



The Seven Sisters versus OPEC: Solving the mystery of the petroleum market structure



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ABSTRACT

This paper provides an explanation of the changing behavior of the crude oil market and tests it using the U.S. data from January 1913 to September 2014. We claim that the crude oil market has experienced two important structural breaks in its industrial organization. The first occurred when Venezuela and the Arab crude oil exporting countries forced the so-called Seven Sisters to sign the Fifty–Fifty profit-sharing agreements. The second occurred after OPEC succeeded in cracking the secrets of the international crude oil marketing and in undertaking the wave of nationalizations of the 1970s.

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1. Introduction

Crude oil is a major component of modern western lifestyle. It has played an important role in many world events for over a hundred years. Wars have been fought over crude oil, and energy security is one of the major concerns of modern economies. By 2010, 34% of the world energy source was crude oil.¹ Yet, despite its strategic importance, crude oil entered into the economic debate only after the oil shocks of the 1970s plunged the world economy into its worst economic crisis since the Great Depression. Salant (1976) proposed an appealing approach to understand crude oil market behavior. He views the OPEC as a “unified enterprise which dominates other extractors because of its larger reserves.” Although initially received with enthusiasm (Pindyck, 1978; Arrow and Chang, 1982; Slade, 1982), the approach was soon dismissed because it was at odds with data (Hamilton, 2013).

In a recent literature that links crude oil prices with macroeconomics, Hamilton (1983) states that for the period 1948–72, “all but one of the U.S. recessions since World War II have been preceded by a dramatic increase in the price of crude oil”, and although he does not mean that oil shocks have caused those recessions, he states that “oil shocks

were a contributing factor in the U.S. recessions prior to 1972.” Hamilton and Herrera (2004) offer evidence that the recessionary effect of an oil price shock cannot be properly compensated even with an aggressive Federal Reserve policy.

Unlike the previous literature which only considered supply shocks, Barsky and Kilian (2002, 2004) identify the existence of demand and precautionary shocks. Kilian (2009) finds that oil shocks cause a temporary decline in real GDP with little effect on the price level, that initially aggregate demand shocks have mild positive effects on crude oil output and prices but eventually cause an adverse effect on real GDP, and that precautionary demand shocks have a negative effect on real GDP, making prices increase. Recent work finds that, during the 21st century, demand shocks have been the main drivers of crude oil prices (Kilian et al., 2009; Peersman and Van Robays, 2012), and that the only geopolitical event that could potentially have shocked crude oil prices since 1992 were the 2002–2003 crude oil workers' strike in Venezuela and the second Persian Gulf War in 2003 (Hamilton, 2011).

This discussion suggests that the sources of unexpected oil price increases have been changing over time. In the early years, oil price shocks stemmed from oil supply disruptions possibly causing subsequent recessions. More recently, unexpected changes in oil prices have been largely caused by demand shocks (Kilian and Vigfusson, 2013).

¹ International Energy Statistics. Retrieved on 17 March 2013.

Interestingly, no work in the literature other than Noguera (2013), considers data before World War II.

Here we set up a simple model to show that the changing behavior of the crude oil market was due to two important structural breaks in its industrial organization. The first occurred between 1947 and 1953 when Venezuela and the Arab crude oil exporting countries forced petroleum transnational firms to sign the Fifty–Fifty profit-sharing agreements. The second occurred after OPEC succeeded in cracking the secrets of the international crude oil marketing and in embarking on the wave of nationalizations of the 1970s. It also shows an empirical test of the proposed theory using the U.S. data from January 1910 to November 2012. To do so, it uses the Kejriwal and Perron (2010) algorithm, which enables detecting structural changes without previous knowledge of the integration order of the series. Section 2 motivates and sets up a model to describe the market behavior before the 1970s. Section 3 uses the model set up in the previous section to explain the market behavior before and during the period in which the Fifty–Fifty profit-sharing agreements were in effect. Section 4 proposes a model in which OPEC emerges as a major actor in the petroleum market. Section 5 presents the econometric model. Section 6 describes the data and Section 7 discusses the findings. Section 8 concludes.

2. Market structure under the Seven Sisters

After the dissolution of the Standard Oil in 1911, three of the *Baby Standards* became some of the major world petroleum companies of the XX century: the Standard Oil of New Jersey (*Jersey*), the Standard Oil of New York (*Socony*) and the Standard Oil of California (*Socal*). By that time, *Gulf Oil* and *Texaco* were already dealing with crude oil in Texas, the *Royal Dutch Shell* was doing so in Russia and Indonesia and the *Anglo-Persian Oil Company* in Persia. In the 1950s, Enrico Mattei coined the term *Seven Sisters* to refer to the dominant position of these companies in the petroleum world² (Yergin, 2008, ch. 1–8).

What was the petroleum industry like under the mastery of the *Seven Sisters*? The petroleum industry consists of five operations: exploration, extraction, refining, transportation and marketing. The *Sisters* were vertically integrated firms that had their arms in all stages of the production process. In fact, the Federal Trade Commission’s report³ of 1952 states that the “control of the industry by these seven companies extends from reserves through production, transportation, refining, and marketing. All seven engage in every stage of operations, from exploration to marketing.” The same report also states that, by 1949, the *Seven Sisters* “controlled about 92 percent of the estimated crude reserve... (and) accounted for more than one-half of the world’s crude production (excluding Russia and satellite countries), about 99 percent of output in the Middle East, over 96 percent of the production in the Eastern Hemisphere, and almost 45% in the Western Hemisphere” and that they control similar market shares in the refining, transportation and marketing activities as well. The position of the *Sisters* in the petroleum market remained similar until the 1970s (Sampson 1975, Ch. 9).

