DOE/EIA-0613
July 1997

Motor Gasoline Assessment Spring 1997

Energy Information Administration
Washington, DC 20585

Contacts and Acknowledgments

This report was prepared by the Energy Information Administration (EIA) under the direction of Dr. John Cook, Director, Petroleum Marketing Division, Office of Oil and Gas, (202) 586-5214, jcook@eia.doe.gov. Questions for this report can be directed to:

John Zyren (202) 586-6405, jzyren@eia.doe.gov
Dave Costello (202 586-1468 dcostell@eia.doe.gov
Aileen Bohn (202) 586-4255, abohn@eia.doe.gov
Charles Riner (202) 586-6610, criner@eia.doe.gov

EIA would like to acknowledge the contributions of Lamar Gowland and Diana House of the Office of Oil and Gas and Jon Rasmussen of the Office of Energy Markets and End Use in preparing this report. In addition, EIA would like to thank the following contract employees for their assistance: Jaime Chan, John Hackworth, Joanne Shore, and Andy Stowe.

Contents

Tables

Figures

1. Introduction

The springs of 1996 and 1997 provide an excellent example of contrasting gasoline market dynamics. In spring 1996, tightening crude oil markets pushed up gasoline prices sharply, adding to the normal seasonal gasoline price increases; however, in spring 1997, crude oil markets loosened and crude oil prices fell, bringing gasoline prices down. This pattern was followed throughout the country except in California. As a result of its unique reformulated gasoline, California prices began to vary significantly from the rest of the country in 1996 and continued to exhibit distinct variations in 1997. In addition to the price contrasts between 1996 and 1997, changes occurred in the way in which gasoline markets were supplied. Low stocks, high refinery utilizations, and high imports persisted through 1996 into summer 1997, but these factors seem to have had little impact on gasoline price spreads relative to average spread.

Chapter 2 summarizes and contrasts the events of the two springs, illustrating the interactions between U.S. gasoline markets, which did not change appreciably, and crude oil markets, which went from tight to loose.

Chapter 3 takes a deeper look at what has recently been changing in gasoline supply, focusing particularly on imports and the yield changes seen over the past several years.

Chapter 4 focuses on California, which is becoming an almost isolated market. In 1996, the uncertainties surrounding the ability to supply its new, unique, reformulated gasoline (CaRFG) pushed prices to record highs as refineries stumbled getting the program underway. In a dramatic turnaround, prices plummeted in the fall as oversupply caused dumping of gasoline and a price war in southern California. As 1997 unfolded, new refinery problems again brought supply concerns that increased prices.

Chapter 5 looks across regions to explore gasoline price behavior by class of trade. Resale price spreads over crude oil cost are also inspected to see if there is any major difference between the patterns of 1996 and 1997 from the information provided by the spot price spreads in Chapter 2. The chapter ends with an observation of consumers' propensity to switch gasoline grades when prices rise.

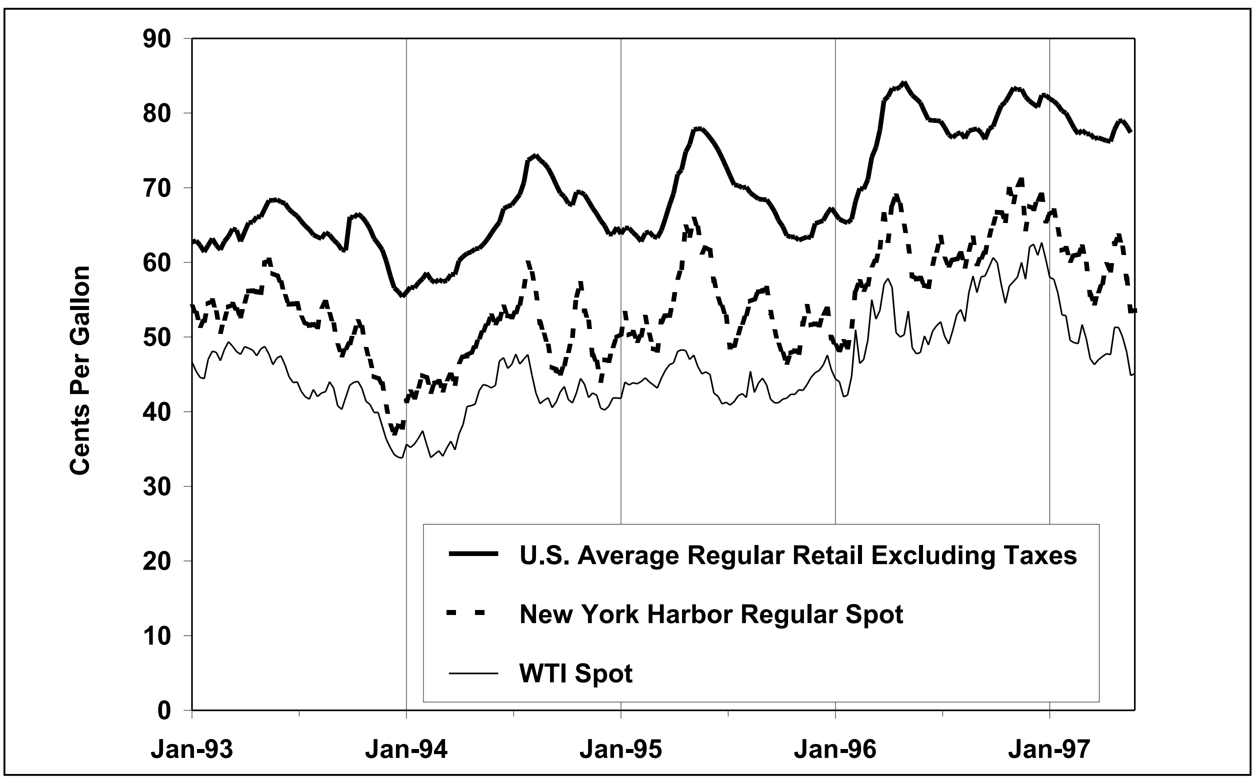
Chapter 6 concludes the report with a more in-depth look at some of the features of gasoline prices: the Energy Information Administration (EIA) Short-Term Integrated Forecasting System is used to further quantify the relationship between crude oil and gasoline market factors; the lag relationship between retail prices and spot prices is quantified; and, finally, an updated outlook for what to expect for the remainder of the summer is provided.

2. Spring 1996 versus Spring 1997

Retail conventional regular gasoline prices in spring 1996 rose sharply, increasing by 19 cents between mid-February and mid-May (Figure 2.1). While gasoline prices frequently increase this time of year, the speed and magnitude of the increase in 1996 alarmed many consumers. The spring 1996 price increases resulted from a combination of factors, some of which were unusual but not unprecedented. Rising crude oil prices and the normal seasonal increase in gasoline prices accounted for most of the retail price increase. However, gasoline markets were also affected by unusual factors, including a late-winter cold spell which caused refiners to focus on production of distillate (heating oil, diesel fuel and kerosene-jet fuel) instead of gasoline longer than usual; lower-than-normal gasoline stocks; continuing high gasoline demand and high refinery capacity utilization; and the persistent expectation that prices would fall several months in the future, which discouraged production of gasoline in excess of demand to build stocks.

The petroleum markets in spring 1997 completed the story of the spring 1996 runup with a price reversal, providing an excellent opportunity to watch the oil market dynamics when crude market factors move in the opposite direction. Table 2.1 summarizes major market factors for comparison.

Figure 2.1 Weekly Conventional Gasoline and Crude Oil Prices



Source Energy Information Administration, Form EIA-878, “Motor Gasoline Price Survey,” Standard and Poor’s Platt’s.
Note: WTI-West Texas Intermediate.

Table 2.1 Spring 1997 and Spring 1996 Summary Market Comparisons

Market Factor	January-April 1996	January-April 1997
World Petroleum Supply/Demand Balance	Winter stock draw was high	Winter stock draw was low
	Good world economy supports petroleum demand	Good world economy supports petroleum demand
	Cold weather increases winter demand more than expected (3.0 percent higher than in winter 1994-95)	Winter demand held in check by milder weather (1.8 percent higher than in winter 1995-96)
	Supply growth less than expected	Supply growth strong
Crude Supply	Iraqi entry into market delayed	Iraq began sales December '96
	Non-OPEC additions expected, but did not arrive	Non-OPEC supply increased, and more expected
	Light crude was abundant	Abundance of light crude grew
Crude Markets	Began 1996 under $20/barrel.	Began 1997 about $26/barrel after high-demand fourth quarter.
	Tight: Prices rose February thru April with cold weather and lack of expected supplies	Weakening: Prices fell January through April with strong supplies relative to demand
	Futures market backwardation was steep	Term structure of crude futures flattened
	Modest light-heavy price differentials	Very small light-heavy price differentials
U.S. Winter Distillate	Began winter with normal stocks, but ended March with lower than normal stocks due to cold weather	Began winter with record low stocks, met demand with extra production, and stocks ended winter at normal levels due to mild weather
	April: With little or no discretionary stocks, late cold weather caused refiners to re-focus on distillate production	April: Although demand was strong, no unexpected re-focusing on distillate production
U.S. Gasoline Supply/Demand Balance	Stocks were low	Stocks were very low
	Demand growth modest (1.1 percent)	Demand growth low to modest (0.8 percent)
	Demand level high (7,601 thousand barrels per day)	Demand level high (7,710 thousand barrels per day)
	Production growth modest	Production growth modest
	Imports high (met 5.8 percent of demand)	Imports very high (met 7.7 percent of demand)
Gasoline Market	Increasing crude oil prices pushed gasoline prices up	Falling crude oil prices brought gasoline prices down
	Spreads mainly at or below seasonal norms	Spreads slightly above seasonal norms

Source: Energy Information Administration

In qualitative terms, the supply/demand balance for gasoline in spring 1997 was almost the same as in spring 1996: demand growth was low to modest; levels of gasoline production from January through April supplied about 97 percent of demand in both years; imports were very high in 1996 and even higher in 1997; and stocks were low. Prices, on the other hand, behaved very differently. Prices rose dramatically during spring 1996, but fell during spring 1997, even though gasoline price spreads were slightly higher in 1997 (Figures 2.2 and 2.3).

The explanation of the spring 1997 price decline lies mainly with crude oil price and normal seasonal spread changes — the main factors behind the spring 1996 price increase. West Texas Intermediate (WTI) crude oil prices in April 1997 averaged 9 cents lower than in April 1996. New York Harbor spot gasoline prices also averaged 9 cents lower in April 1997 than in April 1996. From December 1996 through April 1997, crude oil prices fell 13.5 cents per gallon, and spot prices fell 11.3 cents as the impact from declining crude prices was moderated by normal increases in seasonal spreads.

Crude Markets Reversed between 1996 and 1997

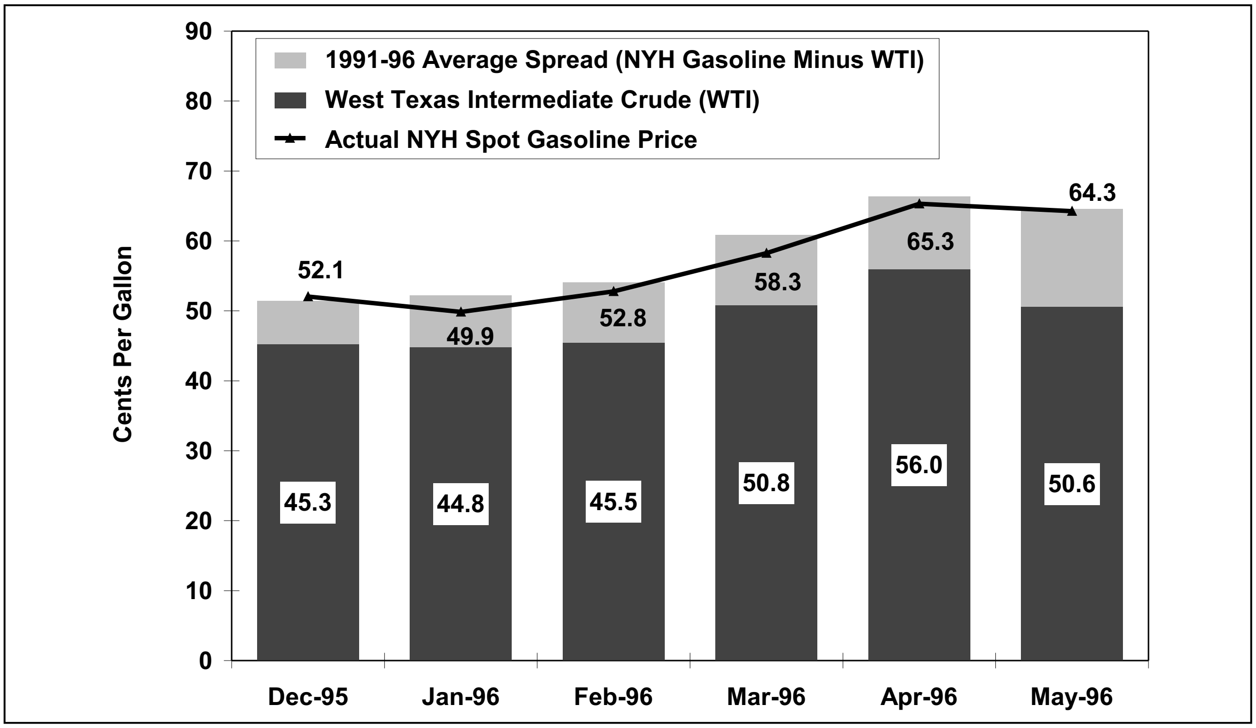
In early 1997, crude oil markets finally seemed to be ending the tight supply/demand cycle that drove prices up in 1996. During the winter of 1995-96, oil product demand was high due to cold weather, while supplies of crude oil were less than expected. Prompt markets were tight during spring 1996, pushing crude oil prices higher, when a late cold snap caused prices to leap even higher and to peak in April. Strong backwardation in crude oil futures persisted through 1996 as buyers kept expecting the tight prompt markets to loosen with new supplies and lower demand. With buyers expecting prices to fall, the building of stocks was discouraged.

Winter 1996-97 was almost a mirror image of winter 1995-96. As winter 1996-97 began, world petroleum stocks were still low, so increased demand in the fourth quarter, coupled with sluggish supply growth, again pushed crude prices up, reaching levels at the end of December that were higher than they were in April 1996 (Figure 2.4). But the weather in winter 1996-97 was not as severe as the prior winter. In addition, Iraqi production entered the market in December and other supplies were increasing, taking the pressure off prices. In the first week of January 1997, WTI was over $26 per barrel, but prices soon fell, tumbling throughout the first quarter. By the first week in April, the price of WTI had dropped $7 per barrel.

During winter (fourth and first quarters), world demand normally exceeds supply, and stocks of crude and product are drawn down (Figure 2.5). In winter 1996-97, the draw was much smaller than normal, reflecting the increasing supply and mild weather restraining demand. Preliminary estimates for the first quarter of 1997 indicate a stock build of 0.1 - 0.2 million barrels per day.[1] In contrast, first quarter 1996 experienced a stock draw of 1.8 million barrels per day, while crude prices climbed $3 per barrel.

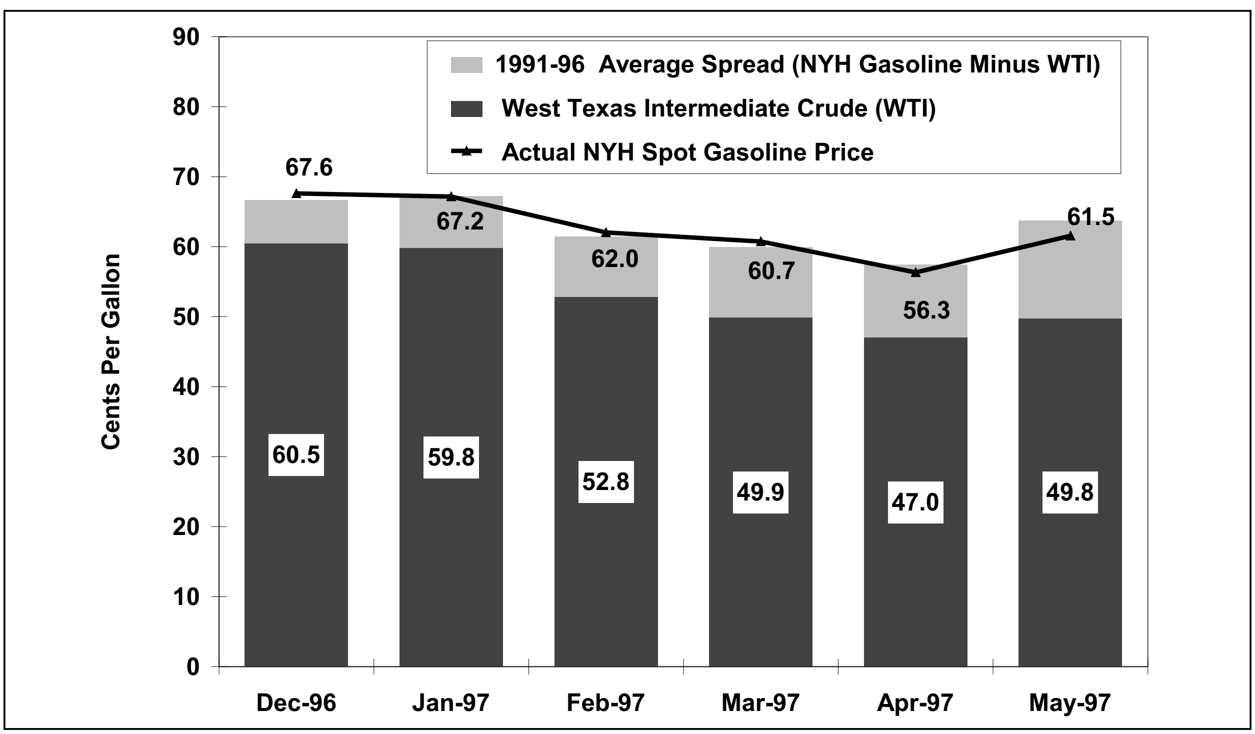
1 International Energy Agency, *Monthly Oil Market Report*, May 9, 1997, p. 51; *Oil Market Intelligence*, May 1997, p. 3.

Figure 2.2 Spring 1996 Gasoline Price Summary



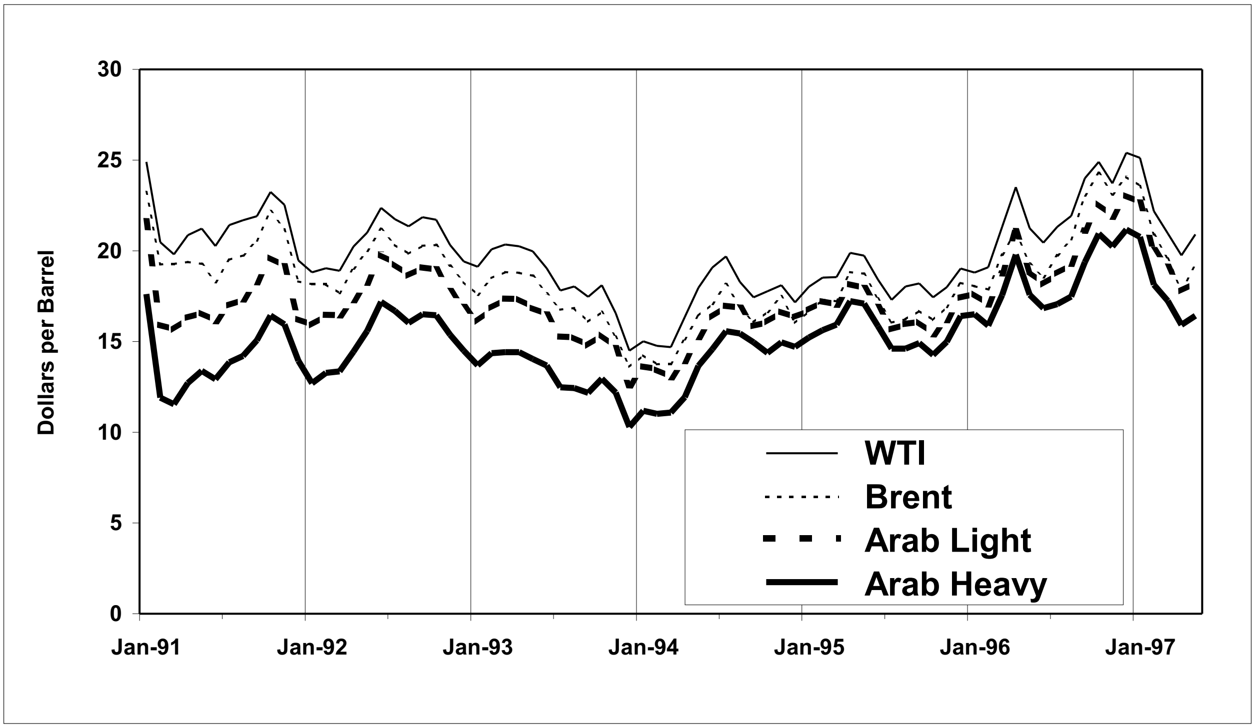
Source: Standard and Poor's Platt's

Figure 2.3 Spring 1997 Gasoline Price Summary



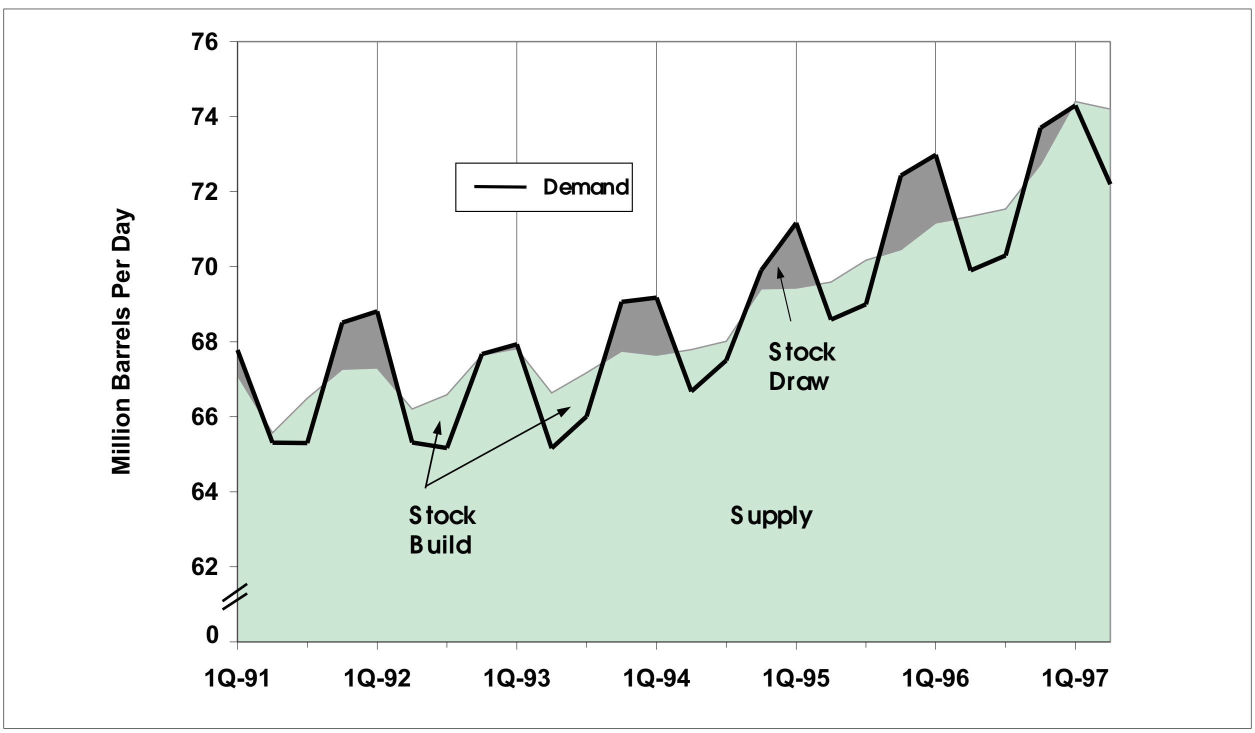
Source: Standard and Poor's Platt's

Figure 2.4 Spot Crude Oil Prices (FOB)



Source: Standard and Poor's Platt's

Figure 2.5 World Petroleum Supply and Demand



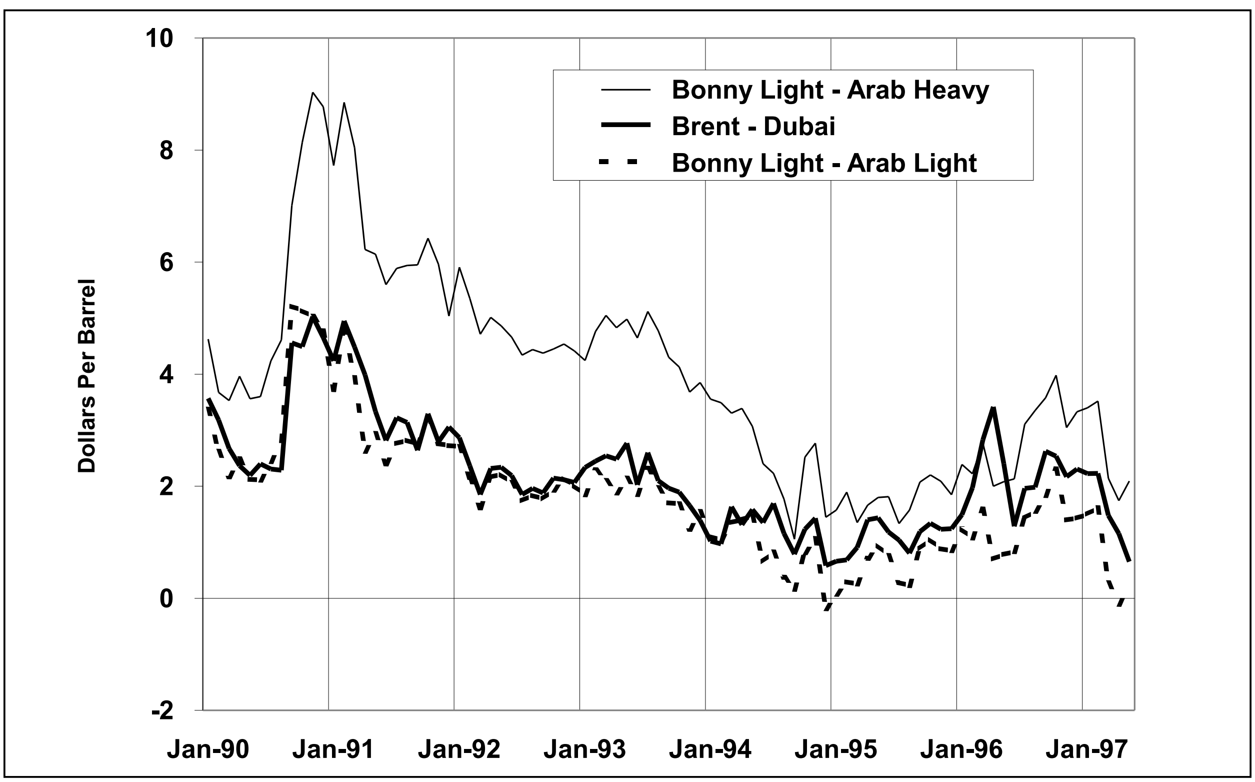
Source: Energy Information Administration, *International Petroleum Statistics*, DOE/EIA-0520, Table 2.1; 1991 Data: January 1996 issue; 1992-1996 Data: May 1997 issue; 1997 first quarter estimate of actual and second quarter projection: *Oil Market Intelligence* Update, June 2, 1997, p. 1.

