WHAT GOES DOWN MUST COME UP

A Review of the Factors behind Increasing Gasoline Prices, 1999-2006

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Executive Summary

U. S. gasoline prices nearly tripled between January 1999 and July 2006. Consumers, policymakers, and the media have questioned why prices rose so quickly and why they remain so high. In this paper, an independent expert in international energy markets reviews the available data and evaluates the various forces that have been suggested as possible causes for these price trends. She finds that recent price patterns are not unprecedented and are mirrored in the price behavior of other commodities. There is no evidence that refiners have been able to block the behavior of a competitive market and some of the factors that have been suggested as reasons for higher prices lack a theoretical basis or are incompatible with statistical evidence. The principal drivers of higher U.S. gasoline prices have been higher crude oil prices and tighter environmental regulations.

The paper's key findings are summarized here.

1. **The current level of gasoline prices is not without precedent.**

   After adjusting for inflation, U.S. average gasoline prices in 2006 were lower than the average annual prices consumers paid in the period 1978 to 1982 and during the 1930s. Recent price levels have been shocking primarily because consumers enjoyed unusually low gasoline prices for over a decade from 1986 to 1999.

2. **Movements in crude oil markets explain almost all of the change in gasoline prices over the period from 1999 to 2006.**

   Historical analysis shows that changes in crude oil prices explain about 97% of the variation in the pre-tax price of gasoline between 1918 and 2006. Over that period, a $1 per barrel increase in the crude oil price consistently generated an increase in the gasoline price of about 2.5 cents. Between January 1999 and summer 2006, crude oil prices more than quadrupled from $15.50 per barrel to over $65 per barrel. Based on the historical pattern, gasoline prices would be expected to increase by $1.25 per gallon in the same period. The actual increase in gasoline prices was slightly lower than this forecast amount. In addition a small percentage of the increased cost of gasoline can be attributed to the increase in refiners' costs to purchase electric power, inorganic chemicals, and organic chemicals. These costs rose by 20%, 25%, and 45%, respectively, from 2000 to 2005.

3. **Higher-than-projected U.S. income levels exerted demand pressure on gasoline prices. The response of gasoline prices to this demand pressure indicates a tight competitive market rather than a market in which refiners have monopolistic pricing power.**

In the United States, a 1% increase in income induces a 0.3% increase in gasoline demand within one year. An unexpectedly strong U.S. economy in 2004 and first quarter 2006 produced higher-than-forecast income growth, and thus higher-than-expected gasoline demand. Because of high refinery utilization rates and the long lead time required to add refinery capacity, short-term gasoline supplies are essentially inelastic—i.e. not very responsive to price changes—so demand levels that are greater than projections can cause dramatic short-term price effects. In the short run, these price effects are not self-correcting because gasoline demand is not very sensitive to price increases. A doubling in prices has been estimated to produce a fall of only 4% in gasoline consumption in the first month. A recent study suggests that demand responses to price increases are even weaker today than they were in the 1970s, perhaps because consumers are less likely to view higher prices as permanent.

4. **The changes in gasoline standards that have improved our environmental quality have also pushed up prices. The proliferation of "boutique fuels" has had the effect of reducing the capacity of the U.S. refining industry and increasing price volatility by limiting arbitrage possibilities.**

Between 1990 and 2002, the number of different grades of gasoline increased from three to fourteen. This trend made refining more complex, requiring refineries to reconfigure their operations at lower production levels or invest money to sustain the same output. This product proliferation also reduced the market's ability to mitigate temporary geographic shortages by diverting gasoline from other regions that did not use the same products. In August 2005, the Energy Policy Act removed the 2% oxygenate mandate effective immediately in California and after 270 days in the rest of the U.S. Many companies had been using Methyl Tertiary Butyl Ether (MTBE) as the only practical solution to meeting this mandate and chose to phase out MTBE in early to mid-2006. This Federal Act also required the use of greater volumes of renewable fuels. So at the same time that MTBE was being eliminated from the gasoline supply, increased volumes of ethanol were being introduced resulting in short-term supply disruptions due to change-over and supply logistics.

5. **Some observers have claimed that increasing concentration in the refining industry has exerted upward pressure on gasoline prices. In fact, concentration and vertical integration have been decreasing.**

A 2004 publication from the U.S. Government Accountability Office (GAO) stated that increased market concentration had led to higher gasoline prices. Not only are there substantial weaknesses in the GAO methodology, in fact, the trend in the refining industry is toward slightly lower levels of concentration as refining operations are unbundled from oil companies into independent entities. A 2004 report by the U.S. Federal Trade Commission (FTC) found that the oil industry is becoming less vertically integrated. According to the

FTC (U.S. FTC, 2005), the share of U.S. refining capacity owned by independent refiners with no production operations rose from 8% in 1990 to over 25% in 2006. The FTC also found that trends in gasoline marketing are likely to increase competition and that price spikes are largely explained by such temporary and external phenomena as refinery accidents, bottlenecks, and the introduction of boutique fuels.

6. **The magnitude of refiner profits is often exaggerated. From 1977 to 2005, the rate of return on investment in U.S. gasoline refining averaged less than 7%. This compares unfavorably with returns over the same period of 9% in durable goods and over 11.5% for the S&P 500 industrials.**

The refinery sector is cyclical, with profits varying with capacity utilization. While a strong U.S. economy, hurricane-induced shortages, and the capacity squeeze prompted by new environmental standards created above-average profitability in 2004-2006, the industry has also experienced extended periods of low profitability and reported aggregate losses in 1992 and 2002. The current profitability the industry enjoys is in large part the result of a massive restructuring in the 1990s that cut costs, increased economies of scale, and improved utilization rates. This restructuring has been essential to the survival of the increasing numbers of independent refiners that cannot use hydrocarbon production profits to subsidize low profitability in refining.

7. **The refining industry's investments in new capacity have been consistent with historical trends and prudent business practice. There is no evidence that investments have been artificially delayed in order to increase gasoline prices and industry profits.**

Investment in capital-intensive industries does not directly track changes in profits or prices. Analysis of historical data shows that annual investments in refinery capacity are more stable than profits, with changes in profits causing a change in investment that is spread over three years. The pattern is similar in the durable goods industry where, for example, profits increased almost 75% in 2004, while investment in plant and equipment increased less than 1%. In the 1970s, additions to capacity following price increases that proved to be temporary led to years of inadequate profitability. The refining industry is now following prudent business practice by adding capacity incrementally, allowing time to gauge the long-term market response to higher prices. Refinery utilization rates in 1999 to 2006 were in the healthy 90-95% range, but were not generally higher than in 1992-1998.

Some analysts have argued that refinery capacity should be substantially higher and that such increases would reduce gasoline prices to $1.50 per gallon. Given that refiners needed $1.95 per gallon to cover their costs in 2005, this theoretical combination of higher capacity and lower prices would not be sustainable. While current high prices indicate that it is desirable to add refinery capacity, analysis suggests that the required additions are in line with the more modest expansion plans that refineries have announced.

Environmental regulations may have reduced capacity additions. To produce fuel that complies with new standards, refiners must often make substantial investments that do not increase total output. Uncertainty about future regulations may also depress investment as refiners delay expenditures until they can accurately forecast the needed mix of products.

8. Lower gasoline inventories have not increased price volatility.

The ratio between gasoline inventories and gasoline sales has fallen steadily since 1980. The magnitude and pattern of this decline has been essentially the same in the gasoline industry as for the entire manufacturing sector, suggesting that what is responsible is continuous improvement in business practices rather than factors that are unique to the oil industry. Gasoline prices were less volatile between 1999 and 2006 than between 1979 and 1992, when inventory levels were substantially higher. The evidence suggests that it is not inventory levels, but volatile crude oil prices, that largely explain gasoline price volatility.

9. U.S. refiners cannot control the U.S. gasoline market. Trade and pricing patterns indicate that arbitrage moderates inconsistencies between U.S. and foreign markets.

Imports of petroleum products have grown at an annual rate of over 10% in the last decade, although still providing only 5% of U.S. gasoline consumption. Increasing imports and highly correlated profit margins between Europe and the East Coast imply the existence a robust arbitrage market across the Atlantic. Even in the Pacific, where differences in product specifications might be thought to reduce arbitrage opportunities, Asian refiners also act as a moderating influence by providing surplus product to U.S. markets as blending stocks.

10. No evidence was found for the claim that U.S. refining is more profitable than foreign refining.

U.S. companies reported slightly higher absolute net income levels from domestic than from foreign refining operations. But their rates of return on investment in international refining averaged almost 14% from 1977 to 2005, compared to 7% domestically, and the profitability of foreign operations was also less variable. This pattern does not support the argument that refiners were able to abuse their market power in the U.S.

11. The argument that speculation in gasoline derivative markets bids up gasoline prices, and that these, in turn, bid up oil prices, is theoretically inconsistent and not supported by the evidence.

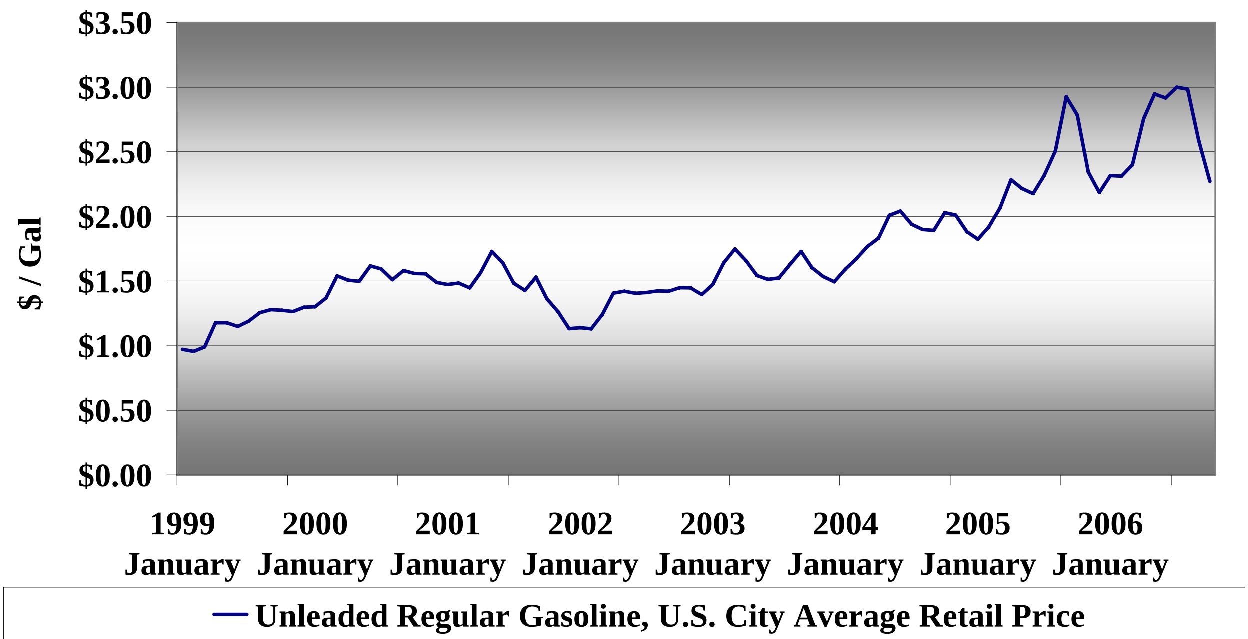
Studies consistently find that derivatives markets improve price stability. They are only destabilizing if speculators are wrong and have very deep pockets, a combination that cannot persist for long. A 2005 study for the Commodity Futures Trading Commission by Haigh et al found no evidence that hedge fund and investment fund speculators bid up oil or natural gas prices. Rather, it found that they provided liquidity in the market and tempered price changes caused by underlying market fundamentals.

The argument that speculative gasoline markets are "pulling up" world crude prices is also theoretically inconsistent with the argument that gasoline prices are high because of supply restrictions. The second argument would imply that gasoline consumption is lower than it otherwise would be—which would put downward, not upward, pressure on crude oil prices.

I. Introduction

Between January 1999 and July 2006, U. S. gasoline prices almost tripled, shocking consumers and spurring public debate about the causes of the increase. Figure 1 shows the quite dramatic run-up that spurred this debate.

Figure 1: Monthly Nominal Gasoline Prices, 1999-October 2006



Source: EIA, MER, http://www.eia.doe.gov/emeu/mer/petro.html.

Simply put, the debate has pitched those who argue that the price reflects the market response to stronger demand and increasing raw materials costs and those who see greedy oil companies using monopoly power to withhold output and artificially inflate prices. The Consumer Federation of America (CFA), for instance, in reports to governmental officials including the Wisconsin Attorney General's Office (Cooper, 2006), has argued:

- Oil companies have consolidated and deliberately failed to invest in capacity, causing shortages and high gasoline prices.
- Speculation in futures markets has bid up gasoline futures prices, which in turn bids up current gasoline prices.
- High gasoline prices have allowed refining companies to earn excessively high real net incomes.

Critics also make such claims as:

- Price increases have been out of line with cost increases.
- Mergers have increased U.S. refining industry concentration and decreased competition.
- U.S refineries are able to exploit their alleged monopoly power because of low demand elasticities.
- Refineries have deliberately reduced their inventories to increase monopoly power.

- Reduced inventories have increased price volatility.
- Investment patterns in U.S. refining are out of line with recent increased profit rates.
- U.S. consumers, with no alternatives, are helpless to change their gasoline consumption patterns.

This paper examines these and other factors that have been suggested as causing high gasoline prices in the light of economic theory and available statistical evidence.

The paper is organized into thirteen sections. Following this introduction, Section II provides a historical review of gasoline prices. Section III presents an economic framework to understand the behavior of the gasoline market. Sections IV and V review factors that have influenced gasoline demand and prices since 1999. Sections VI and VII investigate profitability and return on investment in the U.S. and international refining industries. Section VIII examines the investment behavior of major refiners between 1986 and 2005. Section IX considers historical trends in the level and volatility of gasoline inventories. Section X analyzes market concentration in the refining industry. Section XI investigates the argument that higher gasoline prices create a feedback that pulls up world crude prices. Section XII explores the effect of gasoline financial derivatives on gasoline prices. Section XIII considers demand responsiveness and barriers to entry in gasoline markets. The report’s conclusions are summarized in Section XIV.

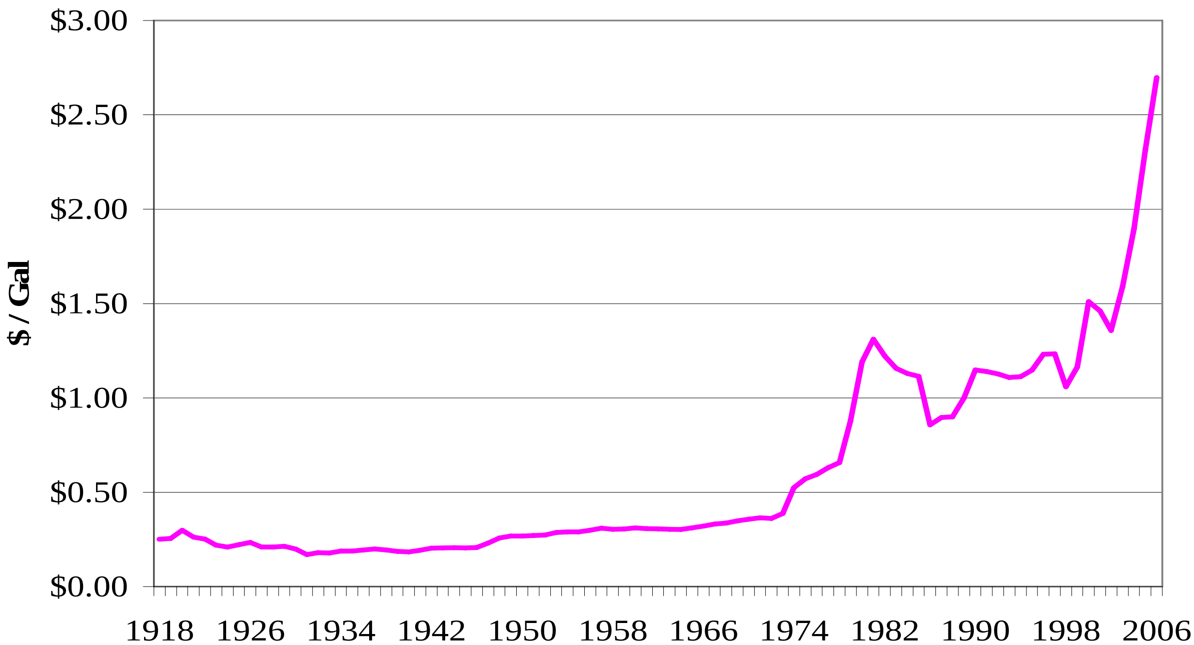
II. What Goes Down Must Come Up: A Historical Review of Gasoline Prices

A review of the history of nominal and real gasoline prices in the U.S. since 1918 finds that recent gasoline price levels are by no means unprecedented. The price increases were shocking because they followed over a decade of the lowest real prices U.S. markets have ever enjoyed. Gasoline price increases paralleled significant increases in the prices of non-petroleum commodities, suggesting that broader economic forces, rather than industry specific actions, were responsible.

Nominal and Real Gasoline Prices

Putting the current price run up in historical context, Figure 2 shows nominal U.S. gasoline prices since 1918. Prices were relatively stable from 1918 to 1970, when large multinational oil companies controlled much of the oil flow. Between 1973 and 1982, prices more than tripled during an era of tight markets, wars, revolutions, and the emergence of powerful national oil companies. An almost equally dramatic increase occurred from 1999 to August 2006, when prices almost tripled before easing in September. Clearly, the current run up is not unprecedented, and the previous increase of this magnitude was followed by a price decline.

Figure 2: Gasoline Prices, 1918 to September 2006, Current Dollars

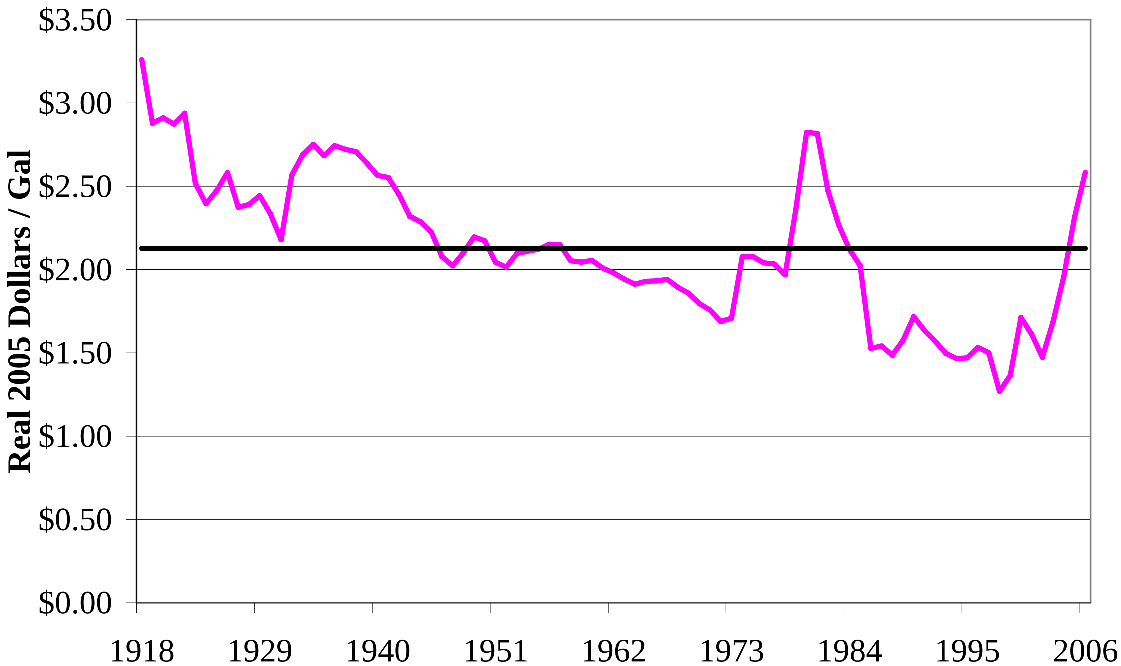


Note: 2006 price is weighted average through September.

Source: American Petroleum Institute (API), 1959, *Petroleum Facts and Figures* and EIA/DOE, 2006, *Annual Energy Review* updated from *Petroleum Navigator*, *http://tonto.eia.doe.gov/dnav/pet/pet_pri_allmg_d_nus_PTA_cpgal_m.htm*

The nominal gasoline prices shown in Figure 2 do not take into account the fact that over time all prices were generally rising with inflation. Figure 3 shows real gasoline prices adjusted using the consumer price index to isolate the behavior of gasoline prices relative to other prices in the economy. Looking at historical gasoline prices in real 2005 dollars shows a general downward trend in gasoline prices except during the two periods of sharply rising crude oil prices in 1973-1982 and 1999-2006. Real prices reached a historical low in 1998 during the Asian economic crisis and did not return to their historical average of $2.13 per gallon (in 2005 dollars) until 2005. The product-weighted average price through September of 2006 was lower, in real terms, than in the 1930s.[2] Rather than being shocked by recent high prices, one might ask why consumers enjoyed such low gasoline prices in the prior decade.

Figure 3: Annual Real Gasoline Prices, 1918-September 2006



Note: 2006 price is weighted average through September.

Sources: Prices from American Petroleum Institute (API), 1959, *Petroleum Facts and Figures* and EIA/DOE, 2006, *Annual Energy Review* updated from *Petroleum Navigator*, *http://tonto.eia.doe.gov/dnav/pet/pet_pri_allmg_d_nus_PTA_cpgal_m.htm*. Prices converted to real 2005 dollars using consumer price index from Department of Commerce *U. S. Historical Statistics Colonial Times to 1975* and Council of Economic Advisors, *Economic Report of the President 2006* updated from the Bureau of Labor Statistics, http://www.bls.gov/news.release/cpi.nr0.htm.

[2] The weighted average price was computed by multiplying each month's average price by the volume of gasoline supplied in that month, summing these products, and dividing the total by the total gasoline volume supplied in the first nine months of 2006.

Gasoline Prices and Other Commodity Prices

The run-up in gasoline prices is also not unique among commodities. Figure 4 shows the combined price for a range of industrial and agricultural commodities, not including petroleum products that make up the Commodity Research Bureau Commodity Price Index. This index rose sharply during 2002 to 2005 to surpass its previous peak of the early 1980s.

Figure 4: Commodity Price Index, 1956-November 2006.

Source: Reuters Commodity Research Bureau. http://www.crbtrader.com/crbindex/

The similar price increases experienced by non-petroleum commodities suggest that the recent trend in gasoline prices reflects a strong world economy, rather than specific actions by oil companies.

The next section will explain how price increases can theoretically result from market forces or the behavior of a group of companies with monopoly power.

III. Market or Monopoly? A Framework for Understanding Gasoline Prices

Economic theory provides several possible explanations for rising prices, including increasing demand, cost increases shifting supply, and market manipulation by a monopoly supplier or supplier group. These mechanisms are described in this section to provide a framework for reviewing the behavior of the gasoline market. A graphical analysis is presented in Appendix A.

Effect of Market Forces

Over the last decade, the number of consumers, drivers, and vehicles has increased and consumers have become richer. Their desire for larger cars and more driving have increased the demand for gasoline. In a competitive market, such a demand shift means that consumers want to buy more gasoline at any given price. This extra demand will pull gasoline prices higher. Higher prices will increase refinery profits and signal to refineries that they should increase their output.

On the supply side, refinery costs have increased due to higher input costs and increasing environmental regulation. Crude oil acquisition costs for U.S. refineries increased from $26 per barrel in January 2001 to almost $70 in August 2006. Under these circumstances, competitive refineries that are making a normal rate of return will need to charge a higher price for gasoline to remain in business. The higher prices will signal increasing scarcity to consumers. Thus, costs will push up prices and the market will allocate gasoline among consumers.

Since gasoline consumption is tied to vehicles that last more than a decade and gasoline production is tied to refineries that last many times longer, the short run responses to demand and supply changes are likely to be muted. If demand increases more than expected, driving up prices, refineries need time to ascertain whether the price increase is permanent and make plans to expand. Meanwhile prices may have to increase substantially to allocate the existing supply.

If gasoline prices increase because costs have increased, consumers need time to determine if the price change is permanent and make plans to reduce their consumption through less driving or purchasing more economical vehicles. Again, the price change may need to be quite large to allocate the existing supply. After a longer adjustment period, both consumers and refiners may invest in capacity or efficiency and the price increases will be moderated. The historical data presented in the previous section demonstrates that this pattern has occurred in the past.

Monopoly Behavior

In a monopoly, one producer or a group of producers is able to control the market by setting price or total output to earn higher profits than would be possible in a free market. In a monopoly, producers are able to set higher prices to yield maximum profits and also sustain these higher prices by restricting entry into the industry.

In the following section, we will explore recent price changes and show that rising supplier costs and increased consumer demand provide a better explanation than the assertion that monopolistic refineries are deliberately withholding capacity to drive up prices and increase profits.

IV. Demand Pull: Demand Factors Influencing Gasoline Prices, 1999-2006

The demand for gasoline is driven by a steady increase in population and the number of drivers overlaid with short-term fluctuations in GDP growth. During the years 2001 to 2006, GDP showed a positive trend that was not only greater than prior years, but was also stronger than expected, resulting in demand pressure on the gasoline market.

Demand and Expected Demand

The level of population and the number of licensed drivers have increased at an average 1.2% a year for the last decade in a relatively smooth and predictable way.[3] Aggregate income has also increased. Statistical studies find that for every 1% increase in income, gasoline consumption increases by about 0.3% in the first year and by even more when given a longer time to adjust. Unlike changes in population and licensed drivers, however, changes in income tend to be somewhat unpredictable.

Figure 5: U.S. Real GDP, 1959-2006

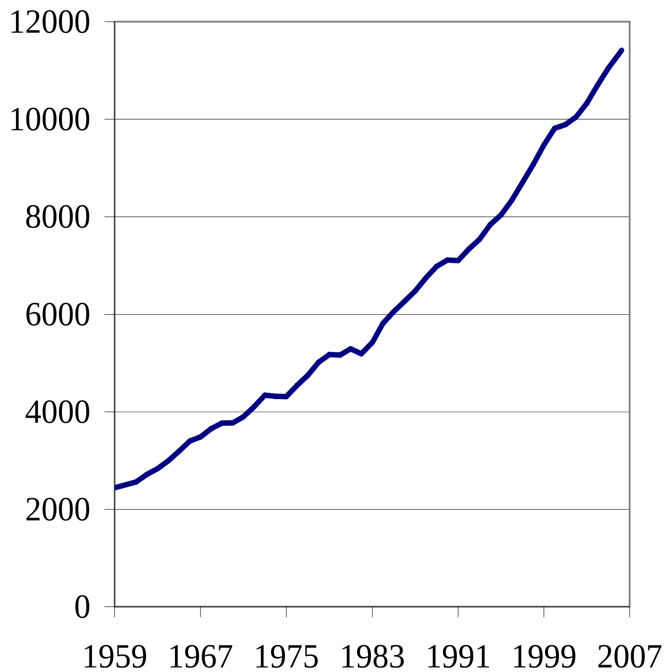


Figure 5 shows historical real U.S. gross domestic product (GDP) since 1959. Although the trend has generally been upward with an average growth rate of 3.4% per annum, it is also cyclical, with periodic booms and busts, shown by interruptions in the upward trend of the graph. Noteworthy are the high rates of growth in some years since 1999. Particularly unexpected were the 4% increase in 2004 and the 5.6% annualized growth rate in the first quarter of 2006, a rate that was well above the historical average and higher than in any year since 1984.[4] Appendix B describes how actual income growth rates differed from forecasts made by the Congressional Budget Office. Refinery managers using these forecasts would have planned for lower gasoline consumption than has actually occurred.

Source: Data from *Economic Report of the President* http://www.gpoaccess.gov/eop/ updated with data from Bureau of Economic Analysis http://www.bea.gov/

[3] See http://www.fhwa.dot.gov/policy/ohim/hs03/dl.htm.

[4] *Economic Report of the President* http://www.gpoaccess.gov/eop/ updated from U.S. Bureau of Economic Analysis, *Gross Domestic Product* http://www.bea.gov/bea/newsrel/gdpnewsrelease.htm.

Normal increases in the driving population and income have increased gasoline demand over time, pulling prices upward and signaling the need for more capacity. In recent years, however, unexpectedly high growth left domestic refineries unable to meet the level of actual demand. As will be seen in Section VIII, some of that shortfall was filled by gasoline exports from Europe, where substitution of diesel fuel for gasoline created a gasoline surplus. At the same time, increasing costs were pushing prices upwards. The next section will examine how costs—particularly for crude oil—strongly influence gasoline prices.

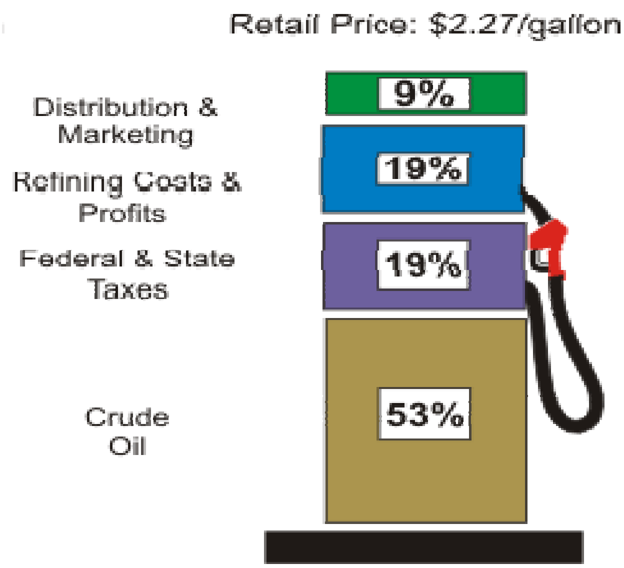
V. Supply Push: Supply Factors Influencing Gasoline Prices, 1999-2006

To produce and sell gasoline, requires a variety of inputs including crude oil, labor, electricity, catalysts, processing capacity, a normal rate of return on capital employed, product distribution, marketing and taxes. Figure 6 shows an approximate breakout of these costs in 2005, when refineries were paying about $50 per barrel for crude oil and receiving a $2.27 retail price for gasoline. Over half of the retail cost of each gallon of gasoline went to buy the crude oil needed to produce it.

Between 1999 and summer 2006, crude oil prices to U.S. refiners more than quadrupled, rising from $15.50 per barrel to more than $65 per barrel. In a competitive market, such increasing costs would be expected to shift the supply curve upwards and raise gasoline prices.

Tighter environmental regulations and other raw materials costs have also raised costs in gasoline refining, in turn bringing higher gasoline retail prices.

Figure 6: Components of Average Retail Gasoline Price, 2005

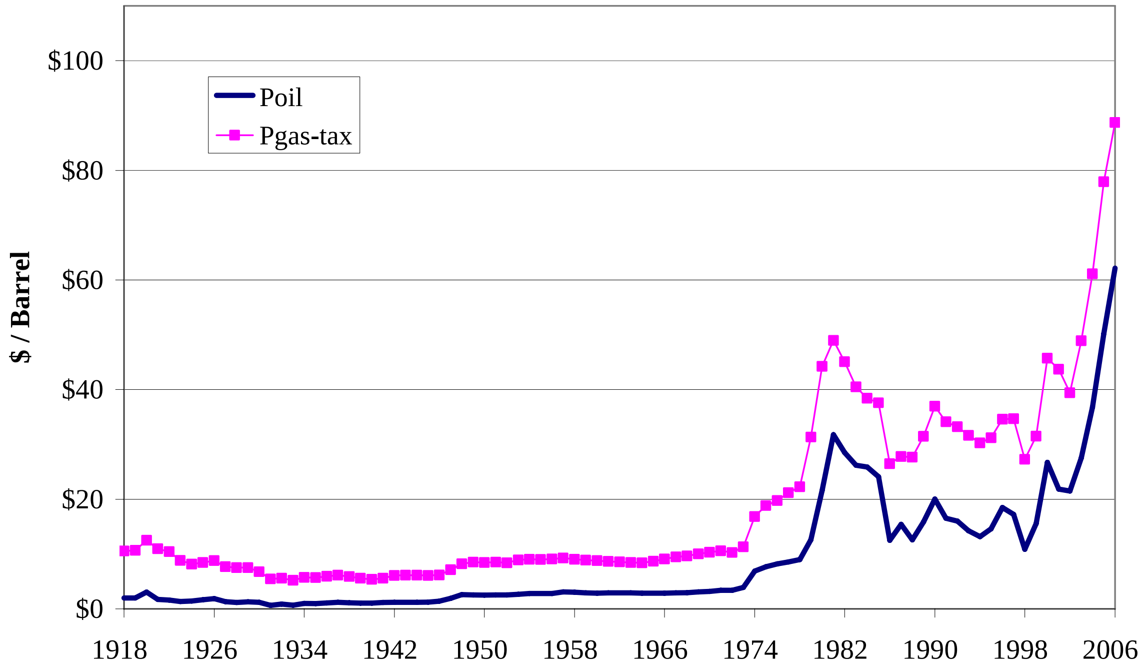


Source: EIA, “A Primer on Gasoline Prices,” http://www.eia.doe.gov/bookshelf/brochures/gasolinepricesprimer/eia1_2005primerM.html

The Relationship between Gasoline and Crude Oil Prices

Figure 7 shows how closely pre-tax gasoline prices have tracked average U.S. refinery acquisition costs for a barrel of crude oil since 1918.

