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GAO

Report to the Ranking Minority Member, Permanent Subcommittee on Investigations, Committee on Governmental Affairs, U.S. Senate

May 2004

ENERGY MARKETS

Effects of Mergers and Market Concentration in the U.S. Petroleum Industry

GAO-04-96

May 2004

GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-04-96, a report to the Ranking Minority Member, Permanent Subcommittee on Investigations, Committee on Governmental Affairs, U.S. Senate

ENERGY MARKETS

Effects of Mergers and Market Concentration in the U.S. Petroleum Industry

Why GAO Did This Study

Starting in the mid-1990s, the U.S. petroleum industry experienced a wave of mergers, acquisitions, and joint ventures, several of them between large oil companies that had previously competed with each other. For example, as shown in the figure, Exxon, the largest U.S. oil company, acquired Mobil, the second largest, thus forming ExxonMobil.

GAO was asked to examine the effects of the mergers on the U.S. petroleum industry since the 1990s. For this period, GAO examined (1) mergers in the U.S. petroleum industry and why they occurred, (2) the extent to which market concentration (the distribution of market shares among competing firms) and other aspects of market structure in the U.S. petroleum industry have changed as a result of mergers, (3) major changes that have occurred in U.S. gasoline marketing, and (4) how mergers and market concentration in the U.S. petroleum industry have affected U.S. gasoline prices at the wholesale level. Commenting on a draft of GAO's report, FTC asserted that the models were flawed and the analyses unreliable. GAO used state-of-the-art econometric models to examine the effects of mergers and market concentration on wholesale gasoline prices. The models used in GAO's analyses were peer reviewed by independent experts. Thus, GAO believes its analyses are sound.

www.gao.gov/cgi-bin/getrpt?GAO-04-96.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

What GAO Found

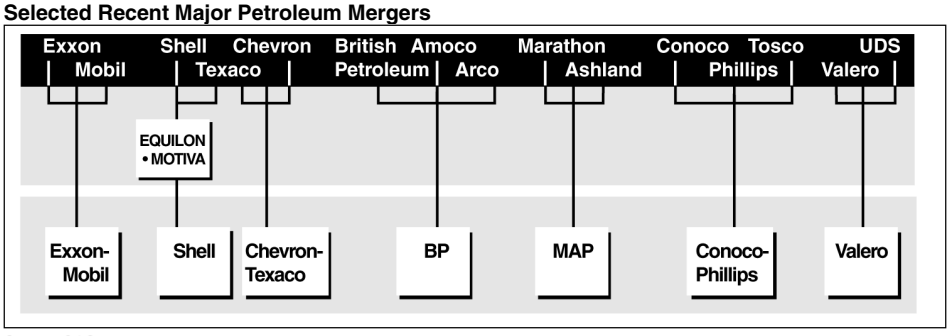
Over 2,600 mergers have occurred in the U.S. petroleum industry since the 1990s. The majority occurred later in the period, most frequently among firms involved in exploration and production. Industry officials cited various reasons for the mergers, particularly the need for increased efficiency and cost savings. Economic literature also suggests that firms sometimes merge to enhance their ability to control prices.

Market concentration has increased substantially in the industry, partly because of these mergers. Concentrated markets can enable firms to raise prices above competitive levels but can also lead to cost savings and lower prices. Evidence suggests mergers also have changed other factors that affect competition, such as the ability of new firms to enter the market.

According to industry officials, two major changes have occurred in U.S. gasoline marketing related to these mergers. First, the availability of generic gasoline, which is generally priced lower than branded gasoline, has decreased substantially. Second, refiners now prefer to deal with large distributors and retailers, which has motivated further consolidation in distributor and retail markets.

GAO's econometric analyses indicate that mergers and increased market concentration generally led to higher wholesale gasoline prices in the United States from the mid-1990s through 2000. Six of the eight mergers GAO modeled led to price increases, averaging about 1 cent to 2 cents per gallon. GAO found that increased market concentration, which reflects the cumulative effects of mergers and other competitive factors, also led to increased prices. For conventional gasoline, the predominant type used in the country, the change in wholesale price due to increased market concentration ranged from a decrease of about 1 cent per gallon to an increase of about 5 cents per gallon. For boutique fuels sold in the East Coast and Gulf Coast regions, wholesale prices increased by about 1 cent per gallon, while prices for boutique fuels sold in California increased by over 7 cents per gallon.

Selected Recent Major Petroleum Mergers



Source: GAO.

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Abbreviations

API	American Petroleum Institute
BP	British Petroleum
CARB	California Air Resources Board
cpg	cents per gallon
DOE	Department of Energy
DOJ	Department of Justice
DTW	Dealer-tankwagon
EAI	Energy Analysts International, Inc.
EIA	Energy Information Administration
FERC	Federal Energy Regulatory Commission
FRS	Financial Reporting System
FTC	Federal Trade Commission
HHI	Herfindahl-Hirschman Index
MAP	Marathon Ashland Petroleum
mmb/d	million barrels per day
MTBE	methyl tertiary butyl ether
OGJ	*Oil and Gas Journal*
OPEC	Organization of Petroleum Exporting Countries
OPIS	Oil Price Information Service
PADD	Petroleum Administration for Defense Districts
PMAA	Petroleum Marketers Association of America
RFG	reformulated gasoline
UDS	Ultramar Diamond Shamrock
WTI	West Texas Intermediate

GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, D.C. 20548

May 17, 2004

The Honorable Carl Levin
Ranking Minority Member
Permanent Subcommittee on Investigations
Committee on Governmental Affairs
United States Senate

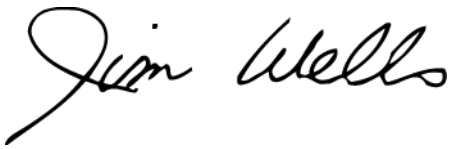
Dear Senator Levin:

This report responds to your request that we examine the effect of the wave of mergers that occurred in the U.S. petroleum industry in the 1990s. The report examines the segments of the petroleum industry that were involved in mergers, the extent to which market concentration and other aspects of market structure that affect competition have changed in the U.S. petroleum industry because of mergers, and major changes that have occurred in U.S. gasoline marketing because of mergers. Finally, the report estimates the effects of mergers and market concentration on U.S. gasoline prices at the wholesale level.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to appropriate congressional committees, the Chairman of the Federal Trade Commission, the Secretary of Energy, the Attorney General, and other interested parties.

Please contact me at (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix VII.

Sincerely yours,



Jim Wells
Director, Natural Resources
and Environment

Executive Summary

Purpose

Since the 1990s, the U.S. petroleum industry has experienced a wave of mergers, acquisitions, and joint ventures (hereafter referred to as mergers), several of them between large oil companies that had previously competed with each other for the sale of petroleum products. For example, in 1998 British Petroleum (BP) and Amoco merged to form BP-Amoco, which later acquired ARCO in 2000. In 1999, Exxon, the largest U.S. oil company, acquired Mobil, the second largest, thus forming ExxonMobil. Increasing concerns about potential anticompetitive effects have caused some policy makers and consumer groups to suggest that these mergers may have reduced competition in the United States and ultimately led to higher gasoline prices.

In this context, the Ranking Minority Member, Permanent Subcommittee on Investigations, Senate Committee on Governmental Affairs, asked GAO to examine the effect of the mergers that have occurred in the U.S. petroleum industry since the 1990s. GAO examined (1) mergers in the U.S. petroleum industry from the 1990s through 2000 and why they occurred, (2) the extent to which market concentration (the distribution of market shares among competing firms within a market) and other aspects of market structure in the U.S. petroleum industry have changed as a result of mergers, (3) major changes that have occurred in U.S. gasoline marketing since the 1990s, and (4) how mergers and market concentration in the U.S. petroleum industry have affected U.S. gasoline prices at the wholesale level.

To address these issues, GAO purchased and analyzed a large body of data on mergers and wholesale gasoline prices, as well as data on other relevant economic factors. GAO also developed econometric models for examining the effects of eight specific mergers and increased market concentration on U.S. gasoline wholesale prices. In doing so, GAO isolated the effects of mergers and market concentration from several other factors that could influence wholesale gasoline prices, such as crude oil costs, gasoline inventories relative to demand, refinery capacity utilization rates, and gasoline supply disruptions. GAO also differentiated among fuel formulations in its analyses. Other factors—including taxes—can affect the retail gasoline prices that consumers ultimately pay, but GAO did not examine the effects of such factors because this study focuses on wholesale gasoline prices.

In the course of its work, GAO consulted with Dr. Severin Borenstein,[1] a recognized expert in the modeling of gasoline markets; interviewed officials across the industry spectrum; and reviewed relevant economic literature and numerous related studies. Furthermore, GAO used an extensive peer review process to obtain comments from experts in academia and relevant government agencies.

Background

The U.S. petroleum industry consists of many firms of varying sizes that operate in one or more of three broad segments—the upstream, which consists of exploration for and production of crude oil and natural gas; the midstream, which consists of pipelines and other infrastructure used to transport these products; and the downstream, which consists of refining crude oil and marketing petroleum products such as gasoline and heating oil. While some firms engage in only one or two of these activities, fully vertically integrated oil companies participate in all of them. Before the 1970s, major oil companies that were fully vertically integrated controlled the global network for supplying, pricing, and marketing crude oil. However, the structure of the world crude oil market has dramatically changed as a result of such factors as the nationalization of oil fields by oil-producing countries, the emergence of independent oil companies, and the evolution of futures and spot markets in the 1970s and 1980s. Moreover, U.S. oil prices, controlled by the government since 1971, were deregulated in 1981. Consequently, the price of crude oil is now largely determined in the world oil market, which is mostly influenced by global factors, especially Organization of Petroleum Exporting Countries' (OPEC) supply decisions and world economic and political conditions.

The United States currently imports over 60 percent of its crude oil supply. In contrast, the bulk of the gasoline used in the United States is produced domestically. In 2001, for example, gasoline refined in the United States accounted for over 90 percent of the total domestic gasoline consumption. Companies that supply gasoline to U.S. markets also post the domestic gasoline prices. Historically, the domestic petroleum market has been divided into five regions, known as Petroleum Administration for Defense Districts (PADD)—PADD I is the East Coast region, PADD II is the Midwest

[1]Dr. Borenstein is E.T. Grether Professor of Business Administration and Public Policy at the Haas School of Business, University of California, Berkeley. He is also the Director of the University of California Energy Institute.

region, PADD III is the Gulf Coast region, PADD IV is the Rocky Mountain region, and PADD V is the West Coast region.

Proposed mergers in all industries, including the petroleum industry, are generally reviewed by federal antitrust authorities—including the Federal Trade Commission (FTC) and the Department of Justice (DOJ)—to assess the potential impact on market competition. According to FTC officials, FTC generally reviews proposed mergers involving the petroleum industry because of the agency's expertise in that industry. FTC analyzes these mergers to determine if they would likely diminish competition in the relevant markets and result in harm, such as increased prices. To determine the potential effect of a merger on market competition, FTC evaluates, among other things, how the merger would change the level of market concentration. Conceptually, the higher the concentration, the less competitive the market is and the more likely that firms can exert control over prices. The ability to maintain prices above competitive levels for a significant period of time is known as market power.

Market concentration is commonly measured by the Herfindahl-Hirschman Index (HHI), calculated by summing the squares of the market shares of all the firms within a given market. According to the merger guidelines jointly issued by DOJ and FTC, market concentration is ranked into three separate categories based on the HHI: a market with an HHI under 1,000 is considered to be unconcentrated; if the HHI is between 1,000 and 1,800 the market is considered moderately concentrated; and if the HHI is above 1,800, the market is considered highly concentrated.

While concentration is an important aspect of market structure—the underlying economic and technical characteristics of an industry—other aspects of market structure that may be affected by mergers also play an important role in determining the level of competition in a market. These aspects include barriers to entry, which are market conditions that provide established sellers an advantage over potential new entrants in an industry, and vertical integration, which is the participation of firms in more than one successive stage of production or distribution in a market.

Results in Brief

GAO's analysis indicates that from 1991 through 2000 all three segments of the U.S. petroleum industry experienced mergers—over 2,600 transactions in all. The majority of the mergers occurred during the second half of the decade, most frequently in the upstream (exploration and production) segment. Petroleum industry officials cited various reasons for this wave of

mergers, particularly the need for increased efficiency and cost savings. Economic literature suggests that firms also sometimes use mergers to enhance their market power. However, the reasons cited by both sources generally relate to the merging companies' desire to ultimately maximize profit or shareholder wealth.

Market concentration, as measured by HHI, has increased substantially in the downstream segment of the U.S. petroleum industry since the 1990s, partly as a result of merger activities, while changing very little in the upstream segment. Increased market concentration can result in greater market power, potentially increasing prices above competitive levels. On the other hand, it can lead to efficiency gains through cost savings, which may be passed on to consumers in the form of lower prices. The impact—either positive or negative—of increased market concentration on prices ultimately depends on whether market power or efficiency dominates. In the downstream (refining and marketing) segment, market concentration in refining increased from moderately to highly concentrated in the East Coast and from unconcentrated to moderately concentrated in the West Coast; it increased but remained moderately concentrated in the Rocky Mountain region. Concentration in the wholesale gasoline market increased substantially from the mid-1990s so that by 2002, most states had either moderately or highly concentrated wholesale gasoline markets. On the other hand, market concentration decreased somewhat in the upstream (exploration and production) segment and remained unconcentrated by the end of the 1990s. While mergers occurred in the midstream (transportation) segment, GAO could not determine the extent to which concentration changed in this segment because of a lack of relevant data and difficulties in defining markets. Anecdotal evidence and economic analysis by some industry experts suggest that mergers not only affected market concentration but also enhanced vertical integration and barriers to entry. GAO could not, however, determine the extent to which these other aspects of market structure changed in the petroleum industry because adequate data do not exist. Like increased market concentration, increased vertical integration can result in higher or lower consumer prices. Barriers to entry are important in a market because firms that operate in concentrated industries with high barriers to entry are more likely to have market power.

According to industry officials, two major changes have occurred in U.S. gasoline marketing since the 1990s, partly related to mergers. First, the availability of unbranded (generic) gasoline has decreased substantially. Unbranded gasoline is generally priced lower than branded gasoline, which

is marketed under the refiner's trademark. Industry officials generally attributed the decreased availability of unbranded gasoline to, among other factors, a reduction in the number of independent refiners that typically supply unbranded gasoline. GAO could not, however, statistically quantify the extent to which the supply of unbranded gasoline has decreased because relevant data are not available. The second change identified by industry officials is that refiners now prefer dealing with large distributors and retailers. This preference, according to the officials, has motivated further consolidation in both the distributor and retail markets, including the rise of hypermarkets—a relatively new breed of gasoline market participants that includes such large retail warehouses as Wal-Mart and Costco.

GAO's econometric analyses show that oil industry mergers and increased market concentration generally led to higher wholesale gasoline prices (measured in this report as wholesale prices less crude oil prices) for different gasoline types in the United States in the second half of the 1990s, although prices sometimes decreased. Six of the eight specific mergers GAO modeled—which mostly involved large, fully vertically integrated companies—generally resulted in increases in wholesale prices for branded and/or unbranded gasoline of about 2 cents per gallon, on average. Two of the mergers generally led to price decreases, of about 1 cent per gallon, on average. For conventional gasoline—the predominant type used in the United States except in areas that require special gasoline formulations to meet clean air standards—the change in wholesale prices ranged from a decrease of about 1 cent per gallon to an increase of about 5 cents per gallon. The preponderance of price increases over decreases indicates that the market power effects, which tend to increase prices, for the most part outweighed the efficiency effects, which tend to decrease prices. Increased market concentration, which captures the cumulative effects of mergers as well as other market structure factors, also generally led to higher prices for conventional gasoline, which is sold nationwide, and for boutique fuels—gasoline that has been reformulated for certain areas in the East Coast and Gulf Coast regions and in California, to lower pollution. The price increases were particularly large in California, where they averaged about 7 cents per gallon. Higher wholesale gasoline prices were also a result of other factors: low gasoline inventories, which typically occur in the summer driving months; high refinery capacity utilization rates; and supply disruptions, which occurred in the Midwest and the West Coast.

GAO's findings are generally consistent with previous studies of the effects of specific oil mergers and of market concentration on wholesale and retail gasoline prices. GAO used extensive peer review to obtain comments from outside experts, which were incorporated as appropriate. GAO believes that this is the first study to model the impact of the petroleum industry's 1990s merger wave on wholesale gasoline prices for the primary gasoline specifications for the entire United States, an effort that required GAO to acquire large datasets and perform complex analyses.

Principal Findings

Mergers Occurred in All Segments of the U.S. Petroleum Industry in the 1990s for Several Reasons

Over 2,600 merger transactions occurred from 1991 through 2000 involving all three segments of the U.S. petroleum industry. Almost 85 percent of the mergers occurred in the upstream segment (exploration and production), while the downstream segment (refining and marketing of petroleum) accounted for about 13 percent, and the midstream segment (transportation) accounted for over 2 percent. The vast majority of the mergers—about 80 percent—involved one company's purchase of a segment or asset of another company, while about 20 percent involved the acquisition of one company's total assets by another so that the two became one company. Most of the mergers occurred in the second half of the decade, including those involving large partially or fully vertically integrated companies.

Petroleum industry officials and experts GAO contacted cited several reasons for the industry's wave of mergers in the 1990s, including achieving synergies, increasing growth and diversifying assets, and reducing costs. Economic literature indicates that enhancing market power is also sometimes a motive for mergers. These reasons mostly relate to companies' ultimate desire to maximize profit or stock values.

Mergers Contributed to Increases in Market Concentration and to Changes in Other Aspects of Market Structure That Affect Competition

Mergers in the 1990s have contributed to increases in market concentration in the downstream segment of the U.S. petroleum industry, while the upstream segment experienced little change overall. Increased market concentration can result in greater market power, potentially allowing firms to increase prices above competitive levels. On the other hand, increased market concentration may also lead to efficiency gains that can be passed on to consumers as lower prices. Whether increased market

concentration results in higher or lower prices depends on which effect predominates. GAO found that market concentration, as measured by the HHI, decreased slightly in the upstream segment, based on crude oil production activities at the national level, from 290 in 1990 to 217 in 2000. Moreover, based on benchmarks established jointly by DOJ and FTC, the upstream segment of the U.S. petroleum industry remained unconcentrated at the end of the 1990s. The increases in market concentration in the downstream segment varied by activity and region. For example, the HHI of the refining market in the East Coast region increased from a moderately concentrated level of 1136 in 1990 to a highly concentrated level of 1819 in 2000. In the Rocky Mountain and the West Coast regions it increased from 1029 to 1124 and from 937 to 1267, respectively, in that same period. Thus, while each of these refining markets increased, the Rocky Mountain region remained within the moderately concentrated range but the West Coast region changed from unconcentrated in 1990 to moderately concentrated in 2000. The HHI of refining markets also increased from 699 to 980 in the Midwest region and from 534 to 704 in the Gulf Coast region during the same period, although these markets remained unconcentrated. In wholesale gasoline markets, GAO found that market concentration increased broadly throughout the United States between 1994 and 2002. Specifically, GAO found that 46 states and the District of Columbia had moderately or highly concentrated markets by 2002, compared to 27 in 1994. For both the refining and wholesale markets of the downstream segment, GAO found that merger activity and market concentration were highly correlated for most regions of the country.

Evidence from various sources indicates that in addition to increasing market concentration, mergers also contributed to changes in other aspects of market structure in the U.S. petroleum industry that affect competition—specifically, vertical integration and barriers to entry. However, GAO could not quantify the extent of these changes because of a lack of relevant data. Vertical integration can conceptually have both pro- and anticompetitive effects. Based on anecdotal evidence and economic analyses by some industry experts, GAO determined that a number of mergers that have occurred since the 1990s have led to greater vertical integration in the U.S. petroleum industry, especially in the refining and marketing segment. For example, GAO identified eight mergers that occurred between 1995 and 2001 that might have enhanced the degree of vertical integration, particularly in the downstream segment. Concerning barriers to entry, GAO's interviews with petroleum industry officials and experts provide evidence that mergers had some impact on the U.S. petroleum industry. Barriers to entry could have implications for market

competition because companies that operate in concentrated industries with high barriers to entry are more likely to possess market power. Industry officials pointed out that large capital requirements and environmental regulations constitute barriers for potential new entrants into the U.S. refining business. For example, the officials indicated that a typical refinery could cost billions of dollars to build and that it may be difficult to obtain the necessary permits from the relevant state or local authorities. At the wholesale and retail marketing levels, industry officials pointed out that mergers may have exacerbated barriers to entry in some markets. For example, the officials noted that mergers have contributed to a situation where pipelines and terminals are owned by fewer, mostly integrated companies that sometimes deny access to third-party users, especially when supply is tight—which creates a disincentive for potential new entrants into such wholesale markets.

U.S. Gasoline Marketing Has Changed in Two Major Ways

According to some petroleum industry officials that GAO interviewed, gasoline marketing in the United States has changed in two major ways since the 1990s. First, the availability of unbranded gasoline has decreased, partly due to mergers. Officials noted that unbranded gasoline is generally priced lower than branded. They generally attributed the decreased availability of unbranded gasoline to one or more of the following factors:

- There are now fewer independent refiners, who typically supply mostly unbranded gasoline. These refiners have been acquired by branded companies, have grown large enough to be considered a brand, or have simply closed down.
- Partially or fully vertically integrated oil companies have sold or mothballed some refineries. As a result, some of these companies now have only enough refinery capacity to supply their own branded needs, with little or no excess to sell as unbranded.
- Major branded refiners are managing their inventory more efficiently, ensuring that they produce only enough gasoline to meet their current branded needs.

GAO could not quantify the extent of the decrease in the unbranded gasoline supply because the data required for such analyses do not exist.

The second change identified by these officials is that refiners now prefer dealing with large distributors and retailers because they present a lower

credit risk and because it is more efficient to sell a larger volume through fewer entities. Refiners manifest this preference by setting minimum volume requirements for gasoline purchases. These requirements have motivated further consolidation in the distributor and retail sectors, including the rise of hypermarkets.

Mergers and Increased Market Concentration Generally Led to Higher U.S. Wholesale Gasoline Prices

GAO's econometric modeling shows that the mergers GAO examined mostly led to higher wholesale gasoline prices in the second half of the 1990s. GAO's analysis shows that the majority of the eight specific mergers examined—Ultramar Diamond Shamrock (UDS)-Total, Tosco-Unocal, Marathon-Ashland, Shell-Texaco I (Equilon), Shell-Texaco II (Motiva), BP-Amoco, Exxon-Mobil, and Marathon Ashland Petroleum (MAP)-UDS—resulted in higher prices of wholesale gasoline in the cities where the merging companies supplied gasoline before they merged. For the seven mergers that GAO modeled for conventional gasoline, five led to increased prices, especially the MAP-UDS and Exxon-Mobil mergers, where the increases generally exceeded 2 cents per gallon. For the four mergers that GAO modeled for reformulated gasoline, two—Exxon-Mobil and Marathon-Ashland—led to increased prices of about 1 cent per gallon, on average. In contrast, the Shell-Texaco II (Motiva) merger led to price decreases of less than one-half cent per gallon for branded gasoline only. For the two mergers—Tosco-Unocal and Shell-Texaco I (Equilon)—that GAO modeled for the reformulated gasoline used in California, known as California Air Resources Board (CARB) gasoline, only the Tosco-Unocal merger led to price increases. The increases were for branded gasoline only and exceeded 6 cents per gallon. The effects of some of the mergers were inconclusive, especially for boutique fuels sold in the East Coast and Gulf Coast regions and in California.

For market concentration, which captures the cumulative effects of mergers as well as other competitive factors, GAO's econometric analysis shows that increased market concentration resulted in higher wholesale gasoline prices. Prices increased for conventional (non-boutique) gasoline, the dominant type of gasoline sold nationwide from 1994 through 2000, by less than one-half cent per gallon for branded and unbranded gasoline. The increases were larger in the West than in the East—the increases were between one-half cent and 1 cent per gallon in the West, and about one-quarter cent in the East (for branded gasoline only). Price increases for boutique fuels sold in some parts of the East Coast and Gulf Coast regions and in California were larger compared to the increases for conventional gasoline. The wholesale prices increased by about 1 cent per gallon for

boutique fuel sold in the East Coast and Gulf Coast regions between 1995 and 2000, and by over 7 cents per gallon in California between 1996 and 2000.

GAO's analysis shows that wholesale gasoline prices were also affected by other factors included in the econometric models—particularly, gasoline inventories relative to demand, refinery capacity utilization rates, and the supply disruptions that occurred in some parts of the Midwest and the West Coast. In particular, wholesale gasoline prices were about 1 cent per gallon higher when gasoline inventories were low relative to demand, typically in the summer driving months. Also, prices were higher by about one-tenth to two-tenths of 1 cent per gallon when refinery capacity utilization rates increased by 1 percent. The prices of conventional gasoline were about 4 to 5 cents per gallon higher on average during the Midwest and West Coast supply disruptions. The increase in prices for CARB gasoline was about 4 to 7 cents per gallon, on average, during the West Coast supply disruptions.

Recommendations for Executive Action

GAO is not making recommendations in this report.

Agency Comments and GAO's Evaluation

GAO provided a draft of this report to FTC for its review and comment. FTC stated that the draft report was flawed and did not provide a basis for reliable judgments about the competitive effects of mergers in the petroleum industry. However, GAO believes that its analyses are sound and consistent with the views of independent economists and experts that peer reviewed GAO's overall modeling approach. In particular, Dr. Severin Borenstein, a recognized expert in the modeling of gasoline markets, reviewed and commented on GAO's econometric analysis and results at several stages. In response, GAO made revisions in the course of developing and estimating its models and in its final report, as appropriate. In addition, partly in response to FTC's comments, GAO re-estimated its models to account for the effects of gasoline supply disruptions that occurred in some parts of the West Coast and Midwest regions.

FTC focused a substantial portion of its comments on GAO's econometric models, outlining five concerns. First, FTC asserted that the models did not control for the many factors that could cause gasoline price increases, citing the following factors: seasonality, temperature, income, changes in

gasoline formulations, and supply disruptions in the Midwest and West Coast regions. This assertion is not correct. GAO's models incorporated key factors that affect wholesale gasoline prices, including crude oil prices, refinery capacity utilization rates, and gasoline inventory-to-demand ratio—a ratio that captures the effects of seasonality and temperature. GAO considered the available data for income by city but found that income data did not vary over time and therefore would not be appropriate for the estimation technique (fixed-effects) that GAO used. GAO controlled for changes in gasoline formulations between seasons through the inventory-to-demand ratio; other changes in formulations either occurred outside the time period that GAO examined or were unlikely to significantly affect the results. During GAO's December 2002 meeting with FTC staff, the staff agreed that the effects of other formulations could be minimal because these other formulations are typically a small percentage of the total volume of gasoline in the areas that GAO modeled. Regarding the potential effects of the Midwest and West coast supply disruptions, GAO believes that the models indirectly captured these effects through the inventory-to-demand ratio. Nonetheless, in response to FTC's comments, GAO included a proxy for these disruptions in its models.

Second, FTC stated that GAO's modeling of the effect of market concentration on wholesale gasoline prices was problematic, primarily because the agency claimed that the methodology GAO used did not meaningfully distinguish correlation from causation. GAO disagrees. Modeling using appropriate economic structure is a common basis for inferring causation, and GAO's market concentration model is consistent with previous studies on prices and market concentration.

Third, FTC said that GAO used geographic markets that were empirically unjustified to conduct its analysis. GAO recognizes the importance and difficulty of defining relevant geographic markets for gasoline, especially at the wholesale level, and discussed this issue with FTC and other industry experts. FTC indicated that it could not provide specific evidence on what the actual geographic markets for wholesale gasoline were across the United States because, when analyzing potential mergers, FTC focuses on a limited geographic area and relies substantially on proprietary company data. Like other industry experts that GAO contacted, FTC staff agreed in a December 2002 meeting that it was appropriate to use terminal cities and even states, in some cases, as geographic markets for wholesale gasoline. GAO therefore used terminal (rack) cities as the geographic unit. In measuring market concentration at the wholesale level, the draft report that GAO provided to FTC used HHI data from DOE's Energy Information

Administration (EIA) that were based on sales of prime suppliers of wholesale gasoline and available only at the state level. In the final report, GAO measured market concentration using HHI data that GAO constructed based on refinery capacity at the PADD level, after consultation with GAO's expert consultant/reviewer, because GAO believes that market concentration at the refining level more effectively captures the potential market power of the refiners.

Fourth, FTC said that GAO's modeling results are, in many cases, not robust. By robustness, FTC meant that model results yielded by alternative modeling approaches should be consistent. GAO believes that the results for its models' key variables—mergers and market concentration—are robust because these models yielded consistent results using alternative model specifications. In particular, when GAO estimated its models without including the effects of supply disruptions in the affected markets, the effects of the key policy variables—mergers and market concentration—were consistent with the results obtained when GAO incorporated the effects of supply disruptions. Furthermore, because market concentration reflects the cumulative effects of the mergers and other competitive factors, one would expect the results from both approaches—market concentration models and mergers models—to be similar if mergers are the predominant contributing factor to market concentration. In GAO's study, the overall results for both approaches were consistent. GAO believes these are valid demonstrations of the robustness of its model results.

Fifth, FTC said that GAO did not provide complete technical documentation for its econometric models. This is not correct. GAO provided a detailed and complete description of the basis of its econometric models, including data sources, sample selection processes (including tables detailing the list of variables, definitions, sources, data frequency, and level), specifications of the econometric models, and estimation techniques.

In addition to criticizing GAO's models, FTC also criticized GAO's findings about the effects of mergers on the structure of the petroleum industry and U.S. gasoline marketing. Specifically, the agency commented that GAO's findings—that mergers have contributed to barriers to entry and vertical integration and that the availability of unbranded gasoline has decreased—lacked quantitative foundations and were therefore flawed. GAO disagrees with this opinion. Economic findings can be qualitative or quantitative. GAO stated in its report that it could not quantify the extent to which

mergers have affected barriers to entry and vertical integration because of a lack of comprehensive data to fully measure these factors and because there is no consensus on how to appropriately measure them. GAO's finding that mergers have contributed to barriers to entry was based on information from industry officials who provided examples, which GAO included in its report, to validate this finding. While GAO discussed the overall importance of barriers to entry in a market, which FTC recognizes in its merger guidelines, GAO did not conclude, contrary to FTC's assertions, that barriers to entry have harmed or eliminated competition in the industry. To validate GAO's finding that mergers have contributed to vertical integration, GAO presented examples of mergers—particularly in the downstream segment between refiners and marketers—that were vertical in nature (that is, the mergers involved different functional levels of the merging companies) and would contribute to increased vertical integration. GAO also added language to its report, as suggested by EIA, acknowledging the shift during the 1990s toward fully integrated companies' divestiture of certain downstream assets, such as refineries, to nonintegrated companies. For its finding that unbranded gasoline has become less available, GAO relied on extensive interviews with industry participants in different regions of the country. While it would be desirable to ascertain this finding quantitatively, GAO noted in its report that EIA—the federal agency mandated by Congress to collect energy data, including data on gasoline supply—told GAO that the agency does not require petroleum companies to report gasoline data in the form that would permit the identification of branded and unbranded sales.

The full text of FTC's comments and GAO's responses are included in appendixes V and VI. Appendix V contains the comments from FTC Commissioners and appendix VI contains the comments from FTC's Bureau of Economics staff.

Introduction

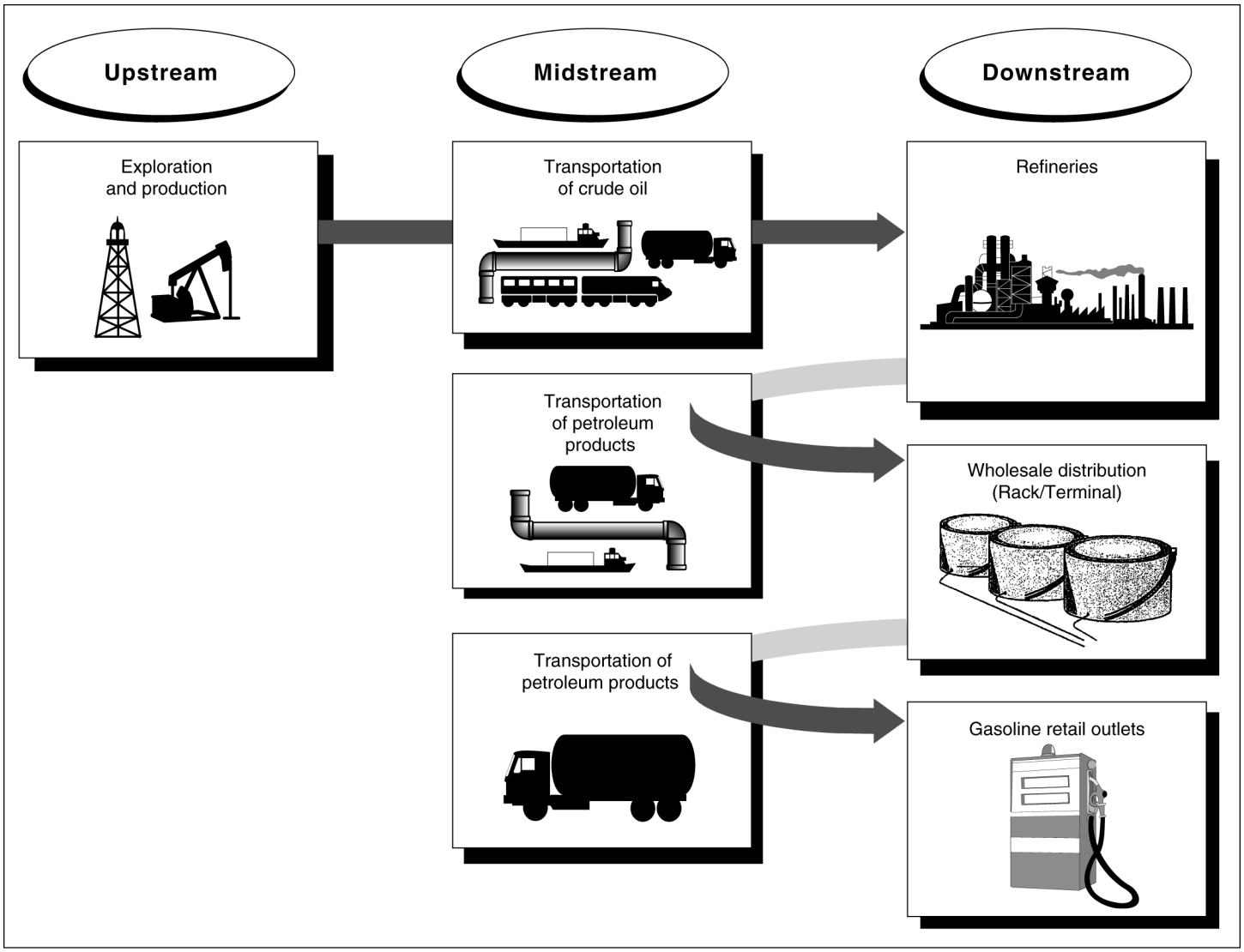
Since the 1990s, the U.S. petroleum industry has experienced a wave of mergers, acquisitions, and joint ventures (hereafter referred to as mergers). Some of these mergers involved well known major petroleum companies that had previously competed with each other for the sale of gasoline and other petroleum products. There were also numerous mergers between smaller companies. Some policy makers and consumer groups believe that these mergers may have reduced competition in the U.S. petroleum industry and ultimately led to higher gasoline prices. During the second half of the 1990s, U.S. gasoline prices exhibited periods of high price volatility, with fairly frequent price spikes. The price of crude oil, the primary input for producing gasoline, was similarly volatile.

The Petroleum Industry Consists of Three Main Segments

As depicted in figure 1, the U.S. petroleum industry consists of the exploration and production segment (upstream); the refining and marketing segment (downstream); and a third segment typically referred to as the midstream, which consists of the infrastructure used to transport crude oil and petroleum products. Some of the petroleum companies in the United States, like Exxon-Mobil and Chevron-Texaco, operate in all segments of the industry—that is, they are fully vertically integrated. Others, like Anadarko and Valero, that operate in one or more but not all segments are generally called partially vertically integrated or independents.[1]

[1]There does not appear to be consensus on what to call the different classes of companies within the industry. In this study, we adopt the term "fully vertically integrated" to refer to companies that operate in all segments. The partially vertically integrated or independents include independent producers that operate only in the upstream. For the downstream, we use "independent refiners" to refer to companies that operate only in refining and marketing, "jobbers" to refer to those that buy gasoline at wholesale and resell it at wholesale and/or retail, and "retailers" to refer to those that operate only at the retail level. While some companies, especially the fully vertically integrated companies, own and operate transportation facilities (midstream), we use the term "pipeline companies," when applicable, to refer to companies that only provide pipeline services.

Figure 1: U.S. Petroleum Industry Chain



Source: GAO.

The Upstream Segment

The activities of the upstream segment consist essentially of exploration for and production of crude oil and natural gas. Hence, the upstream is also referred to as the exploration and production segment. Participants in the U.S. upstream include fully vertically integrated companies and

independent producers. The U.S. upstream segment is characterized by a large number of independent producers and a smaller number of fully vertically integrated oil companies.

The Energy Information Administration (EIA)—the independent statistical and analytical agency within the U.S. Department of Energy (DOE)—has classified U.S. upstream operators into three main categories according to the size of their production in 2001, not according to whether they are integrated or independent:

- large operators—who produced a total of 1.5 million barrels or more of crude, 15 billion cubic feet of natural gas, or both;
- intermediate operators—who produced a total of at least 400,000 barrels of crude oil, 2 billion cubic feet of natural gas, or both, but less than the large operators; and
- small operators—who produced less than the intermediate operators.

Based on this classification, EIA estimated that as of 2001, there were 179 large operators, which accounted for 84.2 percent of crude oil production; 430 intermediate operators, which accounted for 5.8 percent of crude oil production; and 22,519 small operators, which accounted for 10 percent of crude oil production.

Fully vertically integrated companies are generally large operators, while independent producers are generally small operators, with a few medium and large operators. While the fully vertically integrated companies are generally multibillion dollar companies that are publicly traded, the independent producers include many extremely small, privately owned operations as well as a few multibillion dollar and publicly traded companies. In general, the fully vertically integrated companies have upstream operations both in the United States and overseas and accounted for about 60 percent of U.S. crude oil production in 2002. On the other hand, the exploration and production activities of the independents occur

mostly in the United States and accounted for about 40 percent of the crude oil produced in the United States in 2002.[2]

The price of crude oil produced in the United States is determined in the world oil market because the decontrol of domestic oil prices in 1981 has effectively linked the U.S. oil market to the world oil market. In 2000, the United States contained only about 2 percent of world's estimated oil reserves but accounted for about 26 percent of the world's oil demand. From 1990 to 2000, U.S. production decreased significantly, from about 7.4 million barrels per day (mmb/d), or about 55.5 percent of total U.S. crude oil supply, to about 5.8 mmb/d, or 39 percent of total crude oil supply. Nevertheless, the United States was still the world's third largest producer of crude oil. U.S. reliance on oil imports has increased over the last decade as domestic production has dwindled.

The Midstream Segment

The midstream segment transports crude oil and petroleum products. Petroleum transportation facilities include pipelines, marine tankers and barges, railways, and trucks. Pipelines and, to a lesser extent, the other carriers transport domestically produced crude oil from the production points to the refineries, while marine carriers generally transport imported oil. Refined products, such as gasoline, are also carried via these modes from refineries to storage terminals, from which they are generally transported by trucks to retail stations.

In general, pipelines are the dominant and most efficient mode of transporting crude oil and petroleum products in the United States. According to data from the Association of Oil Pipelines, pipelines transported 66.1 percent of all the crude and petroleum products in the United States in 2000. Marine tankers and barges transported 28 percent, while trucks and railways hauled 3.6 percent and 2.3 percent, respectively. According to DOE's Office of Transportation Technology, there are more than 200,000 miles of oil pipelines in the United States in all 50 states. The Federal Energy Regulatory Commission (FERC) regulates the rates on common carrier pipelines. The Association of Oil Pipelines told us that FERC currently regulates about 202 pipeline companies. According to the

[2]Although natural gas is an important product of upstream activities and crude oil and natural gas are often jointly produced, our study focuses on petroleum, and we will not discuss impact of mergers on the natural gas market.

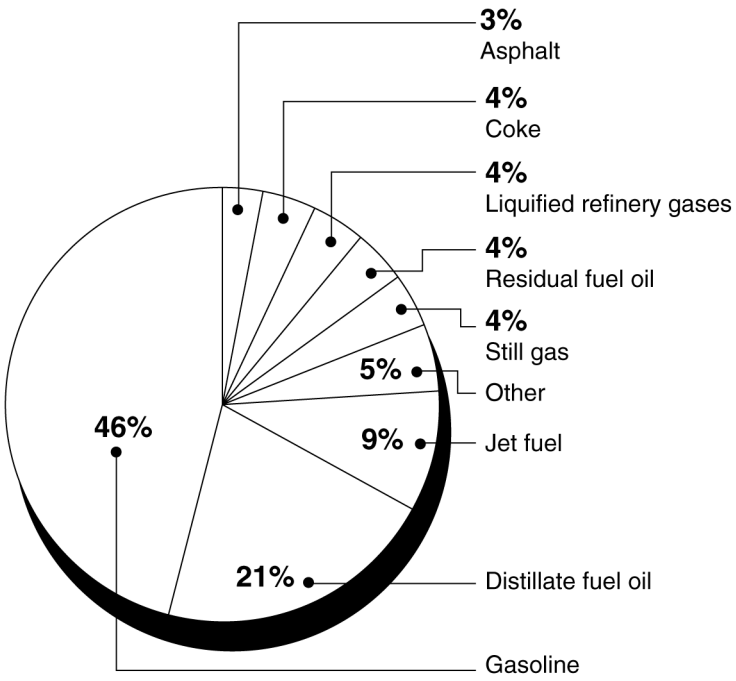
pipeline association, 84 percent of the pipelines are federally regulated while 16 percent are not.

The Downstream Segment

Refining and marketing are the main activities of the downstream segment. Refining is the process of transforming crude oil into petroleum products ranging from gasoline and distillate fuel oil (heating oil) to heavier products such as asphalt. As figure 2 shows, gasoline accounted for nearly half of U.S. refinery output in 2000.[3]

[3]In general, product yields from a barrel of crude oil depend on the quality of the crude input and/or the configuration of the refinery. In general, light and"sweet" (i.e., high gravity and low sulfur) crudes, such as the West Texas Intermediate (WTI), yield a greater proportion of products such as gasoline, distillate, and jet fuel. Also, more sophisticated refineries generally yield higher gasoline and other lighter products. Many U.S. refineries are sophisticated because U.S. refiners have made substantial investments to upgrade their refineries to allow them to maximize the yield of gasoline and other light products.