Crude supply in the first quarter of 1997 increased about 3 million barrels per day over the first quarter of 1996. Organization of Petroleum Exporting Countries (OPEC) contributed the largest portion of the increase. While many of OPEC's members increased production, Iraq showed the largest single increase at about 0.6 million barrels per day. Non-OPEC production increased 1.1 million barrels per day in first quarter 1997 over first quarter 1996, with Latin America (Mexico, Brazil, Argentina, and Colombia) making the largest contribution to non-OPEC production additions. North Sea production increased only about 0.2 million barrels per day as some new field start ups experienced delays.

Light-heavy crude price differentials declined noticeably in the first quarter 1997, ending a brief upward trend that began about two years earlier (Figure 2.6). Low differentials tend to depress refiners' margins. The production increases of light crude oil in the Atlantic Basin exceeded regional market demand, and the light-heavy differential contracts when the supply surplus grows. When the differential reached a low point in April 1997, the West African crude oils became very attractive to the Asian market. Increased shipments to Asia have been reported, and the light-heavy differential has begun to increase again.

From March to April 1996, demand for crude oil declined over 2 million barrels per day, in spite of a cold snap that temporarily required more distillate production. In 1997, April demand is estimated to be about equal to March demand, and the rate of stock build remains steady. As U.S. and

Figure 2.6 Light-Heavy Crude Oil Price Differentials



Source: Standard and Poor's Platt's

European refiners ended their spring maintenance, refinery runs jumped sharply. The stagnating stock build, good U.S. gasoline margins, and increasing demand for Atlantic Basin light crude oils in April 1997 combined to increase crude oil prices somewhat. The price of WTI increased by $2 per barrel from early April 1997 to late May; however, most market observers view this price upturn as temporary, and expect supply/demand fundamentals to weaken crude prices in the second and third quarters as production exceeds demand and a healthy stock build occurs.

Due to the looser world petroleum supply/demand balance, the April 1997 upturn in crude oil prices was nothing like the jump that occurred in April 1996. World petroleum stocks are higher in 1997, reflecting higher supply relative to demand. The futures market in 1997 is also much different, reflecting the turnaround in crude oil markets. In 1997, term structures through April were relatively flat compared to the steep backwardation experienced in April 1996, which resulted both from tight prompt markets and expectations of new supply arriving in the near future.

U.S. Gasoline Demand Remained Sluggish

Gasoline demand in spring of 1996 grew slowly over demand in 1995 (0.5 percent first quarter) as a result of higher prices and bad weather, which discouraged driving (Table 2.2). But with refinery utilization averaging over 92 percent and stocks running below normal, analysts were watching the seasonal demand increases for signs of strength that might temporarily overextend the supply system. Although average demand showed sluggish growth, demand in April popped up almost 218 thousand barrels per day (MB/D) higher than in 1995. (At the same time, distillate demand had surged with a late cold snap that caused refiners to refocus on distillate briefly, when they normally would be gearing up for the spring increase in gasoline demand.) The increase in April gasoline demand sent signals that the weak first quarter performance might be at an end, but the signal proved false. Demand growth remained relatively low throughout the year, averaging 0.8 percent (preliminary estimate)[2], but total average demand pushed gasoline levels consumed to a new high (7,849 MB/D).

Table 2.2 Motor Gasoline Demand

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual	Annual Growth
1993	7,044	7,573	7,754	7,525	7,476	1.4%
1994	7,215	7,709	7,827	7,647	7,601	1.7%
1995	7,477	7,921	7,955	7,796	7,789	2.5%
1996	7,511	7,985	8,001	7,896	7,849	0.8%
1997	7,589					

Source: 1993-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340, Table 3; 1996-1997, *Petroleum Supply Monthly*, DOE/EIA-0109, Table 4 (various issues).

2 As this document was being finalized, revised data for 1996 became available. It showed demand increasing 1.3% from 1995 to 1996.

The first quarter 1997 started very much like the first quarter 1996. First quarter demand was slightly stronger, growing 1 percent over demand in first quarter 1996; this is still only a modest growth rate. April 1997 demand topped the strong 1996 April demand, but as in 1996, preliminary data shows May demand to be sluggish. The economy remains strong, however, and with gasoline prices weaker than last year, summer demand could still show more strength than the first few months would indicate.

U.S. Gasoline Production Stayed Flat, But Import Growth Was High

Production during first quarter 1996 was only 0.7 percent above that during 1995 (Table 2.3). Production met 97.2 percent of demand, with stocks and imports filling in the remainder. In 1997, production grew only 0.3 percent over that in 1996 and supplied 96.4 percent of demand in spite of operable capacity increasing 200 MB/D. However, in April, 1997 production was much higher than in April 1996, and May production may be 300 MB/D higher than that during May 1996.

Table 2.3 Total Gasoline Production

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual	Annual Growth
1993	7,091	7,340	7,413	7,590	7,360	4.3%*
1994	6,885	7,333	7,399	7,620	7,312	-0.7%
1995	7,238	7,683	7,724	7,701	7,588	3.8%
1996	7,292	7,674	7,699	7,704	7,593	0.1%
1997	7,315					

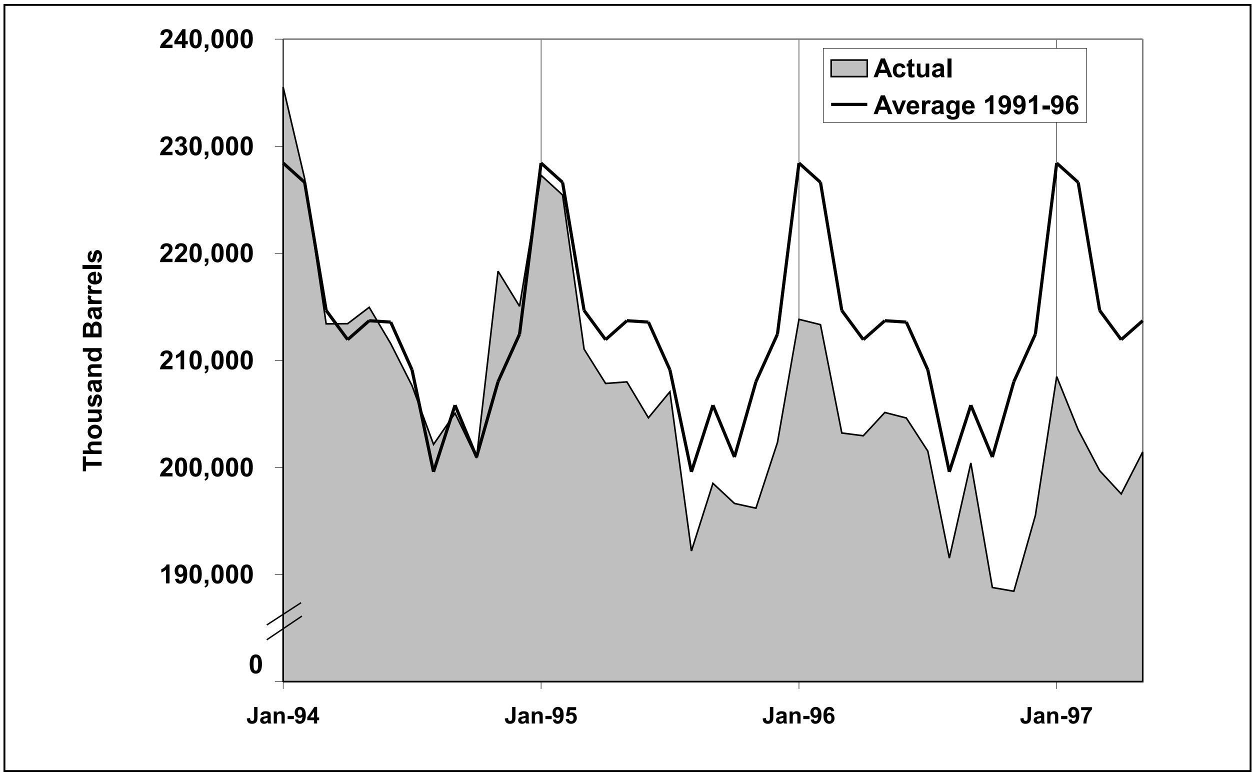
Note: Field-blended gasoline was not available until the end of 1992. Thus, the growth shown from 1992 to 1993 is slightly overstated; however refinery production alone grew 3.5 percent between 1992 and 1993.
Source: 1993-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340, Table 3; 1996-1997, *Petroleum Supply Monthly*, DOE/EIA-0109, Table 4 (various issues).

Imports in 1997 are much higher than in 1996, which itself was a high import year. Venezuela and Canada both exported about 30 MB/D more to the United States in 1996 than in 1995, but Europe contributed the largest amount of increase, accounting for almost 46 percent of the total import gain from 1995 to 1996. Europe continues to be a major source of the import growth in first quarter 1997, as it produces more gasoline than it needs internally. (See Chapter 3)

U.S. Stocks Remained Well Below Average

Gasoline stocks in 1996 began the year lower than average and did not recover prior to the start of the spring gasoline driving season (Figure 2.7). Inventories dropped below normal levels in August

Figure 2.7 Total Gasoline End-of-Month Stocks



Source: 1994-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340 Table 2 (various issues); 1996-1997, *Petroleum Supply Monthly,* DOE/EIA-0109 Table 2 (various issues); April-May 1997, *Weekly Petroleum Status Report*, DOE/EIA-0208, Table 10.

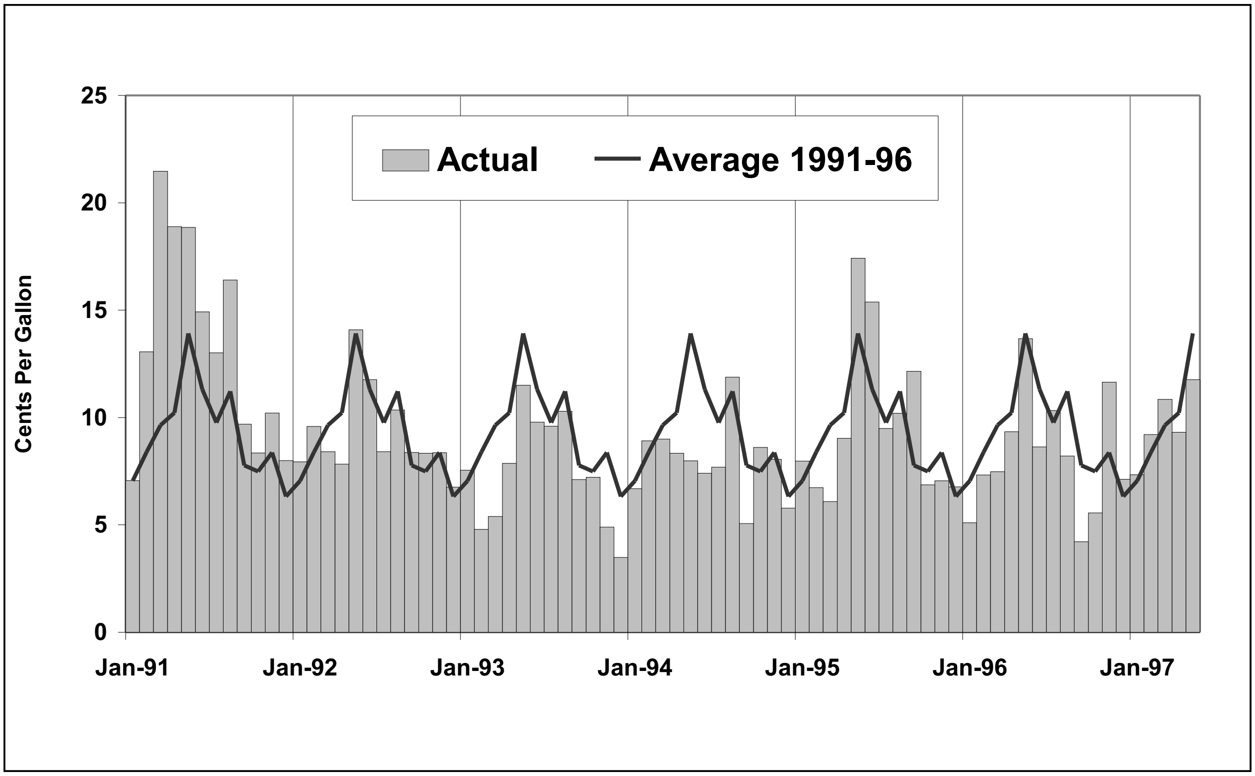
1995 and stayed lower than average through the winter. During April 1996, in spite of strong demand, production and imports were adequate to hold stocks steady when they normally fall at that time of year.

Stocks recovered to more normal levels over the course of summer 1996, but an unusually large demand in October dropped stocks back well under average, where they remained into 1997 in spite of very strong imports supplementing production. In first quarter 1997, stocks were even lower than they had been during first quarter 1996. Total stocks in 1997 were averaging about 4 days less supply than the average days supply during the 1991 through 1996 period.

Prices Rose in Spring 1996 and Fell in Spring 1997

Retail prices averaged 17.9 cents higher in December 1996 than in 1995, but by April 1997, were 3.3 cents lower than in April 1996. Retail regular conventional prices, which lag behind the change in spot prices, had fallen 5.5 cents from December 1996 through April 1997. Thus, consumers in spring of 1997 experienced falling gasoline prices after the dramatic increase in prices experienced in spring 1996.

Figure 2.8 Spot Gasoline Spread (New York Harbor Regular Conventional Minus West Texas Intermediate)



Source: Standard and Poor's Platt's

Spot gasoline spreads (gasoline prices minus crude oil prices) showed more strength in 1997 than in 1996, due mainly to the tighter balance between supply and demand as evidenced by the low stocks (Figure 2.8 and Appendix A). By April, the spreads fell back a bit relative to average as refiners came back on stream following maintenance and demand continued to remain only slightly higher than demand in 1996. During May, production and imports rose high enough to begin replenishing stocks, which still remained lower than normal, but built more than usual during the month. Spreads stayed below average in May, failing to regain their earlier first quarter strength relative to normal levels. With the exception of California (Chapter 5), prices regionally followed the national pattern. Chapter 5 illustrates some regional price differences in more detail.

Financial Performance in 1997 Reflected Higher Gasoline Spreads

On a year-over-year basis, higher oil and natural gas prices in the first quarter 1997 led to large gains in income for the major integrated petroleum companies. Income from U.S. oil and gas production was up 31 percent.[3]

3 Financial News for Major Energy Companies, http://www.eia.doe.gov/emeu/perfpro/news_m/

Income from the majors' U.S. refining and marketing operations increased 19 percent above income first quarter 1996. Nine of fourteen majors reported higher U.S. downstream income, citing improved margins and greater throughput as contributing factors. While distillate spreads were much worse first quarter 1997 than in first quarter 1996 due to warmer weather, gasoline spreads were better, pulling margins higher.

Income gains from foreign downstream operations increased 21 percent as a result of improved margins in Europe and Latin America. Generally, though, refining margins in the Asia Pacific area worsened first quarter 1997 compared to first quarter 1996.

Independent energy companies also experienced improvements during first quarter 1997 over their income in first quarter 1996. Independent oil and gas producers' income more than doubled in the first quarter as a result of higher oil and natural gas prices. Independent refiners' earnings increased 23 percent over last year's earnings.[4]

4 Financial News for Independent Energy Companies, http://www.eia.doe.gov/emeu/perfpro/news_i/

3. Analysis of Gasoline Supply

Gasoline is supplied from refinery production, imports, and from draw down of inventory. In recent years, there have been important changes in all three of these supply components. Refinery production is the dominant source of gasoline supply, with only about 5 percent of supply coming from imports; however, changes in import volumes can have important impacts on refinery production as was the case in 1995 and 1996. When viewed on an annual basis, the volume supplied from stock changes is very minor (19 MB/D, or less than 0.3 percent of supply in 1996), but the build and draw cycle of gasoline stocks is an important indicator of the supply/demand pressure in gasoline markets. (See Chapter 2)

U.S. Supply Bolstered By Imports

Refinery gasoline production in recent years has been impacted by two factors. First, changing environmental regulations have changed the use of feedstocks other than crude oil that contribute to gasoline production. Second, since the beginning of the reformulated gasoline (RFG) program, there has been an increase in imports of gasoline blending components, which are used by blenders and refiners to produce finished gasoline. Moreover, both the environmental requirements for gasoline products and imports have affected the seasonal patterns of gasoline production, a fact that has required yield adjustments between gasoline and distillate.

The annual volume data for the other refinery feedstocks that contribute to gasoline production are shown in Table 3.1. Butane use in gasoline has been decreasing due to progressively more stringent limits on vapor pressure imposed by EPA and individual States. Butane has a high octane number but also is the highest vapor pressure component of material blended into gasoline. It is added to gasoline until the maximum vapor pressure limit is reached. The butane data in Table 3.1 represent butane produced from gas plants that is brought into refineries. Butane is also produced in refineries. Refinery-produced butane is the first source of supply put into gasoline. Refineries now build butane stocks in the summer when vapor pressure limits are low and butane use is low. These stocks are then used during the winter when vapor pressure limits increase.

Oxygenate use in refineries has increased dramatically. A modest amount was used in the 1980's for octane enhancement. Then in 1992, oxygenated gasoline requirements during the winter months and in 1995 RFG requirements year round resulted in significant oxygenate demand. In 1995 and 1996, about 254 MB/D of oxygenates were brought into refineries. Oxygenate use represents 3.4 percent of finished gasoline production.

Production of finished gasoline from refineries, including both refiners and blenders, increased in 1996 over 1995 by 80 MB/D, going from 7,459 to 7,539 MB/D, but this increase is traceable to the increases in blending stock inputs. Blending component input to refineries and blenders experienced a large change from 1995 to 1996. In 1995, more blending components were produced

Table 3.1 Changes in Non-Crude Oil Gasoline Feedstock Volumes (Annual Averages)

	Net Inputs to Refiners and Blenders of Non-Crude Oil Feedstocks for Gasoline Production				Gasoline Yield Percent of Crude Oil Input	
	N-Butane Refinery Use	Other HC's & Oxygenates	Blending Component	N-Butanes+ Oxygenates & Other HCs+ Blending Components	Total Finished Mogas	Finished Mogas - N-Butane - Oxy & Other HC - Blending Components
Year	**MB/D**	**MB/D**	**MB/D**	**MB/D**	**Vol % Yield**	**Vol % Yield**
1981	126	50	154	331	51.3	48.7
1982	169	52	173	394	53.8	50.4
1983	102	53	134	288	54.3	51.8
1984	105	45	115	265	53.6	51.4
1985	84	55	187	326	53.5	50.7
1986	69	58	203	330	53.1	50.5
1987	57	64	131	252	53.2	51.3
1988	46	53	85	184	52.5	51.1
1989	12	59	42	114	52.0	51.1
1990	71	78	26	175	51.9	50.6
1991	71	87	54	211	52.4	50.8
1992	32	131	-2	161	52.7	51.4
1993	57	192	28	278	53.7	51.6
1994	32	199	-40	190	51.8	50.4
1995	31	294	-28	297	53.4	51.2
1996	31	310	97	437	53.2	50.1

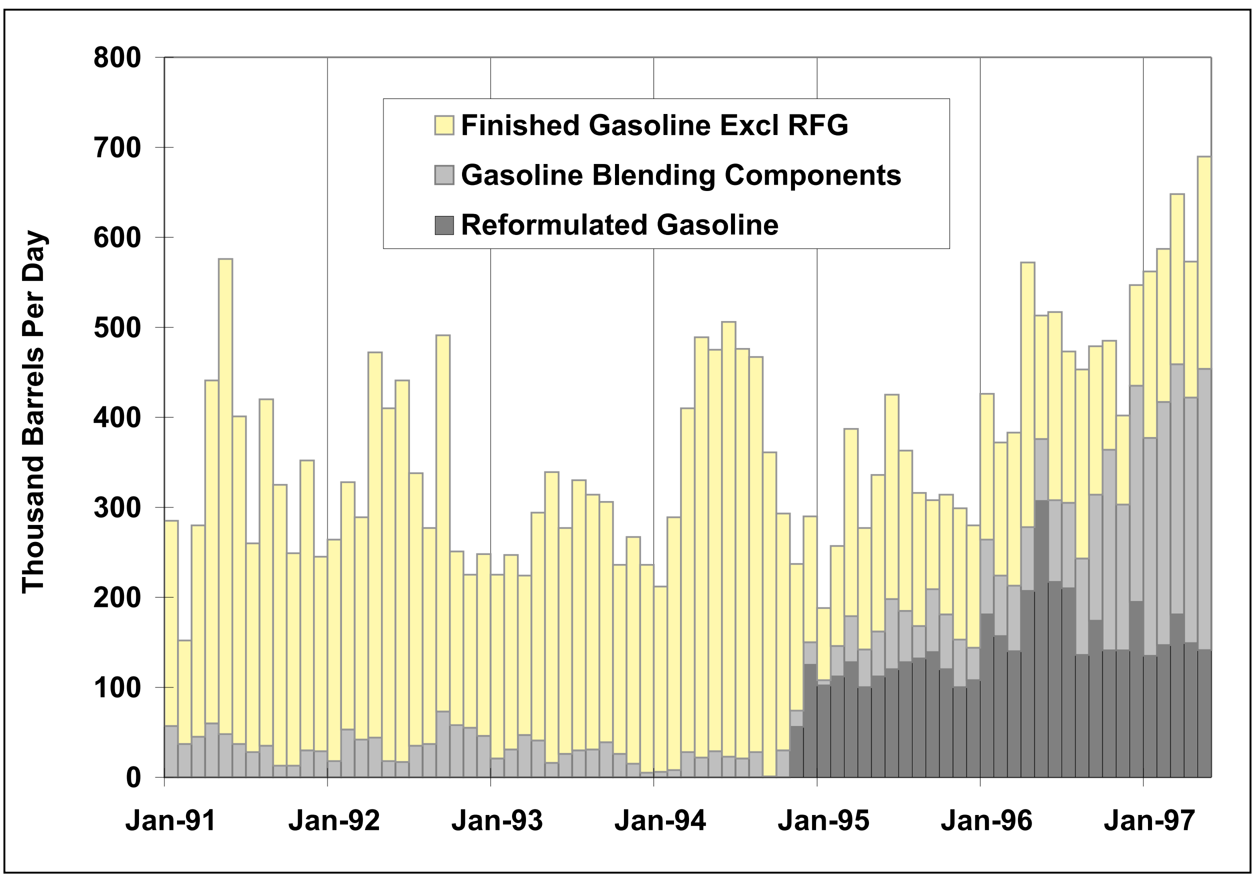
Source: Energy Information Administration, 1981-1995, *Petroleum Supply Annual*, DOE/EIA-0340, Volume 2, Table 3 (various issues); 1996, *Petroleum Supply Monthly*, February, 1997, DOE/EIA-0109, Table 5.
Note: **HC** means hydrocarbons, **Oxy** means oxygenates; Oxygenate use was not reported to EIA separately from other hydrocarbons until 1993.

than were used by refineries with a net production of 28 MB/D. In 1996, blending component use by refiners and blenders was higher than production, with net input averaging 97 MB/D.