Figure 7: Refinery Crude Oil Acquisition Price and Gasoline Price less Tax, 1918-2006, September

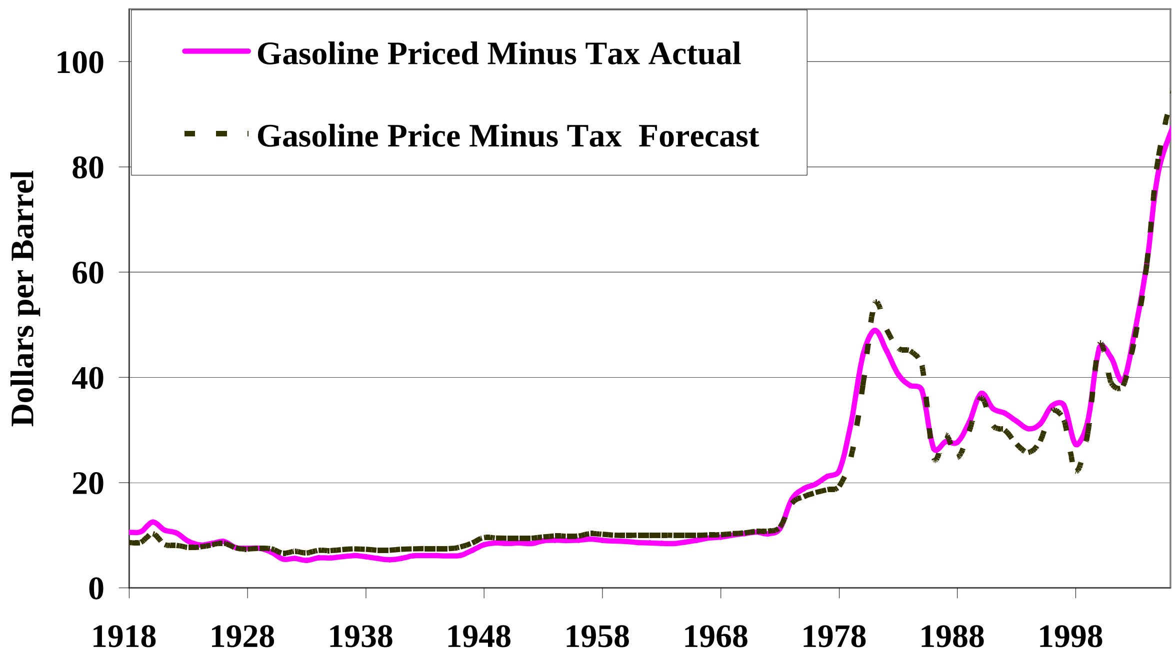


Notes: 2006 price is a weighted average through September; Poil values prior to 1947 are U.S. wellhead prices.

Sources: American Petroleum Institute *(API),* (1959), *Petroleum Facts and Figures,* (2005) *Petroleum Databook*, and EIA/DOE, *Monthly Energy Annual.*

Statistical analysis finds that the crude oil price explains about 97% of the variation in the pretax gasoline price over this time period and that each $1 per barrel increase in the crude oil price is accompanied by an increase in gasoline price of about 2.5 cents per gallon. The full regression analysis is shown in Appendix C. Figure 8 compares actual gasoline prices with the prices that are forecast with the regression equation, showing how closely the actual price matches the predicted price. Based on historical trends, gasoline prices should have been slightly higher in recent years than they actually were. While the price of crude oil more than tripled from 2002 to 2006, gasoline prices increased only 2.5 times.

Figure 8: Gasoline Price Less Tax, Actual and Predicted, 1918-2006



Notes: Prices in dollars per barrel (1 barrel=42 gallons). 2006 price is weighted average through September.

Source: Author's computations and data from the *American Petroleum Institute (API), 1959, Petroleum Facts and Figures, Petroleum Databook (2005) and* EIA/DOE *(2006&2007) Monthly Energy Review, January*.

Other Refining Costs

Crude oil is not the only raw material that refineries purchase to make gasoline. Other purchased items include electric power and various types of organic and inorganic chemicals. From 2000 to 2005, electric power costs increased about 20 percent, inorganic chemical costs about 25 percent, and organic chemical costs about 45 percent. [5]

[5] *API Petroleum Data Book*, "Nelson Refinery Operating Cost Indexes," Section VIII Table 9, updated with *Oil & Gas Journal*, 06/05/06: 53; Others: *Oil & Gas Journal*, 04/07/03: 6, *Oil & Gas Journal*, 04/03/06: 62.

Environmental Costs

Since the first Federal Clean Air Law in 1955, U.S. citizens have increasingly desired a cleaner environment, and environmental protection laws have become increasingly stringent. Table 1, shows new fuel regulations that affected the gasoline refining sector between 1989 and 2005.

Table 1: Environmental Regulations Affecting Product Quality of U.S. Motor Gasoline

Phase 1 Summer Volatility (RVP) Regulation	June 1989
Phase 2 Summer Volatility (RVP) Regulation	May 1992
Oxygenated Gasoline	November 1992
Reformulated Gasoline Phase 1	December 1994
Reformulated Gasoline Phase 2	January 2000
Low Sulfur Gasoline (30 ppm)	January 2005

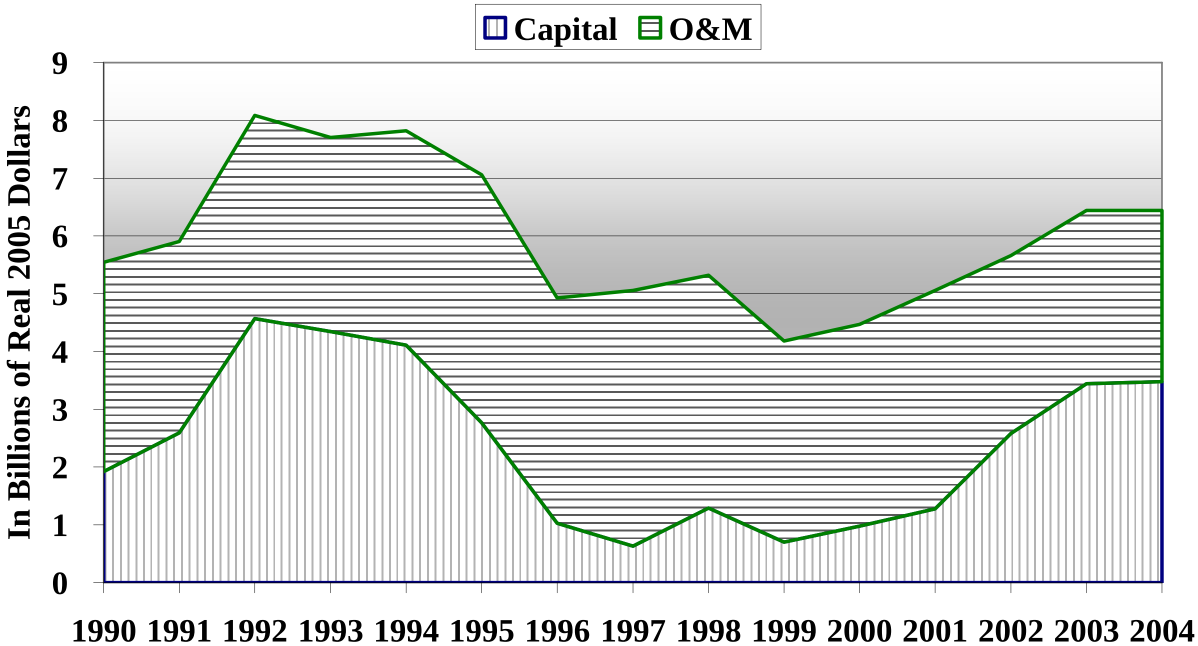
Source: Table 2: U.S. EIA/DOE, *MTBE, Oxygenates, and Motor Gasoline* http://www.eia.doe.gov/emeu/steo/pub/special/mtbe.html#Federal%20gasoline%20product%20quality%20regulations, U.S. EIA DOE, Timing of Startups of the Low-Sulfur and RFS Programs http://www.eia.doe.gov/oiaf/servicerpt/fuel/lows.html

Various estimates have been made of the cost to the industry to comply with these regulations. Figure 9 shows industry estimates of these costs from 1990 to 2004. Capital expenditures tripled from 2001 to 2004, reaching about $3.2 billion in 2004, and raising total environmental costs to over $6 billion dollars in that year. These costs equate to a capital cost of about 2 cents per gallon and a total cost of about 3 cents per gallon of refined product produced. The EPA estimated that its Low Sulfur Gasoline regulation alone added between 4.5 and 5 cents to the cost of each gallon of gasoline.[6] Based on the additional regulations introduced since 2004, environmental compliance costs are believed to be even higher in 2005 and 2006. The ultra-low sulfur diesel standards being phased in as of June 1, 2006 are estimated to have cost the industry another estimated $8 billion for on-road and $1 billion for off-road fuels compliance.[7]

[6] http://www.clean-fuel.org.

[7] See Appendix D for a table containing by country sulfur reduction standards and date of inception.

Figure 9: U.S. Real Environmental Expenditures in Refining, 1990-2004 (2005 Dollars)



Source: API (2006) *Petroleum Data Book,* "Estimated U.S. Petroleum Industry Environmental Expenditures: 1990-2003," Section XV, Table 11 updated by http://www.api.org/statistics/accessapi/surveys/upload/EES_1995_2004.pdf

In addition to adding investment costs, tighter environmental regulations effectively reduce available refining capacity by reducing throughput and even causing the closure of refineries that cannot comply. Small refineries, in particular, have been challenged to meet new fuel standards.[8]

When gasoline was first reformulated to comply with new emissions standards, refiners used Methyl Tertiary Butyl Ether (MTBE) as an oxygenate to raise octane and provide cleaner burning. Possible water contamination risks from MTBE led 19 states to impose partial or total bans by May 2004.[9] In May 2006, the Federal government, operating under EPACT 2005, eliminated the oxygen requirement in gasoline but not the liability for using MTBE, most refiners responded by eliminating the use of MTBE in gasoline. The Federal government's renewable fuels standard led to increased use of ethanol as an oxygenate. This had the effect of increasing costs and tightening gasoline supplies through several mechanisms:

- By increasing the demand for ethanol and its price. Figure 10 shows the substantial increase in ethanol prices in 2005 and 2006.

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[8] Thomson and McCarthy (1999) maintained that the PADD IV region would be hardest pressed to comply with low sulfur requirements because most of its refineries are small. The Secretary of the South Dakota Department of Environment and Natural Resources testified before a Senate subcommittee that the uniform nationwide low-sulfur gasoline standards would lead to refinery closures that would raise gasoline prices and cost South Dakota inhabitants millions of dollars. She noted that when the 30 ppm sulfur standard was introduced in California, five small refineries ceased gasoline production, even after receiving an extension of two years for compliance. (Myers, 1999).

[9] A table of state actions banning MTBE is provided in Appendix E.

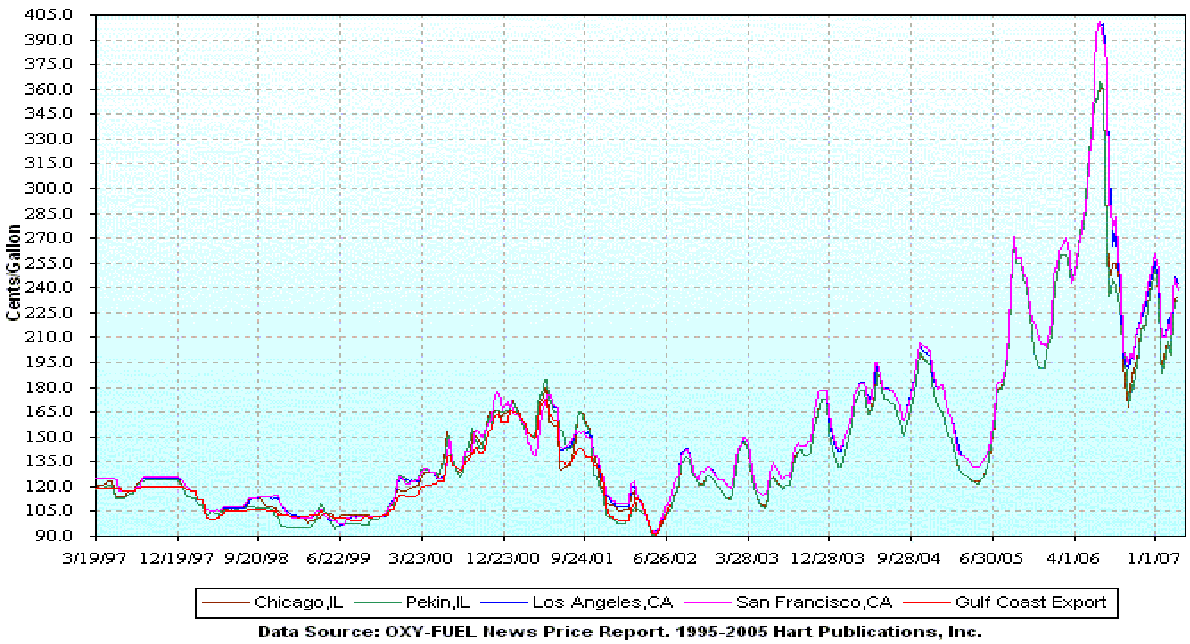
- By requiring companies to invest to reconfigure their refineries to compensate for ethanol's higher vapor pressure and distillation temperatures[10]
- By reducing production capacity by 5-6% in summer months to accommodate the different character of ethanol. In California, where regulations are more stringent, the effective summer capacity loss is even greater.
- By increasing gasoline transportation costs because ethanol blends must be segregated from non-ethanol blends[11]
- By delaying investment expenditures by refiners due to uncertainty about new regulations[12]

[10] See U.S. EIA/DOE (2002) *Supply Impacts of an MTBE Ban*, September 2002 prepared by the Office of Oil and Gas of the Energy Information Administration for more information on these refinery differences. http://tonto.eia.doe.gov/FTPROOT/service/question1.pdf.

[11] EIA, *This Week in Petroleum*, 01/05/2006, http://tonto.eia.doe.gov/oog/info/twip/twiparch/060105/twipprint.html.

[12] U.S. EIA/DOE (2002) notes that "regulatory uncertainties will provide strong disincentives for both the domestic industry and many foreign import refiners to make many speculative investments in advance of the transition out of MTBE."

Figure 10: Fuel Ethanol Terminal Market Price, 1996-2006

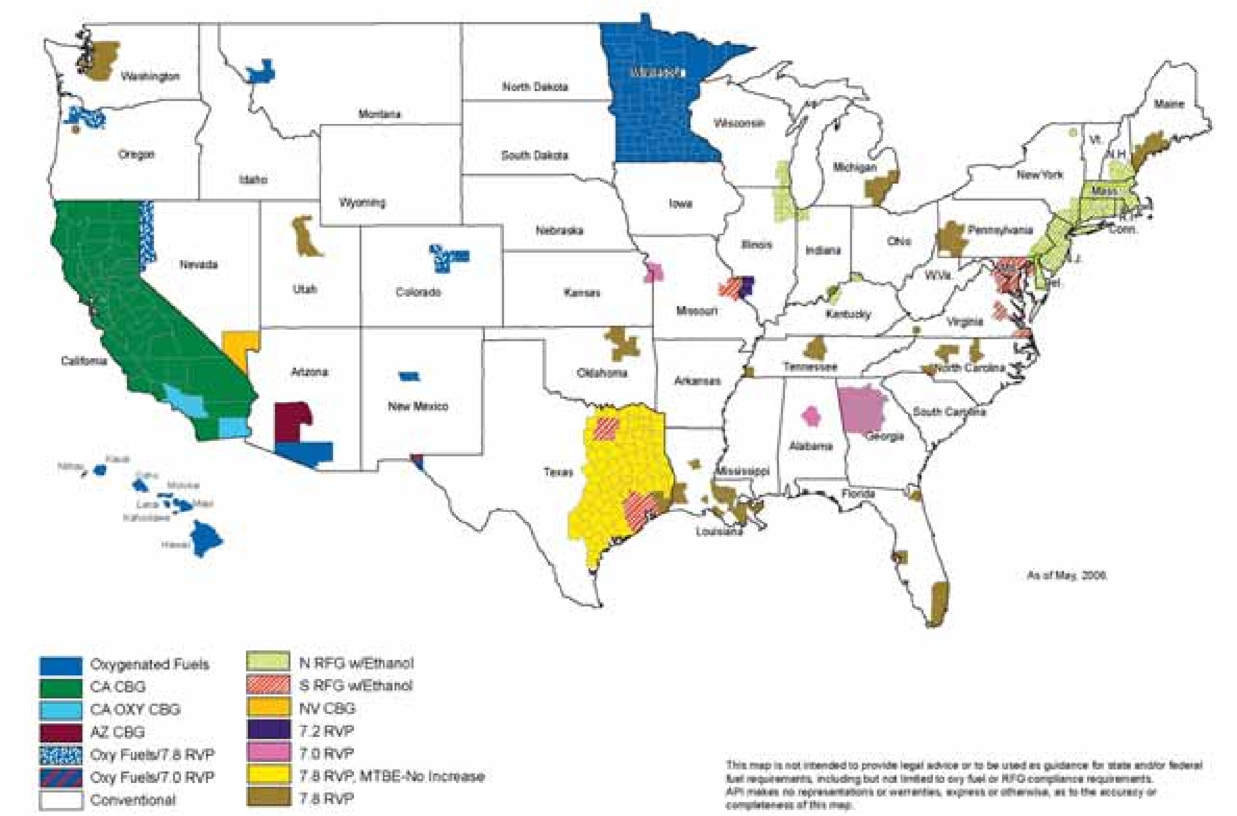


Source: California Energy Commission http://www.energy.ca.gov/gasoline/graphs/ethanol 10-year.html

Tighter environmental controls have also brought a proliferation of fuel types. Some states, and even localities, have created their own fuel standards, sometimes dubbed "boutique fuels," so that the number of gasoline grades increased from three in 1990 to more than 10 in 2006. Figure 11 illustrates the array of gasoline requirements in different parts of the country.[13] As products proliferate, refiners can no longer produce the same volumes of gasoline, effectively lowering the supply. The variations in standards between regions also make it harder to divert gasoline from a surplus market to a shortage market, with resulting increases in price volatility.

[13] Appendix F lists the standards for each state.

Figure 11: U.S. Gasoline Requirements



Source: American Petroleum Institute.

VI. Normal or Not? Refining Industry Profits

Higher oil prices have brought an era of higher oil company profits, causing some media and policymakers to ask whether these profits are excessive. The CFA (Cooper, 2006) asserts that refining profits increased 25-fold from 2001 through 2005 and that these profits are far in excess of refining profits in overseas markets. This section investigates this assertion by reviewing recent refining sector profitability in the light of historical profits and profit margins.

The analysis is based on information provided to the U.S. Energy Information Agency (EIA) by a set of large U.S. oil companies that have been required to report financial information since 1977 on form EIA28.[14] In 2005, 29 large companies participated in this Financial Reporting system (FRS). A list of FRS companies is provided in Appendix G, Table G.1. In 2005, the FRS companies owned about 81% of U.S. refining capacity, held around 80% of their assets in petroleum, and made over 80% of their new investments in petroleum operations.

The section also considers trade flows and refinery margins in different regions to determine whether arbitrage is taking place to eliminate unusual profits where they occur, as would be expected in an open market.

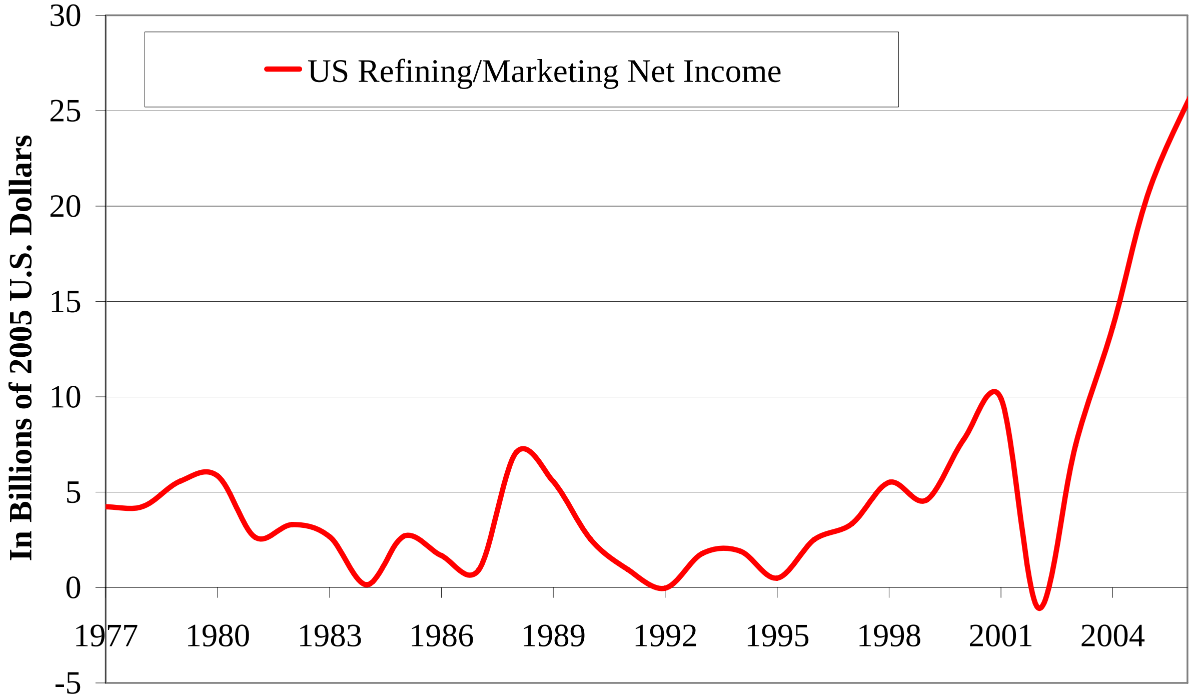
Refining Profits

Figure 12 shows the real net income FRS companies earned in their U.S. refining and marketing operations from 1977 through the first three quarters of 2006.[15]

[14] The Financial Reporting System Public Data http://www.eia.doe.gov/emeu/finance/frsdata.html.

[15] Net income is equivalent to revenues minus costs and taxes. Since figures for 2006 are not yet available, the series was estimated for 2006 as follows. Quarterly data for a subset of 18 companies were obtained from EIA/DOE Selected Financial and Operating Data for a Consistent Set of Major Energy Companies, First Quarter 2001 through Third Quarter 2006. Non-traceable costs were allocated across the four sectors by prorating them with net income. Net income for the 29 FRS companies was assumed to increase at the same annual rate as for the 18 companies included in the EIA/DOE quarterly data. Net income for 2006 was estimated by annualizing the growth in the first three quarters. This method probably overstates the figure for 2006 as prices and consumption fell in the fourth quarter.

Figure 12: Real Net Income from U.S. Refining/Marketing of FRS Companies, 1977-2006: III



Notes: See Footnote 14 for estimation methods used to compute 2006.

Source: Computed from values in http://www.eia.doe.gov/emeu/finance/frsdata.html updated using data in http://www.eia.doe.gov/emeu/perfpro/news_m/consistent.html. The FRS companies are listed in Appendix G.

Over almost two decades, the combined real net refining income for these companies averaged slightly over $5 billion annually. The significant changes in income from year to year tell the story of the industry over the last quarter century. Real income declined from 1978 to 1984, when capacity utilization was low following substantial price increases. Utilization improved from 1984 to 1988, causing income to fluctuate upward, only to fall again from 1988 to 1992, with loses reported in 1992. From 1992 to 2001, profits generally rose as restructuring and cost cutting aimed at returning the industry to profitability. In 2001, profits finally exceeded their historical average. Note that some of the profit increase in 1998 came from the addition of 11 new companies to the FRS group.

Peterson and Mahnovski (2003) found that the refining industry viewed the early 1990s as a time of hardship with low capacity utilization, high environmental compliance costs, and low margins. As a result, in the second half of the decade, the industry undertook massive restructuring aimed at cutting costs, increasing economies of scale and improving profit margins. At the same time, the vertically integrated majors were spinning off their refining operations, increasing the number of players in the industry. Refining capacity operated by independents more than tripled from 8% in 1990 to over 25% in 2006[16]. Returning the industry to profitability was especially important for the increasing numbers of independent refiners such as Valero, who did not have producing operations whose earnings could offset low profitability in refining. Refiners viewed the increase in utilization rates in the second half of the 1990s as a significant accomplishment that made refining once again a viable industry.

After September 2001, U.S. economic growth faltered and refinery product sales fell slightly in 2002.[17] Refinery utilization and profit margins fell, causing net income to fall precipitously to the largest loss in over 30 years. By 2003, however, refiner profits had risen above their historical average and regained their 2000 level. In 2004, unexpectedly high U.S. economic growth drove profits to a record high level. Hurricane Katrina, in August 2005, shut down oil production and pipelines and damaged ports and refineries so that by the end of August 11% of U.S. refining capacity was shut down and 17% was operating at reduced capacity. This temporary disruption brought higher net income: the year-on-year net income increase in the second half of 2005 was over 50%, compared with less than 12% in the first half of the year.

In the first half of 2006, U.S. gross domestic product growth was the highest in 22 years, and real refining net income rose 30% from the first half of 2005.[18] Some refineries that had delayed maintenance after the 2005 hurricanes were down in the spring. Refineries were phasing out MTBE and phasing in ultra-low-sulfur-diesel—all of which made refining capacity tight and drove prices higher. These pressures were apparently alleviated with the end of the 2006 summer driving season.

Although the refiners' profit picture since 2002 has been strong, it has sometimes been exaggerated. The Consumer Federation of America asserts that net income from domestic refining increased 25 times from $1 billion in 2001 to $25 billion in 2005.[19] In fact, according to the EIA data, the FRS companies' nominal net income from U.S. refining and marketing less than doubled over this period, from $12 billion to around $20 billion.

Domestic and Foreign Refining Profits

Another argument that has been made to "prove" that domestic refiners earn excessive profits is that the companies make substantially lower profits in overseas markets. Figure 13 compares net income in domestic refining with net income in foreign refining, again using the FRS data.

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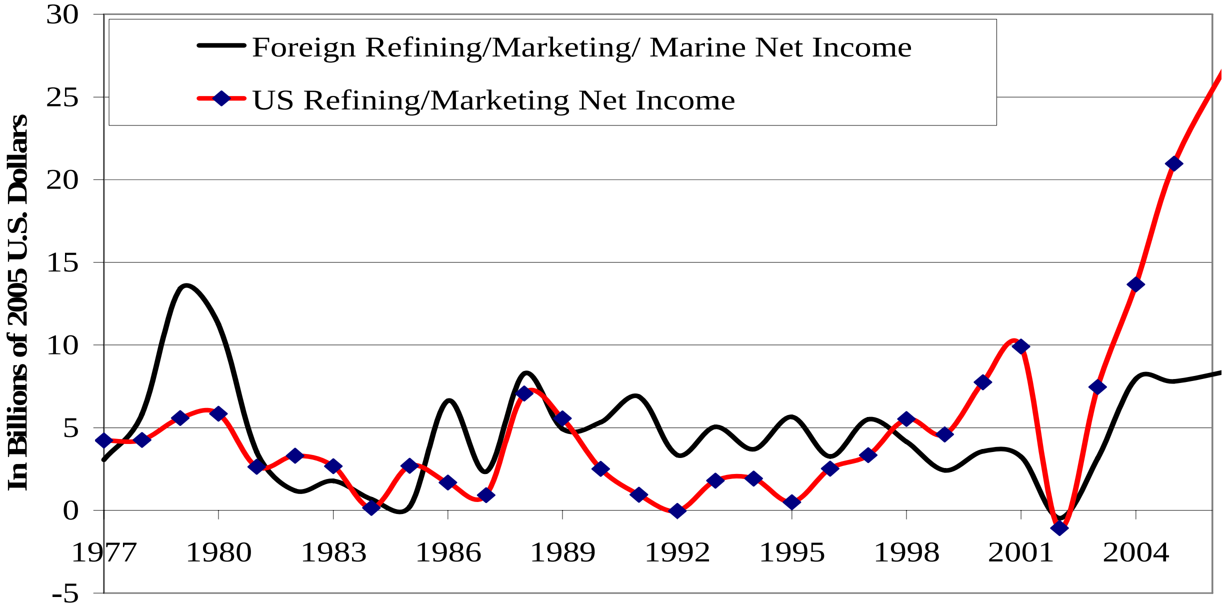
[16] U.S. FTC 2004 and 2006 Computed from Oil and Gas Journal 12/18/2006: 58 and EIA.

[17] EIA/DOE *Annual Energy Review,* 2005.

[18] http://www.eia.doe.gov/emeu/perfpro/news_m/consistent.html.

[19] Cooper (2006), p.1.

Figure 13: Real Net Income of FRS Companies from U.S. Refining/Marketing and Foreign Refining/Marketing/Marine, 1977-2006: III



Notes: See footnote 14 for estimation methods used to compute 2006.

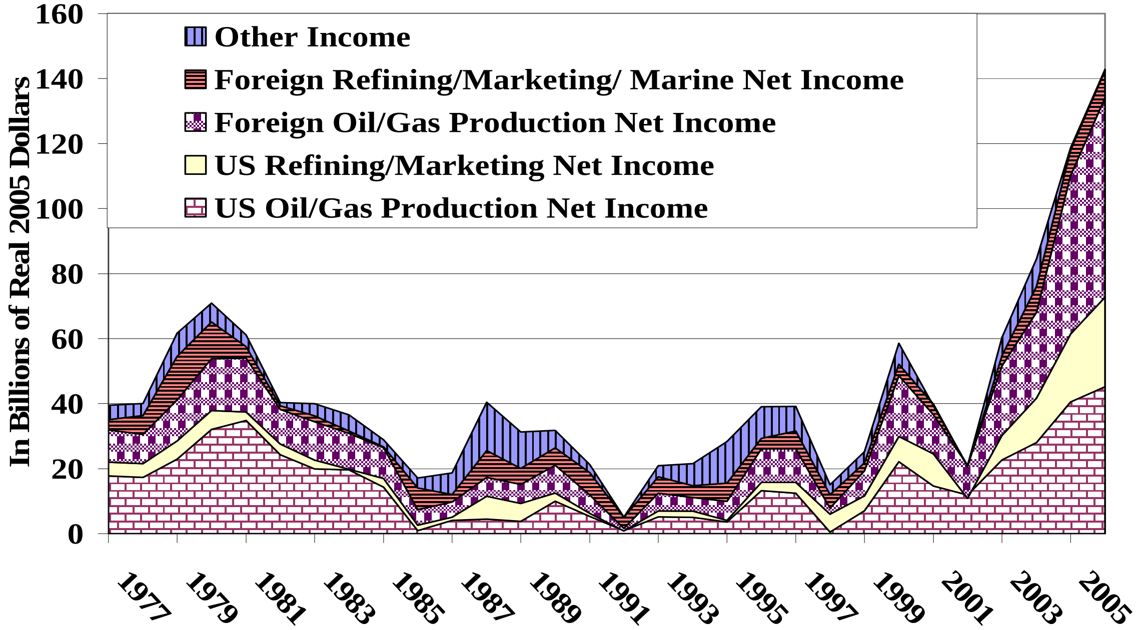
Source: Computed from values in http://www.eia.doe.gov/emeu/finance/frsdata.html update using data in http://www.eia.doe.gov/emeu/perfpro/news_m/consistent.html. The FRS companies are listed in Appendix G.

The profits the FRS companies earned from their domestic and foreign refining operations are roughly comparable. On average between 1977 and 2005, the companies earned a combined $4.7 billion annually from their overseas refining operations, about 10% less than from domestic operations. In most cases, but not always, the cyclical peaks and troughs in the profits of domestic and foreign operations coincide, but domestic income was more volatile than income from overseas refining. Foreign refining enjoyed a large profit spike in 1979. Both were depressed in the early 1980s. Foreign refining did not experience the depression in the 1990s, which lasted domestically until 2001. Both saw the big dip in 2002 as the world economy slowed. With the high economic growth in 2004, U.S. profits surpassed their previous record 2001 level, and foreign refinery profits were more than double their 2001 rate. Foreign refineries saw lower profit increases in 2005 and 2006, when they had lower utilization rates and did not experience the temporary disruptions of hurricanes and the switch out of MTBE.

Refining Profits and Production Profits

While refining profits have been high in recent years, they are dwarfed by the profits FRS companies earn from oil and gas production. Figure 14 shows the FRS companies' net income by sector.

Figure 14: Real Net Income of FRS Companies by Sector, 1977-2006 III



Notes: 2006 figures are first three quarters annualized. See footnote 14 for computations.

Sources: Computed from values in http://www.eia.doe.gov/emeu/finance/frsdata.html updates computed using data in http://www.eia.doe.gov/emeu/perfpro/news_m/consistent.html. The FRS companies are listed in Appendix G.

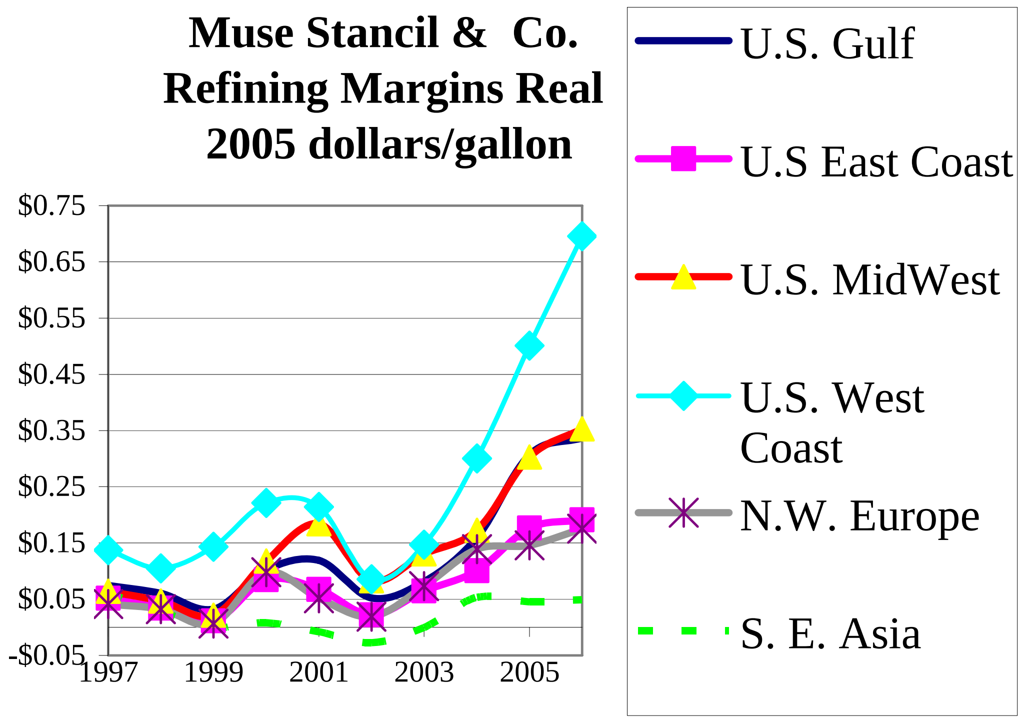
Since 1977, FRS companies have averaged about $15.5 billion in annual profits from domestic production, and slightly more in the foreign production sector. Profits from production have been about three times higher than from refining and have essentially driven total company profitability.

