INTRODUCTION TO THE GLOBAL OIL & GAS BUSINESS

CONTENTS

1

INTRODUCTION

The Demand and Supply of Oil

At the close of Jimmy Carter's presidency, a reporter asked his chief of staff, Hamilton Jordan, if he had any advice for future presidents. Jordan had a straightforward observation: avoid running for reelection in an energy crisis.

Hardly anything stirs public anger like runaway gasoline prices. The widespread availability of oil seems an essential part of modern life, but it was not always so; oil did not become the backbone of the global economy until the second half of the twentieth century. Coal used to be far more important. Oil became the dominant form of energy following a massive wave of Middle East discoveries just before and after World War II. The industry found so much oil that at times they could not give it away. Today the circumstances have reversed. Some claim that the modern world's dependence on oil corresponds to that of an addict—no one can get sober enough, long enough, to break the habit. At the market's peak in 2008, *daily* crude oil production had a cash value of $13 billion, a sum larger than the annual turnover of many industries. So, when prices are on the upswing, all the ensuing uproar raises a key question: Why is oil so valuable?

Much of the answer lies in the unique qualities that make oil a particularly advantageous source of energy. Once found, oil is the easiest of all energy commodities to produce and use. There is little waste in producing and converting crude oil into useful products. Since oil is liquid, it moves cheaply by a variety of methods. As a liquid, oil converts readily into a gas in order to power an engine. Compared to coal, it is less bulky and much cleaner. These advantages are especially valuable for use in transportation, which is oil's primary market.

Arguably, oil is the most efficient form of energy, but it requires vast long-term investments to produce and use. It is the second part of this relationship that raises most political and social issues. In order to use oil, consumers must make large fixed-cost investments in specialized equipment— cars, trucks, furnaces, and so on. Those investments depend on a reliable flow of petroleum products. If there are shortages, or if prices explode, consumers feel cheated. Inflexible investments in oil-producing and in using equipment affect the market in another way. The investments lock everyone in, because when prices existing oil producing and refining infrastructure, the market requires extreme price movements in order to clear. At various times OPEC, and particularly Saudi Arabia, have attempted to stabilize the market by swinging production up and down in tandem with demand. In the mid-1980s, however, Saudi Arabia abandoned its role as "swing producer." So far, attempts by the OPEC cartel, as a whole, to manage price by production cuts among its members, or expansion in the face of rising prices, have failed. Moreover, as oil consumption soared in China, India, and other rapidly developing economies, OPEC did not expand capacity and the consequences in 2008 were a radical price increase, followed by an even more dramatic price collapse.

The Nature of the Resource

Conventional crude oil deposits lie mainly in sedimentary basins around the globe. Geoscientists generally agree that oil and gas derive from compressed and cooked organic matter that buried to significant depths over millions of years.[1] Oil migrates from source rocks and accumulates in reservoirs (commonly porous sandstone or carbonate), capped by impenetrable material (often shale or salt). Since the oil is under considerable pressure, drilling into a reservoir causes it to flow into the well bore and up to the surface. For a given type of deposit, normally the greater the pressure and the more permeable the reservoir, the greater will be the rate of flow and the lower the cost of production (fig. 2–2).

At a certain point after the reservoir is fully developed, the pressure begins to lessen or decrease and the rate of natural flow tapers off. Petroleum engineers describe this as *decline*, and the decline rate is the percent decrease in flow per year. There are many varieties of techniques to maintain pressure and moderate decline. Enhanced recovery is, however, very costly, which means that the cost of extraction rises with the age of the field. This happens for two reasons. Enhanced recovery in a mature field usually involves the drilling of new wells, which obviously adds cost. Water or gas is injected from these new wells either for pressure maintenance or for reinvigorating oil production from older, depleted wells. Added costs come from the injected materials and the energy needed to pump them into the reservoir. These costs vary widely depending on the field's age, the quality of the oil, and the complexity of the geology. Figure 2–3, describing Alaska North Slope oil, illustrates a typical profile of a major oil field's production cycle.

In Alaska's case, the discovery of the Prudhoe Bay oil field sparked a variety of additional activities. Following discovery, geologists delineated the field and estimated its oil reserves. The initial production plan put a cap of 1.5 million barrels per day on production. That production rate was expected to last until 1984, when the field would begin a natural decline, estimated at 9% per year. However, a series of extensions including new wells, a miscible gas project, and

The Staircase of Rising Cost

Cost diversity

If drillers knew nothing about the size and location of oilfields they would most likely find the larger fields first. Indeed, Professor Deffeyes reports that the Russians became frustrated with the analyses of their geologists and simply laid out a horizontal grid for drilling. Apparently, they had just as much success. The intuition of this observation is obvious; the greater the horizontal extent of a field the higher the probability it will be found before any of the smaller fields. This is also the logic behind the first inflection point on the rising portion of Hubbert's Peak. As the industry learns how and where to drill, it has greater and greater success; eventually, however, big finds taper off and, as they do, production increases can be expected to decline, and eventually the supply of oil will dwindle.