When gasoline production is adjusted for butane, oxygenates, and blending stock net inputs, the resulting yield of gasoline from crude oil inputs declined 1.1 percent, from 51.2 percent to 50.1 percent between 1995 and 1996. The decrease in the yield of gasoline from crude oil in 1996 was part of a shift in yield by refiners to increasing distillate yield (diesel, heating oil and jet fuel), while decreasing gasoline yield. This occurred because imports of finished gasoline and blending components increased significantly from 202 MB/D in 1995 to 355 MB/D in 1996, allowing lower production from crude oil in refineries, despite growth in product demand.

Imports grew substantially in both 1996 and 1997 (Figure 3.1). The major increases in import volumes came from Europe, Venezuela, Canada and the Middle East/Africa (Table 3.2). Weak gasoline markets in other areas encouraged gasoline imports to the United States. Gasoline supplies have been in excess in Europe because much of the conversion facilities installed (i.e., fluid catalytic cracking units and cokers) produce more gasoline than diesel, and diesel demand has been growing faster than gasoline demand. The gasoline price difference between the United States East Coast (New York Harbor) and Rotterdam was in the 0-4 cents-per-gallon range from 1991 to 1994, but it has been in the 3-8 cents-per-gallon range since then (Figure 3.2). Since transportation costs are in the 3-5 cents-per-gallon range, Europe to United States movements are economically attractive. Gasoline from the Middle East (principally Saudi Arabia) has been finding its way to U.S. markets because Asian refining growth has impacted the need and economics for gasoline imports. Finally, any strength in U.S. gasoline markets attracts some increases in imports from traditional Western hemisphere sources, such as Venezuela, Virgin Islands, and Canada.

Figure 3.1 1996 Gasoline and Blending Stock Imports



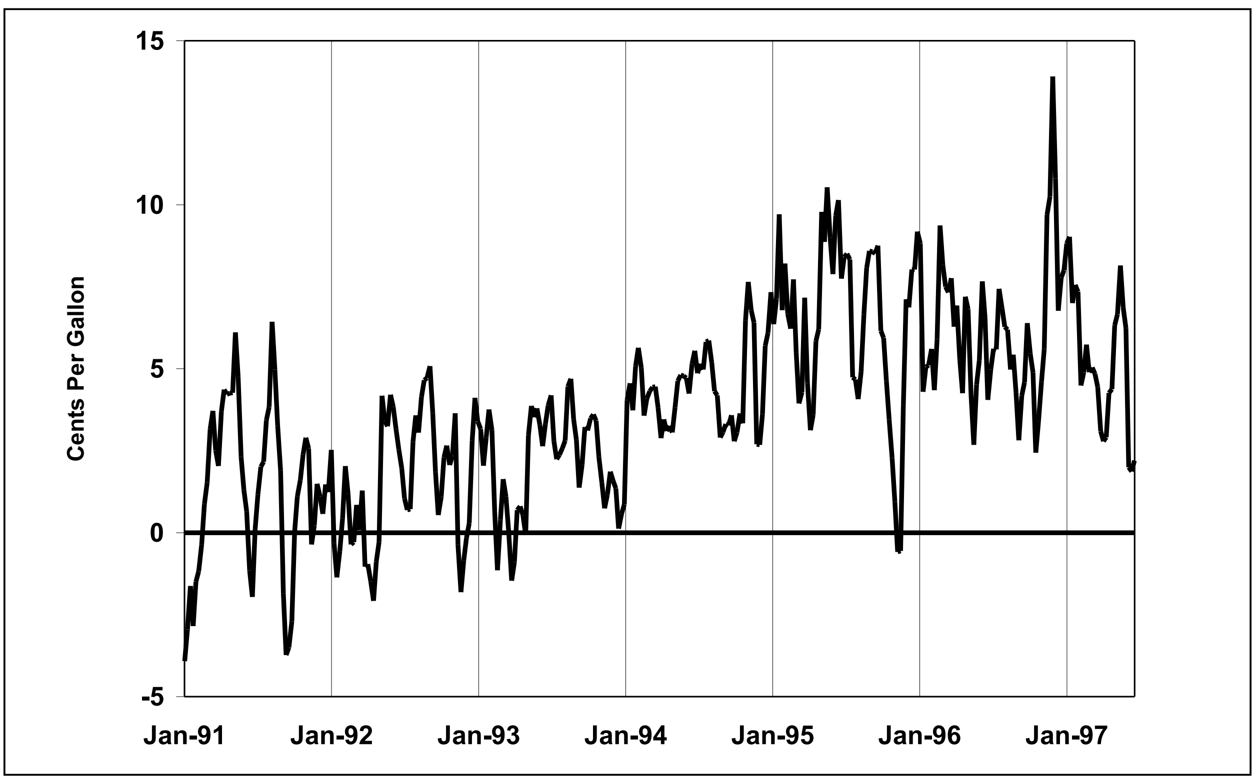
Source: 1994-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340, Table 3 (various issues); 1996-1997, *Petroleum Supply Monthly* DOE/EIA-0109, Table 4 (various issues); April-May 1997, *Weekly Petroleum Status Report*, DOE/EIA-0208, Table 10 (various issues).

Table 3.2 Imports by Geographic Area

	Imports (Thousand Barrels Per Day)				Import Shares (Percent)			
	1994	1995	1996	Q1 1997	1994	1995	1996	Q1 1997
Canada	49.3	66.4	93.7	82.6	13.1%	21.2%	20.0%	13.8%
Virgin Islands	117.7	107.4	105.1	115.0	31.3%	34.3%	22.4%	19.2%
Venezuela	33.4	37.7	64.9	87.0	8.9%	12.0%	13.8%	14.5%
Europe	130.5	67.6	139.3	224.6	34.7%	21.6%	29.7%	37.5%
Middle East & Africa	4.8	11.3	27.6	33.1	1.3%	3.6%	5.9%	5.5%
South & Central America	30.3	14.5	16.5	22.6	8.1%	4.7%	3.5%	3.8%
Other	9.9	7.7	22.3	34.4	2.6%	2.5%	4.7%	5.7%
Total	375.9	312.7	469.5	599.2	100.0%	100.0%	100.0%	100.0%

Source: Energy Information Administration, 1994-1995, *Petroleum Supply Annual,* DOE/EIA-0340, Table 21 (various issues); 1996-1997, *Petroleum Supply Monthly,* DOE/EIA-0109, Table 35 (various issues).

Figure 3.2 New York Harbor-Rotterdam Regular Gasoline Price Differences



Source: Standard and Poor's Platt's

The patterns of supply that were observed when 1996 to 1995 were compared are continuing in 1997. Table 3.3 shows that the volume of imports are increasing, with much of the increase coming in the form of gasoline blending components. A comparison of gasoline supply data for first quarter 1997 to first quarter 1996 shows crude input to refineries declined in 1997, but the growth in imports increased production from refiners and blenders and the volume of product supplied to consumers.

Table 3.3 Supply Patterns, First Quarters 1996 and 1997
(Thousand barrels per day)

	Refinery Crude Oil Input	Refinery Finished Gasoline Production (*)	Gasoline Imports		Gasoline Product Supplied
			Finished	Blending Components	
Quarter 1 1996	13,664	7,512	319	74	7,224
Quarter 1 1997	13,647	7,565	315	263	7,266
Change	-17	+53	-4	+189	

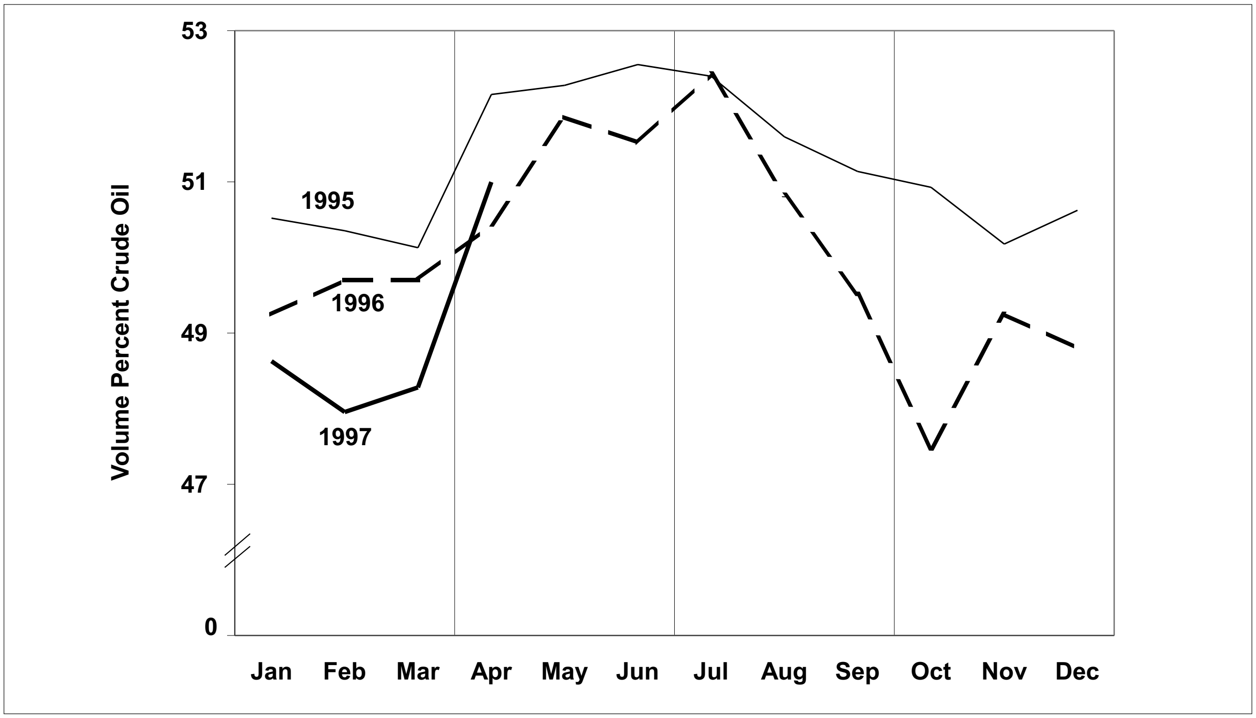
Source: Energy Information Administration, *Petroleum Supply Monthly*, DOE/EIA-0109, Table 4 (various issues).
Note**:** Refinery finished gasoline production includes production from both refineries and gasoline blenders.

A shift of refinery yield patterns from gasoline to distillate continued in 1997 with the yield of gasoline from crude oil down slightly compared to the first few months of 1996, and the yield of distillate plus jet fuel about the same (Figures 3.3 and 3.4). In the past, when winters were unusually cold, high distillate production to meet winter demand was accomplished through high refinery runs and high co-production of gasoline, resulting in a first quarter gasoline stock build — mainly from a high January build. First quarter 1997 saw a small first quarter gasoline stock build, which derived mainly from imported blending components.

Gasoline stocks are also an important part of the gasoline supply picture. Gasoline stocks usually peak at the end of January and are then drawn down from February to the end of August. With lower demand and strong co-production of gasoline with distillate, stocks begin to rebuild after August. In the past, gasoline stock levels were shown to be an important factor in determining the price of gasoline relative to the price of crude (i.e., the price spread, which is gasoline price minus crude oil price). A 1995 EIA study analyzed factors affecting the gasoline spread and found that:

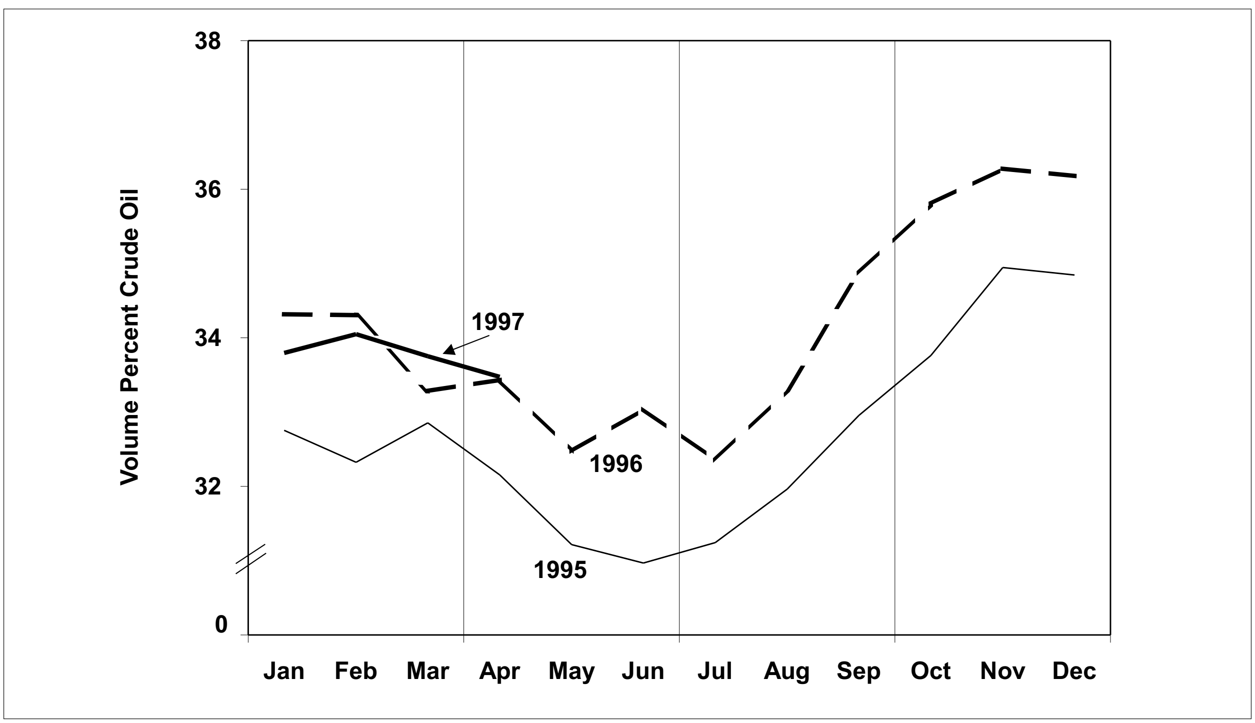
> The result of the exploration comes as no surprise to many market analysts. Stock levels of gasoline relative to normal levels seems to be the most important variable in explaining short-term gasoline spread movements. Of little importance in explaining spread variations are demand, capacity utilization (which is a measure of production capability to provide more gasoline), and a number of other variables... [Stocks are an important factor in spread movements because] in essence, stocks are a yardstick for short-term, supply-demand balance tightness, and the supply-demand balance

Figure 3.3 Motor Gasoline Yield From Crude Oil



Source: 1994-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340, Table 3 (various issues); 1996-1997, *Petroleum Supply Monthly*, DOE/EIA-0109, Table 4 (various issues).

Figure 3.4 Distillate and Kerosene-Jet Yields Combined



Source: 1994-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340, Table 3 (various issues); 1996-1997, *Petroleum Supply Monthly,* DOE/EIA-0109, Table 4 (various issues).

seems to be the most significant market factor explaining gasoline spread variations under and over the normal seasonal swings.[1]

But while gasoline stock levels have been shown to be an important factor in determining gasoline price spreads, a comparison of the stock-price relationship for gasoline with the stock-price relationship for two other oil products, heating oil and propane, also gives some important perspectives. For heating fuels, stocks are an important part of winter fuel supply. In the peak demand months of December through February, typically 12 percent of winter diesel and heating oil demand is met by draw down of stocks. In the case of propane, about 20 percent of the peak winter demand which occurs during December through February usually is met from stock draw. By contrast, gasoline stocks in the peak demand months of March through August supply about 2 percent of demand. The history of price spikes is consistent with the importance of stocks in meeting supply. The Mont Belvieu spot price of propane doubled in December 1989, and Conway prices doubled in November/December 1996. In cold winter months, distillate price has jumped 25 percent. (The normal peak winter distillate spread of 10.5 cents per gallon rose to 26.1 in December 1989.) The extra boost in gasoline prices when markets tighten is generally less. In 1991, gasoline markets tightened and spreads increased 6 cents per gallon above seasonal averages, and in April 1995, spreads were 3 cents per gallon above usual. This represents a 5-10 cents-per-gallon increase in gasoline prices. What this comparison shows is that when there is greater reliance on stocks to meet peak demand, one can expect greater market concern when stocks are low compared to normal levels and, thus, greater price swings when markets tighten.

The pressing question in gasoline markets the past couple of years has been what will be the consequence of the downward trend in gasoline stocks. Each year for the past several years the United States has entered the driving seasons with lower beginning stocks. Does this mean greater price volatility? Will low stocks levels mean higher price spreads? From the perspective of gasoline supply, the potential impact of other supply components may be working to change the situation. Stocks provide the most immediate and accessible source of short-term supply and, thus, have great importance in market-price relationships. But it is worth hypothesizing that gasoline imports may be having a growing impact on market pricing. From a supply perspective, imports are not accessible as quickly as stocks from regional locations, but imports may be able to supply product more rapidly than gearing up refinery production and pushing product through the distribution system.

Regional Supply Patterns Varied Significantly

The supply patterns for the five U.S. Petroleum Administration for Defense Districts (PADDs) vary significantly (Table 3.4 and Appendix E). Almost 60% of PADD 1's gasoline supply comes from other PADDs, primarily PADD 3. PADD 1 also receives almost all of the gasoline imported into the United States. PADD 3 is a large producer of gasoline, producing almost three times what it demands. It acts as a supplier for PADD 1 and, to a lesser extent, for PADD 2. On a "net" basis,

1 John Zyren, "What Drives Motor Gasoline Prices", *Petroleum Marketing Monthly*, Energy Information Administration, DOE/EIA-0380, June 1995, p. xviii.

Table 3.4 Regional Gasoline Supply Profiles
(Thousand Barrels per Day)

	1993	1994	1995	1996	Reformulated 1995	Reformulated 1996
PADD 1						
Adjusted Production *	745	739	813	700	534	517
Net Receipts	1,493	1,423	1,564	1,577	396	361
Net Imports	247	351	297	441	116	173
Dec (Inc) in Stocks	(11)	18	10	9	7	9
Total	2,474	2,531	2,684	2,727	1,053	1,060
PADD 2						
Adjusted Production *	1,787	1,781	1,842	1,819	218	237
Net Receipts	499	537	493	550	2	0
Net Imports	1	2	2	3	0	0
Dec (Inc) in Stocks	(5)	(4)	15	3	7	1
Total	2,282	2,316	2,352	2,375	227	238
PADD 3						
Adjusted Production *	3,303	3,261	3,380	3,413	657	606
Net Receipts	(2,066)	(2,036)	(2,121)	(2,215)	(397)	(367)
Net Imports	(68)	(64)	(93)	(93)	(3)	1
Dec (Inc) in Stocks	(4)	11	(3)	11	(2)	3
Total	1,165	1,172	1,163	1,116	255	243
PADD 4						
Adjusted Production *	233	241	240	244	0	0
Net Receipts	15	11	8	9	0	0
Net Imports	0	0	0	1	0	0
Dec (Inc) in Stocks	(0)	(1)	2	(1)	0	0
Total	248	251	250	253	0	0
PADD 5						
Adjusted Production *	1,273	1,273	1,279	1,296	475	820
Net Receipts	59	65	54	77	0	6
Net Imports	(19)	(14)	(5)	3	1	8
Dec (Inc) in Stocks	(8)	8	11	(4)	-15	30
Total	1,305	1,332	1,339	1,372	461	864

Source: Energy Information Administration, 1993-1995, *Petroleum Supply Annual*, Volume 1, DOE/EIA-0340, Tables 5, 7, 9, 11, 13; 1996, *Petroleum Supply Monthly*, February 1997, DOE/EIA-0109, Tables 8, 12, 16, 20, 24.
Notes: (*) Adjusted Production: Field production of finished motor gasoline and blending components + finished motor gasoline refinery production - refinery inputs of blending components. Net imports and receipts include finished gasoline and blending components.

PADDs 4 and 5 are self-sufficient. Reformulated gasoline is consumed in all PADDs but PADD 4; however, RFG is only a large share of market in PADDs 1 and 5.

PADD 1 experienced a large drop in adjusted gasoline production (i.e., total production remaining after increases due to blending stock component inputs are removed) from 1995 to 1996. Finished gasoline production for PADD 1 dropped by 53 MB/D from 1995 to 1996. The drop occurred because of the shutdown and loss of production from the Marcus Hook refinery, and would have been greater if use of imported blending components had not increased. From 1995 to 1996, adjusted gasoline production declined 113 MB/D, or 60 MB/D more than the loss of finished gasoline production. The decline was made up by increased input of blending components in PADD 1. As 1997 began, PADD 1 finished gasoline production was up 104 MB/D over production in first quarter 1996. Crude oil inputs were up slightly (27 MB/D), but the major component of increase came from the large increase in imports of gasoline blending components.

Most blending component imports into PADD 1 were brought in by blenders and traders rather than refiners. These blenders and traders were responsible for all but 7 MB/D or less of gasoline blending component imports in 1996 and in the first quarter of 1997. Like a large share of the finished gasoline imports, gasoline blending component imports were delivered to terminals in consumption areas. At these terminals, the components were blended with other streams and the finished gasoline was delivered to nearby markets.

Over the past few years, PADD 1 has shown supply flexibility to meet changes in demand without significant price impacts. When RFG was required in 1995, the new demand for RFG and increases in conventional gasoline demand were met by increased refinery production within the PADD and increased movements from PADD 3. Imports in 1995 declined relative to those in 1994. In 1996, PADD 1 refinery production was diminished by the loss of the Marcus Hook refinery. The demand increase was met mostly by increased imports and small increases in inter-PADD receipts.

PADD 5 provides a sharp contrast to PADD 1. As a result of ample import potential, the loss of the Marcus Hook refinery in PADD 1 seemed to have little impact on prices. In California, an explosion and fire at the Shell Martinez refinery on April 1, 1996 had a large impact on prices. The accident damaged the hydrotreating units and virtually shut down the refinery's gasoline production capacity for one month. PADD 5 normally supplies all of its own gasoline demand, but without Martinez, supply had to come from alternative sources. The problem was further compounded because the production volumes that were lost were the new ultra-low sulfur gasoline (CaRFG). The low-sulfur limit made finding even blending components difficult. The lack of short-term alternatives for this fuel was reflected in large price increases. (See Chapter 4)

Implications of Supply Evolution

In summary, the major gasoline supply concern in 1997 is the low level of gasoline stocks at the beginning of the summer driving season. The United States has been experiencing lower stocks in the past several years, but stocks can reach a point where significant supply problems are encountered briefly (Table 3.5). No one knows where that point is. The United States also has been increasing its refining capacity utilization, which heightens concern about supply availability. While stocks and refinery utilization are important factors in the supply picture, the abundance of and price of imports causes this analysis to conclude that 1997 will be a relatively normal price year in U.S. gasoline markets. The stock situation suggests the possibility that events could occur to cause upward price pressures, but stock levels have been improving, and the current weak price spreads imply the market considers supply problems to be a low probability case.

Table 3.5 Total Gasoline Stocks at Beginning of April
(Million Barrels)

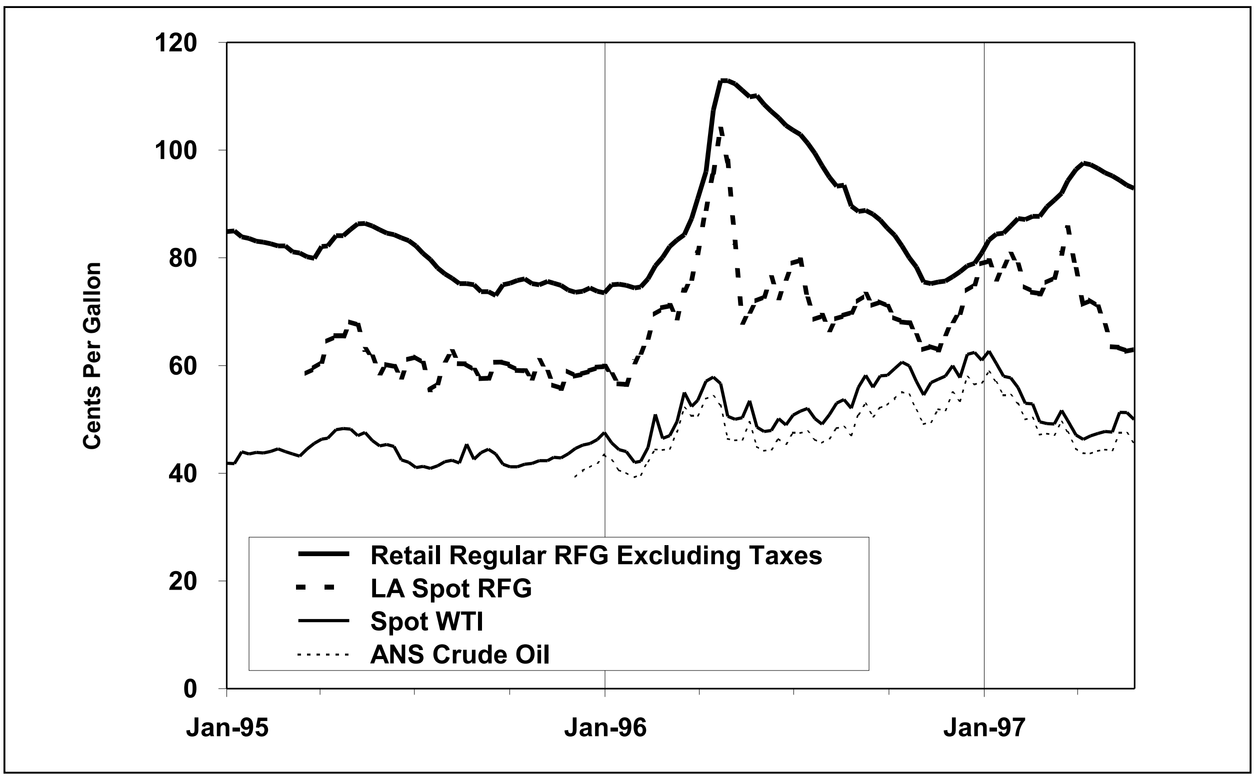
	1991	1992	1993	1994	1995	1996	1997
Stocks	220	224	213	215	211	203	197

Source: Energy Information Administration, 1991-1994, *Petroleum Supply Annual*, DOE/EIA-0340, Table 2 (various issues); 1996-1997, *Petroleum Supply Monthly*, DOE/EIA-0109, Table 2 (various issues).