Refining Margins

The major driver of profits from refining is refining margins, the spread refineries earn on each barrel of refined petroleum. Figure 15 shows these data for four U.S. locations and two overseas locations since 1997, when Muse Stancil & Co. began calculating these refining margins.[20]

[20] The calculation is based on product revenues minus feedstock cost minus fixed and variable costs.

Figure 15: Refining Margins for Selected U.S. and Overseas Locations, 1997-June 2006, 2005 Dollars



Note: 2006 is YTD through June.

Source: *Oil & Gas Journal* 07/17/06, 01/13/03, 01/15/01.

Margins tend to show the same general pattern across regions except for South East Asia. They dipped in 1999, recovered in 2001, dipped in 2002 and recovered through 2005. California with its special suite of transport fuels and tighter environmental regulations[21] has had higher margins and larger margin swings than elsewhere. The claim that refinery profitability is lower overseas is true of S.E. Asia, which has less sophisticated refineries that are distant from the U.S. market.[22] But in N.W. Europe, margins very closely track those on the U.S. East Coast.

Economic theory suggests that in a free global market arbitrage should harmonize refining margins between regions, although they would differ by transport costs. Arbitrage seems to be working well between the U.S. Gulf and the Midwest, markets that are well connected by pipelines and have the largest gasoline flows between any of the five Federal Petroleum Administrative Defense Districts (PADD).[23] Arbitrage also seems to be effective between the East Coast and northwestern Europe, with average deviations of only a few cents. As shown in

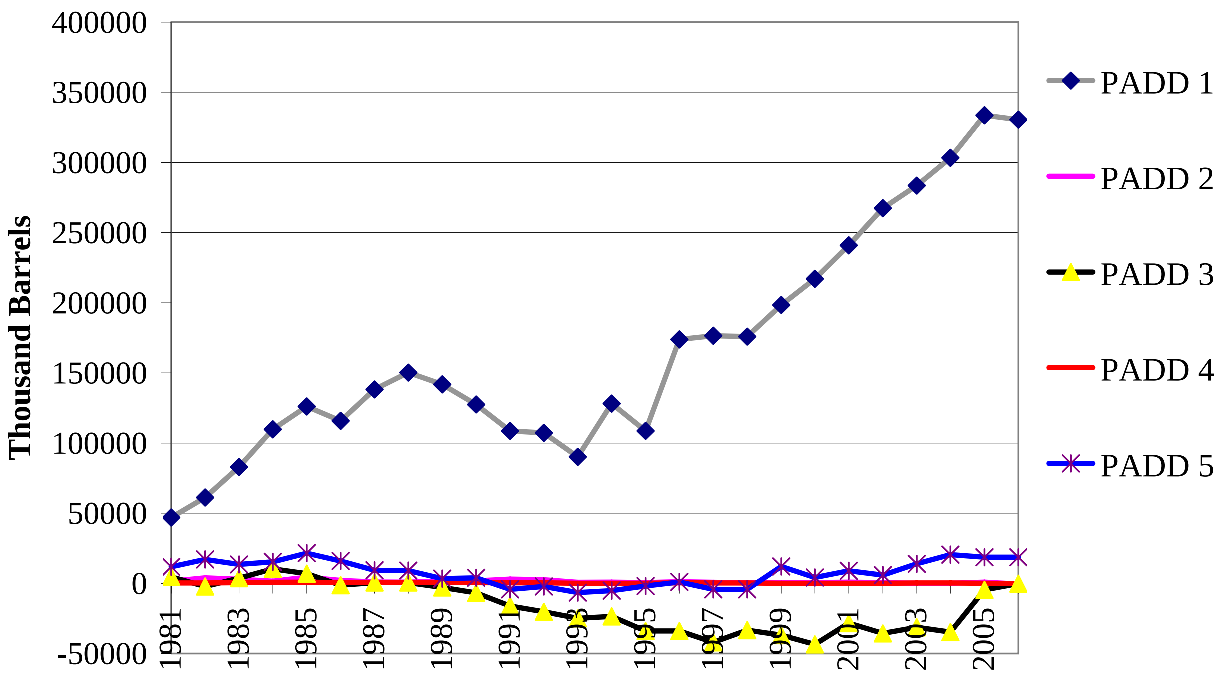
[21] See Appendix H for a table comparing California and U. S. federal regulations.

[22] See Appendix I for comparison of Asian and U. S. refineries by process units.

[23] http://tonto.eia.doe.gov/dnav/pet/pet_move_ptb_dc_R20-R10_mbbl_m.htm. A map of the PAD Districts is provided in Appendix J.

Figure 16, arbitrage has drawn increasing imports into the U.S. East Coast (PADD I). The slight dip in imports in PADD I in 2006 is probably due to the phase-out of MTBE.

Figure 16: Net Annual Gasoline and Blending Stock Imports by PADD, 1981-2006



Note: 2006 is net imports through September annualized

Source: U.S. EIA/DOE *Petroleum Navigator* http://tonto.eia.doe.gov/dnav/pet/pet_move_imp_dc_NUS-Z00_mbbl_m.htm

More puzzling at first is the consistent spread between refining margins on the West Coast and Asia. The average difference in these refinery margins has been $0.16, and this spread widened dramatically after 2003, reaching $0.70 in the first half of 2006. This persistent and increasing gap can be explained by two barriers to arbitrage between Asia and the West Coast: geography and environmental regulations. The distance from Singapore to Los Angeles is almost twice the distance from Rotterdam to New York, creating a lead-time of four or five weeks to export refined products across the Pacific.[24] More importantly, California has been at the forefront of pollution control regulations and has the most stringent gasoline standards in the U.S., severely limiting the ability of Asian refineries to sell their products in California. Appendices H and I compare the evolution of California regulations and U.S. Federal regulations since 1960 and discuss technical refining issues that limit Pacific arbitrage.

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[24] At 15 knots, it takes a tanker around three weeks in transit, plus another week or two of estimated lead-time. See EIA/DOE (2003) "California Gasoline Price Study: Preliminary Findings."

In conclusion, although refining profits are currently high, they have increased much less than has been asserted by CFA, and are far lower than profits in both the domestic and foreign oil and gas producing sectors. The current higher profits follow a decade when refining was acutely depressed. Although the restructuring and cost-cutting of the 1990s returned domestic refining to viability, they did not create sufficient market power to protect the industry from the market downturn of 2002 when refining losses were the largest in the history of FRS reporting.

Beginning in 2004, exceptional U.S. income growth and capacity constraints induced by hurricanes and uncertainties in environmental regulations allowed refineries to push their equipment to its limits to increase output. Even so, supply was insufficient to satisfy the market's thirst for clean summer fuels, causing prices to rise in order to allocate the limited available capacity. These price increases produced exceptional profits in U.S. refining.

Trade with Europe and Asia allows foreign producers to arbitrage exceptionally high U.S. prices, a fact confirmed by the similar refining margins earned on the East Coast and in northwestern Europe. Asian refiners have made inroads in markets for conventional gasoline and blending stocks outside California, but have been prevented from profiting from high West Coast prices by differences in product standards.

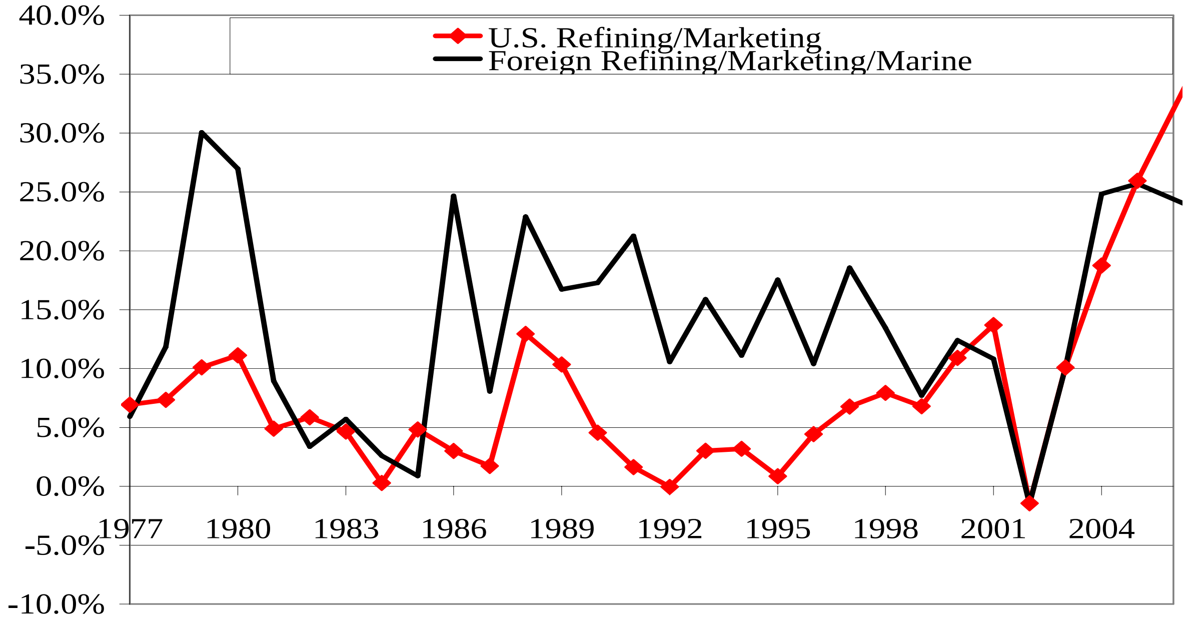
VII. Expected or Excessive? Rates of Return in Refining

The data presented in the last section showed that profits in the domestic refining industry were high in 2005 and 2006 compared to historical levels. This section will consider how these profits translate into rates of return on investment and how the return on investment in refining has compared over time with returns in other petroleum and non-petroleum sectors. It will be seen that, even after these few years of strong profitability, the long-term average return on investment has been significantly lower in refining than in durable goods manufacturing.

Returns on Investment in U.S. and Foreign Refining

The rates of return on fixed investment (ROI) in U.S. and foreign refining were calculated as the ratio between net income and property, plant, and equipment (PP&E), or non-current assets, using data reported to the Financial Reporting System.[25] Figure 17 shows the ROI for U.S. and foreign refining from 1977 to 2006.

Figure 17: Return on Investment from Refining for Financial Reporting System Companies, 1977-2006: III



Note: 2006 ROI is for first three quarters.

Sources: Computed from values in http://www.eia.doe.gov/emeu/finance/frsdata.html updated using data in http://www.eia.doe.gov/emeu/perfpro/news_m/consistent.html. The FRS companies are listed in Appendix G.

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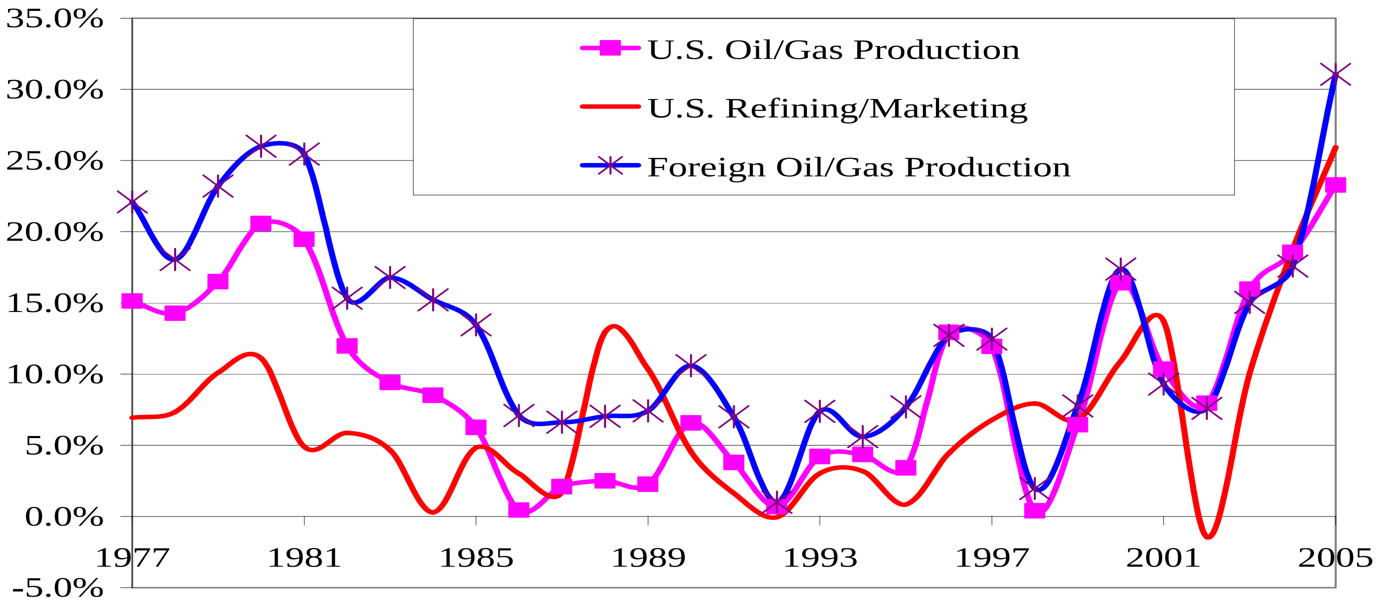
[25] Since published data were available only to 2005, a regression of return on fixed investment (ROI) on net income for 1977 to 2005 was used to estimate ROI for 2006. Results of this regression, which explains 95% of U.S. refining ROI, are shown in Appendix K.

The ROI in domestic refining and marketing reached a peak of over 10% in 1980, followed by very low returns from 1981 to 1987, a strong year in 1989, the challenges of the early 1990s and the climb back to profitability by 2001, followed by the plunge into losses in 2002 and rebound to record high returns. On average, over the twenty-eight-year period from 1977 to 2005, the return on investment in U.S. domestic refining was less than 7%. Adding the 2006 numbers, which were estimated by annualizing date for the first three quarters, adds one percentage point to this return.

Figure 17 also shows that domestic refining has earned a consistently lower ROI than foreign refining, with higher returns in only three years between 1977 and 2002. Only in 2006 did U.S. domestic refining returns surpass the foreign high ROI of 30% earned in 1980. Over the whole period, the ROI FRS companies earned from foreign refining averaged over 13%, almost double that for domestic refining.

Figure 18 compares the return in domestic refining/marketing with the returns in domestic and foreign production.

Figure 18: Return on Investment in Refining and Production for Financial Reporting System Companies, 1977-2005

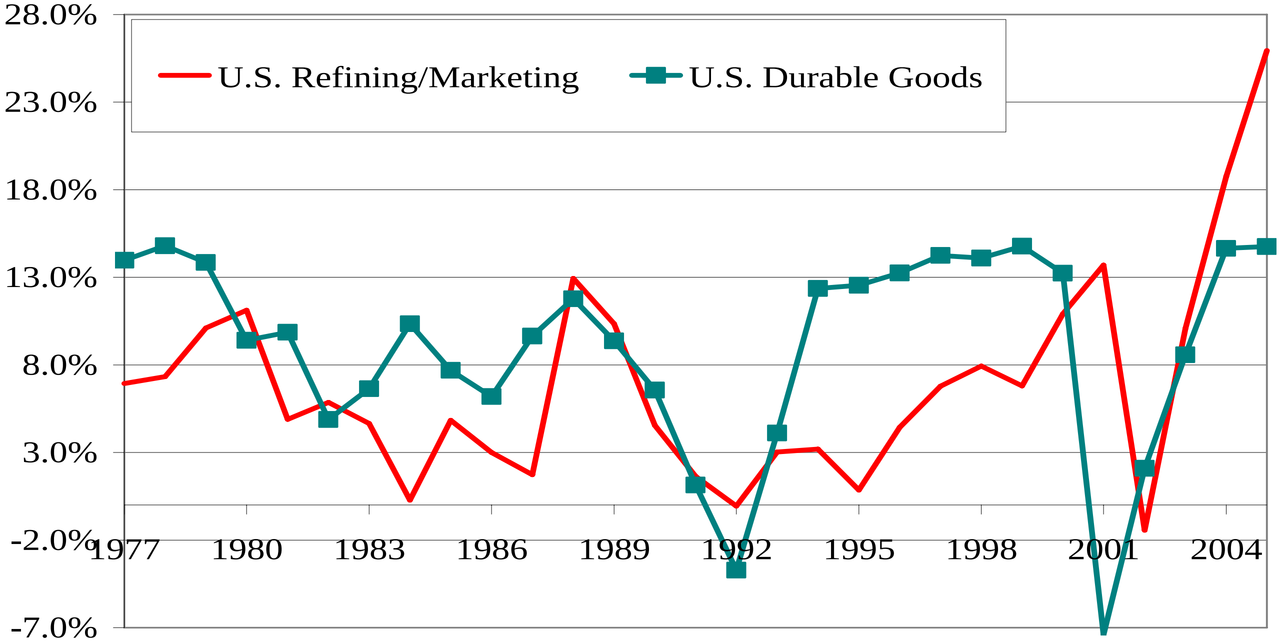


Source: Computed from values in http://www.eia.doe.gov/emeu/finance/frsdata.html. The FRS companies are listed in Appendix G.

The graph shows that, while the rates of return in all sectors are highly variable, domestic refining had the lowest rate of return, averaging less than 7% from 1977-2005, compared with 9.5% for domestic production, 13% for foreign production, and 13.5% in foreign refining/marketing/marine (shown in Figure 17). Through 2004, domestic refining/marketing was the sector with the lowest average rate of return and the lowest volatility (as measured by the standard deviation). If 2005 and 2006 are included, refining/marketing still had the lowest ROI, but it also had the highest volatility.

Figure 19 compares the ROI in U.S. refining with the ROI in the U.S. durable goods industry. The durable goods industry was chosen for a comparison because it is a capital-intensive industry that does not include petroleum, and data were available through 2005.[26]

Figure 19: ROI for U.S. Refining and Durable Goods, 1977-2005



Notes: Accounting changes in the durable goods industry in 1992 and 2001 make these years less reliable.

Source: Computed from values in http://www.eia.doe.gov/emeu/finance/frsdata.html updates for FRS refining/marketing computed using regression analysis and data in http://www.eia.doe.gov/emeu/perfpro/news_m/consistent.html. The FRS companies included are given in Appendix D. Durable goods numbers come from Bureau of Economic Analysis: Current Cost of Net stock of Private Fixed assets located at http://www.bea.gov/bea/dn/FA2004/TableView.asp#Mid, *Economic Report of the President*: Corporate Profits by Industry 1965-2005 table B-92/table B-93 located at http://www.gpoaccess.gov/eop/tables06.html, Bureau of Economic Analysis Table 3.7ES. Historical-Cost Investment in Private Fixed Assets by Industry located at http://www.bea.gov/bea/dn/FA2004/TableView.asp#Mid.

Over the twenty-eight-year period from 1977 to 2005, the U.S. durable goods industry earned a 9% average ROI, compared with 7% in refining, while at the same time having a lower variability in rates of return.[27] After the 1992 recession, refining struggled to return to historical

[26] Note that significant accounting changes in 1992 and 2001 makes data for these years inconsistent with prior years. Evidence suggests that losses for 1992 are overstated, so that the average ROI for durable goods was probably greater than 9%.

ROI levels, while durable goods rebounded much more quickly with a steep rise to 1994. Even in 2001, after a decade of cost-cutting, consolidation, and restructuring, U.S. refining had still not caught up with the peak rates of return being earned in U.S. durable goods. Durable goods returns fell dramatically in 2001 and refining followed in 2002. Only since 2004 has a strong market provided returns in U.S. refining and marketing that exceed the recent highs earned in the durable goods industry.

VIII. If You Build It Will They Pay? Refining Industry Investments in Capacity

Since 1994, U.S. gasoline demand has increased at an average 1.6% per year, while domestic refinery output has increased at an average 1.3%.[28] Some critics argue that U.S. companies have deliberately reduced investment in refining to tighten supply and earn the higher profits shown in the preceding sections. This section reviews the available data on capital expenditures by FRS companies. Changes in the level of investment, as in the durable goods sector as a whole, are found to be more muted than changes in income and to lag those changes by one to three years. After the review of capital expenditure, for which limited data are available, the section will consider changes in refinery capacity and capacity utilization, for which longer series exist.

Capital Investments

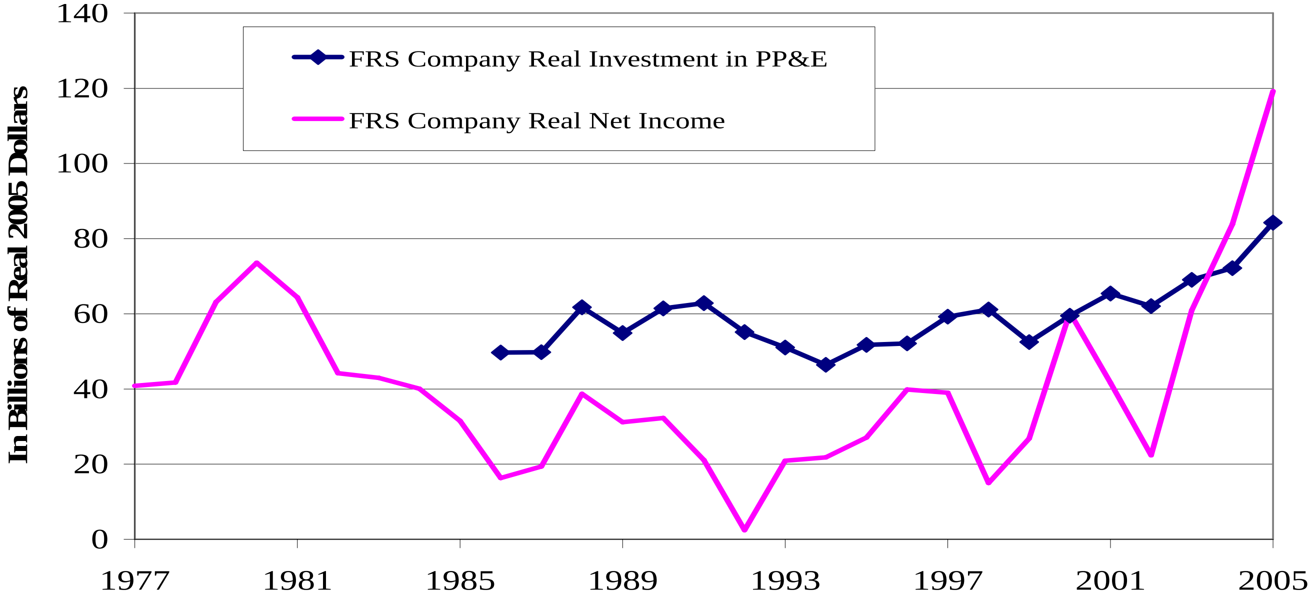
Figure 20 shows the history of domestic and foreign investments in petroleum industry property, plant, and equipment (PP&E) by FRS companies.[29]

[27] The standard deviation in the ROI for durable goods was less than 6%; for U.S. refining/marketing it was greater than 6%.

[28] EIA/DOE Annual Energy Review, http://tonto.eia.doe.gov/dnav/pet/pet_cons_psup_dc_nus_mbbl_m.htm.

[29] FRS investment data is available through 2005 only. Since 1986, the reports have not broken out Property, Plant, and Equipment acquired through acquisitions and mergers, instead providing only aggregate data. Accordingly, this analysis reviews total company investment in PP&E without mergers and acquisitions.

Figure 20: Net Income and Investment by Financial Reporting System Companies in Property, Plant & Equipment, 1977-2005, 2005 Dollars



Note: Investment in PP&E taken from cash flows and excludes acquisitions and mergers.

Source: EIA/DOE http://www.eia.doe.gov/emeu/finance/frsdata.html The FRS companies are listed in Appendix G.

Between 1986 and 2005, annual real investment in property, plant, and equipment (excluding acquisitions) averaged about $59 billion, while real net income averaged $37 billion. Investment varied much less than income from year to year and also tended to lag income. Statistical analysis of the relationship between changes in income and changes in capital expenditure finds that, while changes in income are accompanied by some change in investment in the same year, more of the change in investment occurs in the following two years.[30] Thus, strong income in 1988 was followed by increasing investment in 1990 through 1991 and the collapse of net income in 1992 was followed by declining investment through 1995. The peak income in 1996 was followed by increasing investment in 1998 and the dip in income in 1998 was followed by a dip in investment in 2000.

Current capital investment trends follow the same pattern: investment is up, but by less than income. FRS figures show that worldwide total investment in refining and marketing increased 12% in 2005 compared with 2004. The *Oil and Gas Journal* reported[31] that real U.S. capital expenditures in refining increased by 7% from 2005 to 2006. The National Petrochemical and

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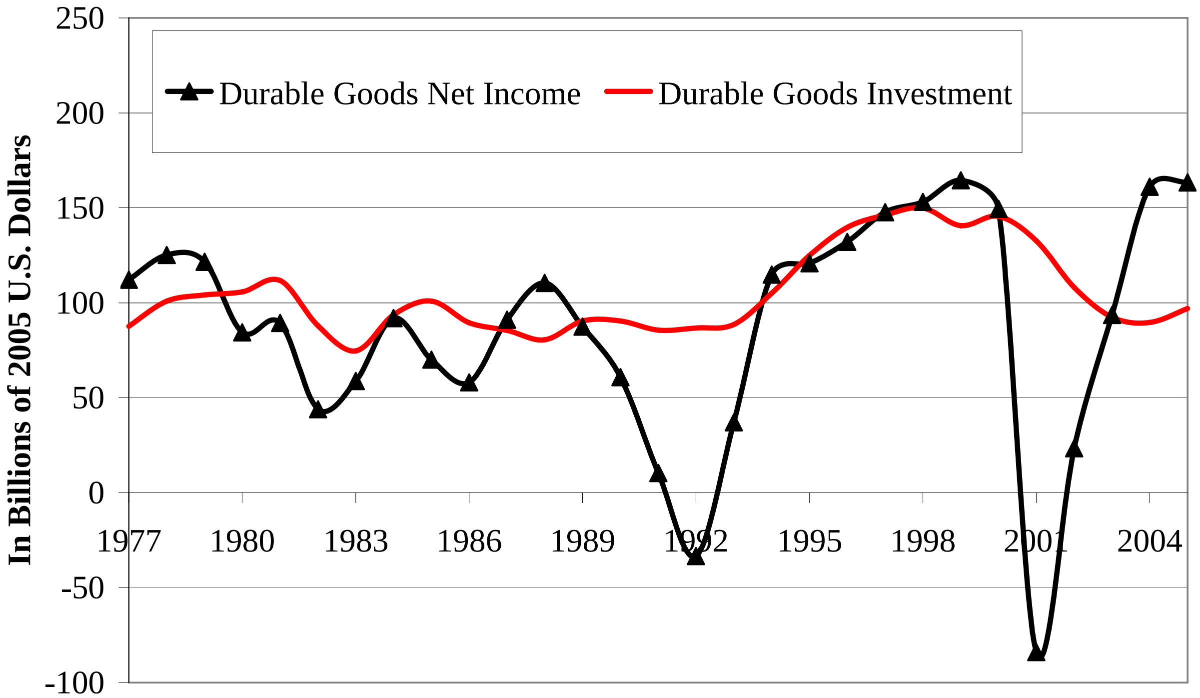
[30] See Appendix L for regression analysis.

[31] *Oil and Gas Journal* Capital Spending Outlook Issue, 4/3/06:20-25.

Refiners Association reports energy companies plan to expand U.S. refinery capacity 8% by 2010.[32]

Figure 21 shows that capital investment patterns are similar in the U.S. durable goods industry. As in refining, changes in investment levels are more muted than changes in income and tend to lag income changes.[33]

Figure 21: Net Income and Investment in Property, Plant and Equipment by U.S. Durable Goods Industry, 1977-2005, 2005 Dollars



Note: Accounting changes in the durable goods industry in 1992 and 2001 make figures for those years inconsistent with prior years.

Sources: *Economic Report of the President*: Corporate Profits by Industry 1965-2005 table B-92/table B-93 located at http://www.gpoaccess.gov/eop/tables06.html. Bureau of Economic Analysis Table 3.7ES. *Historical-Cost Investment in Private Fixed Assets by Industry* located at http://www.bea.gov/bea/dn/FA2004/TableView.asp#Mid

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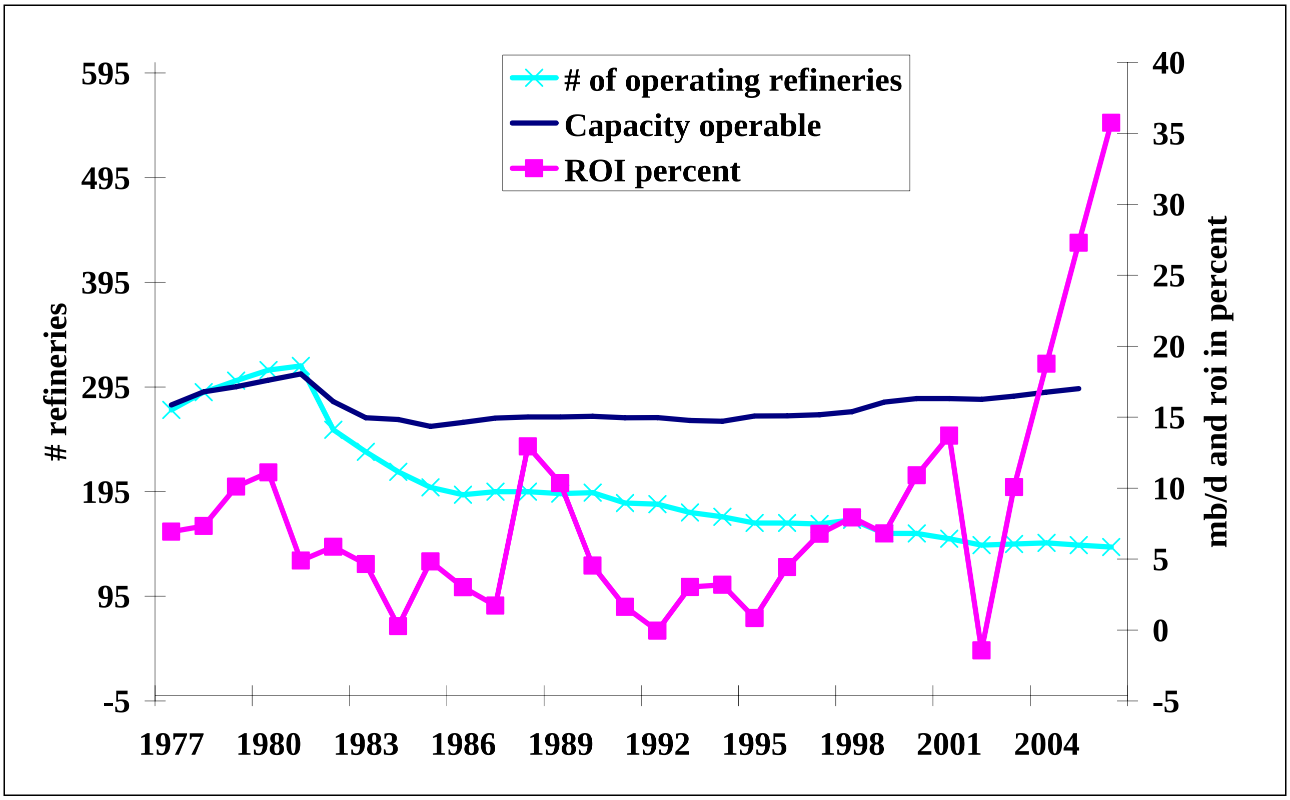
[32] http://washdateline.mgnetwork.com/index.cfm?SiteID=wsh&PackageID=46&fuseaction=article.main&ArticleID=8774&GroupID=213 08/26/2006.

[33] Significant accounting changes in 1992 and 2001 made the data for those years inconsistent with prior years. The evidence suggests that losses for 1992 are overstated.

Refining Capacity

Since the FRS data on investment in U.S. refining are so limited, this paper also examines trends in physical refining capacity over time, for which better data are available. While capacity increases are a proxy for capital investment, it should be remembered that they understate it because the industry has simultaneously invested in making cleaner fuels. Figure 22 shows the number of U.S. operating refineries (left hand scale) and total refinery capacity in millions of barrels per day (mbd) and ROI in percent (right hand scale).

Figure 22: Number, Capacity and Return on Investment for U.S. Refineries, 1977-2006



Sources: *API Petroleum Databook*, Section VIII, Table 4: "United States Crude Oil Refining Capacity as of January 1(a)." ROI as for Figure 17.

During the industry's profitable years up to 1980, when the U.S. protected small refineries, the number of refineries and their combined capacity rose. Between 1980 and 1985, when price controls were lifted, capacity fell and refinery numbers fell even faster. Thereafter, until 1994 with the exception of 1988, capacity was relatively flat or declining, reaching its nadir in 1994 with operable capacity of around 15 mbd, down from 16.4 mbd in 1977. Since 1994, the number of refineries has continued to fall, but capacity has increased on average by 1.2% each year. The years 1998 to 2001 saw many mergers, but continued capacity increases averaging 1.7%

annually. In 1999, capacity increased by about 650,000 barrels a day, the largest annual increase since 1974. Between January 2004 and January, 2006, refinery capacity increased by 1.4% per year, more than the average rate of increase since 1994. This higher rate of expansion continued despite almost flat total oil product consumption in 2005, and falling total product consumption through September 2006.

On three occasions before 2003 (In 1979/80, 1988/89, and 2000/01) the ROI in refining exceeded the 9% long-term average return in durable goods manufacturing. In all cases, refiners increased capacity in the same or the following year. In every case, the capacity changes were more muted than the increase in profits, and in every case, profit rates fell to record lows within 1 to 4 years after the higher investments in new capacity.

Some industry critics[34] emphasize the number of refinery closures in the U.S. and assert that these closures were a deliberate attempt to curtail capacity and increase monopoly power. In fact, many of the refineries that closed[35] were too small to be competitive (they averaged 20,000 barrels per day, compared to 118,000 b/d for the average operating refinery, up from about 57,000 b/d since 1981) and some had operated for over 25 years. Many of these small refineries were originally built to take advantage of oil quotas or price controls which ended in the early 1970s and early 1980s, respectively, and were not viable economically without them.

