Military force has been used to facilitate their implementation. And perhaps most important, since the 1960s, the policies have strongly favored consumption rather than conservation, aggravating the nation's dependence upon foreign sources and setting the stage for future crises. They have not lacked ingenuity. It is hard to conceive of a market intervention more elaborate, and more effective in achieving its questionable objectives, than the two-tier price control program. Only the agricultural price support system rivals it. Yet one might have hoped for a more astute choice of objectives, a longer time perspective, and more coherence among the chosen instruments.

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PETROLEUM REFINING AND MARKETING

Late in the nineteenth century, the Standard Oil Company achieved a near monopoly of petroleum refining in the United States. We analyze the pricing policies and other strategies through which Standard Oil attained and sustained its monopoly position, only to lose it through a precedent-setting antitrust case. To understand the industry's further evolution, we examine the sources of scale economies, the trade-off between scale economies and transportation costs, and the basic logic of oligopolistic pricing rivalry in situations characterized by a "prisoners' dilemma." We then investigate how changes in crude oil supply conditions and in U.S. policies toward the petroleum industry precipitated a restructuring of retail gasoline markets.

INTRODUCTION

Slaking the thirst of U.S. consumers and business firms for petroleum products engages a vast network of refineries, transport media, wholesalers, and retail outlets. In 1987 the "downstream" industry included 187 refineries, 168,000 miles of pipelines, and 137,000 retail gasoline stations. At the refining stage, where crude petroleum is transformed into gasoline, jet aircraft fuel (i.e., kerosene), diesel and heating oil, lubricants, petrochemical feedstocks, asphalt, and other products, the four largest companies accounted for 32 percent of 1987 industry sales; the eight largest originated 52 percent.[1] Thus, ignoring for the moment regional disparities, the structure of the domestic refining industry can be characterized as loosely oligopolistic.

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[1]U.S. Bureau of the Census, *1987 Census of Manufactures*, MC87-S–6, "Concentration Ratios in Manufacturing" (Washington, DC: USGPO, 1992), p. 22.

THE ASCENT AND DECLINE OF STANDARD OIL

This was not always the case. During the last two decades of the nineteenth century and the first decade of the twentieth, the industry was dominated by one company: Standard Oil.

When crude oil was discovered in northwestern Pennsylvania, Cleveland, Ohio, became the nation's leading kerosene refining center. The city enjoyed a natural advantage through its proximity to the oil fields and its excellent rail and water transportation facilities. By 1871, the number of petroleum refineries in Cleveland had grown to somewhere between 25 and 40. (Frequent closures made an exact count difficult.) Among these were the two refineries of the Standard Oil Company, incorporated in 1870, whose operations were initiated by John D. Rockefeller and a partner in 1862. By constructing unusually large refining facilities (including the world's largest unit to date, with a capacity of 1500 barrels per day) and through rigorous quality control and tight-fisted cost reduction, Standard Oil had by 1870 become the nation's largest refiner, with about 10 percent of nationwide capacity.[2]

Rapidly expanding crude oil production and concomitant price declines led Rockefeller and his colleagues to conclude that Standard should undertake an aggressive campaign to bring "order" to the new industry. The first step was the acquisition of nearly all competing refineries in the Cleveland area, along with foothold refining interests on the East Coast. In its quest to consolidate the industry, Standard Oil enjoyed two initial advantages in addition to sheer ambition. Its low-cost operations yielded superior profits to which the company could point in persuading rivals to exchange their equity for Standard's stock: "Join us and you will be wealthier." But more important, Standard exploited the bargaining power derived from its substantial volume and advantageous location to play off the three main-line railroads connecting the East Coast and the Cleveland area—the New York Central, the Pennsylvania, and the Erie—one against the other, extracting from them freight rate concessions or "rebates" ranging from 10 to 50 percent of the rates charged Standard's competitors. At times during the 1870s, Standard also received from Cleveland area railroads "drawbacks," that is, rebates to Standard for the oil and kerosene shipped by *competing* oil companies. Although other refiners also received rebates on occasion, Standard's were larger and more consistent.

[2]Authoritative sources on the early history of Standard Oil include Harold W. Williamson and Arnold R. Daum, *The American Petroleum Industry: The Age of Illumination, 1859–1899* (Evanston, IL: Northwestern University Press, 1959); Allan Nevins, *Study in Power: John D. Rockefeller* (New York: Scribner, 1953); Ralph and Muriel Hidy, *Pioneering in Big Business* (New York: Harper, 1955); and the three-volume report of the U.S. Bureau of Corporations, *Report of the Commissioner of Corporations on the Petroleum Industry* (Washington, DC: 1907 and 1909).