4. California - A Unique Situation

The gasoline markets during 1996 and 1997 demonstrated dramatic differences between the East Coast and the West Coast — the two largest areas using RFG. California not only experienced the same market pressures in 1996 as did the rest of the country, but also experienced additional market pressures due to their introduction and use of a unique reformulated fuel, CaRFG. Retail regular prices of RFG rose 39 cents per gallon from the beginning of January 1996 to early May (Figure 4.1). Crude prices, normal seasonal increases, and the increased costs of making the new RFG might account for about 23 cents of the increase, but the additional 16 cents was due to supply problems that occurred as the new RFG program began in spring 1996. The supply problems led to buyers bidding prices up based on the uncertainty of supply adequacy.

Figure 4.1 California Gasoline and Crude Oil Prices



Source: Spot Prices: Standard and Poor's Platt's; Retail Prices: Energy Information Administration, Form EIA-878 "Motor Gasoline Price Survey."
Note: ANS - Alaskan North Slope.

California introduced its own new and unique Phase 2 reformulated gasoline (CaRFG) during the spring of 1996. CaRFG has more stringent requirements than Federal RFG, making it more difficult and more expensive to produce than Federal RFG. The California Energy Commission estimates the additional cost to produce CaRFG over Federal RFG at between 5 and 8 cents more per gallon.

Although the higher costs translate to higher prices, consumers will benefit from significant smog reduction.

In hindsight, increased price volatility in California compared to that on the East Coast is not surprising given that:

- Most of PADD 5's product is produced by refineries within the PADD, compared to PADD 1, which receives 50 percent of its RFG and 74 percent of all of its gasoline from other PADDs and imports. While refineries serving both PADDs are running at high utilizations, PADD 1 has greater flexibility of supply from its multiple supply sources, should problems occur in any one supply source.
- Transportation of product from other PADDs and foreign sources to PADD 5 is more costly than delivering product to PADD 1 from outside sources. The increased transportation cost alone could drive price up 10 cents per gallon in PADD 5 when internal supplies run short in order to attract any outside supplies.
- With the advent of CaRFG, fewer supply sources exist outside of PADD 5 that can readily produce the product, thereby increasing the difficulty of solving supply/demand imbalances and increasing price volatility.

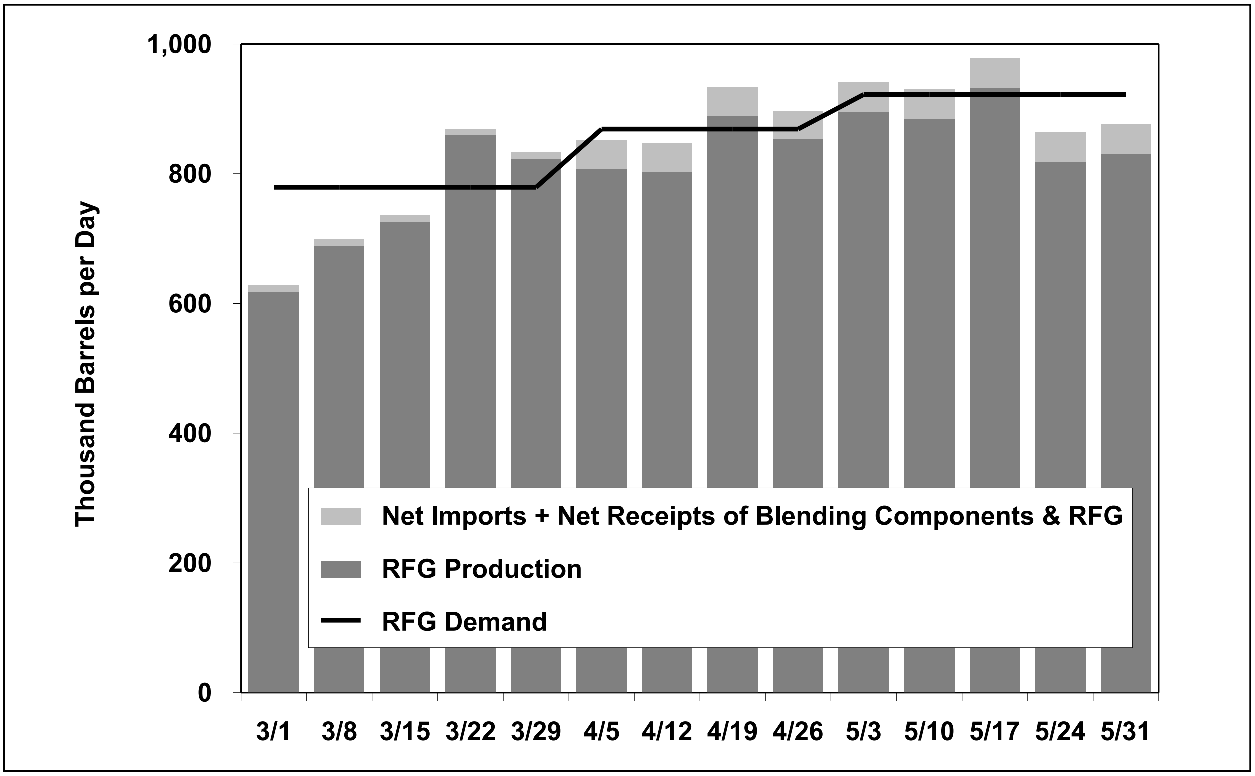
The pattern of increased price volatility in California has been seen several times during 1996 and 1997. The first was in second quarter of 1996, when CaRFG was introduced. Average CaRFG demand was projected at 896 MB/D for the first year (March 1, 1996, through February 28, 1997), taking into consideration the fuel efficiency loss (about 1-2 percent lower than Federal RFG efficiency). Average production was projected at 906 MB/D, providing a 10 MB/D cushion. While not large, this cushion was expected to be adequate.[1] Some supply potential exists outside of California; however, most refiners are not equipped to produce the new fuel in any large amounts, if at all. Refineries in California were expected to use 85-90 percent of their gasoline capacity to produce the new fuel.

Just when the CaRFG program was beginning, supply problems developed as a number of California refineries experienced operating problems and had to shutdown for repairs. On April 1, 1996, the Shell Martinez refinery in California, which has over 100 MB/D of gasoline capability, had a fire that closed the refinery for most of April. Martinez was not able to return to full operation until June. Immediately following the fire and initial shutdown, retail prices in California rose about 10 cents per gallon.[2] During the same period (April through June), several other refineries experienced explosions and mechanical problems and, for short periods of time, over 100 MB/D of CaRFG supply were affected. The 100 MB/D represented about 12 percent of California's spring gasoline demand. Fortunately, other refineries were able to increase production quickly enough to

1 California Air Resources Board and California Energy Commission's February 1996 Supply/Demand Analysis.

2 California Energy Commission and California Air Resources Board, *Motor Vehicle Fuel Price Increases, Joint Report to the Legislature*, January 1997.

Figure 4.2 Spring 1996 PADD 5 RFG Weekly Supply and Demand



Source: Energy Information Administration, Production: Form EIA-800; Product Supplied, Net Imports and Net Receipts: *Petroleum Supply Monthly* DOE/EIA-0109, Table 24 (various issues).
Note**:** Demand, net imports and net receipts are only available monthly and thus are shown as a constant value over the weeks in a given month. All blending component net imports and net receipts are included, which probably overstates the supply of product for CaRFG somewhat, since some of these components may be for conventional gasoline.

keep production from falling on a weekly average much more than 50 MB/D, but this was still enough of a drop to put extra pressure on prices (Figure 4.2).

Table 4.1 Transportation Costs and Time Required to Import Fuels to California

Market	Cost (Cents Per Gallon)	Shipping Time (Days)	Initial Lead Time (1) Plus Shipping Time(Days)
Washington State	3 to 4	4 to 6	11 to 16
Gulf Coast/Caribbean	5 to 10	14	21 to 24
Other U.S.	8 to 12	14	21 to 24
Foreign	10 to 12	23 to 30	30 to 40

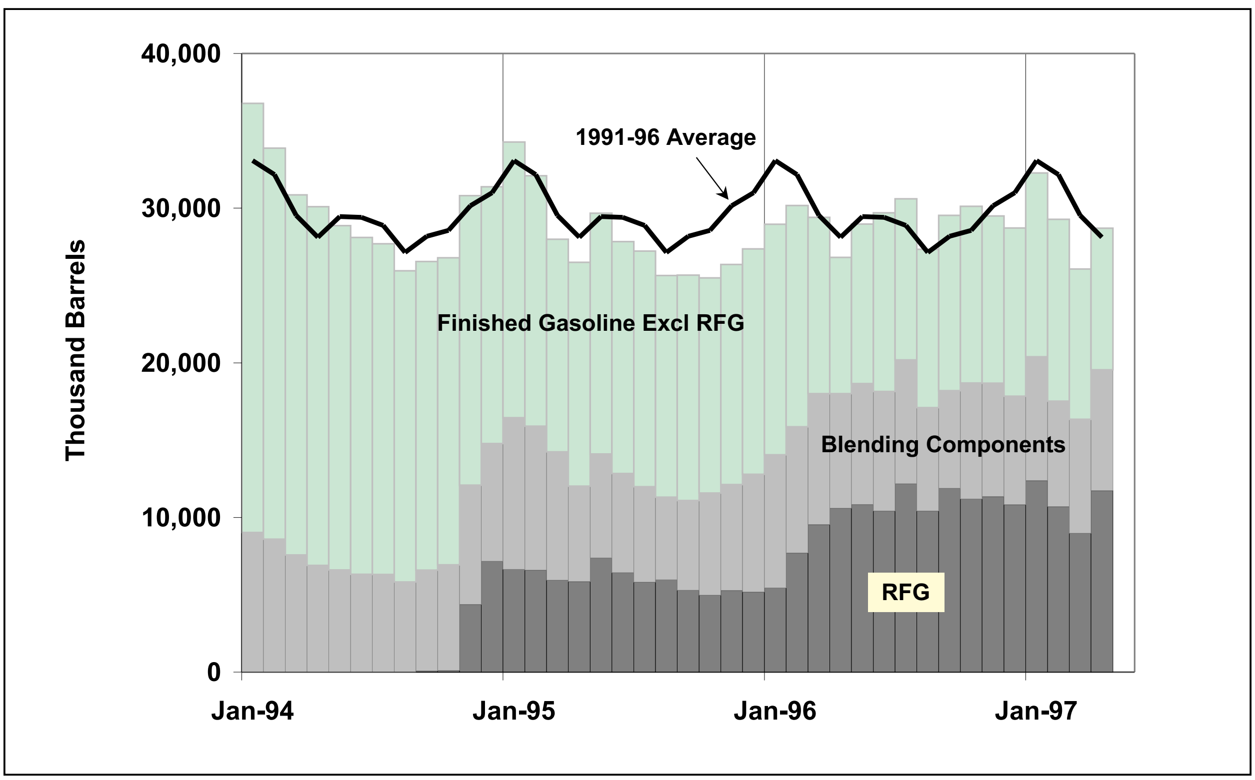
Source: California Energy Commission, California Air Resources Board, *Motor Vehicle Fuel Price Increases,* January 1997, p. 13.
Note: (1) Initial lead time of seven to ten days would typically be needed to produce product for shipping.

Many refineries outside of California cannot produce CaRFG or appropriate blending components. Those refineries on the Gulf Coast (and other distant areas) that can produce CaRFG would not normally be doing so and would not have readily available supplies on hand. It takes time to adjust operations to provide the product and even more time to ship the product by tanker to California (Table 4.1). The long time delays would discourage such refiners from responding to refinery problems in California since normally the supply problems would be resolved by the time the long-distance product arrived. Prices would have receded, and the extra costs of producing CaRFG and hauling it to California might not be recovered. The transportation costs alone from the Gulf Coast add 5 to 10 cents per gallon.

California reported that external supplies did arrive during the spring of 1996 from Washington state, the Gulf Coast, the Caribbean, and even Finland, and that these supplies have been providing an average of 30-50 MB/D of CaRFG or CaRFG blending components since March 1996.

The loss of production as the program began was compounded by low gasoline stocks. In late 1995, PADD 5 gasoline stocks had been running well below average (Figure 4.3). PADD 5 stocks ended January 12.4 percent below their average levels for the month. With the need to empty tanks of old fuel in preparation for the new RFG, stocks did not recover until March, when they ended the month only 0.4 percent below typical March levels, an amount which represented about 1.3 days less supply than the normal 22.1 days supply for the month. In April, stocks fell back again as refinery

Figure 4.3 PADD 5 Total Gasoline Stocks



Source: Energy Information Administration, 1994-1995, *Petroleum Supply Annual*, Volume 2, DOE/EIA-0340, Table 12; 1996-1997, *Petroleum Supply Monthly*, DOE/EIA-0109, Table 22 (various issues).

problems evolved and both conventional and CaRFG prices responded to the supply difficulties. Stocks recovered as the refineries made repairs and went on line. Inventories stayed at or above normal during the June through October period.

Spot prices shot up in April 1996 with retail right behind, driven by a sudden tightening in the supply/demand balance, declining inventories, and uncertainty over the duration of the supply shortfall. Unlike the supply situation in the rest of the country, the supply problems in California affected spreads strongly. Conventional gasoline prices were also affected by the supply problems, since California refiners also serve neighboring States.

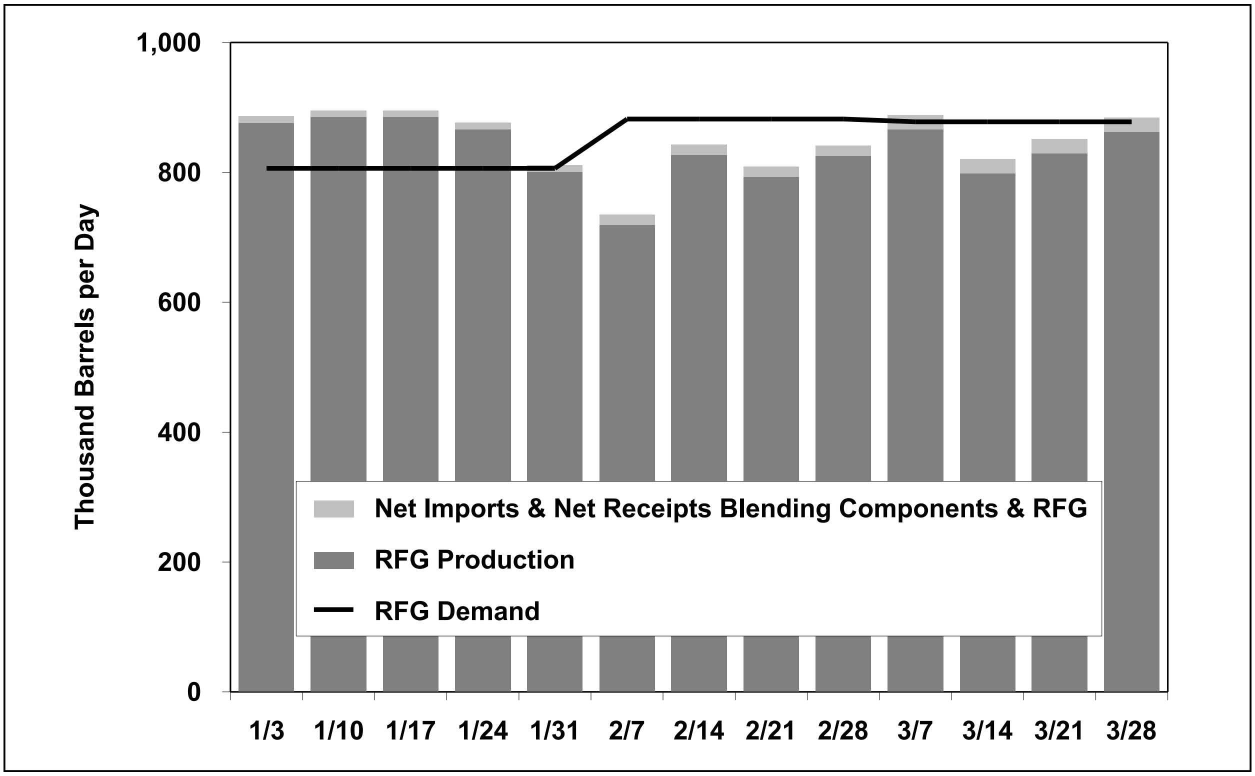
The price increase experienced in California in the spring of 1996 reflected a market stress situation, illustrating price response when supply disruptions occur in a very tight market. With little or no immediate supply alternatives, the loss of expected supply resulted in the market bidding prices up at panic rates. Gasoline price spreads over the cost of crude oil were much higher than normal, unlike spreads in the rest of the country. (See Chapter 5). Consumers in California paid as little as $1.14 during early January for regular RFG. But prices rose to a peak during early May at almost $1.54 due to crude price increases, the normal spring price increases, the changeover to CaRFG, and refinery operating difficulties.

As summer of 1996 progressed, supply returned to normal and prices fell. By fall, high gasoline production and above-normal stock levels began to add downward pressure to prices. Refiners began dumping product on the market, partially to get rid of the extra summer specification gasoline before winter, and prices plummeted. A price war in southern California brought retail prices in some areas below $1.00 per gallon.[3] CaRFG prices actually dropped below U.S. average conventional regular prices in November and December.

During December, production problems at several refineries (Mobil-Torrance, Ultramar-Wilmington, and Chevron-Richmond) put an end to the price decline. Weekly average spot CaRFG prices had bottomed out at under 63 cents per gallon in November 1996, but by year end had climbed to over 75. At the end of January, a large explosion and fire in a hydrocracking unit at Tosco's Avon refinery continued to keep pressure on prices as other refiners prepared to take units down for spring maintenance (Figure 4.4). In mid-January, production averaged 885 MB/D. By the first week in February, it had dropped 166 MB/D to average 719 before beginning to recover. Weekly average spot prices of CaRFG topped 80 cents per gallon in January. Prices sank back in February to just over 73 cents per gallon, but a large stock draw and the threat of a strike and potential shutdown of three refineries towards the end of March sent weekly prices shooting up to over 85 cents per gallon. Finally, as no strike occurred and as refineries came back on stream from maintenance and repairs, the market fell back to under 65 cents per gallon in May. During November, retail regular RFG averaged as little as $1.16 per gallon. It climbed fairly steadily, peaking in April at over $1.38, and by the beginning of June had dropped to under $1.34 as the second spring transition for CaRFG came to a close.

3 United Communications Group, *Oil Price Information Service* (Rockville, MD: November 18, 1996), p. 4.

Figure 4.4 Spring 1997 PADD 5 RFG Weekly Supply and Demand



Source: Energy Information Administration, Production: Form EIA-800; "Product Supplied, Net Imports and Net Receipts:" *Petroleum Supply Monthly,* DOE/EIA-0109, Table 24 (various issues).

Although prices are now easing, another transition is facing California refiners. They are preparing to send RFG to Phoenix, Arizona this year. Phoenix receives much of its gasoline supply from California refineries but until now has not required RFG. Initial findings indicate the transition should be no problem (See Box).

RFG in Phoenix

During 1996, Phoenix, Arizona, currently classified as a moderate ozone nonattainment area,continued to exceed National Ambient Air Quality Standards for ozone, thereby risking reclassification in a more serious nonattainment category. Responding to a request from the governor of Arizona, the U.S. Environmental Protection Agency (EPA) issued a rule requiring RFG at retail stations in the Phoenix area by August 4, 1997. The August 4, 1997 start date at the retail level mandated a July 3, 1997 date for RFG to be available at terminals in Phoenix. Low RVP (low Reid vapor pressure, i.e., 7 pounds per square inch) gasoline has been and will continue to be supplied to the Phoenix market in the summer, so that starting August 4, 1997, consumers will be purchasing low RVP RFG.

California refiners now supply much of the Phoenix market. Early in the discussions, concerns were expressed about California's ability to supply this area with RFG in light of the problems refiners have had periodically in supplying CaRFG. In assessing the feasibility of supplying RFG to the Phoenix area, EPA reviewed logistics, cost, the potential for price spikes, supply and diversity of supply issues. Much of the discussion that follows is taken from the Notice of Final Rulemaking.*

Logistics: Arizona is supplied petroleum products by pipelines from refiners to the east and west of the state. The western pipeline delivers 70 MB/D of gasoline to Phoenix. The pipeline from the east provides 25 MB/D. Both pipelines have unused capacity. The Phoenix area consumes 70 MB/D of gasoline on average. Other volumes delivered to Phoenix will remain as conventional gasoline intended for consumption in surrounding areas.

To assure a smooth transition to the program, Arizona developed an outreach program. The program includes training, an emergency response plan, and information dissemination. Shipments of RFG produced in California and bound for Phoenix began June 1997.

Production: EPA believes at least 6 refiners in California and 2 to 3 refiners to the east would be providing RFG to Phoenix with the combined capacity of these sources exceeding the 70 MB/D average demand. The multiplicity of sources in both the west and east reduces the probability of a supply disruption in the event of a refinery or pipeline outage.

Prices: According to the Oil Price Information Service, the spot prices for Phoenix RFG fell from 67 cents to 60 cents per gallon during May 1997. The difference between Phoenix RFG and California CaRFG gasoline fairly consistently ranged between 1.3 and 1.7 cents per gallon, with Phoenix RFG costing less due to less stringent requirements.**

*Federal Register June 3, 1997, 62-FR 3026.0.

** United Communications Group, Oil Price Information Service (Rockville, MD, various issues).

5. Prices Vary By Region, Class of Trade, and Grade

While gasoline prices across the nation experienced supply/demand pressures described in Chapter 2, regional prices responded somewhat differently. The most dramatic regional variation was in California (Chapter 4). Class of trade (i.e., retail, dealer tank wagon (DTW), and rack) responses to the crude price increases in 1996 were not unusual on a PADD basis, and regional resale price spreads were consistent with the spot price spreads observed in Chapter 2. One interesting turn of events was that, as prices increased, consumers responded by shifting to cheaper grades of gasoline, which they have not done since the price increases experienced during the Gulf War.

Class of Trade Prices and Wholesale Spreads Varied Regionally

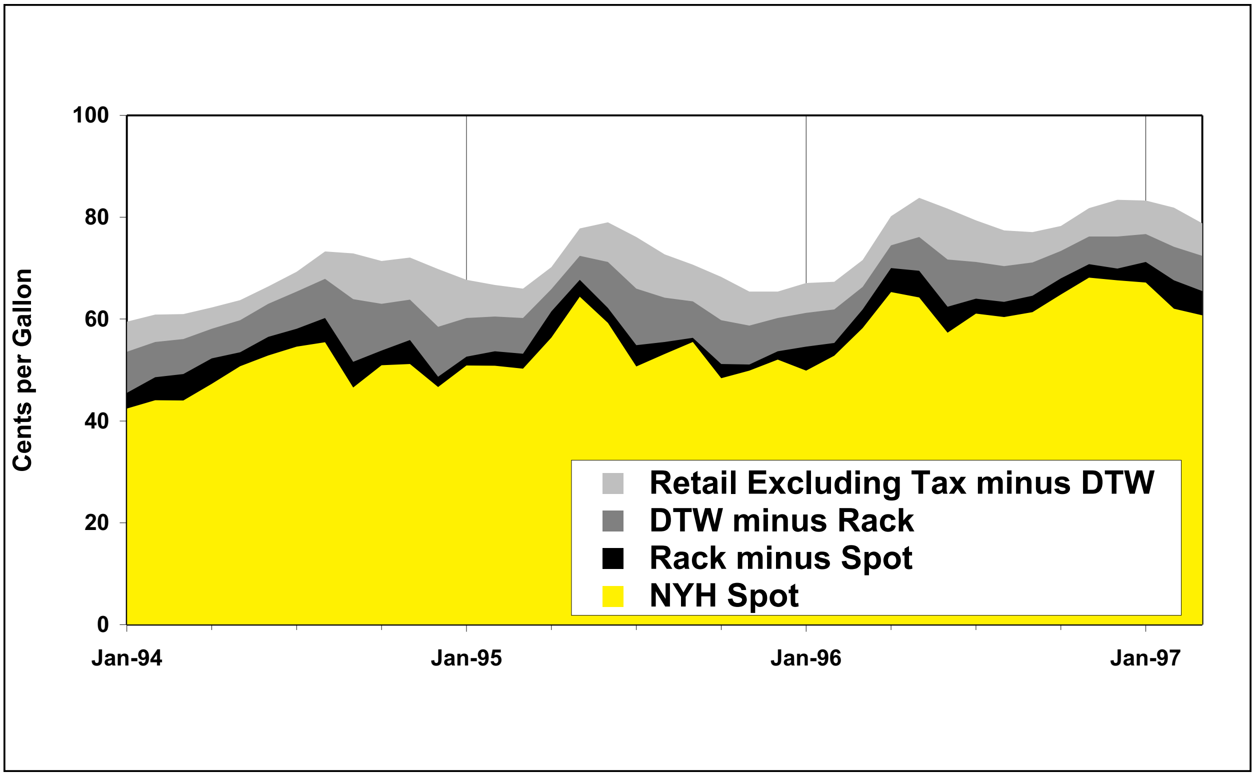
Class of Trade Prices Displayed Expected Variations in 1996

Regional prices vary by class of trade, that is from one level of distribution to the next. Figure 5.1 shows the spot, rack, dealer tank wagon (DTW), and retail prices (excluding taxes) for PADD 1.