Although many refineries have closed, total U.S. refinery capacity has generally been increasing since 1994. In addition to investing in new total capacity, U.S. refineries have also made heavy investments in coking and hydrotreating to allow them to take advantage of the increasing price spread between lighter sweet crudes and heavier sour crudes.[36]

Capacity Utilization

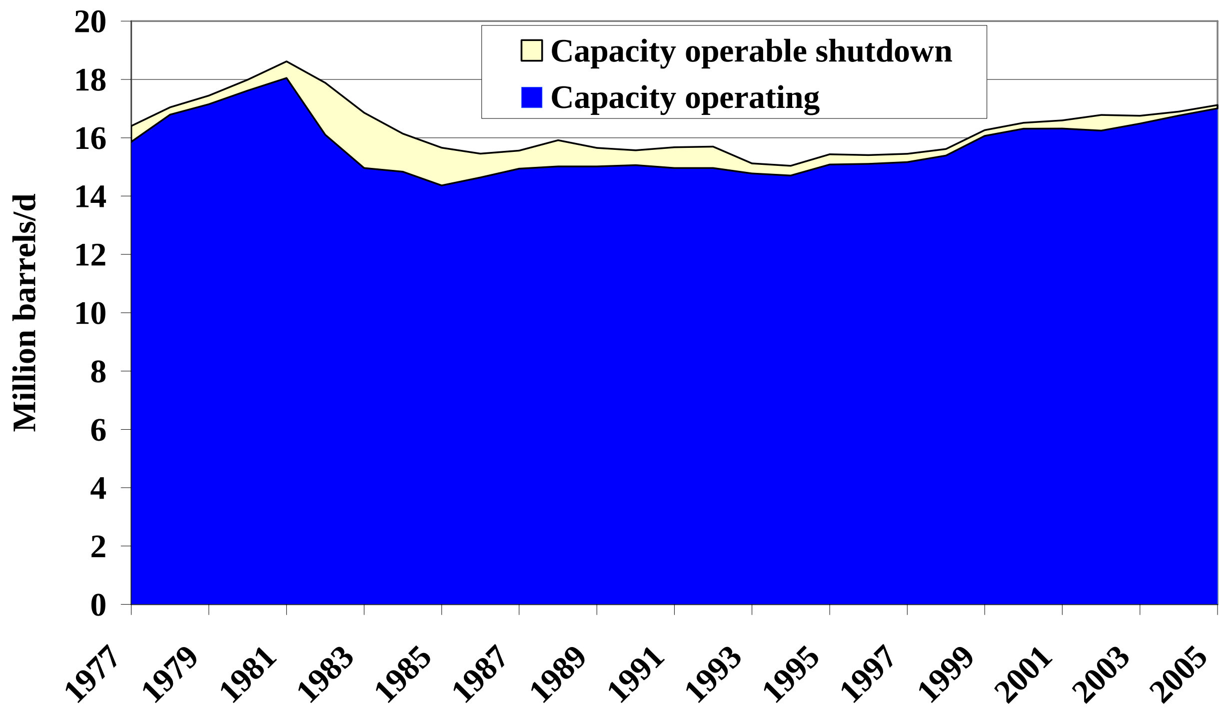
Some of the growth in U.S. gasoline demand has been met by better use of capacity. Figure 23 displays U.S. operating and shut down refinery capacity, showing that shut down operable capacity increases in weak markets and shrinks in tighter markets. While some of this capacity may be down for maintenance, some may simply not be profitable during weak markets. In spring 2006, an unusual amount of refinery capacity was down for maintenance that had been delayed because of the stresses placed on the industry by Hurricanes Katrina and Rita in the late summer and fall of 2005.

[34] For instance, the Consumer Federation of America (Cooper, 2006).

[35] Appendix M lists the 194 U.S. refinery closures between 1981 and 2004.

[36] Appendix N includes a table of changes in process capacity from 1992-2006 and a brief discussion of obstacles to refinery expansion.

Figure 23: U.S. Operating and Shut Down Refinery Capacity, 1977-2005



Source: API Data Book: VIII Table 4 "United States Crude Oil Refining Capacity as of January 1"

Another way to measure capacity use is through utilization rates. The optimum rate of capacity utilization in the U.S. is considered to be 90-95%, with a 95% utilization rate considered to be full capacity.[37] Rates below 90% suggest many units are down for maintenance or that refining margins are so depressed that capacity is being taken off line.[38] At low levels of utilization, refineries lose some of their economies of scale and are likely to have higher costs. At levels of capacity utilization over 95%, costs may also increase because of process bottlenecks.

Figure 24 displays capacity utilization rates in U.S. and worldwide refining since 1970. The graph clearly shows the excess capacity and low utilization rates that developed in the 1970s when rising gasoline prices and recession reduced gasoline consumption. Utilization in the U.S. recovered slowly until 1998, when it peaked at 95% before returning to around 90% through 2004 and then jumping to around 93% in 2004 with summer peaks even higher. Summer peaks in 2005 exceeded 95%; however, annual utilization was lower because of temporary outages from hurricane Katrina and Rita. In 2006, overall capacity utilization fell slightly to 90%, but summer utilization only slightly fell to 93% indicating that high prices at the time were not

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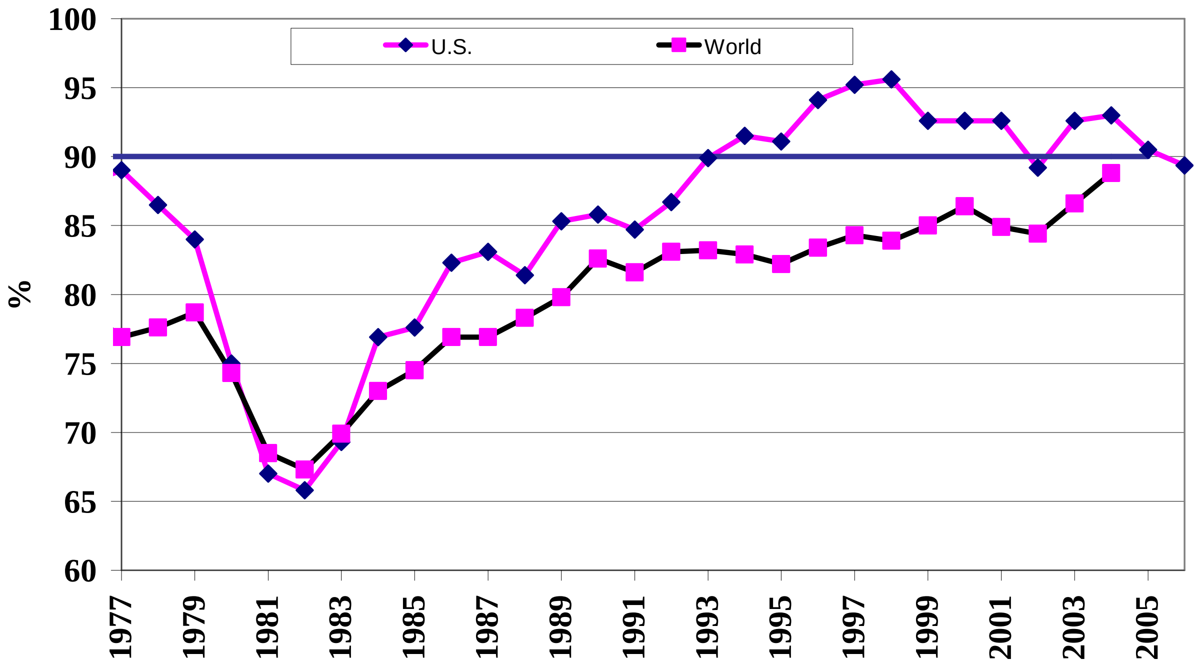
[37] Natural Resources, Government of Canada, http://www.bipp-oppi.gc.ca/reports/2005-09/rates_e.cfm.

[38] California Energy Commission http://www.energy.ca.gov/reports/2002-03-14_600-02-006CR.PDF#search=%22refinery%20utilization%20rate%20full%20capacity %22.

caused by overall capacity shortages, although they could have been partially caused by bottlenecks in specific process units.

For most of the last three decades, refinery utilization rates in the U.S. have been higher than in the rest of the world. Utilization rates bottomed out for both U.S. and foreign refineries in 1982 at less than 70%. U.S. utilization rates rebounded faster than foreign rates because relatively lower gasoline prices spurred consumption. By 1998, US capacity utilization was even tighter than it is today. U.S. capacity additions in 1999 eased the stress in the sector, but lower gasoline consumption growth rates in 2002 pulled U.S. utilization below 90% resulting in losses.

Figure 24: U.S. and World Refinery Utilization Rates, 1977-2006



Sources: *API Petroleum Data Book*, "World Crude Oil Refinery Utilization Rates," Section VIII Table 2, updated to 2006 from EIA: http://tonto.eia.doe.gov/dnav/pet/hist/wpuleus34.htm;

Capacity from Imports

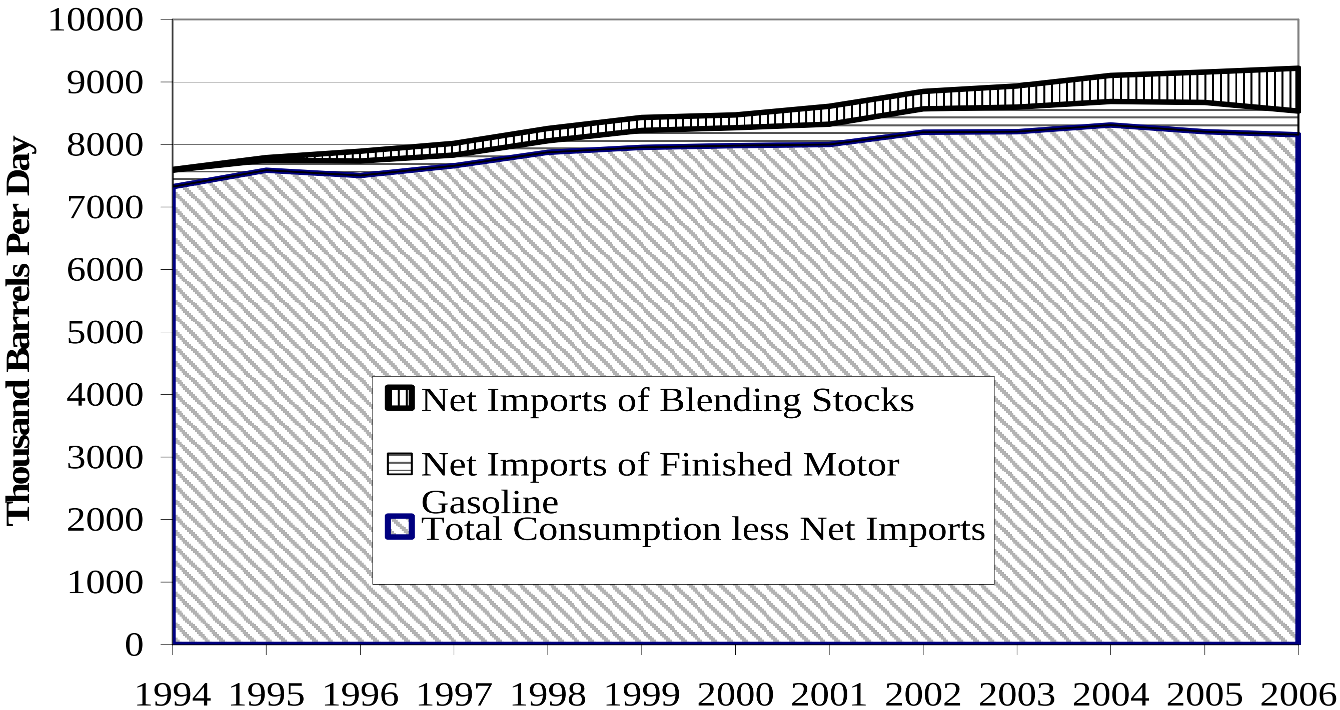
Because gasoline and other oil products are part of a world market, domestic capacity shortfalls can also be filled from imports. About 80% of the world's total refining capacity is outside the U.S. and worldwide refinery capacity has also been growing at a more rapid rate than capacity in the U.S. As shown in Figure 26, world capacity increased by about 16% between 1994 and 2006, just slightly higher than the 15% rate of growth of U.S. capacity, with an especially big jump in 2006. On a global level, there is some excess capacity, with utilization being at about 89%, somewhat lower than in the U.S.[39] While the number of different types of gasoline in the U.S.

[39] See Figure 24.

may limit trade, surplus product increasingly enters U.S. markets, often in the form of blending stocks.

Although U.S. gasoline imports are small relative to the total market, they increased at an annual average rate of over 8% between 2000 and 2005. Figure 25 shows gasoline imports relative to gasoline consumption. The imports are a combination of finished gasoline and gasoline blending stocks, with the latter being the fastest growing segment because of the phase-out of MTBE.[40] The majority of imports come into the East Coast and the Gulf Coast regions, PADD I and III.

Figure 25: U.S. Gasoline Consumption and Net Imports of Finished Gasoline and Blending Stocks, 1994-2006

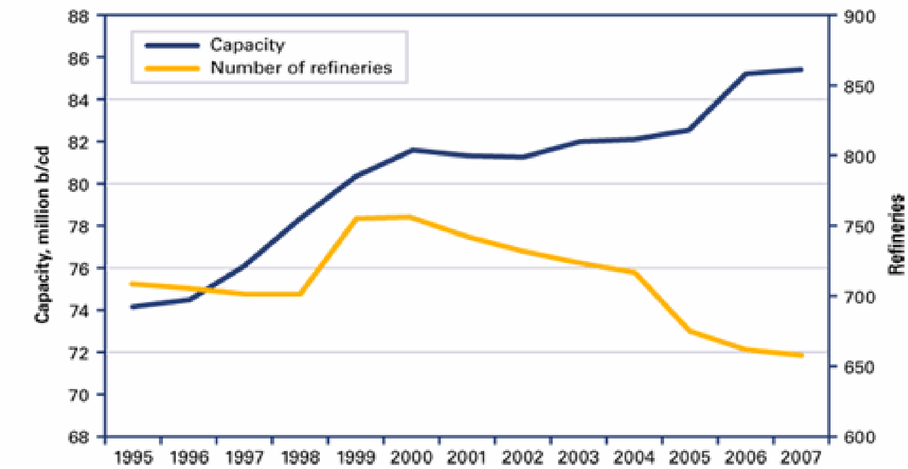


Note: 2006 is YTD through September

Source: EIA http://www.eia.doe.gov/oil_gas/petroleum/info_glance/petroleum.html

[40] EIA/DOE Petroleum Navigator http://tonto.eia.doe.gov/dnav/pet/pet_move_imp_dc_NUS-Z00_mbblpd_a.htm

Figure 26: Refining Capacity and Number of Refineries Worldwide, 1994-2007

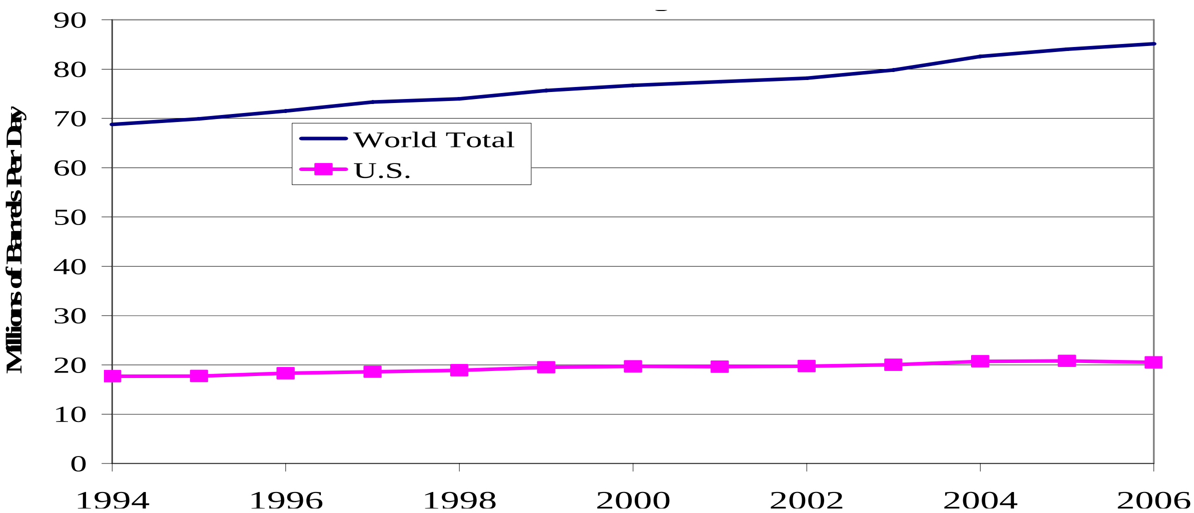


Source: *Oil & Gas Journal* – Dec. 18th, 2006

The total number of refineries in the world was stable from 1994 until 1999, when over 70 new refineries started up, most in the Middle East and Asia. Since 2000, the total number of worldwide refineries has been declining, with about 100 refineries being lost, one-tenth of these in the U.S. Internationally, as in the U.S., the closures tend to be smaller refineries, so that overall capacity grows even as the number of refineries declines.

This faster growth of worldwide capacity was partly driven by faster growth in petroleum product consumption worldwide. As shown in Figure 27, worldwide consumption of petroleum products grew at an average 1.8% per year from 1994 to the second quarter of 2006, while U.S. average consumption grew at 1.3% per year.

Figure 27: U.S. and World Total Petroleum Product Consumption, 1994-2006

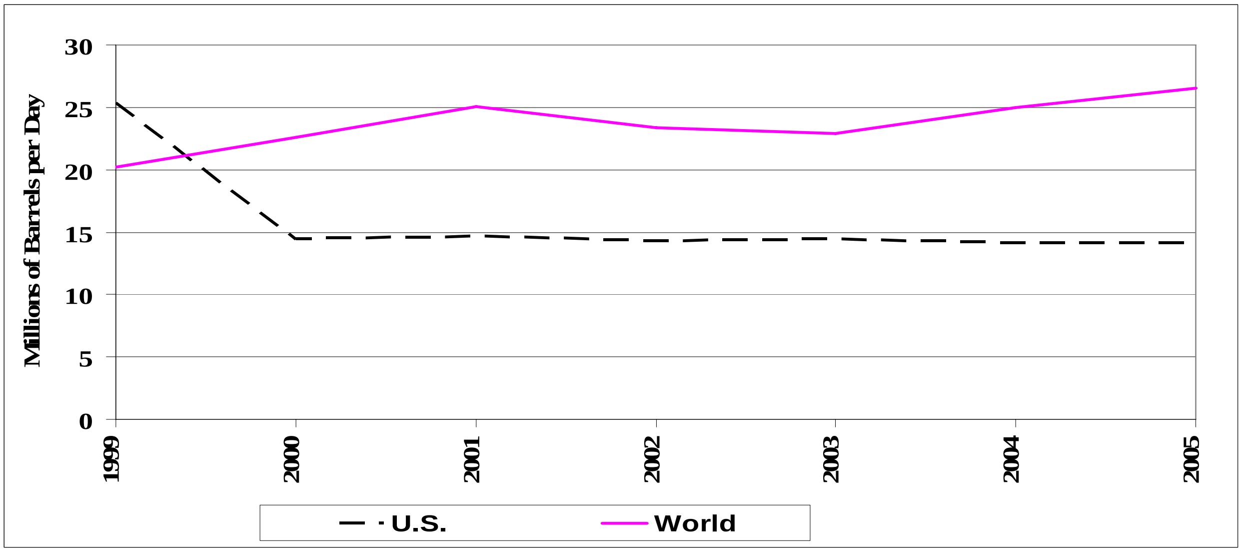


Note: 2006 figures are YTD averages based on actuals through August for the U.S. and June for the world total.

Sources: EIA/DOE *International Energy Annual 2004* updated by *Petroleum Supply Monthly*, February 2006, updated by EIA http://www.eia.doe.gov/emeu/international/oilconsumption.html

Many U.S. refiners also have refining capacity in other parts of the world and use trade to optimize their global operations. Figure 28 shows the U.S. and foreign capacity for the leading approximately 20 U.S. refining companies. The domestic capacity owned by these companies fell from 1999 to 2000 and then remained relatively flat, while the more profitable foreign capacity increased. The substantial decline in these major companies' capacity in 2000 came at a time when overall U.S. capacity was rising, indicating the trend of divestitures and de-integration from larger to smaller refining companies.

Figure 28: Top U.S. Company and World Refining Capacity, 1999-2005



Source: Created from data in *Oil and Gas Journal*, Worldwide Report, mid-December, 1999 to 2005.

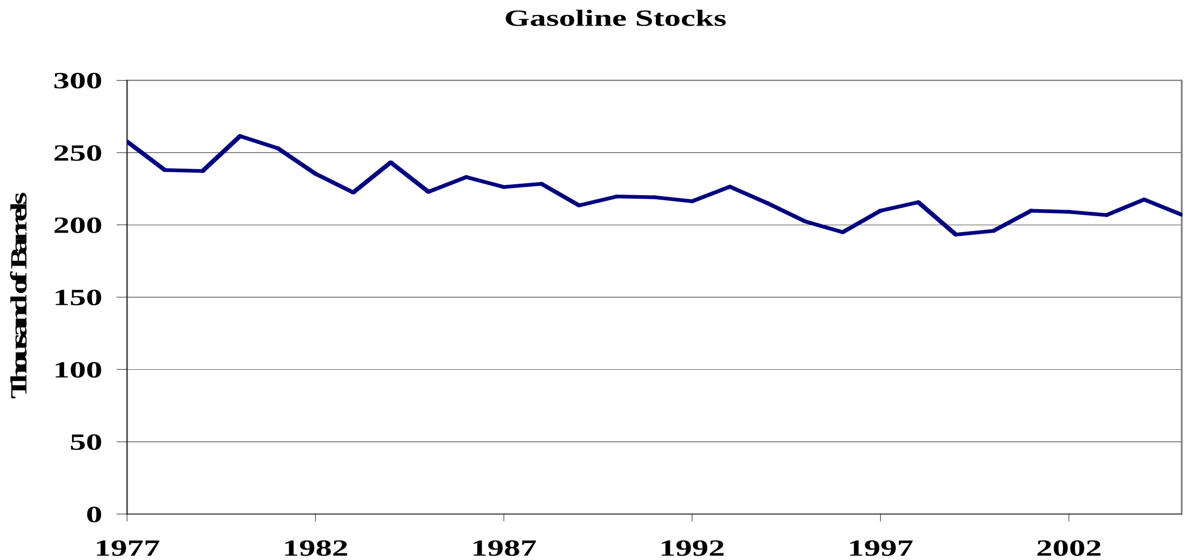
IX. Is the Cupboard Bare? Gasoline Inventories and Price Volatility

One critic of U.S. refiners, the CFA (Cooper, 2006), has argued that during the period from 1990 to 2005, when gasoline product prices increased by 20%, gasoline stocks fell 6% and that this reduced buffer can cause price run-ups even during small market disruptions such as normal spring maintenance operations. This section examines gasoline inventory trends and their relationship to price volatility.

Declining Inventory Ratio

Gasoline inventories have indeed been declining, not only since 1990, but since 1980. Figure 29 shows the downward trend in total gasoline inventories and Figure 30 shows an index of the ratio between inventories and product sales for the same period.

Figure 29: Inventories of Gasoline and Blending Stocks, 1977-2005

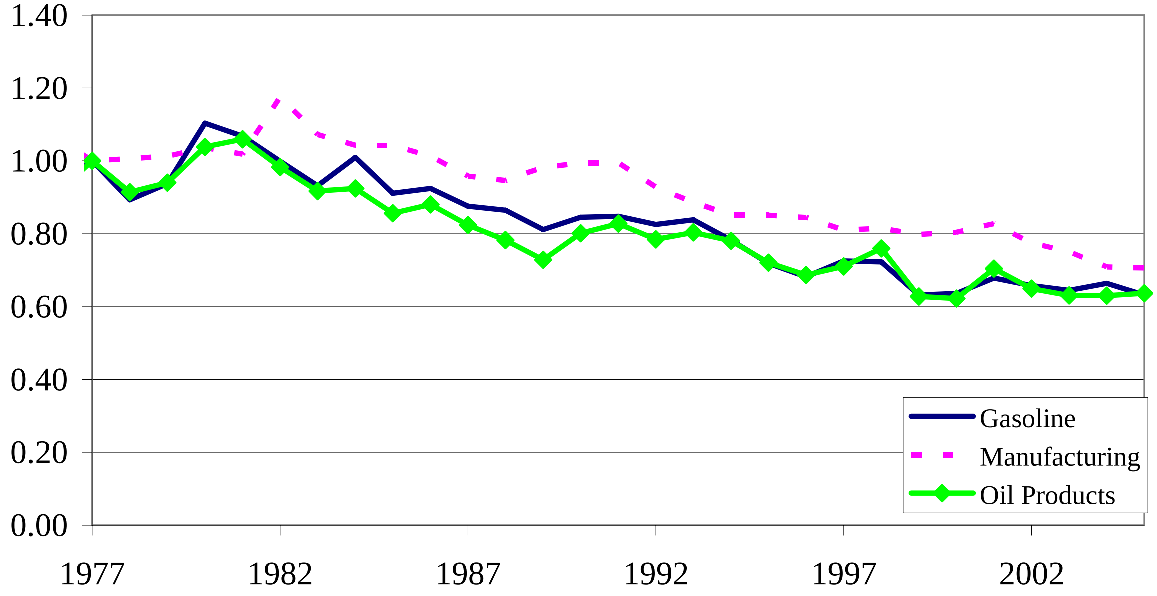


Source: EIA/DOE *Annual Energy Review*, http://www.eia.doe.gov/emeu/aer/petro.html updated from U.S. EIA/DOE Petroleum Navigator, http://tonto.eia.doe.gov/dnav/pet/pet_stoc_wstk_dcu_nus_w.htm

One might expect the decline in inventories to increase gasoline price volatility. Yet, although gasoline price volatility has been generally trending up, current volatility levels are actually less than in the years 1979 – 1992, when inventories were higher.[41] The volatility in those years is probably explained by the more volatile price of crude oil, which was seen in Section V to be the major determinant of gasoline prices. Figure 30 also compares the inventory-to-sales ratios for gasoline, oil products, and the manufacturing sector as a whole, showing parallel patterns of declining inventories. These parallel trends suggest the trend in oil inventories was driven by the evolution of leaner manufacturing practices throughout U.S. industry, rather than by activities specific to the oil industry.

[41] See Appendix O, Figure O.1 for the measure of volatility over this period.

Figure 30: Index of Inventories to Sales for Gasoline, Oil Products, and Manufacturing 1977-2005



Sources: Manufacturing inventories and sales from the *Economic Report of the President* Gasoline stocks and sales from the EIA/DOE *Annual Energy Review*

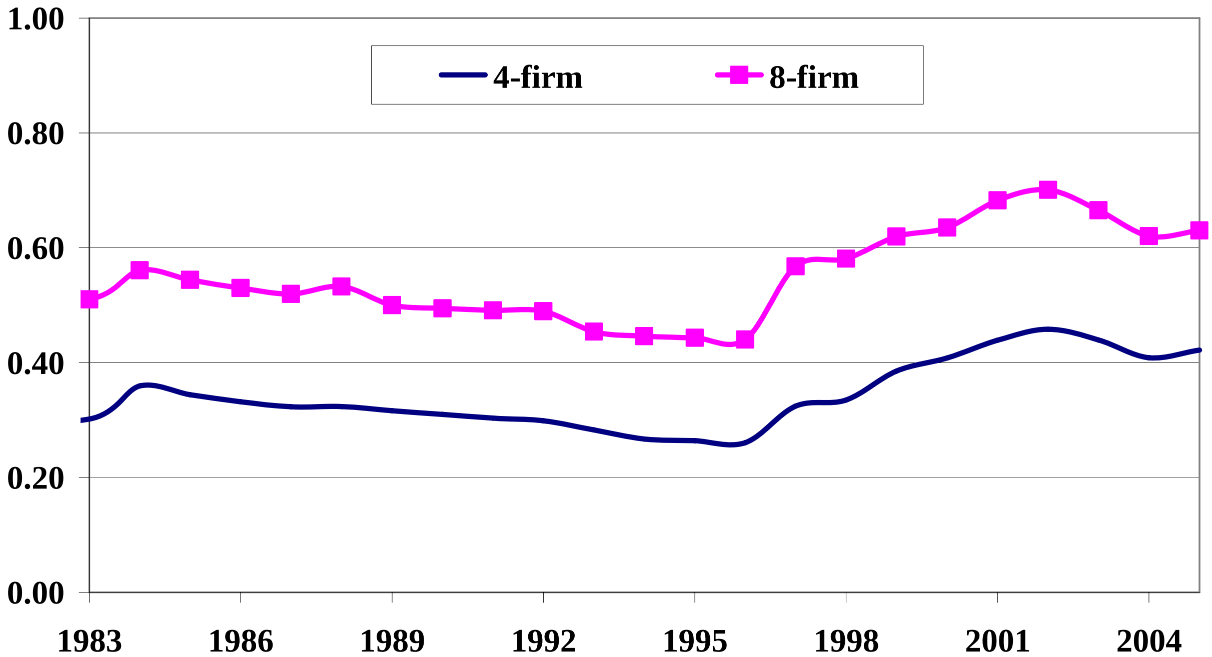
While it is thus correct that oil companies today hold relatively smaller inventories than in the past, the statistical evidence shows the trend is not unique to the oil industry and that volatile prices are not exclusively associated with low inventories.

X. Virtue or Vice: How Concentrated is the Gasoline Market?

CFA (Cooper, 2006) notes that from 1998 to 2002 fourteen oil companies were combined through mergers into seven,[42] and asserts that this deliberate concentration has allowed companies to reap excessive profits since 2002. [43] To support this assertion, CFA cites a 2004 study by the U. S. Government Accountability Office (GAO) (U.S. GAO, 2004).[44] This section discusses market concentration, critically reviews the GAO methodology and critiques of the GAO analysis by the Federal Trade Commission (U.S. FTC) (2004, 2005), and summarizes the FTC's analysis of the state of concentration in the U.S. refining industry.

Figure 31 shows how the merger trend has affected the concentration ratios for the top 4 and top 8 firms in refining from the available data – 1983 to 2005. Concentration generally fell from 1984 to 1996 then rose through the merger period before declining again from 2002.

Figure 31: Four and Eight-Firm Concentration Ratios for Refinery Capacity, 1983-2005



Source: Computed from information in American Petroleum Institute (2006) *Petroleum Data Book*, "Top Leading Gross Sales," Section VII, Table 19

Even with the mergers, these concentration ratios are not high compared to other industries. The fact that the 8-firm concentration ratio fell by almost 10% from 2002 to 2005 suggests entry into this industry is not difficult. One reason for declining concentration has been the move by major

[42] A summary of oil industry mergers and acquisitions since 1996 is presented in Appendix P.

[43] See Cooper (2006, p. 13).

[44] Effective July 2004, the GAO changed its name to Government Accountability Office from General Accounting Office

oil companies away from vertical integration by spinning off less profitable refining assets to concentrate on the production sector. While integrated companies had once dominated the refining industry, independents were able to enter when the crude oil market became more competitive as foreign production displaced domestic sources and improved commodities markets allowed them to hedge their crude oil supply costs.[45] In 1996, 16 of the FRS companies owned and operated 65% of U.S. refinery capacity,[46] by 2001, that share had fallen to 44%.

U.S. Government Studies of Concentration

Allegations that industry concentration has allowed refiners to earn excessive profits have led the FTC, the agency that approves mergers, to conduct studies of the industry in 2004 and 2005. In 2004, the FTC found that concentration in most sectors of the petroleum industry had remained low-to-moderate and that the most important determinant of gasoline price was the price of crude oil.[47] Since May 2002, the FTC has monitored retail gasoline prices in about 360 cities and wholesale terminal rack prices in about 20 urban areas on a daily basis, using statistical methods to determine whether price variability is within expected bounds or might indicate monopolistic behavior. FTC argues that its careful merger investigations, enforcement, and surveillance have successfully limited anti-competitive problems. The FTC has also identified four national trends in retail gasoline sales that may lower gasoline prices and increase competition.[48]

- Traditional service stations repair facilities are being replaced by specialty repair stores such as Firestone and Midas.
- Branded stations have moved towards the convenience store model.
- Independent gasoline retail stores with low margins and high volume called pumpers have entered the market and some branded sellers have followed. This pumper format accounted for about two-thirds of gasoline sales by 1999.
- Hypermarketers such as Walmart and Costco had taken almost 6% of the market in 2002 and were projected to achieve a 13% share by 2007.

One indicator of greater monopoly power is higher company profits that are permanently sustained. The 2004 GAO report sought to determine statistically whether such an increase in profit occurred after the eight large oil company mergers that took place between 1997 and 2000.[49]

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[45] See U.S. FTC (2004)

[46] EIA, Performance Profiles 2001.