These were crucial to Standard's superior cost and profit position, for during the early 1870s, refining costs (excluding the cost of crude oil inputs) varied in the range of 0.5 to 1.5 cents per gallon of kerosene, while a rail shipment of crude oil or products from northwestern Pennsylvania or Cleveland to New York cost from 0.5 to 2.7 cents, depending upon competitive conditions.[3]

In these and especially subsequent acquisitions, Standard is said to have used "predatory" pricing to stimulate its rivals' willingness to sell out, or to induce them to sell at distress prices. "Predatory" must be enclosed in quotation marks, because there is no universally accepted definition. Sometimes the term refers to the intent of a firm to injure or destroy its rivals, but often to selling below some measure of the alleged predator's unit costs—that is, below average total cost or (most commonly) marginal or average variable cost.[4] Given the widely differing definitions, it should not be surprising that there is controversy among scholars as to whether, or how much, Standard engaged in predation.[5] Most of the time, rivals probably sold out voluntarily because they recognized Standard's superior cost position and hoped to share in or capitalize on its monopoly gains. But the historical record is clear that Standard did occasionally use sharply focused price warfare to "sweat" recalcitrant rivals (Rockefeller's term) and induce them to sell. To avoid having to reduce its prices across the board, it created among other things "bogus" subsidiaries which quoted bargain prices only to the customers served by targeted rivals, while branches doing business under the "Standard" name maintained their higher prices.[6] Its ability to target rivals for price cuts was enhanced by an elaborate intelligence network, tapping inter alia the shipping invoices of rivals provided to it by friendly railroads.

Until the late 1880s, Standard Oil showed little interest in finding and owning crude oil reserves. It believed that it could control crude oil markets by being the dominant refiner-buyer of crude oil. This control was facilitated by acquiring and later building pipelines that connected the oil fields with railroad junction points. In 1878, Pennsylvania oil producers attempted to break free from Standard's control by building the Tidewater pipeline, connecting

[3]See Eliot Jones, *The Trust Problem in the United States* (New York: Macmillan, 1921), pp. 48–55; and Alfred Chandler (with Takashi Hikino), *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge: Harvard University Press, 1990), p. 25.

[4]See Joseph F. Brodley and George A. Hay, "Predatory Pricing: Competing Economic Theories and the Evolution of Legal Standards," *Cornell Law Review*, vol. 66 (April 1981), pp. 738–803.

[5]Compare John S. McGee, "Predatory Price Cutting: The Standard Oil (N.J.) Case," *Journal of Law & Economics*, vol. 1 (October 1958), pp. 137–169; and Randall Mariger, "Predatory Price Cutting: The Standard Oil of New Jersey Case Revisited," *Explorations in Economic History*, vol. 15 (October 1978), pp. 341–367.

[6]See Daniel Yergin, *The Prize* (New York: Simon & Schuster, 1991), pp. 42–43.

the oil fields to a major railroad junction in central Pennsylvania. The venture was unprecedented both in its length—109 miles, compared to the previous maximum of 30 miles—and its success in crossing the Allegheny Mountains. Standard quickly retaliated in four ways. First, it secured unusually low rates from the railroads traversing parallel routes. Second, it bought out most of the East Coast refineries to which the Tidewater pipeline was to deliver its oil, thereby depriving the pipeline of its best markets. Third, it commenced a crash program to construct its own pipelines from the oil fields to Philadelphia and Bayonne, New Jersey, as well as to Pittsburgh, Cleveland, and Buffalo. And finally, it succeeded in obtaining first a minority interest in Tidewater's stock and later (in 1883) full control.