- Spot price represents a price agreed to by a buyer and seller for a single cargo of product. It can vary significantly day to day.
- Rack price refers to the wholesale price charged by refiners at their refineries or company terminals to open dealers or distributors. Rack prices are usually determined on a daily basis and are influenced by competitors' prices as well as by spot and futures market prices. Rack prices cover refining costs, including the cost of feedstocks and some storage costs.
- DTW price is that charged by distributors and refiners to their retailers. These prices include transportation costs to the dealers' stations and other business costs (promotions, dealer incentives, etc.) beyond the basic rack price. DTW prices are established by considering competitors prices and spot and futures prices.
- EIA DTW and rack prices include both branded and unbranded prices. Branded prices generally carry an arrangement for security of supply, trademark, credit cards, and advertising, thereby carrying a premium over unbranded prices. However, when markets are tight, volumes available to unbranded dealers may diminish and unbranded prices then can exceed branded prices.
- Retail price is the price paid by the consumer at the gasoline station. It includes the wholesale price paid by the retail station for the fuel, additional station operating costs, dealer margins, and taxes.

Price varies in response to local competition as well as underlying costs. Consumers can find large price variation within small geographic regions due to competitive differences alone.

Figure 5.1 PADD 1 Wholesale Prices for Regular Conventional Gasoline



Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380, Table 32 (various issues).

The three-year average in spread between retail, DTW, rack, and spot prices for each of the five PADDs is shown in Table 5.1. Rack minus spot has less meaning for some regions. For example, PADDs 2 and 4 are located quite far from major spot markets, such as the Gulf Coast or Los Angeles.

Table 5.1 Regional Three-Year Average Distribution Level Price Differences
(Conventional Regular Gasoline - Cents Per Gallon)

	PADD 1	PADD 2	PADD 3	PADD 4	PADD 5
Retail-DTW	6.6	7.5	7.0	9.1	11.1
DTW-Rack	7.2	5.4	8.0	4.5	9.1
Rack-Spot	3.4	N/A	4.6	N/A	5.3

Note: Spot prices used were as follows: PADD 1 - New York Harbor; PADDs 2 and 3 - Gulf Coast; and PADD 5 - Los Angeles.
Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380, Table 32 (various issues).

In general, the PADDs did not show highly unusual price behavior at the retail and DTW levels. Quarterly and annual spreads of retail-DTW and DTW-rack exhibited some of the typical lag effects that occur when underlying crude costs change, but, for the year, the spreads were not much different than the spreads observed in 1994 and 1995. (On a shorter term basis and at a more local level, variations can be much larger than those seen on a regional average.)

PADD 5 stands out with retail minus DTW price and DTW minus rack price being the largest price differences of any of the PADDs. This does not necessarily imply that distributors and dealers make more profit in this region. It may reflect cost differences more than any other factor. Even with the unusually high spring prices in California in 1996, the price level differences were lower or about the same as in the prior two years, with the exception of retail minus DTW, and this difference was only about 1 cent higher. In PADD 5, the annual averages hide some large rack-spot price variations that took place in 1996. Rack prices were below spot prices during February through April and again in December but soared above spot in between. The average rack-spot difference over the year, though, was not much different than in prior years. Rack relative to spot in PADD 5 showed the most volatility in 1996 compared to the other distribution level differences. However, swings in retail-DTW and DTW-rack were not much different than in the prior two years.

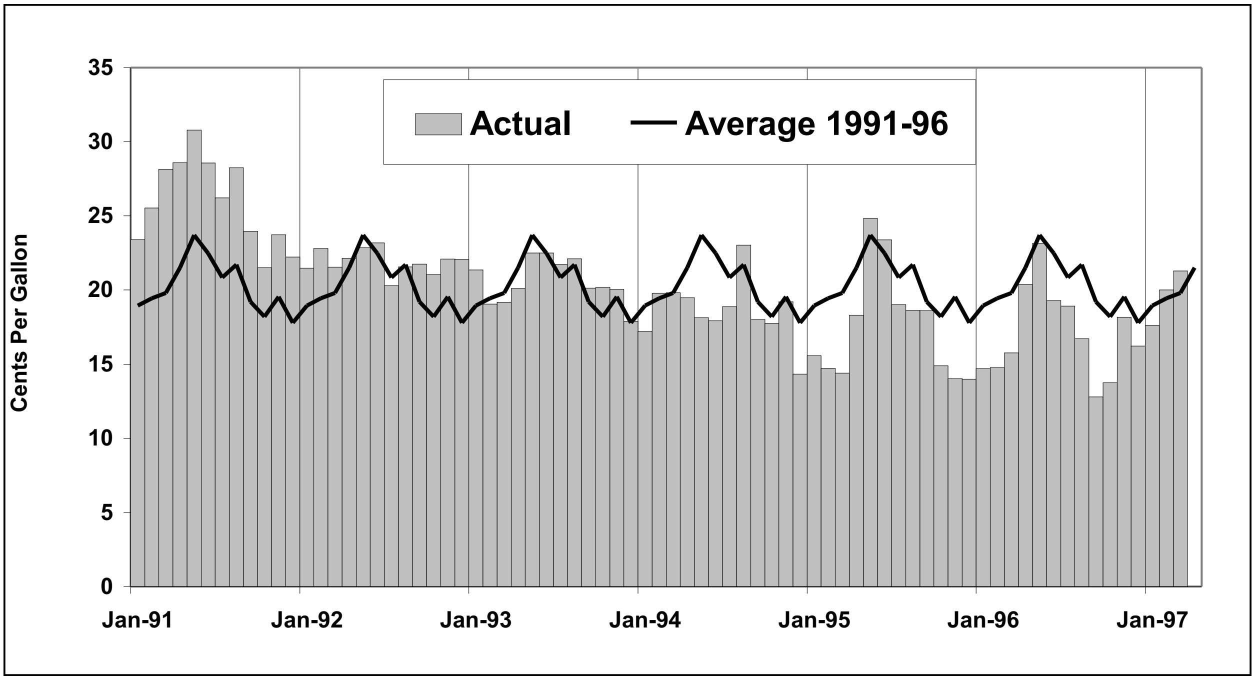
Resale Price Spreads Showed More Strength in First Quarter 1997 than in 1996

Another price variable that displays regional differences is resale price minus refiners' acquisition cost of imported crude oil. Resale price is a wholesale price collected by EIA that includes spot, rack and DTW prices. The refiners' acquisition price of imported crude oil used is not regional, but is the average for the United States (Figure 5.2 and Appendix D). PADDs 1 through 3 have similar seasonal patterns that bottom out in December and peak in May. These three PADDs also show a small resurgence in August as they descend from their May peak. Like the spot price spreads discussed in Chapter 2, resale spreads for all PADDs showed stronger first quarter 1997 results than they did in the first quarter 1996.

In 1996, the spreads in PADD 2 may have been boosted by the runup in ethanol price that occurred. Ethanol is most widely used in PADD 2. The average monthly price of ethanol increased 25 cents per gallon between January and August before starting to decline. If it had been possible to pass this cost through to consumers, it would have added 2.5 cents per gallon to the price of gasohol. Apparently, these costs were not so easy to pass through, however, judging from the drop in ethanol production that occurred during the summer 1996 (See Box).

PADDs 4 and 5 are both fairly self-sufficient PADDs. Both also show a seasonal shape that has a flatter peak than other PADDs. PADD 4's spread on average stays at about the same level from April through August before descending to the winter December low point. PADD 5's spread peaks in April and stays near that level through September before declining. The strength in resale spreads in PADD 5 in 1996 can be attributed to the difficulties in California, but the reason behind PADD 4's unusual spreads in 1996 is not immediately evident. PADD 4 is relatively self-sufficient, supplying over 96 percent of its own needs.

Figure 5.2 PADD 1 Resale Gasoline Spread (Resale Regular Conventional Minus Refiners' Cost of Imported Crude Oil)



Source:Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380, Gasoline Prices: Table 32 (various issues), Crude Oil Prices: Table 1 (various issues).

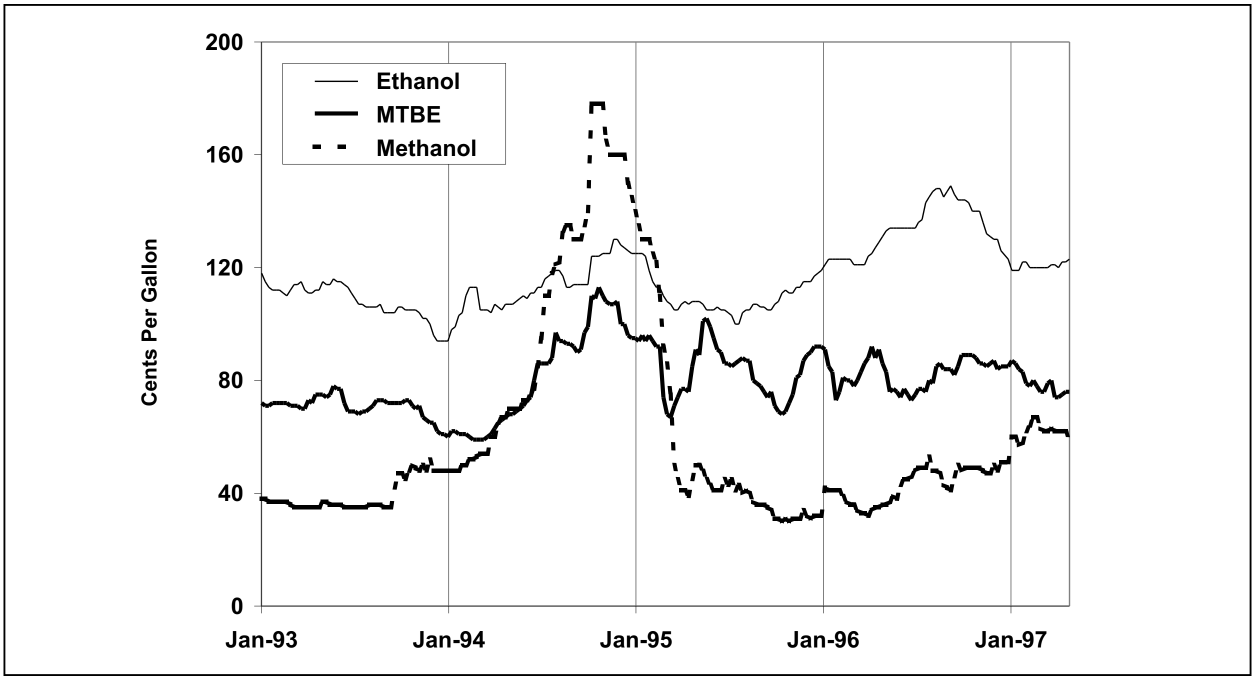
Ethanol Prices Soar in 1996, Causing Companies to Find Alternatives

A bad corn crop brought corn prices up to $5.00 per bushel in June 1996, compared to $2.00 per bushel in October 1994. Ethanol prices on the Gulf Coast rose steadily from $1.05 per gallon in July 1995, to as high as $1.49 in September 1996. Demand fell as prices rose and production of ethanol was cut back from 87 thousand barrels per day in January to 39 MB/D in June and July 1996. Prices eased in September to end the year at about $1.26 and production picked up again. Methanol, the main feedstock for producing MTBE, increased over 20 cents per gallon from first quarter through early 1997, but MTBE markets were loose enough that MTBE prices did not follow. MTBE, however did show some strength during the spring of 1996 as gasoline prices pulled MTBE prices up for a brief period second quarter (Figures 5.3 and 5.4).

Consumers Coped with High Prices By Downgrading

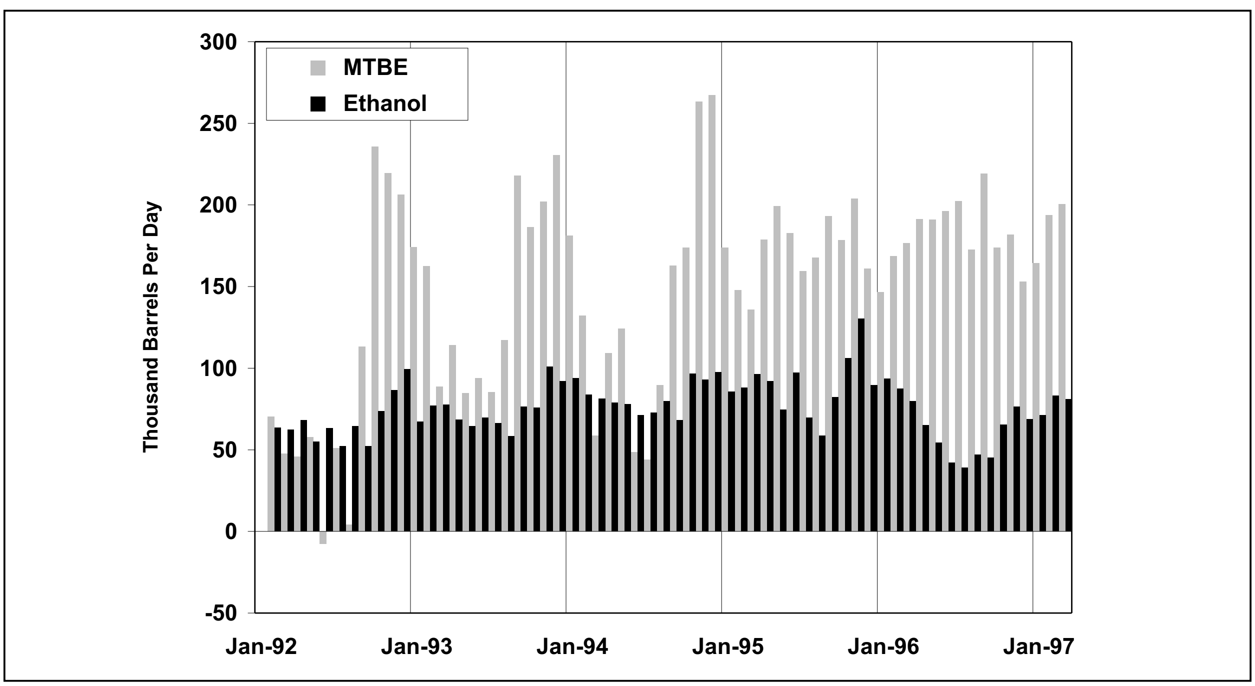
During the spring of 1996, the price increase in gasoline was large and obvious to consumers. While consumers usually do not have access to an alternative to gasoline when prices rise, they can and do shift from more expensive grades to lower-priced grades (Figures 5.5 and 5.6). The large gasoline price decline in 1986, when crude prices fell, probably helped to push the already

Figure 5.3 Oxygenate Prices



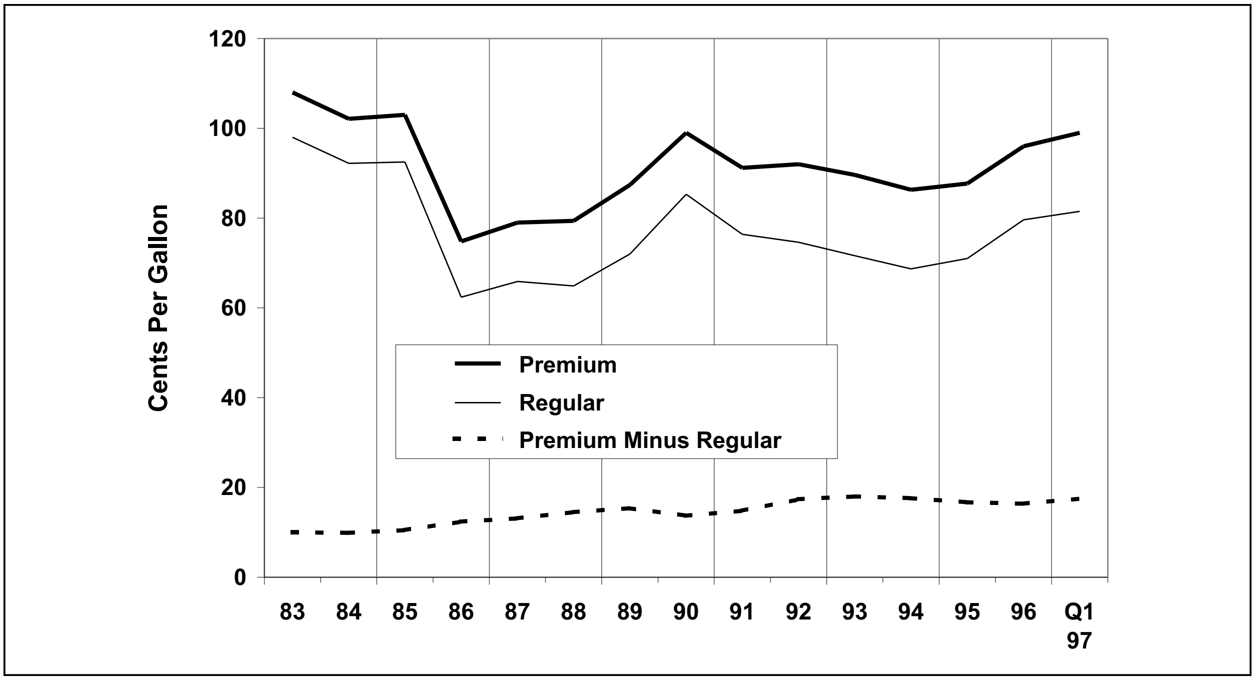
Source: "Octane Week Price Report," *Octane Week*, Hart/IRI Fuels Information Services, Arlington, VA. (various issues).

Figure 5.4 Oxygenate Production and Stock Draw Down Combined



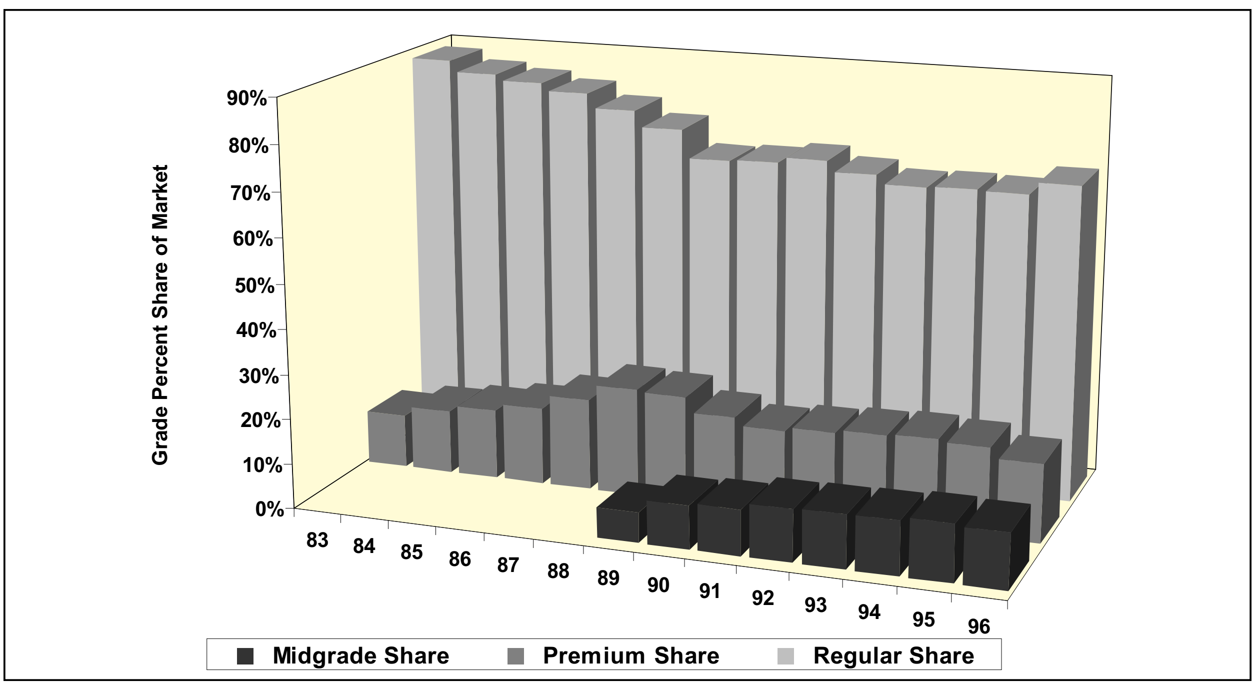
Source: Energy Information Administration, *Petroleum Supply Monthly*, DOE/EIA-0109, Tables D2 and D3 (various issues).

Figure 5.5 Premium and Regular Conventional Gasoline Prices



Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380, Table 32 (various issues).

Figure 5.6 Gasoline Grade Market Shares and Gasoline Price



Source: Energy Information Administration, *Petroleum Marketing Annual*, DOE/EIA-0487, Table 48 (various issues); *Petroleum Marketing Monthly*, DOE/EIA-0380, Table 48 (various issues).

increasing share of premium still higher. However, when prices rose during the Gulf War, premium lost share to midgrade and did not go back to its pre-Gulf War levels. The continuing overall decline in gasoline prices through 1995 did offer enough incentive to increase the premium share of gasoline. Then in 1996, the sharp price increase in spring caused consumers to downgrade again. This time, premium lost share to regular. This does not suggest that premium customers moved to regular. Many premium customers probably moved to midgrade, and a similar number of midgrade customers downgraded to regular, thereby keeping midgrade stable.

The first quarter 1997 continued to show a decline in premium shares, with a corresponding increase in regular. As prices weaken through the year, the premium share may bounce back somewhat; however, judging from the situation during the post-Gulf War period, premium may not regain its prior share.

6. Insights from Modeling Gasoline Prices and Updated Outlook

Gasoline prices are affected in the short-term by supply/demand balances and underlying costs. Chapter 2 provided information on the major factors impacting prices and graphical displays of gasoline price and price spread behavior in response to those factors. This chapter uses the STIFS model (regression analysis) to explore in more depth the variations in price that occurred over the last two years. It also quantifies the lag relationship between spot prices and retail and ends with an update of the outlook for gasoline over the remainder of the summer.

Components of Gasoline Price Changes in 1996 and 1997

Chapter 2 provided a graphic display of price behavior which is reinforced in this chapter. In order to provide a systematic, quantitative summary of the nature of gasoline price movements seen in the United States in recent periods, the Energy Information Administration's Short-Term Integrated Forecasting System (STIFS) model was used to dissect the important elements of gasoline price dynamics since 1996.

By using STIFS, price changes can be broken down into general constituent parts as follows:

- *For wholesale or refiner prices*: total price change, change due to crude oil price changes, change due to normal seasonality, change due to specific "market tightening" (i.e., higher demand, lower stocks, etc.);
- *For retail gasoline prices*: changes due to changes in refiner (wholesale) prices, changes due to normal seasonality, and other changes related to abnormal downstream (i.e., marketing and distribution) margins.

For the sixteen-month period under consideration (January 1996 through April 1997), typical monthly errors for the price forecasting equations in STIFS were in the 1.5- to 2.0-cents-per-gallon range. The errors tended not to be systematic, as the mean errors or "biases" were quite small (Appendix B). The model supported the observation that crude price changes and normal seasonal variations explained most of the price changes in both spring 1996 and spring 1997.

In the case of evaluating year-to-year changes in price, normal seasonality falls out as a component of change. Thus, a summary of gasoline price changes between 1995, 1996, and 1997 can be simply tabulated, as in Table 6.1. The price being explained is an all-grade, all-formulation, U.S. average price. The model was run by using historical actual data as inputs. The resulting variations due to crude prices were taken from the model results. The margin represents the part of actual price explained by remaining factors, mainly market tightness.

Table 6.1 Components of Gasoline Price Change, 1996-1997
(Change from Same Period Prior Year, Cents per Gallon)

	Wholesale			Retail		
	Crude Oil	Margins	Total	Wholesale Price	Margins	Total
1996 Q1	3.5	-0.0	3.5	2.4	-1.0	1.4
Q2	6.9	1.7	5.2	7.6	2.5	10.1
Q3	9.3	-0.1	9.4	8.7	-0.7	8.0
Q4	14.6	0.0	14.6	14.2	-0.6	13.6
1997 Q1	9.5	2.6	6.9	11.5	-0.2	11.2

Source: Energy Information Administration, Short-Term Intermediate Forecasting System simulation for gasoline prices using June 1997 STIFS database.