Figure 2: Product Yield from a Barrel of Crude Oil, 2000



Source: GAO analysis of EIA data.

According to data from EIA, as of January 1, 2002, there were 149 operable refineries in the United States, with a total crude oil distillation capacity of about 16.8 mmb/d. Overall, 60 refining firms, including large fully vertically integrated companies and independent refiners, owned these refineries.[4] The refining companies ranged in size from the smallest, with only 880 barrels per day of crude oil distillation capacity, to the biggest, with a combined refinery capacity of 1.8 mmb/d of crude distillation. Not all of these refineries produce gasoline; some, especially those with small distillation capacity, produce only asphalt.

Marketing in the downstream involves selling petroleum products to customers, who are generally wholesale and retail purchasers. For

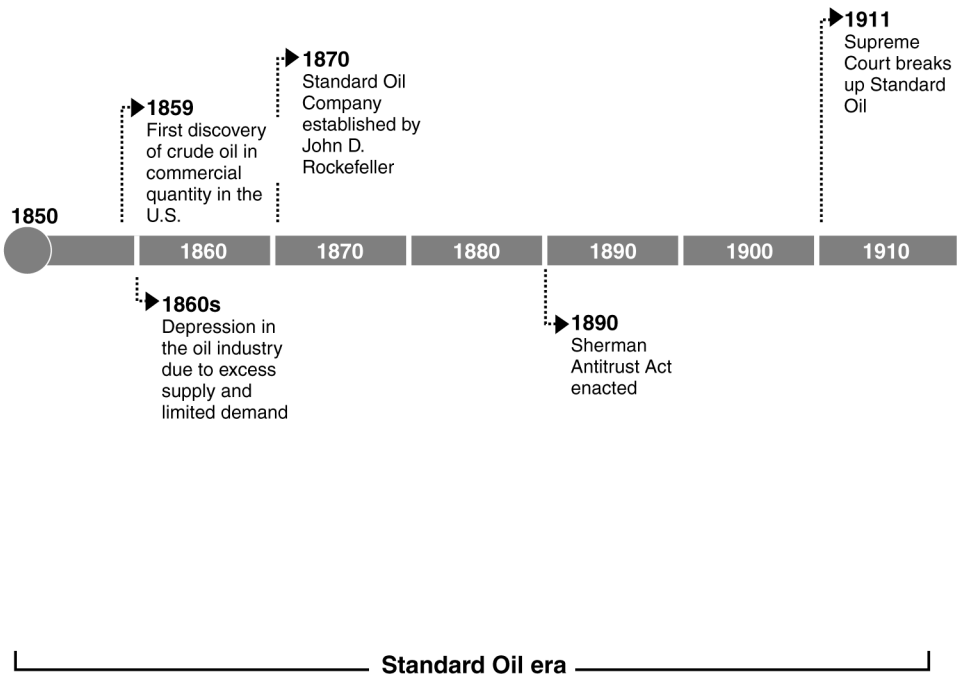
[4]Since January 1, 2002, two of the refining firms—Phillips and Conoco—have merged and another, Equilon, has become part of Shell. Also, four others are joint ventures between two existing refiners that are already counted as separate companies.

gasoline, as shown in figure 1, refiners arrange to move products from the refineries to storage terminals, from which they sell the product to wholesale purchasers. As discussed in detail in chapter 4, there are different classes of wholesale gasoline purchasers in the United States, and the prices they pay depend, in part, on the type of relationship they have with the refiners. From the terminals, gasoline is distributed to retail stations for sale to final consumers.

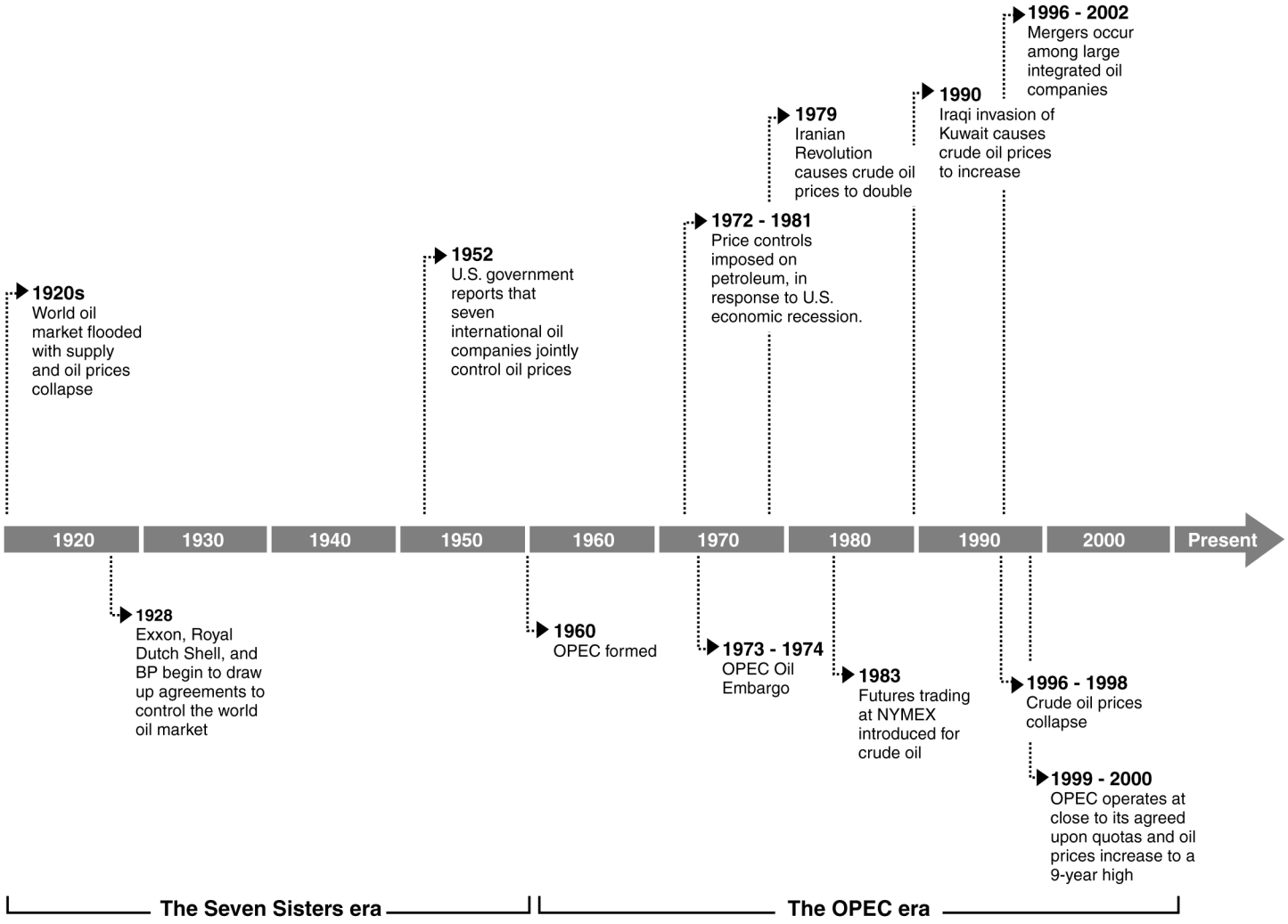
Different Entities Have Historically Exerted Influence over the World Petroleum Market

The world petroleum market, of which the U.S. market is a part, has been characterized by eras when a relatively small number of entities exerted considerable influence on the market. Three entities in particular have significantly influenced the world petroleum market during their eras: (1) Standard Oil, (2) the "Seven Sisters," and (3) the Organization of Petroleum Exporting Countries (OPEC). Figure 3 shows a timeline of the major events that shaped the eras dominated by these entities.

Figure 3: Major Events in the World Petroleum Market



Source: GAO.



The Standard Oil Era

The Standard Oil Company was established in 1870, about a decade after the discovery of crude oil in commercial quantity in the United States, and the company quickly became the dominating force in the emerging U.S. petroleum industry. During the decade prior to the establishment of Standard Oil, the new industry experienced periods of overcapacity in both crude oil production and refining. The industry consisted of numerous

independent producers and refiners. Railroad companies provided transportation services for crude oil and refined products. Thus, the industry tended to be intensely competitive and, by the end of the 1860s, the industry had excess crude oil supply and refinery capacity, resulting in frequent price fluctuations and price collapses.

In response to these conditions, Standard Oil adopted a process of consolidation that would ultimately lead to the virtual monopolization of the industry. Specifically, it employed a combination of tactics that included acquisitions and buyouts of competitors, vertical integration, control of transportation, and below-cost pricing to force competitors out of business. By the time Standard Oil was broken into separate companies in 1911 under the Sherman Antitrust Act, the company was able to effectively determine the purchase price for American crude oil. The breakup of Standard Oil ended its dominance as a single company over the U.S. petroleum market. However, the resulting separate companies began seeking ways to cooperate among themselves and with other foreign oil companies to control the global supply and price of oil.

The "Seven Sisters" Era

During the decades following the breakup of Standard Oil until about 1970, seven oil companies—Exxon, Mobil, Chevron, Gulf, Texaco, Royal Dutch/Shell, and British Petroleum (BP)—dominated and controlled the global network for supplying, pricing, and marketing crude oil. Because of their close association and multiple joint ventures, these companies ultimately became known as the "Seven Sisters." The strategies the companies employed to control the world petroleum market sometimes included cooperation and collusion among themselves. For example, as a surge of oil supply from the United States and other countries flooded the world market in the 1920s, the ensuing competition between some of the companies for market share precipitated collapsing oil prices and threatened the security of their markets. In response, Exxon, Royal Dutch Shell, and BP met to draw up a series of agreements in the late 1920s and 1930s to curb what they viewed as "ruinous competition" in the market. The overall thrust of the agreements was to allocate market shares or quotas; fix prices; and eliminate, through acquisitions and other means, the potential competitive impact of other oil companies outside their group, namely the independent producers and refiners.

Although by the 1960s the Seven Sisters had lost some ground in the world petroleum market—especially in the United States where the role of the independents continued to increase—as late as 1972, the seven companies

were still producing 91 percent of the Middle East's crude oil and 77 percent of the supply outside the United States and the former Soviet Union. By the 1960s and 1970s, the United States had become a substantial net importer of oil.

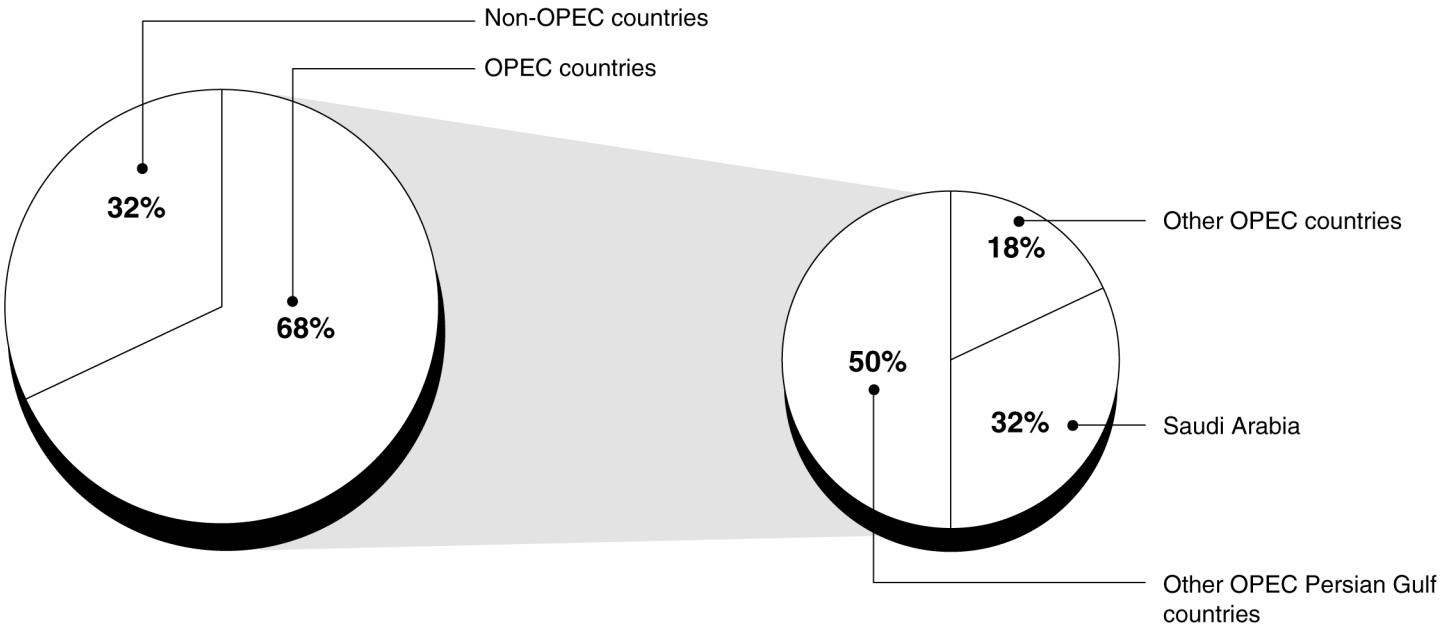
The OPEC Era

OPEC was formed in 1960 after members of the Seven Sisters unilaterally cut the posted price of Middle Eastern crude oil—upon which they paid taxes and royalties to the producing nations—without consulting the producing nations. The founding members of OPEC were Saudi Arabia, Iraq, Iran, Kuwait, and Venezuela. Over time, the organization's membership grew to 13, with the addition of the United Arab Emirates, Nigeria, Libya, Qatar, Algeria, Indonesia, Ecuador, and Gabon.[5] The aim of the organization was to create an entity through which member countries could jointly confront the Seven Sisters over the control of their oil. The group had little or no influence on the world oil market during its first 10 years, partly because the international oil companies, not OPEC member countries, owned and controlled oil reserves in those countries in the 1960s. OPEC also lacked sufficient cohesion among its members to effectively challenge the influence of the Seven Sisters. Since the 1970s, however, OPEC has been a dominant force in the world oil market. OPEC became a major influence in 1973 when it orchestrated a nearly fourfold price increase in a matter of months through an oil embargo by its Arab members against the United States and other countries friendly to Israel. Two other major oil price episodes resulting from events in OPEC member countries also occurred. In 1979 the Iranian revolution caused the doubling of crude oil prices from about $14 a barrel to $34 a barrel, and in 1990 the Iraqi invasion of Kuwait caused an immediate increase in the crude oil price from about $16 a barrel to about $28 barrel.

As a group, OPEC holds the world's largest and lowest-cost reserves of crude oil. As figure 4 shows, OPEC countries accounted for over two-thirds of the world's estimated conventional reserves of about 1 trillion barrels in 2001 (the latest available data). Persian Gulf OPEC countries had by far the largest reserves, with Saudi Arabia alone accounting for over one-fourth of world reserves. In contrast, the United States contained an estimated 2 percent of world reserves.

[5]The latter three are no longer members.

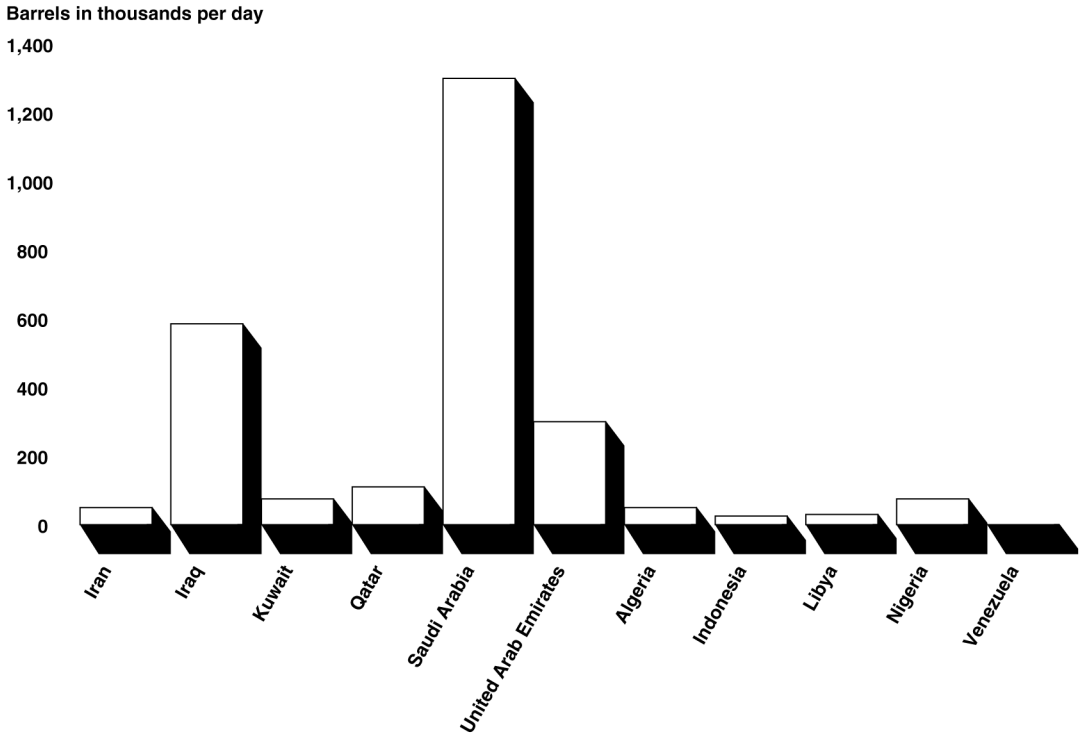
Figure 4: Shares of the World's Conventional Crude Oil Reserves (February 2003)



Source: GAO analysis of EIA data.

Moreover, as shown in figure 5, OPEC countries, especially Saudi Arabia, also hold most of the world's excess production capacity, which means they are the only countries in a position to increase production relatively quickly if there is a supply shortage in the world oil market. These conditions give OPEC countries considerable flexibility to influence world oil prices.

Figure 5: World's Estimated Excess Production Capacity (February 2003)



Source: GAO analysis of EIA data.

During the 1980s, OPEC nations abandoned their strategy of setting "official" prices for their crude oil, but the individual and/or collective actions of the organization's member countries can still have a significant impact on world oil prices. OPEC now establishes a "target" price during its biannual meetings. To achieve this price, OPEC sets an aggregate production level, or quota, based on the organization's determination of the demand for its oil. OPEC then allocates voluntary production quotas among its members, primarily based on the size of each member's oil reserves and other negotiated factors. Whether or not the target price is achieved depends on the discipline exercised in producing oil, as well as the actual demand for oil and non-OPEC countries' production levels. If, by adjusting its production, OPEC keeps the world's oil supply relatively tight with respect to demand, the average world price will likely be close to the target price range.

FTC and DOJ Review Proposed Mergers to Preserve Market Competition

While crude oil prices are determined by global market forces and particularly by OPEC countries' actions, the prices of gasoline and other petroleum products are generally influenced by, among other things, the extent of domestic market competition. Thus, U.S. antitrust laws, which are enforced by the Federal Trade Commission (FTC) and the Department of Justice (DOJ), prohibit mergers and other activities that may be anticompetitive. As part of their responsibility for enforcing the antitrust laws, FTC and DOJ review proposed mergers to ensure they would not be anticompetitive. Under the Hart-Scott-Rodino Act of 1976,[6] as amended, companies contemplating a merger valued at $15 million or more ($50 million or more from February 1, 2001) and meeting certain other conditions must formally notify these agencies. There is then a 30-day waiting period to allow FTC or DOJ to review the proposed merger to determine its potential effect on competition.[7] If the review does not indicate a need for further investigation, the merger can be consummated at the end of the waiting period or earlier if the parties request early termination of the waiting period and the request is granted.[8] According to an FTC official, FTC generally handles mergers in the petroleum industry because of its expertise in the area.

The agencies will challenge a merger if it may substantially lessen competition or tend to create or enhance market power or to facilitate its exercise. Guidelines issued jointly by DOJ and FTC in 1992 outline how the agencies generally analyze proposed horizontal mergers and indicate when the government is likely to challenge a merger.[9] For a recent GAO report, FTC staff told us that the majority of mergers that raise antitrust concerns are horizontal mergers (mergers between firms operating in the same

[6]15 U.S.C. 18a, as amended.

[7]Fifteen days for cash tender offers and bankruptcy filings.

[8]If the review indicates a need for further investigations, a second request may be issued to the merging parties for an additional waiting period of 30 days (20 days prior to February 1, 2001, and 10 days for cash tender offers).

[9]Federal Trade Commission and Department of Justice, *1992 Horizontal Merger Guidelines (*with April 8, 1997, Revisions to Section 4 on Efficiencies), http://www.ftc.gov/bc/docs/horizmer.htm. The guidelines were originally developed by DOJ in 1968 and updated in 1982 and 1984 prior to joint FTC and DOJ issuance in 1992.

market).[10] The guidelines indicate that horizontal mergers should not be permitted to create, enhance or facilitate the exercise of market power, which is the ability of one or more firms to profitably maintain prices above competitive levels for a significant period of time.

In reviewing proposed horizontal mergers, FTC first examines market concentration—a function of the number of firms in a market and their respective market shares. Other things being equal, market concentration affects the likelihood that one company, or a small group of firms, could successfully exercise market power. The merger guidelines identify the Herfindahl-Hirshman Index (HHI) as the measure used in evaluating market concentration. The HHI reflects the composition of a market while giving proportionately greater weight to the market shares of the larger firms.[11] The higher the HHI, the greater the market concentration. According to the guidelines, a merger will generally not be challenged in a market where HHI after the proposed merger would be

- less than 1,000 points (an unconcentrated market);
- 1,000 to 1,800 points (a moderately concentrated market), and the HHI would be increased by less than 100 points by the merger; or
- over 1,800 points (a highly concentrated market), and the merger would increase it by less than 50 points.

Mergers that would increase the concentration above these levels will be examined further by the agency. Other factors that affect market competitiveness, such as barriers to entry into a market, are also considered in deciding whether to challenge a proposed merger. (See chapter three of this report for further discussion of these factors and HHI).

If FTC determines that a merger has potential anticompetitive effects, it can litigate to block the merger; negotiate a settlement to resolve

[10]*Federal Trade Commission: Study Needed to Assess the Effects of Recent Divestures on Competition in Retail Markets* (GAO-02-793, September 25, 2002).

[11]To calculate the HHI, FTC must define the relevant product market and geographic market likely to be affected by the proposed merger. HHI is equal to the sum of the squares of the market shares of each firm in the market. Thus, a market consisting of four firms, each with a 25 percent share, would have an HHI of 2,500. The measure ranges between 0 and 10,000.

anticompetitive aspects of the merger while allowing the transaction to go forward; or develop a consent arrangement that allows the merger to proceed but requires divestiture of assets to remedy the decrease in competition that would otherwise result. FTC has required divestiture of assets in some of the mergers in the petroleum industry since the 1990s. For example, FTC required that Exxon divest all its retail stations from New York to New England and that Mobil divest all its retail stations from New Jersey to Virginia as a condition for the merger between the two companies. Tosco acquired these stations.

Objectives, Scope, and Methodology

As requested by the Ranking Minority Member, Permanent Subcommittee on Investigations of the Senate Committee on Governmental Affairs, this report examines the impact of mergers on the U.S. petroleum industry. It includes an econometric modeling of the effects of mergers and market concentration on U.S. wholesale gasoline markets. Specifically, the report examines

- mergers in the U.S. petroleum industry from the 1990s through 2000 and why they occurred,
- the extent to which market concentration and other aspects of market structure in the petroleum industry have changed since the 1990s as a result of mergers,
- the major changes that have occurred in U.S. gasoline marketing since the 1990s, and
- the effect of mergers and market concentration in the U.S. petroleum industry on U.S. gasoline prices at the wholesale level.

To examine mergers in the U.S. petroleum industry in the 1990s and why they occurred, we analyzed a large body of data on petroleum industry merger transactions that occurred in the United States from the 1990s through 2000. We purchased data on mergers that occurred in all segments of the U.S. petroleum industry from 1990 through 2000 from John S. Herold, Inc., and Thompson Financial. We also obtained information from EIA on some of the industry's mergers since the 1990s. In addition, we interviewed officials from these entities. We also interviewed petroleum industry officials, including those whose firms were involved in mergers, and experts to obtain their views on the reasons for the mergers and reviewed relevant economic literature and FTC documents.

To assess the extent to which market concentration and other aspects of market structure have changed since the 1990s as a result of mergers, we obtained data on petroleum industry market shares from the *Oil and Gas Journal* (OGJ) and EIA. We also used the merger data from John S. Herold, Inc., and Thomson Financial. Using these data, we calculated and analyzed changes in the HHI—a measure of market concentration—for the various segments of the industry and, as necessary, for the relevant geographic markets, from the 1990s through 2000 or 2001, where data availability allowed.[12] We also calculated correlation coefficients, where data availability permitted, to determine the extent to which changes in market concentration were statistically correlated with mergers. Because empirical data on other aspects of market structure--essentially vertical integration and barriers to entry—are usually not available, particularly at the broad levels that our study examined, we relied instead on an extensive body of relevant economic literature. Economic research on market structure is abundant and well developed, although it has rarely been applied specifically to the petroleum industry. We also interviewed oil industry officials and experts to obtain their views.

To determine what major changes have occurred in U.S. gasoline marketing since the 1990s, we analyzed EIA's data on gasoline marketing, reviewed relevant studies and documents from EIA and industry sources, and interviewed petroleum industry officials and experts and EIA officials.

To examine how mergers and market concentration have affected U.S. gasoline prices at the wholesale level, we developed econometric models that examined the effect of mergers and of market concentration on U.S. wholesale gasoline markets from 1994 through 2000. We chose 1994 as the initial year of our analysis because the market concentration (HHI) data on wholesale gasoline provided by EIA were available from 1994. Also, the Oil Price Information Service (OPIS), the company from whom we purchased the wholesale gasoline price data, informed us that it had more comprehensive data on U.S. wholesale gasoline prices starting in the second half of the 1990s than earlier. We developed two groups of econometric models:

[12]Because of concerns about confidentiality of individual company data at the wholesale level, EIA could not provide us with the market share data for individual wholesale gasoline suppliers. Instead, the agency calculated the HHIs and concentration ratios for us.

- one to estimate the impact of selected individual mergers on the wholesale gasoline price (measured in this report as wholesale gasoline price minus crude oil cost) in affected terminal markets and

- another to estimate the impact of market concentration, which essentially captures the cumulative effects of all the mergers in the U.S. wholesale petroleum industry during the 1990s as well as the effects of other changes in the structure of U.S. wholesale gasoline markets on wholesale gasoline prices in different U.S. geographic regions.

In doing so, we isolated the effects of mergers and market concentration from several other factors that could influence wholesale gasoline prices, such as crude oil costs, gasoline inventories relative to demand, refinery capacity utilization rates, and gasoline supply disruptions. We also differentiated among fuel formulations in our analyses. Retail gasoline prices that consumers ultimately pay may be affected by many other factors that vary from location to location, including, among other things, taxes, land values, zoning regulations, and competition at the retail level. We did not examine the effects of such factors because this study focuses on wholesale gasoline prices.

We provided a detailed draft outline of our econometric methodology, including a description of the types and sources of data we used, to a cross section of experts in academia, industry, and government for peer review and comment. We discussed extensively our econometric methodology, including data requirements, with the staff of FTC's Bureau of Economics. We requested comments from the American Petroleum Institute (API) on our econometric methodology, but they did not provide any comments. We also provided the same draft outline and our estimated results and interpretations to our consultant/peer reviewer, Dr. Severin Borenstein, E.T. Grether Professor of Business Administration and Public Policy and Director of the California Energy Institute at the University of California, Berkeley, for review and comment. See appendix II for a list of expert peer reviewers. Based on comments from and discussions with these experts and this consultant, we revised our models and interpretations as appropriate. Also, we interviewed industry officials and representatives involved in all aspects of the petroleum industry and in all major U.S. regions, oil industry experts, and officials from relevant federal and state agencies. In addition, we reviewed numerous economic studies on gasoline markets and pricing, including the few studies that have modeled the impact of mergers on gasoline markets; several textbooks on econometrics and industrial organization; and econometric studies of the impact of

mergers and market concentration on other industries. Appendix IV contains details on our models' methodology, types and sources of data we used, and our econometric analysis.

Although in building our models we drew substantial insight from existing models, our models differ from most previous ones in three principal ways. First, to our knowledge, our study is the first to model the impact of the petroleum industry's merger wave in the 1990s on the wholesale gasoline prices for the entire United States, while isolating the effects of major boutique fuels and unique geographic markets as well as the effects of specific (individual) mergers, including some of the largest in the industry's history. Doing so required us to acquire large and expensive data and make complex computations. Second, we studied the behavior of wholesale prices because this allows us to capture the net effect of any potential market power and efficiency gains from mergers and market concentration. Third, we included the effects of refinery capacity utilization rates and of gasoline inventories, whereas other studies have either omitted these variables entirely or included only one.

Most of the data used for our econometric analysis of the impact of mergers and market concentration on wholesale prices were purchased from OPIS, a company that collects and sells oil industry information to oil companies and other entities. We also obtained data from EIA and the Department of Commerce's Bureau of the Census.

This report did not assess the appropriateness of FTC's review or the actions they took regarding mergers in the petroleum industry. However, we obtained detailed comments from FTC staff and commissioners and EIA staff on our modeling approach and revised our models and report where appropriate.

We conducted our review between June 2001 and April 2004 in accordance with generally accepted government auditing standards.

All Segments of the Petroleum Industry Experienced Mergers for Several Reasons

During the 1990s, mergers occurred in all segments of the U.S. petroleum industry, but the upstream segment had the most mergers. The majority of the mergers—especially mergers among large firms—occurred in the second half of the decade. According to petroleum industry officials, mergers occurred in the petroleum industry for several reasons mostly related to the firms' desire to maximize profits through efficiency gains and cost savings. In addition to these reasons, economic literature also indicates that firms' desire to enhance their market power is a motive for mergers.

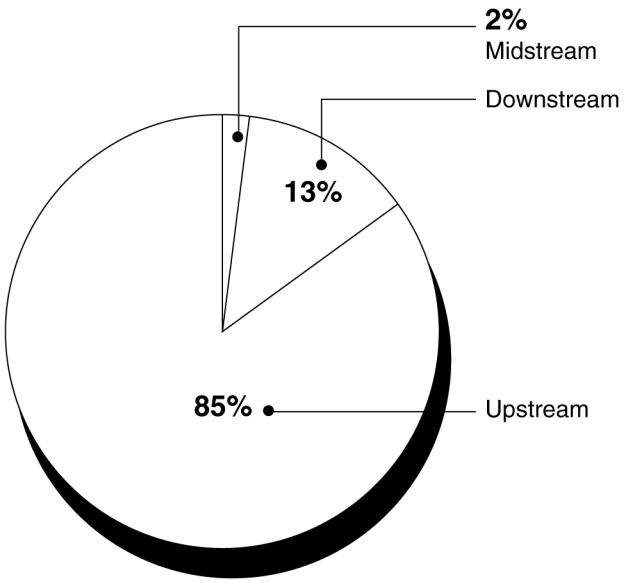
Mergers Occurred in All Three Segments, but Most Frequently in the Upstream

A total of over 2,600 merger transactions occurred in the U.S. petroleum industry from 1991 through 2000.[1] As shown in figure 6, the upstream segment accounted for almost 85 percent of these mergers. About 13 percent of the mergers occurred in the downstream segment. The midstream segment, specifically pipelines—a key infrastructure for moving crude oil and petroleum products—accounted for about 2 percent of the mergers.[2]

[1]John S. Herold, Inc., data were available starting in 1991. A company official told us that to the best of his knowledge, the data includes all known merger transactions during this time period.

[2]Midstream assets can include trucks, tankers, and pipelines, but for the purpose of this report, it only includes pipelines, which constitute the bulk of petroleum transportation.

Figure 6: Percentage of Mergers That Occurred in Each Segment of the Petroleum Industry (1991-2000)

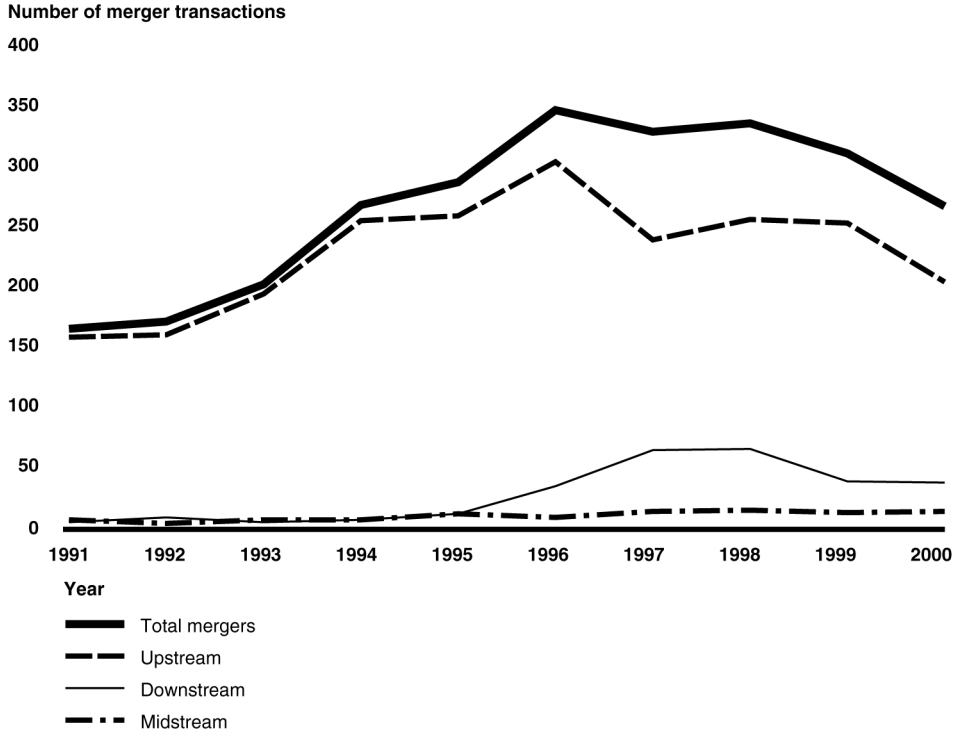


Source: GAO analysis of John S. Herold, Inc., data.

Note: When a merger involved the acquisition of assets simultaneously in each segment, it was counted in the segment with the largest monetary value.

As shown in figure 7, mergers in all segments occurred more frequently in the mid- to late 1990s than in the early 1990s. Some of the mergers involving vertically integrated oil companies and large independent refiners occurred during this time (see figure 8).[3]

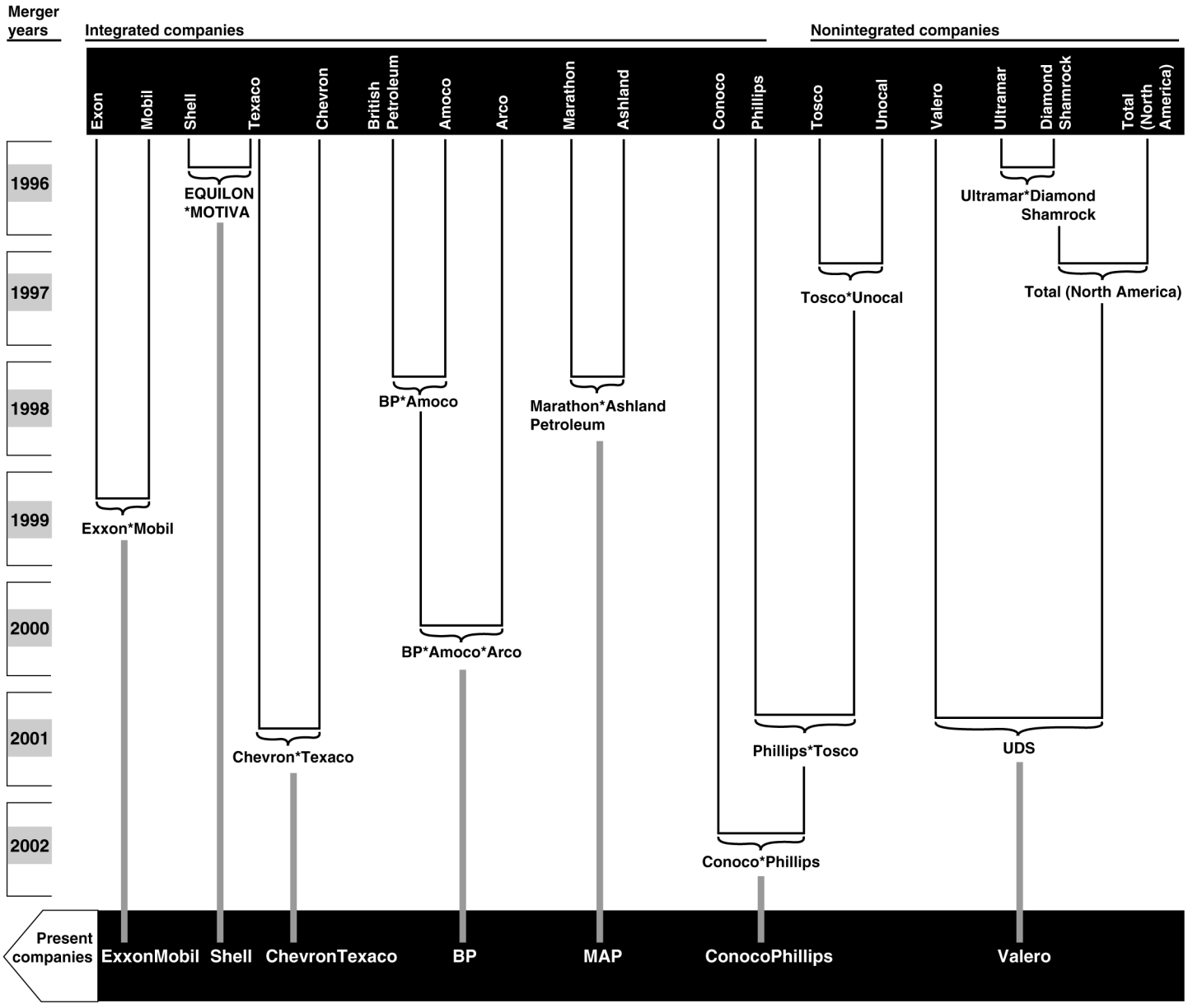
Figure 7: Petroleum Industry Merger Trends (1991-2000)



Source: GAO analysis of John S. Herold, Inc., data.

[3]The mergers depicted in figure 8 involved firms in which one or both belonged to EIA's Financial Reporting System (FRS) companies at the time of the merger or became an FRS company after the merger occurred. FRS companies are U.S.-based major energy producers that report financial statistics to the EIA used by the agency to prepare its annual *Performance Profiles of Major Energy Producers.* According to EIA, as of 2002, criteria for selecting FRS companies include a company that accounts for (1) at least 1 percent of U.S. crude oil or natural gas liquids reserves or production, (2) at least 1 percent of U.S. natural gas reserves or production, or (3) at least 1 percent of U.S. crude oil distillation capacity.

Figure 8: Selected Major Petroleum Mergers (1996–2002)



Source: GAO.

Mergers that occurred in the petroleum industry in the 1990s were categorized into two broad transaction types: corporate mergers and asset

mergers.[4] About 20 percent of the mergers that occurred in the U.S. petroleum industry were corporate mergers, which generally involve the acquisition of a company's total assets by another so that the two become one company.[5] Most of the mergers depicted in figure 8, such as Exxon-Mobil, BP-Amoco, Chevron-Texaco, and Valero-UDS, were corporate mergers.

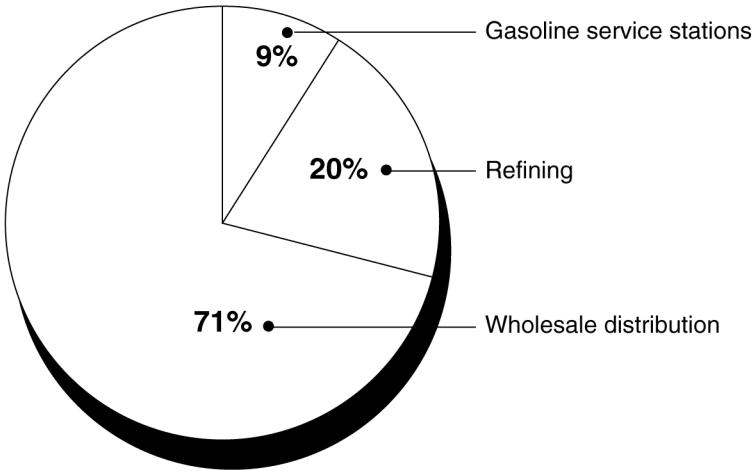
The majority of the mergers (about 80 percent) were asset mergers, which involved one company's purchase of only a segment or asset of another company, such as Williams' purchase of three storage and distribution terminals from Amerada Hess in 1999 and Tosco's acquisition of Unocal's refining and marketing assets on the West Coast. Similarly, the majority of the mergers that occurred in each of the segments were asset mergers. In the upstream, about 85 percent of the merger transactions were asset mergers, involving the acquisition of oil and/or gas reserves.[6] In the downstream segment, about 54 percent were asset mergers, where one or more downstream assets—such as refining or gasoline service station assets—were purchased. As figure 9 shows, 71 percent of all mergers in the downstream segment involved the acquisition of wholesale distribution assets.

[4]Both types of mergers could have implications for the industry's market structure because they both could affect horizontal market concentration and/or vertical integration. Chapter 3 of this report examines mergers and market structure in more detail.

[5]As indicated in chapter 1, the FTC may require one or both merging firms to divest some assets to a third party as an anticompetitive remedy.

[6]According to John. S. Herold officials, mergers among the large fully integrated oil companies, such as the Exxon-Mobil and the BP-Amoco mergers, were typically counted only in the upstream segment, although these mergers also involved downstream assets.

Figure 9: Percentage of Merger Transactions within the Downstream Segment by Type of Key Assets Acquired



Source: GAO analysis of John S. Herold, Inc., data.

Note: According to the data from John S. Herold, Inc., the wholesale marketing category presented here includes both those establishments engaged in wholesale gasoline marketing and those engaged in the storage and/or wholesale distribution of crude petroleum, other petroleum products, and natural gas (including liquid petroleum gas).

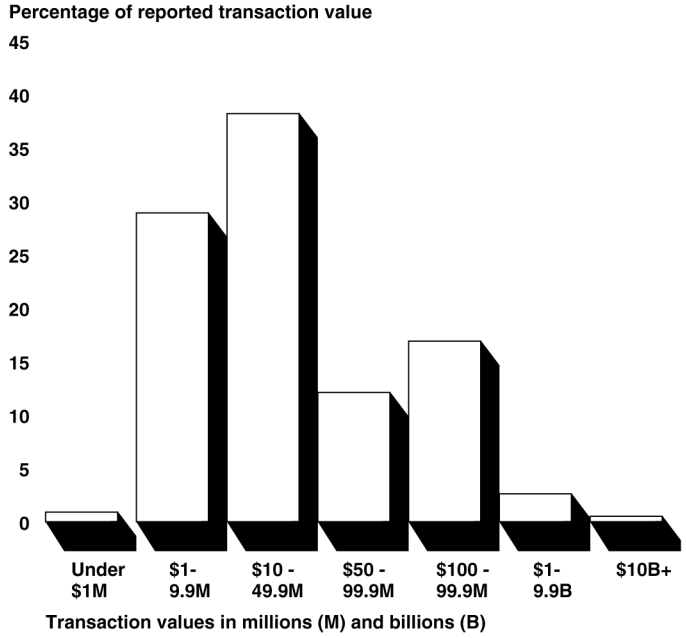
As shown earlier, mergers involving transportation assets in the midstream segment accounted for a small percentage of the total merger transactions in the industry. About 65 percent of the midstream merger transactions were asset mergers.