[47] See U.S. FTC (2004)

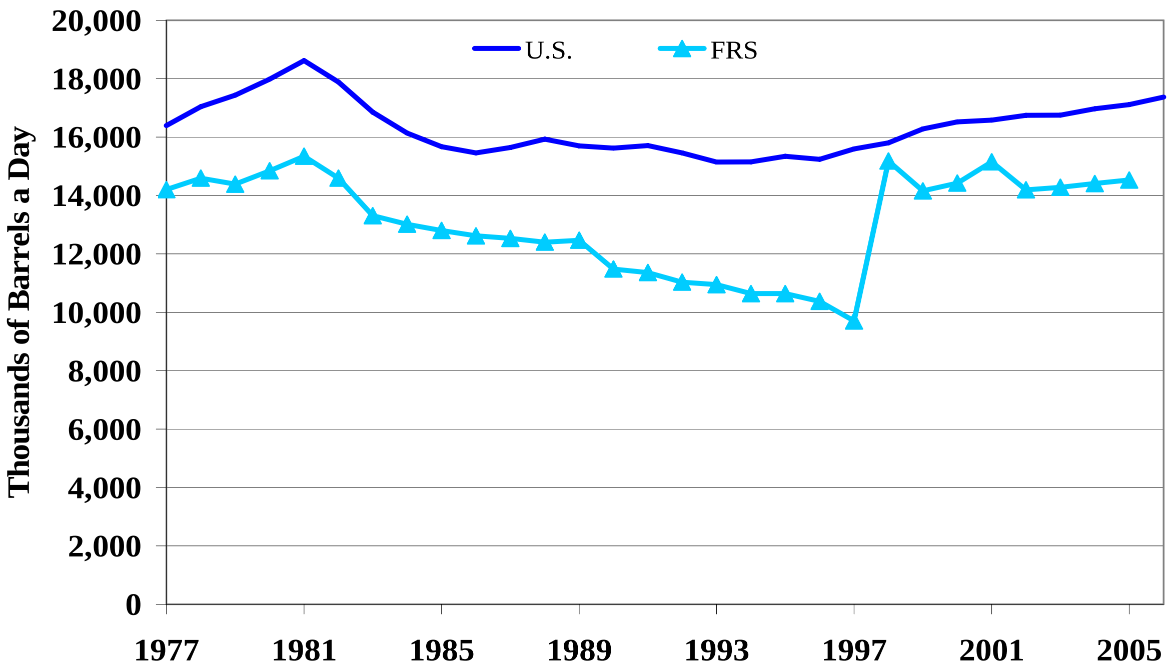
[48] See U.S. FTC (2005)

[49] These mergers were Tosco-Unocal (April 1997), USA-Total (October 1997), Marathon-Ashland (January 1998), Shell-Texaco (Equilon) (February 1998), Shell-Texaco (Motiva) (July 1998), BP-Amoco, (December 1998), Map-UDS (December 1999), and Exxon-Mobil (March 2000).

The FTC, in its 2004 review, is quite critical of this GAO report, arguing that it is fundamentally flawed because, among other things, it does not control for many variables influencing gasoline prices. Appendix Q provides a critique of the GAO report by the author of this paper that identifies many weaknesses in its methodology.

CFA (Cooper, 2006) has argued that monopoly power in refining increased due to vertical integration. In fact, vertical integration has been decreasing. In Figure 32, the bottom line shows the combined refining capacity of the FRS companies. The big jump in 1998 represents not an increase in concentration but the addition of 11 new companies to the FRS group.[50] With the exception of this statistical anomaly, the market share of the largest companies declined rather consistently.

Figure 32: Refining Capacity: U.S. Total and Financial Reporting System Companies, 1977-2006



Source: EIA Performance Profiles of the FRS and API Petroleum Data Book Section VII Table 4

[50] The companies were added to increase the FRS coverage of the refining industry. The new companies included Citgo, Equilon, Lyondell-Citgo Refining, Motiva, Tesoro, Tosco, Ultramar Diamond Shamrock, and Valero. After this expansion, the 33 FRS companies represented some 85% of U.S. refining capacity. A complete list of FRS companies by year is provided in Appendix G.

XI. Climbing the Spiral Staircase: Do Crude Prices Follow Gasoline Prices Up?

Since the U.S. consumes around 40% percent of the world's gasoline,[51] U.S. demand is likely to influence world prices. However, CFA and others who argue that high U.S. gasoline prices drive up world oil prices may not be correct about the direction of the effect.

How U.S. gasoline price movements influence international crude oil prices depends upon the causes of those price movements. The historical discussion presented in earlier sections suggests that different forces have been at work on gasoline prices at different times. In 2004 and early 2005, U.S. gasoline demand was pulling up crude demand and contributing to price increases. In the summer of 2006, it is most likely that ethanol cost increases and possible bottlenecks raised gasoline prices, putting downward pressure on crude prices. The confusing effects of the hurricanes make it harder to determine what mechanism was at work in 2005, but the FTC found no evidence that U.S. refiners were deliberately contributing to price increases.[52]

Theoretically, if higher gasoline prices are due to higher demand, then refiners will want more crude and bid up oil prices. But if, as CFA asserts, recent gasoline price increases were caused by supply-side factors such as restricting refining capacity relative to demand, then they will be accompanied by lower gasoline consumption, reduced oil demand, and downwards pressure on oil prices.

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[51] EIA/DOE *Annual Energy Review* (2004), released May 2006. Although the US has only 20% of the world's total refining capacity, its share of gasoline refining is considerably larger because over 45% of the product of U.S. refineries is in the form of gasoline, compared with a world average of around 25%. CFA (Cooper, 2006) incorrectly states that the U.S. consumes 25% of the world's gasoline.

[52] U.S. FTC 2006.

XII. Does the Tail Wag the Dog? The Role of Derivatives Markets

The CFA (Cooper, 2006) argues that speculation in financial commodity markets has bid up gasoline futures prices which in turn have bid up spot gasoline prices. This section examines the role of derivatives markets in setting oil and gasoline prices and reviews the merits of cries for tighter regulation of these markets.

Futures Markets

Gasoline futures contracts are typically used to lock in prices. Over 99% of contracts do not go to delivery and many traders who are not in the gasoline business purchase contracts in hope of making a profit. Between fall 2003 and 2005, gasoline futures activity increased to levels not seen since 1993. Historically, around 90% of futures contracts have been held by hedgers or commercials, with speculators or non-commercials holding around 10%. In the 2003-2005 period, however, the ratio of non-commercial contract holders doubled to 20% and most of this increase was in long contracts.

CFA (Cooper, 2006) argues that the actions of these speculators are destabilizing the market. Others have claimed that speculators bid up prices by going long futures. Most economists, however, believe that non-commercials help provide liquidity to the market and allow commercials to shed risk, thereby stabilizing the market and providing advance signals about capacity needs. This would suggest that the increased volume of 2003-2005 reflected increased uncertainty that drove both hedgers and speculators into the market to transfer risk.

Theoretically, futures and spot markets are linked as follows: if futures prices rise relative to the spot price, traders buy spot for inventory (bidding up the spot price) and sell futures contracts (pushing their prices down). The trader's then sell inventory in the future lowering future spot prices. Conversely, if futures prices fall, traders sell gasoline out of inventory at the current price and buy futures contracts at lower prices. When traders are right, they reallocate inventories to periods of increased shortage and signal refiners to increase capacity.

Investors are destabilizing only if they erroneously expect shortages. Then they bid up prices, which reinforces the expectation of shortages and raises prices. Although this scenario is possible, it is unlikely to persist for long. Investors who destabilize the market must buy high and sell low, thus losing money. Being wrong in such a game is costly and market fundamentals soon reassert themselves.

Direct observation of gasoline futures markets confirms that they are effective Alan Greenspan, former chairman of the Federal Reserve, (2006) asserts that investors and speculators are thus “hastening the adjustment process” in world oil markets. Smithson (1998), citing over twenty supporting studies, contends that the introduction of derivatives reduces price volatility. He finds derivatives increase the speed at which markets incorporate adjustment and may decrease the bid/ask spread.

Haigh et al. (2005) investigated whether increased speculation increased volatility and pushed up prices. They found no link between price changes and changes in the positions of hedge funds and money market traders and concluded that underlying fundamentals, not speculation, were determining prices. [53]

A detailed discussion of gasoline futures markets with relevant statistics is provided in Appendix R.

Market Regulation

CFA (Cooper, 2006) argues that futures markets should be more tightly regulated, that traders should be required to operate on higher margins, and that over-the-counter markets should be regulated. Since economic theory and statistical studies suggest that futures and forward markets tend to decrease volatility and that speculators provide liquidity, one should be cautious about actions that would decrease this activity.

The futures market is already closely regulated. The U.S. Commodity Futures Trading Commission (CFTC) continuously monitors NYMEX energy contracts for price manipulation and requires reporting of large trades. Since the scandals involving Enron and other traders, CFTC has been more vigilant against the abuse of market power and has penalized natural gas traders who tried to manipulate the market (Lukken, 2006).

Unlike the NYMEX, over-the-counter forward markets are bilateral markets that allow participants to tailor agreements to each participant's specific risk needs. Except for the fact that they are less transparent, these markets work in much the same way as futures markets, and so the same arguments pertain against increased regulation. Participants in these markets generally take delivery, making it even less likely that speculators are manipulating these markets.

CFA does not specify which over-the-counter markets should be regulated, or why, or how. Economists from the time of Adam Smith have been enthusiastic about a competitive market's efficiency and ability to allocate resources where they are most valued. Nobel Laureate George Stigler pointed out as long ago as 1971 that regulation often enhances the real net income of the regulated industry rather than correcting the underlying failure. Small groups may pool their resources to bend the regulatory process in their favor. The smaller the group, the more homogenous their views, and the more certain the effects of various regulatory instruments, the stronger the bond within the group and the more likely they will be successful in influencing regulations (Petersen and Lewis, 1999) Thus, economists require a strong case to be made that regulations will provide a better solution than the market.

There are basically three cases where markets are inefficient and government regulation should be considered: imperfect information, market power, and externalities. These factors do not seem to be a concern in gasoline forward markets because:

- The existence of the regulated transparent futures market provides information to forward markets and it is unclear that government intervention would provide better information.

[53] Haigh et al. aggregate two groups of non-commercials – hedge funds and money market traders – calling them MMTs -- and investigate how MMTs affected commodity prices. They use standard time series techniques to analyze daily data from the natural gas and the crude oil futures and options markets from 8/4/2003 to 8/31/2004. They found MMTs do not change their positions as often as hedgers, and that their position changes tended to be the opposite of hedgers. Haigh et al's graphical causality analysis suggested MMTs provided liquidity to hedgers.

- The futures market and existing anti-trust laws mitigate against any partner in a forward contract monopolizing the market.
- The most likely externality would be one side in a forward contract taking on more risk than it could handle, resulting in a bankruptcy that spilled over into the general economy. This seems unlikely in the forward market where traders take delivery and there is less speculation than in futures markets.

Other forms of derivatives include options and swaps. The writers of options and those that take on risk in swaps can put themselves at spectacular risk, but the same theoretical arguments hold as for futures contracts, so it is unclear why these markets need to be regulated.

In light of the theoretical and statistical evidence that derivatives markets provide stability and liquidity, the onus is on advocates for tighter regulation to explain more specifically the nature of the market failure, how regulation would address the problem, and demonstrate that the costs of the regulation would not exceed the benefits.

XIII. Contestability and Elasticities in Gasoline Markets

Concentration alone does not guarantee monopoly power. A highly concentrated market with few players may still be highly competitive if the market is contestable (Baumol, Willig, and Panzar, 1982). One must consider whether excessive profits will bring changes in products, producers, technologies, or consumer behavior. In the gasoline market in the near term, consumers have limited ability to substitute other products longer term, diesel can compete with gasoline, although since it is petroleum based, its prices will also vary with crude oil prices. CFA (Cooper 2006) argues that ethanol and bio-diesel could make a significant contribution to transportation fuels. However, studies suggest that replacing a significant proportion of gasoline with biofuels would require the development of cellulosic ethanol, which is still a long way off but more fuel-efficient hybrid vehicles can allow consumers to respond to prices and provide more contestability to these markets. For more information on these alternatives see Appendix S.

To understand the behavior of gasoline markets, it is also important to note that short-run demand elasticities are quite small.[54] It is an interesting question whether, as CFA argues, these low elasticities give refiners undue market power.

Since the first oil price shock in 1973, hundreds of studies have measured the price elasticity of gasoline demand.[55] The preponderance of evidence suggests that the annual price elasticity is between -0.2 and -0.3. Thus a 10% increase in gasoline price has historically reduced gasoline consumption between 2 and 3 % within one year. In the first months, the demand adjustment is half or less of the annual adjustment.

A 2006 study[56] finds the monthly elasticity to be as low as -0.04 and to be considerably lower today than in the late 1970s. This would mean that a 100% increase in price would reduce demand in the first month by only 4%. Why the price elasticity of gasoline of demand has fallen, and is it so low that consumers are hostage to big oil?

The apparent shift in elasticities may be explained by changing consumer expectations. In the oil price run-up of the late 1970s, many consumers believed that gasoline prices would go ever higher. This had the effect of overstating the measured elasticity relative to the actual price increase. Today, consumers are much less sure that the run-up is permanent, which may understate the elasticity measured by the 2006 study. Consumers who believe that political uncertainty in oil-producing countries will subside, refining bottlenecks will be resolved, high oil prices will slow the growth of the world economy, and high gasoline prices and slower economic growth will cool the markets, are unlikely to make significant changes in their driving patterns and gasoline use. Even oil industry critics such as CFA seem unconvinced that the high prices represent real permanent higher costs, instead arguing that the high prices are artificially induced by oil companies and can be reduced with appropriate policies.

If higher prices persist, however, demand adjustments will be significant. In the 1970s, Detroit believed consumers would not trade their gas guzzlers for more economic models but, to the delight of Japanese car makers, they did. Surveys suggest that the longer-run demand price

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[54] On this issue, the author agrees with CFA.

[55] Appendix T includes surveys and discussion of many of these studies.

[56] Hughes, Knittel, and Sperling (2006)

elasticity, the total adjustment after the vehicle stock has turned over, is between -0.4 and -1. However, since vehicles now last longer than they used to, it will take more time until the long run adjustment is completed.

CFA argues that refineries have deliberately not added capacity and that U.S. refinery capacity should be 3 million barrels per day (mbd) higher and world capacity should be 15 mbd higher, in both cases a 17% increase over actual levels. These are astonishing numbers when compared to world and U.S. refined product consumption, which grew by only about half these amounts in the entire decade from 1988 to 1998, when prices were generally declining and there were no capacity constraints. CFA further argues that these capacity increases would reduce prices to $1.50 a gallon. This is not a sustainable price. With crude at $50 per barrel, crude costs and taxes alone equate to approximately $1.63 per gallon and total costs before profits to $1.95.[57]

Refiners are right to be vigilant. With low short-run demand elasticities, small surpluses can cause dramatic price reductions. For example, if monthly elasticity is as low as -0.04, then a 350,000 barrel per day refinery capacity increase in July of 2006 would have lowered prices by over 50% from almost $3.00 to $1.50. Such a reduction is not desirable as it would reduce the price below refining costs. Given the extended period of oversupply and inadequate profitability refiners experienced after expanding following the price run-ups of the late 1970s, it seems prudent for refiners to add capacity incrementally and take time to gauge long-run market conditions.

If the long-run demand elasticity is ten times the current monthly elasticity (-0.4), and price is the weighted average price for 2006 through September of around $2.60 a gallon, then if refineries expanded their capacity by 17%, as suggested by CFA, prices would fall by over 40%,[58] again a loss-making proposition for refineries. High profit margins clearly demonstrate that more capacity is needed, but the analysis suggests the additions should be more in line with the expansion plans refineries have announced.

[57] Based on API estimated percentages shown in Figure 6 at crude price of $50 per barrel (approximate price in 2005 and October 2006). This equates to $2.25 per gallon made up of: crude oil $1.20 per gallon, state and federal taxes $0.43 per gallon, distribution and marketing $0.20 per gallon. Analysis of refining margins and profits suggests that refining costs add an additional $0.11 per gallon, for a total estimated cost, not including profits, of $1.95 per gallon.

[58] Prices would change by -0.17 divided by 0.40, which is equal to -0.425 or a fall of 42.5%.

XIV. Conclusions

A spate of refinery mergers from the late 1990s and into this century was accompanied and followed by rapid gasoline price increases. These events led to the belief that increased monopoly power caused the higher gasoline prices. The CFA (Cooper, 2006), in particular, has argued that the price increases are inconsistent with market explanations and asserts that:

- mergers have increased refinery market concentration and pricing power
- a more concentrated refining industry raises prices by deliberately failing to invest in additional capacity
- refineries have reduced inventories to increase price and price volatility
- speculators in energy financial derivative markets are bidding up prices even further
- high gasoline prices bid up crude oil prices to feed a price spiral
- consumers are unable to reduce gasoline consumption because they have been deprived of alternatives, thereby ensuring that the price spiral translates into a profit spiral
- refinery capacity in the U.S. and the world should be over 15% higher

This report evaluates these assertions based on economic theory and careful statistical analysis over an extended historical period to determine:

- whether gasoline price increases are out of line with cost increases
- whether recent gasoline price increases are out of line with price increases for other commodities
- whether refining investment and inventory practices are out of line with history and prudent business practice
- how rates of return in refining have compared with return on investment in other industries
- whether speculators in gasoline futures prices are bidding up gasoline prices and increasing gasoline price instability
- whether gasoline prices are bidding up crude oil prices
- whether alternatives on both the supply and demand side of the market provide the competition needed to bring the market back into balance
- whether world refining capacity should be increased by over 15%

The report finds that the recent gasoline price increases are neither unprecedented nor unique to the gasoline market. After adjusting for inflation, gasoline prices have generally trended downward with spikes in the late 1970s from supply shocks and recent spikes from demand and supply shocks. Even now, real gasoline prices are no higher than they were in the 1930s. Moreover, a strong world economy with particularly rapidly growing Chinese and Indian economies has pulled up all commodity prices in recent years.

As part of this commodity price boom, crude oil prices rose from $15.50 in 1999 to over $65 in summer 2006. Statistical analysis finds that crude oil prices have explained about 97% of the changes in pre-tax gasoline prices over nine decades, including the recent increase, with each $1/barrel change in the crude oil price predicting a 2.5 cents/gallon change in gasoline prices. A $50/barrel increase in crude oil prices thus translates into a gasoline price increase of $1.25/gallon. Chemical and environmental compliance costs have put further cost pressures on the refining industry.

On the demand side, a 1% increase in income increases gasoline consumption by an expected 0.3% within a year and even more in the long run. Since refiners expand their capacity gradually in line with expected increases in long-term demand, the unexpectedly high income growth of 2004 and early 2006 left them short of capacity, with resulting pressure on prices. Hurricanes that disabled U.S. refining capacity added pressure to an already tight market.

Environmental regulations requiring cleaner gasoline and diesel fuels and the transition from MTBE to ethanol have tightened markets still further. Not only are cleaner fuels more expensive to produce, but the proliferation of fuel types (which grew from three in 1990 to fourteen today) requires more refinery and distribution capacity and limits arbitrage that would otherwise reduce prices and price volatility. FTC investigations of price spikes in the Midwest and California have found "boutique fuel" requirements to be important contributing factors.

While there is a perception that mergers and acquisitions have increased concentration and market power in refining, the evidence suggests otherwise. The refining industry is less concentrated now than in 1990. During the unprofitable 1990s, vertically integrated companies shed refining assets to independents to concentrate on the more profitable production sector. FTC divestiture requirements during major oil company mergers also contributed to reduced concentration. In 2006, the four largest independent refiners not affiliated with major oil companies held over 25 % of U.S. refining capacity, more than triple their share in 1990. Shifts towards high-volume gas stations and increasing sales by hypermarketers are also believed to have increased competition in the industry.

Higher prices have led to higher profits. However, the higher profits have come after over a decade of low and negative rates of return on investment and restructuring aimed at returning refining to a viable industry. Over the last three decades, profits in refining have been highly cyclical and the average ROI of 7% compares unfavorably with average returns in the U.S. durable goods industry (9%), the S&P 500 companies (11.5%) and the foreign refining activities of U.S. companies (over 13%).

The charge of inadequate investment is also not supported by the evidence. In the U.S. as in the rest of the world, uneconomic small refineries have been scrapped, but new more sophisticated capacity has been installed. Hydrocracking capacity, in particular, has expanded rapidly. This new capacity makes not only more, but considerably cleaner gasoline. Even during the heavy merger and acquisition period the industry installed new capacity. While it is true that since 1999 U.S. companies have put in more capacity overseas than domestically, these actions are consistent with the relative size and growth of the international markets, their higher profitability, and the regulatory uncertainty in the U.S. over MTBE. Imports of both finished gasoline and blending stocks though still small, have increased over this period and provide some relief when hurricanes, environmental regulations, unexpectedly high income, or the summer driving season have squeezed domestic refiners. As regulatory uncertainties over MTBE have been resolved, this arbitrage—already strong between the eastern U.S. and Europe—should increase.

Although capacity at existing refineries has expanded, no brand new U.S. refinery has come on line in decades. Two attempts to build new refineries were abandoned in the 1970s after years of battles with regulators, and a planned refinery in Arizona has been six years in the permitting process and is unlikely to be built before 2009, if ever.

While it is true that capital investment has not increased as fast as profits, this is consistent with history and other capital intensive industries, where capital spending is always more stable than profits. Changes in profits tend to feed back to investment over three years because investments take time to plan and implement and must follow long term demand trends.

The level of gasoline inventories relative to gasoline sales has declined in recent decades, just as inventories have done in U.S. manufacturing in general. Lower inventories probably reflect general changes in business practice rather than monopoly behavior, and do not seem to have increased gasoline price volatility as price volatility is similar today to the early 1980s, when inventory-sales ratios were much higher. Then, as now, volatile crude prices seemed to drive gasoline price volatility.

The argument that speculators in gasoline derivatives fuel spiraling prices and price volatility is also not supported by the evidence. Theory and statistical studies suggest that speculators provide liquidity to the market and help stabilize prices by increasing inventories and prices before shortages and decreasing inventories and prices during a shortage. No case has been made for increasing regulation of gasoline derivative markets.

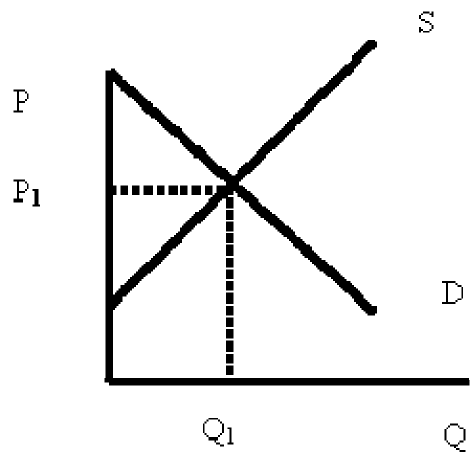
Increasing gasoline demand can bid up gasoline prices, increase crude oil demand, and increase crude oil prices. Such a pattern is consistent with a market-based increase in gasoline prices. If higher gasoline prices had been caused by monopoly suppliers withholding capacity, this would have had the effect of *reducing* gasoline consumption and crude oil demand, and reducing the price of crude oil.

Gasoline consumption and production are both unresponsive to price in the short run. This means that small shifts in demand or supply have large short-term effects on prices. It does not mean that such markets are not competitive or contestable in the long run. The consumer response to prices is more than ten times as great in the long run, when consumers may move closer to work, drive less, or buy a more fuel efficient vehicle. Rapidly increasing imports suggest that foreign refineries provide competition, and the rise of large independent refiners in the U.S. suggests that barriers to entry are not high. Renewable fuels in the form of biodiesel and ethanol may provide some competition, but can only be a significant factor if they are not made from food crops.

The simplistic but appealing explanation that mergers, monopolies, and speculators have caused recent high gasoline prices and profits is not supported by the statistical evidence presented in this report. The real reasons have been high crude oil prices, higher operating costs, proliferating grades of gasoline, unexpected demand growth, lower demand responsiveness, recovery from low and negative rates of return on investment in the 1990s, hurricanes, and regulatory uncertainty. Further, the evidence suggests that the higher profits have been accompanied by normal inventory and investment practices. The assertion that refinery capacity should be increased by over 15% is also not supported by the evidence and would surely lead to the pattern of overcapacity and losses that followed the price increases of the 1970s.

Appendix A: Graphical Analysis of Price Increases

Figure A.1 Supply and Demand Create Price



Market Mantra: Supply = Demand

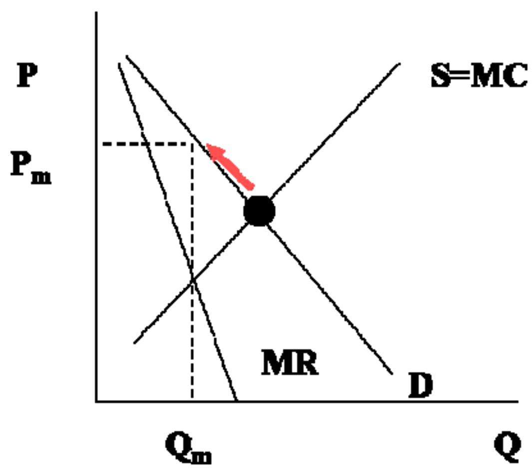
First, consider a competitive market as represented in Figure A.1. In a competitive market, there are many buyers and sellers so that none can influence price. In such a market, demand (D) represents consumers' preference; supply (S) represents the cost of producing a particular gallon of gasoline, which economists call marginal costs. These costs must include a normal profit rate for without profits producers will not stay in business. As prices fall in the market, consumers want to buy more gasoline. As prices rise, suppliers want to sell more gasoline. We expect the market will be pushed towards the price where supply and demand cross at a price of P_1 and a quantity of Q_1. At such a point, price equals the marginal cost of the last or highest-cost producer, called the marginal producer.

If P_1 represents the cost of the marginal producer, the cost of producing the Q_1^{th} gallon of gasoline is P_1 and costs for all previous gallons are lower. In this competitive world, low cost producers are able to make higher profits and shifting supply and demand over time give us market prices.

Monopolist Mantra: MR = MC

If suppliers are not competitive, they, not the market, pick the price. They pay attention to the effect they have on the price, withhold production, and produce less than Q_1.

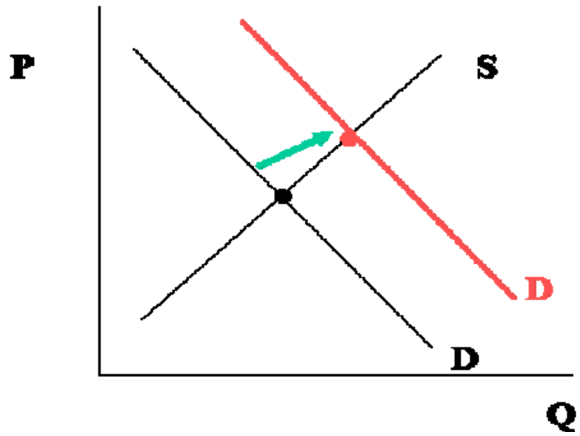
Figure A.2 A Monopolist Picks the Demand Price



Economic theory tells us that a monopolist can maximize profits by producing where marginal revenue equals marginal cost as shown in Figure A.2. More simply, the monopolist withholds production and raise price above the competitive price to receive higher profits. The arrow shows the increase in price, which will result in higher real net income for the monopolist than in a competitive market.

Although monopoly power can increase price, it is not the only possible explanation. *Increasing demand* in a competitive market raises prices as shown in Figure A.3.

Figure A.3 An Increase in Demand Raises Price



When demand increases, price and quantity both increase. Increases in demand can be caused by, among other things, increasing income, increasing the number of drivers, decreasing the price of complementary goods, increasing the price of substitutes, and changing consumer preferences.

Since gasoline refining is very capital intensive, it takes time to plan and put in new refining capacity.

If the increase in demand happens quickly and unexpectedly, demand may hit a supply capacity constraint (S_c) as shown in Figure A.4. Then the short run supply curve (S_{sr}) becomes vertical at S_c and large price increases (P_{sr}) may be required to allocate existing capacity. With a longer time to adjust, more capacity can be put in and the long run supply curve becomes S_{lr} and the price falls to P_{lr} over time.

Figure A.4 Increased Demand with Capacity Constraints

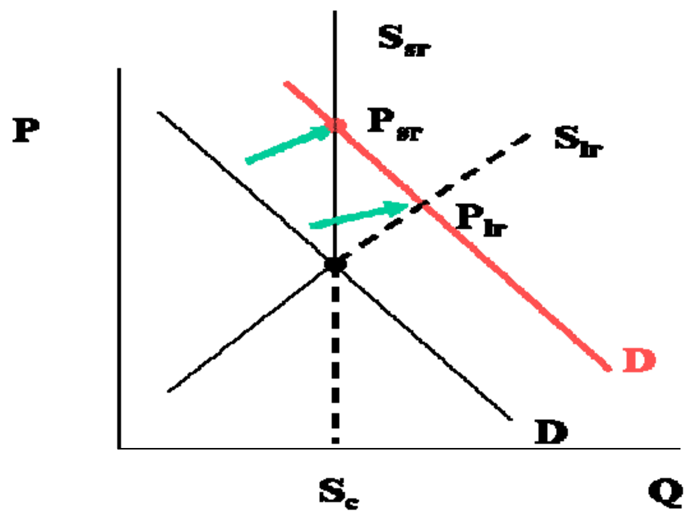
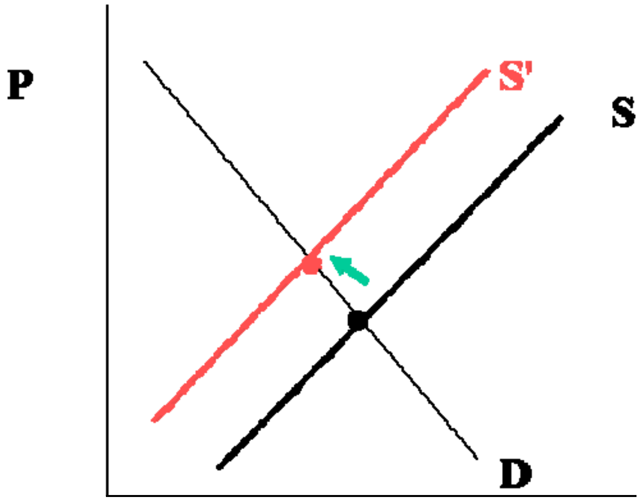


Figure A.5 A Shift in Supply Raises Price.

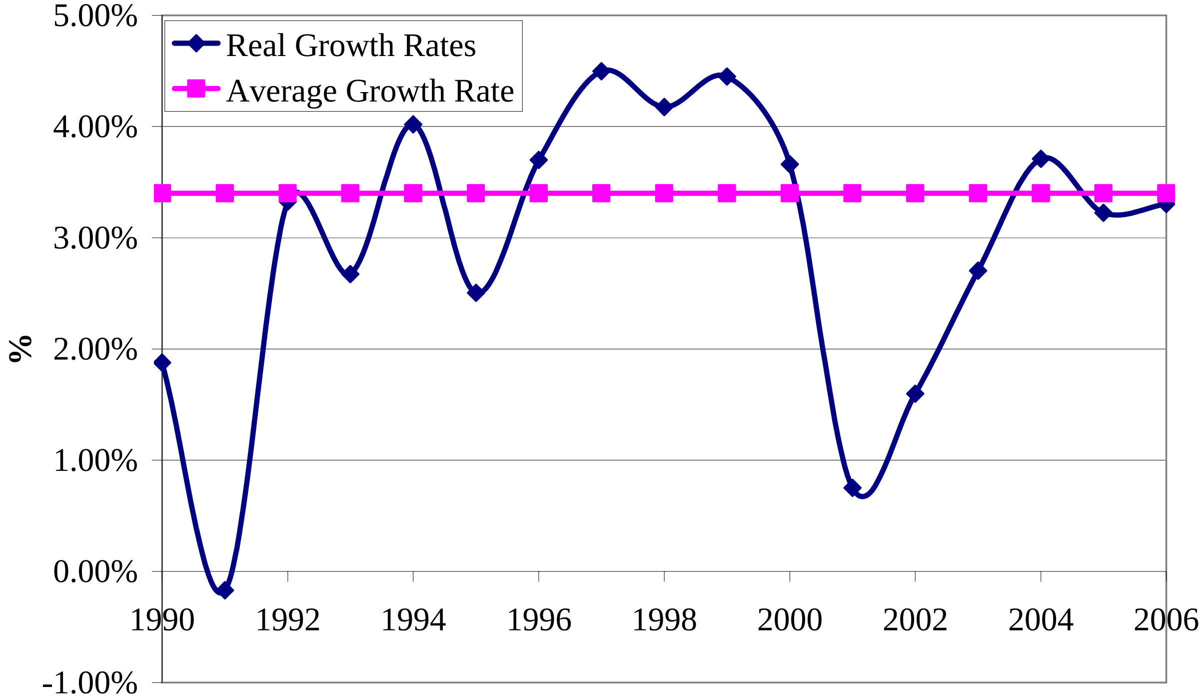


A shift in the supply curve raises prices as shown in Figure A.5. If cost increases, each supplier requires a higher price for each gallon and we get a decrease in supply at any given price. In this case, increasing price is associated with a decrease in gasoline consumption. But here costs, rather than the deliberate actions of a monopolist, drive the price change. Since competitive supply is at the marginal cost, anything that raises costs in the market would decrease supply. In this way, increasing crude oil prices or more stringent environmental regulation can shift the supply curve and push up price.

Appendix B: GDP Growth Rates and Recent Forecasts

Figure B.1 shows growth rates for U.S. Growth Domestic Product (GDP) since 1990. The above average rates in 2004 and 2006:I were particularly unexpected.

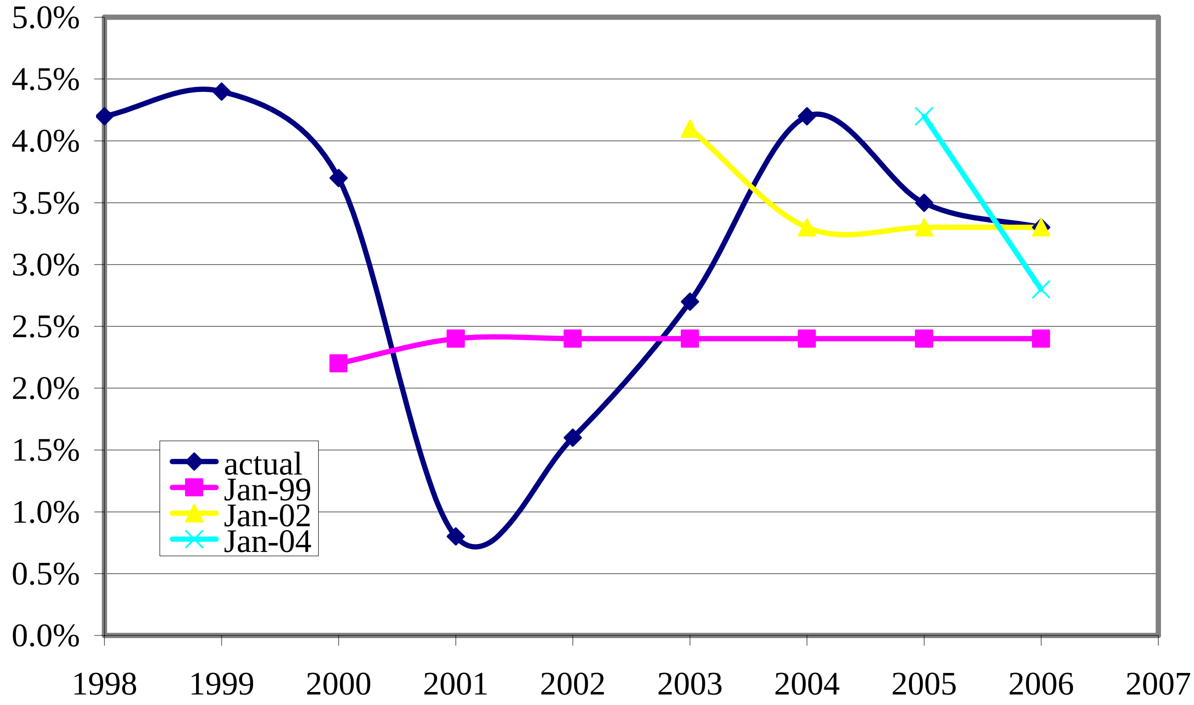
Figure B.1 Annual Real GDP Growth, 1990-2006



Source: Created with data from *Economic Report of the President*, http://www.gpoaccess.gov/eop/, updated with data from Bureau of Economic Analysis. http://www.bea.gov/

Figure B.2 compares actual real GDP growth with forecasts made by the Congressional Budget Office (CBO) in 1999, 2002 and 2004. All the CBO forecasts under predicted U.S. GDP growth in 2004 and 2006, and most under predicted growth in 2005.