In 1996, wholesale gasoline price changes (over previous year levels) were almost entirely attributable to changes in crude oil prices, except during the second quarter. Difficulties in meeting supply requirements associated with increased clean air standards in California contributed largely to higher U.S. margins in second quarter 1996 than in 1995. Consumers shifting away from premium to regular would have countered the average price increase slightly. Retail margins over wholesale prices in the second quarter of 1996 were also stronger than 1995 retail margins. Again, part of this increase was due to the supply pressures and resulting higher-than-normal price spreads in California.

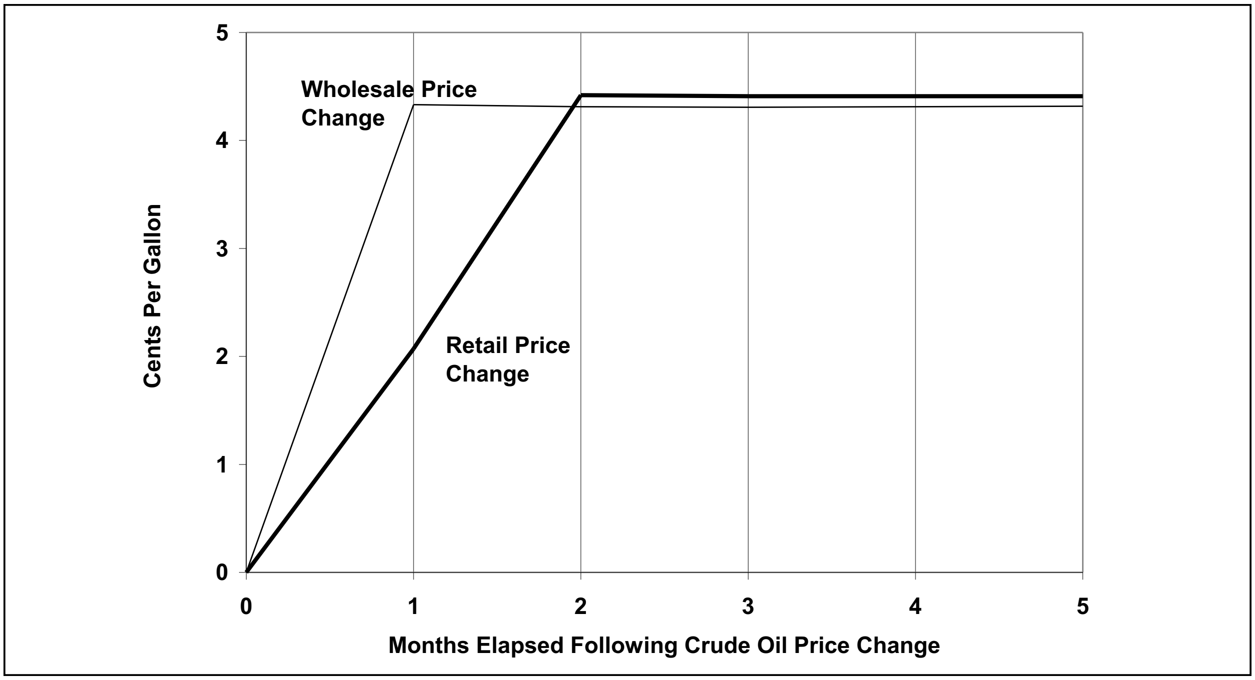
First quarter 1997 gasoline spreads were stronger than spreads in 1996, consistent with the spot spreads shown in Chapter 2 and Appendix A and with the resale spreads mentioned later in this chapter and Appendix D. Gasoline spreads in 1996 were weak during the first quarter, rising only from their lethargy in April and May. In 1997, spot gasoline spreads were slightly higher than average values throughout the quarter, but they eased back in April and May as production and imports began to outpace demand.

Price Movements Through the Distribution System

As spot prices change at major buying centers on the U.S. Gulf Coast (USG) and New York Harbor (NYH), prices further along the distribution chain begin to reflect those changes. Motor gasoline prices travel relatively quickly through the system to the retail level. Prior analysis by EIA showed that nationwide monthly retail prices reflect about half of the resale price change in a given month and half of the resale price change from the previous month.[1]

1 John Zyren, "What Drives Gasoline Prices," *Petroleum Marketing Monthly*, Energy Information Administration, DOE/EIA-0380 (Washington DC, June 1995), p. xvi.

Figure 6.1 STIFS Price Response to 10% Crude Oil Price Change



Source: Energy Information Administration Short-Term Integrated Forecasting System gasoline price model.

The STIFS model, which uses monthly data, picks up this effect. To illustrate how crude prices are passed through to wholesale and then to retail prices, a 10-percent upward shift in average crude oil prices was assumed in the model, and the resultant impact on gasoline prices was calculated. From this scenario, the speed and timing of changes in monthly wholesale and retail gasoline prices is shown (Figure 6.1). It is apparent from the figure that, normally, wholesale prices react quickly to changes in crude oil prices and that retail prices, while lagging the movements in wholesale prices somewhat, generally do fully incorporate refiner price changes after about 1 month which is explored more fully in the next section.

Since prices generally begin to change before a month is out, a brief analysis was made by considering weekly prices rather than monthly prices. Using weekly retail regular conventional gasoline prices gathered by EIA's Motor Gasoline Price Survey (Form EIA-878), EIA explored changes in retail gasoline prices as a function of changes in spot prices. The analysis was done by regressing the weekly change in conventional regular gasoline price as a function of the change in weekly average spot price from prior time periods. A priori, because of pipeline structure and import patterns, it was expected that PADD 1C (lower Atlantic Coast), PADD 2, and especially PADD 3 would be affected by USG prices, whereas PADD 1A (New England) and PADD 1B (Central Atlantic Coast) due to their proximity to NYH would be most affected by NYH spot prices.

Briefly, the regression results showed that NYH prices best explained PADDs 1A and 1B. PADDs 1C, 2, and 3 were best explained with Gulf Coast prices. In general, about 45 percent of a spot price change was passed through to retail within 4 weeks, with an additional 30 percent pass-through occurring in the next 4 weeks. Appendix C summarizes the statistics observed.

PADD 1A retail prices were best explained by NYH spot prices, with about 46 percent pass-through after 4 weeks; after 8 weeks, the total pass-through was 78 percent. PADD 1B retail prices were best explained by NYH spot prices, with 43 percent pass-through after 4 weeks and 72 percent after 8 weeks. PADD 1C retail prices were best explained by using Gulf Coast prices. The statistical results showed a 50 percent price pass-through after 4 weeks and 79 percent after 8 weeks.

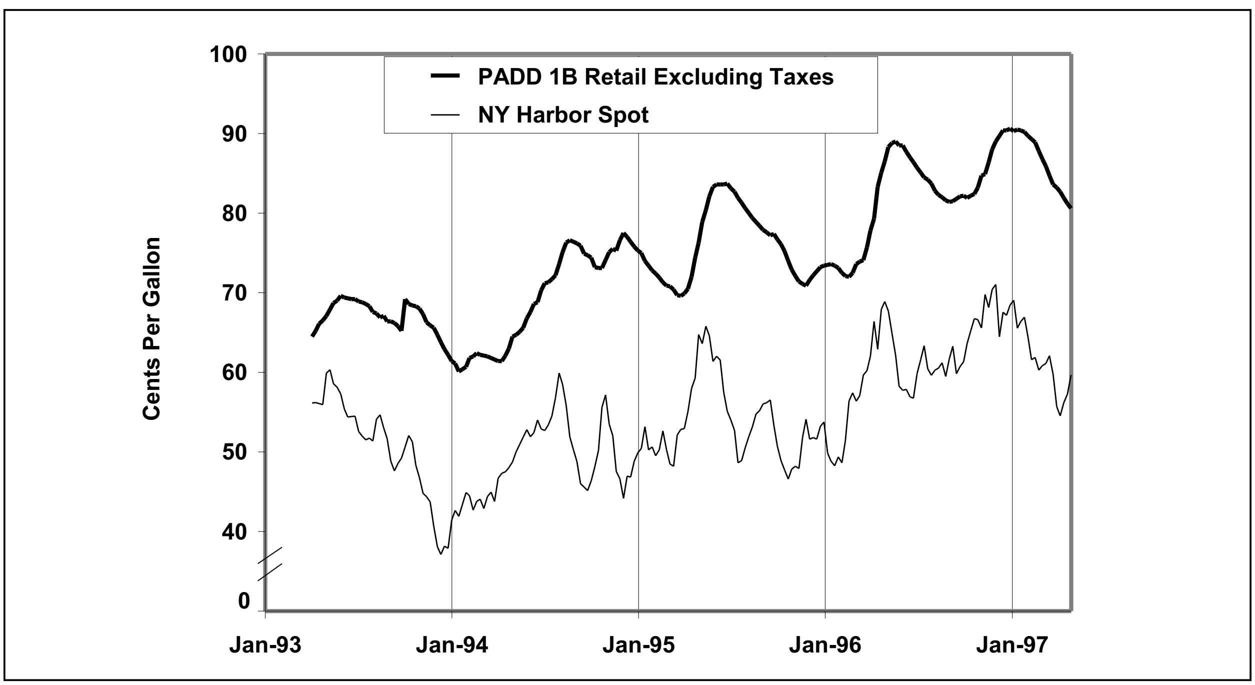
PADD 2 retail prices were best explained by using USG prices, but the pass-through was much more rapid than in the PADD 1 regions. There was an 80 percent price pass-through after 4 weeks, increasing to 104 percent after 8 weeks, after which additional price effects were not statistically detectable. The competitive and distribution system dynamics all affect price movements, and the specific reason for this rapid price pass-through in PADD 2 is not clear at this time.

PADD 3 retail prices were best explained by using U.S. Gulf Coast spot prices. The price pass-through was 46 percent after 4 weeks, increasing to 74 percent after 8 weeks.

Figure 6.2 compares the NYH spot price (weekly average) and retail price of conventional regular gasoline in PADD 1B. Close examination of the figure shows a number of interesting features:

- The retail price of gasoline shows roughly the same long-term pattern as the spot price;

Figure 6.2 PADD 1B Regular Conventional Gasoline Prices



Source: Spot Prices: Standard and Poor's Platt's; Retail Prices: Energy Information Administration, Form EIA-878, "Motor Gasoline Price Survey."

- The fluctuations in retail price are much smoother than the spot price changes (i.e., the retail prices show less short-term (weekly and monthly) volatility than do spot prices);
- The retail price changes lag the spot price changes, as evidenced by the staggered times during which peaks occur.

These observations can best be seen by focusing on prices during 1995 shown in Figure 6.2. The smoothness of the retail price curve is in sharp contrast to the jittery appearance of the spot price curve. The figure also shows that the retail price can be considered as a moving average of the spot prices; that changes in spot prices take time before they are reflected in retail prices (a 2- to 3-week lag); and that the price adjustment is not immediate but can take up to 8 weeks before being fully reflected in the retail price. This is best demonstrated by comparison of the spot and retail prices for the summer driving season. In 1995, the spot prices began increasing in early March and reached a peak during the week of May 15, whereas the retail price responded more slowly, and reached its peak 2 to 3 weeks later. Also, the retail price decline appeared somewhat slower than the spot price decline, and the August and September mini-peaks in spot price were not evident in the retail price. This demonstrates that retail prices adjust more slowly than spot prices, both on the upswing and on the downswing.

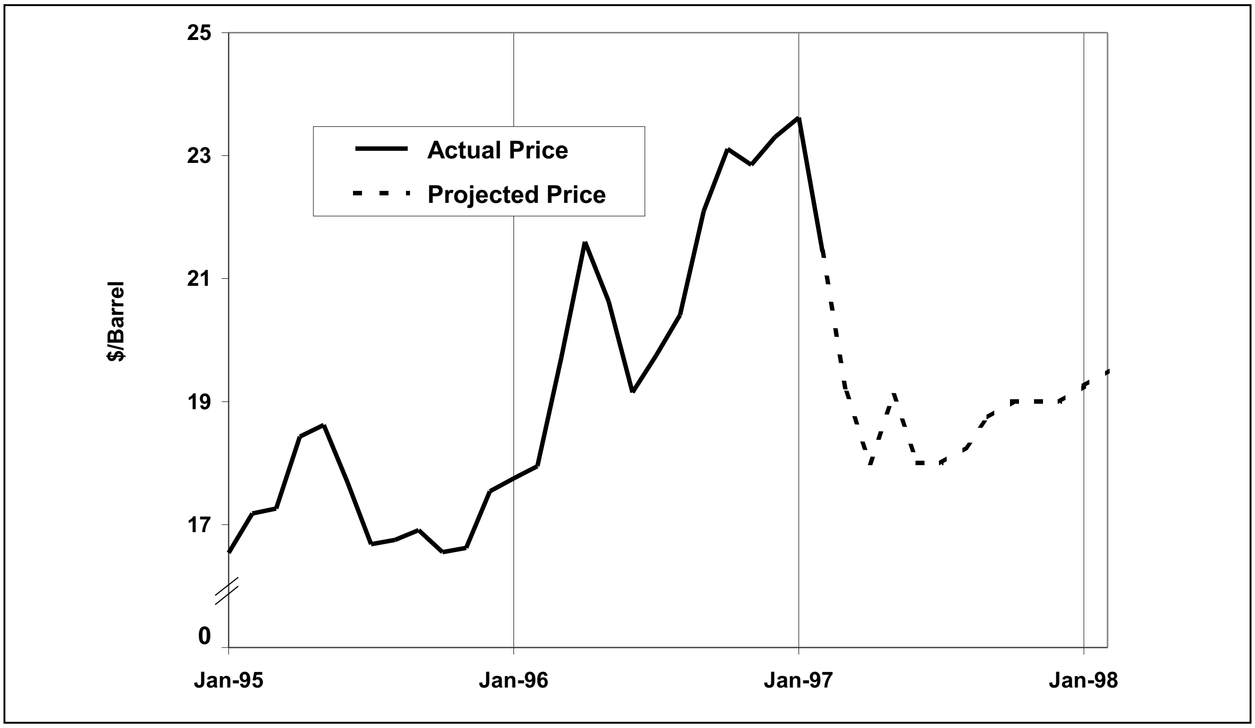
Updated Outlook for Summer 1997

A mid-June update of the April Short-Term-Energy Outlook (STEO) bodes well for drivers. Summer gasoline prices should stay below last year's summer prices as a result of low crude oil prices and normal seasonal declines from June. Crude prices, which already have fallen about $5.00 per barrel since January, are expected to stay low throughout the summer, as supply increases and as world crude oil demand falls to seasonal summer lows. Although crude oil prices showed some renewed strength in April and May, as discussed in Chapter 2, this is not expected to last. The mid-June STEO update is forecasting average refiners acquisition cost of crude oil to decline from a first quarter average of $21.40 per barrel to $18.37 during the second quarter and to $18.33 during the third quarter (Figure 6.3).

Retail prices have fallen since January, pulled down by crude oil prices despite the seasonal increase in wholesale price spread (gasoline price minus crude price). Retail gasoline prices are expected to average $1.28 per gallon during the second quarter (7 cents per gallon lower than during the second quarter of 1996) and to average $1.27 during the third quarter (4 cents lower than during the third quarter of 1996) (Figure 6.4).

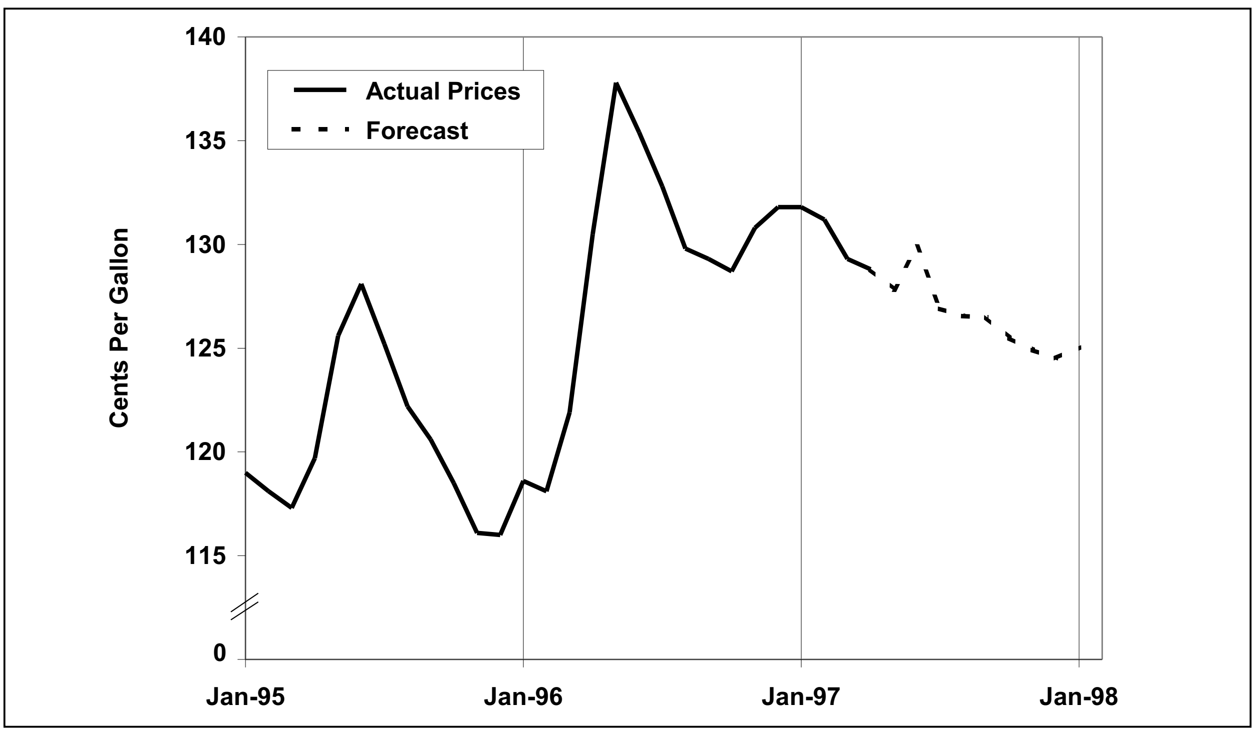
Wholesale gasoline spreads were stronger during the first quarter of 1997 than during the first quarter of 1996 as a result of tighter gasoline markets. But strong gasoline production and imports during second quarter are exceeding demand and causing stocks to build when they normally fall or hold even. With ample crude oil supplies near at hand, and growing stocks, wholesale gasoline spreads have weakened and are expected to remain below last year's spreads until August (Table 6.2).

Figure 6.3 Projected Refiners' Acquisition Crude Oil Prices



Source: Energy Information Administration, update to *Second Quarter Short-Term Energy Outlook*, DOE/EIA-0202, 1997.

Figure 6.4 Projected Gasoline Prices 1997



Source: Energy Information Administration, update to *Second Quarter Short-Term Energy Outlook*, DOE/EIA-0202, 1997.

Table 6.2 Projected Components of Gasoline Price Change, 1996-1997
(Change from Same Period Prior Year, Cents per Gallon)

	Wholesale Price Change			Retail Price Change			
	Total	Crude Oil	Margins	Total	Whsle. Pr.	Margins	
1996 Q1	3.5	3.5	-0.0	1.4	2.4	-1.0	
Q2	6.9	5.2	1.7	10.1	7.6	2.5	
Q3	9.3	9.4	-0.1	8.0	8.7	-0.7	History
Q4	14.6	14.6	0.0	13.6	14.2	-0.6	
1997 Q1	9.5	6.9	2.6	11.2	11.5	-0.2	
Q2	-7.0	-5.0	-2.0	-6.0	-5.7	-0.3	
Q3	-5.0	-5.9	0.9	-4.1	-5.1	1.0	Projections
Q4	-8.0	-9.6	1.6	-5.4	-7.5	2.1	

Source: Energy Information Administration Short-Term Integrated Forecasting System gasoline price model using June 1997 STIFS database.

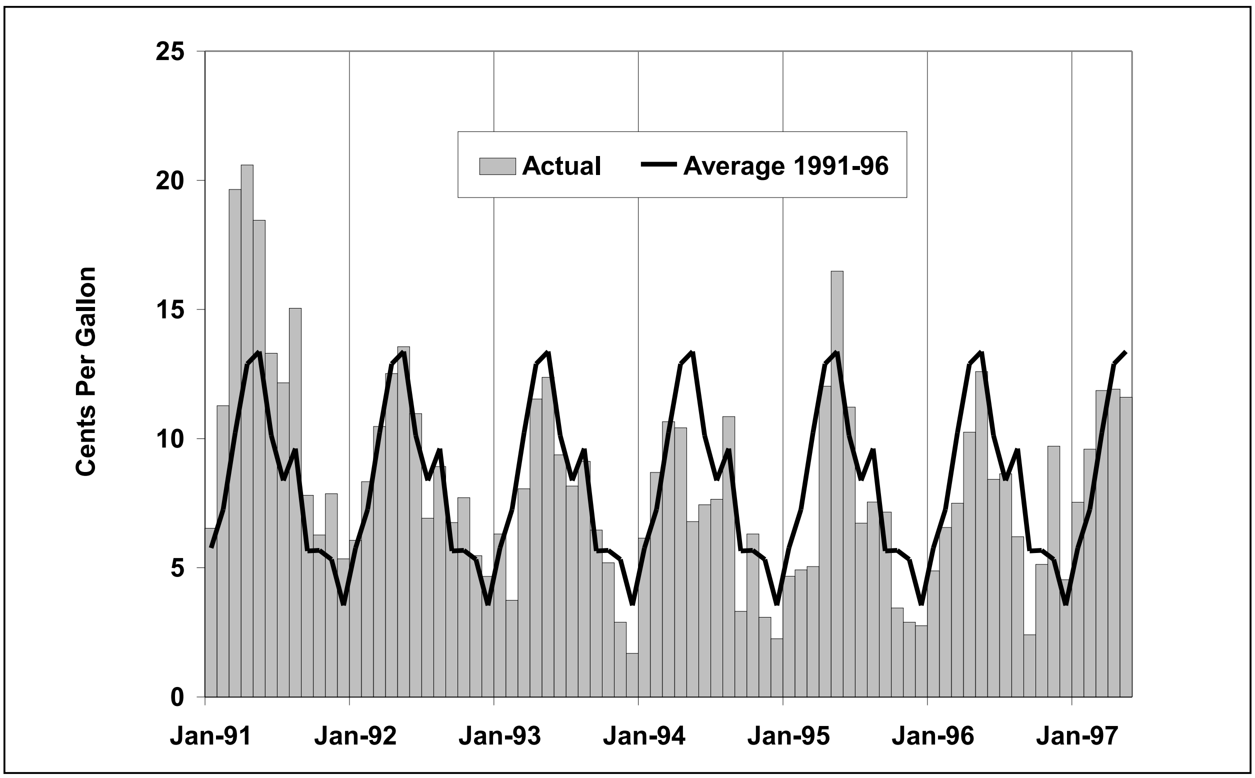
Gasoline demand over the first quarter rose only 1.0 percent over first quarter of 1996. Demand remained somewhat sluggish, partially as a result of continued high retail prices (up 11 cents per gallon over first quarter 1996 retail prices). The economy, however, helped to counter the damping effect of high prices. First quarter expansion was at a 10-year high according to an April 30 news release from the Bureau of Economic Analysis. Demand is expected to be about 2.0 percent higher this summer than last as lower prices and a strong economy encourage driving.

Continued strong production and imports should keep stocks from falling, thereby removing any unusual price pressure.

In summary, the consumer should benefit from lower gasoline prices this summer than last, due mainly to lower crude oil prices. If demand is weaker than forecast and stocks continue to build beyond current projections, gasoline spreads may also be weaker than projected, bringing gasoline prices down even further.