Large oilfields are by far the cheapest to exploit. In addition to their horizontal breadth the deposit usually has a greater vertical depth. This means that the field will likely require fewer wells per barrel, the overall production rate will be higher, and the oil flow will last longer. These are all features that reduce cost. Major oil companies (the big IOCs) normally focus on finding giant oilfields, where they can exploit the economies of scale offered by their size and expertise. Once a field has aged past its most prolific years or if it is too small, the majors sell the properties to independents, who specialize in smaller scale operations. There are thousands of unproduced oil deposits left standing, because they are too small, or the geology too complicated.

The huge difference in the size and quality of known oilfields means that there are significant cost differences in finding, developing, and producing conventional crude oil, and costs rise with uncertainty. The risk and cost of finding and developing the Prudhoe Bay oilfield in Alaska illustrate this issue. Before an oil company can drill a prospect, it must purchase the property or obtain a lease for the mineral rights. In the case of Prudhoe Bay, the land was owned by the State of Alaska (the State was granted large chunks of federal land when the territory became a state). Alaska chose a portion of the coastal plain in the High Arctic between the Brooks Mountains and the Beaufort Sea. The choice was not without controversy, because the only value of the land was its potential for minerals or oil development. Alaskans referred choice to as "Marshall's icebox" or "Marshall's folly," named after the geologist that made the decision. As luck would have it, the land Alaska chose contained the largest oilfield ever found in the U.S. along with a whole set of satellite fields and enormous natural gas reserves.

State and the federal governments have similar policies when leasing mineral rights. In the U.S., governments usually grant leases through a competitive auction—an up-front or bonus payment that gives the winner the right to day. The action was not enough; prices fell. In any case, it is clear that the crudeness of OPEC's decision process has not been successful in stabilizing oil prices. In 2008, alone, prices ranged from $145 to $36 per barrel.

OPEC sets an expansive agenda for itself. "OPEC is a permanent, intergovernmental organization, established in Baghdad, Iraq, 10–14 September 1960… Its objective is to coordinate and unify petroleum policies among Member Countries, in order to secure a steady income to the producing countries; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on capital to those investing in the petroleum industry." (OPEC 2008) Over the years, the cartel has sought to meet much broader objectives than just the maximization of revenue. From their point of view, they are seeking to stabilize the market, just as U.S. programs in the 1950s and 1960s established a price floor for domestic producers. In addition, OPEC has maintained programs to help developing nations, aid the shift to alternative energy, and encourage technology transfer to further resource development.

OPEC's stated agenda and its inconsistent actions raise key questions about its real intent. Is it a cartel seeking to maximize profits or is it attempting to stabilize oil prices, promoting genuine cooperation between oil producers and consumers? There is a commonality between OPEC's members and American oil producers in the early years of the industry. Both have suffered from highly volatile prices and both have sought to develop institutions that put a floor price on oil by forcing production cuts in weak markets. Unfortunately, OPEC has been far less effective in establishing price ceilings, in large measure because there has not been enough investment in swing production capacity. As residual supplier to the world, they need the flexibility to shift supply in response to seasonal changes and economic events. OPEC is now a much smaller percentage of total global energy, and oil demand has proven to be more volatile than expected. If OPEC expects to prevent extreme price cycles, it must maintain a high level of spare capacity and have the discipline to prevent price spikes. The cartel must also be realistic about the level of prices that are sustainable in the long term. Chapter 8 analyzes many of the alternatives to oil and price levels at which they become cost effective.

Posted Prices

OPEC did not invent their system of production management and official prices out of whole cloth; they took the idea of "pro-rationing" from the Texas Railroad Commission and pricing techniques from the North American system of "posted" prices. Traditionally, North American refiners list prices for the various crude oil grades they seek to purchase. The posting bulletins were mailed to interested parties. (They are now online on the companies' Web pages.) Posted prices are for oil delivered in the field or at specific pipeline

> Risk shifting, in the secure liquid markets that the New York Mercantile Exchange provides, allows commercial interests to "hedge" the risk of price fluctuations that could affect profitability and planning of their business operations. For the commercial participant, the result is a form of insurance against the financial adversity that can result from volatile energy prices.

A futures contract is an agreement between two parties for delivery of a particular commodity at a specific time, place, and price. Once initiated, a futures contract obligation can be satisfied by taking an offsetting position or by going through the delivery process and taking possession or making delivery of the commodity. The vast majority of market participants opt for the former, making futures contracts one of the most common and useful financial tools.

In 2008, about 246 billion "paper" barrels of crude oil traded on NYMEX and ICE in just three contracts related to light sweet crude oils at Cushing, Oklahoma and North Sea Brent crude oil. This was approximately eight times greater than annual world oil production.[5] Obviously, there was not enough oil at Cushing, Oklahoma or at Sullom Voe to fill even the tiniest portion of this trade. Nonetheless, as chapter 3 described, prices determined in these exchanges effectively set crude oil prices around the globe.

