Chapter 4

Oil: Has It Reached Its Peak?

Coventional Energy Sources

Introduction

- *Oil's Role in the Global Economy*
  - *The 1970s oil crises highlighted oil's central role in global economies.*
  - *Oil is a **fungible** commodity, meaning it can be replaced by oil from different sources with no effect on the global price, barring geopolitical conflicts.*

- *Global Market Characteristics*
  - *The oil market is global; geopolitical events (like the Russia-Ukraine conflict) can disrupt the market.*
  - *The U.S. used to rely heavily on OPEC for oil imports (over 70% in the 1970s), but now imports only about 10% from OPEC, with Canada being the largest oil supplier.*

Oil Extraction

- *Extracting oil requires large investments and infrastructure.*
  - *Examples include the Alaskan Pipeline and deep-water drilling in the Gulf of Mexico, which require substantial resources.*
  - *The fracking revolution was driven by smaller companies, demonstrating a shift from large-scale operations to more nimble approaches.*

- *Challenges in Oil Extraction*
  - *Different grades of oil (e.g., light sweet crude and sour crude) vary in price due to ease of refining and end-product demand.*
  - *Light sweet crude is preferred for making gasoline and other high-value products, whereas heavy crude is cheaper but better for diesel and residual fuels.*

A Brief Economic History

- *The origins of the modern oil industry trace back to the 1840s when James Young in Scotland distilled early forms of petroleum.*

- *In 1859, the first significant oil well was drilled in Titusville, Pennsylvania, marking the start of the U.S. oil boom.*

- *This was driven by a search for alternatives to whale oil, which was in decline due to overhunting.*

- *The discovery of* ***kerosene*** *and its use for street lighting led to the creation of oil refineries.*

Rockefeller and Standard Oil

- *John D. Rockefeller played a key role in transforming the U.S. oil industry, using strategic acquisitions to dominate the refining market.*
- *In the 1860s, Rockefeller began to build oil refineries.*
- *By 1868, Standard Works was the world's largest oil refinery.*
- *He founded Standard Oil in 1870, controlling 10% of the world's oil.*
- *Rockefeller focused on efficient production, and so was able to underprice competitors and buy out less efficient firms. By 1871, he controlled as much as 90% of U.S. refined oil.*
- *Standard Oil was eventually broken up by antitrust laws in 1911.*

The Majors

- *The Major Oil Companies, commonly called "The Majors", evolved from the breakup of Standard Oil in 1911 due to U.S. antitrust laws.*
- *The Standard Oil Trust, led by John D. Rockefeller, controlled almost 90% of U.S. refining and transportation in the late 19th century.*
- *In 1911, the U.S. Supreme Court ruled* ***Standard Oil was a monopoly*** *and ordered its dissolution, resulting in the formation of 34 independent companies, including:*
  - *Exxon (formerly Standard Oil of New Jersey)*
  - *Mobil (formerly Standard Oil of New York)*
  - *Chevron (formerly Standard Oil of California)*
  - *Amoco (formerly Standard Oil of Indiana)*
- *After the Standard Oil breakup, these companies expanded globally. However, they still cooperated internationally rather than competing.*

The Majors

- *In 1928, the Achnacarry Agreement (also known as the "As-Is Agreement") was signed by major oil companies, including:*
  - *Royal Dutch Shell*
  - *Standard Oil of New Jersey (Exxon)*
  - *Anglo-Persian Oil Company (BP today)*

- *The agreement restricted production to prevent price wars and maintain profits. This informal cartel influenced global oil prices but was not legally enforceable.*

The Majors

- *In the U.S., antitrust laws like the Sherman Antitrust Act (1890) and the Clayton Antitrust Act (1914) prevented oil companies from forming monopolies domestically.*

- *However, these laws did not apply internationally, allowing U.S. and European oil companies to form agreements like the Achnacarry Agreement and later the Red Line Agreement (1928), which divided oil-producing regions among companies.*

- *The Majors controlled Middle Eastern oil production through concessions, where governments granted companies the right to extract oil in exchange for payments. fuel.*

The Majors

- *In the 1950s and 1960s, oil-rich countries started demanding more control and revenue, leading to the formation of OPEC (Organization of Petroleum Exporting Countries) in 1960.*
- *OPEC challenged the dominance of The Majors by setting production quotas and negotiating higher prices.*
- *By the 1970s, nationalization of oil fields in countries like Saudi Arabia, Iran, and Venezuela reduced The Majors' direct control over production.*
- *OPEC disrupted The Majors' control, leading to nationalization of oil resources and shifting power to oil-producing nations.*