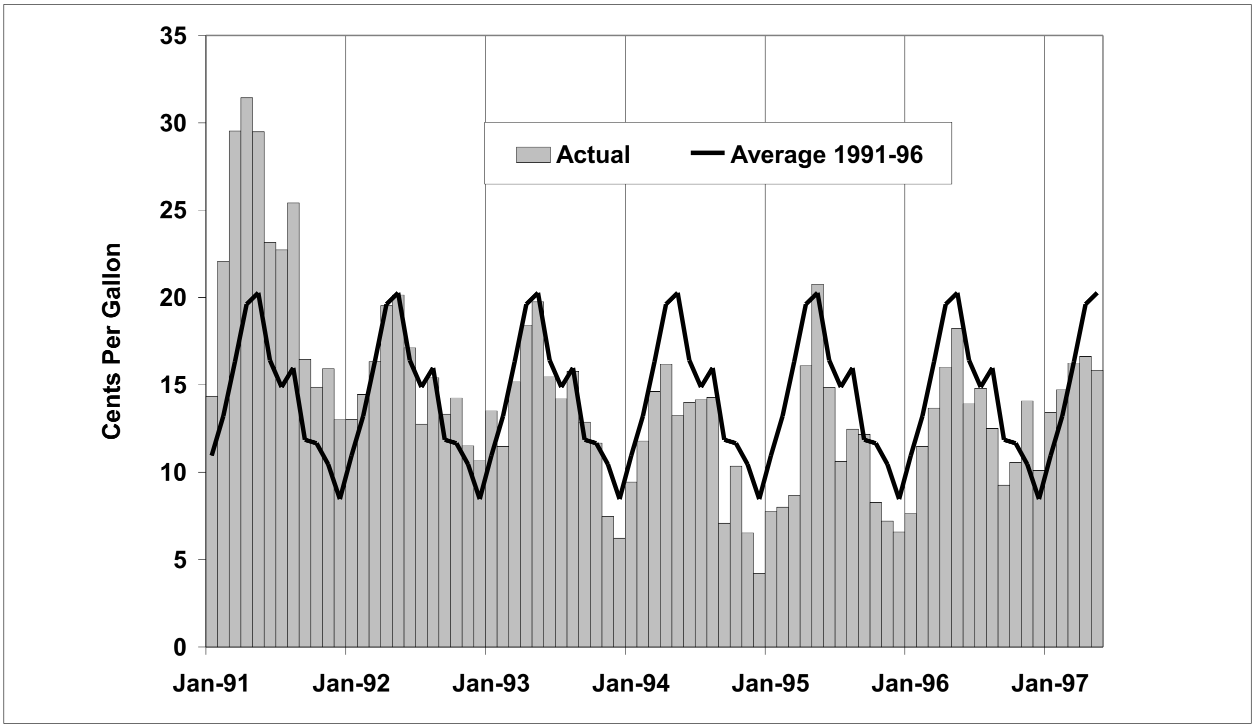
Appendix A: Spot Gasoline Price Spreads

Figure A.1 GC Spot Regular Conventional Minus WTI



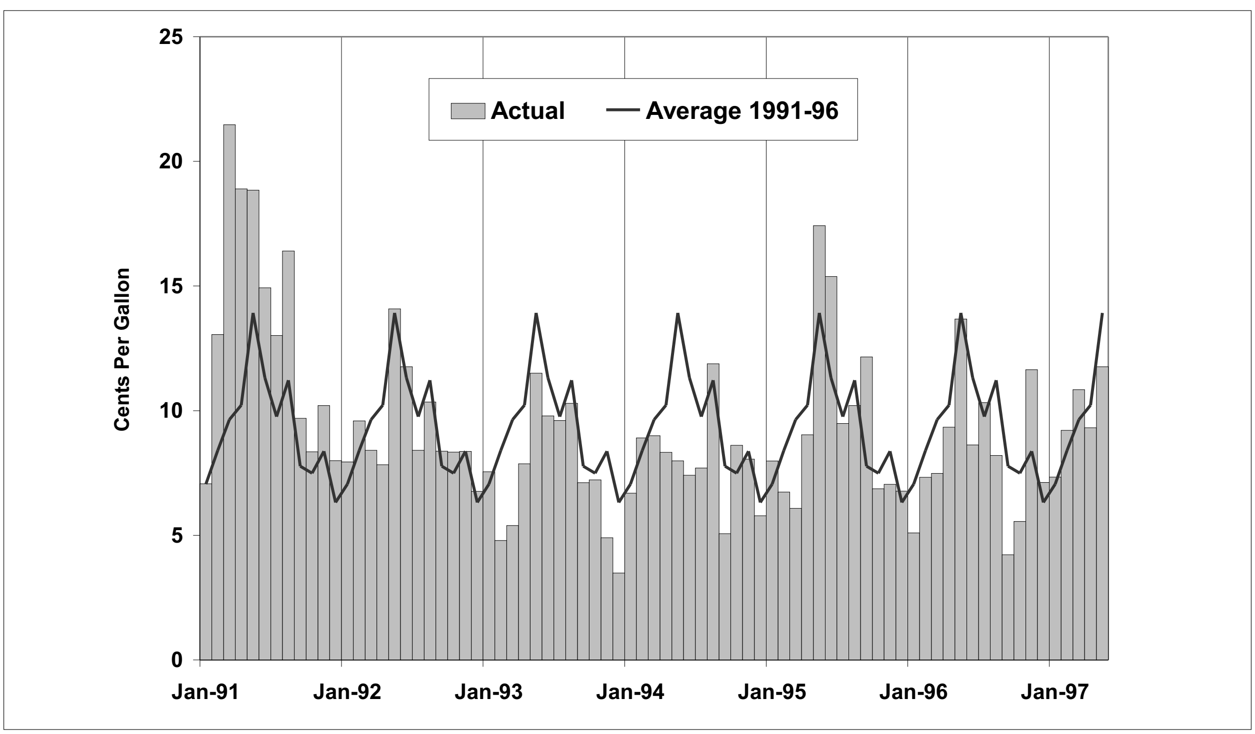
Source: Standard and Poor's Platt's

Figure A.2 GC Spot Regular Conventional Minus Arab Light



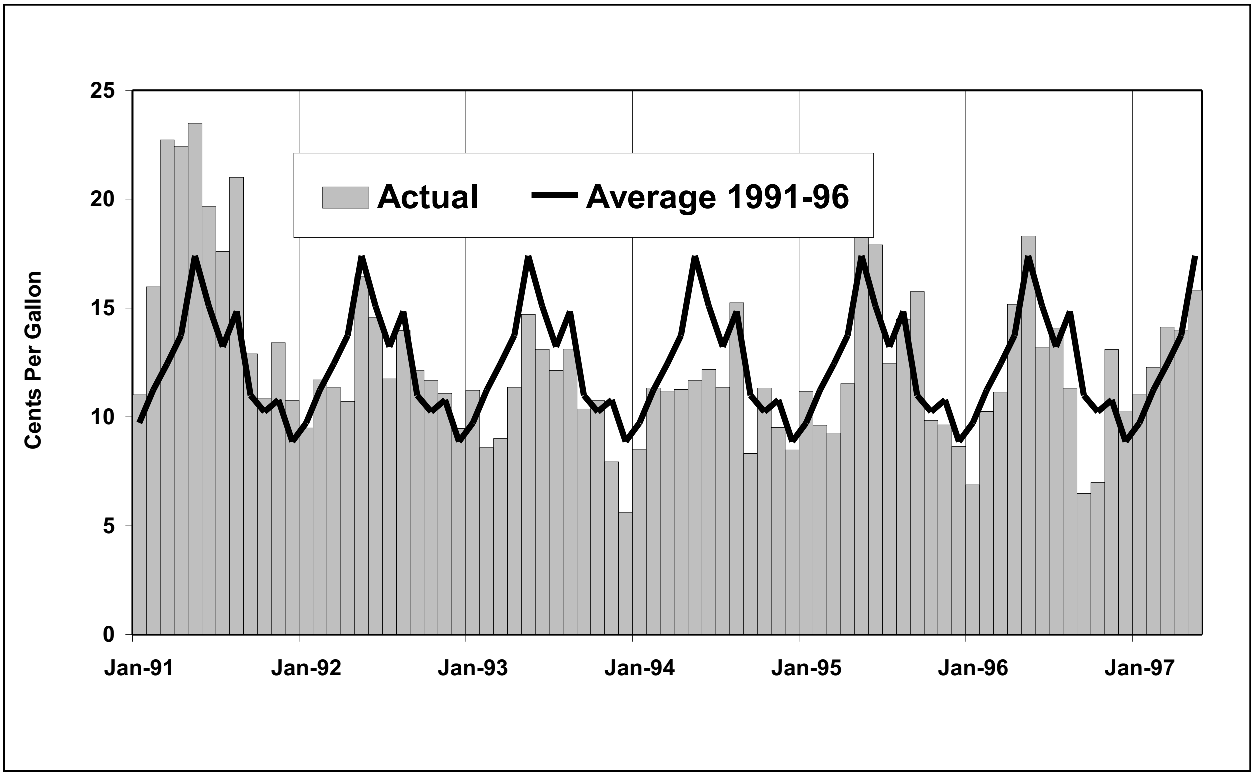
Source: Standard and Poor's Platt's

Figure A.3 NYH Spot Regular Conventional Minus WTI



Source: Standard and Poor's Platt's

Figure A.4 NYH Spot Regular Conventional Minus Brent



Source: Standard and Poor's Platt's

Appendix B: Using STIFS to Explore Price Behavior

In order to provide a systematic, quantitative summary of the nature of gasoline price movements seen in the United States in recent periods, the Energy Information Administration's Short-Term Integrated Forecasting System (STIFS) model was used to dissect the important elements of gasoline price dynamics since 1996. In this section, the basic approach in STIFS to modeling gasoline prices is described, and the overall efficacy of STIFS in predicting gasoline prices is checked.

Gasoline Price Modeling in STIFS

Short-term movements in motor gasoline (and other product) prices in the United States can be thought of as being induced by changes in several key market variables, namely: crude oil prices, domestic gasoline inventories, and demand relative to current supply capacity. Short-run variations in crude oil prices are determined primarily by changes in the balance of short-run supplies (including crude oil inventories at or near refining centers) and demand for crude oil, generated by shifts in the production requirements for petroleum products in general (not just gasoline). But gasoline prices also typically have significant seasonal variation. The underlying seasonality of U.S. gasoline prices stems quite naturally from the seasonality of gasoline demand here, which tends to be relatively low during the fall and winter months and relatively high during the summer (with approximately a 10-15 percent difference between monthly high and low demand levels).

The part of the STIFS model representing gasoline prices can be characterized as follows:

- *Wholesale Prices*: The wholesale or refiner price of gasoline at time *t* is a function of crude oil cost at time *t;* the relative abundance, on a seasonally adjusted basis, of primary finished gasoline at the outset of the month; and seasonal factors. The seasonal factors capture the impact on refiner prices of seasonally changing demand in the face of essentially unchanged aggregate production capacity;
- *Retail Prices*: The average retail gasoline price is a function of increased wholesale prices (raw material costs to distributors and marketers) and seasonal factors that reflect downstream market seasonality distinct from that which is transmitted through refiner prices (See Box). Typically, a change in the retail price due to a given change in the average wholesale price is not affected contemporaneously, hence the presence of the lag term for wholesale price in the retail price relationship.

STIFS GASOLINE PRICE MODEL

The STIFS model roughly incorporates these market characteristics into its gasoline forecasting equations, as follows:

$$P_t^{g,w} = f(P_t^c, \quad (K_{t-1} / D_t), \quad S_t^{g,w}) \qquad (1)$$
$$> 0 \qquad <0 \qquad \text{(Signs of First Derivatives)}$$

Where:

$P_t^{g,w}$ = Gasoline wholesale price (refiner to resellers), period t
P_t^c = Crude oil price (domestic refiner acquisition cost of crude), period t
K_{t-1} = Finished gasoline stocks, deseasonalized, end of period t-1
D_t = Gasoline demand, deseasonalized, period t
$S_t^{g,w}$ = Vector of seasonal factors for wholesale gasoline price

And

$$P_t^{g,r} = f(P_t^{g,w}, \quad P_{t-1}^{g,w}, \; S_t^{g,r}) \qquad (2)$$

Where:

$P_t^{g,r}$ = Gasoline retail price (average U.S., all grades, all service), period t
$S_t^{g,r}$ = Vector of seasonal factors for retail gasoline price, period t

The signs of the first derivatives of each function with respect to key market variables is noted below in expressions (1) and (2).

Linear forms of both (1) and (2) are estimated and implemented in STIFS.

Recent Predictive Efficiency

Tables B.1 and B.2 and Figures B.1 and B.2 provide a view of how well the STIFS model would have predicted refiner and retail gasoline prices between January 1995 and April 1997, given crude

Table B.1 Summary Measures of Gasoline Price Predictive Accuracy: January 1995 to April 1997

	Wholesale	Retail
Mean Absolute Error		
Cents per Gallon	1.3	1.9
Percent of Mean Actual	1.9%	1.5%
Root Mean Squared Error		
Cents per Gallon	1.6	2.1
Percent of Mean Actual	2.4%	1.8%
Mean Error (Bias)		
Cents per Gallon	-0.1	0.1
Percent of Mean Actual	-0.1%	0.0%

Source: EIA Short-Term Integrated Forecasting System.

Table B.2 Actual and Predicted Motor Gasoline Prices

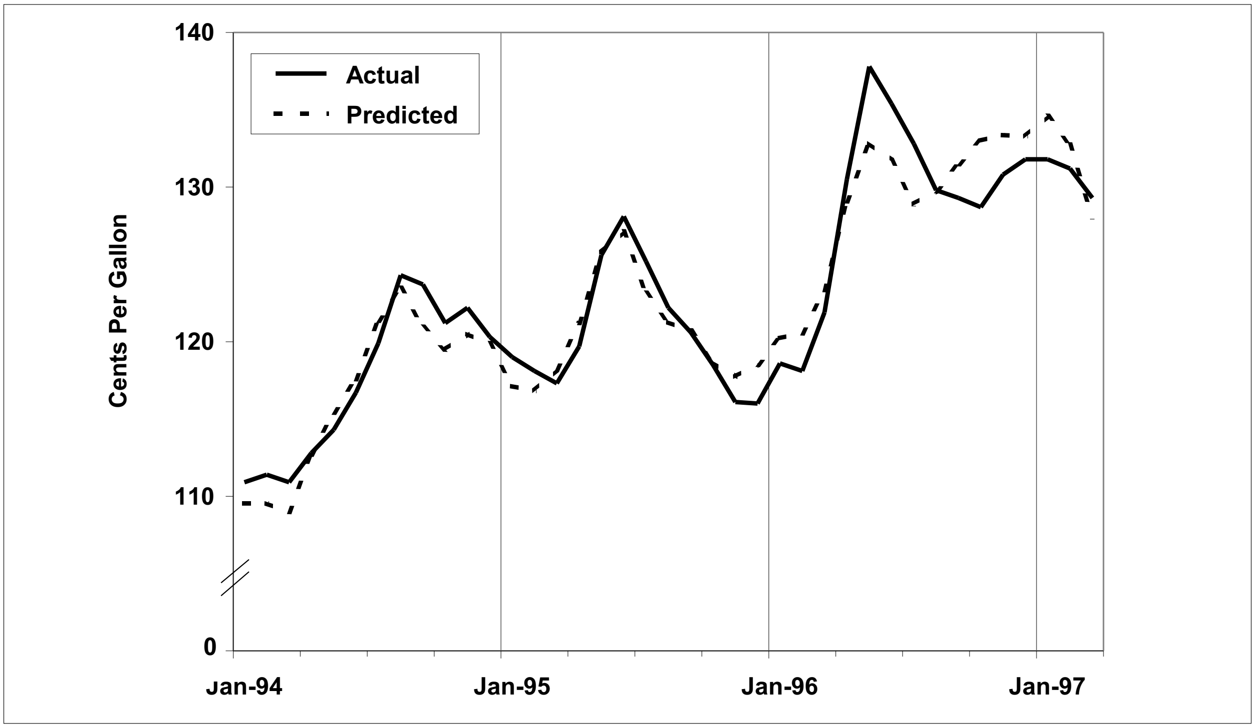
Date	Wholesale Actual	Wholesale Predicted	Wholesale Error	Retail Actual	Retail Predicted	Retail % Error
	(cents per gallon)		(percent)	(cents per gallon)		(percent)
9501	60.0	58.6	-2.3%	119.0	117.2	-1.5%
9502	60.3	61.3	1.7%	118.1	117.0	-0.9%
9503	60.0	61.7	2.8%	117.3	118.3	0.8%
9504	66.5	66.7	0.2%	119.7	121.3	1.3%
9505	71.8	70.7	-1.6%	125.6	126.1	0.4%
9506	68.2	68.1	-0.1%	128.1	127.4	-0.5%
9507	62.9	62.7	-0.3%	125.2	123.3	-1.5%
9508	62.0	63.0	1.6%	122.2	121.2	-0.8%
9509	62.3	61.7	-1.0%	120.6	120.6	0.0%
9510	58.8	60.8	3.4%	118.5	119.1	0.5%
9511	58.0	60.1	3.6%	116.1	118.2	1.8%
9512	59.9	60.3	0.6%	116.0	118.5	2.1%
9601	61.1	61.8	1.2%	118.6	120.0	1.1%
9602	61.6	63.5	3.1%	118.1	120.2	1.8%
9603	68.0	68.5	0.7%	121.9	123.5	1.3%
9604	76.1	74.5	-2.1%	130.5	129.4	-0.8%
9605	78.1	75.8	-2.9%	137.8	133.1	-3.4%
9606	73.0	70.9	-2.9%	135.4	131.7	-2.7%
9607	72.3	70.7	-2.2%	132.8	129.1	-2.8%
9608	71.1	71.7	0.8%	129.8	130.2	0.3%
9609	71.6	72.9	1.8%	129.3	131.2	1.5%
9610	72.8	74.5	2.3%	128.7	132.4	2.9%
9611	74.5	74.4	-0.2%	130.8	132.9	1.6%
9612	73.1	73.4	0.4%	131.8	132.9	0.9%
9701	74.8	75.6	1.1%	131.8	134.1	1.8%
9702	72.9	71.2	-2.3%	131.2	132.2	0.7%
9703	71.4(E)	68.4	-5.6%	129.3	128.2	-0.8%
9704	68.0(E)	66.6	-4.8%	128.8	126.1	-2.1%

Source: Energy Information Administration Short-Term Integrated Forecasting System gasoline price model using June 1997 STIFS database.
Note: E - estimated.

oil prices and gasoline market data. Note that the retail price errors include the effects of any errors in the wholesale price.

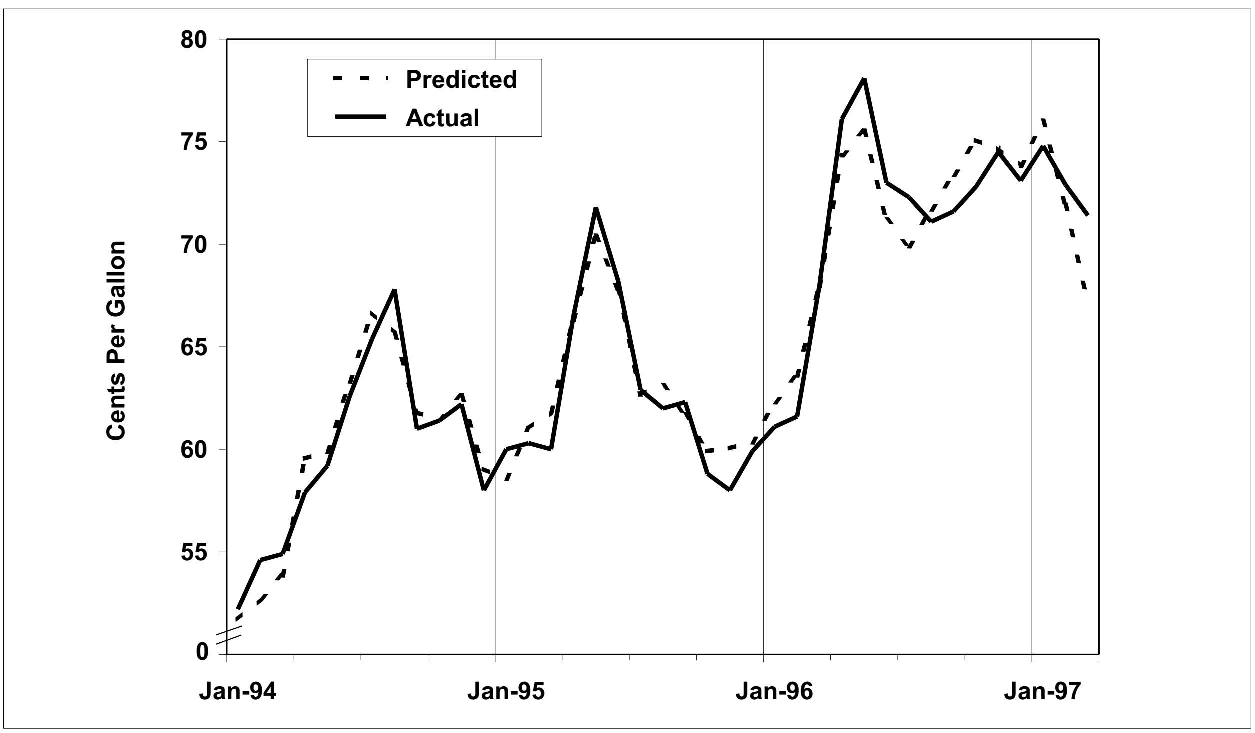
For the sixteen-month period under consideration, typical monthly errors for the price forecasting equations were in the 1.5- to 2.0-cents-per-gallon range. The errors tended not to be systematic, as the mean errors or “biases” were quite small (Table B.1).

Figure B.1 Retail Gasoline Price (Actual versus Predicted)



Source: EIA Short-Term Integrated Forecasting System.

Figure B.2 Wholesale Gasoline Price (Actual versus Predicted)



Source: EIA Short-Term Integrated Forecasting System.

From Table B.2 a few observations are worth noting. There was a tendency to under predict prices during the spring and early summer of 1996 (by about 3 percent). On the other hand, fall and winter prices (1995-96) tended to be over-predicted (by about 1 percent). Prediction errors for this past winter (1996-97) are generally small until one reaches February, where some noticeable under predictions begin to appear. There is little question that, from January through March, refiner prices (wholesale gasoline prices) have been higher than is typical, given the observed average crude oil prices and gasoline supply indicators (Figure B.1).

Appendix C. Quantitative Explanation of Motor Gasoline Market Price Passthrough

By using industry and EIA data, an analysis was undertaken to explore the speed of price change passthroughs from the spot market to the retail market. The results reported below are preliminary in nature and were considered in order to form the basis for more formal research on pricing mechanisms in product markets.

Estimates showed that the price passthrough from spot market to retail level is complete in two to three months, with about 45 percent of the change occurring within 4 weeks and 75 percent within 8 weeks.

An attempt was made to estimate the speed of adjustment of motor gasoline retail prices as a function of spot prices by using weekly EIA data from the Form EIA-878, "Motor Gasoline Price Survey." The gasoline prices used were those of PADD 1A, 1B, and 1C and PADD 2 and PADD 3 conventional regular gasoline. The U.S. Gulf Coast (USG) and New York Harbor (NYH) spot conventional regular motor gasoline prices were taken from Platts and were weekly averages of daily prices. Investigation of the time series properties of the price data was performed in order to assist in specifying the form of the model; for example, data with unit root properties are best analyzed by using first differences, whereas stationary series can be estimated in level form. Augmented Dickey-Fuller tests could not reject the hypothesis that the retail gasoline data had a unit root, whereas the averaged spot data rejected the unit root hypothesis at the 5 percent level but not at the 1 percent level. Since all series had a strong autoregressive component, first differences were used for the regression analysis. The retail prices and the weekly averages of the spot prices were defined to correspond to the same week, so that the retail prices were estimated as a function of lagged spot prices.

Equation C1

$$\Delta RP_t = \sum_{i=1}^{k} \beta_i \Delta SPOT_{t-i} \quad + \quad D04OCT93 \quad + \quad NYUSG_{t-1} \quad + \quad U_t \quad + \quad AR, MA \quad terms$$

Where:

RP_t is the Monday motor gasoline retail price for week t

$SPOT_t$ is the average gasoline spot price for week t

D04OCT93 is the dummy variable for the Federal tax increase on October, 1993

$NYHUSG_t$ is the difference between NYH and USG gasoline spot price for week t

U_t is the random error term at time t

AR, MA are autoregressive and moving average terms.

Table C.1 shows the parameter estimates for the various regions when the Ordinary Least Squares (OLS) estimation method is used. The OLS results are not unreasonable, except that *a priori* we would expect to see an approximately 1:1 eventual pass-through of spot price changes and we would also expect the influence of a spot price change to decrease monotonically over time after the first few time periods. The OLS results show, depending on the area, that anywhere between 73 to 100 percent of a spot price change is passed through to retail and that, although the lag effect does tend to decrease over time, the situation does occur where a longer lag has a larger effect than a shorter one.

An estimation was also attempted to give the lag effect parameters a definite structure. The Polynomial Distributed Lag (PDL) technique is often used to increase the significance of the estimated coefficients when the independent variable is correlated with its lagged values; the PDL method imposes an empirically determined polynomial structure on the estimated β's. (See G. S. Maddala, *Introduction to Econometrics*, 2nd edition, Macmillan Publishing Company, 1992, Chapter 10.) Table C.2 shows the parameter estimates when PDL estimation is used. In most cases, a linear (decreasing) function (i.e. only PDL0 and PDL1 significant) was found to provide the best fit; only PADD 2 required a higher order polynomial (viz., cubic). PDL estimation also found that lags of 9 to 13 weeks were also significant (except for PADD 2). As a whole, the estimation results appear better that the OLS results because the spot price passthrough was found to be between 90 and 100 percent.

The robustness of the results displayed in Tables C.1 and C.2 can be seen in Table C.3, which shows the cumulative spot price pass-through to the retail level. Close examination of the entries shows that the cumulative passthrough is independent of the estimation method. The table shows that, for all areas except PADD 2, for a 10-cent initial spot price change, slightly less than 3 cents pass-through occurred after two weeks, increasing to between 4 and 5 cents after 4 weeks (or one month), and increasing to between 7 and 8 cents after 2 months. The reason for the more rapid (and complete) passthrough to retail price for PADD 2 is not clear at this time.