Price transparency

When confronted with futures exchange volume for the first time almost everyone has the same reaction. Why is trading volume so high? The prime advantage of such a large turnover is price transparency and market liquidity. These days an investor would almost have to be blind and deaf to avoid knowing the daily price of oil. Before NYMEX, however, finding out the price of a barrel of crude oil was challenging and connoted a substantial amount of uncertainty. There were anecdotal reports of spot prices, but longer-term prices were not available from any source. This led to inefficient decisions in physical markets.

The high turnover in crude oil and natural gas markets futures contracts is typical of commodities traded in this manner, because as futures trading matures, the cost of trading declines.[6] It then becomes economic to adjust portfolios in response to changes in weather, inventories, or any of the other variables that affect demand and supply.

Trading liquidity

The fact that there are three primary standardized futures contracts for crude oil is significant. The limited number of contracts plus a high rate of turnover is what allows a liquid market. The concept of market liquidity is not as straight forward, as it might seem. Ruben Lee (1998, pp. 50–51) discusses all of its implications:

5

THE NEW INDUSTRY STRUCTURE

The Big Bang Theory of the Universe

Most physicists subscribe to the *big bang theor*y of the universe's origin, resulting in an ongoing expansion. Opinions on future events are more diverse; will the universe continue to expand or will it expand, contract, and then expand again? The latter theory is not popular, but it has a tidy logic. More importantly for the analysis here, that logic fits a cyclical industry. Largely, it is the experience of the oil industry.

Figure 5–1 depicts what Joseph Schumpater (an economist writing in the time of the Great Depression) might have identified as "creative destruction," that is, capitalism's ability to recast its principal activities as circumstances and opportunities change. Figure 5-1 encapsulates a diverse set of events during the last four decades. In so doing, it invariably omits details and anomalies, but it is useful vision for gaining perspective and helps to explain the present petroleum industry structure.

The background of the chart is significant. The shaded area of figure 5–1 represents the total value of crude oil produced during each year, adjusted for inflation (2007 dollars). From 1965 through 1972 surplus Middle East crude oil and low prices kept the value low; during the period total value only rose from $138 to $242 billion. At the time, a few publicly owned corporations dominated oil trade. The corporations sprang from just three countries, the U.S., UK, and the Netherlands. They had familiar brand names: Exxon, Mobil, Shell, BP, Chevron, Gulf, and Texaco; nicknamed, the Seven Sisters by the Italian, Enrico Mattei, anxious to join the club. During this period, OPEC member governments chaffed at the Seven Sisters' market control and independent companies fought for access.

Figure 5–1 is also a timeline of changes in industrial structure. In general, the bottom part of the chart identifies the number and types of significant oil companies *created*. In most cases, host governments sponsored the new entities, reflecting concern about control over resources or markets. The first wave of new companies was a consequence of the OPEC revolution. The second wave came along several years later with the breakup of the Soviet Union and China's shift away from state-owned enterprises.

7

ORGANIZING PRINCIPALS

Form Follows Function

"Form follows function" was the mantra of architects Louis Sullivan and his assistant Frank Lloyd Wright. The description was apt as building design broke away from classical styles and adapted new materials and construction techniques. The skyscraper was the consequence of a natural evolution driven by increasing urbanization, new technologies, and new building materials. Similarly, students of the petroleum business, such as Paul Frankel, argue that commodity's unique attributes drive the oil industry's form. In Frankel's view, organization, competition, investment decisions, product shape, and delivery systems all flow from the nature of the petroleum resource itself. Other economists are less persuaded, noting that the petroleum industry has reshaped itself many times in response to changes in regulation, property rights, or technology. Nonetheless, an examination of the petroleum industry's structure must begin with the idiosyncrasies of petroleum. What, if anything, makes the oil business, or any energy business, different?

Continuous flow

Petroleum industry executives describe the business as one of "continuous flow." Crude oil and natural gas flow from fields into pipelines that transport the commodity to processing centers and refineries. In a refinery, crude oil is converted to three primary products—gasoline, middle distillates, and heavy fuel oils. (A sophisticated refinery produces upwards of one hundred different products, ranging from coke to petrochemical feedstocks, but the main products remain gasoline and middle distillates). The refineries' products, in turn, flow to distribution centers, service stations, and so on. The oil never slows down. There are working storage tanks in the fields, at refineries and distribution centers, and at points of final usage. Typically, however, the amount of oil in storage will cover only a few days of demand. The primary role of working storage is to prevent logistical irregularities from creating spot shortages. There is one modest exception to the production and consumption cycle. During the spring, surplus gasoline is stored for the peak summer driving season and during the fall, heating oil is stored for the winter. The shoulder periods of refining activity are also the time for scheduled refinery maintenance.