Organization of Petroleum Exporting Countries (OPEC)

- *OPEC was created in 1960 by five founding members: Venezuela, Iran, Iraq, Kuwait, and Saudi Arabia.*
- *This formation was driven by a shared desire to gain greater control over their oil resources and achieve higher revenues from oil exports, which they believed they were not receiving under the earlier concessionary arrangements with Western oil companies.*
- *The countries were motivated by the desire to reduce the influence of the "Seven Sisters", the dominant international oil companies, mostly based in the U.S. and Europe, which had significant control over oil prices and production.*

The Seven Sisters:

–Standard Oil of New Jersey (Exxon)
–Standard Oil of New York (Mobil)
–Standard Oil of California (Chevron)
–Royal Dutch Shell
–Anglo-Persian Oil Company (BP)
–Texaco
–Gulf Oil

Organization of Petroleum Exporting Countries (OPEC)

- *Initially, OPEC was not able to significantly influence oil prices in the global market. During the 1960s, member countries were gradually able to win a larger share of oil revenues, but price manipulation by OPEC was still limited.*

- *The 1973 oil embargo, in response to geopolitical events (the Yom Kippur War), marked a pivotal moment. OPEC countries imposed an oil embargo on countries that supported Israel, including the U.S. This drastically reduced oil supply and caused prices to skyrocket from $3 to $12 per barrel. The embargo had widespread economic effects, contributing to stagflation (a combination of inflation and unemployment) in many oil-importing countries.*

- *In the 1970s, OPEC's influence on global oil prices grew stronger, as the organization coordinated production cuts to restrict supply and push prices higher. In 1979, the Iranian Revolution triggered a second major price shock, pushing oil prices close to $40 per barrel.*

OPEC+

- *In the 2000s, OPEC's influence was again tested by new technologies, such as fracking, which dramatically increased oil production, particularly in the U.S.*
- *By the 2010s, OPEC formed a strategic alliance with Russia and other non-OPEC countries in an effort to manage global supply through the OPEC+ arrangement.*
- *This partnership was aimed at maintaining price stability, though tensions within the group occasionally arose, as seen in the 2020 price war between Saudi Arabia and Russia, which caused oil prices to plummet to historic lows.*

Oil Consumption

- *Oil remains the largest source of global energy, accounting for 31% of total energy consumption in 2020. However, its share has been declining since 2000.*
- *The impact of COVID-19 in 2020 caused a sharp reduction in consumption due to reduced work and leisure travel.*
- *Despite this, oil consumption has continued to grow in regions like Asia and the Middle East, while it has flattened or declined in the U.S. and the EU.*
- *Transportation is the largest consumer of oil, with gasoline, diesel, and jet fuel making up nearly 90% of energy used for transportation in the U.S.*
- *While the adoption of electric vehicles (EVs) is growing, their share remains small (around 1% in the U.S. and 3% globally), though their percentage is increasing quickly.*

Oil Consumption

- *The industrial sector in the U.S. accounts for about 28% of oil use.*
- *Oil is used for a wide range of applications such as:*
  - *Heating*
  - *Powering equipment*
  - *Construction and road maintenance*
  - *Feedstock for chemicals*
- *Petroleum's role in electricity production is declining.*
- *It accounts for 3% globally and only 0.1% in the U.S. However, some regions still rely heavily on oil for electricity:*
  - *For example, Hawaii generates about 60% of its electricity from imported oil, leading to the highest electricity rates in the U.S.*
  - *Some countries like Gibraltar and Curacao continue to be almost entirely dependent on oil for electricity generation.*

Oil Production

- *Hydraulic Fracturing (Fracking) has revolutionized oil production, particularly in North America.*
- *The shale oil boom began in the U.S. in 2009 with fracking and horizontal drilling, leading to significant increases in domestic oil production.*
- *As oil prices drop, the number of drilling rigs decreases due to lower profitability, particularly for high-cost producers like frackers.*
- *When prices are high, fracking becomes highly profitable and leads to a surge in drilling activity.*

Oil Production

- *Upstream activities (exploration and extraction) come with high risks and high costs.*
- *For instance, Shell Oil's Arctic exploration was abandoned after spending $7 billion due to low oil prices, demonstrating the uncertainty in long-term exploration investments.*
- *Economists argue that oil will not run out in the near future because prices will rise, prompting new technologies and alternative sources like biofuels to be developed.*

Oil Supply Chain

- The oil supply chain includes
  - upstream (exploration and production)
  - midstream (transportation and storage)
  - downstream (refining and distribution)
- Pipelines are the most common and efficient method of oil transportation, although rail and trucking are used for flexibility, particularly when new pipeline construction is slow or politically challenged.