Table C.1 Ordinary Least Squares Regression Results
Weekly Prices to May 19, 1997

Start Date	April 5 1993	April 5 1993	April 5 1993	October5 1992	October 5 1992
Independent Variable:	NYH	NYH	USG	USG	USG
	Change in Retail Price (dependent variable)				
Parameter	**PADD 1A**	**PADD1B**	**PADD1C**	**PADD 2**	**PADD3**
Δ SPOT(t-1)	0.145***	0.099***	0.136***	0.374***	0.104***
	(0.023)	(0.016)	(0.017)	(0.032)	(0.019)
Δ SPOT(t-2)	0.109***	0.131***	0.159***	0.224***	0.187***
	(0.023)	(0.017)	(0.016)	(0.032)	(0.019)
Δ SPOT(t-3)	0.082***	0.090***	0.112***	0.110***	0.090***
	(0.023)	(0.017)	(0.016)	(0.031)	(0.019)
Δ SPOT(t-4)	0.112***	0.093***	0.096***	0.095***	0.080***
	(0.023)	(0.016)	(0.016)	(0.032)	(0.019)
Δ SPOT(t-5)	0.120***	0.079***	0.084***	0.040	0.053***
	(0.023)	(0.017)	(0.016)	(0.031)	(0.019)
Δ SPOT(t-6)	0.083***	0.077***	0.060***	0.069**	0.073***
	(0.023)	(0.017)	(0.016)	(0.031)	(0.018)
Δ SPOT(t-7)	0.059**	0.057***	0.045***	0.088***	0.064***
	(0.023)	(0.017)	(0.016)	(0.032)	(0.019)
Δ SPOT(t-8)	0.059**	0.067***	0.077***	0.043	0.076***
	(0.023)	(0.017)	(0.016)	(0.031)	(0.019)
Δ SPOT(t-9)	0.062***	0.044***	0.048***		
	(0.023)	(0.017)	(0.016)		
Δ SPOT(t-10)	0.054**				
	(0.023)				
D04OCT93	4.366***	4.385***	4.560***	4.585***	4.729***
	(0.644)	(0.438)	(0.413)	(0.908)	(0.514)
NYHUSG(t-1)	-0.022	-0.044*	-0.038*	0.003	-0.044**
	(0.022)	(0.023)	(0.021)	(0.025)	(0.020)
AR(1)	0.720**	0.754***	0.776***		0.336***
	(0.278)	(0.093)	(0.088)		(0.063)
MA(1)	-0.618**	-0.389***	-0.433***		
	(0.313)	(0.128)	(0.127)		
Sum of Spot Lags	0.885	0.739	0.816	1.044	0.726
adj. R^2	0.527	0.705	0.766	0.58	0.653
F-Statistic	19.3	43.5	59.1	37.8	46
D.W. Statistic	2.09	2.04	2.03	2.15	2.1

The general form of the linear model is shown in Equation C1.
All prices in cents per gallon.
"Δ" is the weekly price change.

SPOT is the spot price of regular, conventional motor gasoline at New York Harbor (NYH) or U.S. Gulf Coast (USG).
D04OCT93 is a dummy variable corresponding to the change in Federal tax on motor gasoline.
NYHUSG is the spot price difference between NYH and USG.

Standard errors appear in parentheses below the parameter estimates.
*** indicates significant at 1% criteria (p-value.01).
** indicates significant at 5% criteria (p-value.05).
* indicates significant at 10% criteria (p-value.10).

Table C.2 Polynomial Distributed Lag Estimation Results
Weekly Prices to May 19, 1997

Start Date:	April 5 1993	April 5 1993	April 5 1993	October 5 1992	October 5 1992
Independent Variable:	NYH	NYH	USG	USG	USG
	Change in Retail Price (dependent variable)				
Parameter	**PADD 1A**	**PADD1B**	**PADD1C**	**PADD 2**	**PADD3**
ΔSPOT(t-1)	0.135***	0.123***	0.143***	0.379***	0.130***
	(0.010)	(0.011)	(0.011)	(0.029)	(0.011)
ΔSPOT(t-2)	0.125***	0.115***	0.131***	0.214***	0.120***
	(0.009)	(0.010)	(0.010)	(0.017)	(0.010)
ΔSPOT(t-3)	0.115***	0.107***	0.120***	0.119***	0.110***
	(0.008)	(0.009)	(0.009)	(0.018)	(0.009)
ΔSPOT(t-4)	0.104***	0.098***	0.108***	0.075***	0.100***
	(0.007)	(0.009)	(0.008)	(0.015)	(0.008)
ΔSPOT(t-5)	0.094***	0.090***	0.096***	0.065***	0.089***
	(0.007)	(0.008)	(0.008)	(0.015)	(0.007)
ΔSPOT(t-6)	0.084***	0.082***	0.084***	0.070***	0.079***
	(0.006)	(0.008)	(0.008)	(0.018)	(0.007)
ΔSPOT(t-7)	0.074***	0.074***	0.072***	0.071***	0.069***
	(0.006)	(0.008)	(0.007)	(0.016)	(0.006)
ΔSPOT(t-8)	0.063***	0.065***	0.061***	0.050*	0.059***
	(0.006)	(0.008)	(0.008)	(0.028)	(0.006)
ΔSPOT(t-9)	0.053***	0.057***	0.049***		0.049***
	(0.007)	(0.008)	(0.008)		(0.007)
ΔSPOT(t-10)	0.043***	0.049***	0.037***		0.039***
	(0.007)	(0.009)	(0.009)		(0.007)
ΔSPOT(t-11)	0.033***	0.041***	0.025***		0.029***
	(0.008)	(0.010)	(0.009)		(0.008)
ΔSPOT(t-12)	0.023**	0.032***	0.014		0.019**
	(0.009)	(0.011)	(0.010)		(0.009)
ΔSPOT(t-13)	0.013				0.009
	(0.01)				(0.010)
D04OCT93	4.348***	4.415***	4.752***	4.528***	4.926***
	(0.638)	(0.414)	(0.381)	(0.901)	(0.524)
NYHUSG(t-1)	-0.014	-0.026	-0.041**	0.003	-0.030
	(0.017)	(0.018)	(0.020)	(0.024)	(0.019)
PDL0	0.074***	0.082***	0.084***	0.075***	0.069***
	(0.006)	(0.008)	(0.008)	(0.015)	(0.006)
PDL1	-0.010***	-0.008***	-0.012***	-0.024**	-0.010***
	(0.001)	(0.002)	(0.001)	(0.012)	(0.001)
PDL2				0.017***	
				(0.003)	
PDL3				-0.003**	
				(0.001)	
AR(1)		0.729***	0.334***		0.263***
		(0.100)	(0.068)		(0.063)
MA(1)		-0.409***			
		(0.126)			
Other ARMA terms		MA(7)	AR(2,6,8), MA(5)		
Sum of Spot Lags	0.957	0.934	0.94	1.044	0.899
adj. R^2	0.53	0.725	0.778	0.584	0.644
F-Statistic	81.4	94.8	91.2	68.4	109
D.W. Statistic	1.86	2.04	2.06	2.16	2.03

The general form of the linear model is shown in Equation C1.
All prices in cents per gallon.
"Δ" is the weekly price change.

SPOT is the spot price of regular, conventional motor gasoline at New York Harbor (NYH) or U.S. Gulf Coast (USG).
D04OCT93 is a dummy variable corresponding to the change in federal tax on motor gasoline.
NYHUSG is the spot price difference between NYH and USG.
PDL0, PDL1, PDL2, and PDL3 are the constant, linear, squared, and cubic PDL terms, respectively.

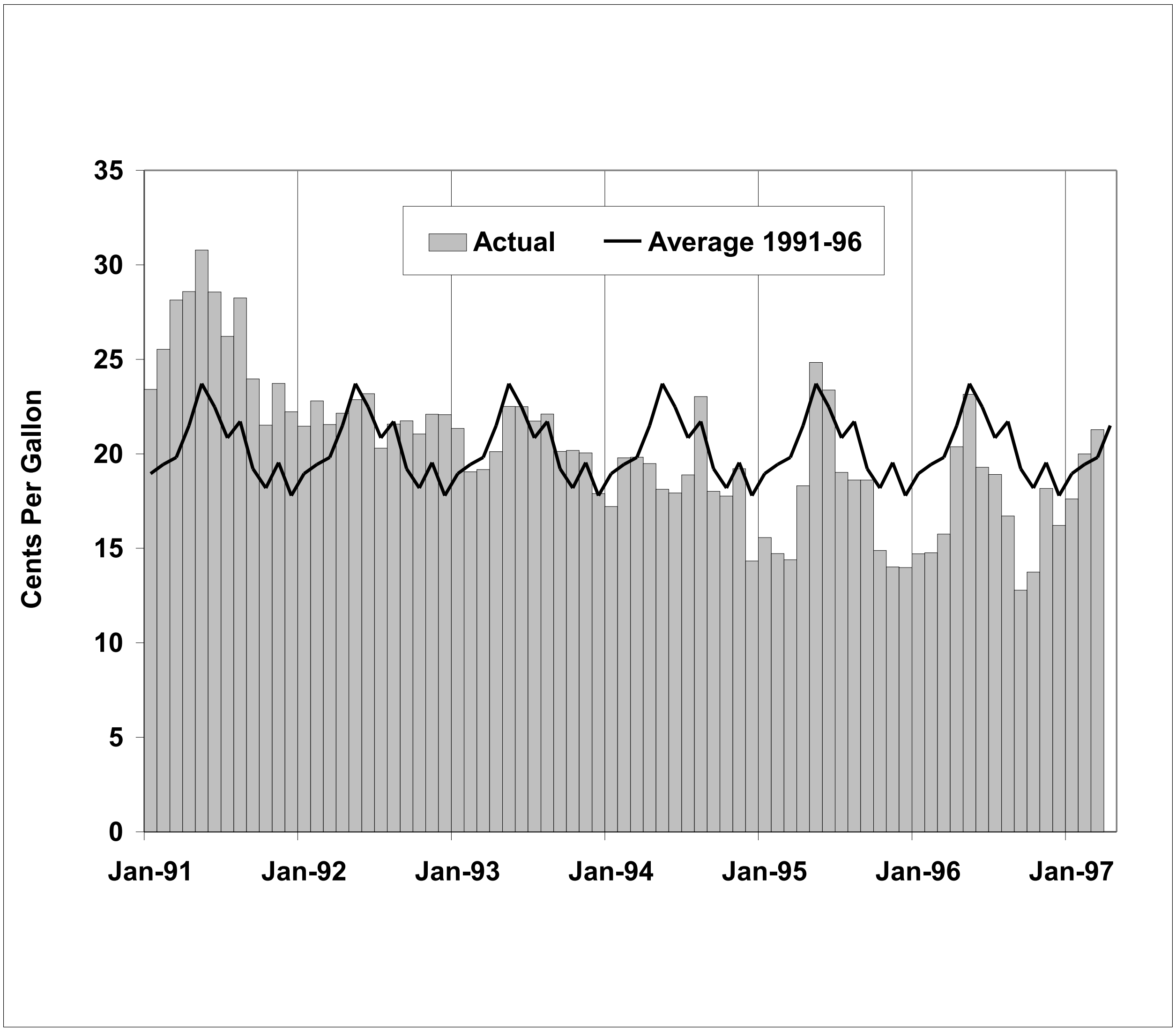
Standard errors appear in parentheses below the parameter estimates.
*** indicates significant at 1% criteria (p-value.01).
** indicates significant at 5% criteria (p-value.05).
* indicates significant at 10% criteria (p-value.10).

Table C.3 Cumulative Passthrough to Retail for 10-Cent Change in Spot Price (Comparison of OLS and PDL Estimation Results)

Time Elapsed	Calculation Method	PADD 1A	PADD 1B	PADD 1C	PADD 2	PADD 3
		Cents Per Gallon				
2 Weeks	OLS	2.54	2.30	2.95	5.97	2.91
	PDL	2.60	2.38	2.74	5.93	2.50
4 Weeks	OLS	4.48	4.14	5.03	8.03	4.61
	PDL	4.79	4.43	5.02	7.88	4.59
6 Weeks	OLS	6.51	5.70	6.46	9.12	5.87
	PDL	6.57	6.15	6.82	9.23	6.28
8 Weeks	OLS	7.69	6.94	7.69	10.44	7.26
	PDL	7.94	7.54	8.15	10.44	7.56

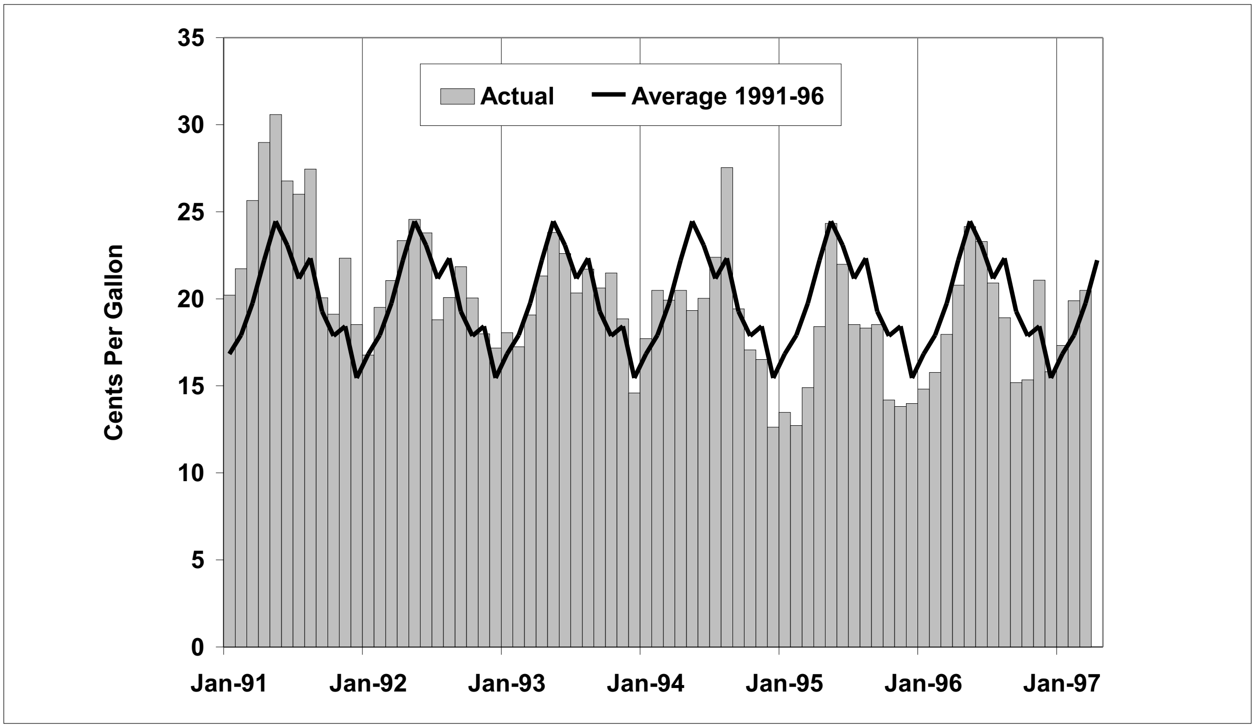
Appendix D: Resale Gasoline Price Spreads

Figure D.1 Resale Regular Conventional - Refiner's Cost Imported PADD 1



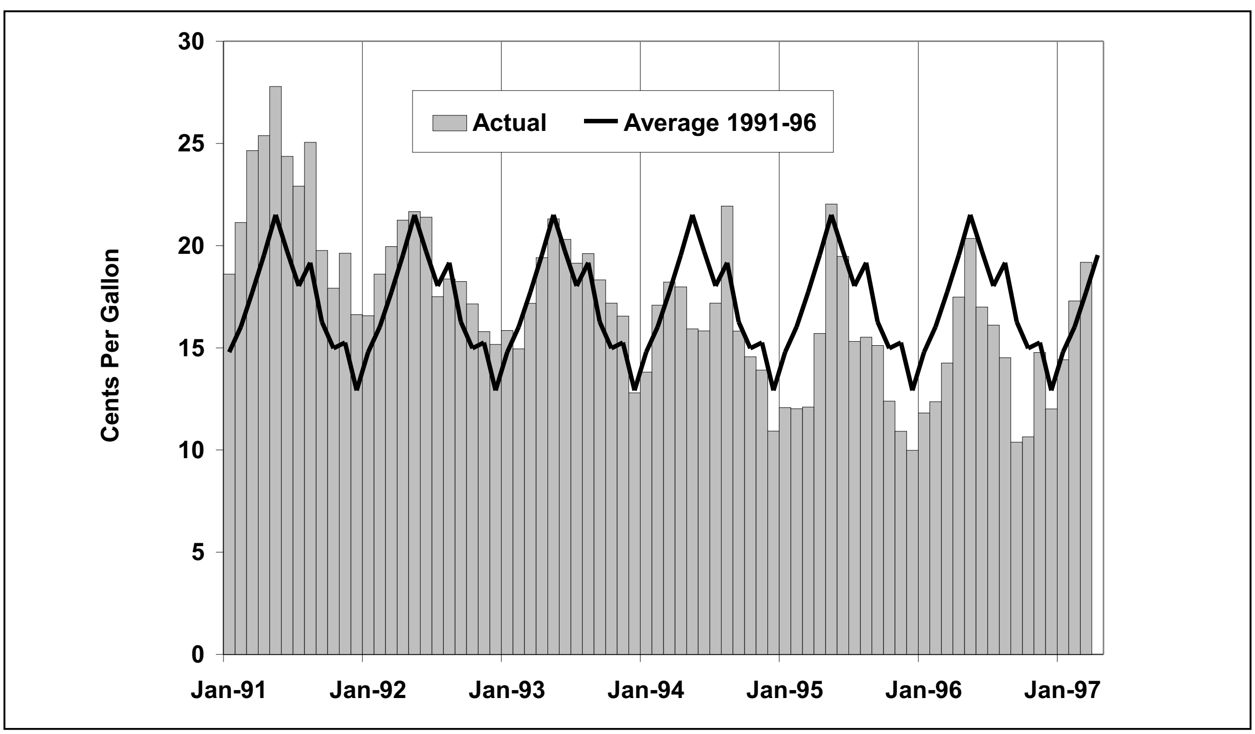
Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380; Gasoline Prices: Table 32 (various issues); Crude Oil Prices: Table 1 (various issues).

Figure D.2 Resale Regular Conventional - Refiner's Cost Imported PADD 2



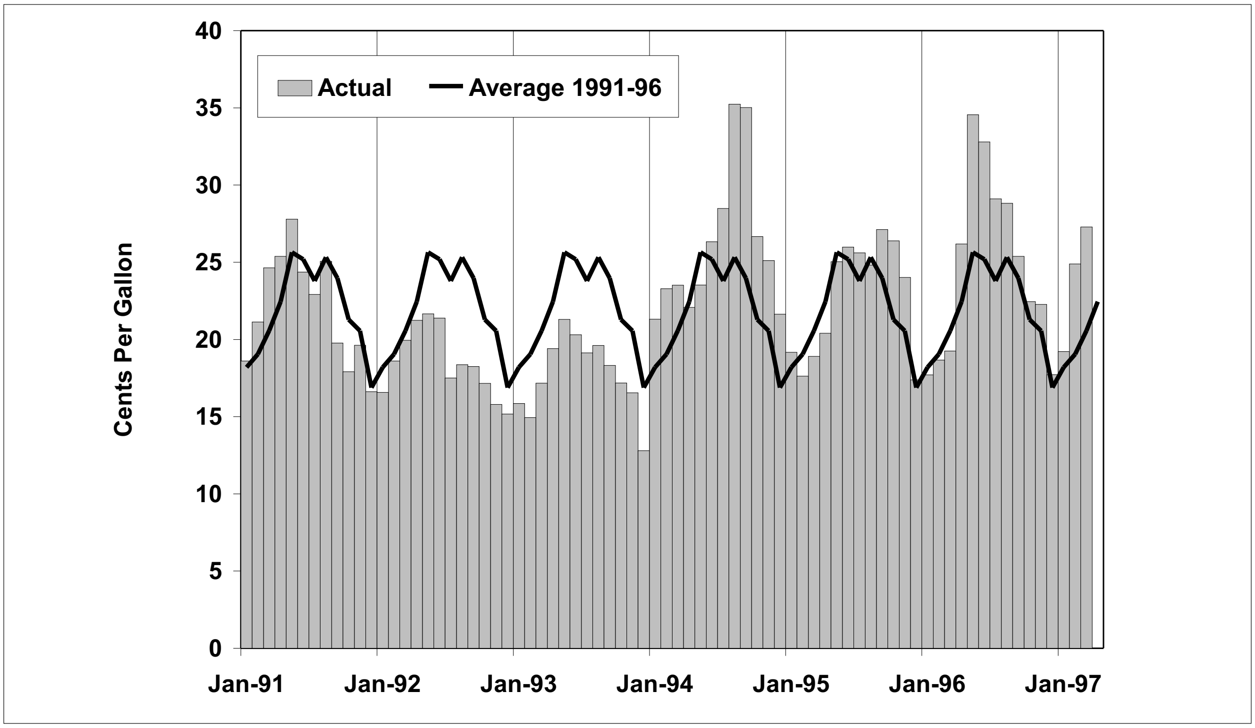
Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380; Gasoline Prices: Table 32 (various issues); Crude Oil Prices: Table 1 (various issues).

Figure D.3 Resale Regular Conventional - Refiner's Cost Imported PADD 3



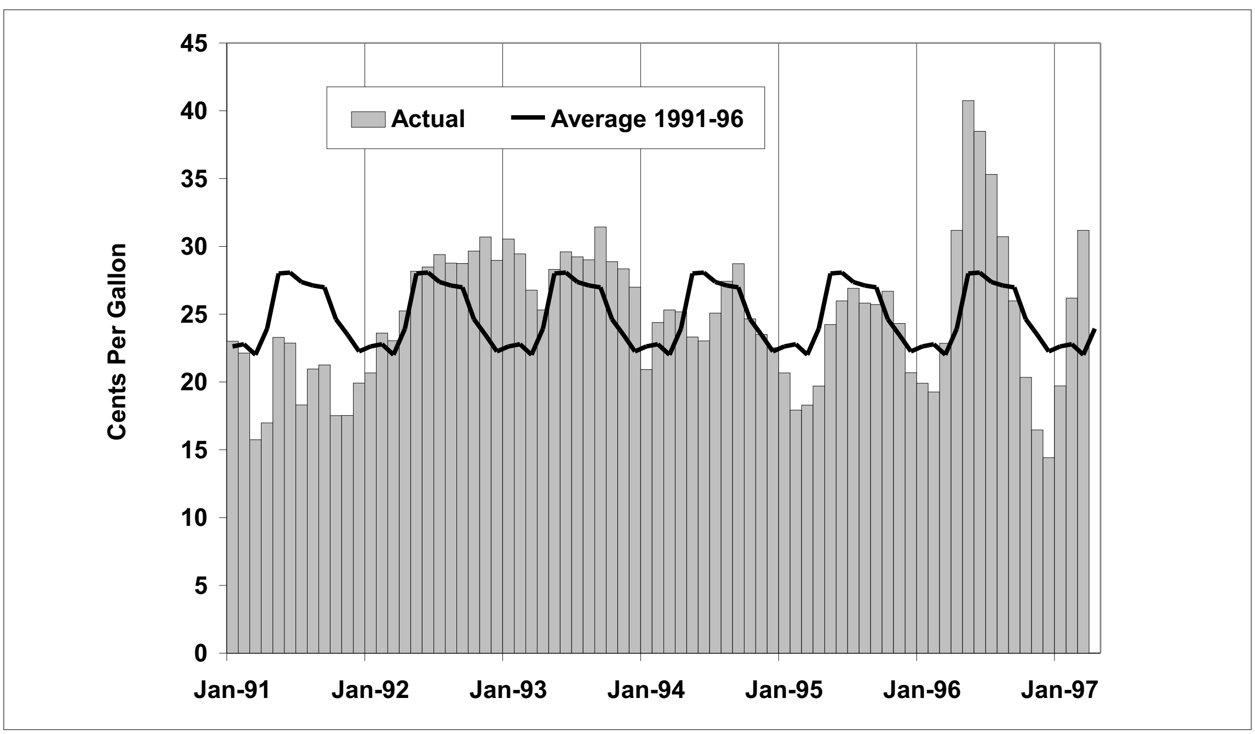
Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380; Gasoline Prices: Table 32 (various issues); Crude Oil Prices: Table 1 (various issues).

Figure D.4 Resale Regular Conventional - Refiner's Cost Imported PADD 4



Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380; Gasoline Prices: Table 32 (various issues); Crude Oil Prices: Table 1 (various issues).

Figure D.5 Resale Regular Conventional - Refiner's Cost Imported PADD 5



Source: Energy Information Administration, *Petroleum Marketing Monthly*, DOE/EIA-0380; Gasoline Prices: Table 32 (various issues); Crude Oil Prices: Table 1 (various issues).

Appendix E: Petroleum Administration For Defense Districts (PADDs)

PADD 1:

PADDs 1A, 1B, 1C, which are Subdistricts of PADD 1.

PADD 1A: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont.

PADD 1B: Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania.

PADD 1C: Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia.

PADD 2:

Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, Wisconsin.

PADD 3:

Alabama, Arkansas, Louisiana, Mississippi, New Mexico, Texas, Federal Offshore Gulf.

PADD 4:

Colorado, Idaho, Montana, Utah, Wyoming.

PADD 5:

Alaska (North Slope and Other Mainland), Arizona, California, Hawaii, Nevada, Oregon, Washington, Federal Offshore California.