Figure B.2 US Real GDP and Forecasted GDP Growth



Source: Created with data from the Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2000-2009*, January 1999, http://www.cbo.gov/showdoc.cfm?index=1059&sequence=1.

The Budget and Economic Outlook: Fiscal Years 2003-2012, January 2002, http://www.cbo.gov/showdoc.cfm?index=3277&sequence=3.

The Budget and Economic Outlook: Fiscal Years 2005-2014, January 2004, http://www.cbo.gov/showdoc.cfm?index=4985&sequence=3.

Appendix C: Regression of Gasoline Price Less Tax on Crude Oil Price

The nominal price of gasoline less tax is in dollars per gallon and the nominal price of crude is in dollars per barrel. Regressions from 1947-2005 and 1977-2005 found a similar effect for crude price on gasoline price less tax.

Table C.1 Summary Statistics for Regression of Gasoline Price less Tax on Crude Price

$$\text{Price of Gasoline Less Tax} = \underset{(17.02)}{5.63} + \underset{(59.22)}{0.0256} * \text{Price of Crude}$$

R^2	0.976	$F_{1,87} = 3506$	Years 1918-2005

Appendix D: Worldwide Ultra Low Sulfur Diesel (ULSD) Regulations

Table D.1 shows the timeline for some of the worldwide regulations related to sulfur in diesel fuel that have contributed to increases in the cost of diesel fuel.

Table D.1 Worldwide ULSD Regulations

Country/Region	Target (ppm)	Date
United States	15	2006
Canada	15	2006
Europe	50	2005
	10	2006-09
Australia	50	2006
	10	2009
Japan	10	2007
Korea	30	2006
China	500	2005
Some Cities	350	2005
India	500	2005
	350	2010
Some Cities	350	2005
Some Cities	50	2010
Singapore	50	2006
Latin America	50-5000	2005-10
South Africa	500	2006
	50	2010”

Source: Tippee, Bob “Sulfur Cuts, European Demand Growth Reshaping Diesel Market,” *Oil and Gas Journal*, 12/12/05:19.

Appendix E: State Actions Banning MTBE

The following Table compiled by EPA shows each state's restrictions on methyl tertiary-butyl ether (MTBE). For more information on MTBE, see http://www.epa.gov/mtbe.

Table E.1 State Restrictions on MTBE

State (EPA Region)	**Phase-out date** (in chronological order)	**Complete or partial ban?**	**Applies to other oxygenates?**	**Date of adoption**
IA (7)	7/1/00	Partial: no more than trace amounts (0.5% by vol.) MTBE in motor vehicle fuel.	MTBE only	5/11/00 Replaced previous limit of 2% (vol.)
MN (5)	7/2/00 (partial) 7/2/05 (complete)	Partial/then complete: no more than 1/3 of 1% oxygenate as of 7/2/00; complete ban as of 7/2/05.	MTBE, ETBE[1], and TAME[2]	Early 2000
NE (7)	7/13/00	Partial: no more than 1% (vol.) MTBE in any petroleum product.	MTBE only	4/11/00
SD (8)	7/1/01	Partial: no more than trace amounts (less than 0.5% vol.) resulting from commingling during storage or transfer.	MTBE only	2/28/01 Replaced previous limit of 2% (vol.)
CO (8)	4/30/02	Complete ban by 4/30/02.	MTBE only	5/23/00
CA (9)	Originally12/31 /02; delayed to 12/31/03	Complete ban by 12/31/02, but latest Exec. Order requires CARB to implement by 7/31/02 a one-year delay in ban. On 7/25/02, CARB delayed the ban by 1 year.	MTBE only	10/9/99 (Orig. E.O. issued 3/25/99; latest E.O. issued 3/15/02)

[1] ETBE: Ethyl tertiary butyl ether [2] TAME: Tertiary amyl methyl ether

1

State (EPA Region)	Phase-out date (in chronological order)	Complete or partial ban?	Applies to other oxygenates?	Date of adoption
MI (5)	6/1/03	Complete ban by 6/1/03; can be extended if determined by 6/1/02 that phase out date is not achievable.	MTBE only	6/26/00
CT (1)	1/1/04	Complete ban by 1/1/04, planned in conjunction with NESCAUM regional fuels task force.	MTBE only	6/1/00 (Orig. phase out date 10/1/03; extended to 1/1/04 on 6/18/03)
NY (2)	1/1/04	Complete ban as of 1/1/04.	MTBE only	5/24/00
WA (10)	1/1/04	Partial: may not be intentionally added to fuel, or knowingly mixed in gasoline above 0.6% (vol.)	MTBE only	5/10/01
KS (7)	7/1/04	Partial: may not sell or deliver any motor vehicle fuel containing more than 0.5% (vol.) MTBE	MTBE only	4/19/01
IL (5)	7/24/04	Partial: may not use, sell or manufacture MTBE as a fuel additive, but may sell motor fuel containing trace amounts of MTBE (0.5% or less by volume)	MTBE only	7/24/01 (original ban) revised 6/24/02 to allow trace amounts
IN (5)	7/24/04	Partial: no more than 0.5% (vol.) MTBE in gasoline	MTBE only	3/14/02
WI (5)	8/1/04	Partial: no more than 0.5% (vol.) MTBE in gasoline	MTBE only	8/11/03
OH (5)	7/1/05	Partial: no more than 0.5% (vol.) MTBE in motor vehicle fuels	MTBE only	5/29/02

State (EPA Region)	Phase-out date (in chronological order)	Complete or partial ban?	Applies to other oxygenates?	Date of adoption
MO (7)	7/31/05	Partial: no more than 0.5% (vol.) MTBE in gasoline sold or stored	MTBE only	7/11/02
KY (4)	1/1/06	Partial: no more than trace amounts of MTBE in fuel after this date	MTBE only	4/23/02
ME (1)	1/1/07	Partial: no more than 0.5% (vol.) MTBE in gasoline sold.	MTBE only	4/14/04
NH (1)	The latter of 1/1/07 or 6 months after Federal approval to opt out of RFG	Partial: no more than 0.5% (vol.) in gasoline sold or stored	MTBE, other gasoline ethers, or tertiary butyl alcohol (TBA)	5/27/04

Source: EPA420-B-04-009 June 2004, http://www.epa.gov/mtbe/420b04009.pdf.

Appendix F: Refinery Capacity, Pipelines and Gasoline Specifications by State

Table F.1 Refinery Capacity, Product Pipelines and Gasoline Specifications by State

State	Refinery Capacity (barrels/ day)	Product Pipelines	Gasoline Specifications
Alabama	113,500	3	7.0 RVP gasoline in Birmingham metropolitan area and conventional gasoline statewide
Alaska	373,500	0	Conventional gasoline statewide
Arizona	0	1	The Phoenix area: Arizona Clean Burning Gasoline Tucson: oxygenated gasoline from October 1 to March 31.
Arkansas	76,800	3	Conventional gasoline statewide
California	2,004,788	3	California Reformulated Gasoline used in all but LA and Sacramento area and they use Federal Reformulated Gasoline.
Colorado	87,000	5	Oxygenated gasoline in the contiguous metropolitan areas stretching from Denver to Fort Collins during winter
Connecticut	0	1	Reformulated gasoline statewide
Delaware	175,000	1	Reformulated gasoline statewide
Florida	0	2	7.8 RVP gasoline in the Miami, Jacksonville, and Tampa/St. Petersburg metropolitan areas, while conventional gasoline statewide
Georgia	0	2	7.0 RVP gasoline in Atlanta while conventional gasoline statewide
Hawaii	147,500	0	Conventional gasoline is used statewide
Idaho	0	2	Conventional gasoline is used statewide
Illinois	147,500	11	Chicago area uses reformulated gasoline made with ethanol
Indiana	433,000	7	Conventional gasoline except near Chicago is required to use reformulated gasoline blended with ethanol, and the northern suburbs of Louisville, Kentucky that is required to use 7.8 RVP gasoline
Iowa	0	4	Conventional gasoline is used statewide
Kansas	296,200	10	Kansas City requires 7.0 RVP and conventional statewide
Kentucky	227,500	2	Reformulated gasoline in the Louisville area and the suburbs of Cincinnati, while conventional gasoline is used throughout the rest of the state

State	Refinery Capacity (barrels/ day)	Product Pipelines	Gasoline Specifications
Louisiana	2,772,723	9	7.0 to 7.8 RVP gasoline in the heavily populated corridor that stretches from New Orleans to Baton Rouge, the City of Alexandria, and the Lake Charles area. All other areas of the state use conventional gasoline
Maine	0	2	Conventional gasoline in the winter and lower 7.8 RVP gasoline in the summer
Maryland	0	1	Reformulated gasoline in Baltimore/Washington areas but uses conventional gasoline in the rest
Massachusetts	0	2	Reformulated gasoline statewide
Michigan	74,000	5	Conventional gasoline statewide requires7.8 RVP in Detroit area
Minnesota	335,000	2	Oxygenated gasoline statewide
Mississippi	364,800	2	Conventional gasoline statewide
Missouri	0	9	Reformulated gasoline in St. Louis area, 7.0 RVP gasoline in Kansas City area, and conventional gasoline in the rest
Montana	181,200	3	Oxygenated gasoline in Missoula area, conventional gasoline rest of state
Nebraska	0	5	Conventional gasoline statewide
Nevada	1,707	2	Nevada Clean Burning Gasoline in the Las Vegas area while 7.8 RVP oxygenated gasoline is required in the Reno area
New Hampshire	0	0	Reformulated gasoline around Manchester and Nashua while conventional gasoline is used in the rest of the state.
New Jersey	615,000	3	Reformulated gasoline statewide
New Mexico	112,600	6	Oxygenated gasoline in the Albuquerque area, and conventional gasoline in the remaining areas of the state
New York	0	2	Reformulated gasoline blended with ethanol in New York City conventional gasoline in the other regions of the state
North Carolina	0	2	7.8 RVP in Raleigh/Durham, Winston-Salem, Greensboro, and Charlotte, while conventional gasoline is used in the rest of the state
North Dakota	58,000	3	Conventional gasoline statewide
Ohio	551,400	7	Conventional gasoline statewide
Oklahoma	484,961	6	7.8 RVP in Tulsa area and conventional gasoline statewide
Oregon	0	2	Oxygenated gasoline in Medford and Grants Pass areas and 7.8 RVP oxygenated gasoline in the Portland region
Pennsylvania	770,000	6	Reformulated gasoline along the heavily populated eastern section of the state, while lower 7.8 RVP in the Pittsburgh metropolitan area during summer

State	Refinery Capacity (barrels/ day)	Product Pipelines	Gasoline Specifications
Rhode Island	0	1	Reformulated gasoline statewide
South Carolina	0	2	Conventional gasoline statewide
South Dakota	0	3	Conventional gasoline statewide
Tennessee	180,000	3	7.8 RVP in Nashville and Memphis and conventional gasoline throughout the rest of the state
Texas	4,627,611	24	Oxygenated 7.0 RVP gasoline in El Paso; reformulated gasoline in the Dallas/Fort Worth and the Houston/Galveston metropolitan areas; 7.8 RVP gasoline in the Beaumont area; 7.8 RVP (MTBE) gasoline in other East Texas areas; and conventional gasoline in the rest of the state
Utah	167,350	2	The Salt Lake City/Ogden metropolitan area requires 7.8 RVP gasoline Provo area requires oxygenated 7.8 RVP gasoline
Vermont	0	0	Conventional gasoline statewide
Virginia	58,600	2	Reformulated gasoline in the Northern Virginia suburbs of Washington, D.C., and areas of Richmond and Norfolk/Hampton Roads.
Washington	616,150	3	Conventional gasoline statewide
West Virginia	19,400	0	Conventional gasoline statewide
Wisconsin	33,000	2	Reformulated gasoline blended with ethanol in winter months
Wyoming	152,000	5	Conventional gasoline statewide

Source: EIA, http://tonto.eia.doe.gov/oog/info/state/al.html.

Appendix G: Companies Representing the FRS from 1974-2005

Table G.1 Companies Reporting to the Financial Reporting System (FRS), 1974-2004

	74		83-	85-			89-		92-	94-							03-
Company	**81**	**82**	**84**	**86**	**87**	**88**	**90**	**91**	**93**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**05**
Amerada Hess Corporation	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
American Petrofina, Inc.[1]	o	o	o	o	o	o	o										
Anadarko Petroleum Corporation								o	o	o	o	o	o	o	o	o	o
Apache Corporation														o	o	o	o
Ashland Inc. [4]	o	o	o	o	o	o	o	o	o	o	o						
Atlantic Richfield Co. (ARCO) [29]	o	o	o	o	o	o	o	o	o	o	o	o	o				
BP America, Inc.[3 5]					o	o	o	o	o	o	o	o	o			o	o
BP Amoco Corporation[2 3 29]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		
Burlington Northern Inc.[6]	o	o	o	o	o												
Burlington Resources Inc.[6]						o	o	o	o	o	o	o	o	o	o	o	o
Chesapeake Energy Corporation																	o
ChevronTexaco Corporation [8 30]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Citgo Petroleum Corporation												o	o	o	o	o	o
Cities Service[9]	o	o															
ConocoPhillips, Inc.[10 11 33]	o											o	o	o	o	o	o
Devon Energy Corporation														o	o	o	o
Dominion Resources														o	o	o	o
E.I. du Pont de Nemours and Co.[10 11]		o	o	o	o	o	o	o	o	o	o						
El Paso Energy Corporation [28]													o	o	o	o	o

	74		83-	85-			89-		92-	94-							03-
Company	**81**	**82**	**84**	**86**	**87**	**88**	**90**	**91**	**93**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**05**
Enron Corp.									o	o	o	o	o	o			
EOG Resources														o	o	o	o
Equilon Enterprises, LLC [12]												o	o	o	o		
Equitable Resources, Inc.																	o
Exxon Mobil Corporation [13]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Getty Oil[14]	o	o	o														
Gulf Oil[8]	o	o	o														
Kerr-McGee Corporation [15]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
LYONDELL-CITGO Refining, LP [16]												o	o	o	o	o	o
Marathon [17]	o															o	o
Mobil Corporation [13] [18]	o	o	o	o	o	o	o	o	o	o	o	o					
Motiva Enterprises LLC [19]												o	o	o	o	o	o
Nerco, Inc.[20]									o								
Occidental Petroleum Corporation[9]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Oryx Energy Company[15 21]						o	o	o	o	o	o						
Phillips Petroleum Company[32 33]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
Premcor Refining Group [27]												o	o	o	o	o	o
Shell Oil Company	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Sonat Inc.											o	o					
Standard Oil Co. (Ohio) (SOHIO)[5]	o	o	o	o													
Sunoco, Inc.[21 22]	o	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o

Company	74-81	82	83-84	85-86	87	88	89-90	91	92-93	94-96	97	98	99	00	01	02	03-05
Superior Oil[18]	o	o	o														
Tenneco Inc.[23]	o	o	o	o	o	o											
Tesoro Petroleum Corporation												o	o	o	o	o	o
Texaco Inc.[14 30]	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
The Coastal Corporation [28]	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
The Williams Companies, Inc.												o	o	o	o	o	o
Tosco Corporation [32]												o	o	o	o		
Total Holdings, USA.[1 26 35]								o	o	o	o	o	o	o	o	o	o
Total Petroleum (North America) Ltd.[24]							o	o									
Ultramar Diamond Shamrock Corporation [34]												o	o	o	o		
Union Pacific Resources Group, Inc. [25 31]	o	o	o	o	o	o	o	o	o	o	o	o	o				
Unocal Corporation	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
USX Corporation	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		
Valero Energy Corporation [34]												o	o	o	o	o	o
XTO Energy, Inc.																o	o

[1]American Petrofina, Inc. changed its name to Fina, Inc., effective April 17, 1991.

[2]Formerly Standard Oil Company (Indiana).

[3]Amoco merged with British Petroleum plc and became BP Amoco plc on December 31, 1998. BP America was renamed BP Amoco, Inc. The companies reported separately for 1998 and 1999.

[4]Ashland was dropped from the FRS system for 1998 after spinning off downstream and coal operations and disposing of upstream operations.

[5]In 1987, British Petroleum acquired all shares in Standard Oil Company (Ohio) that it did not already control and renamed its U.S. affiliate, BP America, Inc.

[6]Burlington Resources was added to the FRS system and Burlington Northern was dropped for 1988. Data for Burlington Resources covers the full year 1988 even though that company was not created until May of that year.

[7]Formerly Standard Oil Company of California.

[8]Chevron acquired Gulf Oil in 1984, but separate data for Gulf continued to be available for the full 1984 year.
[9]Occidental acquired Cities Service in 1982. Separate financial reports were available for 1982, so each company continued to be treated separately until 1983.
[10]DuPont acquired Conoco in 1981. Separate data for Conoco were available for 1981; DuPont was included in the FRS system in 1982.

[11]Dupont was dropped from the FRS system when Conoco was spun-off in 1998. Conoco began reporting separately again in 1998.
[12]Equilon is a joint venture combining Shell's and Texaco's western and midwestern U.S. refining and marketing businesses and nationwide trading transportation and lubricants businesses. Net income is duplicated in the FRS system since Shell and Texaco account for this investment using the equity method.

[13]In December 1998, Exxon and Mobil agreed to merge. Both companies reported separately for 1998.

[14]Texaco acquired Getty in 1984; however, Getty was treated as a separate FRS company for that year.

[15]In 1998, Kerr-McGee and Oryx merged. The financial reporting for both was consolidated under Kerr-McGee for 1998.
[16]LYONDELL-CITGO is a limited partnership owned by Lyondell Chemical Company and Citgo. There will be some duplication of net income since Citgo accounts for its investment using the equity method.

[17]U.S. Steel (now USX) acquired Marathon in 1982.

[18]Mobil acquired Superior in 1984, but both companies were treated separately for that year.
[19]Motiva is a joint venture approximately equally owned by Shell, Texaco and Saudi Refining, Inc. The joint venture combines the company's Gulf and east coast refining and marketing businesses. Duplication exists for the net income related to Shell and Texaco's interests which are accounted for under the equity method.
[20]RTZ America acquired the common stock of Nerco, Inc., on Feb. 17, 1994. In Sept. 1993, Nerco, Inc. sold Nerco Oil & Gas, Inc., its subsidiary. Nerco's 1993 submission includes operations of Nerco Oil & Gas, Inc., through Sept. 28, 1993.
[21]Sun Company spun off Sun Exploration and Development Company (later renamed Oryx Energy Company) during 1988. Both companies were included in the FRS system for 1988; therefore, some degree of duplication exists for that year.
[22]Sun company withdrew from oil and gas exploration and production in 1996. Sun’s 1996 submission includes oil and gas exploration and production activities through September 30, 1996. Refining/marketing activities are included for the entire 1996 calendar year. In 1998 the company changed its name to Sunoco, Inc.
[23]Tenneco sold its worldwide oil and gas assets and its refining and marketing assets in 1988. Other FRS companies purchased approximately 70 percent of Tenneco's assets.

[24]Effective June 1, 1991, Total's exploration, production, and marketing operations in Canada were spun off to Total Oil & Gas, a new public entity.
[25]Effective October 15, 1996, Union Pacific Corporation distributed its ownership in the Union Pacific Resources Group, Inc. to its shareholders. Prior to 1996, the FRS system included Union Pacific Corporation. The FRS system includes only Union Pacific Resources Group, Inc. for 1996.
[26]Prior submissions were reported at the FINA, Inc. level. FINA, Inc. was the parent of Fina Oil and Chemical Company, which is now ATOFINA Petrochemicals. Due to a series of mergers and acquisitions, beginning in 2000, the submission is reported at the American Petrofina Holding Company level, which is the holding company of ATOFINA.

[27]In May 2000, Clark Refining & Marketing changed its name to Premcor Refining Group.
[28]In January 2001, Coastal merged with a wholly owned subsidiary of El Paso Energy Corporation. The name was changed to El Paso CGP Company. Data were reported separately in 2000 under the name The Coastal Company.
[29]BP Amoco acquired Atlantic Richfield Company (ARCO) in April of 2000. The reporting was consolidated under BP Amoco for 2000. Data for ARCO is not included in the database for the period from January 1, 2000 to April 14, 2000.

[30]In October 2000, Chevron and Texaco agreed to merge. Both companies reported separately for 2000.
[31]Union Pacific merged with Anadarko on July 14, 2000. Anadarko's 2000 submission includes data for Union Pacific after July 14, 2000. Data for Union Pacific was not submitted for the period from January 1, 2000 to July 14, 2000.

[32]In September 2001, Phillips acquired Tosco. Both companies reported separately in 2001.
[33]In November 2001, Phillips and Conoco agreed to merge forming ConocoPhillips in 2002. Both companies reported separately in 2001. The companies reported separately in 2002 until the time of the merger.

[34]In December 2001, Valero and Ultramar Diamond Shamrock agreed to merge. Both companies reported separately in 2001.

[35] In 2002, the name was changed to Total Fina Elf and changed to Total Holdings, USA in 2003.

o : Indicates that the company was included in the FRS system for the year indicated.

Source: 2005 EIA/DOE *Performance Profiles of Major Energy Producers*, 1977 – 2004 at http://www.eia.doe.gov/emeu/perfpro/taba1.html.

Appendix H: Comparison of California and Federal Fuel Regulations

Table H.1 contains a comparison of U.S. Federal and California gasoline regulations. California Phase 2 gasoline required in 1996 is roughly equivalent to the Federal Phase II reformulated in 2000 and California Phase III, required in 2004, banned MTBE.

Table H.1

Federal	Year	Year	California
		1960	**Bromine Number** Control/reduce the formation of ozone
		1971	**Summer Vapor Pressure** Reduce evaporative hydrocarbon emissions from vehicles and fuel distribution system, and reduce ozone
Unleaded Gasoline Reduce health risks from airborne lead oxides and enable use of catalytic converters on vehicles to reduce emissions	1974		
		1976 1978 1980	**Sulfur Content** Reduce sulfur oxide emissions and particulates
Summer Vapor Pressure Reduce evaporative hydrocarbon emissions from vehicles and fuel distribution system and reduce ozone	1989		
Summer Vapor Pressure Further reduce evaporative hydrocarbon emissions and ozone **Winter Oxygen** Reduce carbon monoxide emissions from vehicles in nonattainment areas	1992	1992	**Phase 1 Reformulated (Summer Vapor Pressure)** Further reduce evaporative hydrocarbon emissions and ozone — more restrictive than federal requirements **Winter Oxygen** Reduce carbon monoxide emissions from vehicles **Leaded Fuels Banned** Protect public health **Deposit Control Additives** Reduce carbon monoxide emissions
Phase I Reformulated Reduce ozone and toxics in nonattainment areas **Deposit Control Additives** Reduce vehicle emissions caused by fuel system deposits	1995		
Leaded Fuels Banned Protect public health	1996	1996	**Phase 2 Reformulated** Achieve maximum "cost-effective" reductions in vehicle emissions, including toxics
Phase II Reformulated Further reduce ozone and toxics in nonattainment areas	2000		
Tier 2 Sulfur Regulation Ensure effectiveness of advanced emission control technologies	2004	2004	**Phase 3 Reformulated** Bans MTBE and provides more refinery blending flexibility

Source: http://www.chevron.com/products/prodserv/fuels/bulletin/motorgas/2_air-quality/pg5.asp.

Appendix I: Comparison of Refining in the U.S. and Asia

Simple distillation units in a refinery heat crude oil at atmospheric temperatures to decompose crude into its component parts. For cleaner and lighter products, more complicated processes than simple distillation are needed including:

- Vacuum distillation which heats crude at lower pressures and temperatures to prevent cracking
- Thermal cracking, catalytic cracking, and catalytic hydrocracking, all of which crack heavier hydrocarbons into lighter products
- Coking which converts very heavy products into coke and much lighter products
- Catalytic hydrotreating, which cleans sulfur from products
- Catalytic reforming which raises the octane of gasoline

U.S. refineries with large amounts of these specialist processing capacities are amongst the most sophisticated in the world. Table I.1 shows the percentage of charge capacity for each downstream process in the United States and six Asian gasoline exporting countries.

Table I.1

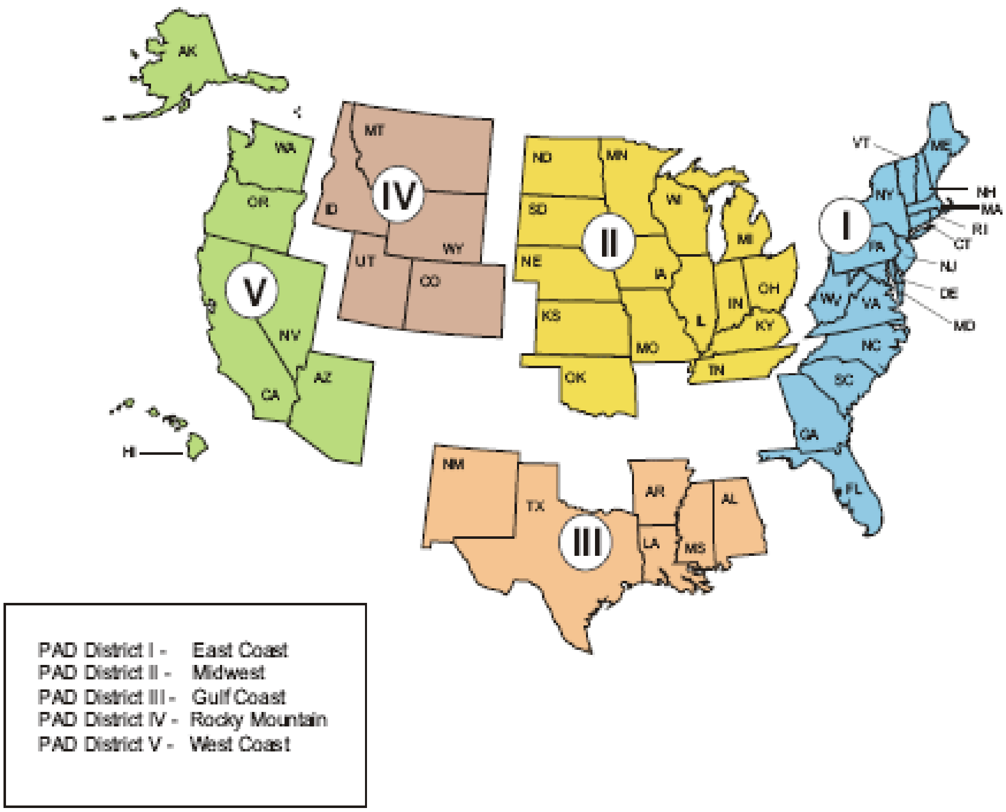
Process Capacity as Percent of Total Crude Distillation Capacity

	Vacuum Distillation	Coking	Catalytic Cracking	Catalytic Reforming	Catalytic Hydro-cracking	Catalytic Hydro-treating
U.S.	44.3%	13.7%	33.3%	20.5%	8.5%	77.0%
China	3.8%	2.5%	9.4%	2.5%	0.8%	7.1%
China, Taiwan	15.7%	4.2%	16.1%	9.4%	0.0%	40.8%
India	22.5%	7.5%	13.2%	1.8%	2.4%	10.1%
Korea, S.	12.2%	0.7%	7.3%	9.2%	4.7%	41.5%
Singapore	23.5%	0.0%	5.2%	10.7%	7.3%	43.8%
Thailand	26.4%	0.0%	12.0%	13.3%	6.1%	65.6%

Source: Compiled from information in *Oil and Gas Journal.* 12/19/05:64.

For each barrel of oil distilled, the U.S. has close to two or more times as much downstream processing capacity as the Asian refiners. For example, around 14% of the crude refined in the U.S. can be sent to a coker, compared to only 7% in India. One third of each U.S barrel can be sent to a cat cracker, one fifth to a reformer. Singapore can send almost as much of a barrel to a hydrocracker as the U.S., but has considerably less catalytic hydrotreating capacity.

Appendix J: Map of U.S. Petroleum Administrative Defense (PAD) Districts



Source: Energy Information Administration. Office of Integrated Analysis and Forecasting

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Appendix K: Regression Results for ROI on Income

Table K.1 displays the regression results of real net income by sector on Return on Investment (ROI) for the sector for 1977-2005. This regression was used to forecast ROI in 2006 for each sector. The forecasted values were only used for U.S. refining, U.S. production, and foreign refining. Foreign production was not used due to the low R^2.