The mergers varied widely in terms of transaction values, but the highest value mergers were corporate mergers. Our merger data included transaction values for about 57 percent of the mergers, and those values ranged from less than $1 million to over $10 billion. As indicated in chapter 1, under the Hart-Scott-Rodino Act, firms contemplating mergers with a transaction valued at $50 million or more are required to provide information to FTC and the Department of Justice and to observe a waiting period before completing the transaction while it is reviewed for potential anticompetitive effects. FTC reviews required some petroleum companies that merged to divest assets to remedy potential anticompetitive effects.

As figure 10 shows, the majority of the reported transaction values were below $50 million, and over 89 percent of these mergers were asset transactions. Of the mergers with reported transactions values, about 32

percent of them exceeded $50 million, and about 3 percent were over $1 billion. The latter accounted for over 83 percent of the total dollar value reported for all petroleum mergers during the past decade.

Figure 10: Range of Reported Merger Transaction Values (1991-2000)



Source: GAO analysis of John S. Herold, Inc., data.

Several Reasons Were Cited for Mergers in the Petroleum Industry

Petroleum industry officials and experts that we spoke with cited a number of reasons for the wave of mergers in the industry in the 1990s. These reasons generally related to the need for increased efficiency and cost savings to ultimately maximize profits. Specifically, as discussed below, the officials and experts said that mergers were motivated by the firms' desire to achieve synergies, diversify their assets, reduce costs, enhance stock values, and respond to price volatility.[7] However, economic literature also

[7]The desire to enhance stock values, like maximizing profits, is an ultimate goal of companies. However, we discuss it since many industry officials cited it as a reason for mergers.

indicates that the desire to enhance and use market power—as a means to help maximize profits—may also have been a motive.

Achieving Synergies

Many oil industry officials indicated that achieving synergies—benefits from the combined strengths of different companies—was an important motivation for some of the mergers in the industry in the 1990s. Firms that engage in different but complementary activities may achieve synergies from mergers because it is more efficient and less costly for one company to perform two related activities than for two specialized firms to perform them separately. Furthermore, economic literature states that mergers can create synergies that improve firms' growth potential by yielding scale economies in production, marketing, research and development, and management, among other things. We found several instances of mergers where company officials cited synergies or complementary activities as a factor for the transactions. These mergers include Marathon Ashland's acquisition of Ultramar Diamond Shamrock's Michigan terminals, jobber networks, convenience stores, and pipelines in 1999; Sunoco's acquisition of crude oil transportation and marketing business assets from Pride Refining in 1999; and Tesoro's acquisition of BP Amoco's West Coast marine fuels operations in 1999.

Diversifying Assets

According to industry officials, the need for firms to diversify their portfolios in order to maintain stable profits played a role in petroleum industry mergers. Officials cited the acquisition of natural gas assets as a reason for mergers. Within the upstream segment, most independent exploration and production firms have both oil and gas in their portfolios because crude oil and natural gas are generally produced jointly. However, in the 1990s, some companies sought to increase their natural gas reserves through acquisition. For example, in 1999, Dominion acquired Remington Energy, Ltd., a natural gas production and exploration company, and increased its natural gas reserves to one trillion cubic feet. For a producer, natural gas could become a cushion during periods of low oil prices, all things being equal, allowing the producer to develop and produce more gas when oil prices are low, and vice versa. Moreover, EIA has reported that natural gas demand is likely to increase in coming years due to its relatively clean-burning qualities in comparison with other fossil fuels.

Within the downstream segment, some independent refiners acquired marketing and retail assets to expand their presence in U.S. retail markets. For example, Tosco's acquisition of Unocal's West Coast refining,

marketing, and transportation assets allowed Tosco to diversify into retail operations on the West Coast.

Reducing Costs

Industry officials said that some mergers occurred as part of efforts to cut costs. Petroleum companies generally view each activity—such as exploration and production, refining, wholesaling, and retailing—as an individual "profit center." As a prudent business practice, petroleum firms assess the performance of each profit center relative to their overall business to determine where they could reduce costs or improve efficiency by acquiring or divesting assets. For example, one industry official said that mergers occurred frequently in the upstream segment partly because it is more cost effective and less risky to buy existing reserve assets than to discover new ones. Industry officials also told us that some firms divested refineries partly because of high operating costs and low returns. For companies acquiring these refineries, it was more cost effective to acquire an existing refinery than to build one, especially given the high cost and stringent environmental requirements for refinery construction in the United States.

Enhancing Stock Values

Some industry officials said that mergers, especially those involving publicly traded companies, were also partly motivated by the need to enhance stock values. The value of a company's common stock depends on investor expectations regarding its future profits. According to one industry official, the technology-fueled stock market boom of the 1990s heightened investor expectations for firms to consistently generate high stock appreciation. Thus, like other so-called old economy sectors, the petroleum industry was under pressure to meet Wall Street's expectations for rapid growth. Mergers were seen as a quick strategy for achieving this growth. Industry officials also believe that companies used mergers as a growth strategy to facilitate access to the capital markets, which seemingly favored bigger companies.

Responding to Price Volatility

Some industry officials believe that the large number of mergers that occurred in the second half of the 1990s may have been related, in part, to increased oil price volatility. According to one industry official, the collapse in crude oil prices, which dropped from $18.46 per barrel in 1996 to $10.87 in 1998, dried up access to capital and made long-term investment difficult, especially for small firms. As a result, some high-cost producers became

financially distressed, making them valuable yet inexpensive takeover targets.

Enhancing Market Power

While many of the reasons that industry officials cited for mergers are broadly consistent with achieving efficiency, economic literature also cites companies' desire to enhance market power as a motive for some mergers.[8] As described in the literature, mergers increase market concentration and could reduce competition, allowing companies to exert greater control over prices. However, while mergers raise concern about potential anticompetitive effects, as stated in the previous chapter, U.S. antitrust laws are intended to mitigate such effects. Chapter 3 of this report examines in more detail the relationship between mergers and market concentration and other aspects of market structure that can affect competition in the U.S. petroleum industry.

[8]According to the *1992 Horizontal Merger Guidelines*, market power is defined as the seller's ability to profitably maintain prices above competitive levels for a significant period of time.

Mergers Contributed to Increases in Market Concentration and Other Changes in Market Structure

Mergers contributed to substantial increases in market concentration—the extent to which a small number of firms controls most of an industry's sales—in the downstream segment of the U.S. petroleum industry, while concentration in the upstream segment changed very little by the end of the 1990s. Within the downstream segment, the increases were most significant in refining and wholesale gasoline markets. The overall impact of mergers is less clear for other aspects of petroleum market structure that also affect competition—in particular, vertical integration (the extent to which the same firms own the various stages of production and marketing of a product) and entry barriers (market conditions that provide established sellers in an industry an advantage over potential entrants). However, anecdotal evidence and economic studies indicate that mergers have affected these aspects as well.

Market Concentration Increased Mostly in the Downstream Segment of the Petroleum Industry During the 1990s

While market concentration in the upstream segment changed very little, the downstream segment of the petroleum industry experienced increases in concentration by the end of the 1990s that were largely associated with mergers during that period.[1] Although mergers also occurred in the midstream segment, we could not determine the extent of midstream concentration during this period.[2]

Analyzing Market Concentration in Relation to Mergers

Increased market concentration can result in greater market power, potentially increasing prices above competitive levels.[3] Economists have posited that the extent of market power in a given market is directly and positively related to the degree of market concentration as measured by the Herfindahl-Hirschman Index (HHI) of that market, other things held

[1]This contrasts with a 1989 study by the FTC that examined mergers in the U.S. petroleum industry from 1971 to 1984 and concluded that mergers had little impact on industry concentration.

[2]We did not determine midstream pipeline market concentration because of data availability issues, complications in pipeline ownership, and difficulties in defining the relevant geographic market. However, FTC officials told us that they are working on concentration issues for oil pipelines.

[3]FTC and DOJ have defined market power for a seller as the ability profitably to maintain prices above competitive levels for a significant period of time.

constant. This index, as discussed earlier, reflects the composition of a market while giving proportionately greater weight to the market shares of the larger firms.[4] On the other hand, increased concentration may also lead to cost savings and efficiency gains, which may be passed on to consumers in lower prices. Ultimately, the impact of higher concentration on prices depends on whether market power or efficiency dominates. (The effects of mergers and market concentration on wholesale gasoline prices are analyzed in chapter 5.)

Economists and federal antitrust agencies have identified mergers as a major factor leading to higher market concentration. For example, in a 1989 study on mergers in the petroleum industry, FTC reported that mergers and acquisitions, as well as other factors, affected changes in concentration in the petroleum industry. DOJ and FTC pay close attention to market concentration when reviewing proposed mergers. In the DOJ/FTC *1992 Horizontal Merger Guidelines*[5] for determining the potential anticompetitive effect of a proposed merger and whether to challenge such a merger, a central analysis is to assess whether the merger would significantly increase market concentration, as measured by the HHI, after defining the relevant geographic and product market. We based our analysis of market concentration in the various segments of the U.S. petroleum industry on the HHI criteria established by the guidelines. These guidelines, previously outlined in chapter 1, are summarized in table 1.

[4]HHI is equal to the sum of the squares of the market shares of each firm in the market. Thus, a market consisting of four firms, each with a 25 percent share of the market, would have an HHI of 2,500. The measure ranges between 0 and 10,000.

[5]FTC and DOJ, 1992 *Horizontal Merger Guidelines*.

Table 1: FTC/DOJ Horizontal Merger Guidelines on the General Standards for Evaluating Postmerger Market Concentration

Postmerger HHI	Degree of market concentration	Change in HHI that would result from the proposed merger	Potential competitive consequences and likely need for further DOJ/FTC analysis
HHI less than 1,000	Unconcentrated	Not applicable	Mergers in this category require no further analysis
HHI between 1,000 and 1,800	Moderately concentrated	HHI increase <100	No further analysis
		HHI increase > 100	Could raise significant competitive concerns, depending on other factors
HHI greater than 1,800	Highly concentrated	HHI increase < 50	No further analysis
		HHI increase > 50	Could raise significant competitive concerns, depending on other factors
		HHI increase > 100	Likely to create or enhance market power or facilitate its exercise

Sources: FTC and DOJ.

As table 1 shows, the guidelines establish market concentration into three broad categories of market concentration as measured by the HHI: an unconcentrated market has an HHI less than 1,000, a moderately concentrated market has an HHI between 1,000 and 1,800, and a highly concentrated market has an HHI over 1,800. Along with the level of HHI, the agencies also consider changes in HHI that would result from a proposed merger. In order to examine market concentration and any changes in the proper market context, the guidelines stipulate that the relevant geographic and product markets be defined on a case-by-case basis. For example, firms selling a given product may compete at the national level—in which case the relevant geographic market is national—while firms selling another product may compete at less than the national level—in which case the relevant geographic market could be regional, statewide, or smaller.

In analyzing market concentration, we based our choice of relevant geographic markets on various criteria, including what FTC officials and industry experts told us. We also based our choice of relevant market on the availability of data.

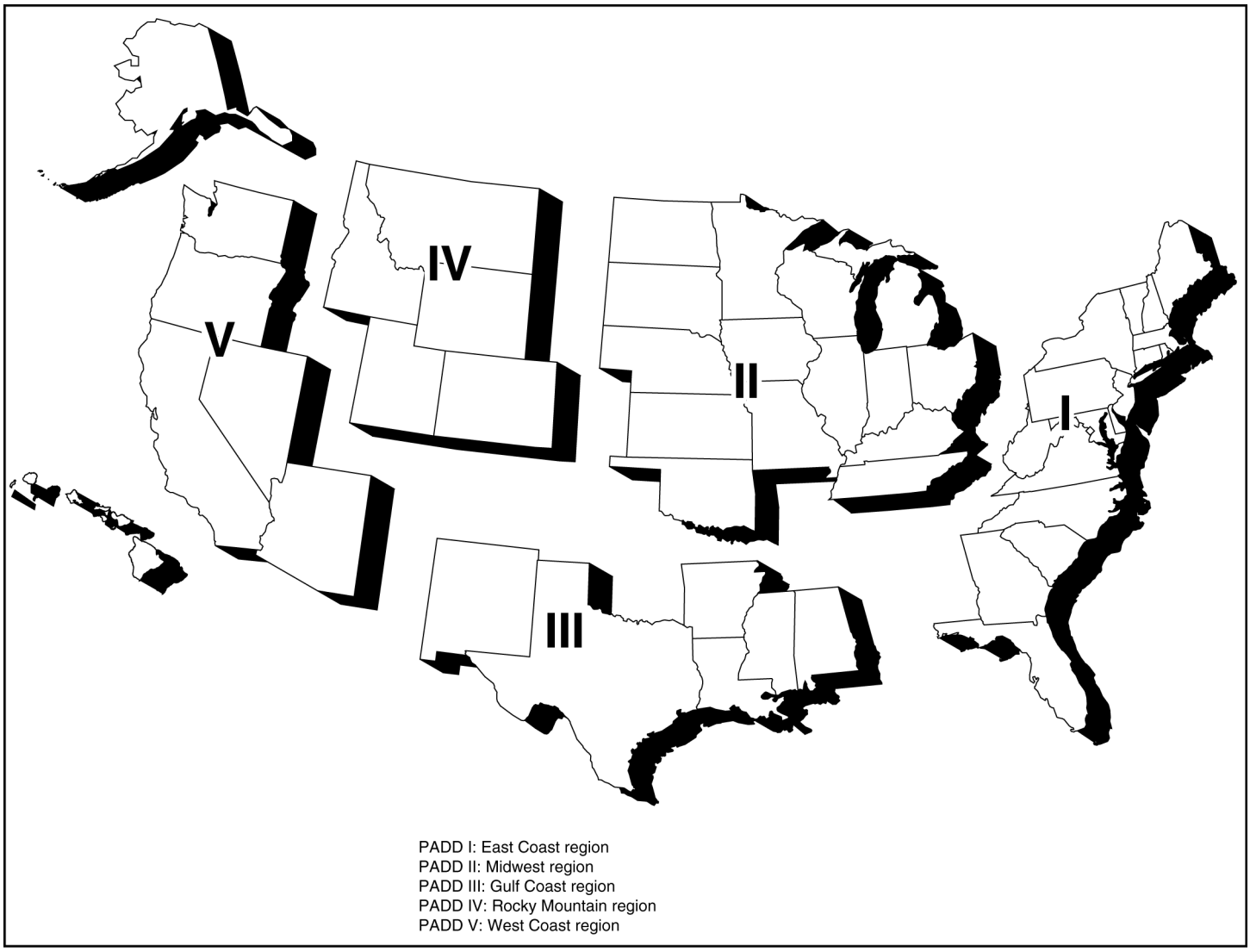
For the U.S. petroleum upstream segment, we analyzed market concentration, as measured by HHI,[6] at the national level. For the downstream segment, we examined market concentration separately for refining and wholesale gasoline marketing, focusing our HHI analyses for refining at the regional (or the Petroleum Administration for Defense Districts or PADD) level and, for wholesale gasoline marketing, at the state level.[7,8] Figure 11 depicts the U.S. PADDs and the states within each PADD.

[6]We used the HHI because it is the most comprehensive measure of market concentration available. Other measures of market concentration include the share of the market controlled by the four or eight largest firms (known as four-firm or eight-firm concentration ratios, CR4 or CR8, respectively).

[7]The Department of Energy (DOE) has divided the United States into five regions known as Petroleum Administration for Defense Districts (PADD). See figure 11 for PADDs and states in each PADD.

[8]We could not analyze concentration at the retail level because there are no comprehensive data at this level.

Figure 11: Petroleum Administration for Defense Districts



Source: EIA.

To determine the extent to which mergers were associated with increased market concentration in the U.S. petroleum industry in the 1990s, we performed statistical correlation analyses. Correlation numbers (or coefficients), which range from –1 to +1, measure the strength and

direction of the relationship between two variables.[9] A positive number denotes a positive and direct relationship, while a negative number denotes a negative or inverse relationship. Overall, the higher the number, the stronger the relationship between the two variables being analyzed. (See appendix III for a more detailed discussion of our correlation analysis). For our analysis, we used as a surrogate for the level of merger activity the average transaction value of all the mergers for which such values were reported.[10] We correlated this value with the HHI for the upstream segment, refining (at the PADD level), and the wholesale gasoline market (at the state level).[11] Other factors besides mergers that can affect market concentration include firms entering and exiting the industry. For example, if a company withdraws from a market and is not replaced by a new company, both the market shares of the remaining firms and concentration would increase.[12]

[9]Correlation coefficients, which range from –1 to +1, are commonly converted into and discussed in terms of percentages.

[10]John S. Herold, Inc., tracks the transaction values of mergers at the time of the offer and bases this value on the seller's assets or the offer from the buyer. We calculated an average value of transactions by dividing the reported total value of yearly transactions by the number of mergers for that year. We adjusted the total yearly value of transactions for inflation using the Producer Price Index for Energy from the 2002 *Economic Report of the President*. While the total transaction value of the mergers reflects both the number and the size of the mergers, the average transaction value primarily captures the size of the mergers. In our correlations, we also used the total transaction value, and the results were similar.

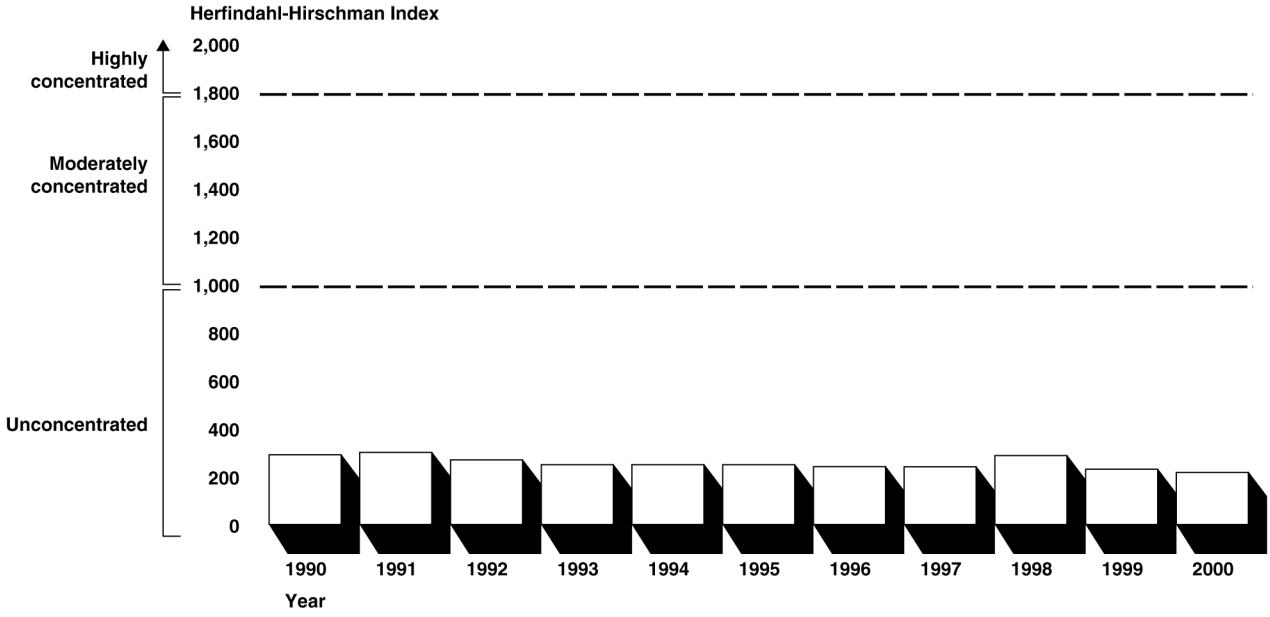
[11]We had some data limitations in performing these correlation analyses. First, transaction values were not reported for all mergers in our merger database. Merger transaction values were reported for about 57 percent of the mergers overall. More importantly, the transaction values were reported for all of the major mergers—i.e., mergers with transaction values exceeding $1 billion. Second, merger transaction values were not separated by segment to allow for the correlation of merger transaction values for each segment or level with the corresponding segment's/level's HHI. Nonetheless, we believe that our correlation analyses provide a broad indication of the potential statistical association between mergers and market concentration. We believe that the use of merger transaction values for the overall industry to estimate the statistical correlation with concentration at the segment or other operating level is reasonable because many of the mergers for which transactions were reported involved vertically integrated oil companies whose mergers could potentially affect concentration throughout the industry spectrum.

[12]While we are aware that other factors—such as entry and exit—may affect concentration, we focus our examination on the linkage between merger activity, as measured by the average yearly transaction values of mergers, and market concentration.

The Upstream Segment Experienced Little Change in Market Concentration and Remained Unconcentrated Over the 1990s

Based on crude oil production activities, concentration in the upstream segment of the U.S. petroleum industry experienced little change over the decade. Specifically, the HHI for the upstream market decreased somewhat from 290 in 1990 to 217 in 2000 (see figure 12). Hence, the upstream segment of the U.S. petroleum industry remained unconcentrated as of the year 2000. Moreover, notwithstanding the level of domestic upstream concentration, industry officials and experts believe that because crude oil prices are generally determined in the world market, individual U.S. companies are not likely to have much influence on the global market.

Figure 12: Market Concentration for the Upstream Segment, as Measured by the HHI (1990-2000)



Source: GAO analysis of *Oil and Gas Journal* production data.

For the upstream market, we did not find a statistically significant correlation between mergers in the 1990s and market concentration, as measured by the HHI, for U.S. crude oil production.

Overall, the Downstream Segment of the Market Became More Concentrated

In general, the downstream segment—consisting of the refining, wholesale, and retail marketing levels—became more concentrated in the 1990s. However, the extent to which concentration increased varied among operating levels and geographic regions.

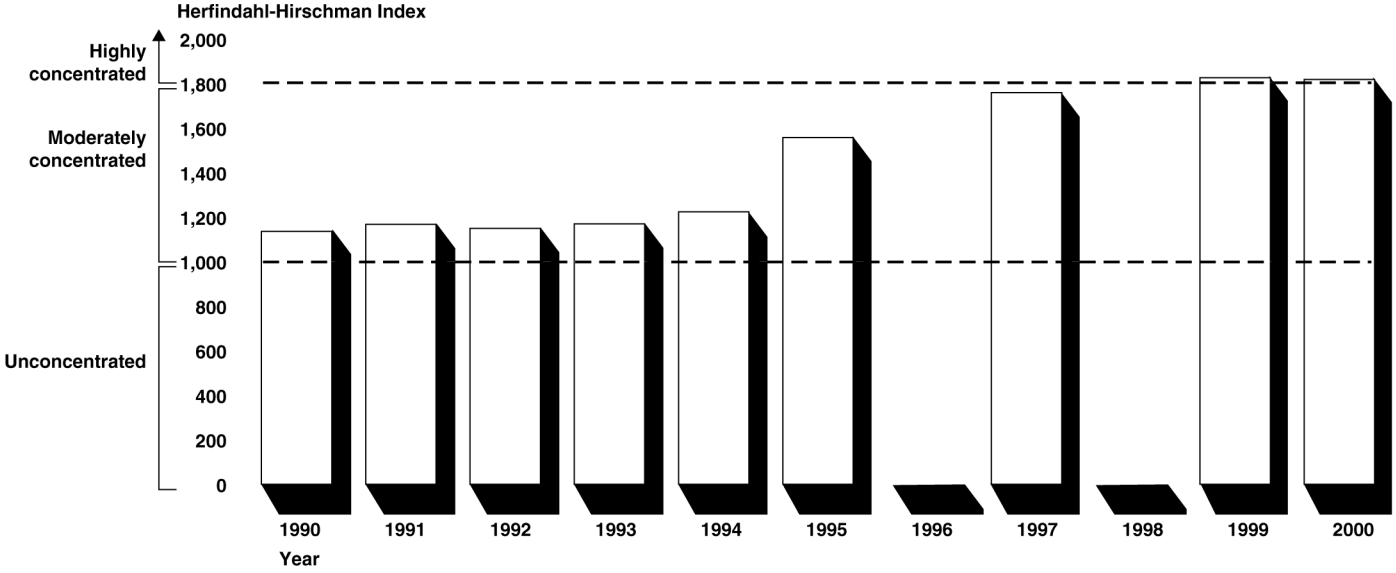
Refining

Overall, the U.S. refining market experienced increasing levels of market concentration (based on refinery capacity) during the 1990s, especially during the latter part of the decade, but the levels as well as the changes of concentration varied geographically.

In PADD I—the East Coast—the HHI for the refining market increased from 1136 in 1990 to 1819 in 2000, an increase of 683 (see figure 13). Consequently, this market went from moderately concentrated to highly concentrated. Compared to other U.S. PADDs, a greater share of the gasoline consumed in PADD I comes from other supply sources—mostly from PADD III and imports—than within the PADD. Consequently, some industry officials and experts believe that the competitive impact of increased refiner concentration within the PADD could be mitigated.[13]

[13]However, if the same PADD I refiners are also mostly responsible for importing gasoline into the PADD, it could have implications for the PADD's wholesale gasoline market concentration. In addition, the extent to which these companies control vital infrastructure, such as terminals and pipelines, within the region could impact competitive conditions.

Figure 13: Refining Market Concentration for PADD I Based on Crude Oil Distillation Capacity (1990-2000)

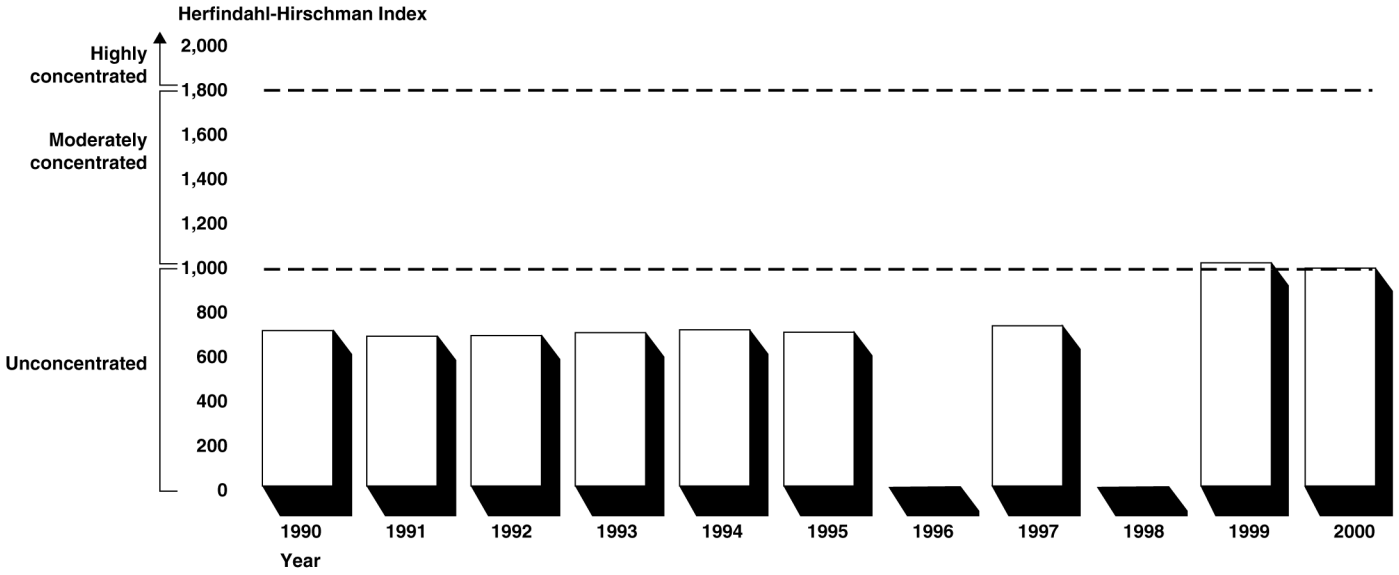


Source: GAO analysis of EIA data.

Note: Data for 1996 and 1998 were unavailable.

For PADD II (the Midwest), the refinery market concentration increased from 699 to 980 —an increase of 281—between 1990 and 2000. However, as figure 14 shows, this PADD's refining market remained unconcentrated at the end of the decade. According to EIA's data, as of 2001, the quantity of gasoline refined in PADD II was slightly less than the quantity consumed within the PADD.

Figure 14: Refining Market Concentration for PADD II Based on Crude Oil Distillation Capacity (1990-2000)

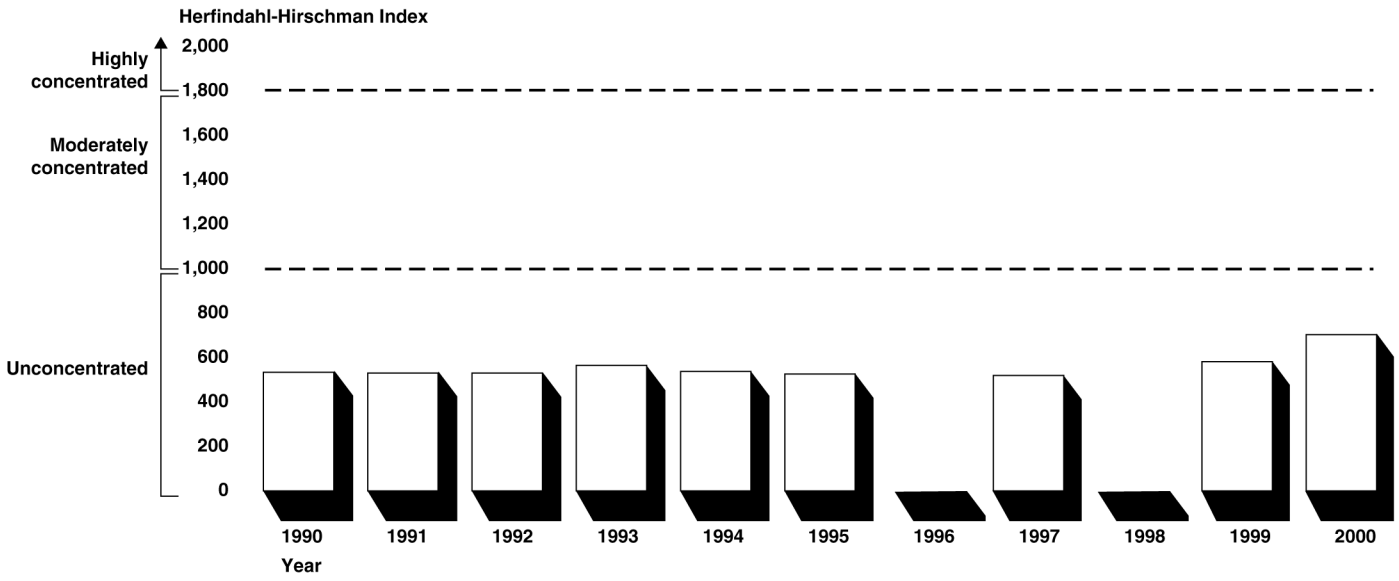


Source: GAO analysis of EIA data.

Note: Data for 1996 and 1998 were unavailable.

The refining market in PADD III (the Gulf Coast), like PADD II, was unconcentrated as of the end of 2000, although its HHI increased by 170—from 534 in 1990 to 704 in 2000 (see figure 15). According to EIA's data, much more gasoline is refined in PADD III than is consumed within the PADD, making PADD III the largest net exporter of gasoline to other parts of the United States.

Figure 15: Refining Market Concentration for PADD III Based on Crude Oil Distillation Capacity (1990-2000)

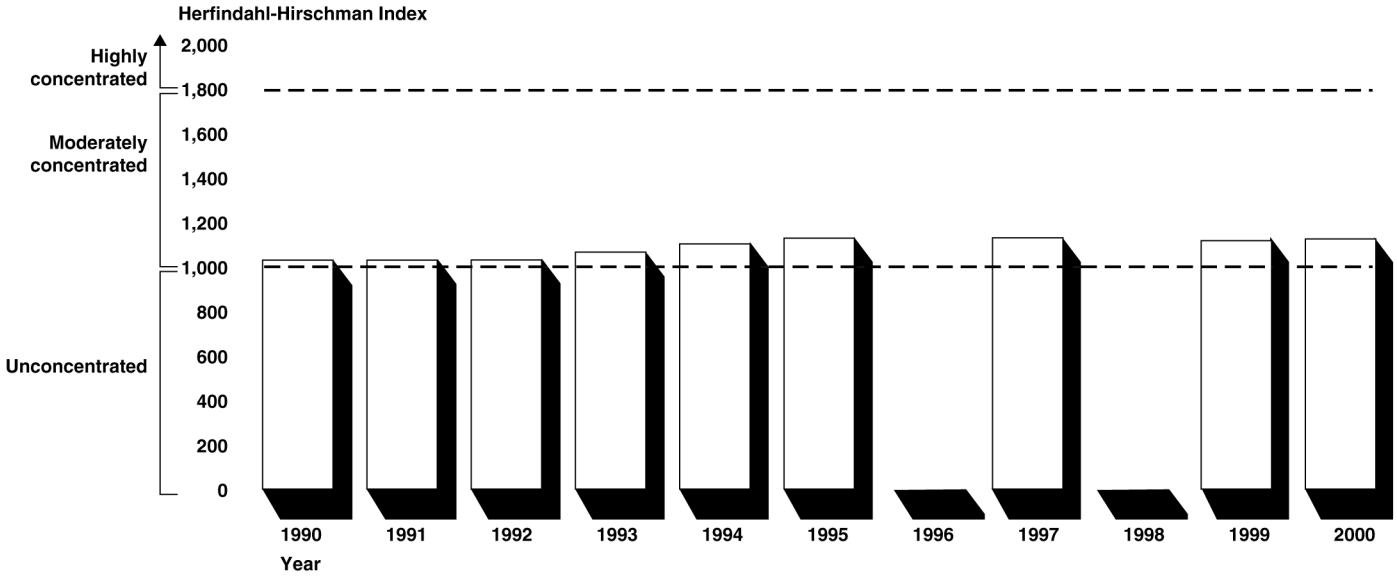


Source: GAO analysis of EIA data.

Note: Data for 1996 and 1998 were unavailable.

The HHI for the refining market in PADD IV—the Rocky Mountain region—where gasoline production and consumption are almost balanced—increased by 95 between 1990 and 2000. This increase changed the PADD's refining market from 1029 in 1990 to 1124 in 2000, within the moderate level of market concentration (see figure 16).

Figure 16: Refining Market Concentration for PADD IV Based on Crude Oil Distillation Capacity (1990-2000)



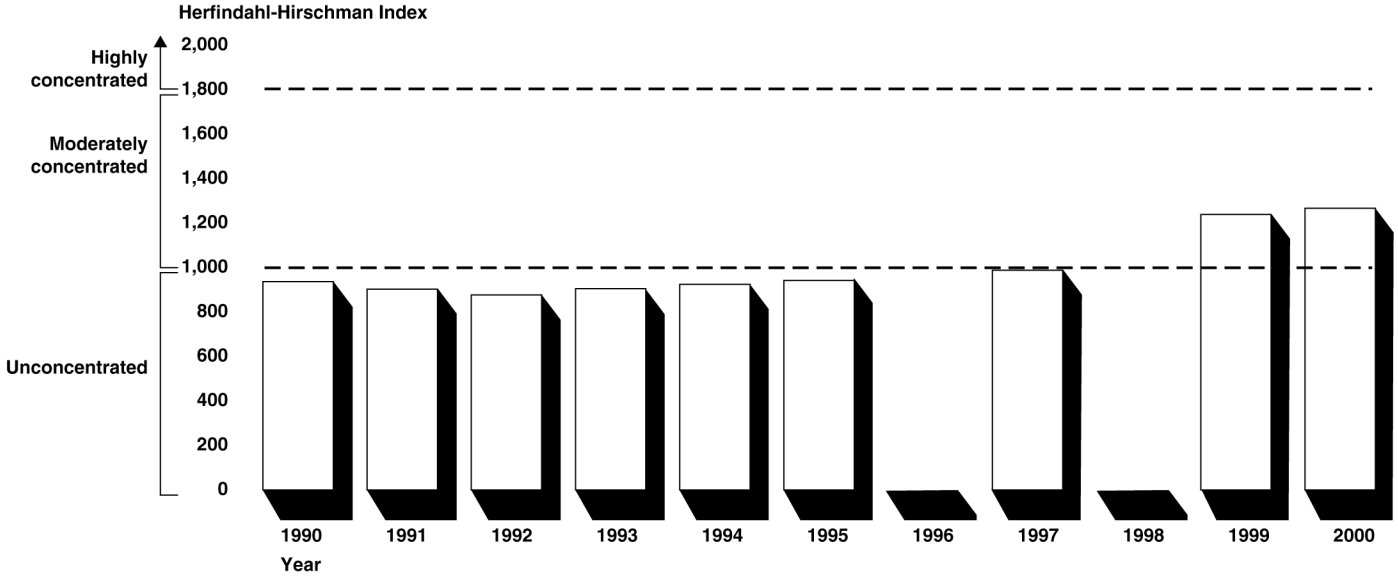
Source: GAO analysis of EIA data.

Note: Data for 1996 and 1998 were unavailable.

The refining market's HHI for PADD V—the West Coast—increased from 937 to 1267, an increase of 330, between 1990 and 2000 and changed the West Coast refining market, which produces most of the gasoline it consumes, from unconcentrated to moderately concentrated by the end of the decade (see figure 17).[14]

[14]Some industry officials and experts believe that the California refining market, which is a part of PADD V, is more concentrated than the PADD as a whole because a unique (CARB) gasoline is consumed in the state and the production of the gasoline is dominated by a few large refiners.

Figure 17: Refining Market Concentration for PADD V Based on Crude Oil Distillation Capacity (1990-2000)



Source: GAO analysis of EIA data.

Note: Data for 1996 and 1998 were unavailable.

We estimated a high and statistically significant degree of correlation between merger activity and the HHIs for refining in PADDs I, II, and V for 1991 through 2000. Specifically, the corresponding correlation numbers are 91 percent for PADD V (West Coast), 93 percent for PADD II (Midwest), and 80 percent for PADD I (East Coast). While mergers were positively correlated with refining HHIs in PADDs III and IV—the Gulf Coast and the Rocky Mountains—the estimated correlations were not statistically significant. (See table 11 in appendix III for correlation coefficients and associated statistics for each of the PADDs.)

Wholesale Gasoline

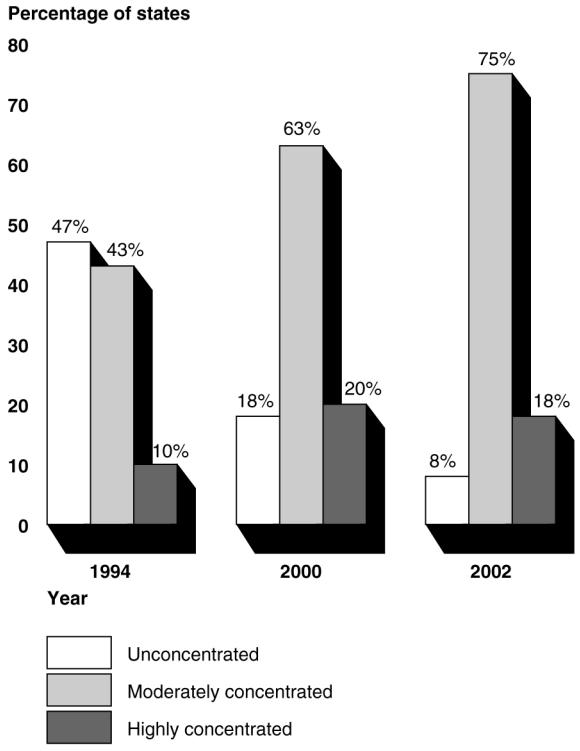
The overall U.S. wholesale gasoline market—measured at the state level[15]—also experienced significant increases in and higher levels of concentration, based on HHI data for wholesale gasoline from 1994 to 2002

[15]Many analysts believe that the relevant market for wholesale gasoline may be defined at the state or possibly the terminal level. Here, we are using states as the definition of the market, even though in some cases this definition may be too large or too small, depending upon the particular geographic market.

that we obtained from the Department of Energy's Energy Information Administration (EIA).[16] We found that all but four states and the District of Columbia experienced increases in wholesale gasoline market concentration between 1994 and 2002. (See table 10, app. III.) Forty-six states and the District of Columbia had moderately or highly concentrated wholesale gasoline markets in 2002, compared to 27 in 1994. For the years 1994, 2000, and 2002, figure 18 illustrates how the percentage of states categorized as unconcentrated has fallen while the percentage of states categorized as moderately to highly concentrated has risen. Specifically, the proportion of states categorized as unconcentrated has decreased from 47 percent to 8 percent, while the percentage of states in the moderate category has risen from 43 percent to 75 percent. The percentage of states in the highly concentrated category has risen from 10 percent to 18 percent.

[16]The state is the smallest geographic level for which EIA computes HHI for wholesale gasoline markets. We performed our analysis at the state level but grouped the states according to their respective PADDs. EIA computed the HHIs for wholesale gasoline for us using data submitted by wholesale gasoline suppliers that the agency calls "prime suppliers." The agency performed the calculation, rather than give us the data to do the calculation, to protect the confidentiality of individual companies.

Figure 18: Percentage of U.S. States with Unconcentrated, Moderately Concentrated, and Highly Concentrated Wholesale Gasoline Markets (1994, 2000, and 2002)



Source: GAO analysis of EIA data.

To determine the degree to which mergers and market concentration in wholesale gasoline were related and how closely they moved together during this period, we performed a correlation analysis for this operating level. We found that mergers, as measured by their transaction values, were significantly and highly positively correlated with market concentration, as measured by the state HHI, for wholesale gasoline. (See table 12, appendix III for the correlation coefficients and associated statistics for individual states.)[17] This was especially the case for states that exhibited high levels of

[17]Our correlations for wholesale gasoline supply were between the lag of the average yearly transaction values of mergers and market concentration, as measured by the state monthly HHIs. This was especially necessary because the HHIs were monthly while the transaction values of mergers were measured on an annual basis. (See appendix III for details.)

concentration or experienced large changes in concentration between 1994 and 2001.

Figure 19 shows a comparison of concentration levels in individual states and the District of Columbia—grouped within PADDs--between 1994 and 2002.

Figure 19: Wholesale Gasoline Market Concentration by State in Each PADD (1994 and 2002)

Source: EIA.