What about the crude oil market structure? Until the Second World War, there were episodes of Bertrand-like competition such as the price war between *Jersey*, *Socony* and *Royal Dutch Shell* in 1927 (Yergin 2008, p. 225). At times, they acted like a typical cartel, such as when they signed the “Achnacarry Agreement” to allocate quotas and divide markets in 1928. Yet, it is misleading to think of the *Sisters* as a stable cartel as they recurrently cheated despite the agreements (Yergin 2008, pp. 247–48). Instead, it would be wiser to think of them as a

quantity competition oligopoly, that is, as a Cournot oligopoly. There are several reasons for this. First, during the 1930s, governments imposed many restrictions on the companies. The French government for instance allocated market shares to each company, and in the USA and Europe, a number of independent refineries competed in quantity (Yergin, 2008, pp. 241–52). Second, although the *Sisters* produced most of the world crude oil, other producers such as the Soviet Union never missed a chance to capture new markets, forcing the *Sisters* to respond in quantity. Some “independents” like ENI and *la Compagnie Française des Pétroles* (currently *Total*) were often faced with similar challenges. The discovery of new wells in Texas, the Middle East and elsewhere caused the same effect (Shwadran 1973, p. 536). Third, during the 1960s, there was a permanent conflict between the *Sisters* and OPEC country governments because of the former’s policy to allocate quotas between countries to target total output goals and avoid conflicts, and the latter’s pressures on the *Sisters* to expand production to obtain higher revenue. John Blair, responsible for the famous Federal Trade Commission report of 1952 states that the crude oil market was one of *oligopolistic interdependence* in which the *Sisters* controlled quantities without engaging in direct collusion (Sampson 1975, Ch. 8).

In response of the above discussion, motivating a model of the crude oil market structure under the mastery of the *Seven Sisters* is constructed. Consider the crude oil market and one of its refined products, such as gasoline. Both gasoline and crude oil producers behave like a Cournot oligopoly. Let the gasoline demand function be $Q = AP_g^{-b}$, where Q denotes the gasoline output, P_g the gasoline price and A is a parameter. Let $X^d = c_q Q^s$ be the cost function of producing gasoline, where X^d is the demand for crude oil. Let P_x^c denotes the price of crude oil.

Suppose that there are N big firms called the *Sisters* that participate in both the gasoline and the crude oil market, so each of them produce the crude oil that they need as input for their own gasoline production. Suppose also that there is a product that is not produced by the *Sisters*, that needs crude oil as input, but whose demand of crude oil is marginal compared to the demand of the *Sisters*. Suppose that the demand for crude oil of the marginal industry is $X_i = P_x^{-b}$, where X_i is their demand for crude oil and for the sake of simplicity we assume that there is the same elasticity of demand (b) in the gasoline and the marginal markets.

Let $C(X^c) = c_x X^c$ be the crude oil cost function where X^c denotes the production of crude oil, and let τ be an *Ad Valorem* tax rate to be applied to a “posted price”, so in practice it turns to be an income tax.⁴ Then, the profit function of the *Sister* is

$$\pi_7 = [P_g Q_7 - P_x X_7^d] + [(1-\tau)P_x X_7^d - c_x X_7^d] + [(1-\tau)P_x X_7^i - c_x X_7^i], \quad (1)$$

where the subscript “7” denotes that that is one of the *Seven Sisters*. The first bracket represents the profit that the *Sister* obtains from the gasoline market, the second bracket the one obtained for producing the crude oil that it needs as input for itself and the third bracket, the profits for producing crude oil for the marginal market.

3. The tax issue

After World War II, crude oil prices plummeted. Between 1948 and 1968, the WTI increased at 0.89% per year and even though the US-CPI did it at 1.86%. That meant a decrease of about 1% per year in the real crude oil price for 20 years.⁵ What could explain the drop in crude oil prices? On the demand side, the decades following the Second World War, the so-called *the golden age of capitalism*, were years of economic expansion (Marglin and Schor, 1992), thus, the argument that demand was low does not seem appealing. One may think of an excess supply due to huge expansion of crude oil production in Venezuela and the Middle

² In 1963, *Socony* was renamed *Mobil*, and in 1973, *Jersey* renamed *Exxon*; both companies merged in 1999 to form *ExxonMobil*. In 1984, *Socal* and *Gulf* merged to form *Chevron*, which acquired *Texaco* in 2000. In 1935, the *Anglo-Persian* changed its name to *Anglo-Iranian* (AIOC), which in 1954 became the *British Petroleum* (BP).

³ The International Petroleum Cartel, Staff Report to the Federal Trade Commission, released through Subcommittee on Monopoly of Select Committee on Small Business, U.S. Senate, 83d Congress, 2nd Session (Washington, DC, 1952), Chapter 2, “Concentration of Control of the World Petroleum Industry,” pp. 21–36.

⁴ In the next section it will be apparent why we introduce income tax instead of tax on profits into the model.

⁵ Source: Fred, Federal Reserve Bank of Saint Louis.

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