34566
1992	7.79	41.47	8.352	1.186	.925	.628	-17740	-7270
1993	7.96	42.41	6.921	1.118	.911	.590	-17268	-4007
1994	8.24	43.37	6.785	1.201	.895	.557	-10487	5856
1995	8.49	44.36	7.003	1.280	.870	.570	-5325	2854
1996	8.76	45.03	7.505	1.375	.894	.625	681	24665
1997	9.06	45.95	7.520	1.361	.878	.578	305	19431
1998	9.39	47.03	6.362	1.170	.819	.476	-13150	-6306
1999	9.57	48.03	6.773	1.240	.902	.586	-4600	20612

Note: Petroleum Concentration = Value of Crude Oil & Petroleum Product
Exports/Value of Total Exports
Source: OPEC (1999)

Table 2: Test of Dominant Firm Production Behavior by Saudi Arabia
**(Each countervailing change supports dominant firm hypothesis & contradicts cartel hypothesis)**

Year	Countervailing Monthly Production Adjustments/Year	
	Number per Year	Percentage of Months
1973	4	36.4
1974	4	33.3
1975	5	41.7
1976	5	41.7
1977	4	33.3
1978	5	41.7
1979	2	16.7
1980	2	16.7
1981	6	50.0
1982	4	33.3
1983	3	25.0
1984	8	66.7
1985	2	16.7
1986	3	25.0
1987	5	41.7
1988	2	16.7
1989	6	50.0
1990	6	50.0
1991	5	41.7
1992	2	16.7
1993	5	41.7
1994	7	58.3
1995	1	8.3
1996	4	33.3
1997	4	33.3
1998	7	58.3
1999	4	33.3
2000	4	33.3

Note: 1973 results based on 11 observed monthly changes.
Source: Calculated from monthly crude oil production of Saudi Arabia & other OPEC members.
Monthly production data from U.S. Energy Information Administration (2001).

Figure 1: OPEC Production Compliance
(Monthly Data)
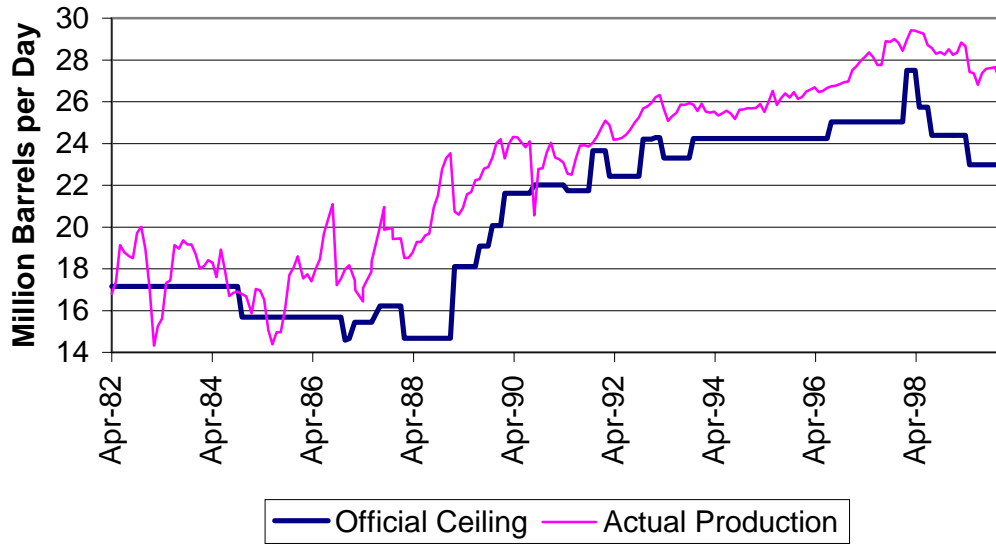
Sources: Official production ceiling level reported by OPEC (1999); actual monthly crude oil
            production reported by U.S. Energy Information Administration (2001).

Figure 2: Frequency of Dominant Firm Behavior
(Based on Saudi Arabia's Monthly Production Adjustments)
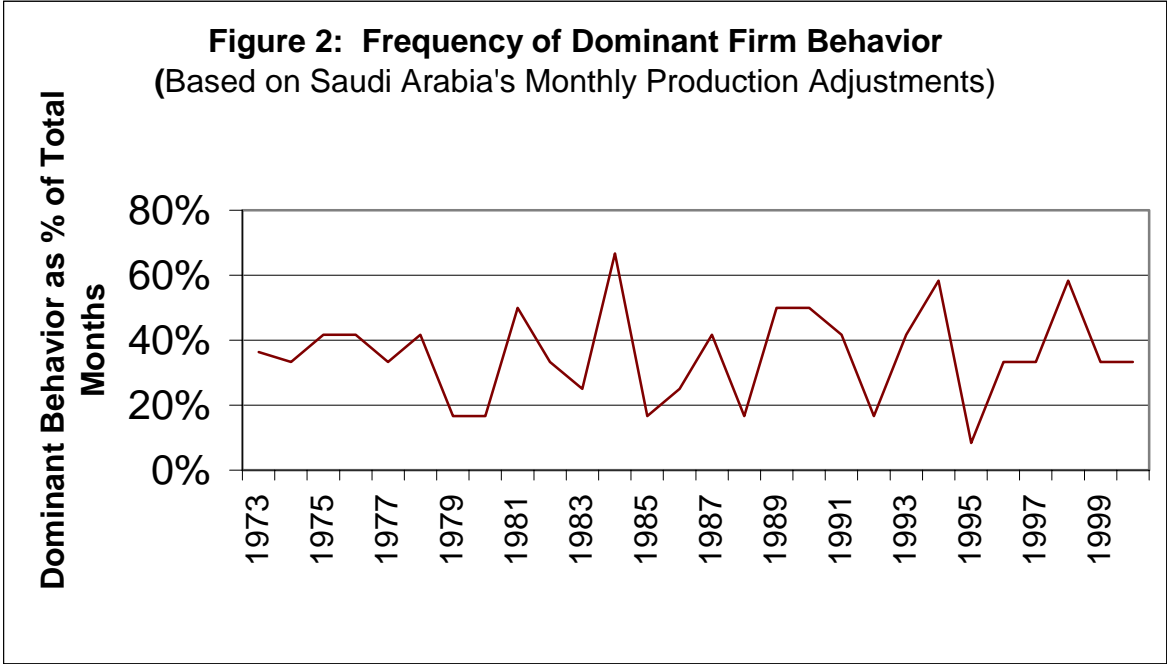
Sources: Calculated values based on monthly crude oil production reported by U.S. Energy
Information Administration (2001).