- As can be observed, the wholesale gasoline market in 16 states in PADD I (the East Coast) were moderately concentrated in 2002, compared to 7 states in 1994. Also, in PADD I, the number of states that had unconcentrated wholesale gasoline markets decreased from 10 in 1994 to just 1 in 2002. Some key mergers that affected PADD I during this period include Exxon-Mobil, BP-Amoco, and Shell-Texaco (Motiva).

- In PADD II (the Midwest) the wholesale gasoline markets in 5 states were highly concentrated, 8 were moderately concentrated, and 2 were unconcentrated as of 2002. By comparison, in 1994, there were no highly concentrated markets, 7 states were moderately concentrated, and 8 states were unconcentrated in this PADD. Some key mergers that affected PADD II during the period included Marathon-Ashland, Marathon-Ultramar Diamond Shamrock (UDS), BP-Amoco, Shell-Texaco (Equilon), and UDS-Total.

- The wholesale gasoline market in all the states in PADD III (the Gulf Coast region) except one had become moderately concentrated in 2002, compared to 1994 when all were unconcentrated. Key mergers that affected PADD III during the period include Exxon-Mobil, Shell Texaco (Motiva), Marathon-Ashland, and Valero-UDS.

- For the states included in PADDs IV and V (the Rocky Mountains and the West Coast, respectively), wholesale gasoline markets remained in the moderately or highly concentrated range in 2002 as in 1994. Within this range, concentration levels increased in all but one state in PADD IV and in all but one state in PADD V between 1994 and 2002. Key mergers that affected PADD IV during this period include Shell-Texaco (Equilon), Phillips-Tosco, Conoco-Phillips, and UDS-Total. Key mergers that affected PADD V during the period included Tosco-Unocal, Shell-Texaco (Equilon), Chevron-Texaco, Phillips-Tosco, and Valero-UDS.

Mergers Have Caused Changes in Other Aspects of Market Structure, but the Extent of These Changes Is Not Easily Quantifiable

Evidence from various sources suggests that in addition to market concentration, mergers affected other aspects of market structure—in particular, vertical integration and barriers to entry. The extent to which they did so, however, could not be easily quantified because, in addition to lack of consensus on how to appropriately measure these aspects, there are no comprehensive data on them.

Vertical Integration

Like increased concentration, increased vertical integration, as measured by the extent to which the various stages of production and marketing of a product are owned by the same firms, could conceptually have both procompetitive and anticompetitive effects, with the net effect depending on which effects dominate. One procompetitive view of vertical integration is that it promotes efficiencies and leads to lower prices by allowing a company to lower costs by making transactions that are internal rather than external to the company. On the other hand, a high degree of vertical integration in an industry could be anticompetitive by creating disincentives for new firms to enter a market because of the need to enter at several levels of the market in order to compete effectively. Vertical integration could also allow firms to use a strategy of "market foreclosure" against their non-vertically-integrated rivals by reducing input supply for rivals, raising prices paid by rival retailers, or totally refusing to sell product to rival retailers. Some studies have recently found that increased vertical integration in the U.S. petroleum industry has been associated with higher wholesale gasoline prices.[18]

While our review was not comprehensive, we found that a number of the mergers since the 1990s led to greater vertical integration in the U.S. petroleum industry, especially in the downstream market, as shown in table

[18]Justine Hastings and Richard Gilbert, "Vertical Integration in Gasoline Supply: An Empirical Test of Raising Rivals' Costs," Working Paper Series of the Program on Workable Energy Regulation (POWER), University of California Energy Institute, Berkeley, California, July, 2001. See also, Zava Aydemir and Stefan Buehler, "Estimating Vertical Foreclosure in U.S. Gasoline Supply," Working Paper No. 0212, Socioeconomic Institute, University of Zurich, November 2002. This study specifically found evidence of both market foreclosure and efficiency effects in vertical integration in U.S. refining, but the foreclosure effect dominated the efficiency effect and led to increased wholesale gasoline prices.

2. EIA has also reported that a substantial number of vertical mergers have occurred between independent refiners and marketers in the United States since the 1990s.[19] Table 2 presents some examples of petroleum industry mergers since the mid-1990s that created or enhanced vertical integration.

Table 2: Selected Vertical Mergers in the Petroleum Industry Since the 1990s

Year	Acquiring company	Stage of operation	Company acquired	Stage of operation for assets purchased
1995	Diamond Shamrock	Refining	Stop-N-Go	Gasoline retailing
1996	Tosco	Refining	Circle K	Gasoline retailing
1997	Tosco	Refining	Unocal Corporation	Refining/marketing/ retail
1997	ARCO	Integrated	Thrifty	Gasoline retailing in California
1998	Shell (Joint Venture)	Integrated (with small downstream market share)	Texaco	Integrated (with large downstream market share)
2000	Tosco	Refining	Some of Exxon's and Mobil's East Coast retail gasoline stations	Retail gasoline stations
2001	Phillips	Integrated	Tosco	Refining/marketing/ retail
2001	Valero	Refining	Ultramar Diamond Shamrock	Refining/marketing/retail

Source: GAO.

Typically, firms in the petroleum industry are either fully vertically integrated—operating across the entire industry spectrum from crude production to retail gasoline sales—or partially vertically integrated—operating in more than one but not all stages of the petroleum industry's operation. We included in our analysis mergers that have led to either type of vertical integration. Also, we have included in our analysis mergers that have enhanced the degree of vertical integration in the market—even if the mergers were essentially horizontal—such as the acquisition of an independent refiner by an already partially or fully vertically integrated company. Our analysis of mergers encompassed all these types of vertical integration because they all can affect competition in the market.

[19]U.S. Department of Energy, Energy Information Administration, *The U.S. Petroleum Refining and Gasoline Marketing Industry*, June 1999.

As shown in table 2, many mergers that contributed to increased vertical integration occurred between independents as well as between fully vertically integrated companies and independents.[20] For example, Tosco, a previously independent refiner that had no retail operation, acquired several retail assets on the West Coast, such as Circle K (a retail chain) and Unocal's retail stations and other downstream assets.[21] These acquisitions essentially transformed Tosco into a partially vertically integrated downstream company before Phillips Petroleum, a fully vertically integrated company, acquired it. This acquisition most likely boosted Phillips' downstream position in both refining and wholesale and retail marketing. Also, the acquisition of Thrifty, an independent chain retailer on the West Coast, by ARCO, an integrated company, enhanced the latter's retail position in the West Coast retail market. Likewise, the acquisition of UDS' wholesale gasoline terminals and retail outlets in Michigan by Marathon Ashland Petroleum—a joint venture between Marathon and Ashland, which are both fully vertically integrated oil companies—enhanced Marathon Ashland Petroleum's position in Michigan's wholesale and retail market.

Barriers to Entry

Our interviews with petroleum industry officials and experts provided anecdotal evidence that mergers have had some impact on barriers to entry in the U.S. petroleum industry, but there are generally no empirical data to quantify the extent of the impact. Barriers to entry can be defined as market conditions that provide established sellers in an industry an advantage (typically cost advantage) over potential entrants. Entry barriers are important in a market because of their effect on competitive conditions; theoretically, industries that are highly concentrated and have high entry barriers are more likely to possess market power. Industry officials that we interviewed indicated that large investment capital

[20]However, according to EIA analysts, even though vertical integration may have increased—especially in the downstream segment between refining and marketing—there has been a shift toward divestiture of downstream assets (particularly refineries) by fully vertically integrated oil companies since the 1990s, giving independent refiners opportunities to acquire and grow their refining assets.

[21]These mergers are also documented in Justine Hastings and Richard Gilbert, "Vertical Integration in Gasoline Supply: An Empirical Test of Raising Rivals' Costs," Working Paper Series of the Program on Workable Energy Regulation (POWER), University of California Energy Institute, Berkeley, California, July, 2001. Tosco also acquired some retail assets from Exxon and Mobil on the East Coast. This acquisition was a result of a divesture FTC mandated as a condition for the merger of Exxon and Mobil.

requirements, regulatory impediments/environmental concerns, and public opposition to siting facilities constitute significant entry barriers that may have been exacerbated by mergers.

For example, industry officials told us that in the upstream segment, crude oil exploration and production activities moved increasingly offshore to areas such as the deep waters of the Gulf of Mexico during the 1990s because of the greater likelihood of finding oil. Offshore operations are generally riskier and require much higher capital investments than onshore operations.[22] One official estimated that it could cost a company about $40 million to $100 million just to drill several wells in deep waters and purchase equipment, and some operations could cost as much as $1 billion. As a result, some firms, mostly large producers that already had the wherewithal to engage in offshore activities, merged to further share the risks and costs. These mergers tended to help consolidate their dominance in offshore activities and made it more difficult for smaller firms to enter the market.

For the transportation infrastructure segment—pipelines—the potential barriers to entry include high investment costs and large economies of

[22]The term offshore indicates a portion of open sea and the petroleum exploration and production activities carried out in such areas, while onshore refers to land operations.

scale.[23] Moreover, as noted by one source, procedural requirements and associated legal costs for entry into the pipeline business have limited the number of companies in the segment.[24] Thus, as mergers, and possibly concentration, increased, entry barriers also increased because firms must make large and high-cost investments in order to enter the market and be competitive at large scales of operation.

Like the upstream and midstream segments, the downstream segment of the U.S. petroleum industry is characterized by pervasive barriers to entry, including large capital investment requirements at the refining level, and regulatory and permitting impediments at the refining and wholesale/retail levels. For example, regarding refining, industry officials told us that building a typical refinery or even upgrading an existing one is a multibillion dollar investment. Also, they said that it is extremely difficult to obtain a permit from the relevant state or local authorities to build a new refinery in many parts of the country because of regulatory hurdles and public opposition. In addition, they noted that federal and state environmental regulations to meet clean air requirements have contributed to the high cost of owning and operating a refinery. Furthermore, they pointed out that return on investment in refining has been relatively low compared to investment in other industries. They attributed the failure to build any new refineries in the United States in over 20 years to these factors.

We could not quantify the extent to which mergers may have increased or decreased these barriers because of the lack of empirical data to properly measure entry barriers. Industry officials said that mergers have not caused these barriers. Instead, they opined that some of the mergers and acquisitions in refining have been partly a result of these barriers because merging with or acquiring existing refineries is less expensive than building a new one. During the 1990s, many refiners expanded through mergers and acquisitions as well as through upgrading existing facilities. For example,

[23]Production exhibits economies of scale if average (per unit) costs fall as output increases, and diseconomies of scale if average cost increases as output increases. Scale economies can occur at the level of the individual plant, in which case they generally reflect elements of the production process. Scale economies may be distinguished as technological, reflecting changes in input use as output expands, or pecuniary, reflecting changes in prices paid for inputs as output expands. At the firm level, they may also reflect elements of marketing and distribution costs.

[24]John J. Coyle, Edward J. Bardi, and Robert A. Novack, *Transportation*, 5th Ed., (Mason, Ohio: South-Western College Publishing, 2000).

refiners such as Tosco and Tesoro entered the industry through acquisitions in the early 1990s.

Entry barriers also exist at the wholesale gasoline marketing level of the downstream segment in the form of high investment capital requirements, regulatory/permitting impediments, and infrastructure barriers. For example, a potential entrant into the wholesale gasoline supply market may enter by operating his own refinery and producing gasoline and/or buying from existing domestic refiners or importing gasoline for distribution. As a potential refiner, he faces the entry barriers in refining discussed above. On the other hand, industry officials told us that while it is possible to enter this market as an independent purchaser from domestic refiners and/or importers, there are potential infrastructure impediments to doing so, such as lack of access to pipelines and terminals. They pointed out that although shipping gasoline through a third-party, common carrier pipeline operator such as Kinder Morgan offers an option in some markets, this option may not be available in the particular market that the shipper wants to bring gasoline into. Moreover, to ship gasoline through such a common-carrier pipeline, the shipper must have access to a terminal on that route to receive the product, or the pipeline operator cannot accept such shipment. According to some industry officials, oil companies who own most of the gasoline terminals around the nation sometimes deny access to third-party users, especially when supply is tight. Some industry officials indicated that mergers have exacerbated entry barriers at the wholesale level in some markets because mergers have created a situation in which pipelines and terminals in some markets are owned by fewer, mostly integrated companies who use these facilities mostly proprietarily. In addition, industry officials pointed out that there has been a preference for larger distributors over smaller distributors in the market. For example, wholesale marketers or distributors need to be large enough to secure credit lines to make large volume purchases or minimum volume requirements set by refiners. Also, in some markets, such as California, boutique fuel specifications to meet clean air requirements limit the ability of potential independent wholesalers to enter the market because the unique gasoline blends are not widely produced in other refining centers.

At the retail level, industry officials pointed out that mergers have exacerbated the barriers for potential retail entrants because there are fewer companies to supply gasoline to retailers and, as discussed in more detail in chapter 4, retailers must operate at a large scale in order to meet minimum volume requirements preferred by refiners. They also indicated that restrictive land-use laws and permitting processes in some areas of the

country, such as California and Washington, D.C., constitute a barrier for potential retailers seeking to build new stations.[25]

[25]As discussed in chapter 4, however, hypermarkets such as Wal-Mart and Costco, have entered the retail gasoline market using the marketing strategy of high volume and low prices. They have the advantage of already owning the land for the gasoline retail site.

Gasoline Marketing Has Changed in Two Major Ways

According to industry officials, two major changes have occurred in gasoline marketing since the 1990s, partly related to mergers. First, the availability of generic (unbranded) gasoline has decreased for various reasons; more gasoline is now marketed as branded, under the refiner's trademark. Branded gasoline is generally higher priced than unbranded. We could not statistically quantify the extent of this change because no data on the supply of unbranded gasoline exist. Second, refiners now prefer dealing with large distributors and retailers. This preference, officials told us, has motivated further consolidation in both the distributor and retail sectors, including the rise of "hypermarkets"—a relatively new breed of gasoline market participants that include such large retail warehouses as Wal-Mart and Costco.

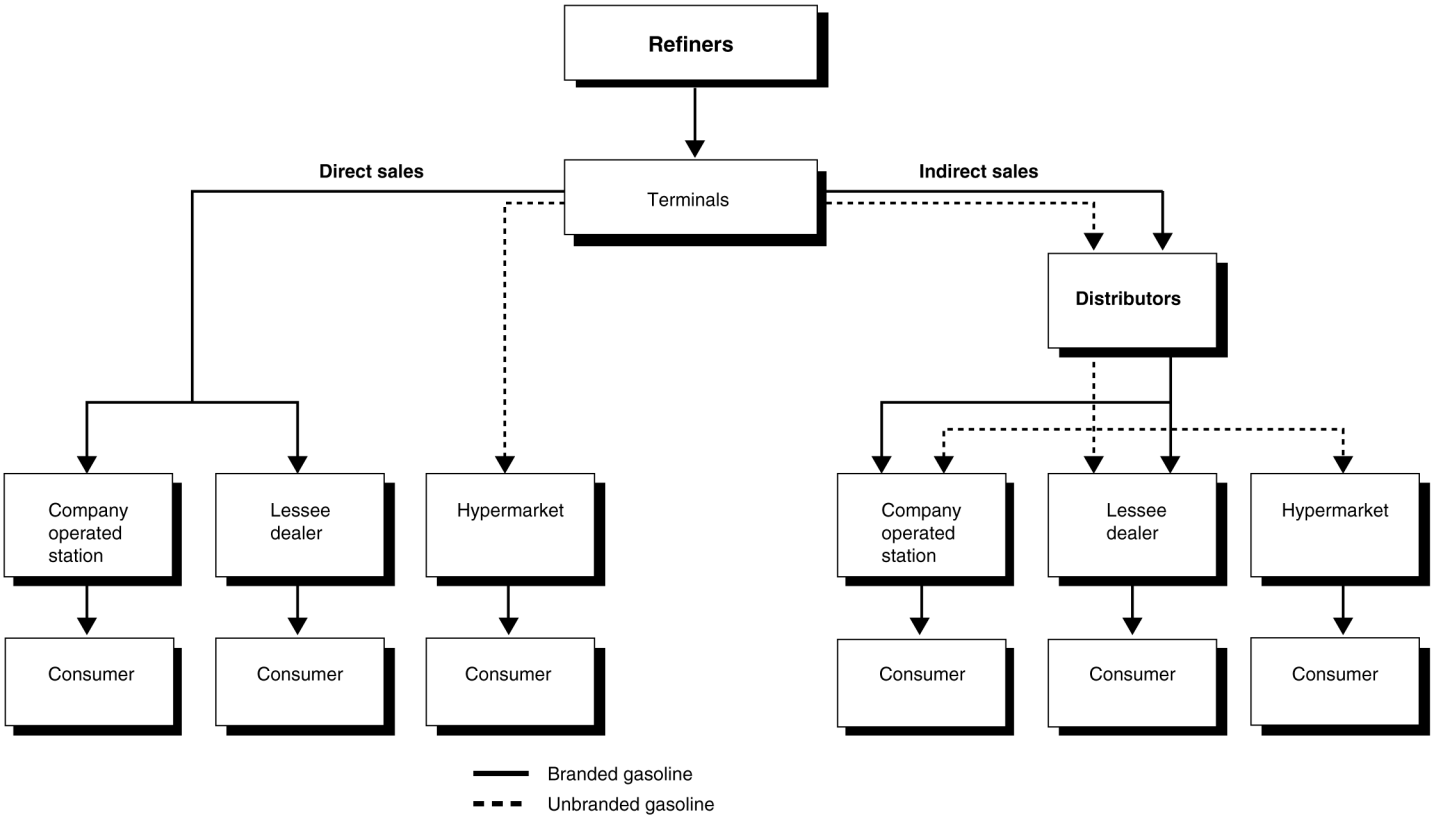
The Availability of Unbranded Gasoline Decreased

Refiners market either branded or unbranded gasoline through several wholesale channels, but since the 1990s the availability of unbranded gasoline from refiners has decreased substantially, according to industry officials. Officials generally attributed this decrease to a reduction in the number of independent refiners, the sale and/or mothballing of refineries by mostly fully vertically integrated oil companies, and better inventory management by major branded refiners. The decrease cannot be precisely quantified because the data are not adequate to do so.

Refiners Market Either Unbranded or Branded Gasoline through Several Channels

The gasoline market consists of various supply arrangements that ultimately influence gasoline prices throughout the supply chain. Gasoline flows through several marketing channels, as shown in figure 20. The refiner can market gasoline to the consumer through a direct distribution system and an indirect distribution system.

Figure 20: The Flow of Gasoline Marketing



Source: GAO analysis of oil industry data.

The direct system typically involves the sale and/or supply of branded gasoline by a refiner to its company-operated stations or other retail outlets operated by lessee dealers who lease the service station and basic equipment from the refiner or distributor but operate their own retail outlets. Branded gasoline is marketed under the refiner's trademark. Refiners can also sell unbranded gasoline directly to hypermarkets—including such large retail warehouses as Wal-Mart and Costco, as well as grocery store chains such as Safeway—that have over the last decade added gasoline retailing to their locations. (The role of hypermarkets is discussed later in this chapter.) Retailers of unbranded gasoline can sell it as a generic/private brand and tend to compete mostly through lower prices than their branded competitors. In the direct distribution system, these hypermarkets have, over the last decade, taken the place of open

dealers who either own their own stations or lease them from distributors or third parties in the supply structure.

In the indirect distribution system, refiners sell branded or unbranded gasoline to independent middlemen—generally called distributors, marketers, or jobbers—who resell the gasoline to other retailers or sell to consumers through their own retail operations. Branded gasoline that flows through the indirect system must also be marketed by distributors or retailers under the refiner's trademark, while unbranded could be sold under the distributor's or retailer's private name. Many market participants told us that much of the gasoline sold through both the direct and indirect channels is now branded.

Depending on the type of supply arrangement with the supplier, gasoline distributors and retailers may pay one or more of the distinct wholesale prices summarized in table 3 below. Under normal market conditions, the spot price is the lowest wholesale price, followed by the unbranded rack price, branded rack price, and dealer-tankwagon price. Because, as discussed below, transfer prices are generally considered proprietary, it is not clear how high or low they are relative to the other prices.

Table 3: Types of Wholesale Prices Paid for Gasoline

Wholesale purchaser of gasoline	Spot	Unbranded rack	Branded rack	Dealer-tankwagon	Transfer[a] price
Distributor	X	X	X		
Company- operated outlet					X
Lessee dealer				X	
Open dealer		X	X	X	
Hypermarket	X	X			

Source: GAO.

[a]Transfer prices are internal prices at which refiners and distributors supply gasoline to their company-owned and -operated stations.

Spot Prices are generally the lowest wholesale price under normal market conditions because there is no binding contract between the seller and the buyer, and gasoline sold in the spot market is typically unbranded**.** Market participants typically use the spot market when faced with surpluses or shortages that may arise from their contractual transactions. The spot market accounts for only a small portion of domestic gasoline sales, even

smaller than it was a decade ago, partly because just-in-time inventory management leaves less gasoline for spot sales. Nonetheless, spot prices, as well as futures prices, strongly influence the other wholesale prices.

Rack Prices are the prices that distributors and retailers pay for gasoline supplied at a refiner's wholesale terminal or rack. Typically, rack prices are set daily by refiners and are generally influenced by prices in the spot and futures markets, as well as by the extent of competition among refiners within a particular market. Average rack prices are generally higher than spot prices under normal market conditions**.** There are two types of rack prices—branded and unbranded.

- *Branded rack prices* are paid by distributors who buy gasoline supplies from major refiners selling under their trademarks. Branded rack prices include a premium reflecting the recognized brand name, the costs of issuing company credit cards, and other costs such as advertising. In addition, when refiners sell branded gasoline to distributors and retailers, the contracts tend to be less flexible than contracts for unbranded gasoline but guarantee a more secure supply. Thus, branded rack prices may also include a premium for this additional security.

- *Unbranded rack prices* are paid by distributors, hypermarkets, and open dealers for unbranded gasoline supplied primarily by independent refiners and, to a small extent, by fully vertically integrated refiners. Under normal market conditions, unbranded rack prices tend to be lower than branded rack prices. Buyers of unbranded gasoline may or may not have a binding contractual arrangement with a refiner.[1] Therefore, a buyer of unbranded gasoline may not be guaranteed a secure supply or lower prices, particularly during a market shock involving a reduction in overall gasoline supply. Thus, when there is a disruption in the supply system, such as those caused by pipeline or refinery breakdowns, unbranded rack prices can be higher than branded rack.[2]

[1]Unbranded gasoline purchasers have traditionally been able to shop around for the best available price in the marketplace without any binding contractual arrangement. However, this situation may be changing because, many distributors told us, some suppliers of unbranded gasoline are now requiring buyers to sign a binding contract to guarantee their supply.

[2]In a time of low gasoline supply, branded companies will accommodate their branded contracts first, shifting gasoline supply from unbranded to branded, causing unbranded gasoline prices to rise.

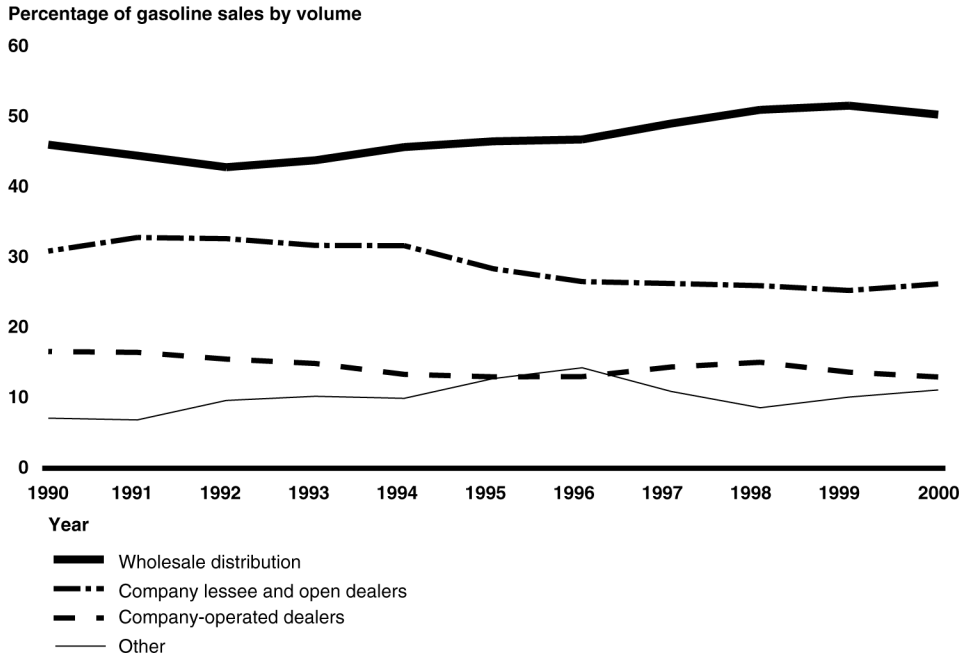
Dealer-tankwagon (DTW) prices are contract prices paid by lessee dealers and some open dealers to refiners or distributors for branded gasoline delivered at the dealers' stations. DTW prices, which are set by suppliers, include the cost of transporting the gasoline to the stations and a premium associated with the suppliers' brand name. Suppliers set their DTW prices using the futures and/or spot prices as a reference, as well as the DTW prices of other suppliers in the market area. In general, DTW prices are less volatile and higher than spot and rack prices.

Transfer Prices are internal prices at which refiners or distributors supply gasoline to their company-owned and -operated stations at the retail level. Oil companies generally regard their transfer prices as proprietary information and do not publicly disclose them. Several oil companies told us that transfer prices are based on market prices such the DTW, but we were unable to confirm this.

Based on data on gasoline sales reported to EIA by major U.S. energy companies under the EIA's Financial Reporting System (FRS),[3] about 46 percent of U.S. refiners' gasoline was marketed through distributors in 1990; this share increased to over 50 percent in 2000 (see figure 21). Despite distributors' significant role in gasoline marketing, the distributors we interviewed stated that their marketing activities are generally confined to rural or less urban areas. Distributors said that refiners who supply them with branded gasoline preclude them from operating stations within certain proximities of major metropolitan markets where the refiners generally prefer to locate their company-owned and -operated and lessee dealer stations—a phenomenon the distributors described as "redlining." We did not explore the impact, if any, of this practice on the gasoline market because it is outside the scope of the present study.

[3]According to EIA officials, FRS companies accounted for about 85 percent of the total U.S. gasoline supply.

Figure 21: Percentage Volume of Gasoline Sold through Different Marketing Channels



Source: EIA.

In 1990, refiners marketed about 31 percent of their gasoline through lessee dealers who pay DTW prices and open dealers who pay rack and/or DTW prices; this percentage declined to 26 percent in 2000.[4] Lessee dealers that we spoke with attributed their declining role as a marketing channel to high DTW and rent costs charged by their suppliers. The dealers also alleged that continued decline in their market participation could ultimately lead to reduced competition and higher gasoline price to consumers. Again, we did not attempt to further analyze these claims because they are not within the scope of our study.

The percentage of gasoline sold by refiners to consumers through company-operated stations remained virtually unchanged between 1990 and 2000—16 percent and 13 percent, respectively.

[4]EIA's data combined sales by lessee dealers and open dealers.

Industry Officials Cited Several Reasons for the Decrease in the Availability of Unbranded Gasoline

Oil industry officials whom we interviewed indicated that the availability of unbranded gasoline has decreased since the 1990s. According to these officials, more branded gasoline is now sold at a price that is generally higher than that of unbranded gasoline, as discussed above. This premium is presumably justified because of certain additives in branded gasoline and consumer brand loyalty.

In general, industry officials cited one or more of the following reasons for the decrease in the availability of unbranded gasoline.

- Fewer independent refiners are supplying gasoline. Independent refiners generally supply unbranded gasoline, but since the 1990s their numbers have decreased as they merged with branded companies, grew large enough to be considered a brand, or closed down. For example, Tosco was one of the largest independent refiners selling unbranded gasoline in the United States. However, the company made several acquisitions—some involving purchases of retail stations from branded companies like British Petroleum—which allowed it to market some of its gasoline through branded outlets. Tosco also acquired downstream assets on the East Coast that were divested from Exxon and Mobil as a condition for their merger. These acquisitions allowed Tosco to market gasoline under the Exxon and Mobil brands under a consent agreement worked out with FTC and ExxonMobil. Moreover, in 2001 Tosco was acquired by Phillips Petroleum, a large branded refiner. According to some gasoline distributors who used to purchase unbranded gasoline from Tosco, their ability to purchase unbranded gasoline has decreased substantially because of Tosco's acquisition by Phillips. They said that Phillips now sells a greater share of its gasoline as branded so that they no longer have access to as much unbranded gasoline.

- Fully vertically integrated oil companies have decided to sell some refineries to independents or to mothball inefficient refineries. Fully vertically integrated oil companies have, in recent years, sold off or mothballed refineries they deemed to be unprofitable.[5] As a result, some of them now have only enough refinery capacity to produce gasoline to meet their branded supply needs, while others said that they have even become net buyers of gasoline. Moreover, independent refiners, some of

[5]Fully vertically integrated oil companies who merged with other companies also divested some refineries as mandated by the FTC as part of its remedy for potential anticompetitive effects of such mergers.

whom bought refineries from the fully vertically integrated oil companies, also sell a portion of their gasoline to these companies, further reducing the amount of gasoline that the independent refiners can sell to unbranded distributors and retailers.

- The major branded refiners have increased the efficiency of their inventory management systems. Some unbranded supply came from excess gasoline production. Synergies developed through mergers have increased the industry's ability to use just-in-time inventory management system, which ensures that refiners produce an amount of gasoline sufficient to meet their current branded needs without producing any excess that can be sold as unbranded. For example, officials from one large fully vertically integrated oil company told us that its refineries produce just enough gasoline to cover its company-operated stations and lessee dealer sales.

Data Are Not Adequate to Precisely Quantify the Decreasing Availability of Unbranded Gasoline

Although oil industry officials we interviewed overwhelmingly said that the supply of unbranded gasoline in the U.S. has decreased significantly in the 1990s, we could not statistically quantify this change because the data required for such an analysis do not currently exist. DOE's EIA is the federal agency mandated by Congress to collect energy data. EIA collects data on gasoline supply and prices, but EIA officials told us that the agency does not require petroleum companies to report gasoline data in the form that would permit the identification of branded and unbranded sales for two reasons: (1) the agency lacks the resources to properly track these data and (2) the industry has sued the agency on several occasions on the grounds that tracking this type of information was too burdensome. EIA, however, acknowledged that unbranded gasoline provides a low-cost competitive option for consumers. EIA also acknowledged that data on unbranded gasoline supply would facilitate better monitoring of the overall competitive trends in the gasoline market.

Refiners Prefer Dealing with Large Distributors and Retailers

Market participants that we spoke with told us that refiners now prefer dealing with large distributors and retailers for two reasons: (1) large distributors and retailers are a much lower credit risk than their smaller counterparts and (2) it is more efficient to sell a larger volume through fewer entities than to sell a smaller volume through many entities because minimizing the number of transactions reduces administrative and distribution costs. As mergers have occurred among refiners, fewer supply

options exist for distributors. This consolidation at the refining level has allowed large refiners to dictate the terms of supply contracts, including minimum volume requirements. Partly in response, distributors are becoming larger through mergers and consolidation. In addition, hypermarkets, which often buy gasoline in large quantities from the refiners and so receive volume discounts on the unbranded rack price, are becoming major unbranded retailers.

Distributors Are Becoming Larger and Fewer in Several Markets

Distributors, through whom about half of all gasoline is sold, are themselves merging or entering into joint ventures with branded refiners to enlarge their scale of operation, which has ultimately led to a reduction in their number. For example, at the end of 2002, there were about 7,000 distributors and dealers who were members of the Petroleum Marketers Association of America (PMAA), compared to about 10,000 in 1991. PMAA officials attributed this decline mostly to mergers and consolidations among their members. According to a PMAA official, the trend since the 1990s has been not only for large distributors to absorb smaller ones but for large ones to merge among themselves to enhance their competitive position. This pattern of consolidation has been particularly noted in some areas, such as parts of Colorado and Michigan. For example, one industry official told us that the number of distributors in some rural Colorado communities has decreased from about seven or eight distributors a decade ago to generally only one today. According to market participants, distributors have several incentives for consolidation. First, it gives the distributors the ability to meet minimum volume requirements. Second, it increases distributors' ability to negotiate volume discounts in supply contracts. Finally, by increasing their scales of operation, distributors can enhance their access to capital, allowing them greater flexibility in purchasing gasoline on credit.

Hypermarkets Are Becoming a Significant Player in U.S. Gasoline Marketing

Our interviews with oil industry officials and available data suggest that hypermarkets are playing a significant and growing role today in U.S. gasoline marketing to consumers. As noted above, hypermarkets generally buy directly from the refiner and typically deal in heavy volumes. For example, two hypermarkets that we spoke with reported that they sold about 420 million and 470 million gallons, respectively, of gasoline per year. This is comparable to the volume sold by some of the largest distributors we interviewed, whose sales volume ranged between 200 million and 700 million gallons per year. Hence, the typical hypermarket fits the profile of the large wholesale purchasers that refiners now prefer to deal with.

Hypermarkets purchase and sell almost entirely unbranded gasoline and are becoming a channel for the sale of the dwindling unbranded gasoline supply.[6] Hence, they are rapidly displacing the "mom and pop" open dealers who used to dominate the unbranded retail market. These dealers are now either "branding up"[7] or going out of business.

Although the overall market share of hypermarkets in U.S. gasoline marketing is currently relatively small, it is projected to grow very rapidly, at least in the short term. According to a study by Energy Analysts International, Inc. (EAI), a consulting firm that has analyzed hypermarkets, there were between 1,230 and 1,250 hypermarket locations selling gasoline in the U.S. in 2000, and these locations collectively sold over 4 billion gallons of gasoline, or 3.3 percent of total gasoline sales to consumers.[8] Furthermore, EAI projects that by 2005, hypermarkets' gasoline sales will increase more than five-fold to 22.7 billion gallons, or 16 percent of gasoline sales to consumers.

In general, it appears that hypermarkets are gaining market share in gasoline retailing through an aggressive pricing strategy—on average, their pump prices are lower than those of their competitors--a situation that has raised concern among some of the traditional competitors, especially distributors. Many distributors contend that hypermarkets use their gasoline as a "loss leader" and subsidize gasoline sales with profits from store sales. For their part, hypermarkets told us that because they often buy in large volumes, they are able to negotiate and receive discounts on their unbranded rack price. Lower purchase prices allow them to set lower pump prices. However, if the supply of unbranded gasoline continues to dwindle because of the attrition, acquisition, and/or vertical integration of unbranded refiners, it is not clear how the hypermarkets will respond. The hypermarkets that we spoke with said that if they could not obtain an adequate supply of unbranded gasoline in the future, they would have to switch to branded gasoline. Some of them have considered purchasing refineries to produce their own gasoline and/or importing gasoline.

[6]As discussed earlier, data are not available on unbranded gasoline supply to determine the percentage of the unbranded gasoline sales that hypermarkets represent.

[7]The small, unbranded open dealer usually becomes branded by entering into a contract with a distributor to supply branded gasoline, which must be retailed under the brand's trademark.

[8]Energy Analysis International, Inc, *U.S. Hypermart Petroleum Market Study*, 2001 Edition.

Mergers and Increased Market Concentration Generally Led to Higher Wholesale Gasoline Prices in the United States

The results of our econometric analyses suggest that six of eight specific oil industry mergers—which mostly involved large, fully vertically integrated, companies—generally led to increases in wholesale gasoline prices (which in this report are measured by wholesale prices less crude oil prices) for branded and/or unbranded gasoline of about 2 cents per gallon, on average. Two of the mergers generally led to price decreases, of about 1 cent per gallon, on average. These findings imply that the combined effects of market power (which tends to increase prices) and efficiency gains (which tend to decrease prices) from the mergers led to increased prices. These findings applied to both conventional gasoline, the dominant type of gasoline sold nationwide, and to "boutique fuels"—gasoline that has been reformulated for certain geographical areas to mitigate environmental pollution.

In a complementary analysis, we found that increased market concentration, which captures the cumulative effects of mergers as well as other market structure factors, generally resulted in increased wholesale prices for conventional and boutique fuels. For conventional gasoline, the increases in prices were larger in the western half of the United States than in the eastern half, in part because the West has limited access to gasoline supplies from abroad and from the Gulf Coast region, which has high refinery capacity. For the boutique fuels—which are sold only in certain cities in the East Coast and Gulf Coast regions, or in California—increased market concentration led to higher wholesale prices than for conventional gasoline. This difference likely stems from the limited availability of the boutique fuels, which can only be produced by a few refiners. The changes in the wholesale prices can be attributed partly to the wave of mergers that reduced the number of suppliers in the affected geographic regions. Our results also suggest that lower gasoline inventories relative to expected demand, higher refinery capacity utilization rates, and supply disruptions in the Midwest and West Coast led to higher wholesale gasoline prices.

As part of our methodology to model the effects of mergers and market concentration, we used extensive peer review to obtain comments from outside experts and made changes as appropriate. However, due to the complexities of analyzing the effects of mergers and market concentration on wholesale gasoline prices, there are some limitations to our econometric methodology, including the time periods over which we could model the effects of the mergers and the market concentration data that we used.

Econometric Models Developed to Estimate the Effects of Mergers and Market Concentration on Wholesale Gasoline Prices

In developing our econometric models, we relied on information from previous studies, industry experts, and our own analysis of the oil industry, specifically wholesale gasoline markets. We developed two groups of econometric models to estimate the effects of individual mergers and increased market concentration on wholesale prices of different gasoline types—conventional, reformulated, and CARB[1]—in the second half of the 1990s. To estimate effects on wholesale gasoline prices, we used wholesale prices minus crude oil prices, [2] with crude oil prices serving as our proxy for marginal input costs (crude costs constitute about two-thirds of total refining costs).[3] We focused our study on wholesale gasoline markets because trends in gasoline prices usually are observed in wholesale markets before the retail markets and because more comprehensive data on volumes were available at the wholesale level than the retail level.

For both models, we used panel data—data pooled across all cities where wholesale gasoline terminals or racks are located and over time. This enabled us to account for variations in prices across rack cities (city-specific effects) and over time (time effects). Also, for mergers, the panel data allowed us to estimate the effect on prices in the rack cities where the merging companies operated, relative to prices in rack cities where they did not, taking into account other variables. In addition to mergers, which are measured by indicator (or dummy) variables for consolidations between the merging companies, and market concentration, which is measured by the Herfindahl-Hirschman Index (HHI) of refinery capacity, we included in our models other relevant variables that could affect wholesale gasoline prices, such as gasoline inventories relative to demand and refinery capacity utilization rates, and supply disruptions.

[1]Our analysis is based on regular, unleaded gasoline, which is the predominant type of gasoline sold. CARB is California Air Resources Board's requirement to have reformulated gasoline for lower pollution. Conventional gasoline contains no additive, but reformulated and CARB gasoline contain MTBE (methyl tertiary butyl ether) as an additive.

[2]Wholesale gasoline prices are measured by the average prices at the terminals or racks. To help isolate the effects of mergers and market concentration on gasoline prices at the wholesale level, it was necessary to account for the effect of changes in crude oil prices. Henceforth, we refer to wholesale gasoline prices minus crude oil prices simply as wholesale gasoline prices.

[3]The other contributors to the marginal wholesale costs are labor costs, capital costs, energy, and purchased services. We could not subtract capital costs or labor costs from the wholesale prices because the available data for these inputs are annual price indices. See appendix IV for details.

There were supply disruptions that caused price spikes in the Midwest in 2000 and on the West Coast in 1999 and 2000. The immediate causes of the disruptions included refinery outages and pipeline ruptures and, in the case of the Midwest, changes in gasoline formulations. It is difficult to determine the timing, duration, and the extent of the geographical impact of the disruptions, all of which makes it difficult to construct reliable and accurate measures of the supply disruptions.[4] Nonetheless, we constructed crude measures of these supply disruptions that we included in our models for the markets that were affected.

There are two common approaches for estimating panel data—the "random-effects" model and the "fixed-effects" model. The random effects model is preferred when observations (rack cities) are drawn randomly from a common population and any difference in individual effects can only be attributed to chance. Otherwise, the fixed effects model is preferred. The selection of the rack cities used in our study was based on data availability and not random choice. Furthermore, in wholesale gasoline markets, unobserved city-specific differences might include unmeasured supply or demand effects such as different pricing strategies of the refiners at different rack cities and the level of development of the transportation system in the different areas. These differences are not random. We, therefore, prefer the fixed-effects model, which—unlike the random effect model—remains valid even when the unobserved city-specific effects are not independent of the included explanatory variables.

Although we preferred to use wholesale gasoline prices minus crude oil prices as the dependent variable for economic and statistical reasons, as part of our sensitivity analysis, we reestimated the models with the crude oil prices as an explanatory variable. We found that these results were similar, but the explanatory power, as expected, increased significantly. Also, because some of the explanatory variables are likely to be determined simultaneously with gasoline prices (particularly gasoline inventories and refinery capacity utilization rates), we estimated our models taking this into account. Furthermore, it is likely that prices of wholesale gasoline would be correlated across nearby racks, partly due to spatial competition. Our estimation technique accounts for possible contemporaneous correlations across the racks. A complete discussion of our econometric

[4]The size and duration of the disruptions would depend on several conditions, including the preexisting market conditions and how the refining industry chooses to respond to the disruptions. See appendix IV for a complete discussion of these supply disruptions.

approach, including model specifications, variables used, data sources, and estimation techniques, is provided in appendix IV.

Mergers in the Second Half of the 1990s Mostly Led to Increases in Wholesale Gasoline Prices

The results of our econometric modeling indicate that most of the individual mergers we examined led to increases in the prices of wholesale gasoline for the time periods we analyzed, while a smaller number of mergers led to price decreases. Overall, we examined eight mergers, shown in table 4, including the two largest in the petroleum industry in history—the BP-Amoco and Exxon-Mobil mergers.[5] We selected these mergers because of their transaction size, FTC's review of them,[6] or concerns expressed by some industry participants and state officials we interviewed about their potential anticompetitive effects.[7]

[5]We refer to all the transactions collectively as mergers, since they led to the consolidation of assets. We could not analyze the BP-Amoco merger with ARCO in April 2000 or the Chevron-Texaco merger in October 2000 because of data limitations.

[6]While some of these mergers were included in our study because of FTC's review of them, our study did not assess the appropriateness of FTC's review and actions they took regarding these selected mergers.

[7]The industry participants we interviewed include petroleum marketing associations, independent refiners, and fully vertically integrated oil companies.