By 1880, through acquiring more than 100 competitors along with its own refinery and pipeline building programs, Standard came to control approximately 90 percent of U.S. petroleum refining capacity. It retained an 85 to 90 percent share for the next 20 years. It continued to receive rebates and discriminatorily favorable freight rates from the railroads at least through 1906, even though the Interstate Commerce Act of 1887 sought to outlaw discrimination in favor of individual shippers. More important to its continuing dominance was its control of pipelines, which provided much lower-cost crude oil transportation than the railroads. At the height of the contest between Standard and the Tidewater pipeline, for example, rail rates from northwestern Pennsylvania to the New York harbor were reduced from $1.15 per barrel to 20 cents for Standard and 30 cents for other shippers, but oil could be transported over the same route by pipeline at a cost of less than 17 cents.[7] Standard attempted to prevent the construction of competing pipelines by opposing their petitions seeking eminent domain and paying premiums for crude oil originating in the producing areas they sought to serve. Although required by the Hepburn Act of 1906 to behave as a common carrier, letting rivals ship over its pipelines, it prevented them from doing so by quoting extremely high rates, quoting no rates at all to the most attractive destinations, and imposing minimum shipment quantities too large for most crude oil shippers to meet.[8]

Gradually, however, Standard's market share began to ebb. Because of handicaps imposed by the Texas antitrust laws,[9] Standard failed to dominate the purchase of oil from the 1901 Spindletop discovery, permitting Gulf, Texaco, and Shell to gain strong footholds. It was also slow in recognizing the potential of California oil fields, allowing Union Oil (now Unocal) to become

[7]Jones, *The Trust Problem*, p. 55.

[8]Jones, *The Trust Problem*, pp. 66–72.

[9]Joseph A. Pratt and Mark E. Steiner, "'An Intent To Terrify': State Antitrust in the Formative Years of the Modern Oil Industry," *Washburn Law Journal*, vol. 29 (Winter 1990), pp. 270–289.

established. In the East, several independent refining companies banded together to form a viable Pure Oil Company.

To control their increasingly far-flung operations, Standard Oil's principal owners brought their various affiliates under the umbrella of a trust created in 1882 under Ohio law. Thus emerged the first of the great market-dominating "trusts," giving a name (often inconsistent with the actual legal structure) to all big businesses of the time and, in 1890, to a new federal law, the Sherman Antitrust Act, passed to rein them in. Challenged under Ohio state antitrust laws, the Ohio Standard Oil trust was dissolved, and in 1899 it was reorganized as a holding company under the more permissive laws of New Jersey.

The Sherman Act was passed as a reaction to public concern over the new and monopolistic, but poorly understood, business forms epitomized by Standard Oil and emulated in diverse ways by other enterprises. It contained two main substantive provisions. Section 1 outlawed contracts, combinations, and conspiracies in restraint of trade, which presumably included both loose-knit price-fixing and other restrictive agreements and also mergers and trusts that permanently eliminated competition. Section 2 prohibited "monopolization" and attempts to monopolize any part of interstate or international trade or commerce, leaving imprecisely defined exactly what the word "monopolization" meant.

At first the new law was enforced in desultory fashion. Key precedents articulated during the late 1890s suggested that it had more clout against price-fixing agreements among supposedly independent competitors than against the mergers through which competitors became permanently joined in common cause. This real or perceived bias helped trigger the most sweeping merger wave in U.S. history between 1899 and 1904, fusing the leading firms in dozens of industries into new enterprises that dominated the markets they served.[10]

With the ascent of Theodore Roosevelt to the presidency in 1901, enforcement of the antitrust laws took a much more vigorous turn. A major investigation of Standard Oil was launched by the newly formed Bureau of Corporations, and in November 1906, a suit was brought accusing Standard Oil of monopolizing the petroleum industry. Standard Oil lost at the circuit court level in 1909, and in May of 1911, the Supreme Court concurred.[11] Establishing a "rule of reason" approach to determining whether monopolization had

[10]See, for example, Jesse W. Markham, "Survey of the Evidence and Findings on Mergers," in the National Bureau of Economic Research conference report, *Business Concentration and Price Policy* (Princeton, NJ: Princeton University Press, 1955), pp. 141–212; Ralph L. Nelson, *Merger Movements in American Industry* (Princeton, NJ: Princeton University Press, 1959); and Naomi R. Lamoreaux, *The Great Merger Movement in American Business: 1895–1904* (New York: Cambridge University Press, 1985).

occurred, it recited the many competition-excluding practices of which Standard was accused and concluded:

> [W]e think no disinterested mind can survey the period in question without being irresistibly driven to the conclusion that . . . [the] acts and dealings [were] wholly inconsistent with the theory that they were made with the single conception of advancing the development of business power by usual methods, but which, on the contrary, necessarily involved the intent to drive others from the field and to exclude them from their right to trade. . . .