Oil Supply Chain

- Upstream (Exploration and Production)
  - The upstream stage involves the exploration, drilling, and extraction of crude oil. This stage is known for high risks and rewards.
  - Companies explore domestic and foreign oil fields to secure oil supplies. For example, Shell abandoned its Arctic exploration project after spending $7 billion due to fluctuating prices and high risks
  - The Deepwater Horizon disaster in 2010 also exemplifies the inherent risks in offshore drilling, leading to catastrophic environmental damage

Oil Supply Chain

- *Midstream (Transportation and Storage)*
  - *The midstream stage involves transporting crude oil from production sites to refineries.*
  - *This is done primarily through pipelines, which carry about 77% of the oil in the U.S. Ships, barges, rail, and trucks are also used, with rail becoming more important due to the rapid rise of fracking production*
  - *Storage is another midstream function, managing oil inventories to balance supply with demand.*
  - *Seasonal demand variations, such as higher consumption during summer driving seasons, lead companies to store oil during off-peak times.*
  - *Large inventories can cause price drops, as seen in March 2020 when oil prices briefly turned negative due to storage limits*

Oil Supply Chain

- *Downstream (Refining and Distribution)*
  - *The downstream stage is where crude oil is refined into various products such as gasoline, diesel, jet fuel, and petrochemicals.*
  - *The refining process includes heating the oil, cracking longer molecules into lighter ones (e.g., gasoline), and combining lighter molecules into heavier ones (e.g., diesel)*
  - *Refined products are then distributed to storage terminals, distributors, and gas stations, although many gas stations are now independently owned rather than by the major oil companies*

Market Models of OPEC Behavior

- *To better understand OPEC's ability to influence price, we examine market structure.*
- *We present two oligopoly models to explain OPEC behavior:*
  - *cartel*
  - *dominant firm price leadership*
- *Oligopoly models apply when there are a small number of interdependent firms in an industry.*

OPEC Behavior as a Cartel

- *In a cartel, producers collaborate to set industry output and then allocate quotas to the cartel members.*
- *The intention is to mimic monopoly, producing industry quantity Q_m at corresponding price P_m.*
- *This is the price-quantity combination that corresponds to MR = MC for a monopoly.*
- *In OPEC's case, industry supply is the sum of MCs for individual members.*
- *Assuming all members are the same size and that there are n members, each country produces $q_m = Q_m/n$.*

OPEC Behavior as a Cartel

- *OPEC holds periodic meetings to determine individual country quotas.*
- *However, from an individual member perspective, the most profitable point is* q_{cheat}.
- *The individual member sees its demand (d) as infinitely elastic, since one member is too small to affect industry price.*
- *Individual member marginal revenue (mr) is identical to its perceived demand and price, the horizontal line at* P_m.

Why q_{cheat}?

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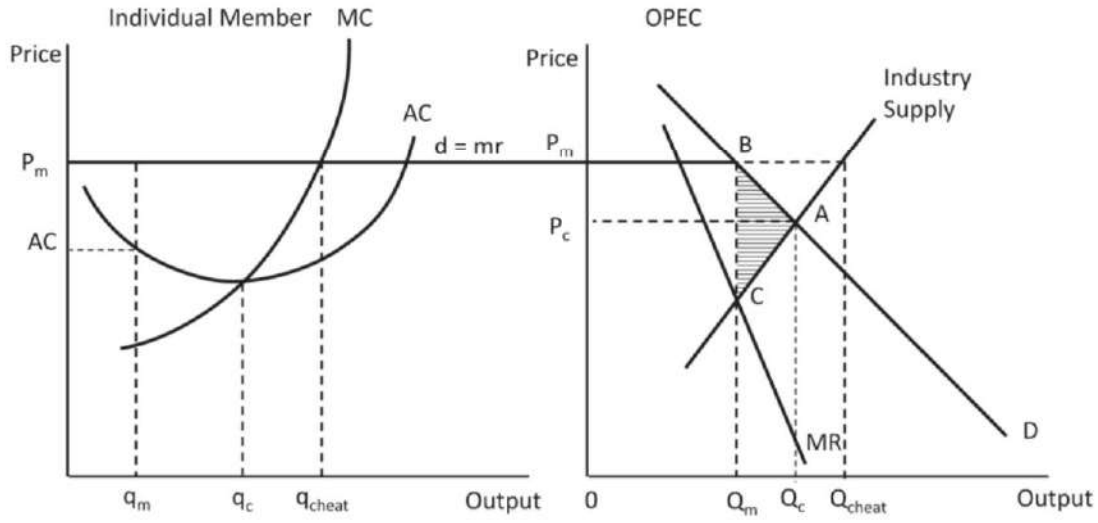
- *Individual member marginal revenue (mr) is identical to its perceived demand and price, the horizontal line at* P_m.
- *If all firms cheat, industry quantity is* Q_{cheat}.
- *There is a surplus of oil* ($Q_{cheat} - Q_m$), *and the price will fall.*
- *In the long run, if the cartel cannot enforce the quota, the industry will evolve into perfect competition.*