Table 4: Selected Oil Industry Mergers Affecting Wholesale Gasoline Markets, 1994-2000

Merger[a]	Effective date of merger[b]	Acquirer	Target	Relevant geographic region[c, d]	Markets in which FTC identified competitive concerns
Tosco-Unocal	April 1, 1997[e]	Tosco	Unocal	PADD V	Not applicable
UDS-Total	October 1, 1997[f]	UDS	Total	PADD II, III, IV	Not applicable
Marathon-Ashland	January 5, 1998[e]	Joint venture	Joint venture	PADD I, II, III	Not applicable
Shell-Texaco I[g] (Equilon)	February 1, 1998[f]	Joint venture	Joint venture	PADD II, III, IV, V	Refining Wholesale Retail
Shell-Texaco II[g] (Motiva)	July 1, 1998[e]	Joint venture	Joint venture	PADD I, II, III	Pipelines
BP-Amoco[h]	December 31, 1998[e]	BP	Amoco	PADD I, II, III	Wholesale
MAP-UDS	December 13, 1999[e]	MAP	UDS (Michigan)	PADD II	NA
Exxon-Mobil[h]	March 1, 2000[f]	Exxon	Mobil	PADD I, III	Refining Pipelines Retail

Legend

UDS=Ultramar Diamond Shamrock;
BP=British Petroleum
MAP=Marathon Ashland Petroleum

Sources: GAO's analysis of EIA, FTC, OPIS, and Thomson Financial data.

[a]The first company is the acquirer and the second company is the target.

[b]The effective dates are either the merger completion date or the date when FTC's merger remedies became effective.

[c]Both merging companies operated in rack cities located in these geographic regions.

[d]Traditionally, the United States has been divided into five Petroleum Administration for Defense Districts (PADD): PADD I, the East Coast region; PADD II, the Midwest region; PADD III, the Gulf Coast region; PADD IV, the Rocky Mountain region; and PADD V, the West Coast region. (See figure 11.)

[e]The merger completion date.

[f]The date when FTC's merger remedies became effective. The merger completion date for the UDS-Total merger was September 25, 1997; for the Shell-Texaco I (Equilon) merger, January 23, 1998; and for the Exxon-Mobil merger, November 30, 1999.

[g]The Shell-Texaco II joint venture involved Shell, Texaco, and Star (jointly controlled by Texaco and Saudi Refining Company). The Shell-Texaco mergers ended in 2000 when Chevron and Texaco merged to form Chevron-Texaco. Shell then acquired the Shell-Texaco assets as a condition by FTC to allow the Chevron-Texaco merger.

[h]This merger also involved upstream assets of these companies, but our modeling focused on the effects at the wholesale gasoline level.

In tables 5-7 we present the effects of the mergers we modeled on wholesale prices of conventional gasoline, reformulated gasoline, and

CARB gasoline, respectively. The tables show (1) the geographic regions that the mergers affected and (2) the estimated changes in wholesale gasoline prices associated with each merger in the relevant geographic areas.

Our estimates in table 5 show that of the seven mergers we analyzed for conventional gasoline sold nationwide, five—the Marathon-Ashland, the Shell-Texaco I (Equilon), BP-Amoco, MAP-UDS, and the Exxon-Mobil mergers—led to price increases for both branded and unbranded gasoline ranging from about 0.39 to 5.00 cents per gallon.[8] The two other mergers, UDS-Total and the Shell-Texaco II (Motiva), led to price decreases for both branded and unbranded wholesale conventional gasoline ranging from about 0.89 to 1.77 cents per gallon. Similarly, for reformulated gasoline, which is sold mainly in cities in the East Coast and Gulf Coast regions, table 6 shows that the mergers of Marathon-Ashland and Exxon-Mobil increased wholesale gasoline prices from about 0.71 to 1.61 cents per gallon. The Shell-Texaco II merger led to decreased prices of about 0.39 cents per gallon for branded gasoline and the BP-Amoco merger was not associated with price changes. For CARB reformulated gasoline, as shown in table 7, the Tosco-Unocal merger led to price increases for branded gasoline of about 6.87 cents per gallon, while the Shell-Texaco I merger led to price decreases of about 0.69 cents per gallon. Neither the Tosco-Unocal merger nor the Shell-Texaco merger affected the prices of unbranded CARB gasoline.

[8]Unless otherwise noted, all the estimated changes in prices (increases or decreases) are statistically significant. In other words, the estimated changes are statistically different from zero at the 10 percent significance level or less. See appendix IV for more discussion of the econometric results of the effects of individual oil industry mergers.

Table 5: Estimated Changes in Conventional Wholesale Gasoline Prices Associated with Individual Mergers (1994-2000)

Merger	Estimated change in prices (cents per gallon)[a]
UDS-Total[b]	
Branded	- 0.89
Unbranded	- 1.25
Marathon-Ashland[c]	
Branded	0.70
Unbranded	0.39
Shell-Texaco I[d]	
Branded	0.99
Unbranded	1.13
Shell-Texaco II[e]	
Branded	- 1.77
Unbranded	- 1.24
BP-Amoco[f]	
Branded	0.40
Unbranded	0.97
MAP-UDS[g]	
Branded	1.38
Unbranded	2.63
Exxon-Mobil[h]	
Branded	3.71
Unbranded	5.00

Sources: GAO econometric analysis of EIA, FTC, QPIS, and Thomson Financial data.

Notes:

See table 15 in appendix IV for additional information.

The average estimated prices (measured as wholesale gasoline prices less crude oil prices) were 19 cents and 17 cents per gallon for branded and unbranded gasoline, respectively. (See table 20 in appendix IV.)

[a]The effective date, which is the first date in the postmerger period, is based on either the merger completion date or the date when FTC's remedial actions became effective. The time periods over which the estimates were obtained are provided in table 15 in appendix IV. The estimated changes associated with the mergers are statistically significant at the 1 percent level or lower.

[b]The UDS-Total merger affected rack cities in the Midwest, Gulf Coast, and Rocky Mountain regions.

[c]The Marathon-Ashland merger affected rack cities in the East Coast, Midwest, and Gulf Coast regions.

[d]The Shell-Texaco I merger affected rack cities in the Midwest, Gulf Coast, Rocky Mountain, and West Coast regions.

[e]The Shell-Texaco II merger affected rack cities in the East Coast, Midwest, and Gulf Coast regions.

[f]The BP-Amoco merger affected rack cities in the East Coast, Midwest, and Gulf Coast regions.

[g]The MAP-UDS merger affected rack cities in the Midwest region.

[h]The Exxon-Mobil merger affected rack cities in the East Coast and Gulf Coast regions.

As shown in table 5, for conventional wholesale gasoline, we found the following effects of individual mergers on prices.

UDS-Total: This merger led to price reductions for both branded and unbranded gasoline of about 1 cent per gallon. FTC did not identify potential anticompetitive concerns for this merger.

Marathon-Ashland: We found statistically significant increases in prices of branded gasoline of about 1 cent per gallon and in unbranded gasoline of about one-third cent per gallon due to this merger. FTC did not identify potential anticompetitive concerns.

Shell-Texaco I (Equilon): This merger led to price increases of about 1 cent per gallon for both branded and unbranded gasoline. FTC identified this merger as raising potential anticompetitive concerns at the refining, wholesale, and retail levels in certain markets. Thus, the agency sought to preserve competition by taking remedial actions.

Shell-Texaco II (Motiva): This merger led to decreases in prices of about 1 cent to 2 cents per gallon for both branded and unbranded gasoline. This finding is consistent with FTC's determination that the merger was not likely to reduce competition in the affected wholesale gasoline markets.

BP-Amoco: We found that this merger led to increases in prices of about one-half to 1 cent per gallon for both branded and unbranded gasoline. FTC identified many cities or metropolitan areas in the eastern half of the United States (East Coast, Midwest, and Gulf Coast) where this merger could reduce competition in wholesale markets. The agency, therefore, took remedial actions to preserve competition in wholesale gasoline markets affected by this merger.

MAP-UDS: This merger led to price increases of about 1 cent to 3 cents per gallon for both branded and unbranded gasoline. FTC did not identify this merger as raising potential anticompetitive concerns in the wholesale gasoline markets and so did not take remedial action.

Exxon-Mobil: This merger led to increases in prices of about 4 to 5 cents per gallon for both branded and unbranded gasoline. The merger was identified by FTC as raising potential anticompetitive concerns in some retail markets, but not in wholesale markets. Thus, FTC required divestitures of retail assets in the affected wholesale markets.

Table 6: Estimated Changes in Reformulated Wholesale Gasoline Prices Associated with Individual Mergers (1995-2000)

Merger[a]	Estimated change in prices (cents per gallon)[b]
Marathon-Ashland[c]	
Branded	0.71[d]
Unbranded	0.86[d]
Shell-Texaco II[e]	
Branded	- 0.39[f]
Unbranded	0.09
BP-Amoco[g]	
Branded	0.55
Unbranded	0.40
Exxon-Mobil[h]	
Branded	1.61[d]
Unbranded	1.01[f]

Sources: GAO econometric analysis of OPIS, EIA, FTC, and Bureau of Labor statistics data.

Notes:

See table 16 in appendix IV for additional information.

The average estimated prices (measured as wholesale gasoline prices less crude oil prices) were 20 cents and 18 cents per gallon for branded and unbranded gasoline, respectively. (See table 20 in appendix IV).

[a]No estimates are reported for the UDS-Total merger because data are available for only one rack city.

[b]The effective date, which is the first date in the postmerger period, is based on either the merger completion date or the date when FTC's remedial actions became effective. The time periods over which the estimates were obtained are provided in table 16 in appendix IV.

[c]The Marathon-Ashland merger affected rack cities in the East Coast, Midwest, and Gulf Coast regions.

[d]The estimated changes associated with the mergers are statistically significant at the 1 percent level or lower.

[e]The Shell-Texaco II merger affected rack cities in the East Coast and Gulf Coast regions.

[f]The estimated changes associated with the mergers are statistically significant at the 5 percent level or lower.

[g]The BP-Amoco merger affected rack cities in the East Coast, Midwest, and Gulf Coast regions.

[h]The Exxon-Mobil merger affected rack cities in the East Coast and Gulf Coast regions.

The results presented in table 6 for reformulated wholesale gasoline sold in cities in the East Coast and Gulf Coast indicate the following effects of the individual mergers on prices.

Marathon-Ashland: This merger led to increases in prices of about 1 cent per gallon for both branded and unbranded gasoline. As already indicated, FTC did not identify potential anticompetitive concerns.

Shell-Texaco II (Motiva): This merger led to price reductions of about 0.39 cents per gallon for branded gasoline. As already indicated, this finding is consistent with FTC's determination that the merger was not likely to reduce competition in the affected wholesale gasoline markets.

BP-Amoco: The effects of this merger were inconclusive. As already indicated, FTC took remedial actions to preserve competition in wholesale gasoline markets affected by this merger.

Exxon-Mobil: This merger led to increases in prices of about 1 cent to 2 cents per gallon for both branded and unbranded gasoline. As already indicated, FTC required divestitures of retail assets in the affected wholesale markets.

Table 7: Estimated Changes in CARB Reformulated Wholesale Gasoline Prices Associated with Individual Mergers (1996-2000)

Merger	Estimated change in prices (cents per gallon)[a]
Tosco-Unocal[b]	
Branded	6.87[c]
Unbranded	-1.58
Shell-Texaco I[d]	
Branded	- 0.69[c]
Unbranded	-0.24

Sources: GAO econometric analysis of OPIS, EIA, FTC, and Bureau of Labor Statistics data.

Notes:

See table 17 in appendix IV for additional information.

The average estimated prices (measured as wholesale gasoline prices less crude oil prices) were 36 cents and 31 cents per gallon for branded and unbranded gasoline, respectively. (See table 20 in appendix IV).

[a]The effective date, which is the first date in the postmerger period, is based on either the merger completion date or the date when FTC's remedial actions became effective. The time periods over which the estimates were obtained are provided in table 17 in appendix IV.

[b]The Tosco-Unocal merger affected rack cities in the West Coast region (California only).

[c]The estimated changes associated with the mergers are statistically significant at the 5 percent level or lower.

[d]The Shell-Texaco I merger affected rack cities in the West Coast region (California only).

As shown in table 7, for CARB wholesale gasoline sold in California, we found the following price changes associated with individual mergers.

Tosco-Unocal: This merger, which affected both refining and marketing (wholesale and retail), led to higher prices of branded gasoline—increases of about 7 cents per gallon. FTC did not take remedial actions in the merger.

Shell-Texaco I (Equilon): This merger led to decreases in prices of about 1 cent per gallon. As already indicated, FTC sought to preserve competition by taking remedial actions in this merger.

Increased Market Concentration Generally Led to Higher Wholesale Gasoline Prices

Based on our econometric analyses, we found that increased market concentration led to higher wholesale prices for all gasoline types. This finding is consistent with the fact that the wave of oil industry mergers in the second half of the 1990s reduced the number of competitors in the wholesale markets. As shown in table 8, the estimated increases in wholesale prices of branded and unbranded conventional gasoline from 1994 to 2000 were less than one-half cent per gallon for all regions. The increases in prices of wholesale gasoline were larger, especially for unbranded gasoline, in the western half of the United States, which generally has limited access to gasoline supplies from other regions or from abroad, potentially exacerbating the effects of market concentration.

Table 8: Estimated Changes in Conventional Wholesale Gasoline Prices Associated with Increased Market Concentration (1994-2000)

	Market concentration (HHI)			
Conventional wholesale gasoline	1994	2000	Increase in HHI	Estimated change in prices due to increase in HHI (cents per gallon)
All regions[a]	803	1101	298	
Branded				0.15[b]
Unbranded				0.33[b]
Geographic area				
Eastern United States[c]	773	1090	317	
Branded				0.25[b]
Unbranded				0.10
Western United States[d]	1032	1180	148	
Branded				0.56[b]
Unbranded				1.29[e]

Sources: GAO econometric analysis of OPIS, EIA, FTC, and Bureau of Labor statistics data.

Note: See table 18 in appendix IV for additional information.

[a]All states except Alaska, California, Connecticut, Delaware, District of Columbia, Hawaii, Massachusetts, New Hampshire, New Jersey, and Rhode Island.

[b]The estimated changes in prices are statistically significant at the 1 percent level or lower.

[c]The Eastern U.S. consists of the East Coast, Midwest, and Gulf Coast regions.

[d]The Western U.S. consists of the Rocky Mountains and West Coast (excluding California) regions.

[e]The estimated changes in prices are statistically significant at the 5 percent level or lower.

As shown in table 9, we also found that increased market concentration led to higher wholesale prices of about 1 cent per gallon for reformulated gasoline sold in certain cities in the East Coast and Gulf Coast regions from 1995 through 2000. As also shown in table 9, for CARB gasoline (sold only in California), we estimated that prices of both branded and unbranded gasoline increased by about 7 and 8 cents per gallon, respectively, from 1996 to 2000. The California market is isolated from refinery centers in rest of the United States both geographically and in terms of its gasoline type.

Table 9: Estimated Changes in Boutique Fuels Wholesale Prices Associated with Increased Market Concentration (1995-2000)

	Market concentration(HHI)			
	1995	2000	Increase in HHI	Estimated change in price margin due to increase in HHI (cents per gallon)
Reformulated wholesale gasoline1995-2000[a]				
Branded	1,237	1,477	240	0.98[b]
Unbranded	1,237	1,477	240	0.89[b]
CARB reformulated wholesale gasoline: 1996-2000[c]	**1996**	**2000**	**Increase in HHI**	
Branded	965	1,267	302	7.19[b]
Unbranded	965	1,267	302	7.94[d]

Source: GAO econometric analysis of OPIS, EIA, FTC, and Bureau of Labor statistics data.

Note: See table 19 in appendix IV for additional information.

[a]The area consists of Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, Virginia in the East region; Kentucky in the Midwest region; and Texas in the Gulf Coast region.

[b]The estimated changes in prices are statistically significant at the 1 percent level or lower.

[c]The area consists of California.

[d]The estimated changes in prices are statistically significant at the 10 percent level or lower.

Other Factors Also Resulted in Higher Wholesale Gasoline Prices

In addition to the price increases resulting from the mergers and market concentration, we found that low gasoline inventories relative to demand, high refinery capacity utilization rates, and supply disruptions in the Midwest and West Coast resulted in higher wholesale gasoline prices[9]—a finding generally consistent with the expected effects.

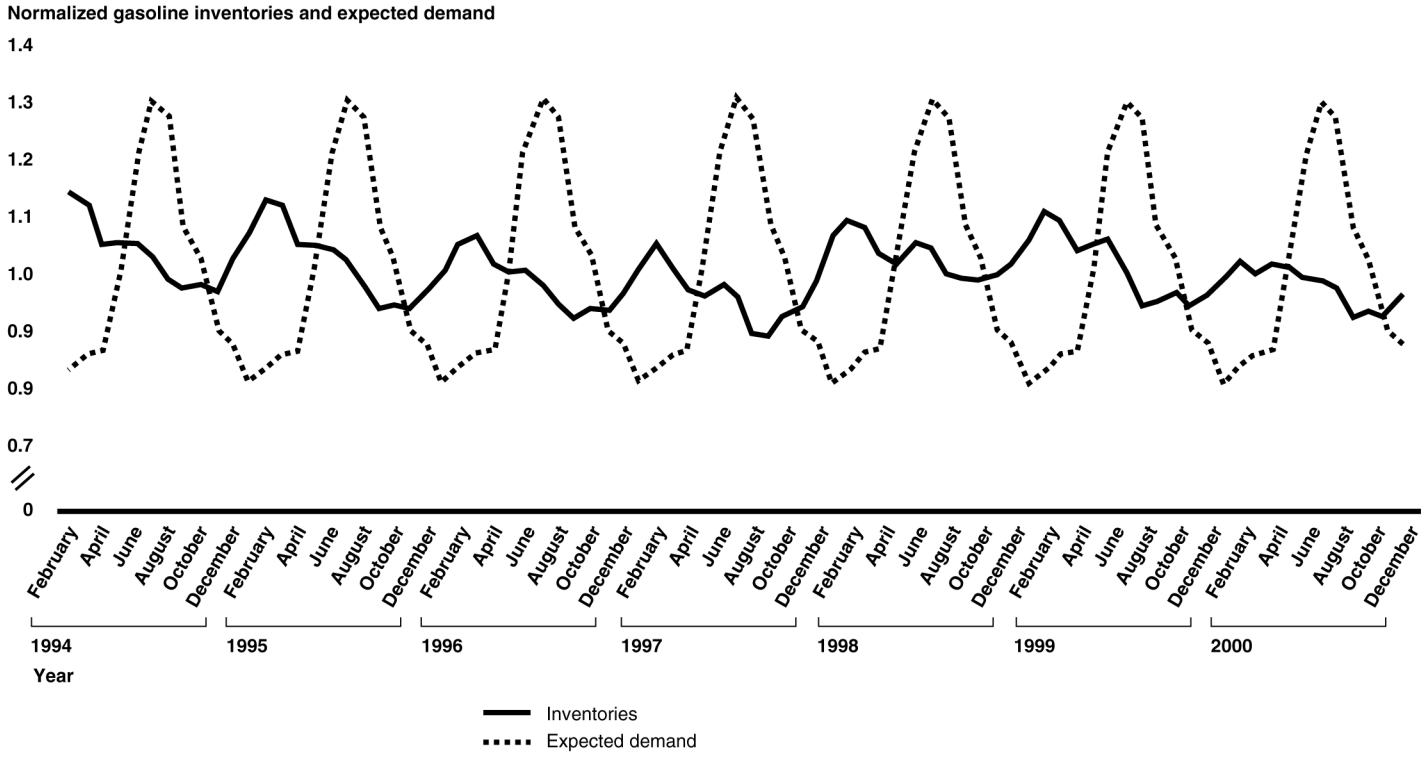
Our econometric models indicate that when gasoline inventories are low relative to demand, there is less protection against unexpected or not fully anticipated supply problems, thereby increasing prices.[10] Based on our

[9]See appendix IV for complete details of these results.

[10]Pinkse et al. obtained similar results using data on percentage changes in gasoline inventories.

analysis of EIA's data, low inventories relative to demand occurred mostly between May/June and October, the summer driving months. We found that wholesale prices were about 1 cent per gallon higher between May/June and October compared to the other months of the year. As shown in figure 22, both the inventories of gasoline and expected demand for wholesale gasoline follow seasonal patterns, but they move in opposite directions.

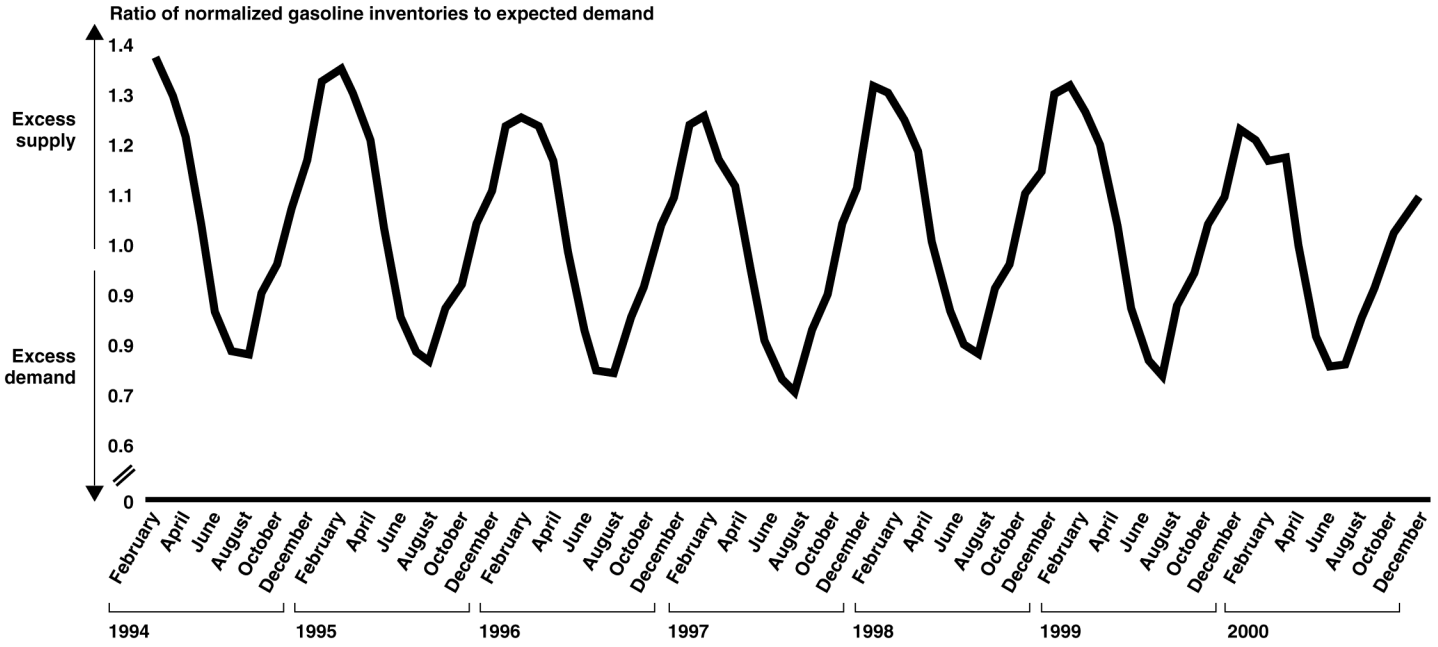
Figure 22: Normalized Inventories and Expected Demand for Wholesale Gasoline (1994-2000)



Source: GAO analysis of EIA data.

The ratio of gasoline inventories to expected demand, shown in figure 23, demonstrates a seasonal pattern, and prices are expected to increase when the ratio is less than one, which is from about May/June to October, and to decrease when the ratio exceeds one, which is from about November to April.

Figure 23: Ratio of Inventories to Expected Demand for Wholesale Gasoline (1994-2000)



Source: GAO analysis of EIA data.

Our econometric models also indicate that when refinery capacity utilization rates were high—averaging about 93 percent over the period of our study—wholesale gasoline prices increased. In general, refineries are utilized at high rates when gasoline demand increases relative to gasoline inventories, all other things being constant. High utilization rates increase operating costs, hence higher prices. We estimated that a 1 percent increase in refinery capacity utilization rates was associated with about one-tenth to two-tenths of 1 cent per gallon increase in wholesale prices. The effect of high refinery capacity utilization rates on prices has not been analyzed in previous studies.

We found that both the Midwest and West Coast supply disruptions led to higher wholesale gasoline prices, as expected, in the areas that were affected by these disruptions. Specifically, prices of conventional gasoline were about 4 to 5 cents per gallon higher on average during both the Midwest and West Coast supply disruptions. The increase in prices for

CARB gasoline was about 4 to 7 cents per gallon, on average, during the West Coast supply disruptions.[11]

Our Findings Are Generally Consistent with Previous Studies' Empirical Results

Although our econometric models differed from the few previous studies in the 1990s in several aspects, our results are generally consistent with previous studies' findings that specific oil industry mergers or increased market concentration have generally led to increases in wholesale gasoline prices. For example, one study (Hastings and Gilbert) examined the effects of changes in vertical and horizontal market structures on the wholesale prices of unbranded gasoline.[12] Two kinds of analyses were performed—one for 26 rack cities on the West Coast from 1993 to 1997 and the other for the effect of the 1997 merger between Tosco and Unocal in 13 West Coast cities. The authors found that an increase in vertical integration was associated with higher wholesale prices for unbranded gasoline. In particular, consistent with the strategic incentive to raise competitors' input costs, they found that wholesale gasoline prices were higher in cities where there was greater competition between integrated refiners and independent retailers. As discussed earlier, our model of the effects of the

[11]See appendix IV for complete details of these results.

[12]See Justine Hastings and Richard Gilbert, "Vertical Integration in Gasoline Supply: An Empirical Test of Raising Rivals' Costs," Program on Workable Energy Regulation (POWER), PWP-084, 2002.

Tosco-Unocal merger, using data from 1996 to 2000 in six rack cities, found increases in the prices of branded gasoline.[13]

Another study (Hendricks and McAfee) analyzed the effects of the then proposed merger between Exxon and Mobil—two fully vertically integrated oil companies— on CARB wholesale gasoline prices.[14] The authors found the gasoline industry in California to have 20 percent price-cost margins (or markup), and that the merger would increase the margins by about one or two percentage points for prices. In addition, most of the postmerger changes would result from changes at the refining rather than retail level, emphasizing the vertical links in these markets. [15]

In another study (Chouinard and Perloff) examining the determinants of wholesale and retail gasoline prices in the United States, using data for 48 states covering 1989 to 1997, the authors analyzed the effects of 8 mergers affecting refining and wholesale markets in 5 states and of 27 mergers affecting retail markets in 19 states.[16] Unlike our study, this study found that, overall, there were more decreases in prices than increases for these mergers. However, none of the mergers was large and none affected many regional markets. Moreover, the mergers did not include any of the eight specific mergers we studied.

We reviewed a study by FTC staff on the effects of the Marathon-Ashland merger on reformulated wholesale gasoline prices and retail prices in only one city, Louisville, Kentucky, using data from 1997 to 1999. The FTC study

[13]For unbranded gasoline, our results were not statistically significant. Hastings also found that ARCO's purchase of Thrifty's retail gasoline stations in California in 1997, which decreased the market share of independent retailers and increased retail market concentration, raised retail prices. See Justine Hastings, "Vertical Relationships and Competition in Retail Gasoline Markets: Empirical Evidence from Contract Changes in Southern California," Program on Workable Energy Regulation (POWER), PWP-075 (2001). We did not examine the effect of mergers on retail prices of gasoline because that is beyond the scope of this study.

[14]See Kenneth Hendricks and R. Preston McAfee, "A Theory of Bilateral Oligopoly, With Applications to Vertical Mergers," unpublished paper (2000). The authors did not analyze the actual effects of the merger between the two companies that occurred in December 1999.

[15]The authors measured prices as wholesale gasoline prices less marginal cost ("price-cost margin").

[16]See Hayley Chouinard and Jeffrey Perloff, "Gasoline Price Differences: Taxes, Pollution, Regulations, Mergers, Market Power, and Market Conditions," unpublished paper (2001).

found that wholesale prices increased, consistent with our findings, while retail prices did not increase.[17]

Although we developed our models drawing on insights from some of these and other studies, and there are some similarities with them, the models that we estimated differ from most existing ones in several ways. First, ours is a comprehensive study of wholesale gasoline markets that examines the effects of major individual mergers that were part of the petroleum industry's merger wave in the 1990s. Second, we examined the cumulative effects of these mergers as well as the effects of other market structure factors, using the market concentration index. Third, we performed our study for different types of gasoline—conventional gasoline sold nationwide and boutique fuels sold in California and in certain cities in the East Coast and Gulf Coast regions. Fourth, we focused on the changes in wholesale price-crude cost margins (wholesale prices less crude oil prices) instead of wholesale prices because this allowed us to capture the net effects of any potential market power and efficiency gains from mergers and market concentration.[18] Fifth, unlike most previous studies, we included the effects of gasoline inventories and refinery capacity utilization rates on wholesale prices, whereas previous studies have typically included either none of the factors or only gasoline inventories.

As we have already indicated, there are limitations to our methods for estimating the effects of individual mergers and market concentration on wholesale gasoline prices.[19] First, we based the timing of the mergers on the effective dates as provided by FTC. These are either the merger completion dates or the dates when FTC's merger remedies became effective for mergers that were subject to remedies. In reality, the effective dates of some of the mergers could be some time after the dates we used. However, because the mergers typically occurred very close to one another

[17]See Christopher Taylor and Daniel Hosken, "The Economic Effects of the Marathon-Ashland Joint Venture: The Importance of Industry Supply Shocks and Vertical Market Structure," FTC Bureau of Economics Working Paper 270, March 17, 2004. The FTC notified GAO of this study on March 24, 2004. As we discuss in appendix IV of our report, the FTC study has shortcomings in several areas, including the econometric methodology and interpretation of the results.

[18]The statistical properties of price-crude cost margins provided another motivation for their use.

[19]See appendix IV for a complete discussion of the limitations of our econometric methodology.

and there were overlaps, we could not perform sensitivity analyses on the timing of the mergers since changing the timing of one merger could cause it to coincide with the timing of another merger. Furthermore, the effective date is what most experts use to date mergers, and it is expected that using these dates would generally underestimate the effect of the mergers. More importantly, we used the dates that FTC indicated as the merger effective dates. Second, to estimate the effects of mergers on prices, we would have preferred to use market shares of the merged companies. These data are not usually available because they are proprietary. We therefore determined the effects of the mergers by estimating the difference in average prices before and after the effective dates of the mergers. Also, because of the closeness in the timing of the oil industry mergers in the second half of the 1990s as well as the overlapping nature of the mergers, estimates from our econometric models captured the mergers' effects on prices over shorter time periods. However, because our estimate of a merger's effect starts from the date that FTC indicated to be the effective date of the merger, we believe that our results are sound and reasonable. Third, the market concentration variable, measured by the Herfindahl-Hirschmann Index (HHI) of refinery capacity at the refining (or PADD) level, includes the production of other products in addition to gasoline. Also, the data were not available for 2 years (1996 and 1998), and we constructed the missing data using the average of the values of the adjacent years. Nonetheless, we believe that in a vertically integrated gasoline market, market power is better captured by production of gasoline at the refinery level since it captures the ability of refiners to control gasoline sales. Also, previous studies have identified some conceptual limitations of price-concentration relationships, in particular the problem of obtaining meaningful estimates from these relationships due to possible endogeneity of market concentration. This issue is less relevant to our models because it is not likely that prices at the rack cities would affect decisions on refinery capacity, which is made for the broader regional (PADD) market. Also, we chose to use the mergers and market concentration models and found that the effects from both models are generally consistent.

We utilized an expert in econometric modeling of the petroleum industry, Dr. Severin Borenstein, as a consultant/peer reviewer, and he provided us with comments on our econometric methodology and results, which we incorporated in our report. Other experts that reviewed a detailed outline of our econometric methodology also provided comments, which we incorporated as appropriate.

Agency Comments and Our Evaluation

We provided a draft of this report to FTC for its review and comment. FTC strongly disagreed with our econometric approach and findings, stating that the draft report was flawed and did not provide a basis for reliable judgments about the competitive effects of mergers in the petroleum industry. However, we believe that its analyses are sound and consistent with the views of independent economists and experts that peer reviewed our overall modeling approach and with previous studies. We also believe that our model specifications captured key variables that could affect wholesale gasoline prices. Partly in response to FTC's comments, we reestimated its models to account for the effects of gasoline supply disruptions that occurred in some parts of the West Coast and Midwest regions.

The full text of FTC's comments and our responses are included in appendixes V and VI. Appendix V contains the comments from FTC Commissioners and appendix VI contains the comments from FTC's Bureau of Economics staff.

Companies, Agencies, and Organizations Contacted by GAO

Integrated Oil Companies
British Petroleum
ChevronTexaco
ExxonMobil
Shell Oil Company

Exploration and Production Companies
Apache Corporation
AROC, Inc.
Devon Energy Corporation
Dominion Oil and Gas
Kerr-McGee

Independent Refiners
Kern Oil
Flint Hills Resources, LP (wholly owned by Koch Industries)
Sunoco
Valero

Pipelines and/or Terminal Operators
Kinder Morgan Energy Partners, LP
Holland Terminal Company

Independent Distributors
Barger
Cato, Inc., MD
CMS Oil Company
Congress Gas & Oil
Cross Petroleum
Downeast Energy
Free Enterprise, Inc
Global Petroleum, LLC
Holland Oil
Johnson and Dicks
Karbowski Oil Company
Lykins Companies, Inc.
Ocean Petroleum
Primar Petroleum, Inc
Quality Oil
Rice Oil Company
Rusche Distributors
Silco Oil

Southern Counties Oil Company
Speigel & Sons Oil Company
Van Manen Petroleum Group
Westco, Inc
World Oil
X-Vest, Inc.

Federal Agencies
Federal Trade Commission
Department of Energy/Energy Information Administration
Federal Energy Regulatory Commission

State Agencies
Michigan Assistant Attorney General's Office
Michigan Public Service Commission

Associations
Association of Oil Pipelines
American Petroleum Institute (API)
California Independent Oil Marketers Association (CIOMA)
California Service Station Dealers' Association
Colorado Petroleum Marketers Association
Independent Petroleum Association of America (IPAA)
Michigan Petroleum Association/Michigan Association of Convenience Stores
Michigan Service Station Dealers' Association
National Petrochemical & Refiners Association
New York Service Station Dealers' Association
Ohio Service Station Dealers' Association
Pennsylvania Service Station Dealers' Association
Petroleum Marketers Association of America (PMAA)
Society of Independent Gasoline Marketers Association
Texas Marketers Association

Hypermarkets/Unbranded Retailers
Rotten Robbie
Fuel Mart
Wawa
Sheetz
Safeway
Meijer

Costco
Kroger

Consultants
PIRA Energy Group

Industry Data Sources
John S. Herold, Inc.
Oil Price Information Service (OPIS)
Thomson Financial

Experts Who Reviewed GAO's Econometric Models

Peter Ashton
President, Innovation and Information Consultants

Hank Banta, Partner
Law Firm of Label, Novins, Lamont (Antitrust Issues)

Severin Borenstein, Ph.D.
E. T. Grether Professor of Business Administration and Public Policy,
Haas School of Business, University of California at Berkeley
Director, University of California Energy Institute
Research Associate, National Bureau of Economic Research

John S. Cook, Ph.D.
Director, Petroleum Division, and his staff
Energy Information Administration

Lawrence Goldstein, Ph.D.
President, Petroleum Industry Research Foundation, Inc.

Justine Hastings, Ph.D.
Assistant Professor of Economics, Yale University

Kenneth Hendricks, Ph.D.
Professor of Economics, University of Texas

Louis Silva, Ph.D.
Assistant Director, Antitrust 1, and other economists
Federal Trade Commission

Correlation Analysis of Mergers and Market Concentration in the U.S. Petroleum Industry

In this appendix, we present levels of wholesale gasoline market concentration as well as the results of our correlation analysis between mergers and market concentration for the petroleum refining and wholesale gasoline markets. We found that levels of wholesale gasoline market concentration increased—in some cases dramatically—in all but five states from 1994 to 2002. Our correlation analysis for petroleum refining showed a positive and statistically significant correlation between the average transaction value of mergers (henceforth mergers) and market concentration in three of the five geographic regions of the U.S. including—the East Coast, the Midwest, and the West Coast. For wholesale gasoline markets, we found a positive and statistically significant correlation between mergers and market concentration in nearly all states from 1994 through 2001. This correlation was generally highest in states that experienced large changes in market concentration over this period.

Wholesale Gasoline Market Concentration by State

As seen in table 10, most states experienced moderate to high levels of market concentration in wholesale gasoline by the year 2002, using thresholds defined by the *1992 Horizontal Merger Guidelines* jointly issued by the Department of Justice and the Federal Trade Commission.[1] Also, 43 states had increases in market concentration of well over 100 points, as measured by the Herfindahl-Hirschman index (HHI) between the years 1994 and 2002. Only 4 states—New York, Idaho, Montana, Oregon—and the District of Columbia experienced decreases in market concentration during this period, and in those cases the decrease did not change the category of market concentration under the Guidelines. For PADD I, market concentration levels in 2002 ranged from a low of 986 in New Hampshire to a high of 2,967 in the District of Columbia. In addition, market concentration increases ranged from 28 in Maryland to 652 in Rhode Island from 1994 through 2002. Decreases in concentration during this period were found in both New York and the District of Columbia. In PADD II, concentration levels in 2002 ranged from a low of 951 in Iowa to a high of 2,162 in North Dakota. Increases in concentration in this PADD ranged from 152 in Illinois to 911 in Kentucky from 1994 through 2002. In PADD III, market concentration levels in 2002 ranged from a low of 857 in Arkansas to a high of 1,326 in New Mexico, with increases in concentration ranging from 228 to 432 in Arkansas and Alabama, respectively. PADD IV

[1]The guidelines categorize markets with concentration levels, as measured by the Herfindahl-Hirschman Index, of less than 1,000 as unconcentrated, from 1,000 to 1,800 as moderately concentrated, and markets above 1,800 as highly concentrated.

experienced concentration levels ranging from 1,222 in Idaho to 2,316 in Montana, with changes in concentration from 1994 through 2002 ranging from a decrease of 40 in Idaho to an increase of 477 in Colorado. Finally, in PADD V, concentration levels in 2002 ranged from a low of 1,171 in Arizona to a high of 3,123 in Hawaii, with changes in market concentration ranging from a decrease of 143 in Oregon to an increase of 596 in Hawaii from 1994 through 2002.

Table 10: State-level HHI for Wholesale Gasoline (1994–2002)

		Year									
PADD[a]	State	1994	1995	1996	1997	1998	1999	2000	2001	2002	Change
I	CT	1028	1110	1223	1248	1292	1374	1302	1418	1501	473
I	MA	966	1023	1130	1107	1218	1249	1079	1185	1280	314
I	ME	1171	1193	1305	1385	1435	1423	1349	1340	1453	282
I	NH	749	810	917	844	855	997	884	920	986	237
I	RI	1037	1073	1154	1167	1180	1513	1470	1647	1689	652
I	VT	1061	1164	1134	1111	1114	1148	1015	1198	1164	103
I	DC	3474	3465	3249	3117	3245	2997	3033	2784	2967	-507
I	DE	865	839	884	975	1002	1076	1044	1182	1283	418
I	MD	1120	1095	1060	1117	1041	1179	1148	1105	1148	28
I	NJ	828	834	882	907	889	1018	1026	955	1130	302
I	NY	1087	1094	1146	1113	1130	1075	927	977	1048	-39
I	PA	946	945	956	967	927	1076	1167	1203	1341	395
I	FL	839	860	844	828	743	997	1093	1070	1043	204
I	GA	715	722	723	715	694	1152	1151	1088	1089	374
I	NC	831	888	886	893	846	1160	1222	1138	1117	286
I	SC	814	820	817	833	823	1007	1023	1029	1023	209
I	VA	895	957	948	963	921	1124	1083	1162	1116	221
I	WV	1654	1374	1446	1602	2356	2487	2020	1785	1744	90
II	IA	765	778	806	931	828	849	866	834	951	186
II	IL	1147	1140	1173	1176	1188	1260	1253	1281	1299	152
II	IN	1599	1636	1644	1676	1966	1983	1917	2069	2117	518
II	KS	873	888	912	875	923	944	992	1023	1214	341
II	KY	1216	1285	1392	1437	2170	2116	2033	2161	2127	911
II	MI	1150	1156	1158	1091	1241	1337	1838	1861	1884	734
II	MN	1162	1183	1204	1211	1268	1298	1340	1362	1383	221

(Continued From Previous Page)

		Year									
PADD[a]	State	1994	1995	1996	1997	1998	1999	2000	2001	2002	Change
II	MO	739	770	818	850	899	884	908	895	983	244
II	ND	1761	1815	1845	1916	1516	2292	2278	1892	2162	401
II	NE	898	878	856	844	874	943	898	987	1307	409
II	OH	1540	1508	1495	1536	2058	2147	2132	2040	1943	403
II	OK	895	927	991	944	944	957	1001	933	1048	153
II	SD	845	934	927	887	760	898	957	943	1153	308
II	TN	742	806	835	853	871	1215	1251	1224	1231	489
II	WI	944	999	1003	1123	1187	1120	1201	1235	1275	331
III	AL	713	718	762	809	779	1216	1170	1150	1145	432
III	AR	629	637	625	633	772	817	840	784	857	228
III	LA	897	912	941	936	845	1055	1105	1098	1157	260
III	MS	711	731	738	771	727	1025	1043	1019	1063	352
III	NM	938	966	1030	1111	1225	1305	1192	1236	1326	388
III	TX	794	825	852	850	837	941	977	970	1117	323
IV	CO	1002	1029	1039	1039	1240	1282	1278	1274	1479	477
IV	ID	1262	1272	1151	1120	1035	1098	1130	1089	1222	-40
IV	MT	2339	2290	2282	2079	2024	2064	2303	2380	2316	-23
IV	UT	1142	1153	1161	1146	1270	1320	1305	1200	1391	249
IV	WY	1115	1129	1070	992	1107	1291	1402	1325	1350	235
V	AK	2505	2577	2679	2975	2828	2719	2599	2721	2746	241
V	AZ	1142	1069	1151	1215	1427	1331	1175	1045	1171	29
V	CA	1122	1144	1200	1310	1488	1511	1356	1395	1597	475
V	HI	2527	2575	2339	2271	2222	2813	2890	2942	3123	596
V	NV	1417	1463	1425	1339	1361	1354	1282	1359	1555	138
V	OR	1867	1495	1406	1445	1699	1734	1594	1556	1724	-143
V	WA	1421	1381	1398	1427	1572	1557	1423	1376	1579	158

Source: GAO analysis of EIA data.

[a]Petroleum Administration Defense Districts (PADD) are regional districts defined by the Department of Energy.