The Court ordered that the Standard holding company be broken into 34 separate companies within six months, with the stock in those companies distributed pro rata to shareholders of New Jersey Standard Oil.[12] Among the 33 corporations whose stock interests had to be divested were 12 refining and/or marketing companies—Atlantic (now Arco), Continental Oil (Conoco, now a subsidiary of Du Pont); Standard of California; Standard of Indiana (now Amoco); Standard of New York (now Mobil); Standard of Ohio (acquired by British Petroleum in 1987); Solar (acquired in 1931 by Standard of Ohio); Standard of Kansas (liquidated in 1948, after its refining assets were acquired by Standard of Indiana in 1932); Standard of Kentucky (acquired by Standard of California in 1961); Standard of Nebraska (acquired by Indiana Standard in 1939); Vacuum (acquired by Standard of New York in 1931); and Waters-Pierce (whose fate is unknown). Also divested were four subsidiaries producing crude oil (one of which became Marathon Oil, acquired in 1982 by United States Steel), ten pipeline companies, and Standard's British affiliate. Standard Oil of New Jersey (renamed Exxon in 1972) retained sizable refineries in New Jersey, Texas, West Virginia, and Louisiana; and most of its overseas subsidiaries, including the Imperial Oil Company of Canada.

At first the breakup did little to increase competition in petroleum refining and marketing. The principal divested Standard Oil companies were organized along regional lines, and divestiture left each company with a dominant position in its natural geographic market. Each was at first reluctant to interpenetrate others' markets, perhaps in part because John D. Rockefeller and his associates still controlled a majority interest in each of the divested companies' shares. Rockefeller alone owned 25 percent. Also, despite the 1906 law declar-

[11] U.S. v. Standard Oil Company of New Jersey et al., 221 U.S. 1 (1911).

[12] The next several paragraphs are drawn from William S. Comanor and F. M. Scherer, "Rewriting History: The Early Sherman Act Monopolization Cases," *International Journal of the Economics of Business*, vol. 2 (July 1995), pp. 266–269.

ing them to be common carriers, the divested pipeline companies continued to shun or charge high rates to independent petroleum companies.[13]

Gradually, however, the divested fragments began to compete. The ownership position of the Rockefeller family and the other founding fathers declined as large amounts of stock were transferred to philanthropic trusts, which diversified or liquidated their holdings, and as new public stock offerings were floated to support the expansions needed to meet the burgeoning demand for automotive fuel and to achieve greater balance between crude oil and refining operations. At first slowly, but during the 1920s at an expanding rate, the refining and marketing companies spread out from their traditional territories into adjacent and later more distant states. Surveying the situation in 1927, the Federal Trade Commission found that "a considerable degree of competition" had emerged among the spin-off companies, with no Standard company achieving as much as 50 percent of the sales in its home territory.[14] By 1955, at least three successor companies were selling in each state of the United States.[15]

The explosive growth of demand and the discovery of vast new crude oil sources outside Pennsylvania and Ohio also created opportunities for the entry and growth of non-Standard companies. Standard's petroleum product market share slipped from 90 percent in 1899 to 87 percent in 1904 and 80 percent before the breakup in 1911. The combined market share of Standard's spin-off companies declined at an accelerated rate between 1910 and 1920. See Figure 4.1. This decrease was apparently not attributable to disruptions caused by divestiture, since there was little evidence of organizational problems. Indeed,

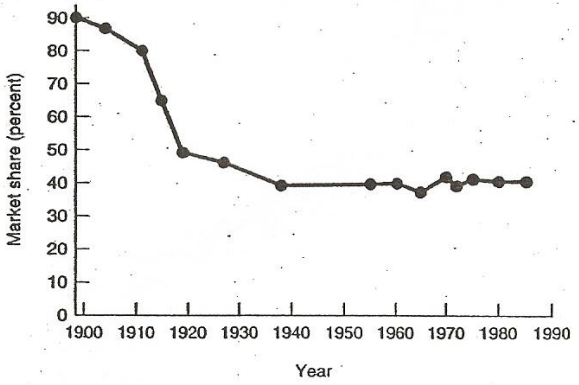
[13] The newly named president of three divested pipeline companies had his initial post divestiture office in the Manhattan headquarters of New Jersey Standard Oil! George S. Gibb and Evelyn H. Knowlton, *The Resurgent Years: 1911–1927* (History of Standard Oil Company) (New York: Harper, 1956), p. 18.