OPEC Behavior as a Cartel



Cartel's Deficiency

- *Historically, cartels have had a short lifetime.*
- *In the U.S., cartels are illegal under the* ***Sherman Antitrust Act****.*
- *In 2020, OPEC's share of production was about 40%, although their share of global exports is still about 60% of total international oil trade*

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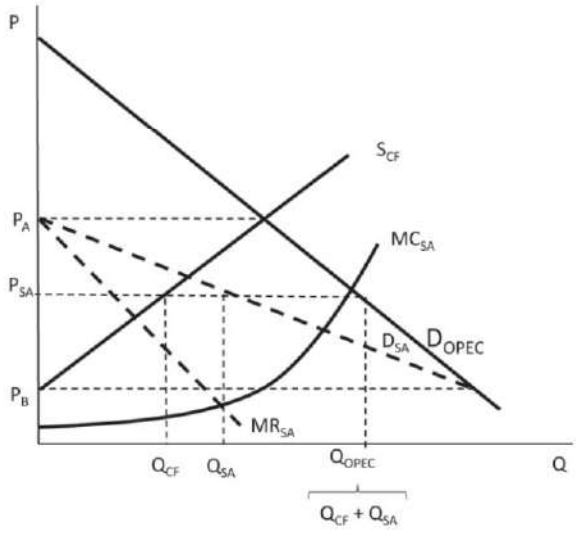
- *In 2020, OPEC's share of production was about 40%, although their share of global exports is still about 60% of total international oil trade.*
- *The cartel model has the virtue of simplicity. It provides useful predictions on how OPEC sets quotas, and why they often exceed those quotas.*
- *The predictions are consistent with the cyclic history of high prices followed by collapsing prices. However, the model does not capture the disproportionate influence of Saudi Arabia.*

Saudi Arabia as Swing Producer

- *Saudi Arabia has taken the role of swing producer, adjusting its output to maintain the organization price.*
- *Saudi Arabia has substantial spare capacity.*
- *When price falls below OPEC's target level, Saudi Arabia reduces production so that price will recover in the next period of time.*

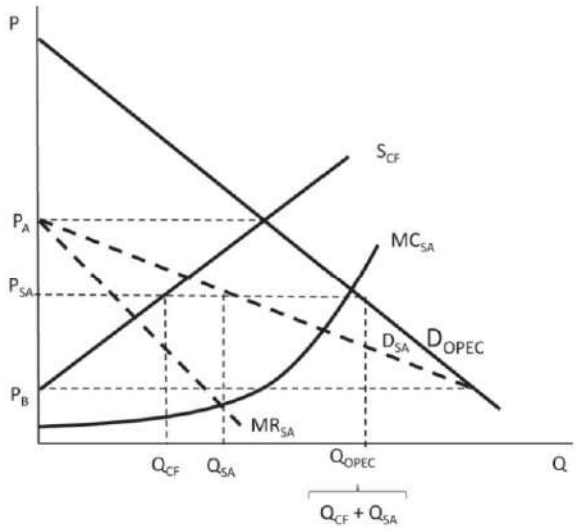
Dominant Firm Price Leadership Model

- *Figure shows the dominant firm price leadership model for Saudi Arabia and the other OPEC members.*
- *The price leader, in our case Saudi Arabia determines price.*
- *The leader faces a residual demand (D_{SA}) that begins at P_A obtained by subtracting the supply of the competitive fringe (S_{CF}) from industry D (D_{OPEC}).*
- *The competitive fringe is composed of all the other OPEC countries, each of which is considered too small to influence industry price.*
- *Their supply begins at P_B.*