Return on Investment (ROI) = $B_o + B_1$ * Net income

Table K.1 Summary Statistics by Sector

		U.S. Refining	
	ROI = .012064 + 0.012853 * Net Income		
	(3.93) (26.56)		
R^2	0.964	$F_{1,27} = 705$	Years 1977 - 2005
		U.S. Production	
	ROI = .010673 + 0.005859 * Net Income		
	(1.54) (15.25)		
R^2	0.895	$F_{1,27} = 232$	Years 1977 - 2005
		Foreign Refining	
	ROI = .021772 + 0.025084 * Net Income		
	(2.50) (16.14)		
R^2	0.909	$F_{1,27} = 260$	Years 1977 - 2005
		Foreign Production	
	ROI = .059918 + 0.006193 * Net Income		
	(4.09) (6.10)		
R^2	0.579	$F_{1,27} = 37.18$	Years 1977 - 2005

Appendix L: Regression of Investment on Income

In order to determine how income affects investment, we regressed investment against net income and lags in net income. The equation with current and two years of lagged income had the best explanatory power. The results of the regression are in table L.1. The regression shows that for every $1 increase in current period net income investment increases by about $0.18. The regression also shows that there is a lag effect and this $1 increase in net income raises next year's investment by about $0.14 and the following year an additional $0.17.

$$Investment = B_o + B_1 * Income_t + B_2 * Income_{t-1} + B_3 * Income_{t-2}$$

Table L.1

$$Investment = 42.49 + .185 * Income_t + 0.142 * Income_{t-1} + 0.168 * Income_{t-2}$$

	(17.18)	(3.65)	(1.81)	(2.24)
R^2	0.815		$F_{1,16} = 23.51$	Years 1986 - 2005

Appendix M: Refinery Closures 1981-2005

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United States Refineries Inoperable Shutdown as of January 1, 1981 through January 1, 2004

District/Refinery	Location	Crude Distillation Capacity (b/d)	Date of Last Operation	Date Shutdown	Years in Operation
PAD District I					
American Refining Group, Inc.	Indianaola, PA	180	03/84	12/85	3
Amoco Oil Co.	Baltimore, MD	15,000	01/82	03/82	25+
Ashland Oil Inc.	Buffalo, NY	64,000	07/82	12/84	36+
Ashland Oil Inc.	Freedom, PA	6,800	04/85	12/85	37+
ATC Petroleum Inc.	Newington, NH	13,400	07/81	12/81	7
Calumet Lubricants Co. LP	Rouseville, PA	12,800	03/00	06/00	50+
Chevron U.S.A. Inc.	Baltimore, MD	14,200	12/88	12/86	38
Cibro Refining	Albany, NY	41,850	07/93	09/93	14+
City Gas and Transmission Corp.	Wilmington, NC	10,000	05/81	12/89	11
Elk Refining Co. (division of Pennzoil Co. Inc.)	Falling Rock, WV	5,600	12/82	12/82	25+
GNC Energy Corp.	Greensboro, NC	3,000	NA	NA	10
Manatee Energy Co.	Port Manatee, FL	28,400	05/81	10/81	2
Mobil Oil Corp.	Buffalo, NY	43,000	05/81	07/81	25+
Primary Energy Corp.	Richmond, VA	6,100	NA	NA	7
Quaker State Oil Refining Corp.	Emlenton, PA	0	12/83	12/83	25+
St. Mary's Refg. Co.	St. Mary's, WV	4,000	02/93	03/93	45+
Seminole Refining Corp.	St. Marks, FL	17,000	05/87	03/88	28
Virginia Oil & Refining Co.,Inc.	Jonesville, VA	1,000	06/87	12/87	2
Young Refining Corp.	Douglasville, GA	5,400	07/05	07/05	48
TOTAL PAD I		291,730			
PAD District II					
Allied Materials Corp.	Stroud, OK	7,600	12/84	02/85	37+
Amoco Oil Co.	Sugar Creek, MO	104,000	05/82	06/82	25+
Amoco Oil Co.	Wood River, IL	104,000	05/81	10/81	25+
Ashland Oil Inc.	Findlay, OH	20,400	02/82	12/84	36+
Ashland Oil Inc.	Louisville, KY	25,200	04/82	12/84	36+
Barrett Refg. Corp.	Custer, OK	10,500	01/96	01/96	15
B-T Energy Corp.	Louisville, KY	3,000	11/84	11/85	3
Champlin Petroleum Co.	Enid, OK	53,800	06/83	12/83	25+
Chevron U.S.A. Inc.	Cincinnati, OH	43,700	05/86	08/86	38+
Coastal Refg. & Mktg.	Augusta, KS	0	05/93	06/93	7
Coastal Refg. & Mktg.	El Dorado, KS	0	*	*	
Coastal Refg. & Mktg.	Wichita, KS	43,700	05/93	06/93	45+
Conoco Inc.	Wrenshall, MN	23,500	05/81	09/81	5
CRA,Inc.	Scottsbluff, NE	5,800	05/82	06/82	25+
Crystal Refining	Carson City, MI	3,000	10/92	09/93	45+
Cyril Petrochemical Corp.	Cyril, OK	7,500	05/95	12/95	2
Dillman Oil Recovery Inc.	Oblong, IL	1,200	01/81	02/82	4+
Dow Chemical U.S.A.	Bay City, MI	20,000	05/80	09/81	25+
E-Z Serv Refining Inc.	Shallow Water, KS	9,500	04/81	02/82	25+
Energy Cooperative Inc.	East Chicago, IN	126,000	05/81	06/82	25+
Energy Development	Crossville, IL	1,000	02/81	04/81	22
Farmland Industries	Phillipsburg, KS	26,400	12/91	07/92	43+

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United States Refineries Inoperable Shutdown as of January 1, 1981 through January 1, 2004

District/Refinery	Location	Crude Distillation Capacity (b/d)	Date of Last Operation	Date Shutdown	Years in Operation
Flying J Petroleum Inc.	Williston, ND	4,600	08/84	12/87	32
Gladieux Refinery Inc.	Fort Wayne, IN	19,000	12/85	06/86	27+
Gulf Oil Corp.	Toledo, OH	50,300	06/81	11/81	25+
Hudson Refining Co. Inc.	Cushing, OK	19,000	12/82	11/83	6
Indian Refining	Lawrenceville, IL	80,750	09/95	10/95	6
Indiana Refining Inc.	Princeton, IN	5,000	12/80	02/81	23
Industrial Fuel and Asphalt of Indiana Inc.	Hammond, IN	7,600	12/81	06/82	25+
Intercoastal Energy Services Corp.	Troy, IN	1,250	11/90	3/91	
Kentucky Oil & Refining	Betsy Layne, KY	600	02/81	11/88	21
Laketon Refining Co.	Laketon,IN	11,100	06/95	01/96	5
Lakeside Refining Co.	Kalamazoo, MI	5,600	09/85	12/87	39
Marathon Oil Co.	Indianapolis, IN.	50,000	09/93	10/93	45+
Mid-America Refining Co. Inc.	Chanute, KS	3,000	03/81	07/82	25+
Motor Oils Refining	McCook, IL	1,500	01/88	02/88	6
Northland Oil and Refining Co.	Dickinson, ND	5,000	02/81	02/82	7
Okmulgee Refining Co.	Okmulgee, OK	25,000	06/82	12/82	25+
Premcor Refining Group	Blue Island, IL	80,515	01/01	04/01	50+
Premcor Refining Group	Hartford, IL	64,000	09/02	10/02	50+
Phillips Petroleum Co.	Kansas City, KS	80,000	08/82	09/82	25+
Texaco Inc.	Lockport, IL	72,000	04/81	10/81	25+
Texas American Petrochemical Inc.	West Branch, MI	11,500	09/81	02/82	25+
Tonkawa Refining Co.	Arnett, OK	12,000	06/84	09/84	16
Total Petroleum, Inc.	Arkansas City, KS	56,000	08/96	09/96	4
Tosco Corp.	Duncan, OK	47,000	06/83	12/84	35
TPI Petro. Inc.	Alma, MI	51,000	11/99	12/99	51
Wireback Oil Co.	Plymouth, OK	1,800	02/81	03/81	25+
TOTAL PAD II		1,404,715			
PAD District III					
Adobe Refining Co., div. of Funding Systems Refining Corp.	La Blanca, TX	5,200	11/81	12/81	25+
Amber Refining Inc.	Fort Worth, TX	19,700	12/85	12/88	42
Amerada Hess	Purvis, MS	30,000	01/94	02/94	35+
American International	Lake Charles, LA	30,000	09/01	01/02	2
Arcadia Refg. & Mktg.	Lisbon, LA	7,350	01/96	06/96	13
Barrett Refining Corp.	Vicksburg, MS	8,000	01/79	06/95	16+
Bayou State Oil Corp.	Houston, LA	3,000	01/81	03/82	25+
Berry Petroleum Co.	Stephens, AR	6,700	07/99	02/00	50+
Brio Refining Inc.	Friendswood, TX	12,500	09/82	12/82	4
Bronco Refining Co.	Houston, TX	2,250	04/81	07/82	1
Canal Refining Co.	Church Point, LA	9,500	05/97	06/97	44+
Carbonit Refining Co.	Hearne, TX	11,000	02/81	12/81	6
Caribou-Four Corners Inc.	Farmington, NM	2,200	05/82	08/84	19

United States Refineries Inoperable Shutdown as of January 1, 1981 through January 1, 2004

District/Refinery	Location	Crude Distillation Capacity (b/d)	Date of Last Operation	Date Shutdown	Years in Operation
Clark Oil & Refining Corp.	Mt. Airy, LA	0	12/86	12/87	39
Clinton Manges	Palestine, TX	6,000	07/81	07/82	25+
Conoco Inc.	Alvin/Texas City, TX	33,274	10/85	12/85	22
Conoco Inc.	Egan, LA	2,800	12/86	02/89	16
Copano Refining Co.	Ingleside, TX	11,100	09/81	02/82	4
Damson Gas Processing Corp.	White Deer, TX	0	02/85	05/85	12
Donna Refining Partners Ltd.	Donna, TX	4,750	11/89	12/89	1
Dorchester Refining Co.	Mt. Pleasant, TX	26,500	09/84	12/84	36+
Dow Chemical U.S.A.	Freeport, TX	190,000	08/81	06/82	1
Dubach Gas	Dubach, CA.	8,500	12/93	12/93	20
Eagle Refining	Jackson, TX	1,800	01/90	10/90	
Eddy Refining Co.	Houston, TX	3,250	10/84	11/84	36+
El Paso Refining, L.P.	El Paso, TX	50000	10/92	12/92	6
Erickson Refining Corp.	Pt. Neches, TX	30,000	12/81	08/83	4
Evangeline Refining Co.	Jennings, LA	4,500	12/82	12/82	25+
Flint Chemical Co.	San Antonio, TX	1,500	01/85	03/85	23
GAMXX Energy Inc.	Theodore, AL	27,000	01/88	03/88	17
Giant Industries Inc.	Farmington, NM	13,500	05/82	11/82	7
Gold Line Refg., Ltd.	Lake Charles, LA	27,600	05/97	04/97	17+
Gold Line Refg., Ltd.	Jennings, LA	12,000	07/97	01/98	1
Gulf Oil Corp.	Venice, LA	28,700	04/81	12/81	13
Imron Refg., Inc.	San Leon, TX	7,000	NA	08/90	0
Independent Refining Corp.	Winnie, TX	50,000	10/81	08/83	23
Liquid Energy Corp.	Bridgeport, TX	10,000	02/87	10/88	6
Longview Refining Assoc.	Longview, TX	13,300	08/92	09/92	3
MacMillan Petroleum Co.	Norphlet, AR	5,800	08/87	12/87	39
Mallard Resources Inc.	Gueydan, LA	7,400	11/83	12/83	4
McTan Refining Corp.	St. James, LA	19,300	07/81	08/83	6
Mid-Gulf Energy Corp.	Ingleside, TX	39,400	10/83	05/84	6
Natchez Refining Co.	Natchez, MS	16,000	06/82	09/82	2
OGC Corp.	Egan, LA	5,000	09/87	10/88	2
Pacific Refg.	Hercules, CA	50,000	07/95	09/97	29
Petraco-Valley Oil Refining Co.	Brownsville, TX	12,300	03/83	12/83	5
Petrolite Corp.	Kilgore, TX	600	12/97	02/98	45+
Petromax Refining Co.	Houston, TX	2,000	09/85	05/86	4
Placid Oil Co.	Mont Belvieu, TX	8,500	01/82	07/82	2
Port Petroleum Inc.	Stonewall, LA	3,200	12/83	02/84	4
Pride Refg. Inc.	Abilene, TX	42,750	05/98	04/98	37+
Quintana Petrochemical Co.	Corpus Christi, TX	33,300	07/84	09/84	30
Quitman Refining Co.	Quitman, TX	6,600	04/82	06/82	4
Rattlesnake Refining	Wickett, TX	8,000	02/92	03/92	2
Rio Grande Crude Refining	Brownsville, TX	9,500	06/81	06/82	3
Rio Grande Recovery Systems Inc.	Brownsville, TX	1,000	05/81	02/82	2
Sabine Resources	Stonewall, LA	12,000	(b)	02/92	0
Schulze Processing Inc.	Tallulah, LA	1,760	05/81	08/82	4

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District/Refinery	Location	Crude Distillation Capacity (b/d)	Date of Last Operation	Date Shutdown	Years in Operation
Shepard Oil Co.	Jennings, LA	10,000	05/81	02/82	4
Shell Oil Co.	Odessa, TX	28,300	10/98	11/98	39+
Shore, Inc.	Kilgore, TX	550	03/83	07/83	3
Sooner Refining Co.	Darrow, LA	8,000	01/82	02/82	2
Southern Union Refining Co.	Monument, NM	5,400	01/81	10/81	25+
Southern Union Refining Co.	Lovington, NM	36,100	08/84	11/84	8
Southland Oil Co.	Yazoo City, MS	5,500	02/81	07/81	25+
Tesoro Petroleum Corp.	Carrizo Springs, TX	26,100	07/84	12/84	27
T & S Refining Co.	Jennings, LA	10,500	07/81	03/82	2
Texaco Refining and Marketing Inc.	Amarillo, TX	20,000	04/85	12/85	37+
Texas NAPCO Inc.	St. James, LA	17,000	08/83	12/88	15
Texas Refining Co.	Midland, TX	2,500	04/81	06/81	1
Texas Standard Refining Inc.	Houston, TX	1,800	01/81	10/81	(a)
Texas United Refining Corp.	Nixon, TX	20,900	04/92	06/92	17
Thriftway Co.	Bloomfield, NM	4,000	01/92	10/92	6
Thriftway Oil Co.	Graham, TX	1,184	04/81	11/83	25+
Tipperary Refining Co.	Ingleside, TX	7,320	01/82	03/82	4
Trans-American Refiining Corp.	Norco, LA	300,000	(b)	12/92	0
Tropicana Energy Co.	Ft. Worth (Euless),TX	4,650	12/83	12/85	19
Unocal Corp.	Nederland, TX	120,000	12/89	12/89	6
Vulcan Refining	Cordova, AL	9,500	09/90	12/90	
Warrior Asphalt Refining Corp.	Holt, AL	4,000	08/89	12/89	34
Wickett Refining Co.	Wickett, TX	8,000	01/76	02/82	25+
TOTAL PAD III		1,646,188			
PAD District IV					
Amoco Oil Co.	Caspar, WY	40,000	12/91	12/91	6
Caribou-Four Corners Inc.	Woods Cross, UT	8,400	12/82	12/84	21
C & H Refinery Inc.	Lusk, WY	180	01/81	02/82	25+
Flying J. Petroleum Inc.	Cutbank, MT	5,600	03/83	02/88	36
Glacier Park Co.	Osage, WY	10,000	02/81	03/82	4
Glenrock Refinery Inc.	Glenrock, WY	6,000	04/81	09/81	5
Husky Oil Co.	Cody, WY	11,500	06/82	09/82	25+
Kenco Refining Inc.	Wolf Point, MT	4,700	10/85	12/85	8
Landmark Petroleum Inc.	Fruita, Co.	10,000	01/92	11/93	3+
Morrison Petroleum Co.	Woods Cross, UT	6,000	12/85	12/85	36
Mountaineer Refining Co.,Inc.	LaBarge, WY	350	12/87	06/88	13
Pennzoil Producing Co.	Roosevelt, UT	8,000	09/94	10/94	20+
Sage Creek Refining Co.	Cowley, WY	1,000	01/82	06/82	17
Silver Eagle Oil Co.	LaBarge, WY	3,000	10/82	12/87	13
Southwestern Refining Co.	La Barge, WY	1,040	04/81	08/81	7
Texaco Inc.	Casper, WY	21,000	03/82	07/82	25+
TOTAL PAD IV		136,770			

District/Refinery	Location	Crude Distillation Capacity (b/d)	Date of Last Operation	Date Shutdown	Years in Operation
D District V					
Anchor Refining Co.	McKittrick, CA	10,000	6/91	8/91	
Beacon Oil Co.	Hanford, CA	17,300	11/87	12/87	27
Chemoil Refg. Corp.	Long,Beach, CA.	18,000	02/94	04/94	5+
Chevron	Kenai, AK	22,000	6/91	7/91	7
Chevron U.S.A. Inc.	Bakersfield, CA	26,000	04/86	07/86	38+
Chevron U.S.A. Inc.	Richmond Beach, WA	0	05/00	06/00	48+
Coastal Petroleum Refiners Inc.	Bakersfield, CA	10,000	06/85	12/85	6
Demenno-Kerdoon	Compton, CA	10,000	01/83	08/83	6
Eco Asphalt Inc.	Long Beach, CA	10,550	(b)	10/92	0
Fletcher Oil & Refining	Carson, CA	29,675	09/92	10/92	44+
Foreland Refining Group	Tonopah, NV	3,000	02/01	01/02	4
~~Gibson Oil & Refining~~	~~Bakersfield, CA~~	~~9,600~~	~~07/87~~	~~12/90~~	
Golden Eagle Refining Co.,Inc.	Carson, CA	16,170	11/84	02/85	37+
Golden West	Santa Fe Springs, CA	47,000	02/92	03/92	9
Intermountain Refining Co.	Fredonia, AZ	3,800	01/94	05/96	1+
Newhall Refining Co.,Inc.	Newhall, CA	22,500	11/89	12/89	42
Petro Source Refining	Tonopah, NV	4,500	09/91	12/92	21
Powerine Oil Co.	Santa Fe Springs, CA	46,500	06/95	09/95	8+
Quad Refining Corp.	Bakersfield, CA	7,000	08/80	10/81	2
Road Oil Sales Inc.	Bakersfield, CA	6,000	01/81	12/81	9
Sabre Refining Inc.	Bakersfield, CA	10,000	12/86	09/87	16
Sound Refining Inc.	Tacoma, WA	40,000	10/98	12/98	30+
~~Sunbelt Refining Co.~~	~~Coolidge, AZ~~	~~10,000~~	~~08/93~~	~~09/93~~	~~3+~~
Sunland Refining Corp.	Bakersfield, CA	12,000	03/95	12/95	47+
Tosco Corp.	Bakersfield, CA	38,800	11/83	11/84	33
Tricor Refining LLC	Bakersfield, CA	14,400	07/01	01/02	50+
United Independent Oil Co.	Tacoma, WA	730	07/80	03/82	7
U.S.A. Petrochemical Corp.	Venturam, CA	24,000	12/84	12/84	7
West Coast Oil Co.	Oildale, CA	5,000	10/85	10/88	32
Western Oil & Refining	Long Beach, CA	19,200	02/84	12/87	11
TAL PAD V		493,725			
TAL UNITED STATES		3,973,128			

Less than one year.
Never operated.
Not Available.

rce: U.S. Energy Information Administration, Petroleum Supply Annuals.

Appendix N: Barriers to Entry in Refining and U.S. Capacity Additions by Process

Capacity increases in the U.S. are due to upgrades of existing refineries, since NIMBY ("Not in my Backyard") issues make it exceptionally difficult to site new refineries. The last greenfield integrated refinery sited in the U.S. was completed in 1976 at Garyville, Louisiana. When Energy tried to build another in Portsmouth, Virginia in the 1970s, it gave up after 9 years of court and regulatory battles.[59] Arizona Clean Fuels Technology has been working to build a new refinery in Arizona. It took the company 6 years, from 1999 to 2005, to get the air quality permit.[60] A delay in securing crude supplies in 2006 may delay construction further, requiring an extension for the air quality permit. Construction did not begin in 2006 and the refinery is unlikely to be on stream before 2009.[61] These sorts of obstacles are unlikely to be reduced in future; a bill to promote refinery expansion and reduce regulatory delay was rejected by the U.S. House of Representatives in May 2006.[62]

The statistics presented in Section VIII of this report relate only to distillation capacity. To make the complex array of petroleum products in use today, distillation capacity is only a small part of the investment. Other processes are required for cracking heavier products into more valuable light products and producing products that comply with clean air regulations. Table N.1 shows the capacity U.S. refiners have built since 1992 in some of these other process units. In the last fifteen years, refiners have invested particularly heavily in coking and catalytic hydrotreating.

[59] http://www.gasandoil.com/goc/news/ntn12966.htm.

[60] A timeline on the permitting process was presented to the Senate Committee on Natural Resources on 07/13/2006. http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID =1573&Witness_ID=4452.

[61] http://www.azcentral.com/arizonarepublic/business/articles/0419biz-refinery19.html.

[62] http://washtimes.com/national/20060503-112133-3071r.htm.

Table N.1

U.S. Refinery Process Capacity as of January 1, 1992 - 2006

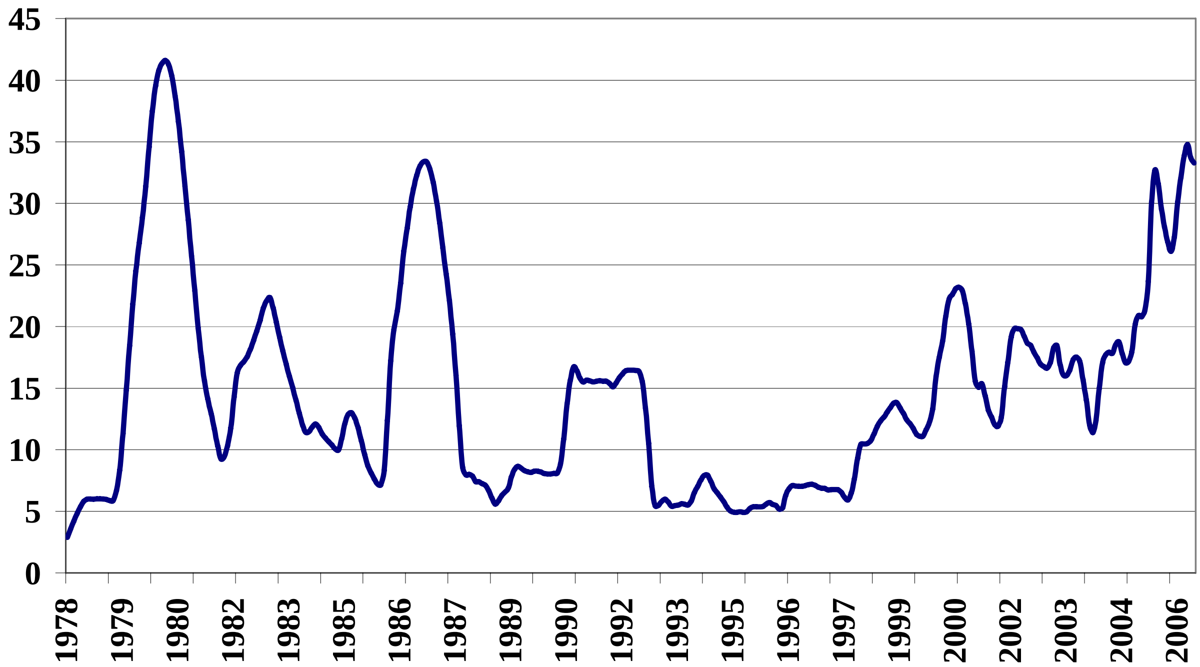
	No Plants	Crude b/cd	Vacuum Distillation	Coking	Catalytic Cracking	Catalytic Reforming	Catalytic Hydro-cracking	Catalytic Hydro-treating
1992	192	15,326,556	7,056,480		5,504,300	3,938,570	1,315,290	7,348,000
1993	184	15,209,853	6,634,353		5,200,235	3,597,148	1,229,040	7,040,945
1994	178	15,141,556	6,601,815		5,221,475	3,656,608	1,237,390	8,149,239
1995	173	15,318,635	6,717,590		5,324,360	3,649,468	1,242,970	8,323,289
1996	169	15,354,140	6,789,550		5,283,450	3,623,193	1,335,982	8,198,415
1997	163	15,432,595	6,907,905	1,848,880	5,180,131	3,648,583	1,350,490	8,525,305
1998	163	15,898,380	7,046,325	1,846,220	5,404,831	3,559,388	1,340,090	8,817,870
1999	161	16,422,670	7,423,805	2,039,450	5,419,931	3,579,268	1,485,620	8,945,160
2000	154	16,540,990	7,376,895	2,022,490	5,561,550	3,526,818	1,423,520	8,960,460
2001	152	16,538,540	7,468,220	2,100,380	5,588,100	3,559,080	1,441,020	10,856,270
2002	143	16,564,483	7,424,840	2,154,760	5,608,830	3,497,944	1,470,520	11,022,606
2003	133	16,623,301	7,347,704	2,243,947	5,677,355	3,512,237	1,474,710	11,247,745
2004	132	16,698,225	7,437,911	2,283,696	5,637,749	3,504,868	1,415,343	12,144,041
2005	132	16,774,878	7,617,533	2,339,930	5,730,990	3,527,367	1,439,550	12,669,223
2006	131	17,126,169	7,583,038	2,353,120	5,703,717	3,507,949	1,458,350	13,181,747
Average Annual Growth	-2.6%	1.0%	1.2%	2.4%	0.7%	-0.3%	1.4%	4.0%

Source: *Oil and Gas Journal*, “Annual Refining Issue,” 1993-2005.

Appendix O: Volatility of Gasoline Prices as Measured by Standard Deviation

Figure O.1 shows monthly gasoline price volatility as measured by the standard deviation for the previous 12 months from January 1977 to November 2006. The average volatility from January 1978 to January 1988, when oil prices were highly volatile and average inventories were much higher was about 18.2 cents per gallon. The average volatility from January 1988 to January 1998 when average inventories were declining but crude prices were less volatile was about 8.6 cents a gallon, and the average volatility from January 1998 to November 2006 when crude prices were highly volatile and average inventories their lowest level yet was about 18 cents per gallon.

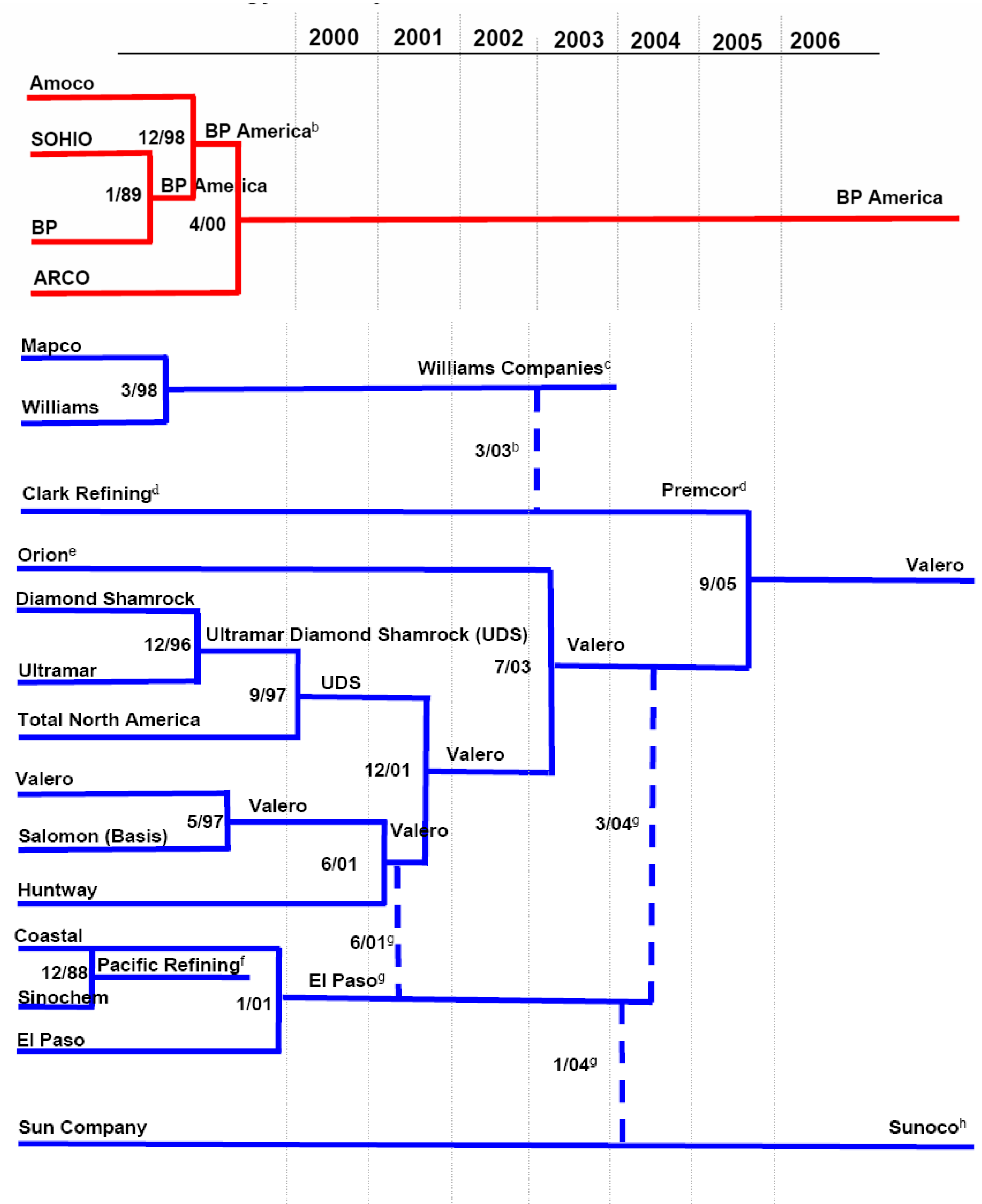
Figure O.1: Standard Deviation of Real Gasoline Prices, 1977-2006



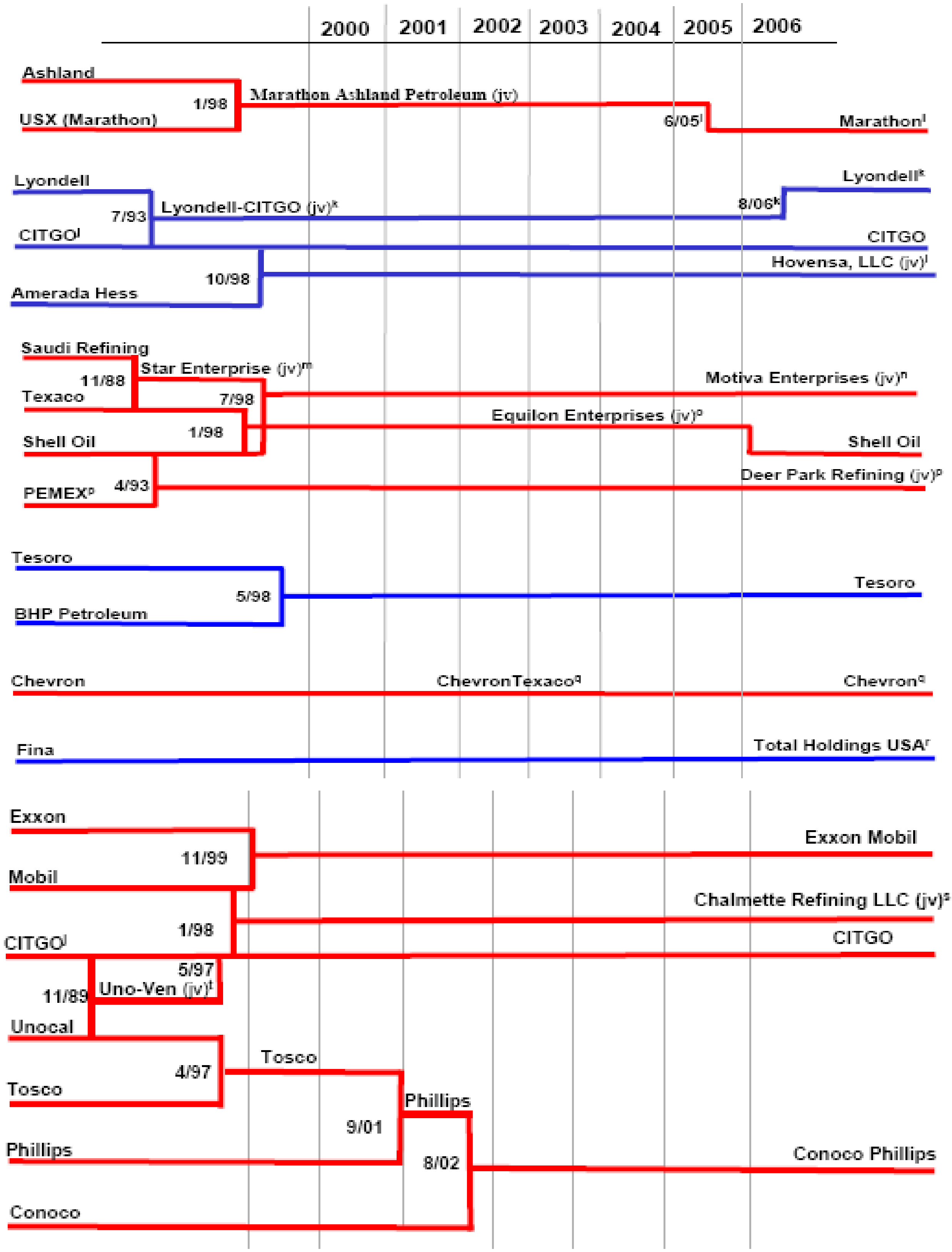
Source: EIA, *Monthly Energy Review*, Table 9.4 “Motor Gasoline Retail Price U.S. City Average,” http://www.eia.doe.gov/emeu/mer/petro.html. Converted to real 2005 dollars using CPI from The U.S. Department of Labor, Bureau of Labor Statistics, http://www.bls.gov/cpi/#tables. Standard deviations for each month are computed using data from the last 24 months.

Appendix P: Refining Industry Mergers and Acquisitions

Figure P.1: Genealogy of Major U.S. Refiners



Genealogy Of Major U.S. Refiners (continued)



Note: See Source for footnotes.
Source: Energy Information Agency: Mergers and Acquisitions. http://www.eia.doe.gov/emeu/finance/mergers/summary.html.

Appendix Q: Critique of Government Accountability Office report of 2004

In 2004, the U.S. Government Accountability Office published "Energy Markets: Effects of Mergers and Market Concentration in the U.S. Petroleum Industry" (U.S. GAO, 2004). This author has strong reservations about the conclusions of GAO (2004) for the following reasons.

1. GAO represents profit as gasoline rack price minus the price of West Texas Intermediate. Evidence suggests that a national price for oil is not a good proxy for refinery acquisition price at the local level.
2. GAO did not subtract from the rack price other costs that have clearly changed over the study period. These other costs account for some of the observed price changes. This is especially true of environmental costs. For example, Muehlegger (2006) summarizes regulators' estimates for cost increases of various fuel formulations that ex post have been supported. Federal Phase I reformulated gasoline required in 1995 was estimated to cost 3 cents more per gallon, Federal Phase II, phased in January of 2000 with even stricter summer regulation, added an additional 1-2 cents. California Reformulated Gasoline Phase I rules became effective January 2, 1993, California Phase II rules became effective in March 1996 and CARB Phase III rules lowered sulfur in gasoline to 30 ppm in March 2003 and phased out MTBE by the end of 2003. The more stringent CARB rules may have cost from 8 – 11 cents per gallon. Before attributing price increases to merger activity, these other costs must be accounted for.
3. GAO chooses to represent the period of price change after mergers as temporary and a matter of months up to a year, while theory suggests that the price change must be much more permanent for a market to be considered monopolistic.
4. GAO correctly assumes refinery utilization rates will affect profit margins, but incorrectly use national rates to explain local profits. National utilization rates explain about 80% of utilization rates for the Texas Gulf region, almost none of the utilization rates for Appalachia, and around a third of the utilization rates on average for all regions in the U.S.
5. GAO estimates expected gasoline consumption, but leaves out such important variables as population density, drivers, vehicles, real income, cooling and heating degree days, all of which are known to influence gasoline consumption.
6. GAO fails to properly account for price spikes, which the Federal Trade Commission (2004) attributes to the introduction of Phase II reformulated gasoline with an ethanol requirement for oxygen, a pipeline rupture, boutique fuel requirements that make the market less flexible and low inventories related to futures prices. FTC (2004) also noted that the industry's response to the price spike was remarkably rapid.
7. GAO argues that mergers caused increased market concentration but failed to account for the other causes of increased concentration such as divestitures, entry, exit, growth and economies of scale.
8. GAO uses national measures of mergers to explain local levels of concentration. However, a national measure is a very blunt instrument to measure changes in concentration at the state level. Further, the FTC carefully monitored the expected increase in concentration in local markets and required divestures where they felt an increase in concentration might cause a lack of competition. FTC (2004) maintains that

merger-related increases in concentration left the majority of markets in the unconcentrated or moderately concentrated category. In the majority of the large mergers FTC investigated, some divestitures were required where they felt the market would be non-competitive. FTC has also been monitoring local gasoline prices since 2002 to watch for non-competitive behavior. Their investigations show price spikes have been largely explained by supply bottlenecks from accidents or special fuel requirements in regional fuels. FTC (2005) also studied recent gasoline price changes. They considered the costs affecting gasoline and also noted that vertical integration has been decreasing in the oil industry as more refineries are being broken off from the integrated companies. They did not find specific evidence of wrongdoing in their investigations but noted areas where it would be good to remain vigilant for potential non-competitive problems.

9. The overall explanatory power of the GAO models was low and the price increases found were minimal. They found mergers:

   - Raised conventional gasoline prices in PADD I-III by a trivial 1/10 to 1/3 of a cent per gallon
   - Raised wholesale conventional branded gasoline prices in PADD IV-V by less than a cent a gallon and unbranded gasoline by less than 2 cents per gallon
   - Raised reformulated Phase II gasoline prices by less than 1.6 cents per gallon in all PADDs, which is within the estimated 1-2 cent estimated cost increase
   - Raised CARB gasoline prices by 6 cents per gallon which is also well within the estimated cost increase for this fuel

Appendix R: Financial Derivative Markets

In the spot market, gasoline is bought and sold for delivery as soon as it can get space in the transport network. Alternatively, companies may want to lock in future gasoline prices. Sellers may want to lock in a price in case prices fall, and buyers may want to lock in a price in case prices rise. Some participants may want to lock in prices to reduce risk; others may want to lock in prices to take on risk in hopes of making a profit. Contracts that lock in future prices or bounds on future prices are called financial derivatives because their value is derived from the underlying asset. When such derivatives are bought and sold anonymously with standard contracts on a regulated exchange, they are called futures contracts. When they are bilateral with specific agreements between buyers and sellers, they are called forward contracts and are considered to be in the "over the counter" market.