Correlation Analysis of Mergers and Market Concentration

To determine the degree of association or connection between changes in merger activity and market concentration we analyzed correlations for both petroleum refining and wholesale gasoline supply.[2] For both correlations, we used average merger transaction values from John S. Herold, Inc., as a proxy for merger activity and market concentration data from the Energy Information Administration (EIA) of the Department of Energy.[3] Transaction values were reported for nearly 60 percent of the mergers in the John S. Herold merger database, including all mergers during the period valued at over $1 billion. We performed the correlations using the Pearson correlation coefficient from the SAS (Statistical Analysis System) statistical package. This coefficient measures the strength of the linear relationship between two variables and ranges from –1 to +1, with a positive number corresponding to a positive or direct association and a negative number corresponding to a negative or inverse association. In addition, we used the SAS package to test the statistical significance for each pair of variables in the correlation.

Correlation Analysis for Petroleum Refining

To perform the correlation analysis for petroleum refining, we used market concentration data at the regional or PADD level because we were able to obtain data at this level and were told by experts and academicians that this was a relevant geographic market for refining. We used yearly average merger transaction values and yearly market concentration (HHI) data from 1991 to 2000, omitting the years 1996 and 1998 because market concentration (HHI) data were unavailable for these years. Table 11 presents the results of our correlation analysis between the average transaction value of mergers and market concentration for the petroleum refining market.

[2]While we are aware that other factors may affect market concentration, such as growth of the market, entry, and exit, we focused our examination on the linkage between merger activity, as measured by the average yearly transaction values of mergers, and market concentration.

[3]For the correlations, we also used the yearly total value of mergers as it captures both the size and the number of mergers, and the results were similar to the average annual transaction value of mergers.

Table 11: Correlation between the Average Transaction Value of Mergers and Market Concentration (HHI) for Petroleum Refining by PADD (1991-2000)

Petroleum Administration for Defense Districts (PADD)	PADD I East Coast Region	PADD II Midwest Region	PADD III Gulf Coast Region	PADD IV Rocky Mountain Region	PADD V West Coast Region
Market concentration (HHI); range of lowest to highest	1,150-827	674-004	520-704	1,029-1,128	877-1,267
Correlation coefficient between the average of transaction value of mergers and HHI[a]	0.80[b] (0.0177)	0.93[b] (0.0091)	0.53 (0.1773)	0.37 (0.3652)	0.91[b] (0.0018)

Source: GAO analysis of data from John S. Herold, Inc., and the EIA.

Notes: (1) The correlation between mergers and concentration by Petroleum Administration for Defense Districts (PADDs) does not include years 1996 and 1998 because HHI data are unavailable for these years. (2) We calculated the average transaction values of mergers using the transaction values of mergers divided by the total number of mergers, as reported in the John S. Herold, Inc., dataset. John S. Herold defines transaction value as the value of the merger at the time of the offer, based on either the value of the seller's assets or the offer from the buyer.

[a]Numbers in parenthesis indicate the statistical significance of the estimate of correlation.

[b]Eestimates are statistically at the 0.05 level or below.

As table 11 shows, the average transaction values of mergers and petroleum refining market concentration (HHIs) are positively correlated and highly statistically significant for the regions of PADD I (the East Coast), PADD II (the Midwest), and PADD V (the West Coast).

Correlation Analysis for Wholesale Gasoline

To perform the correlation analysis for wholesale gasoline supply, we used market concentration data at the state level because we were able to obtain data at this level and were told by experts and academicians that this was the relevant geographic market. We estimated correlations between the transaction values of mergers and market concentration (HHI) for wholesale gasoline supply from 1994 through 2001. Although we were able to obtain monthly HHI data from 1994 through 2002 for each state, we only had yearly merger transaction data. Therefore, for this correlation, we matched lagged values of the yearly average merger transaction from 1993 through 2000 with monthly observations of the HHI for each state from 1994 through 2001. Table 12 presents the results of our correlation analysis between the yearly average transaction values of mergers and market concentration for wholesale gasoline supply. The correlation was positive and statistically significant in almost all states.

Table 12: Correlation between the Average Transaction Value of Mergers and Market Concentration (HHI) for Wholesale Gasoline (1994-2001)

PADD	State	Correlation coefficient	Statistical significance
I	GA	0.92	<.0001
I	NC	0.91	<.0001
I	SC	0.86	<.0001
I	VA	0.80	<.0001
I	FL	0.78	<.0001
I	RI	0.77	<.0001
I	NH	0.75	<.0001
I	NJ	0.74	<.0001
I	WV	0.74	<.0001
I	MD	0.68	<.0001
I	CT	0.67	<.0001
I	DE	0.65	<.0001
I	ME	0.61	<.0001
I	PA	0.58	<.0001
I	MA	0.58	<.0001
I	VT	0.36	0.0003
I	NY	-0.36	0.0004
I	DC	-0.37	0.0002
II	TN	0.91	<.0001
II	OH	0.85	<.0001
II	KY	0.76	<.0001
II	ND	0.76	<.0001
II	IL	0.69	<.0001
II	IN	0.68	<.0001
II	MN	0.63	<.0001
II	MI	0.62	<.0001
II	MO	0.61	<.0001
II	WI	0.56	<.0001
II	KS	0.55	<.0001
II	NE	0.39	<.0001
II	IA	0.31	0.002
II	OK	0.25	0.0128
II	SD	0.21	0.0395
III	AL	0.91	<.0001

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PADD	State	Correlation coefficient	Statistical significance
III	MS	0.89	<.0001
III	AR	0.82	<.0001
III	NM	0.77	<.0001
III	LA	0.74	<.0001
III	TX	0.73	<.0001
IV	UT	0.83	<.0001
IV	CO	0.78	<.0001
IV	WY	0.74	<.0001
IV	MT	-0.03	0.7746
IV	ID	-0.43	<.0001
V	CA	0.76	<.0001
V	HI	0.72	<.0001
V	WA	0.64	<.0001
V	AZ	0.37	0.0003
V	OR	0.33	0.0009
V	AK	-0.01	0.9060
V	NV	-0.21	0.0430

Source: GAO analysis of data from John S. Herold, Inc., and EIA.

Note: We calculated the average transaction values of mergers using the transaction values of mergers divided by the total number of mergers, as reported in the John S. Herold, Inc., dataset. John S. Herold defines transaction value as the value of the merger at the time of the offer, based on either the value of the seller's assets or the offer from the buyer.

A comparison of tables 10 and 12 illustrates that, with few exceptions, states with large increases in market concentration from 1994 through 2002 also displayed a high level of correlation between the average transaction value of mergers and market concentration for wholesale gasoline over this period. For instance, 13 of 18 states in PADD I had correlations between mergers and market concentration greater than 0.60. Of those 13 states, 11 experienced increases in their HHI from 200 to 400 between 1994 and 2002. In PADD II, states with correlations above 0.70 (Tennessee, Ohio, Kentucky, and North Dakota) all had HHIs that increased by 400 to over 900 index points over the period. Similarly, in PADD III, all states displayed correlations over 0.70 and all had increases in their HHI of over 200 to over 400 points. In PADD IV, the states of Utah, Colorado, and Wyoming, all had increases in HHI of 200 to over 400 points and displayed correlations over 0.70. Lastly, in PADD V, California and Hawaii experienced increases in their HHI of 400 to over 500 points and also had correlations over 0.70.

Econometric Analyses of the Effects of Specific Mergers and Market Concentration on U.S. Wholesale Gasoline Prices

This appendix discusses our analysis of the effects of specific mergers, market concentration, and other factors on wholesale gasoline prices in the United States in the second half of the 1990s. In particular, we discuss

- the development of two groups of econometric models we used to estimate the effects of eight specific oil industry mergers, market concentration, and other factors on wholesale gasoline prices of different gasoline specifications,
- the data sources and selection of the geographic markets that we analyzed,
- specifications of econometric models and estimation methodology,
- our econometric results, and
- limitations of our econometric methodology.

GAO's Econometric Models of Wholesale Gasoline Prices Built on Previous Studies and Market Analysis

We developed two groups of econometric models to determine the effects of mergers and market concentration on U.S. wholesale prices of different gasoline specifications—conventional, reformulated, and CARB—in the second half of the 1990s. The first group of models (mergers models) determined the effects of eight individual oil industry mergers on wholesale gasoline prices using a broad panel data that included racks where the merging companies operated before they merged.[1] The second group of models (market concentration models) determined the effects of market concentration on wholesale gasoline prices nationwide. The market concentration models capture the cumulative effects of mergers as well as other structural factors such as barriers to entry. We relied on information from previous studies, industry experts, and from our own analysis of the oil industry, specifically the wholesale gasoline market, to develop our econometric models.

[1]Wholesale gasoline sales occur at terminals or racks that are near or in cities, sometimes referred to as rack cities.

Oil Industry Mergers in the Second Half of the 1990s Affected Wholesale Gasoline Markets

Several oil industry mergers involving large and partially or fully vertically integrated companies in the second half of the 1990s affected wholesale gasoline markets. These mergers generally reduced the number of suppliers at the relevant wholesale racks, except in the cases where the Federal Trade Commission (FTC) required the merging parties to divest assets to a third party.[2]

The second half of the1990s witnessed a wave of oil industry mergers, and we examined the eight transactions listed below—which we refer to generally as mergers since they led to consolidation of assets, although some of the transactions were identified as joint ventures.

- Tosco-Unocal: On April 1, 1997, Tosco bought Unocal's West Coast refining and marketing (wholesale and retail) assets in Petroleum Administration for Defense District (PADD) V.[3]

- UDS-Total: On September 25, 1997, Ultramar Diamond Shamrock (UDS) merged with Total, affecting wholesale markets mainly in PADDs II, III, and IV.

- Marathon-Ashland: On January 5, 1998, Marathon formed a joint venture with Ashland, creating Marathon Ashland Petroleum LLC (MAP), a refining and marketing (wholesale and retail) company, affecting PADDs I, II, and III.

- Shell-Texaco I (Equilon): On January 23, 1998, Shell formed a joint venture with Texaco to combine their refining and marketing (wholesale and retail) businesses mainly in PADDs II, III, IV, and V, creating Equilon.[4]

[2]In order to preserve competition at racks that would have been affected significantly by the mergers, the FTC provided remedies, particularly in the form of divestitures, in order to replace the competition that would be lost as a result of the mergers. A divestiture requires that one or both of the merging parties sell some of its assets to restore or maintain competition where it might be harmed.

[3]The United States is divided into five regions: PADD I, the East Coast region; PADD II, the Midwest region; PADD III, the Gulf Coast region; PADD IV, the Rocky Mountain region; and PADD V, the West Coast region.

[4]Downstream businesses include refining and marketing (wholesale and retail).

- Shell-Texaco II (Motiva): On July 1, 1998, Shell formed a joint venture with Texaco and Star (jointly controlled by Texaco and Saudi Refining Company) to combine their refining and marketing assets mainly in PADDs I, II, and III, creating Motiva.

- BP-Amoco: On December 31, 1998, British Petroleum (BP) merged with Amoco, affecting wholesale markets in PADDs I, II, and III.

- Exxon-Mobil: On November 30, 1999, Exxon merged with Mobil, affecting wholesale markets in PADDs I and III.

- MAP-UDS: On December 13, 1999, MAP bought the assets of UDS located in Michigan (PADD II), including its distribution network and rack facilities in the wholesale market.

Some of the mergers had the potential to directly reduce competition in wholesale gasoline markets because the merging companies supplied wholesale gasoline in overlapping markets before they merged. For instance, FTC identified the BP-Amoco merger as having potential anticompetitive effects on wholesale gasoline markets in 30 cities or metropolitan areas in the eastern part of the U.S. Mergers that reduce competition in other levels of the downstream segment of the petroleum industry—such as refining or retail—could also indirectly reduce competition in wholesale markets if one of the merging companies is partially or fully vertically integrated. For instance, the Exxon-Mobil merger, which had the potential to reduce competition in refining in the West Coast and in retail markets on the East Coast, could have had competitive implications in the relevant wholesale markets.

Several Factors, Including Mergers and Market Concentration, Are Expected to Affect Wholesale Gasoline Prices

We used the same general econometric specification to estimate the effects of individual mergers, market concentration, and other factors on prices in wholesale gasoline markets. In U.S. wholesale gasoline markets, wholesalers (consisting of affiliated and independent distributors)[5] buy

[5]The affiliated distributors buy only from their parent companies, which are typically the large integrated oil companies, while the independents typically buy from the lowest-priced seller. Both buyers sell to their own retail stations as well as to other retail stations.

gasoline from refiners (consisting of integrated refiners and independents)[6] at racks and truck the gasoline to retail gasoline stations. In models of vertically integrated markets such as gasoline marketing, market power can be assigned to either the sellers or to buyers.[7] It has been previously assumed that the refinery (upstream) market is imperfectly competitive while the wholesale (downstream) market, in contrast, is generally competitive.[8] We focused on prices the refiners post at the racks ("rack prices") because, on average, that is the most dominant form of wholesale market transaction nationwide and there are no publicly available data on transfer prices and no reliable systematic data on dealer-tankwagon sales.[9]

Dependent Variable—Wholesale Prices

Our dependent variable is wholesale prices—measured by wholesale gasoline prices less crude oil prices—because this approach enables us to assess the combined market power and efficiency effects of mergers and market concentration on wholesale prices.[10] We used the average rack prices at the rack cities for both the mergers' models and the market concentration models—for the mergers' models, we used the average prices instead of prices of only the merging companies because the average rack prices better capture competition at the racks before and after the mergers.

[6]The integrated refiners are large companies that typically sell branded gasoline that bears their trademarks (e.g., Exxon and BP), while the independents are small, tend to be less integrated, and sell a higher proportion of unbranded gasoline. Branded gasoline contains an additive associated with the brand, but unbranded gasoline need not, and often does not, contain the same additive package. Integrated refiners use exchange agreements to get gasoline in locations where they do not have refineries or rack space.

[7]See, for example, Hendricks and McAfee (2000).

[8]See Pinkse et. al (2002).

[9]The rack prices can be contract or noncontract. Transfer prices are implicit prices at which integrated refiners supply their company-owned and company-operated retail stations. Dealer-tankwagon prices are contract prices charged to lessee dealers (dealers that operate retail stations leased from an integrated refiner) and open dealers (dealers that own a retail station but contract with a refiner to sell its branded gasoline). See chapter 4 for a description of the wholesale gasoline marketing structure.

[10]See Hastings and Gilbert (2002) and Hendricks and McAfee (2000) for a similar approach using price margins (wholesale prices less crude costs or prices in other rack cities).

Explanatory Variables

Several of the explanatory variables we used in our models have been used in previous studies of wholesale gasoline prices. We used the following variables in our basic models.[11]

- MERGERS: In the mergers models we used dummy variables for each of the mergers (e.g., an Exxon-Mobil dummy variable for the merger between Exxon and Mobil) to determine the average differences in wholesale gasoline prices before and after the respective mergers.

- HHI (Herfindahl-Hirschman Index): In the market concentration model, we used an index of market concentration, the HHI, to determine the effects of market concentration on wholesale gasoline prices. The effects of market concentration incorporate mergers' effects because mergers increase this measure of market concentration in an amount that is specific to each merger. The market concentration data are based on refinery capacity at the refinery (or PADD) level, a higher level of aggregation than the rack-city level. We believe that the source of potential market power in the wholesale gasoline market is at the refinery because, as already indicated, the refinery market is imperfectly competitive and refiners essentially control gasoline sales at the racks. For instance, using market concentration data for Nevada (in PADD V) based on gasoline sales is less meaningful because gasoline sold in Nevada comes mainly from California (also in PADD V). Furthermore, using refinery capacity data is an appropriate measure of concentration in the wholesale gasoline market because refinery capacity captures the ability of the suppliers (refiners) to produce.[12]

[11]See for example, studies in the oil industry by Borenstein and Shepard (1996a, 1996b), Chouinard and Perloff (2001), GAO (1993), Hastings and Gilbert (2002), Hastings (2002), Pinkse et al. (2002), and Vita (2000).

[12]Hendricks and McAfee (2000) advocated using capacity to measure the effect of mergers on gasoline markets. We constructed the market concentration using the Department of Energy's EIA (Energy Information Administration) data on refinery capacity, which are annual. A limitation of the refinery capacity data is that they do not give the exact yield for gasoline—some refineries can yield about 55 to 60 percent and others can yield only about 45 to 50 percent of gasoline. However, the refinery capacity data are generally fixed for a long period of time.

- CRUDE: We included the cost of crude oil (CRUDE), which has the largest share of input cost used in the production of gasoline, although for econometric and interpretative purposes we used it as part of the dependent variable.[13]

- INVENTORIES RATIO: The ratio of gasoline inventories to expected demand (INVENTORIES RATIO)[14] could affect the availability of gasoline at the wholesale level and, hence, prices—prices will increase if inventories are low relative to demand and decrease if inventories are high relative to demand.

- UTILIZATION RATES: The level of refinery capacity utilization rates (UTILIZATION RATES) could impact wholesale gasoline prices through changes in supply. Although the data for UTILIZATION RATES are available only at the national level and do not allow us to account for differences in utilization rates across the United States, the data are still useful because gasoline is mostly fungible, especially in the eastern part of the United States.

- SUPPLY DISRUPTIONS: We also included dummy variables to account for the supply disruptions that occurred in the Midwest in June 2000 (MW CRISIS) and in the West Coast during periods in 1999 and 2000 (WC CRISIS). These disruptions contributed to price spikes in these markets. We based our information on the Midwest and the West Coast disruptions on FTC's report[15] and a study by FTC staff, respectively.[16] In both cases, the supply disruptions were identified by simply comparing over time the price differences between the assumed affected areas and

[13]We did not include CRUDE directly as an explanatory variable in the price-margin equation, because the dependent variable is defined as wholesale prices less crude oil costs. Although we did not have price data for other inputs, such as labor and capital costs, at the rack city level, we do not expect this to significantly affect our findings because these inputs comprise a small share of the inputs used to produce gasoline. Crude oil costs constitute about 66 percent of total refining costs. The other costs are capital costs (20 percent), labor costs (6 percent), purchased services costs (6 percent), and energy costs (2 percent).

[14]The gasoline inventories, based on EIA data, included gasoline inventories at bulk racks and refineries and in pipelines at the PADD level. The data used were aggregated for finished gasoline, including conventional and reformulated. However, the aggregate data reflect the dominant type of gasoline in the region.

[15]See FTC (2001a) for more details.

[16]See Taylor and Fischer (2001) and EIA (2001).

an assumed unaffected city on the Gulf Coast. In the case of the West Coast, the authors attributed observed spikes to refinery and/or pipeline problems carried in the trade press during the period. Although these studies seem to imply that the disruptions were regional in scope (Midwest—PADD II and—West Coast—PADD V), it is difficult to determine the geographical scope of these disruptions or their timing and duration. In particular, the geographic scope of these disruptions could be smaller or bigger than the entire region depending on the fungibility of gasoline in the area. Nonetheless, as part of our sensitivity analysis, we used dummy variables to construct measures of the Midwest and the West Coast supply disruptions based on the assumption that these disruptions were regional in scope. We therefore consider our measures of these supply disruptions to be crude, at best.

Table 13 presents the expected effects of all the explanatory variables used in our models. [17, 18]

[17]We did not include year effects because while the year effects would control for cyclical patterns that are common to all rack cities, we do not believe there are annual cyclical phenomena in the gasoline markets that we studied. Also, we could not estimate the effects of income and population density—demand-related variables—because the data do not vary across time within a rack city (they are time invariant).

[18]Due to the possibility that certain variables— in particular, INVENTORIES RATIO and UTILIZATION RATES—could be influenced by wholesale gasoline prices, and hence be endogenous, we used the following variables as instruments: 52 weekly (seasonal) dummy variables (WEEKS), a time trend (TREND), and a squared time trend (TREND SQUARED). We considered the HHI, based on refinery capacity, to be exogenous to rack prices—this is in contrast to using the actual flow of gasoline sales, which are more reactive to actual current gasoline prices, to measure market concentration.

Table 13: Expected Effects of Key Explanatory Variables on Wholesale Gasoline Prices

Explanatory variable	Expected effect	Explanation of expected effect on wholesale gasoline prices
MERGER dummy (e.g., EXXON-MOBIL)	Uncertain	Mergers have both market power effects and efficiency effects, which increase and reduce prices, respectively.[a]
HHI	Uncertain	Increased market concentration can have both market power effects and efficiency effects, which increase and reduce prices, respectively.[b]
INVENTORIES RATIO	Decrease	While an increase in the ratio of gasoline inventories to expected demand leads to high inventory costs, the increase provides more protection against unexpected or not fully anticipated supply problems, decreasing prices.[c]
UTILIZATION RATES	Uncertain	An increase in refinery capacity utilization rate will generally increase output levels, hence lower prices, but when the utilization rates are at an already very high level, higher utilization would increase costs and prices.
SUPPLY DISPRUPTIONS: MW CRISIS, WC CRISIS	Increase	The supply disruptions, by decreasing available supply relative to demand, would increase prices.[d]

Sources: GAO analysis of previous studies on gasoline pricing.

[a]See, for example, Chouinard and Perloff (2001) and Hastings and Gilbert (2002); see, also Karikari et al. (2002) for railroad mergers, Kim and Singal (1993) for airline mergers, and Vita and Sacher (2001) for hospital mergers.

[b]See, for example, Borenstein and Shepard (1996b) and Hastings and Gilbert (2002).

[c]See, for example, Pinkse et al. (2002) who used changes in inventories.

[d]See EIA (2001) and Taylor and Fischer (2001).

It has been suggested in a previous study that spatial-price competition is important in U.S. wholesale gasoline markets.[19] Essentially, although wholesale gasoline is physically an almost completely homogeneous product, its geographic location could differentiate it from the same product in another location, implying that prices at the nearest neighboring rack city could influence prices at a rack city. We did not, however, incorporate this variable directly in our models because there is co-movement between the nearest price variable and prices since both variables are likely to be generated by the same set of independent variables.[20] More importantly, if there are omitted regional or local variables that drive wholesale prices, then the nearest prices will be a strong predictor of prices, even if the suppliers at nearby racks do not

[19]See Pinkse et al. for details.

[20]In fact, in our preliminary estimations we found that the estimated coefficients on the nearest prices were not statistically different from one.

compete. So the nearest prices might not actually be estimating the true spatial effects but simply picking up the effects of the omitted variables. However, dropping the nearest prices is likely to introduce correlation across residuals of prices at nearby racks, which could benefit from correction. While the distances between racks and the nearest racks could have helped capture the effect of spatial competition, we could not estimate this effect because the data do not vary across time within a rack city—they are time invariant. Consequently, we addressed the issue of spatial competition through a variance adjustment procedure for the error terms.[21]

It is also likely that in markets where both branded gasoline and unbranded gasoline are sold, the prices of one brand could affect the prices of the other. However, this relationship may be less important than spatial-price competition for several reasons. First, the correlation between the prices of one brand at a rack and the nearest-neighbor prices of the same brand was higher than the correlation between prices of branded and unbranded gasoline at the same rack.[22] Second, a major supplier typically supplies both branded and unbranded gasoline at a rack but is less likely to operate in the nearest rack, implying that brand competition is less likely than spatial-price competition.

We could not estimate the effects of states' divorcement regulations, which restrict ownership of retail gasoline stations by gasoline refiners, because the data are time-invariant. The effect of this regulation on wholesale gasoline prices, from a theoretical perspective, is uncertain.[23]

Data Sources and Sample Selection

In analyzing the effects of mergers and market concentration on wholesale gasoline prices, we used all available data from all the racks in the contiguous United States. Using the OPIS (Oil Price Information Services) rack data, we performed several data-processing tasks, including matching the OPIS Rack data to data from several other sources. The data covered

[21]See the section on estimation methodology below for a discussion of how we handled this potential problem by accounting for contemporaneous cross-sectional (rack city) correlations.

[22]We should note that branded and unbranded gasoline might compete to some extent in a market.

[23]See Vita (2000) for a detailed discussion of the possible effects of divorcement regulations.

three types of regular, unleaded gasoline—conventional gasoline from 1994 through 2000, reformulated gasoline from 1995 through 2000, and CARB gasoline from 1996 through 2000. In addition, we used gasoline data from the EIA and merger data from the FTC and Thomson Financial.

Data Sources

The wholesale price data were obtained from the OPIS rack data, which are posted rack prices at the racks. The data are collected from more than 350 racks, which represent over 90 percent of the racks in the United States, and information on companies that supply gasoline at the racks, the gasoline specification, and the gasoline brand. We also obtained (1) data from the EIA, including crude oil prices, gasoline inventories, refinery capacity for the construction of market concentration data, and refinery capacity utilization rates and (2) merger data from the Federal Trade Commission and Thomson Financial. Table 14 lists the variables that we constructed and the data sources.

Table 14: Variables in Our Econometric Analysis of Wholesale Gasoline Prices

Variable	Definition	Data source	Data frequency, level
PRICES: BRANDED UNBRANDED	Wholesale gasoline prices (cents per gallon, 2000 dollars): Branded Unbranded	OPIS ERP	Weekly, City
CRUDE	Crude oil spot prices (cents per gallon, 2000 dollars): West Texas Intermediate (WTI)	EIA ERP	Weekly, National
HHI	Market concentration, measured by the HHI of refinery capacity	EIA GAO analysis	Yearly,[a] PADD
TOSCO-UNOCAL	Dummy variable for the Tosco-Unocal merger, equals 1 if postmerger period (from 4/1/1997 to 12/31/2000), 0 otherwise	TF[b] OPIS	Weekly, City
UDS-TOTAL	Dummy variable for the UDS-Total merger, equals 1 if postmerger period (from 10/1/1997 to 12/31/2000), 0 otherwise	FTC[c] OPIS	Weekly, City
MARATHON-ASHLAND	Dummy variable for the Marathon-Ashland merger, equals 1 if postmerger period (from 1/5/1998 to 12/31/2000), 0 otherwise	TF[b] OPIS	Weekly, City
SHELL-TEXACO I (Equilon)	Dummy variable for the Shell-Texaco I merger, equals 1 if postmerger period (from 2/1/1998 to 12/31/2000), 0 otherwise	FTC[c] OPIS	Weekly, City

(Continued From Previous Page)

Variable	Definition	Data source	Data frequency, level
SHELL-TEXACO II (Motiva)	Dummy variable for the Shell-Texaco II merger, equals 1 if postmerger period (from 7/1/1998 to 12/31/2000), 0 otherwise	TF[b] OPIS	Weekly, City
BP-AMOCO	Dummy variable for the BP-Amoco merger, equals 1 if postmerger period (from 12/31/1998 to 12/31/2000), 0 otherwise	TF[b] OPIS	Weekly, City
MAP-UDS	Dummy variable for the MAP-UDS merger, equals 1 if postmerger period (from 12/13/1999 to 12/31/2000), 0 otherwise	TF[b] OPIS	Weekly, City
EXXON-MOBIL	Dummy variable for the Exxon-Mobil merger, equals 1 if postmerger period (from 3/1/2000 to 12/31/2000), 0 otherwise	FTC[c] OPIS	Weekly, City
INVENTORIES RATIO	Ratio of gasoline inventories to expected demand. Gasoline inventories are one-period lagged levels of normalized gasoline inventories, and expected demand is the fitted values from a regression equation of a normalized volume of gasoline sales.	EIA GAO analysis[d]	Weekly, PADD
UTILIZATION RATES	Refinery capacity utilization rates (in percent)	EIA	Weekly, National
MW CRISIS	Dummy variable for Midwest gasoline supply disruption—equals 1if June 2000 and PADD II, 0 otherwise	FTC (2001a, Figure 2)	Weekly, City
WC CRISIS	Dummy variable for West Coast gasoline supply disruptions in 1999 and 2000—equals 1 for 3/5/99-9/10/99, 2/12/00-5/6/00, and 7/10/00-12/31/00, in the West Coast, 0 otherwise	Taylor and Fischer (2002) EIA (2001)	Weekly, City
WEEKS[e]	Dummy variables for the 52 weeks in a year—equals 1for each week of the year (e.g., Week 1), 0 otherwise	NA	Weekly, NA
TREND[e]	Time trend	NA	NA
TREND SQUARED[e]	Square of TREND	NA	NA

Legend

BP=British Petroleum

EIA=Energy Information Administration (Department of Energy)

ERP=Economic Report of the President (February 2002, table B-66, p. 397)

FTC=Federal Trade Commission

MAP=Marathon Ashland Petroleum

NA = Not applicable

OPIS=Oil Price Information Services

TF=Thomson Financial

UDS=Ultramar Diamond Shamrock

Source: GAO analysis of EIA, FTC, OPIS, and Thomson Financial data.

[a]Data were not available for 1996 and 1998, and we constructed data for the missing years using the average of the two adjacent years.

[b]The effective date is the merger completion date.

[c]The effective date is when FTC's merger remedies became effective.

[d]Gasoline inventories were normalized using the PADD mean over the sample period. The demand for wholesale gasoline was based on prime suppliers' sales of total regular gasoline in each state. We used an approach similar to the Borenstein and Shepard's (1996b) study to estimate the demand for gasoline. A simplified demand equation, in reduced form, for each state was obtained using the following regression equation: $NVOLUME_t = a_0 + a_1 NVOLUME_{t-1} + \Sigma b_j MONTH_j + a_2 TREND_t + a_3 TREND\ SQUARED_t + e_t$, where t=time (monthly), j = 2, … , 12. NVOLUME is the normalized monthly demand for wholesale gasoline in each state—prime suppliers' sales of gasoline in each state divided by the state mean over the sample period. The data for prime suppliers' sales was obtained from the EIA. $MONTH_j$ is a monthly dummy variable, and TREND and TREND_SQUARED are time trend and square of time trend, respectively. The R^2 of these predicting equations varied between 0.50 and 0.96. The expected demand is the fitted values from estimating the regression equation above because it is assumed that suppliers' form their expectations of next-period demand based on current and past sales volumes observed in their markets. The expected demands for the states were aggregated to the PADD level to match the data for the inventories.

[e]The variables are instruments.

Selection of Geographic Markets and Gasoline Types

Although there is no consensus on which geographic areas across the United States constitute separate wholesale gasoline markets because of the difficulty in defining true geographic market areas, many industry experts generally identify a rack city as an appropriate geographic market. Rack cities are well defined and generally cover small geographic areas.[24] Our analysis is therefore based on racks. The selection of the geographic areas, the gasoline specifications (conventional, CARB, and reformulated), and time periods of the analysis was based primarily on the availability of data, after merging and matching data from the different sources. The conventional gasoline contains no additive, but reformulated gasoline and CARB contain MTBE (methyl tertiary butyl ether) as an additive. For the mergers models, we used data for conventional gasoline for each of the mergers, except the Tosco-Unocal merger, which affected primarily California, where CARB gasoline is used. Data for CARB gasoline were used for the Shell-Texaco I and Tosco-Unocal mergers. We used reformulated gasoline data for the BP-Amoco, Exxon-Mobil, Marathon-Ashland, and Shell-Texaco II mergers since they affected the East Coast and the Gulf Coast, the predominant markets for reformulated gasoline. Data for the mergers and market concentration models were based on rack cities that were directly affected by the mergers and rack cities not affected

[24]Most of the studies on wholesale gasoline markets have used a rack city as the unit of analysis; see, for example, Borenstein and Shepard (1996a, 1996b), Hastings and Gilbert (2002), and Pinkse et al. (2002).

by these mergers. We had data for conventional gasoline, the dominant type of gasoline, from all five regional geographic regions—data for over 280 rack cities (for branded) and over 250 rack cities (for unbranded) out of the over 350 rack cities in the OPIS database.[25] The data for conventional gasoline were available from 1994 through 2000 (specifically, 2/3/94-12/31/00), reformulated gasoline from 1995 through 2000 (specifically, 3/2/95-12/31/00), and CARB gasoline from 1996 through 2000 (specifically, 5/16/96-12/31/00).

Specification of Econometric Models and Estimation Methodology

We used quasi reduced-form price models to analyze the effects of mergers and market concentration on wholesale gasoline prices because such models have been found to be useful in previous studies.[26] Two types of models were developed and estimated—one for the effects of the eight individual mergers and the other for the effects of market concentration on wholesale gasoline prices. We used econometric techniques appropriate for estimating our panel data—the fixed-effects estimator in the context of a feasible generalized least squares (FGLS) technique to account for contemporaneous cross-sectional correlations and corrections for heteroskedasticity and first-order autocorrelation.[27]

Model Specifications

A useful methodology for estimating the effects of oil industry mergers on wholesale prices is to compare prices in the affected markets before and after the merger. One method relates wholesale gasoline prices in markets affected by the merger to prices in control markets that were not impacted by the merger or other mergers within the time frame of the study, after controlling for appropriate variables.[28] Another method relates wholesale

[25]There are no rack data for Hawaii and the District of Columbia.

[26]The equations we estimated are single-equation or limited information models because we do not specify the complete structural equations for the other potential endogenous variables. The regressions used to obtain the estimated values of the other endogenous variables are computational devises used to purge the prices from potential correlation with the error term. A reduced-form price model is useful for analyzing the total impact of a policy-relevant event, such as a merger, on prices. In addition, a reduced-form model may provide more robust and reliable estimates; see, for example, Schmidt (2001). See also FTC (2001b, p. 24).

[27]See Greene (2000) for the FGLS technique.

[28]See, for example, Barton and Sherman (1984) and Kim and Singal (1993).

gasoline prices in the affected markets to a merger-related variable and demand and cost shifters.[29] Our approach is a blend of both approaches, which requires that we specify a quasi reduced-form relationship for prices that is a function of market structure and regulatory factors, and other supply and demand factors, using a broad panel data of rack cities comprising those affected and not affected by the mergers.

Using panel data—data across markets (racks) and over time—the quasi reduced-form relationship for wholesale gasoline prices can generally be specified as follows:[30]

(1) $Y_{it} = \theta + X_{it}\,\delta + \nu_i + \varepsilon_{it}$,

and $\varepsilon_{it} = |\rho|\,\varepsilon_{i,t-1} + \eta_{it}$,

where:

i = 1,. . ., N, represents the individual units (racks) in the panel data.

t = 1, . . ., T, represents the time periods (weekly).

Y_{it} = wholesale prices (wholesale gasoline prices less crude oil costs) at rack i in week t.

X_{it} = a vector of explanatory variables consisting of market structure and regulatory factors, other cost/supply factors, and other demand factors at rack i in week t.

θ = constant term.

δ = the coefficients of X_{it}.

ν_i = the rack city-specific error component, which is a fixed-effect or random-effect specification.

[29]See, for example, Karikari et al. (2002).

[30]See, for example, Chouinard and Perloff (2001), Hastings and Gilbert (2002), and Pinkse et al. (2002).

ε_{it} = autoregressive error component.

η_{it} = white-noise error term, which is independently and identically distributed (*iid*) with mean zero and variance σ^2. We later allow correlations across the rack observations, i.

In the estimation of equation (1), ν_i could be treated either as fixed or random. We later discuss our choice of the estimation technique based on the context of the data, among other factors. The error component in equation 1 is given a first-order autoregressive error structure, *AR(1)*, to help capture the dynamic effects of wholesale gasoline prices. More important, our statistical tests indicated that the error terms are *AR(1)*, based on the estimated autocorrelation coefficients. Also, the statistical tests we performed indicated that wholesale gasoline prices (for some gasoline specifications and types) and crude oil prices were each nonstationary—specifically, they were integrated of order one, *I(1)*, using the adjusted Dickey-Fuller (ADF) test for unit root.[31] Hence, we used wholesale gross prices—wholesale prices less crude oil prices—to obtain stationary series in addition to helping to capture the market power and efficiency effects of mergers and market concentration.[32]

Using the general specification provided in equation 1, we estimated different equations for the effects of mergers and the effects of market concentration on wholesale gasoline prices. We used the following basic equations to determine the effects of individual mergers and market concentration on wholesale prices of different specifications of gasoline (conventional, reformulated, and CARB), and gasoline types (branded and unbranded), using panel data of weekly data and racks.

Mergers Model

$$(2)\ \text{PRICES}_i = \alpha_0 + \Sigma\alpha_{1,k}\,\text{MERGER}_{ki} + \alpha_2\,\text{INVENTORIES RATIO}_i + \alpha_3\,\text{UTILIZATION RATES}_i + \alpha_4\,\text{MW CRISIS} + \alpha_5\,\text{WC CRISIS} + \mu_{1i},$$

where i represents the racks, k represents only the racks where the merging companies operated before they merged, $\alpha_{1,k}$ captures the effects

[31]See Dickey and Fuller (1979).

[32]The ADF unit root test indicated that the HHI is stationary only in PADD I. Nonetheless, we regard the unit root tests to be weak because the HHI is bounded (ranges from 0 to 10,000). Furthermore, it would not be appropriate to first-difference the HHI to obtain stationarity since the data are generally constant over some relatively long periods of time.

of merger k on prices in those cities, and μ_{1i} is a random error term. Separate equations were estimated for the following gasoline specifications—conventional (branded, unbranded), CARB (branded, unbranded), and reformulated (branded, unbranded).

Market Concentration Model

$$(3)\ PRICES_i = \beta_0 + \beta_1\ HHI_i + \beta_2\ INVENTORIES\ RATIO_i + \beta_3\ UTILIZATION\ RATES_i + \beta_4\ MW\ CRISIS + \beta_5\ WC\ CRISIS + \mu_{2i},$$

where i represents the racks, and μ_{2i} is a random error term. Separate equations were estimated nationally and for various geographic areas—very broad geographic areas defined as the eastern half and the western half of the United States.[33] Furthermore, similar to the mergers models, the estimates were obtained for the following gasoline specifications and types, where data were available: conventional (branded, unbranded), CARB (branded, unbranded), and reformulated (branded, unbranded).

For the mergers model given by equation (2), we used dummy variables for each of the mergers to determine the average differences in wholesale gasoline prices before and after the mergers either because data were not available for the market shares of the merging companies before and after the mergers or because the HHI was not available at the level of the racks. We used racks that had all available data, and the specific merger dummy variables ($MERGER_{ki}$) were applicable only in the rack cities where the merging companies operated. This technique has the merit of providing estimates for the merger effects in the relevant racks relative to the racks that were not affected by those mergers. Our approach also has the merit of allowing potential price correlations across rack cities contemporaneously.

Model Estimation Techniques

Our econometric analyses are based on panel data, which pool cross-sectional and time-series data.[34] The cross-sectional data are based on racks for wholesale gasoline, and the time-series data are weekly. Several

[33]The eastern half of the United States consists of PADDs I, II, and III, which are generally areas to the east of the Mississippi River, and the western half consists of PADDs IV and V.

[34]An important purpose in combining cross-sectional and time-series data is to control for individual city-specific unobservable effects, which may be correlated with explanatory variables in the model.

econometric issues have to be dealt with in estimating the effects of mergers and market concentration on prices, using equations (2) and (3), respectively, and panel data. First, the unobserved city-specific error component could be treated as fixed or random. The fixed-effects estimator is preferred when observations are not chosen randomly and there are likely to be unobservable, site-specific effects (see, for example, Hsiao, 2003). This estimator can be implemented by demeaning the data by rack city (i.e., transforming the data into mean-deviations). In wholesale gasoline markets such unobserved differences might include unmeasured supply or demand effects, such as different pricing strategies of the refiners at the different rack cities and the level of development of the transportation system in the different areas. A major advantage of the fixed-effects estimator is that there is no need to assume that the unobserved city-specific effects are independent of the included explanatory variables. Furthermore, since the selection of the rack cities used in our study was not randomly drawn but was based on data availability, we prefer the fixed-effects estimator for this study. This estimator allows us to account for variations in wholesale prices across the racks that we could not explicitly account for, such as transportation costs. On the other hand, the random-effects estimator allows one to include a time-invariant variable. Also, the random-effects estimator allows one to make unconditional (marginal) inferences with respect to the population of all effects. However, one has to make specific assumptions about the pattern of correlation (or assume no correlation) between the unobserved effects and the included explanatory variables. The need for these assumptions is a major shortcoming of the random-effects estimator because there are reasons to believe that the assumption of no correlation may not be correct for wholesale gasoline markets and could bias the estimates.

Second, in both the mergers and the HHI models, we focus on their effects on prices, conditional on other variables in the price equations. Since two of the explanatory regressors in the price equations might be endogenous—INVENTORIES RATIO and UTILIZATION RATES—we test for their endogeneity using the Hausman (1978) specification test.[35] In all the models, the endogenous regressors are instrumented using these excluded exogenous variables—time trend, time trend squared, and 52 seasonal weekly dummies—as well as the included exogenous variables in

[35]The Hausman (1978) specification test can be used to test for endogeneity of regressors; see, for example, Wooldridge (2002, pp. 118-119).

the respective models. In each case, the instrumented endogenous regressor is the predicted value in a regression of the corresponding endogenous regressor on all the instruments—both the excluded exogenous regressors and the included exogenous regressors in the respective models. Essentially, the instruments are used to purge the potential endogenous regressors of their correlations with the prices to obtain consistent estimates. If exogeneity of the variables is rejected, we use the instrumental variable method. Otherwise, we use the least squares method. Furthermore, if exogeneity of the variables is rejected, we check the appropriateness of the instruments (test of the overidentifying restrictions) using the Hausman (1978) test.[36]

In a merger equation, the effect of a merger on prices is captured by the coefficient estimate for that merger dummy. This estimate measures the change in the mean of price conditional on the covariates in this regression equation. Technically, this is the estimate of the partial derivative of the conditional mean of price, where the conditioning set contains all regressors including inventory and capacity utilization.

It should be noted that the instrumented regressors in the instrumental variable estimation are not based on a true first-stage regression since we do not have a fully specified system of simultaneous equations. In particular, we do not specify a model for INVENTORY RATIO or for UTILIZATION RATES because our main interest is in price. Our estimation should, therefore, be interpreted as a single-equation instrumental variable estimation. A consistent estimation of the price equation requires that INVENTORY RATIO and UTILIZATION RATES or the instruments used for them be uncorrelated with the regression error, and we used tests for endogeneity of the regressors and exogeneity of the instruments to check this requirement.

Third, the regression errors are perhaps contemporaneously correlated across rack cities because they capture all unobservables impacting various rack cities at the same time. Depending on the outcome of the

[36]The Hausman (1978) specification test can be used to test for overidentifying restrictions; see, for example, Wooldridge (2002, pp. 122-123). Our tests indicated that the two regressors were exogenous in some models. In the cases where the variables were endogenous, the tests indicated that the instruments were appropriate or valid. (Also, the instruments were relevant for both the INVENTORY RATIO and UTILIZATION RATES—the R^2s for the first-stage regressions ranged from 85 to 90 percent, and from 58 to 66 percent, respectively). See the regression estimates in tables 21-28 for details.

endogeneity test, we used a Feasible Generalized Least Squares/Instrumental Variables estimation (FGLS/IV) or just the FGLS estimation as the proper method of inference. In either case, we accounted for both contemporaneous correlations and groupwise heteroskedasticity, and the estimation is done using panel data in a fixed-effect context.[37]

Fourth, the regression errors might be serially correlated. We used the FGLS/IV or FGLS estimator assuming a first-order autoregressive structure, AR(1). We tested for the presence of AR(1) by regressing the residuals from the preferred estimator—FGLS/IV or FGLS—depending on the outcome of the endogeneity test, on one-period lagged residuals, and testing for significance of the coefficient.[38]

Econometric Results

Our econometric results show that

- mergers generally increased wholesale gasoline prices,
- increased market concentration resulted in higher wholesale gasoline prices, and
- low gasoline inventories, high refinery capacity utilization rates, and supply disruptions increased wholesale gasoline prices.