Dominant Firm Price Leadership Model

- *SA maximizes profits where $MR_{SA} = MC_{SA}$*
- *Dominant firm price is P_{SA} and quantity is Q_{SA}.*
- *The followers take P_{SA} as their price, and choose output Q_{CF} where $P_{SA} = MC$ (S_{CF}).*
- *Finally, OPEC supply is $Q_{CF} + Q_{SA}$.*



Oil Financial Instruments

- *Financial derivatives such as **forwards**, **futures**, and **options** helps managing the volatility of oil prices.*
- *These financial tools are essential for market participants who seek to hedge against price fluctuations or speculate for profit.*
- *Oil Derivatives*
  - *Forwards*
  - *Futures*
  - *Options*

Forward Contracts

- *Private agreements where two parties agree to buy or sell oil at a specific price at a future date.*
- *These contracts are customizable and are often traded over-the-counter (OTC), meaning they don't take place on exchanges.*

Futures Contracts

- *Similar but are standardized and traded on organized exchanges like the New York Mercantile Exchange (NYMEX).*
- *Futures contracts offer more transparency, as prices and terms are public.*
- *Both forward and futures markets help reduce price risk for participants by locking in future prices, allowing businesses (like refineries) and other stakeholders to avoid unpredictable price swings.*
- *They also allow traders to speculate on future prices, making them central to global oil price discovery*

Options Contracts

- *Options give the buyer the right, but not the obligation, to buy or sell oil at a future price. There are two main types:*
  - *Call options: The right to buy oil at a specified strike price.*
  - *Put options: The right to sell oil at a specified strike price.*
- *Options are used by traders to speculate on price movements without the obligation to buy or sell oil.*
- *For instance, a $60 call option on oil gives the holder the right to buy oil at that price, profiting if the oil price exceeds $60.*
- *Speculators in the futures and options markets play a key role in providing liquidity and reducing price volatility by buying when prices are low and selling when prices are high. They absorb the risk that hedgers are not willing to take. Speculators profit from correctly predicting price movements but also help stabilize prices in the process*

Crack Spread

- *A crack spread is a strategy used by refiners to hedge against fluctuations in the price difference between crude oil and refined products (like gasoline).*
- *If a refiner expects that the price of crude oil will fall, but gasoline prices will also fall, they can simultaneously trade oil futures and gasoline futures to offset losses in one market with gains in another.*

Summary

- *Early Development: Oil started as an unwanted substance but became highly valuable by the late 1800s. It was initially used for lighting, heating, and transportation after technologies were developed to extract and refine it.*
- *John D. Rockefeller: In the late 19th century, Rockefeller, through Standard Oil, gained control over much of U.S. oil refining. He used efficient business practices, and some say predatory pricing to eliminate competition and establish a near-monopoly.*
- *Antitrust Laws: To prevent monopolistic behavior, U.S. antitrust laws broke up Standard Oil in 1911, leading to the formation of multiple oil companies.*
- *After the breakup of Standard Oil, many of the resulting companies became the "Majors", which still held substantial market influence. The Achnacarry Agreement of 1928 is an example of how these companies coordinated to control oil production and prices.*
- *Texas Production: By the early 1930s, Texas became the dominant oil producer in the U.S. The Texas Railroad Commission set production quotas to limit supply and stabilize prices.*

Summary

- *As oil-rich countries became more aware of their resource wealth, they started asserting control over oil production. This led to the nationalization of their oil industries and the formation of OPEC (Organization of the Petroleum Exporting Countries).*
- *OPEC's Role: OPEC was formed to coordinate production and limit supply to increase prices, mirroring earlier agreements like Achnacarry and Texas Railroad Commission practices.*
- *Cartel Model: This model suggests that OPEC behaves like a cartel, where members agree to produce limited quantities (like a monopoly) to raise prices. However, enforcing such agreements is difficult because members have an incentive to cheat and produce more than their quotas.*
- *Dominant Firm Model: This model highlights the dominant role of Saudi Arabia within OPEC. Saudi Arabia often acts as the price leader, with other OPEC members following its production decisions. This model is simpler and better predicts OPEC's behavior than the cartel model in certain situations.*