Pipeline access and pricing problems eased as the pipelines achieved greater independence from their former parent and new lines were built. But even after more stringent pricing and access rules were negotiated in a 1941 consent decree, problems remained. See U.S. Senate, Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, Staff Report, *Oil Company Ownership of Pipelines* (Washington, DC: USGPO, 1978); Edward J. Mitchell, ed., *Oil Pipelines and Public Policy* (Washington, DC: American Enterprise Institute, 1979); and U.S. Department of Energy, Energy Information Administration, *Oil Pipeline Symposium* (Washington, DC: USGPO, October 1980). Regulatory responsibility was transferred from the Interstate Commerce Commission to the Federal Energy Regulatory Commission in 1977.

[14] U.S. Federal Trade Commission, *Petroleum Industry: Prices, Profits, and Competition*, Senate Document 61, 70th Congress, 1st sess. (Washington, DC: USGPO, 1928), pp. 263–265.

[15] Simon N. Whitney, *Antitrust Policies*, vol. I (New York: Twentieth Century Fund, 1958), p. 106.

FIGURE 4.1
Trends in the Combined Market Shares of Standard Oil and Its Spin-Offs



Sources: Oil industry histories, annual compilations by the Department of Interior under the oil import program, and (after 1975) *Oil and Gas Journal* refinery capacity estimates.

a new generation of Standard managers seems to have thrived on the postdivestiture challenges.[16] Rather, there were two main causes: the doubling of U.S. crude oil output between 1911 and 1920, and the tendency of the regional Standard companies to set their prices relatively high, holding an umbrella that encouraged the expansion of rivals into their territories.[17] Gradually, however, as the Standard fragments began competing more aggressively for market position, the rate of market share decline slowed, and after 1938, the combined share of the (now independent) spin-off companies stabilized at approximately 40 percent.

[16]See Comanor and Scherer, "Rewriting History."

[17]See Melvin G. de Chazeau and Alfred E. Kahn, *Integration and Competition in the Petroleum Industry* (New York: Yale University Press, 1959), pp. 457–459; and Edmund P. Learned with Catherine C. Ellsworth, *Gasoline Pricing in Ohio* (Boston: Harvard Business School Division of Research, 1959), pp. 23–24.

TECHNOLOGY, ECONOMIES OF SCALE, AND MARKET STRUCTURE

By 1987, to reiterate, the four leading U.S. petroleum refiners originated 32 percent of domestic output. The largest seller, Standard of California, which had taken over industry leadership from Exxon (successor to the original New Jersey Standard Company) by acquiring Gulf Oil in 1984, accounted for 11 percent.[18] To what extent is this degree of seller concentration, modest though it may be, required to achieve the cost savings stemming from economies of scale?

A petroleum refinery is a plumber's dream—an assortment of processing vessels connected by intricate piping and valves, all controlled from an elaborately instrumented operations center. Crude oil normally reaches the refinery by tanker ship or pipeline. After blending and other preliminary treatment, the crude oil is heated under vacuum conditions until it evaporates. The vapor flows into a distillation tower—usually the largest single processing unit in a refinery—where it condenses in stages, the most volatile fractions (e.g., propane, natural gasoline, and naphtha) condensing at the top, intermediate fractions (kerosene and heating oil) condensing at lower levels, and the heaviest fractions (residual fuel oil, tar, and asphalt) settling to the bottom. Gasoline comprises roughly 16 to 24 percent of the resulting distillate, with light crudes yielding a higher gasoline fraction than heavy crudes. This amount is not enough to satisfy U.S. consumers' craving for gasoline, which averaged 42 percent of total petroleum distillate yields during the 1980s.[19] Thus, further processing is necessary to transform heavier fractions into gasoline and also to increase the octane rating of natural gasoline. These processes include cracking, in which heavy molecules are broken into lighter ones under pressure and heat in the presence of catalysts; alkylation, in which light gaseous molecules are fused into high-octane gasoline; hydrogenation, in which hydrogen is added to molecules to lighten them; and various catalytic re-forming steps that alter the molecular structure to yield either gasoline or petrochemical feedstocks. The black, sticky residue that remains may be used directly as asphalt for road and roof construction, or it may be processed in a coking unit to obtain more volatile fractions and carbon coke. As a rule, the higher a refin-

[18]Conventionally calculated concentration ratios overstate the true degree of concentration, since petroleum product imports from a diversity of sources amounted to 12 percent of domestic output.

[19]The fraction of petroleum products consumed as gasoline is higher in California and the South, where fuel oil is demanded less, and lower in New England, where much home heating is done using fuel oil. The "traditional" western European refinery produced relatively little gasoline and much fuel oil, but that has changed with growing automobile ownership and greater availability of natural gas for heating.