Mergers Generally Increased Wholesale Gasoline Prices

Mergers, by reducing the number of suppliers of wholesale gasoline, affect market concentration, and hence have predicted effects on wholesale prices. As shown in tables 15-17, we found that wholesale prices generally

[37]In cases where the estimation method is FGLS/IV, we used two Stata software programs to carry out the testing and estimation. The programs are a panel-data instrumental variable estimator (IVREG2) and the feasible generalized least squares (XTGLS) estimator. To be able to use the two programs in an integrated fashion, we had to slightly modify XTGLS so that it takes as input the residuals of the IVREG2 estimator for calculating autocorrelation and contemporaneous correlation parameters. Without this modification, a two-stage XTGLS would calculate the instrumental variables (IV) residuals using the instrument rather than the endogenous regressors causing biased estimation. (See, for example, Davidson and Mackinnon (1993, p. 221).

[38]See pp. 282-283 of Wooldridge. Our tests indicated the presence of AR(1) in all the models. See the regression estimates in tables 21-28 for details.

increased as result of mergers, but there were also some decreases.[39] For conventional gasoline, the mergers resulted in increases in prices of wholesale gasoline for five of the seven mergers (see table 15). In particular, our model results show that the mergers of Marathon-Ashland, Shell-Texaco I (Equilon), BP-Amoco, MAP-UDS, and Exxon-Mobil had increases in the prices of both branded and unbranded gasoline, while the mergers of UDS-Total and Shell-Texaco II (Motiva) resulted in decreases in prices. In table 16, for reformulated gasoline, the Marathon-Ashland and Exxon-Mobil mergers increased prices while the Shell-Texaco II (Motiva) merger decreased only the prices of branded gasoline. The effects of the Shell-Texaco II (Motiva) merger on unbranded gasoline and the BP-Amoco merger on both branded and unbranded gasoline prices were inconclusive. Our estimates in table 17 also show that for CARB gasoline, the Tosco-Unocal merger increased prices of branded gasoline while the Shell-Texaco I (Equilon) merger decreased prices of branded gasoline. The effects of the two mergers on unbranded gasoline were inconclusive.

The estimates in tables 15-17 are summaries of the effects of the individual mergers on wholesale gasoline prices (using the mergers models) for different gasoline specifications—conventional, reformulated, and CARB—and their branded and unbranded varieties.[40] The full econometric estimates are provided in tables 21-23, and they show that all the estimated relationships are highly statistically significant based on the models' probability values (p-values).[41] The estimates presented in tables 15-17 are based on the estimates in tables 21-23 that include the supply disruptions in the Midwest in 2000 and/or in the West Coast in 1999 and 2000, shown in column (ii) for branded gasoline and column (iv) for unbranded gasoline. The R-squares for these estimates range from 20 percent to 36 percent.[42] The autocorrelation coefficients indicate the presence of autocorrelation in the error terms, which we accounted for in the estimation process by specifying a first-order autoregressive structure (see the tests of autocorrelation in tables 21-23). The Hausman (1978) specification tests

[39]A statistically significant change means that the estimated changes in prices are statistically different from zero.

[40]A complete discussion of the effects of each merger on prices is provided in chapter 5.

[41]The only exception is column (iii) of table 23. All the econometric estimates were obtained using Stata (Version SE 8.0), College Station, Texas.

[42]When we estimated the models for conventional gasoline by including crude oil prices as a regressor, instead of as part of the dependent variable, the R-squares exceeded 80 percent.

indicated that the preferred estimator for unbranded conventional gasoline and unbranded CARB gasoline was the instrumental-variables (IV) technique; the other estimates were based on the least squares estimates.

In chapter 5, we discussed previous studies on mergers affecting gasoline markets, including a recent study by FTC staff, sent to us on March 24, 2004.[43] Here, we provide a more detailed assessment of the FTC study because the study examines one of the mergers that we studied; it is also, to our knowledge, the first public retrospective analysis of mergers in the petroleum industry done by FTC staff. In the study, FTC staff examined the economic effects of the Marathon-Ashland merger and found that this merger increased wholesale prices of reformulated gasoline in Louisville, Kentucky, by 3 to 5 cents per gallon during the period they analyzed—1998 and 1999. They argued, independent of their statistical analysis, that the increase was due to increased demand from St. Louis, Missouri, which switched to reformulated gasoline during the period of the study and not due to the merger. Furthermore, they found that retail prices at gasoline stations supplied by rack distributors did not increase, presumably due to competition from retailers of reformulated gasoline supplied directly by refiners and retailers of conventional gasoline that did not experience increases in their relative wholesale prices.

Although the increase in wholesale prices of reformulated gasoline found by the FTC is consistent with our findings, the study has shortcomings in several related areas, including sampling, econometric methodology, and interpretation of results. First, the FTC study uses prices in three selected control cities (Chicago, Houston, and Northern Virginia, which we believe includes Fairfax) to help separate the merger's effects from other demand and supply effects. We believe that all three cities fail to meet the essential requirement of a control unit—that the control cities and the city of interest are nearly identical, except for the Marathon-Ashland merger, in terms of demand and supply conditions of gasoline. For instance, the Marathon-Ashland merger affected the wholesale gasoline market in Fairfax, which would make Northern Virginia an inappropriate control city for this merger.[44] Furthermore, other key mergers affected the control cities, making the control cities inappropriate. Specifically, the Shell-Texaco II

[43]See Taylor and Hosken (2004).

[44]From the OPIS rack database, both Ashland and Marathon were important participants in the wholesale gasoline market in Chicago from 1994 until 1997, when Ashland left. The merger also affected the markets in Norfolk and Richmond, both in Virginia.

(Motiva) merger in July 1998 affected Fairfax and Houston, and the BP-Amoco merger in December 1998 affected Fairfax. Also, the seasonal demand factors may be different between Louisville and the control cities.

Second, the FTC study does not take into account the potential effects of the BP-Amoco merger, which occurred in December 1998 and affected the wholesale gasoline market in Louisville. This makes it difficult to separate the effects of the Marathon-Ashland merger from the effects of the BP-Amoco merger in 1999, severely limiting the interpretation of the results.

Third, FTC argued that increased demand from St. Louis was solely responsible for the increased wholesale prices. However, the FTC study did not explicitly include demand from St. Louis and so it is not evident how much of the increase in prices was due to the Marathon-Ashland merger and how much was due to the increased demand from St. Louis. Interpreting the price increase in wholesale prices as an artifact of St. Louis' entry into the reformulated gasoline market without such evidence confounds FTC's interpretation of the effects of the merger. Furthermore, even if the increased demand from St. Louis was potentially responsible for the price increase found in FTC's study in 1999, FTC's study fails to explain the price increase in 1998, prior to the switch to reformulated gasoline in St. Louis in 1999. Finally, using only one market (city) unnecessarily reduces the scope of findings for the impact of the merger.

Tables 15-17 present the results of our model showing the effects of each of the individual mergers on wholesale gasoline prices in the racks that were affected by those mergers. The cumulative effects of all the mergers, as well as the effects of other market structure factors, are estimated using market concentration, which is a comprehensive measure of market structure. The effects of market concentration on wholesale prices are presented in the next section.

Table 15: Effects of Mergers on Conventional Wholesale Gasoline Prices (1994-2000)

		Estimates are obtained using data for		
Merger	Geographic region[a]	premerger period	postmerger period[b]	Estimated change in price margin (cents per gallon)
UDS-Total	PADD II, III, IV	2/3/94–9/30/97	10/1/97–1/31/98	
Branded				- 0.89[c]
Unbranded				- 1.25[c]
Marathon-Ashland	PADD I, II, III	2/3/94–1/4/98	1/5/98–6/30/98	
Branded				0.70[c]
Unbranded				0.39[c]
Shell-Texaco I	PADD II, III, IV, V	2/3/94–1/31/98	2/1/98–12/30/98	
Branded				0.99[c]
Unbranded				1.13[c]
Shell-Texaco II	PADD I, II, III	1/5/98–6/30/98	7/1/98–12/30/98	
Branded				- 1.77[c]
Unbranded				- 1.24[c]
BP-Amoco	PADD I, II, III	7/1/98–12/30/98	12/31/98–2/29/00	
Branded				0.40[c]
Unbranded				0.97[c]
MAP-UDS	PADD II	12/31/98–12/12/99	12/13/99–12/31/00	
Branded				1.38[c]
Unbranded				2.63[c]
Exxon-Mobil	PADD I, III	12/31/98–2/29/00	3/1/00–12/31/00	
Branded				3.71[c]
Unbranded				5.00[c]

Source: GAO econometric analysis of EIA, FTC, OPIS, and Thomson Financial data.

Notes: The data are from 2/3/94 to 12/31/00.

See also table 21.

[a]PADD I=East Coast, PADD II=Midwest, PADD III=Gulf Coast, PADD IV=Rocky Mountain, and PADD V=West Coast.

[b]The effective date, which is the first date in the postmerger period, is based on either the merger completion date or the date when FTC's merger remedies became effective. As shown in the table, when mergers closely followed each other, they tended to shorten the before-merger and after-merger time periods that we could model, especially when more than one merger affected the same rack cities. Nonetheless, we believe we had sufficient data for the analysis.

[c]The estimated changes in prices are statistically significant at the 1 percent level or lower.

Table 16: Effects of Mergers on Reformulated Wholesale Gasoline Prices (1995-2000)

		Estimates are obtained using data for		
Merger[a]	**Geographic region[b]**	**premerger period**	**postmerger period[c]**	**Estimated change in price margin (cents per gallon)**
Marathon-Ashland	PADD I, II	3/2/95–1/4/98	1/5/98–6/30/98	
Branded				0.71[d]
Unbranded				0.86[d]
Shell-Texaco II	PADD I, III	1/5/98–6/30/98	7/1/98–12/30/98	
Branded				- 0.39[e]
Unbranded				0.09
BP-Amoco	PADD I, II	7/1/98–12/30/98	12/31/98–2/29/00	
Branded				0.55
Unbranded				0.40
Exxon-Mobil	PADD I, III	12/31/98–2/29/00	3/1/00–12/31/00	
Branded				1.61[d]
Unbranded				1.01[e]

Source: GAO econometric analysis of EIA, FTC, OPIS, and Thomson Financial data.

Notes: The data are from 3/2/95 to 12/31/00.

See also table 22.

[a]No estimates are reported for the UDS-Total merger because data are available for only one rack city. See table 22 for details.

[b]PADD I=East Coast, PADD II=Midwest, and PADD III=Gulf Coast. PADD II had data for only one rack city.

[c]The effective date, which is the first date in the postmerger period, is based on either the merger completion date or the date when FTC's merger remedies became effective. As shown in the table, when mergers closely followed each other, they tended to shorten the before-merger and after-merger time periods that we could model, especially when more than one merger affected the same rack cities. Nonetheless, we believe we had sufficient data for the analysis.

[d]The estimated changes in prices are statistically significant at the 1 percent level or lower.

[e]The estimated changes in prices are statistically significant at the 5 percent level or lower.

Table 17: Effects of Mergers on CARB Wholesale Gasoline Prices (1996-2000)

		Estimates are obtained using data for		
Merger	Geographic region[a]	premerger period	postmerger period[b]	Estimated change in price margin (cents per gallon)
Tosco-Unocal	PADD V	5/16/96–4/10/97	4/11/97–1/31/98	
Branded				6.87[c]
Unbranded				-1.58
Shell-Texaco I	PADD V	4/11/97–1/31/98	2/1//98–12/31/00	
Branded				- 0.69[c]
Unbranded				-0.24

Source: GAO econometric analysis of EIA, FTC, OPIS, and Thomson Financial data.

Notes: The data are from 5/16/96 to 12/31/00.

See also table 23.

[a]PADD V=West Coast (only California).

[b]The effective date, which is the first date in the postmerger period, is based on either the merger completion date or the date when FTC's merger remedies became effective. As shown in the table, when mergers closely followed each other, they tended to shorten the before-merger and after-merger time periods that we could model, especially when more than one merger affected the same rack cities. Nonetheless, we believe we had sufficient data for the analysis.

[c]The estimated changes in prices are statistically significant at the 5 percent level or lower.

Increased Market Concentration Resulted in Higher Wholesale Gasoline Prices

We show in tables 18 and 19 that increased market concentration in wholesale gasoline markets resulted in price increases for conventional gasoline, as well as for boutique fuels—reformulated gasoline and CARB gasoline. This finding is partly attributed to the mergers' reducing the number of suppliers in the wholesale gasoline markets. The changes in wholesale prices of conventional gasoline, however, varied across broad geographic regions partly because of differences in access to gasoline supplies from other refining centers of the country or from abroad. As shown in table 18, the increases in prices were larger in the western part of the United States (PADDs IV and V) than the eastern part (PADDs I, II, and III) for branded gasoline. In table 19, the wholesale prices of CARB gasoline (sold only in California) were substantially larger as a result of increased market concentration. This is partly due to the unique

requirement in California as well as the state's relative isolation from the major refining centers in the Gulf Coast.[45]

Tables 18 and 19 summarize our econometric estimates of the effects of market concentration on different gasoline specifications (conventional, reformulated, and CARB) and their branded and unbranded varieties, based primarily on the econometric results in tables 24-28. All the estimated models are highly statistically significant based on the models' probability values (or p-values). The estimates presented in tables 18 and 19 are based on the estimates in tables 24-28 that include the supply disruptions in the Midwest in 2000 and/or on the West Coast in 1999 and 2000 in column (ii) for branded gasoline and column (iv) for unbranded gasoline. Similar to the estimates for the mergers, the R-squares for these estimates range from 16 percent to 36 percent.[46] Also, the autocorrelation coefficients indicate the presence of first-order autoregressive error structure; see the tests of autocorrelation in tables 24-28. Furthermore, the Hausman (1978) specification tests indicated that the preferred estimator for unbranded conventional gasoline, broadly, and for unbranded CARB gasoline was the instrumental-variables (IV) technique; the other estimates were based on the least squares estimates.

[45]A complete discussion of the effects of market concentration on prices is provided in chapter 5.

[46]When we estimated the models for conventional gasoline by including crude oil prices as a regressor, instead of as part of the dependent variable, the R-squares exceeded 80 percent. We also considered other possible relationships between the HHI and prices, including the squared HHI. The results for the HHI were not statistically significant, or the estimates were not inconsistent with our results.

Table 18: Effects of Market Concentration on Conventional Wholesale Gasoline Prices (1994-2000)

	Market concentration (HHI)			
All regions[a]	**1994**	**2000**	**Increase in HHI**	**Estimated change in wholesale price margin due to increase in HHI (cents per gallon)[b]**
Branded	803	1101	298	0.15[c]
Unbranded	803	1101	298	0.33[c]
Geographic area				
Eastern United States (PADDs I, II, III)				
Branded	773	1090	317	0.25[c]
Unbranded	773	1090	317	0.10
Western United States (PADDs IV, V)				
Branded	1032	1180	148	0.56[c]
Unbranded	1032	1180	148	1.29[d]

Source: GAO econometric analysis of EIA, FTC, and OPIS data.

Notes: The data are from 2/3/94 to 12/31/00.

See also tables 24-26.

[a]All states except Alaska, California, Connecticut, Delaware, the District of Columbia, Hawaii, Massachusetts, New Hampshire, New Jersey, and Rhode Island. These states were excluded due to the lack of sufficient data.

[b]The changes in prices were obtained by multiplying the increases in HHI by the marginal effects (coefficients) of HHI in tables 24-26, columns (ii) and (iv) for branded and unbranded, respectively.

[c]The estimated changes in prices are statistically significant at the 1 percent level or lower.

[d]The estimated changes in prices are statistically significant at the 5 percent level or lower.

Table 19: Effects of Market Concentration on Wholesale Prices of Boutique Fuels (1995-2000)

	Market concentration (HHI)			
	1995	2000	Increase in HHI	Estimated change in price margin due to increase in HHI (cents per gallon)[b]
Reformulated wholesale gasoline: 1995-2000[a]				
Branded	1,237	1,477	240	0.98[c]
Unbranded	1,237	1,477	240	0.89[c]
CARB reformulated wholesale gasoline: 1996-2000[d]	**1996**	**2000**		
Branded	965	1,267	302	7.19[c]
Unbranded	965	1,267	302	7.94[e]

Source: GAO econometric analysis of EIA, FTC, and OPIS data.

Note:

See also tables 27 and 28.

[a]The data are from 3/2/95 to 12/31/00 for Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, and Virginia in PADD I; Kentucky in PADD II; and Texas in PADD III.

[b]The changes in prices were obtained by multiplying the increases in HHI by the marginal effects (coefficients) of HHI in table 27 for reformulated and table 28 for CARB reformulated, columns (ii) and (iv) for branded and unbranded wholesale gasoline, respectively.

[c]The estimated changes in prices are statistically significant at the 1 percent level or lower.

[d]The data are from 5/16/96 to 12/31/00 for California.

[e]The estimated changes in prices are statistically significant at the 10 percent level or lower.

Low Gasoline Inventories, High Refinery Capacity Utilization Rates, and Supply Disruptions Increased Wholesale Gasoline Prices

We found that the effects of other factors on wholesale gasoline prices during the second half of the 1990s are generally consistent with expectations. We discuss the effects of the gasoline inventories and refinery capacity utilization rates on prices based on the regression results for conventional wholesale gasoline (the dominant gasoline type used in most geographic regions) presented in table 24 for branded and unbranded gasoline. The results for the supply disruptions are based on the estimates

for conventional gasoline in table 24 and for CARB in table 28.[47] Also, we used the market concentration model because market concentration better represents overall market structure conditions than mergers. Using results from the econometric models of pricing of wholesale conventional gasoline, we found that wholesale prices were higher when inventories were low relative to expected demand and when refinery capacity utilization rates were high. Also, both supply disruptions in the Midwest and in the West Coast regions were associated with higher gasoline prices.[48]

Summary statistics for selected variables used in the econometric analysis are presented in table 20 based on data for conventional gasoline. The results show that wholesale prices (wholesale gasoline prices less crude oil prices) of branded gasoline exceeded those of unbranded gasoline by about 2 cents for conventional and reformulated gasoline, but by more for CARB. Also, the wholesale gasoline markets used in our study were, on average, close to moderately concentrated based on the HHI, with wide variations across states. The refinery capacity utilization rates averaged 94 percent. And there were wide variations in gasoline inventories and demand that generally reflect a seasonal pattern.

The estimates in table 24 show that the other explanatory factors used in the models generally have the expected effects. The subsequent discussions are based mainly on the estimates in columns (ii) and (iv) of the tables. The effect of INVENTORIES RATIO is unambiguously negative, which indicates that lower gasoline inventories (relative to demand) had the expected effect of increasing prices.[49] In particular, prices are about 1 cent higher from about May to October, the summer driving months, when inventories are low relative to expected demand, compared to the period from about November to April when inventories are high relative to

[47]The results were generally similar to those for the mergers models. The Midwest supply disruptions affected only one rack city in the data for reformulated gasoline.

[48]We could not obtain estimates for demographic factors such as income and population density or for competitive conditions such as distance, number of terminals, and divorcement regulations because the data are time-invariant.

[49]Pinkse et al. (2002) also obtained a negative effect in their model, even though they used percentage changes in inventories.

expected demand.[50] We included refinery capacity utilization rates—a variable that has not been used in previous studies but has been suggested as influencing gasoline prices by industry experts—in the model to assess its impact on wholesale gasoline prices. In table 24, the results indicate that higher utilization rates are associated with higher prices—particularly for the estimates for unbranded gasoline. A 1 percent increase in refinery capacity utilization rates resulted in about 0.10 to 0.20 cent per gallon increase in prices. We found that prices were higher because high refinery capacity utilization rates in the oil refining industry leave little room for error in predicting short-run demand.

As shown in tables 24 and 28, both supply disruptions in the Midwest and the West Coast were associated with higher gasoline prices of branded and unbranded gasoline. The effects of both the Midwest and West Coast supply disruptions on prices ranged from about 4 to 5 cents per gallon for conventional gasoline, and the effects of the West Coast supply disruptions on CARB gasoline ranged from about 4 to 8 cents per gallon. Also, the price increases were slightly larger for unbranded gasoline than for branded, consistent with the fact that disruptions would reduce the supply of unbranded gasoline more than branded as refiners meet the demand from their branded distributors first.

[50]The coefficient for INVENTORIES RATIO represents the change in prices when the ratio of inventories to expected demand increases by 100 percent. Therefore the estimated coefficients are about 7 to 9 cents per gallon (see columns (ii) and (iv) of table 24). Assuming an increase of about 14 percent (which is about 2 standard deviations for INVENTORIES, see table 20) from May to October, it implies that prices are typically about 1 cent per gallon higher from May through October compared to the other months.

Table 20: Selected Summary Statistics for Conventional Wholesale Gasoline Markets

Variable	Mean	Standard deviation	Minimum	Maximum
BRANDED PRICES[a]				
Conventional	18.57	7.04	-0.59	72.98
Reformulated	19.70	5.74	4.06	55.86
CARB	35.53	13.15	2.59	96.51
UNBRANDED PRICES[b]				
Conventional	16.96	7.11	-3.45	85.12
Reformulated	18.31	6.12	3.19	68.85
CARB	30.66	14.36	1.45	103.40
HHI	950	387	520	1827
NUMBER OF SUPPLIERS	10	5	1	26
INVENTORIES[c]	1.00	0.07	0.72	1.33
DEMAND[d]	1.004	0.15	0.77	1.30
UTILIZATION RATES	93.5%	3.2%	84.6%	100.5%
DISTANCE (in miles)	48	29	2	208
TERMINALS[e]	12	8	1	34

Source: GAO analysis of Census Bureau, EIA, and OPIS data.

Note: Branded and unbranded prices are in cents per gallon.

[a]BRANDED PRICES are branded wholesale gasoline prices less crude oil prices.

[b]UNBRANDED PRICES are unbranded wholesale gasoline prices less crude oil prices.

[c]INVENTORIES are normalized inventories of wholesale gasoline at the PADD level.

[d]DEMAND is normalized expected sales for wholesale gasoline at the PADD level.

[e]TERMINALS is the number of racks in a state.

Our Econometric Methodology Had Some Limitations

There are some limitations to our methods for estimating the effects of individual mergers and market concentration on wholesale gasoline prices. First, the timing of a merger is based on the effective date of the merger provided by FTC, which is either the merger completion date or the date when FTC's merger remedies became effective if the merger was subject to remedies. Although the true effective dates of some mergers could be some time after these dates, we could not perform sensitivity tests on the timing of the mergers since changing the timing of one merger could coincide with the timing of another merger, as the mergers typically occurred very close to each other and there were overlaps in certain rack

cities. In any case, the effective date is what most experts use to date mergers, and it is expected that using these dates would generally underestimate the effects of the mergers.

Second, the market concentration variable, measured by the HHI, was measured at the PADD level using refinery capacity. While we believe that in a vertically integrated gasoline market, market power is better captured by production of gasoline at the refinery level, the data for refinery capacity include the production of other products in addition to gasoline. Also, data were not available for two years (1996 and 1998).[51]

Third, some variables were only available at higher levels of aggregation than we would have preferred or were not publicly available. The gasoline inventories were available at the regional (PADD) level, and refining capacity utilization rates were available at the national level, instead of the city or even state level; however, these limitations are less important since gasoline is mostly fungible, particularly in the regions in the eastern half of the country (PADDs I, II, and III).

Fourth, to estimate the effects of mergers on prices, we would have preferred to use market shares of the merged companies. However, these data are not usually available because they are proprietary. We therefore determined the effects of the mergers by estimating the difference in average prices before and after the effective dates of the mergers. Also, because of the closeness of the timing of the oil industry mergers in the second half of the 1990s as well as the overlapping nature of the mergers, estimates from our econometric models captured the mergers' effects on price margins over shorter time periods.

Fifth, we could not obtain data that would directly capture possible vertical relationships between the refiners and marketers of gasoline, and the role of independent refiners and retailers. However, we attempted to capture some of these effects indirectly by performing separate analyses for gasoline types (branded and unbranded) since integrated refiners sell primarily branded gasoline, and independent refiners are dominant in the unbranded market nationwide.

[51]Another possible measure of market concentration for our study is using HHI data that (1) are based on gasoline sales by prime suppliers who are not all refiners and (2) exclude small refiners. When we used these data in our models, the results were generally similar but not as robust compared to those reported.

Although there are limitations to our methodology of estimating the effects of mergers and market concentration on wholesale gasoline prices, our model specifications and results are generally consistent with previous studies.[52]

[52]See chapter 5 for a discussion of results from previous studies. See also, for example, Borenstein and Shepard (1996b), Chouinard and Perloff (2001), and Pinkse et al. (2002).

Table 21: Econometric Estimates of Mergers' Effects on Conventional Wholesale Gasoline Prices

	Branded		Unbranded	
Independent variable	FGLS (i)	FGLS (ii)	FGLS/IV (iii)	FGLS/IV[a] (iv)
UDS-TOTAL	-1.0240[b] (0.0249)	- 0.8894[b] (0.0202)	-1.2519[b] (0.0726)	-1.2466[b] (0.0667)
MARATHON-ASHLAND	0.9218[b] (0.0192)	0.6995[b] (0.0149)	0.5859[b] (0.0573)	0.3850[b] (0.0523)
SHELL-TEXACO I	1.9289[b] (0.0362)	0.9920[b] (0.0261)	2.0012[b] (0.0681)	1.1345[b] (0.0569)
SHELL-TEXACO II	-1.7556[b] (0.0384)	-1.7686[b] (0.0332)	-1.2156[b] (0.0912)	-1.2406[b] (0.0919)
BP-AMOCO	0.3303[b] (0.0176)	0.4007[b] (0.0158)	0.7236[b] (0.0519)	0.9679[b] (0.0836)
EXXON-MOBIL	3.8154[b] (0.0788)	3.7107[b] (0.0687)	5.0514[b] (0.1301)	5.0005[b] (0.1007)
MAP-UDS	0.9339[b] (0.0772)	1.3846[b] (0.0703)	1.9756[b] (0.1479)	2.6333[b] (0.1507)
INVENTORIES RATIO	- 8.3756[b] (0.1306)	- 8.5344[b] (0.1346)	- 5.9058[b] (1.4575)	- 6.6552[b] (1.3967)
UTILIZATION RATES	0.0873[b] (0.0346)	0.0975[b] (0.0335)	0.2274[b] (0.0685)	0.2678[b] (0.0687)
MW CRISIS	NA	4.2460[b] (0.1076)	NA	5.4164[b] (0.1243)
WC CRISIS	NA	4.7384[b] (0.1946)	NA	5.2531[b] (0.3339)
Constant	- 0.0090 (0.2677)	- 0.0044 (0.2234)	0.0228 (0.2959)	0.0113 (0.2495)
Model prob-value	0.0000[b]	0.0000[b]	0.0000[b]	0.0000[b]
R-squared[c]	0.18	0.24	0.11	0.20
Hausman 1 (χ^2, df)[d]	(3.10, 2)	(2.70, 2)	(6.02, 2)[e]	(9.20, 2)[e]
Hausman 2 (χ^2, df)[f]	NA	NA	(- 52.06, 51)	(1.10, 51)
AR(1) coefficient[g]	0.8352[b]	0.8259[b]	0.8305[b]	0.8149[b]
Rack cities	282	282	256	256
Weeks	361	361	361	361

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, OPIS, and Thomson Financial data.

Note: The values in parentheses are standard errors.

[a]The instruments excluded the squared time trend variable to obtain valid instruments. The effects of the mergers were however similar.

[b]The estimates are significant at the 1 percent level or lower.

[c]R-squared is based on a regression of the dependent variable on its predicted values.

[d]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

residuals on one-period lagged values.

[e]The estimates are significant at the 5 percent level or lower.

[f]Hausman 2: The null hypothesis is the instruments are exogenous or valid (no overidentifying restrictions). The test statistic is based on Hausman's (1978) specification test. A negative χ^2 is interpreted as lack of evidence to reject the null hypothesis; see Stata 7, Reference H-P, (2001), vol. 2, p. 13.

[g]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 22: Econometric Estimates of Mergers' Effects on Reformulated Wholesale Gasoline Prices

	Branded		Unbranded	
Independent variable	FGLS (i)	FGLS (ii)	FGLS (iii)	FGLS (iv)
UDS-TOTAL	- 0.3848[a] (0.0757)	- 0.3875[a] (0.0745)	- 0.2260 (0.1720)	- 0.2237 (0.1679)
MARATHON-ASHLAND	0.7042[a] (0.2237)	0.7131[a] (0.2221)	0.8493[a] (0.3127)	0.8558[a] (0.3060)
SHELL-TEXACO II	- 0.3770[b] (0.1844)	- 0.3896[b] (0.1825)	0.1117 (0.3643)	0.0862 (0.3531)
BP-AMOCO	0.5641[b] (0.2324)	0.5500[b] (0.2309)	0.3790 (0.3252)	0.3976 (0.3185)
EXXON-MOBIL	1.5718[a] (0.3023)	1.6080[a] (0.3010)	0.9613[b] (0.4546)	1.0118[b] (0.4503)
INVENTORIES RATIO	- 3.4738[a] (0.8283)	- 3.4529[a] (0.8275)	- 3.8467[a] (0.9472)	- 3.8524[a] (0.9432)
UTILIZATION RATES	0.1898[c] (0.0972)	0.1905[b] (0.0971)	0.0812 (0.1051)	0.0835 (0.1048)
MW CRISIS	NA	2.8199[a] (1.0261)	NA	5.2124[a] (1.4006)
Constant	0.0588 (0.6665)	0.0565 (0.6561)	0.0048 (0.7107)	0.0042 (0.6908)
Model prob-value	0.0000[a]	0.0000[a]	0.0000[a]	0.0000[a]
R-squared[d]	0.23	0.24	0.23	0.24
Hausman 1 (χ^2, df)[e]	(1.87, 2)	(1.99, 2)	(0.93, 2)	(0.97, 2)
AR(1) coefficient[f]	0.8382[a]	0.8375[a]	0.8365[a]	0.8347[a]
Rack cities	22	22	19	19
Weeks	305	305	305	305

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, OPIS, and Thomson Financial data.

Note: The values in parentheses are standard errors.

[a]The estimates are significant at the 1 percent level or lower.

[b]The estimates are significant at the 5 percent level or lower.

[c]The estimates are significant at the 10 percent level or lower.

[d]R-squared is based on a regression of the dependent variable on its predicted values.

[e]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[f]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 23: Econometric Estimates of Mergers' Effects on CARB Wholesale Gasoline Prices

	Branded		Unbranded	
Independent variable	**FGLS (i)**	**FGLS (ii)**	**FGLS/IV (iii)**	**FGLS/IV (iv)**
SHELL-TEXACO I	- 0.2365 (0.3976)	- 0.6933[a] (0.3167)	- 0.0143 (0.6401)	- 0.2440 (0.4619)
TOSCO-UNOCAL	7.3136[b] (3.8245)	6.8685[a] (3.3136)	-1.2480 (1.4079)	-1.5767 (1.2388)
INVENTORIES RATIO	-20.5206[c] (6.1944)	-20.9206[c] (5.9529)	-11.8892 (9.8474)	- 9.7019 (9.2235)
UTILIZATION RATES	0.3336 (0.2187)	0.3625[b] (0.2186)	0.4464 (0.4928)	0.5667 (0.4812)
WC CRISIS	NA	4.8834[a] (2.0148)	NA	10.5541[c] (2.5493)
Constant	0.6609 (2.3521)	0.3891 (1.6817)	0.0437 (2.0216)	-0.0171 (1.4937)
Model prob-value	0.0011[c]	0.0000[c]	0.4093	0.0002[c]
R-squared[d]	0.21	0.36	0.03	0.34
Hausman 1 (χ^2, df)[e]	(1.27, 2)	(1.77, 2)	(5.39, 2)[b]	(7.43, 2)[a]
Hausman 2 (χ^2, df)[f]	NA	NA	(20.47, 51)	(9.02, 51)
AR(1) coefficient[g]	0.8863[c]	0.8647[c]	0.8240[c]	0.7510[c]
Rack cities	6	6	7	7
Weeks	242	242	242	242

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, OPIS, and Thomson Financial data.

Note: The values in parentheses are standard errors.

[a]The estimates are significant at the 5 percent level or lower.

[b]The estimates are significant at the 10 percent level or lower.

[c]The estimates are significant at the 1 percent level or lower.

[d]R-squared is based on a regression of the dependent variable on its predicted values.

[e]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[f]Hausman 2: The null hypothesis is the instruments are exogenous or valid (no overidentifying restrictions). The test statistic is based on Hausman's (1978) specification test.

[g]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 24: Econometric Estimates of Market Concentration on Conventional Wholesale Gasoline Prices

	Branded		Unbranded	
Independent variable	FGLS (i)	FGLS (ii)	FGLS/IV (iii)	FGLS/IV (iv)
HHI	0.0015[a] (0.0002)	0.0005[a] (0.0002)	0.0019[a] (0.0001)	0.0011[a] (0.0001)
INVENTORIES RATIO	- 8.3367[a] (0.1314)	- 8.5415[a] (0.1344)	- 6.2377[a] (1.5351)	- 6.6088[a] (1.4540)
UTILIZATION RATES	0.1012[a] (0.0359)	0.1113[a] (0.0348)	0.2352[a] (0.0717)	0.2374[a] (0.0710)
MW CRISIS	NA	4.2808[a] (0.1041)	NA	5.0059[a] (0.1409)
WC CRISIS	NA	4.9552[a] (0.2065)	NA	5.2203[a] (0.3327)
Constant	- 0.0091 (0.2797)	- 0.0044 (0.2319)	0.0225 (0.3124)	0.0130 (0.2575)
Model prob-value	0.0000[a]	0.0000[a]	0.0000[a]	0.0000[a]
R-squared[b]	0.18	0.23	0.10	0.17
Hausman 1 (χ^2, df)[c]	(4.41, 2)	(3.59, 2)	(5.74, 2)[d]	(5.44, 2)[d]
Hausman 2 (χ^2, df)[e]	NA	NA	(-7.90, 51)	(-21.59, 51)
AR(1) coefficient[f]	0.8364[a]	0.8269[a]	0.8265[a]	0.8139[a]
Rack cities	282	282	256	256
Weeks	361	361	361	361

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, and OPIS data.

Note: The values in parentheses are standard errors.

[a]The estimates are significant at the 1 percent level or lower.

[b]R-squared is based on a regression of the dependent variable on its predicted values.

[c]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[d]The estimates are significant at the 10 percent level or lower.

[e]Hausman 2: The null hypothesis is the instruments are exogenous or valid (no overidentifying restrictions). The test statistic is based on Hausman's (1978) specification test. A negative χ^2 is interpreted as lack of evidence to reject the null hypothesis; see Stata 7, Reference H-P, (2001), vol. 2, p. 13.

[f]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 25: Econometric Estimates of Market Concentration on Conventional Wholesale Gasoline Prices: Eastern Region (PADDs I-III)

	Branded		Unbranded	
Independent variable	**FGLS/IV (i)**	**FGLS/IV (ii)**	**FGLS (iii)**	**FGLS (iv)**
HHI	0.0013[a] (0.0001)	0.0008[a] (0.0001)	0.0008[a] (0.0002)	0.0003 (0.0002)
INVENTORIES RATIO	- 5.2729[a] (1.6506)	- 5.5154[a] (1.5890)	-7.2808[a] (0.2110)	- 7.3751[a] (0.2265)
UTILIZATION RATES	0.2260[a] (0.0752)	0.2219[a] (0.0751)	0.0045 (0.0476)	0.0084 (0.0465)
MW CRISIS	NA	4.1027[a] (0.1614)	NA	5.3168[a] (0.1488)
Constant	0.0477 (0.3400)	0.0340 (0.2869)	- 0.0133 (0.3430)	- 0.0139 (0.2804)
Model prob-value	0.0000[a]	0.0000[a]	0.0000[a]	0.0000[a]
R-squared[b]	0.11	0.16	0.14	0.22
Hausman 1 (χ^2, df)[c]	(7.20, 2)[d]	(6.38, 2)[d]	(3.73, 2)	(3.51, 2)
Hausman 2 (χ^2, df)[e]	(-2.62, 51)	(-13.52, 51)	NA	NA
AR(1) coefficient[f]	0.8274[a]	0.8191[a]	0.8176[a]	0.8064[a]
Rack cities	250	250	235	235
Weeks	361	361	361	361

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, and OPIS data.

Note: The values in parentheses are standard errors.

[a]The estimates are significant at the 1 percent level or lower.

[b]R-squared is based on a regression of the dependent variable on its predicted values.

[c]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[d]The estimates are significant at the 5 percent level or lower.

[e]Hausman 2: The null hypothesis is the instruments are exogenous or valid (no overidentifying restrictions). The test statistic is based on Hausman's (1978) specification test. A negative χ^2 is interpreted as lack of evidence to reject the null hypothesis; see Stata 7, Reference H-P, (2001), vol. 2, p. 13.

[f]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 26: Econometric Estimates of Market Concentration on Conventional Wholesale Gasoline Prices: Western Region (PADDs IV-V)

	Branded		Unbranded	
Independent variable	FGLS/IV (i)	FGLS/IV (ii)	FGLS (iii)	FGLS (iv)
HHI	0.0051[a] (0.0021)	0.0038[b] (0.0023)	0.0088[a] (0.0040)	0.0087[a] (0.0038)
INVENTORIES RATIO	-12.0385[c] (2.9641)	-12.2358[c] (2.8805)	- 6.6587[c] (1.4067)	-7.2434[c] (1.4044)
UTILIZATION RATES	0.2166 (0.1644)	0.2136 (0.1641)	0.1899[a] (0.0936)	0.2032[a] (0.0928)
WC CRISIS	NA	1.4228[c] (0.4406)	NA	0.9352 (0.7404)
Constant	0.1191 (0.8819)	0.1059 (0.8074)	0.0050 (0.9221)	0.0059 (0.7684)
Model prob-value	0.0000[c]	0.0000[c]	0.0000[c]	0.0000[c]
R-squared[d]	0.29	0.32	0.28	0.31
Hausman 1(χ^2, df)[e]	(9.47, 2)[c]	(9.48, 2)[c]	(3.76, 2)	(4.31, 2)
Hausman 2 (χ^2, df)[f]	(1.00, 51)[g]	(1.90, 51)[g]	NA	NA
AR(1) coefficient[h]	0.8737[c]	0.8855[c]	0.8814[c]	0.8709[c]
Rack cities	32	32	21	21
Weeks	361	361	361	361

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, and OPIS data.

Note: The values in parentheses are standard errors.

[a]The estimates are significant at the 5 percent level or lower.

[b]The estimates are significant at the 10 percent level or lower.

[c]The estimates are significant at the 1 percent level or lower.

[d]R-squared is based on a regression of the dependent variable on its predicted values.

[e]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[f]Hausman 2: The null hypothesis is the instruments are exogenous or valid (no overidentifying restrictions). The test statistic is based on Hausman's (1978) specification test.

[g]The difference in variances of the estimators is not positive definite, and the value was obtained using a generalized inverse—the test is interpreted as lack of evidence to reject the null hypothesis; see Greene (2000), p. 386.

[h]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 27: Econometric Estimates of Market Concentration on Reformulated Wholesale Gasoline Prices

	Branded		Unbranded	
Independent variable	FGLS (i)	FGLS (ii)	FGLS (iii)	FGLS (iv)
HHI	0.0041[b] (0.0016)	0.0041[b] (0.0016)	0.0037[a] (0.0019)	0.0037[a] (0.0019)
INVENTORIES RATIO	-3.5124[b] (0.8145)	-3.4990[b] (0.8147)	-3.7669[b] (0.9561)	-3.7742[b] (0.9543)
UTILIZATION RATES	0.1827[c] (0.1006)	0.1830[c] (0.1005)	0.0770 (0.1098)	0.0797 (0.1096)
MW CRISIS	NA	2.6429[b] (1.0268)	NA	4.8318[b] (1.3905)
Constant	0.0815 (0.7560)	0.0790 (0.7432)	0.0091 (0.8223)	0.0088 (0.7980)
Model prob-value	0.0000[b]	0.0000[b]	0.0003[b]	0.0000[b]
R-squared[d]	0.15	0.16	0.16	0.17
Hausman 1 (χ^2, df)[e]	(1.96, 2)	(2.08, 2)	(1.75, 2)	(1.81, 2)
AR(1) coefficient[f]	0.8451[b]	0.8447[b]	0.8414[b]	0.8401[b]
Rack cities	22	22	19	19
Weeks	305	305	305	305

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, and OPIS data.

Note: The values in parentheses are standard errors.

[a]The estimates are significant at the 5 percent level or lower.

[b]The estimates are significant at the 1 percent level or lower.

[c]The estimates are significant at the 10 percent level or lower.

[d]R-squared is based on a regression of the dependent variable on its predicted values.

[e]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[f]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Table 28: Econometric Estimates of Market Concentration on CARB Wholesale Gasoline Prices

	Branded		Unbranded	
Independent variable	FGLS (i)	FGLS (ii)	FGLS/IV (iii)	FGLS/IV[a] (iv)
HHI	0.0283[b] (0.0157)	0.0238[b] (0.0132)	0.0390[c] (0.0154)	0.0263[b] (0.0142)
INVENTORIES RATIO	-22.3141[d] (6.2573)	-22.6641[d] (6.0101)	-10.1821 (9.7460)	-3.8253 (9.5057)
UTILIZATION RATES	0.3526 (0.2200)	0.4020[b] (0.2194)	0.9110[b] (0.4970)	0.9707[b] (0.5460)
WC CRISIS	NA	4.0592[b] (2.1198)	NA	7.9664[d] (2.8164)
Constant	0.5462 (2.2909)	0.3394 (1.6786)	0.0838 (1.9545)	0.0104 (1.4941)
Model prob-value	0.0005[d]	0.0000[d]	0.0146[c]	0.0001[d]
R-squared[e]	0.28	0.36	0.18	0.32
Hausman 1 (χ^2, df)[f]	(1.33, 2)	(1.67, 2)	(7.83, 2)[c]	(21.65, 2)[d]
Hausman 2 (χ^2, df)[g]	NA	NA	(0.58, 51)	(-2165, 51)
AR(1) coefficient[h]	0.8789[d]	0.8648[d]	0.8045[d]	0.7504[d]
Rack cities	6	6	7	7
Weeks	242	242	242	242

Legend

FGLS=Feasible generalized least squares.

FGLS/IV=FGLS using instrumental variables.

NA=Not available.

Source: GAO econometric analysis of EIA, FTC, and OPIS data.Note: The values in parentheses are standard errors.