Futures contracts are typically used to lock in prices and less than 1% of them run to delivery. Usually the owners of these contracts take opposite positions in the market before the contracts come due, thereby cancelling out the contracts but locking in prices. In the futures market, traders who are not in the gasoline business may own contracts, taking on risk, in hope of making a profit, thus transferring risk to those who prefer to take it on and providing liquidity to the market. Such traders are called "non-commercials." Futures markets provide price transparency and gasoline contracts may be pegged to near term New York Mercantile Exchange (NYMEX[63]) futures prices. The New York Mercantile Exchange has traded contracts in the gasoline market since December 1984, providing gasoline futures that go out 12 consecutive months. The market is regulated and monitored continuously for price manipulation by the Commodity Futures Trading Commission. [64]

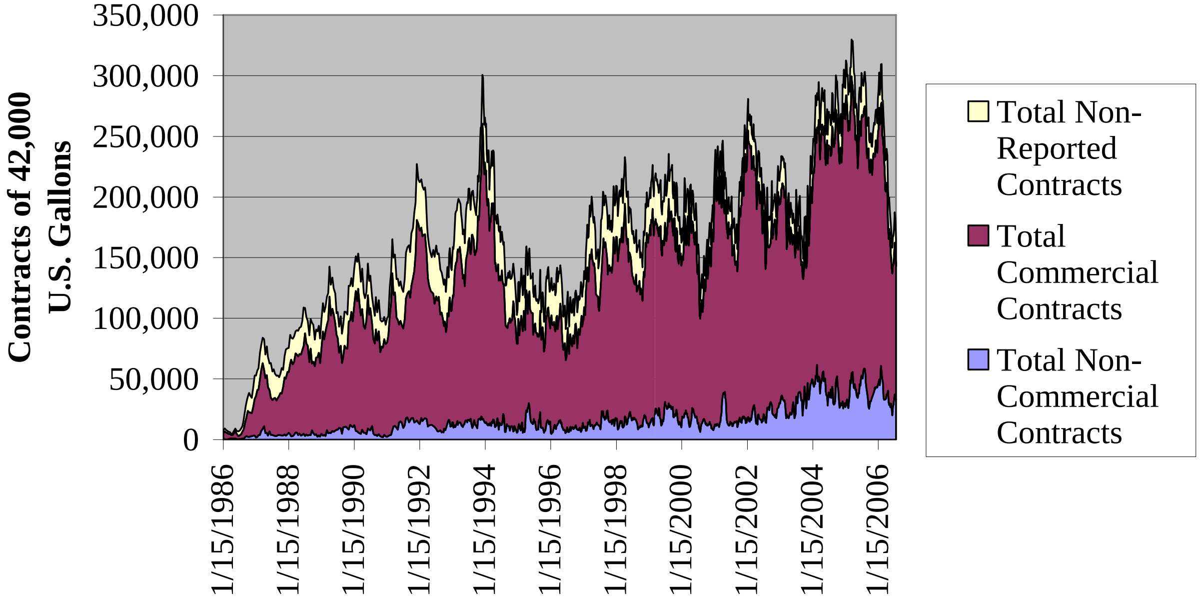
Forward contracts are part of everyday business with delivery usually taken on the contract. Thus, both parties are typically in the gasoline business. Such contracts are made under normal commercial law with each side of the contract obligated to fulfill its part of the agreement. Some contracts run a month or two ahead to facilitate billing; others extend longer than futures. They may be more risky than futures because one side of the contract may default whereas the exchange guarantees performance on futures contracts. Also, because agreements are bilateral, over the counter markets are not as transparent as futures markets.

Figure R.1 shows the volume of NYMEX gasoline futures contracts for commercial, non-commercials, and traders who have not reported their affiliation. Contract volume represents the combined number of long and short contracts.

[63] http://www.nymex.com.

[64] See http://www.cftc.gov.

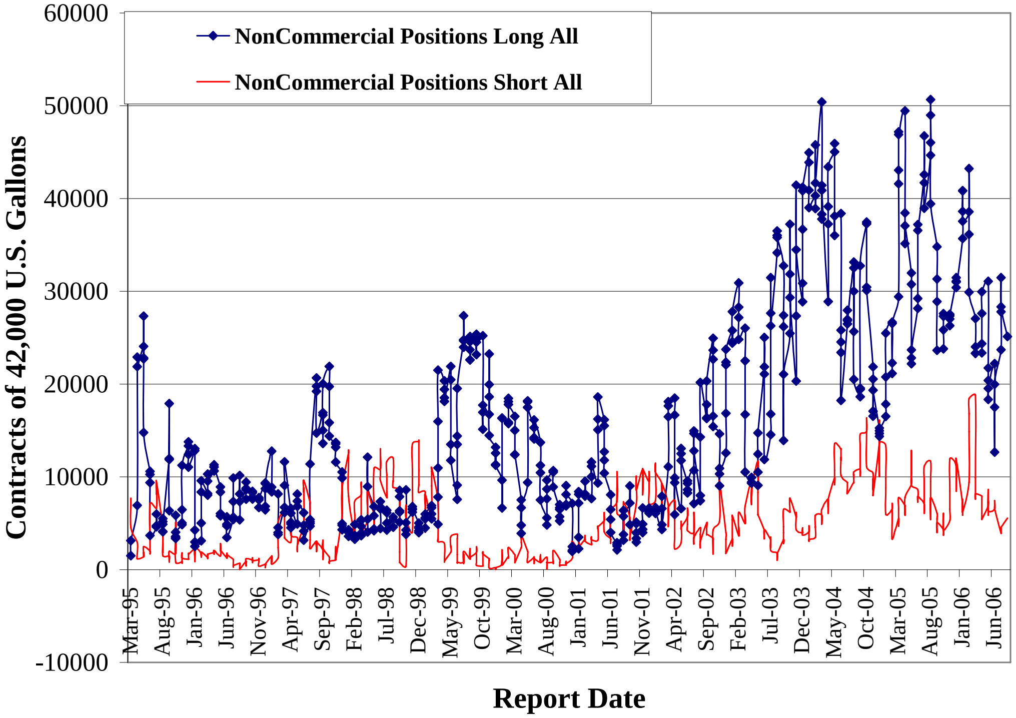
Figure R.1 NYMEX Unleaded Gasoline Futures Contracts by Reporting Group, 1986-2006:Nov



Source: http://www.cftc.gov/dea/history/deahist-cot-fo.html.

Figure R.2 breaks out the non-commercial contracts shown in Figure R.1 into short and long contracts. Those who sell short are betting on price decreases, those who buy long are betting on price increases.

Figure R.2 Non-Commercial Long and Short NYMEX Unleaded Contracts



Source: http://www.cftc.gov/dea/history/deahist-cot-fo.html.

Prices for gasoline in the derivative markets are related to the spot price. Arbitrage suggests that at the margin, the value of a futures contract should be equal to the cost on the spot market. Thus, what you pay with the futures contract should equal the cost of buying on the spot and holding it until the future expiration date at time T. The link between futures and spot prices can be shown by the following formula.

$F^T = S_t +$ carry cost

Where S is the current spot price of gasoline

F^T is the futures price of gasoline to be paid at time T

Carry cost equals interest and storage costs from t to T

In this equation, if S_t increases the future price will increase, if F^T increases the spot price will increase. Or as argued in the text of this report, future prices can bid up the spot price. If there were no surprises in the world, this formula would hold exactly. Everyone would know exactly how much product they will need and would have contracts for that product. But in the real world the future is uncertain. There may be surprises in consumption and production as well as prices. Inventories (also called stocks) smooth out the market by filling in during shortages or when there is higher than anticipated demand. In such periods, prices are likely to be higher, and those who hold gasoline stocks can benefit from the higher prices. In periods of weak demand or supply surplus, prices may fall and there may be a cost or negative benefit to having stocks. The net benefit of holding stocks, called convenience yield (δ), does not accrue to traders who only hold futures contracts. Since futures do not have the benefit, the futures price must be reduced by the amount of the benefit to holding spot to be competitive. Thus, the above formula must be adjusted by subtracting this benefit from the cost of holding the inventory.

$$F^T = S_t + \text{carry cost} - \delta$$

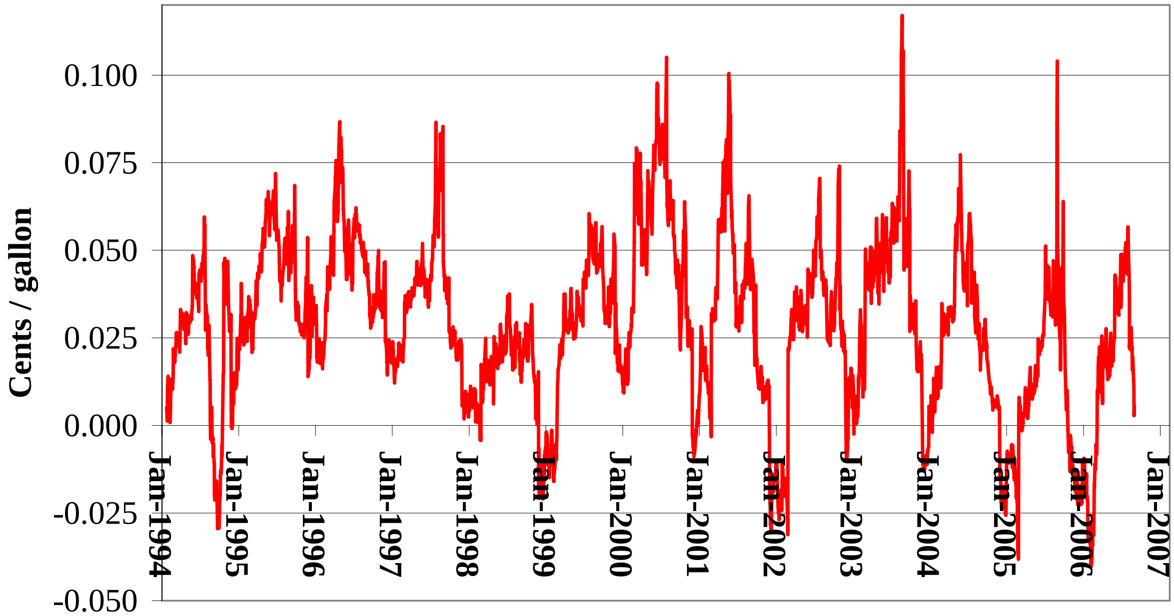
δ will be positive when there is an advantage to having inventories, or when prices may rise. δ will be negative when there is a disadvantage to having inventories, or when prices may fall. If (carry cost - δ)> 0, then the convenience yield is smaller than carrying costs (interest and storage). Such a market is called a normal or contango market and future prices are higher than spot prices. If (carry cost -δ) < 0, the convenience yield is larger than carrying costs (interest and storage). Such a market is called a backward or inverted market and futures prices are lower than spot prices. If there is a current supply or demand shock with low inventories, δ will be high and the market is more likely to be in backwardation. With high inventories, δ is more likely to be low or even negative and the market normal or in contango.

Thus, the relationship between the spot and the future price sums up the market's expectations. Positive convenience yields indicate markets are expected to tighten and negative convenience yields suggest markets are expected to loosen. Since spot and future price prices are known, the convenience yield can be computed as an indicator of market expectations.

$$\delta = S_t - F^T + \text{carry cost}$$

Carrying costs include the interest foregone on money invested in inventories (futures only require a small margin) and the cost of storage. Figure R.3 gives the values for convenience yields since 1994 using Moody's Yield on Seasoned Corporate Bonds - All Industries, AAA and gasoline storage costs of $0.50/ barrel per month.

Figure R.3 Reformulated Regular Gasoline Three Month Convenience Yield, 1994-2006:Sept



Source: Energy Information Administration, http://www.eia.doe.gov/emeu/international/oilprice.html visited on 07/18/06. Federal Reserve Statistical Release F1033 visited on 07/18/06.

Note that convenience yields tend to be smallest around January, falling negative briefly in 1995, 1998, 1999 and 2001-2006. This suggests refinery capacity should be more than sufficient to satisfy demand through May and no price spikes are expected. Convenience yields typically peak in the summer months. Since driving is heavier in the summer, prices are more likely to increase then and potential price spikes causes convenience yield to increase. In 1996, convenience yield spiked in April, predicting a price increase that came a month later. Convenience yield averaged lower in 1998 as gasoline prices fell, falling to negative at the end of the year but rebounding from 1999 though mid-2001 with the usual seasonal spikes as gasoline prices rose as well. The convenience yield foreshadowed the price decline after 9/11. The early spike in May of 2004 predicted the tight market over the summer of 2004. It spiked with the devastating hurricanes of 2005 but quickly fell, forecasting that higher prices would handle the shortage. The lower spike in 2006 suggests that the market was expecting the market weakening in the fall. Thus, the market worked much as theory would suggest.

Appendix S: Gasoline Alternatives

A recent study by the National Academy of Sciences (Hill et al. 2006) suggests that there are many challenges to replacing gasoline and diesel with biofuels.

> "Corn ethanol and soybean biodiesel have proven that we can make viable biofuels, . . . A major challenge is getting enough biofuel. Already, 14.3 percent of corn grown in the United States is converted to ethanol, replacing just 1.72 percent of gasoline usage. Even if all the remaining corn were converted to ethanol, the total ethanol would only offset 12 percent of gasoline. The entire soybean crop would replace a much smaller proportion of transportation fuels--only 6 percent of current diesel usage . . ." [65]

The study finds that to make a significant contribution these fuels must be produced competitively from cellulosic fuels on marginal farmlands to not compete with the food supply.

Another study (National Academy of Engineering (2004)), considered the use of hydrogen in light duty vehicles. They listed four barriers that would need to be overcome to make hydrogen competitive – reduce the high distribution costs resulting from hydrogen's low density, improve fuel cell and storage systems, develop cheaper electricity from renewables, and sequester CO_2 from coal used for hydrogen production. They did not feel that hydrogen would make much of a contribution to transportation fuels in the next 25 years.

Conservation in the form of hybrid vehicles, which achieve higher gas mileage per gallon of fuel, is an important potential for increasing substitution, making demand more elastic, and in effect creating competition for the refining industry. From the introduction of the two-seater Honda Insight in 1999, the number of hybrids in the U.S. has grown considerably. See Table S.1 for the hybrid models available in 2006 along with estimates of their miles per gallon in the city (c) and on the highway (h) for some of them.

[65] http://www.pnas.org/cgi/content/abstract/0604600103v1.

Table S.1 Availability of Hybrids in the U.S.

Hybrid Cars available in the U.S.	2005	2006
Toyota Prius (2000) [60c,51h]	X	X
Honda Insight (1999) [51-60c,56-66h]	X	X
Honda Civic (2002) [26c,45h]	X	X
Honda Accord	X	X
Toyota Highlander [22c,27h]	X	X
Ford Escape (2004) [31c,36h]	X	X
Lexus RX400 (2005)	X	X
Mercury Mariner [22c,26h] (2004)	X	X
GM Silverado	X	X
GM Sierra	X	X
Dodge Ram (2005)		X
Nissan Altima (2006)		X
Lexus GS (2006)		X
Saturn VUE [23c,29h] (2006)		X

Notes: Dates in parentheses are year introduced. Numbers in square brackets are miles per gallon for city driving (c) and highway driving (h).

Source: http://www.Ineed2Know.org
http://www.ineed2know.org/hybrid_cars.htm?referrer=adwords&kw=honda%20civic%20hybrid%20review&gclid=CN-VmJ2Cs4cCFR0OYAodyWVvMg.

http://www.edmunds.com/reviews/list/top10/108467/article.html,
http://www.edmunds.com/reviews/list/top10/108468/article.html.

The EIA *Annual Energy Review* (2005) estimates that in 2004 passenger vehicles averaged 22 miles per gallon (mpg) and vans, pickups, and SUVs averaged 16 mpg., leaving considerable room for increasing fuel efficiency as the U.S. auto fleet turns over. Although hybrids are still a small share of the U.S. market, Table S.2 shows their rapid increase from 2000 to 2005. In 2005, they were just over 1% of new vehicle registrations.

Table S.2 U.S. Hybrid Vehicle Registrations

2000	7,781
2001	27,744
2002	63,728
2003	109,676

2004	192,829
2005	391,977

Source: http://usa.polk.com/News/LatestNews/news_042505.htm.
http://usa.polk.com/News/LatestNews/2006_0504_hybrids.htm.

In a 2005 study on consumer attitudes towards hybrids R L. Polk found

- 97 percent of respondents recognize “hybrid” vehicle terminology
- 78 percent of respondents would consider buying a hybrid vehicle
- 61 percent indicate they are concerned with price”

Nor did most of the respondents believe hybrids were merely a passing fad. [66] Although alternative fuels may not considerably increase competition or demand elasticities in the near term, alternative vehicle technologies may be more promising near term substitutes.

[66] http://usa.polk.com/News/LatestNews/news_071105_01.htm.

Appendix T: Gasoline Supply and Demand Elasticities

Gasoline demand and supply price elasticities tell us how much consumers and producers respond to changes in price. Formally, we can define these elasticities as a percentage change in quantity divided by a percentage change in price. Less is known about the elasticity of supply. Dahl and Duggan (1996) found four studies examining gasoline supply. One explicitly estimates both a short and long run elasticity; the remaining studies estimate a single elasticity which would be long run if total adjustment takes place in one period but would be less than long run if adjustment takes place over many periods. Although decades old now, these studies suggest that historically refineries did respond to price over time and in some cases quite substantially. Tsurumi (1980) found a much larger price response in the early 1970s before the large price run up than after the embargo from April of 1974 to December of 1976.

Table T.1 Gasoline Supply Elasticities

Reference	Sample		Short run		Long run
Koshal et al. (1991)	51-83	T	2.58		4.2
Tsurumi(1980)	70:1-73:10	Tm		1.98	
Tsurumi(1980)	74:3-76:12	Tm		0.77	
Yang & Hu(1984)	70:I-79:IV	Tq		1.47	
Rice & Smith(1978)*	46-73	T		14.49	

Notes: * indicates the elasticity has been computed from information in the study, T= times series annual U.S. data, Tm = time series monthly data, Tq= time series quarterly data.

Source: Dahl and Duggan (1996).

There have been numerous studies of gasoline demand elasticities. Results from these surveys are included in Table T.2 with most of the included studies on industrial countries. The price elasticities show how responsive gasoline consumption is to price and the income elasticities show how responsive consumption is to income.

Table T.2: Gasoline Demand Elasticity Survey Results

	# Studies	Study Years	Psr	Plr	Ysr	Ylr
Taylor (1977)	7	70-76	(0.10,-0.50)	(-0.25,-1.00)		
Bohi (1981)	11	74-78	-0.20	-0.70		near 1
Kouris (1983) Country CSTS	7	75-83	(-0.10,-0.20)			
Kouris (1983) US TS	7	72-83	(-.20,-.40)	-0.70		
Bohi and Zimmerman (1984)	10	79-82	-0.20	inelastic	0.40	elastic
Dahl (1986)	69	69-84	-0.12 (m,q)		0.31 (m,q)	
			-0.29 (a)	-1.02	0.47 (a)	1.38
Dahl and Sterner (1991a, 1991b)	~100	66-88	-0.26	-0.86	0.48	1.21
Goodwin (1992)	12		-0.27	(-0.71,-0.84)	nr	nr
Dahl (1995)	14	89-93	-0.20	-0.60		<1
Espey (1996) U.S.	41	69-90		-0.65		0.91
Espey(1998)	95	66-97	-0.16	-0.81	0.32	0.90
Graham and Glaister (2002)	113	66-00	(-0.20,-0.30)	(-0.60,-0.80)	(0.30,0.50)	(0.50,1.50)
Hanly, Dargay, Goodwin (2002)	69	72-01	-0.25	<-0.60	0.40	>1.00

Notes: Numbers in parenthesis indicate authors range of estimates (a) = annual, (m,q) = monthly and quarterly, CSTS = cross section time series dats, TS = time series data, <-0.60 means more

The conclusions from the above surveys are that short-run annual demand elasticities are between -0.2 and -0.3, with quarterly and monthly responses less elastic. The annual income elasticity is between 0.3 and 0.5. Long-run price elasticity is more uncertain but is likely to be between -0.6 and -1. Long-run income elasticities are even more uncertain, although more studies have concluded that demand is income elastic. Unfortunately, none of the surveys includes studies beyond 2001 that use data after 1999, when real gasoline prices began their recent increase.

One new interesting study is by Hughes, Knittel, and Sperling (2006) (HKS06). Their study specifically considers whether there have been structural shifts in gasoline demand between the price run-ups in the last half of the 1970s and the similar price run up in the early part of this century. They have estimates on static models and dynamic models with a lagged endogenous variable to measure long and short run elasticities. They compare estimates on monthly data for January, 1975 to January, 1980 and for March, 2001 to March, 2006. Models with one-month lags have not performed well in the past and do not perform well in HKS06 (as the authors note). When the lagged endogenous variable has a twelve-month lag, which has performed better in other studies, the results in HKS06 are disappointing. When the estimates on the lagged endogenous variable are well behaved, the coefficients on income are not, and when the coefficients on income are well behaved, the coefficients on the lagged endogenous variable are not. Although lagged endogenous models often provide large variations in long run elasticities it is unusual for the coefficient on the lagged endogenous variable to be less than 0.35 and it is highly unusual for them to be negative. The likely culprit is multicollinearity between income and the lagged endogenous variable.

Thus, HKS06 were not able to estimate any long-run price or income elasticities. Their static model is better behaved and measures a monthly price elasticity of around -0.30 from 1975-1980 and -0.04 from 2001 to 2006, which suggests that the short-run price elasticity is less than observed earlier. When this author reproduced their results, the difference was found to be statistically significant. Income elasticity was around 0.5 not found to be significantly different from the earlier to the later period.

Has the price elasticity really fallen so dramatically? Sipe and Mendelsohn (2001) investigate demand elasticities on cross sectional data for individuals in California and Connecticut for 2000. Their data set is based on experimental survey data for 200 to 300 individuals and includes low price gasoline scenarios from $1.70 to $2.90 and high price scenarios from $3.10 to $5.80, which span high hurricane related and summer prices in the last year. Short run and long run response are based on how much the survey respondents say they would adjust driving and their auto stock in the short and long run. Both price and income elasticities are significant at the 5% level or better. California residents, who drive on average about 5% more, say they are more price responsive (short run price elasticity equal to -0.55) than Connecticut residents (short run price elasticity of -0.37). In both cases, the long run price elasticity was between 20 and 30% higher than the short run elasticity. If we can trust Sipe and Mendelsohn's consumers, they say they would make substantial responses to *permanent* large price increases.

One of the big differences between the recent price increase and that in the late 1970s is that then many consumers believed that gasoline prices would go ever higher, whereas today many consumers are not sure that the increase is permanent. Even CFA, for example, does not seem convinced that the high prices represent permanent higher costs: if they are artificially induced by oil companies, they can be reduced with the appropriate policy. Other consumers may be waiting to see whether political uncertainty in oil producing countries will subside, whether refining bottlenecks will be resolved, whether high oil prices will slow the growth of the world economy, and whether high gasoline prices and slower economic growth will cool the markets.

Bibliography

Alm, James, Edward Sennoga, and Mark Skidmore (2005) “Perfect Competition. Spatial Competition, and Tax Incidence in the Retail Gasoline Market.” Andrew Young School Research Paper No. 06-01, Georgia State University, Atlanta, GA. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=889372.

American Petroleum Institute (2006) *Basic Petroleum Data Book.* 26 (1), Washington, D.C.

Baumol, William J., John C. Panzar, and Robert D. Willig (1982) *Contestable Markets and the Theory of Industry Structure*. San Diego: Harcourt Brace**.**

Bohi, Douglas R. (1981) *Analyzing Demand Behavior: A Study of Energy Elasticities*. Published for Resources for the Future by Johns Hopkins Press, Baltimore, MD.

Bohi, Douglas R. and Zimmerman, Mary (1984) "An Update on Econometric Studies of Energy Demand," *Annual Review of Energy*, 9:105-154.

Bureau of Economic Analysis (2007) “Gross Domestic Product.” http://www.bea.gov/national/index.htm#gdp.

Congressional Budget Office. (1999) *The Budget and Economic Outlook: Fiscal Years 2000-2009.* January, http://www.cbo.gov/showdoc.cfm?index=1059&sequence=1.

Congressional Budget Office. (1999) *The Budget and Economic Outlook: Fiscal Years 2003-2012*. January, http://www.cbo.gov/showdoc.cfm?index=3277&sequence=3.

Congressional Budget Office. (1999) *The Budget and Economic Outlook: Fiscal Years 2005-2014*. January, http://www.cbo.gov/showdoc.cfm?index=4985&sequence=3.

Cooper, Mark (2006) “The Role of Supply, Demand, Industry Behavior, and Financial Markets in the Gasoline Price Spiral.” Prepared for the Consumer Federation of America (CFA) and the Wisconsin Attorney General.

Dahl, Carol A. (1986) "Gasoline Demand Survey." *The Energy Journal*, 7(1):67-82.

Dahl, Carol A. (1993) “Energy Demand Elasticities in Support of the Development of the NEMS.” For the U.S. Department of Energy, Washington, D.C., October 19.

Dahl, Carol A. (1994) "A Survey of Oil Product Demand Elasticities for Developing Countries. *OPEC Review*, XVIII(1):47-87.

Dahl, Carol A. (1995) “Demand for Transportation Fuels: A Survey of Demand Elasticities and Their Components” *Journal of Energy Literature*, 1(2) Fall.

Dahl, Carol A. (2004) *International Energy Markets: Understanding Pricing, Policies, and Profit.* Tulsa, OK: Pennwell Press, March.

Dahl, Carol A. and Duggan, Thomas. (1996) “U. S. Energy Product Supply Elasticities: A Survey and Application to the U.S. Oil Market.” *Resources and Energy Economics*, 18:243-263.

Dahl, Carol A. and Sterner, Thomas (1991) "A Survey of Econometric Gasoline Demand Elasticities." *International Journal of Energy Systems*, January:52-76.

Dahl, Carol A. and Sterner, Thomas (1991) "Analyzing Gasoline Demand Elasticities: A Survey." *Energy Economics*, July, 13(3):203-210.

Economic Report of the President (2007) “Real Gross Domestic Product, 1959-2006.” http://www.gpoaccess.gov/eop/tables07.html.

ENSR Corporation (2006) “Current Permitting Obstacles Limiting Increasing Petroleum Refinery Capacity in the United States and Opportunities for Streamlining.”

Errera, Steven and Stewart L. Brown (2002) *Fundamentals of Trading Energy Futures and Options.* Tulsa, OK: PennWell Corp.

Goodwin, P. B., Joyce Dargay, and M. Hanly (2004) "Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review." *Transport Reviews,* 24(3) May, 375-292.

Goodwin, P.B. (1992) "A Review of New Demand Elasticities with Special Reference to Short and Long Run Effects of Price Changes." *Journal of Transport Economics and Policy*, May:155-169.

Graham, Dan and Stephen Glaister (2004) “The Responses of Motorists to Fuel Price Changes: A Survey.” *Transport Reviews,* 24(3) May:261-74.

Greenspan, Alan (2006) “Testimony to Committee on Foreign Relations United States Senate.” June 7. http://lugar.senate.gov/energy/hearings/pdf/060607/Greenspan_Testimony.pdf.

Haigh, Michael, Jana Hranaiova, and James Overdahl. (2005) “Price Dynamics, Price Discovery, and Large Futures Trader Interactions in the Energy Complex.” *Office of the Chief Economist: US Commodity Futures Trading Commission*. Working Paper, April 28.

Hill, Jason, Erik Nelson, David Tilman, Stephen Polasky and Douglas Tiffany (2006), “Environmental, Economic and Energetic Costs and Benefits of Biodiesel.” *Proceedings of the National Academy of Science 2006,* 103:11206-11210. Located at http://www.pnas.org/cgi/content/short/103/30/11206. Last accessed 9/16/06.

Hodge, Tyler (2006) “The Impact of Tropical Cyclones on Gulf of Mexico Crude Oil and Natural Gas Production.” Draft Copy, U.S. Energy Information Administration Department of Energy, Washington, D.C.

Hughes, J.E., C.R. Knittel, and Daniel Sperling (2006), “Short-Run Gasoline Demand Elasticity: Evidence of Structural Change in the U.S. Market for Gasoline”, Working Paper, Institute of Transportation Studies, University of California, Davis, July 31.

ICF Consulting (2005) “The Emerging Oil Refinery Capacity Crunch.”

Kahn, Alfred E. (1971) *The Economics of Regulation: Principles and Institutions*.” New York: Wiley.

Koshal, Rajindar K.; Koshal, Manjulika; Boyd, Roy; and Roussois, Panagiotis (1991) "Why did Gasoline Prices Tumble in the Eighties? A Supply and Demand Analysis. (Unpublished paper) Ohio University, Athens.

Kouris, George (1983) "Energy Demand Elasticities in Industrialized Countries: A Survey." *The Energy Journal*, 4(3):73-94.

Levin, Robert A. (2006) “Testimony to Committee on Energy and Commerce United States House of Representatives.” May 4. http://energycommerce.house.gov/reparchives/108/Hearings/05042006hearing1865/Levin.pdf.

Lukken, Walter (2006) “Testimony to Committee on Agriculture United States House of Representatives.” April 27. http://www.cftc.gov/opa/speeches06/opalukken-19.htm.

Muehlegger, Erich (2006) “The Effects of Regulatory Heterogeneity: A Study of Regional Gasoline Content Regulations.” Working Paper, Harvard University, John F. Kennedy School of Government, June 6. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=939649.

Myers, Nettie H. (1999) “Gasoline Sulfur Standards.” Testimony before the Committee On Environment and Public Works Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety, on Gasoline Sulfur Standards, Washington, D.C., May 18. http://epw.senate.gov/107th/mye_5-18.htm.

National Academy of Engineering, (2004) “The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs.” Board on Energy and Environmental Systems, Washington, D.C.

Newsome, James (2006) “Testimony to Committee on Agriculture, Nutrition and Forestry United States House of Representatives.” April 27.

Oil & Gas Journal. 4/3/06:62.

Oil & Gas Journal. 6/5/06:53.

Oil & Gas Journal. "Refining Cost Indexes," 4/7/03:66.

Petersen, H. C. and Lewis, W. C. (1999), *Managerial Economics*. New York, Prentice-Hall, 4th Edition.

Peterson, D.J. and Sergej Mahnovski (2003) “New Forces at Work in Refining: Industry Views of Critical Business and Operations Trends.” National Energy Technology Laboratory, United States Department of Energy.

Polk Center for Automotive Studies. (2005) “Consumer Considerations for Hybrid Vehicles: Public Views on an Emerging Segment.” July. http://usa.polk.com/NR/rdonlyres/5D1BB0DB-120F-4782-BBF3-7EC2FAFBDB8F/0/HybridViews_final.pdf

Rice, Patricia and V. Kerry Smith (1977). "An Econometric Model of the Petroleum Industry." *Journal of Econometrics*, November 6:263-287.

Sipes, K.N. and R. Mendelsohn (2001) “The Effectiveness of Gasoline Taxation to Manage Air Pollution.” *Ecological Economics,* 36(2):299–309.

Smithson, Charles W. (1998) *Managing Financial Risk*. New York: McGraw Hill Companies.

Stigler, George J. (1971) “The Theory of Economic Regulation.” *The Bell Journal of Economics and Management Science,* 2(1):3-21

Taylor, Lester D. (1977) "The Demand for Energy: A Survey of Price and Income Elasticities." In *International Studies of the Demand for Energy*, ed. by William D. Nordhaus, Amsterdam: North Holland.

Thompson, Stephen and James B. McCarthy (1999) *Sulfur in Gasoline*, National Council for Science and the Environment**,** Resources, Science, and Industry Division, May 20, http://ncseonline.org/NLE/crsreports/energy/eng-51.cfm.

Tippee, Bob (2005), “Sulfur Cuts, European Demand Growth Reshaping Diesel Market.” *Oil and Gas Journal.* December:12:19.

Tsurumi, Hiroki. (1980) “A Bayesian Estimation of Structural Shifts by Gradual Switching Regressions with an Application to the U.S. Gasoline Market." *Bayesian Analysis of Econometrics and Statistics*, Amsterdam: North Holland.

U.S. Energy Information Administration/Department of Energy (1993-2005) *Performance Profiles of Major Energy Producers,* Washington, D.C.

U.S. Energy Information Administration/Department of Energy (2006) *Monthly Energy Review*. June, Washington, D.C.

U.S. Energy Information Administration/Department of Energy (2006) *Annual Energy Review*. Washington, D.C.

U.S. Energy Information Administration/Department of Energy (2001) “The Transition to Ultra-Low-Sulfur Diesel Fuel: Effects on Prices and Supply.” Office of Integrated Analysis and Forecasting, Washington, D.C., May. (http://www.eia.doe.gov/oiaf/servicerpt/ulsd/preface.html).

U.S. Energy Information Administration/Department of Energy (2003), “California Gasoline Price Study: Preliminary Findings.” Office of Oil and Gas, Washington, D.C., May.

U. S. Federal Trade Commission (FTC) (2004) “Statement of Federal Trade Commission Chairman Timothy J. Muris on the GAO Study on 1990s Oil Mergers and Concentration.” Washington, D.C., May 27.

U. S. Federal Trade Commission (FTC) (2005) “Gasoline Price Changes: The Dynamics of Supply, Demand, and Competition.” Washington, D.C., June.

U. S. Federal Trade Commission (FTC) (2001) “Midwest Gasoline Price Investigation.” Washington, D.C., March 29.

U.S. Government Accountability Office (GAO) (2004) “Energy Markets: Effects of Mergers and Market Concentration in the US Petroleum Industry.” Washington, D.C., May.

Yang, B. M. and Hu, T. W. (1984) "Gasoline Demand and Supply under a Disequilibrium Market." *Energy Economics*, 6(4) October:276-282.