[a]Monthly (seasonal) dummies were used as instruments instead of weekly (seasonal) dummies to obtain valid instruments. The effects of HHI were however similar.

[b]The estimates are significant at the 10 percent level or lower.

[c]The estimates are significant at the 5 percent level or lower.

[d]The estimates are significant at the 1 percent level or lower.

[e]R-squared is based on a regression of the dependent variable on its predicted values.

[f]Hausman 1: The null hypothesis is INVENTORIES RATIO and UTILIZATION RATES are exogenous. The test statistic is based on Hausman's (1978) specification test.

[g]Hausman 2: The null hypothesis is the instruments are exogenous or valid (no overidentifying restrictions). The test statistic is based on Hausman's (1978) specification test. A negative χ^2 is

interpreted as lack of evidence to reject the null hypothesis; see Stata 7, Reference H-P, (2001), vol. 2, p. 13.

[h]A test of first-order autocorrelation, AR(1), using a test of significance of the coefficient from a regression of the residuals on one-period lagged values.

Comments from the Federal Trade Commission's Commissioners

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

UNITED STATES OF AMERICA
FEDERAL TRADE COMMISSION
WASHINGTON, D.C. 20580

Office of the Chairman

August 25, 2003

James E. Wells
Director
Natural Resources & Environment
U.S. General Accounting Office
441 G. St. N.W.
Washington, DC 20548

Dear Mr. Wells:

This letter submits the preliminary view of the Federal Trade Commission ("Commission") on the General Accounting Office ("GAO") report entitled "Effects of Mergers and Market Concentration in the U.S. Petroleum Industry in the 1990s" ("Report"). Our response consists of this letter and the three enclosures. The Report purports to examine the effects of recent mergers on several aspects of the petroleum industry, including wholesale gasoline prices, concentration, vertical integration, and barriers to entry. We understand that the GAO will publish it shortly. Regrettably, the Commission has had only a limited opportunity to review the report, receiving it in early August just a few weeks before the Report was to be published.[1]

See comment 1.

The subject of this Report is important and timely, and warrants careful and reliable analysis for Congress to be able to make informed policy determinations. Unfortunately, the Report in its present form is so flawed that reliable judgments cannot be formed regarding the competitive effects of mergers in the petroleum industry. These flaws include:

See comment 3.

- Methodological mistakes that make the Report's quantitative analyses wholly unreliable. For example, the Report does not use obvious controls for isolating the effect of a merger. It does not properly compare supposedly affected areas

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See comment 2.

[1] Commission staff were not provided with a draft of the Report until August 4, 2003 and were not permitted to make or retain copies of the Report, despite the fact that it is roughly 200 pages long and includes complex econometric analyses that took the GAO most of a year to complete. The Commissioners received copies on August 12 but were not allowed to share these copies with the FTC staff. GAO also declined to provide the Commission with the underlying data used for the Report, and did not supply it with a detailed description of the Report's final methodology. It has therefore effectively been impossible for the Commission and its staff to analyze, replicate, or test fully the Report's methodology. A more detailed commentary on the econometric analysis in the report is attached at Enclosure 1.

See comment 3.

with unaffected areas. It also does not include non-merger factors that almost certainly will affect price, like seasonality, supply disruptions, and temperature.

See comment 4.

- Critical factual assumptions that are both unstated and unjustified. For example, the Report simply assumes that state boundaries delimit meaningful geographic markets – an assumption that in most cases is devoid, to our knowledge, of any empirical basis or support. These assumptions often then are combined in the Report with further methodological flaws that do not meaningfully distinguish correlation from causation.

See comment 5.

- Conclusions that lack any quantitative foundation. For example, there appears to be no quantitative basis for the Report's conclusion that unbranded gasoline has become less available. At the same time, the Report makes no effort to assess the (major) regional differences regarding the availability of unbranded gasoline, making the Report's treatment of regional differences inconsistent as well as arbitrary.

See comment 6.

The Commission has spent significant resources investigating consummated mergers, both to determine whether past enforcement actions were correct, and to identify anticompetitive mergers the effects of which could be attenuated by future Agency action. As a result, we have accumulated substantial methodological expertise and have applied that expertise to the oil industry as part of our enforcement mission. Based on this expertise and our initial review of the analyses in the report, we find that the event study and the price-concentration regression are fundamentally flawed.[2]

I. THE REPORT'S ECONOMETRIC ANALYSES ARE FUNDAMENTALLY FLAWED

See comment 8.

The heart of the Report consists of two econometric analyses. The first performs what is sometimes called an "event study." The analysis attempts to isolate the impact of eight petroleum mergers that occurred in the late 1990s on the price of wholesale gasoline (adjusting for crude oil costs). The results purport to show that six of the eight mergers in question were

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[2] The Commission staff previously provided GAO staff with preliminary oral and written comments in December 2002 on issues, among others, relating to the data and methodology encompassed in the Report's econometric analyses. (*See* Enclosure 2 to this letter.) GAO staff appears to have ignored most of the comments provided by Commission staff about the basic methodology that the GAO staff proposed to use at that time. GAO staff also failed to apprise Commission staff of methodological changes made subsequent to December 2002, which changes further undermine the reliability of the conclusions in the Report's econometric analyses. FTC staff also forwarded the attached report by Professor John Geweke on "Empirical Evidence on the Competitive Effects of Mergers in the Gasoline Industry," unpublished draft, July 16, 2003, to GAO staff. (*See* Enclosure 3) Professor Geweke is one of the most widely respected econometricians in the United States.

See comment 7.

See comment 8.

associated with statistically significant price increases, ranging from less than one cent per gallon to over five cents per gallon for at least one type of gasoline. (According to the event study, the other two mergers were associated with price decreases.) The second econometric analysis contained in the Report seeks to describe the relationship between wholesale gasoline prices (adjusting for crude oil costs) and wholesale concentration measured at the state level. This price-concentration analysis purports to show a positive and significant relationship between higher wholesale gasoline prices and industry concentration. Depending upon a variety of factors, such as fuel type and region of the country, the analysis estimates that an increase in the Herfindahl-Hirschman Index (HHI) of 100 points may lead to an increase in the price of wholesale gasoline of as much as four cents per gallon.

Based on our initial review of these econometric analyses, the methodologies underlying both analyses are fundamentally flawed. Five primary reasons support this conclusion.

See comment 9.

First, the models used do not control for the many factors that could cause prices to increase. Isolating the effect on price from a merger necessarily requires the correct and comprehensive identification of factors that might influence demand (seasonality, temperature, income) as well as those that might influence supply (supply disruptions, changes in gasoline formulation). The Report is conspicuous in its failure to control for *any* of these factors. For example, the period at issue was characterized by several supply shortages, which can cause short-term price spikes entirely unrelated to the mergers under investigation. Similarly, seasonality is a crucial factor in analyzing this market: gasoline prices tend to increase in the summer in response to increased demand. Not controlling for seasonal effects is especially problematic because in some cases the post-merger period contains only a short time period, encompassing just one season, while the pre-merger period includes at least an entire year. By not controlling for such factors, the Report fails to provide meaningful information regarding whether price changes were merger-related or not.

See comment 10.

An approach superior to that of the study would be to compare price changes in the affected markets with price changes in carefully selected comparable non-merger markets. If post-merger prices in non-merger markets went up as much as those in the merger market, then there is no rational basis for concluding that the merger caused the price increases. No such carefully defined "natural experiment" was conducted by GAO staff; at least none is included in the Report. Instead, the preferred estimates in the Report simply compare the post-merger prices in the areas affected by the merger to the pre-merger prices in those areas.

See comment 11.

Second, the price-concentration methodology used by the GAO is subject to several well known problems that make it unacceptable as an alternative to a well-conducted event study. The most important of these problems is the difficulty in distinguishing between correlation and causation. Simply because two factors move together does not mean that one caused the other.

See comment 12.

Third, any reliable price-concentration analysis necessarily requires that concentration be calculated in an economically well-defined market – that is, an area in which a particular merger or other increase in concentration is likely to have an economic effect. The Report's assumptions

See comment 12.

of state-wide geographic markets are unjustified. We are not aware of any supporting empirical data that markets generally coincide with state boundaries. Indeed, all of the data with which we are familiar point to the conclusion that wholesale markets in this industry rarely coincide with state limits. Accordingly, while price-concentration analyses may provide some useful information on general industry trends in concentration, they cannot be used to determine if an economically meaningful relationship exists between price and concentration.

See comment 13.

Fourth, the results in the Report are, in many cases, not robust. Economists usually consider various approaches to estimating a model to determine whether the results from one approach (or "specification") are consistent with those using alternative approaches. This procedure is known as checking the "robustness" of the results. If results differ substantially for different methods or approaches, the reliability of the results is questionable. The Report's results in fact differ substantially across models. For example, in some cases, when estimating the effect of a particular merger on wholesale gasoline prices, the Report finds positive effects with some specifications and negative effects in other specifications.

See comment 14.

Finally, documentation of the technical work on the econometric models is incomplete. For example, there is no discussion regarding how divestitures were treated, or which terminal racks were used in which regressions, or how price observations were constructed. The Report's approach to these issues, had they been better documented, might raise more concerns about the methodology used to reach the reported results. Moreover, given the failure to provide the underlying data, it is impossible to replicate independently the Report's results or to perform more rigorous robustness tests (including taking into account the missing factors that influence price changes as discussed above). Results that cannot be replicated or thoroughly analyzed for robustness are of little scientific value.

II. THE REPORT'S ASSERTIONS ABOUT STRUCTURAL CHANGES IN THE PETROLEUM INDUSTRY, AND THEIR COMPETITIVE EFFECT ON GASOLINE MARKETS, ARE ALSO FLAWED

See comment 15.

In addition to the flaws in the Report's quantitative analyses, there are several conclusions in the Report that appear to be without quantitative support. Other observations appear to overlook important factual issues, or invite unwarranted conclusions about the effect of particular facts on the extent of competition in the market.

See comment 16.

For example, the Report suggests that the mergers in question have raised barriers to entry, while acknowledging that the effect of these mergers on entry barriers could not be quantified. The Report further observes that mergers may have made it more difficult for smaller firms to compete, or for new competitors to enter these markets. These observations, however, even if true, do not mean that competition in the petroleum industry has been harmed or eliminated. For example, to the extent that mergers confer cost-reducing scale advantages (as the Report suggests), consumers will benefit when cost savings are passed on through lower prices. Complaints from small competitors that competition with larger-scale entities is putting them in

See comment 16.

jeopardy therefore may well suggest *enhanced* competition, as all firms feel pressured by competition to reduce costs by whatever means possible and thereby reduce retail prices to consumers. Similarly, other structural factors detailed in the Report – such as minimum volume requirements and the alleged preferences of refiners to deal with larger distributors – are as consistent with a theory of *enhanced* competition as they are with a theory that petroleum industry consolidation has adversely affected consumers.

See comment 17.

Another finding in the Report without quantitative support is the conclusion that vertical integration between refining and marketing has increased. Characterizing the degree of vertical integration between functional levels is more complicated than the Report suggests. EIA data on volume of gasoline distributed by channel of distribution indicate that, for the nation as a whole, the sale of gasoline through independent distributors – by far the leading channel of gasoline distribution – has increased in recent years. These data indicate that overall vertical integration between marketing and refining has *not* increased in recent years. These data, and our own experience, also reveal that vertical integration between refining and marketing differs significantly across different geographic areas within the United States. Moreover, the competitive implications of vertical integration are complex, with the potential for procompetitive as well as anticompetitive effects.

See comment 18.

Finally, the Report finds that unbranded gasoline has become less available. This conclusion appears to have no firm quantitative foundation, but is instead based on interviews with various industry participants. In fact, the availability of unbranded gasoline varies significantly across geographic areas. The Report specifically notes that hypermarkets almost always supply unbranded gasoline and are growing significantly. The success of hypermarkets and other unbranded marketers in some areas of the country raises important questions about the competitive significance of "branded gasoline" in attracting consumers, and suggests that generalizations about possible impediments to the expansion of unbranded marketers are unwarranted.

III. CONCLUSION

See comment 19.

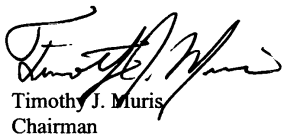
The Commission and its staff stand ready to provide further assistance to the GAO. The Report deals with a timely and important topic, and its findings have potentially important implications for public policy regarding petroleum mergers. In the Commission's view, however, this report does not meet the high standards of "accountability, integrity, and reliability"[3] we

[3] "Accountability describes the nature of GAO's work. GAO helps the Congress oversee federal programs and operations to ensure accountability to the American people." *See* www.gao.gov. "Integrity describes the high standards that GAO sets for itself in the conduct of its work. GAO takes a professional, objective, fact-based, nonpartisan, nonideological, fair, and balanced approach to all of its activities. Integrity is the foundation of reputation, and GAO's approach to its work assures both." *Id.* "Reliability describes GAO's goal for how its work is viewed by the Congress and the American public. GAO produces high quality reports,

See comment 19.

would expect from GAO's reports and publications. We, too, are governed by similar standards for protecting the public interest.[4] Accordingly, we remain willing and eager to assist in the production of a more accurate report.

By direction of the Commission.



Timothy J. Muris
Chairman

Enclosures

(1) Discussion of Deficiencies in Chapter 5 of the GAO Report "Effects of Mergers and Market Concentration in the U.S. Petroleum Industry in the 1990's"

(2) FTC Staff Comments on the GAO methodology for "Econometric Analysis of Effects of Market Concentration and Mergers on U.S. Wholesale Gasoline Prices in the 1990's," December 20, 2002

See comment 20.

(3) Professor John Geweke, "Empirical Evidence on the Competitive Effects of Mergers in the Gasoline Industry," unpublished draft, July 16, 2003

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testimony, briefings, legal opinions, and other products and services that are timely, accurate, useful, clear and candid." *Id.*

[4] The Federal Trade Commission Act provides that the Commission take action when it determines that such action would be in the public interest. 15 U.S.C. § 45(b). For provisions specifically addressing data quality, *see also* Data Quality Act, i.e., Treasury and General Government Appropriations Act for Fiscal 2001, Pub. L. No. 106-554, § 515 (Dec. 21, 2000); 67 Fed. Reg. 8452 (Feb. 22, 2002) (Office of Management and Budget guidance); http://www.ftc.gov/opa/2002/08/fyi0242.htm (FTC guidelines implementing the Data Quality Act).

The following are GAO's comments on the Federal Trade Commission's letter dated August 25, 2003

GAO's Comments

1. We agree that the issues addressed in this report are important and timely, particularly since no comprehensive study has been done on the effects of the recent merger wave in the petroleum industry in the second half of the 1990s. We disagree, however, with FTC's assertion that the methodology we used in our study is flawed. Our methodologies incorporate state of the art techniques in econometrics and are consistent with existing literature and the comments of industry experts. In developing our empirical approach, we relied on GAO economists and obtained comments from economists outside GAO, including our consultant/peer reviewer, who is a recognized expert in the modeling of gasoline markets. As stated in a paper by FTC's (former) Director and the Deputy Director of the Bureau of Economics,[1] "Analyses can lead to different conclusions because of different data, different economic modeling, different econometric techniques, and /or fundamental mistakes." Furthermore, they stated that, "there is no 'perfect' econometric study… Lack of unnoticeable perfection should not be a bar to an econometric study being given weight." We agree with these statements, especially given the complexity of our study. Nonetheless, partly in response to FTC comments, we re-estimated our models to account for the effects of gasoline supply disruptions that occurred in some parts of the West Coast and Midwest regions.

2. We provided an opportunity for FTC to review a draft of this report on August 5, 2003, consistent with GAO's policy. Copies of the draft report were delivered to FTC staff, who retained them for the period of their review. Copies were subsequently delivered to FTC's Commissioners on August 12, 2003, and they retained the copies. The copies provided to the Commissioners were the same drafts shared with FTC staff earlier on August 5, 2003. GAO's policy does not prevent the Commissioners from sharing their copies with FTC staff. We obtained all the data used in this report from publicly available sources, including a substantial purchase of data from OPIS, Thomson Financial, and J.S. Herold, Inc., which we have no obligation to share. We provided a complete and

[1]Scheffman and Coleman, FTC Perspectives on the Use of Econometric Analyses in Antitrust Cases, unpublished paper, undated.

detailed description of the data and their sources in the draft report that FTC reviewed.

3. We disagree. In developing our econometric models, we considered and discussed the importance of merger variables, market concentration variables, and other supply and demand variables, and we controlled for such variables when we believed it was appropriate. We specifically considered and discussed the following variables in our models: crude oil prices, the ratio of gasoline inventories to expected demand, refinery capacity utilization rates, and supply disruptions in the Midwest and West Coast regions. The ratio of gasoline inventories to expected demand captures the behavioral response to seasonality and temperature (see below). In the draft report (but not in the final report), we also considered income, population density, prices in nearby rack cities, distances between nearby rack cities, divorcement laws—which could help capture the effects of vertical relationships between refining and retail gasoline marketing—year-specific effects, week-specific effects, and city-specific effects. While we used wholesale gasoline prices minus crude oil prices as the dependent variable for economic and statistical reasons, we also estimated the models with the crude costs as an explanatory variable and the results were generally similar.

   Although no econometric model perfectly depicts reality, we believe that our current models are methodologically sound and produce reasonable estimates. FTC's suggestion that we use seasonality, temperature, and supply disruptions in our merger regressions means resorting to proxies when we have more direct measures of demand and supply shocks. FTC's suggestion is contrary to accepted econometric practice. Seasons and temperature affect gasoline prices by changing demand and supply. Supply disruptions affect gasoline price through changes in inventory. Since we used measures of gasoline inventories and demand, resorting to proxies is not necessary.

   Our overall methodology is consistent with previous studies of gasoline markets, and our findings are fact-based and objective. External experts, including those who have conducted empirical studies in the petroleum industry, reviewed our econometric model outline and provided comments that we incorporated in our analysis. In addition, we consulted with a well-known and respected expert on economic modeling of the petroleum industry, who reviewed the methodology and the models' results. We disagree with FTC's assertion that we did

not use appropriate variables in our models or did not appropriately control for the following variables.

Seasonality and temperature: As stated above, in our models, seasonality and temperature are captured by the variable for gasoline inventories relative to demand. (See figure 22 in the report, which clearly shows the seasonal variations in gasoline inventories and demand).

Supply disruptions: We acknowledged the potential effects of the West Coast disruptions and the Midwest disruptions on wholesale prices of gasoline in our draft report. Nonetheless, in responding to FTC's comments, we have subsequently included proxies to account for the effects of these disruptions, and they did not significantly change our underlying results about the effects of mergers and market concentration on wholesale gasoline prices. This is not surprising because we believed we had indirectly captured some of the effects of the supply disruptions through the inventory variable. Moreover, we believe that the proxies used for the supply disruptions were crude and imprecise for the following reasons. First, the supply disruptions are not identified as affecting many of the mergers and areas that we modeled—the supply disruptions affected the Midwest (PADD II) and West Coast (PADD V, excluding California) for conventional gasoline and CARB in the West Coast. Second, as indicated above, we believe that the behavior of gasoline inventories and demand, which we included in our models, is useful in capturing some effects of the supply disruptions. FTC itself, in its investigation of the Midwest supply disruptions (see *Midwest Gasoline Price Investigation*—FTC, 2001a), determined that low gasoline inventories were a primary factor affecting the disruptions. In fact, we found that the relationship between gasoline price margins and inventories, as measured by the correlation coefficient, nearly doubled during the supply disruptions compared to the whole sample period. (The correlation coefficients increased from between - 0.16 and - 0.17 for the whole sample period to between - 0.27 and - 0.32 during the disruptions). In addition, FTC indicated that demand in the Midwest increased significantly relative to the average increase for the nation. Third, it was difficult to construct variables for the supply disruptions because of the lack of appropriate and comprehensive data. In particular, there is no accurate information on the timing, duration, and specific geographic areas that were affected by these supply disruptions. For instance, with respect to the West Coast disruptions, one of the authors of a paper by FTC staff on

these disruptions (see Taylor and Fischer, 2002), indicated in an email to GAO staff, "While this paper does a fairly good job of identifying West Coast Supply disruptions for the years it looks at, I would not want to claim it is totally comprehensive." We believe that the assumption that the West Coast disruptions affected the whole of the West Coast (PADD V) overstates the coverage and impact of the disruptions. Also, for the Midwest disruption, FTC did not identify the specific geographic markets for conventional gasoline that were affected by the disruption. Using the whole Midwest geographic region would tend to overstate the coverage and impact of the disruption, because it would attribute to the disruption the effects that may be attributed to mergers.

Nonetheless, we constructed two different measures for the Midwest and the West Coast disruptions, using the available limited information. We constructed a Midwest disruption indicator variable based on FTC's (2001a) report, which suggested that the supply disruption occurred roughly in June 2000 in the Midwest (PADD II). Similarly, we constructed a West Coast disruptions indicator variable based on the study by FTC staff (Taylor and Fischer, 2002), suggesting that the supply disruptions occurred in some periods of 1999 and 2000 in the West Coast (PADD V).

4. We recognized the importance and difficulty of defining appropriate geographic markets for gasoline, especially at the wholesale levels. We discussed the issue of defining meaningful geographic gasoline markets (including wholesale) with FTC and other oil industry experts. FTC indicated to us that it could not provide specific evidence on actual geographic markets for wholesale gasoline across the United States because, when performing analysis of potential mergers, FTC focuses on a limited geographic area and relies substantially on proprietary company data, which are not publicly available. Like other industry experts that we contacted, FTC agreed in our December 2002 meeting that it was appropriate to use terminal cities and even states, in some cases, as geographic markets for wholesale gasoline. We therefore used rack cities as the geographic unit.

   In the draft report, we used data for gasoline prime suppliers provided by the Department of Energy's Energy Information Administration (EIA), available only at the state level, in measuring market concentration (HHI) at the wholesale level. We believed that using the state-level HHI was reasonable, and FTC has not provided any reason

or evidence for why doing so would bias our results. In the final report, however, we have used yearly HHI based on refinery capacity because we believe, after consultation with our expert/consultant, that market concentration at this level captures more effectively the ability of refiners to control gasoline sales (or their market power). As stated in the draft report, we noted the limitation of using HHI data because of potential problems with geographic market delineation and indignity. In the final report, our use of HHI data at the refinery level is likely to reduce the potential endogeneity problem because the HHI at that level would likely be exogenous to rack prices.

A study by Vita (2000), an FTC staff member, used the state as the geographic unit in analyzing retail gasoline prices, even though it is generally agreed that the geographic gasoline market at the retail level is smaller than at the wholesale and that it is therefore less meaningful to use the state as the geographic unit for retail markets. Professor Geweke, an econometrician whom FTC cites in its comments and whom FTC has asked to review research on the effects of petroleum mergers, commented in his review of GAO's 1986 study of wholesale gasoline prices that using the geographic unit of the state was inappropriate. However, Geweke apparently found nothing inappropriate with Vita's use of the state as a geographic unit.

We disagree with FTC's assertion that we did not meaningfully distinguish between correlation and causation. In fact, the use of appropriate economic structure for modeling is a common basis for inferring causation.

5. We disagree. Economic findings can be qualitative or quantitative. We clearly indicated in chapter 4 that we based our finding that unbranded gasoline has become less available on extensive interviews of industry participants in different regions of the country, who consistently indicated to us that that was the case. While it would be desirable to ascertain this finding quantitatively, according to the EIA there are currently no systematic and comprehensive data available on unbranded gasoline supply. We stated in the draft and final reports that we could not statistically quantify the extent to which unbranded gasoline supply has decreased because the data required for such an analysis do not currently exist. We also stated in the draft and final reports that EIA—the federal agency mandated by Congress to collect energy data, including gasoline supply—told us that "the agency does not require petroleum companies to report gasoline data in the form

that would permit the identification of branded and unbranded sales." We also disagree with FTC's assertion about our treatment of regional differences (we assume FTC is referring to our estimates for the effects of market concentration on conventional gasoline in the eastern versus the western part of the United States in chapter 5). We did not imply any relationship between our discussion of less availability of unbranded gasoline in chapter 4 and the separate econometric estimates for the east and west in chapter 5. The east-west distinction was based primarily on the degree of integration of refining markets within these broad geographic regions.

6. Given FTC's mission to protect the public interest in mergers affecting the petroleum industry, we expected FTC to have considerable expertise in this industry. However, FTC has not provided evidence to support its criticisms of our analysis, even though FTC's officials have stated, "In most circumstances a technically-based critique should be supported by an empirical analysis that shows that dealing appropriately with the technical issue makes a meaningful difference in the results" (see Scheffman and Coleman (undated), p. 3). The only FTC study on the competitive effects of mergers in the petroleum industry that we are aware of is a recently released study on the effects of the Marathon-Ashland merger. The FTC study looked at the effects of this merger in only one rack city, Louisville. We believe that FTC's study has several shortcomings, including the econometric methodology and the interpretation of the results. [2]

7. As part of our peer review process, we provided an outline of our econometric methodology, which was a roadmap of our methodology, to many experts in the petroleum industry, and FTC. While we provided no specific econometric equation(s), we included a list of potential variables and proposed estimation techniques. FTC provided us written comments on the preliminary outline of our econometric model that included data and methodology issues. At FTC's request, we met and discussed each of the issues raised in their written comments, particularly the issues that they deemed to be crucial. We discussed issues FTC felt might be addressed, but some of the issues FTC raised

[2] See Taylor and Hosken (2004). See appendix IV for a detailed assessment of the FTC study. The other two FTC studies of consummated mergers that we know of were not for the petroleum industry. (See a study by Scheffman and Coleman (2002), p. 364, FTC's former Director and Deputy Director of the Bureau of Economics, respectively).

were so complex and theoretical that they themselves could not offer feasible solutions. In instances where it was reasonable and possible to make changes, we did so. In particular, a major point of concern FTC expressed after our December 2002 meeting was the limitation of the HHI data EIA provided to us—the mergers were not reflected in the HHI data until the merged firms began to file a combined report with EIA, which could be months or even years after a merger is completed. We subsequently contacted EIA, who provided us with revised HHI data, adjusted properly for the timing of the merger, as well as monthly data (instead of the annual data that EIA had provided to us earlier). FTC also provided information on possible sources of data on the West Coast disruptions. We also made changes to our model based on comments we received from experts in industry and academia. A few days before we delivered the draft report to FTC for their review, FTC sent to us the paper by Professor Geweke, and the accompanying letter stated that it was subject to revision. We made no changes to our draft based on Professor Geweke's paper.

8. Our statistical results do show the results questioned by FTC. We believe that our results are reasonable and consistent with the findings of the few previous studies that have been done on this issue. Our responses to FTC's specific comments follow.

9. We believe that our models appropriately control for the many variables that could affect gasoline prices. We have fully discussed these issues in comment 3 above, including our preferred methods for addressing seasonality and temperature and our incorporation of alternative measures of supply disruptions. Our analysis would not likely be affected by changes in gasoline formulations. For instance, for CARB, the change from Phase I to Phase II occurred in 1996, and our analysis reflects this change because the data used start from 1996.

10. We disagree. The approach suggested by FTC attempts to match the many diverse merger cities to a representative nonmerger city, and FTC's plain words suggest an unconditional comparison that assumes that all differences between the cities are due solely to differences caused by the merger. While this matching process might be useful in theory, it is almost impossible to find a control city that has the same demand and supply characteristics, except for the merger, when one has to use all the available cities that were affected by the mergers. The merger affected cities are generally diverse because in most cases a merger affected more than one broad geographic area, and the affected

racks generally include large as well as small cities. Furthermore, even if one could select a nonmerger control city, that city is likely to be near the merger cities. In that case, the mergers could indirectly affect prices in the selected nonmerger control city as well, violating the requirement that the merger should not affect the selected control city. We note that despite FTC's experience in reviewing most of the mergers that we modeled, FTC did not provide any examples of appropriate control cities in our discussions with them concerning our proposed methodology and the mergers we were analyzing.

We also disagree with FTC's assertion that we did not appropriately perform the pre- and postanalysis for the mergers. In fact, we clearly identified the pre- and postperiods of the mergers to determine the effects of the mergers in the merger affected cities. Furthermore, in constructing the data, we used due diligence to ensure that there were enough data both before and after the mergers to estimate the mergers' effects.

11. While we agree that two factors moving together do not imply causation, we disagree with the remainder of FTC's comment. We note that our market concentration analysis was a complement to the event type study of the mergers. FTC's comment suggests that FTC is confusing the link between market concentration and mergers. A merger constitutes a single event, and therefore could be modeled as an event study, as we did. Market concentration captures a number of events that occur over time, in particular mergers, but also other factors such as entry and exit, which are often difficult to date. Therefore, we disagree that one could model the effects of market concentration as an event, as FTC suggests. We found it more appropriate to model the effects of market concentration as a regression of prices on market concentration, among other variables, measured over time.

    We disagree with FTC's characterization of our price-concentration study. In the draft and final reports, we have recognized and discussed the methodological issues associated with price-concentration studies, including a citation of the study by Evans, Froeb (the current Director of FTC's Bureau of Economics), and Werden (1993). We note that FTC's horizontal merger guidelines are premised on links between concentration and market power effects, such as price increases. We believe that an econometric estimation based on economic theory, and

controlling for other extraneous factors, generally allows meaningful estimates that can be interpreted as causal.

12. We disagree. See comments 3 and 9 above.

13. We disagree. The consistency of the results we obtained from the different specifications and estimations of our models, as well as consistency in the results for the merger effects and the market concentration effects, supports the robustness of our results. In particular, we provide the following evidence for the robustness of our results in the draft report. First, because market concentration is the cumulative effect of the mergers and other competitive factors, one would expect that the results from the market concentration models and mergers models would be similar, but not exactly comparable, if mergers are the predominant contributing factor to market concentration. In our study, the majority of the results for the two approaches were similar. In the draft report, we also estimated the effects of the mergers using two approaches—using data for all rack cities and using data for only the merger cities. Both approaches yielded similar results. Second, in the draft report, in cases where the estimated results from using different approaches had different signs, we discuss the possible reasons for such differences and why we chose the preferred approach. In particular, when we included the refinery capacity utilization rates, in addition to the ratio of gasoline inventories to demand, only the estimated effects of market concentration for conventional gasoline changed signs. We explained why we preferred the models that excluded these variables. Specifically, the expected signs were inconsistent for the utilization rates but not for the ratio of gasoline inventories to demand. Furthermore, when the ratio of gasoline inventories to demand was excluded, the utilization rates variable had the expected sign. Also, the data for utilization rates are available nationally, while the data for the ratio of gasoline inventories to demand are available regionally, which better captures differences in prices across markets. Nonetheless, in the final report, both the ratio of gasoline inventories to demand and refinery capacity utilization rates variables are included in all the models that were estimated and have the economically expected signs in all our models.

    FTC supports its claim of lack of robustness by citing a few examples in its technical comments on the draft report. For example, FTC stated that, "In Table 16 [in the draft report], the estimated price effect of the BP-Amoco merger ranges from no price effect to 3.5 cents a gallon

among the three regression specifications." But the results in the draft report were 2.03 (and highly significant) using all rack cities and without year effects, 1.14 (and not significant) using all rack cities and without year effects, and 3.54 (and highly significant) using only the merger affected cities and without year effects. Although one of the results is not statistically significant, they all have the same sign. Furthermore, the results without the year effects are reasonably similar. Also, FTC stated that in a few cases the estimates with instrumental variables were different from those without the variables. But, econometrically, robustness of the estimates does not require these two estimates to be the same. In fact, as noted in Evans, Froeb, and Werden (1993), "With panel data, fixed-effects procedures can be combined with instrumental variables to eliminate bias."

14. We provided a detailed and complete description of the basis of our econometric models, data sources, sample selection process (including tables detailing the list of variables, definitions, sources, data frequency, and level—see table14), and specification of the econometric models and estimation techniques (see appendix IV). As detailed in table 14, the effective dates for the mergers were based on dates FTC recommended when merger remedies (divestitures) became effective. These dates, upon FTC's recommendation to EIA, were also used by EIA to compute the market concentration (HHI) data, based on prime suppliers' sales used in the draft report. We stated in the draft and final reports that we used all available data on the rack cities from the Oil Price Information Services (OPIS)—data on over 280 rack cities for branded and over 250 for unbranded conventional gasoline out of the 350 rack cities in the OPIS database, representing over 90 of the racks in the United States. For the merger analysis, we indicated in the draft report that we also used only rack cities where the merging companies operated before they merged. We also stated in the draft and final reports that we used the average prices at a rack. We believe that we have provided a full and complete documentation of our econometric methodology.

15. We disagree. As stated in comment (4), we believe that findings can be qualitative or quantitative. Throughout the report, we believe our findings have been well supported, both quantitatively and qualitatively.

16. We disagree with FTC's characterization of our discussion of barriers to entry. While we stated in the draft and final reports that mergers have had an impact on barriers to entry, based on information from industry

officials, we stated that we could not quantify the extent of this impact because of a lack of data as well as a lack of consensus on an appropriate measure. We discussed the overall importance of barriers to entry in a market; FTC recognizes the importance of barriers to entry in its horizontal merger guidelines. Nonetheless, nowhere in the draft report do we say that barriers to entry have harmed or eliminated competition in the petroleum industry.

17. We disagree with FTC's assertion that a finding must only be based on quantitative analysis, especially given that, as FTC stated, vertical integration between functional levels is complex. Our report presents examples of mergers that were vertical in nature (that is, the mergers involved different functional levels of the merging companies), which would contribute to increased vertical integration (see table 2). FTC's use of the term "independent distributors" may be misleading. In the draft report, distributors (or jobbers) are generally independent middlemen and their activities, most often, do not decouple the vertical chain between refining and retail. While it is true that the distributors are the largest channel for distributing gasoline to the retail level, this distribution function does not affect the contractual relationship between the refiner and a retailer for branded gasoline, which represents the largest volume of gasoline sold. In fact, as noted by Royer (1998, p. 95), vertical coordination involving contractual supply relationships could increase the downstream company's costs because unlike market transactions for the intermediate good, a downstream company can no longer turn to alternative suppliers for its inputs. Moreover, as we state in our report, according to an EIA report and discussions with EIA officials, there have been a substantial number of vertical mergers in the downstream market between refiners and marketers over the decade of the 1990s. However, as per a close-out meeting with EIA, we did add language to our report to recognize that there has been a shift during this period toward the divestiture of certain downstream assets, such as refineries, by fully integrated companies. We do not know the basis of FTC's assertion that vertical integration between refining and marketing differs significantly across different geographic areas within the United States, given the complicated nature of vertical integration between functional levels in the petroleum industry. In the draft and final reports, as in the case of the potential effects of (horizontal) mergers and market concentration, we discussed the procompetitive as well as the anticompetitive effects of vertical integration.

18. We disagree. As we stated in comment 5 above, economic findings can be based on qualitative or quantitative information.

19. We appreciate FTC's offer of further assistance but have chosen instead to respond to its concerns. In particular, we have taken their suggestion to investigate in more detail the supply disruptions in the Midwest and West Coast, have reestimated our models incorporating these supply disruptions, and have discussed the implications of these supply disruptions in our response. Incorporating these supply disruptions did not change our finding that mergers generally led to price increases.

    The report uses data and information from a wide range of reliable sources. Our methodology is sound, transparent, and consistent with the economic literature on mergers and market concentration. Our report's results are presented in a balanced, fact-based, and objective manner and have undergone external peer review. Moreover, the report provides valuable information about the overall effects of the mergers in the petroleum industry, information that was critically lacking.

    We believe that this report meets our core values of accountability, integrity, and reliability. We welcome continuing public scrutiny or discourse on such an important issue that impacts public policy.

20. We are honoring the restriction imposed on the release on Professor Geweke's unpublished draft paper and are not publishing this attachment.

Comments from the Federal Trade Commission's Bureau of Economics Staff

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Bureau of Economics

August 25, 2003

Enclosure 1:
Discussion of Deficiencies in Chapter 5 of the GAO Report "Effects of Mergers and Market Concentration in the U.S. Petroleum Industry in the 1990's"[1]

I. Background

See comment 1.

These are comments of the Federal Trade Commission's (FTC) Bureau of Economics (BE) Staff on Chapter 5 and the related appendix of the Report. These comments reflect the limited ability that FTC staff had to review the draft.[2] Additional time would have allowed a more comprehensive set of staff comments. Nevertheless, even within the short time we have

See comment 2.

had to review the report, we have identified fundamental methodological flaws with the econometric analyses that we will discuss in detail. These fundamental flaws mean that the Report cannot provide a reliable basis for addressing the issues it claims to study.

See comment 3.

BE staff provided six pages of comments to the GAO in a December 20, 2002 letter as well as verbal comments at a subsequent meeting with GAO staff on the draft methodology for the GAO study, dated December 2, 2002.[3] Most of the FTC staff comments on the draft econometric model were not incorporated into the Report. In addition, changes in the methodology in the Report and the methodology provided in December 2002 raise additional

[1] In the memorandum, we will refer to the GAO report as the "Report."

See comment 4.

[2] FTC staff was only given access to the Report on August 4, 2003 (a few weeks prior to when we understand that GAO plans to publish the report) and was not allowed to retain copies of the report.

See comment 5.

[3] FTC staff also forwarded the attached report by Professor John Geweke on "Empirical Evidence on the Competitive Effects of Mergers in the Gasoline Industry," unpublished draft, July 16, 2003, to GAO staff. Professor Geweke is one of the most widely respected econometricians in the United States.

1

See comment 3.

concerns.[4] This comment includes the comments that the FTC staff previously gave to the GAO as well as comments on the changes made from the December 2002 methodology and problems that were not evident in that methodology.

II. Summary

See comment 6.

Chapter 5 of the Report contains two econometric analyses. The first attempts to estimate the wholesale price effects of eight petroleum mergers on conventional, reformulated (RFG), and CARB gasoline (separately for branded and unbranded). The second attempts to estimate the relationship between wholesale prices and concentration (HHI) for the three main formulations of gasoline.[5] The Report purports to show: (1) significant price increases for at least one gasoline formulation for six of the eight mergers reviewed; and (2) a significant positive relationship between price and concentration. As discussed below, there are fundamental flaws with both the merger event analysis and the price/margin concentration analysis. Given the severity of the flaws, the results of the statistical analysis cannot be used to make reliable inferences about the price effects from the mergers analyzed or the relationship between price and concentration.

See comment 7.

The flaws with the analyses stem both from the underlying theoretical models and the implementation of the models used by the GAO. Of key importance is the lack of controls for important factors that affect the price of gasoline. Without such controls, the analyses cannot be used to reliably isolate the impact of the mergers or concentration on price. There are also

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See comment 8.

[4] Given the important differences between the December 2002 methodology and the methodology used in the current Report, the opinions of external reviewers may not be the same for the Report as for the December methodology. If the external reviewers have not reviewed the final Report, they should be given that opportunity or the representation of their views should state that fact.

See comment 9.

[5] Both of these analyses use posted rack (wholesale) pricing data, which will not reflect any discounts distributors may receive off posted prices. Gasoline is also sold to dealers at a dealer tank wagon price or is transferred to refiner owned and operated outlets at some internal transfer price. The portion of transactions that are sold on a rack basis varies considerably across the country, and as a result, any inferences about effects on retail prices from predictions regarding rack prices must be carefully qualified.

See comment 10.

See comment 11.

See comment 12.

See comment 13.

serious problems with the interpretation and characterization of the results. In several instances the results in the Report are not as robust as represented in the discussion of the results. Also, the results of some of the specifications reveal some of the underlying methodological problems. Finally, the size of the estimated price effects, both positive and negative, of the mergers is implausibly large in the context of this industry.[6]

An additional problem is that the documentation of the regressions and methodology is incomplete. The discussion in the Report should be sufficient so that a researcher with access to the same data set could replicate the results. Unfortunately, the discussion does not satisfy this basic requirement.

III. Merger Event Study Methodology

See comment 14.

There are several generally recognized methodologies that might be used to analyze the price effects of a merger through an event study. These approaches emphasize the need to control for factors unrelated to a merger that may influence prices. Controlling for such factors is important because the goal of an event study is to isolate the effect of the event on the variable of interest such that any changes in the variable after the event can be attributed to the event. GAO's preferred model, however, excludes important control variables, and as a result, can not reliably isolate any price effect–be it positive or negative–that can be attributed to a merger.

See comment 15.

See comment 16.

[6] Many of the estimated merger effects from the preferred estimations are over a nickel a gallon. When determining what is the relevant antitrust market in which to assess a proposed merger, the FTC asks the question: what is the smallest relevant market in which a hypothetical monopolist could impose a small but significant and non-transitory price increase? *See* U. S. Department of Justice and the Federal Trade Commission, Horizontal Merger Guidelines, April 1997. The FTC has generally applied a one cent per gallon price increase as the standard for evaluating market definition in refined petroleum products, including gasoline. While a one cent per gallon increase is smaller than that generated under the 5% price increase rule that the FTC typically uses in evaluating mergers, a one cent per gallon increase is extremely significant in this industry. The petroleum industry is characterized by large volumes and relatively thin margins. For example, data from the Energy Information Administration indicate that the net refinery margins (which reflect crude costs as well as refinery operating costs) were on the order of four cents per gallon during the late 1990's.

See comment 14.

See comment 17.

See comment 18.

Among the factors not adequately controlled for in GAO's specifications are supply shocks, changes in fuel specifications, and seasonal effects. The Report's use of instrumental variables to deal with endogeneity issues is also problematic. Finally, it is well known that achieving reliable results in an event study requires that the event's pre- and post-periods be appropriately specified: unfortunately, the Report is flawed on this dimension as well.

The remainder of this section discusses: (1) general methodologies employed in event studies regarding the effects of mergers; (2) why the approach chosen by the GAO is inferior to potential alternatives; and (3) why the implementation of the approach chosen by the GAO is fundamentally flawed.

A. General Approaches in Merger Event Studies

See comment 19.

The GAO Report correctly cites a number of published economic studies that examine the price effects of consummated mergers.[7] In most merger event studies that examine the price of products before and after a merger, one of two types of regressions has been estimated. In the first type of regression (*see* Barton and Sherman (1984) and Kim and Singal (1993)), the price of the product affected by the merger is compared to a substitute product or the same product in another market that faces similar demand and cost conditions before and after the merger. Specifically, the analysis is a reduced form regression of the price of the product of the merged firm relative to control product(s) on various time trends and a merger dummy variable. To implement this approach for oil mergers, the dependent variable would be the price of gasoline in

See comment 20.

[7] Relevant economic papers include Barton, D.M., and R. Sherman,"The Price and Profit Effects of Horizontal Merger: A Case Study", *Journal of Industrial Economics*, 33(2), December 1984, pp. 165-77. Kim,E.H, and V. Singal,"Mergers and Market Power: Evidence from the Airline Industry,"*American Economic Review*, 83(3), June 1993, pp. 549-69. Schumann, L., J. Reitzes, and R. Rogers, "In the Matter of Weyerhaeuser Company: The Use of a Hold-Separate Order in a Merger with Horizontal and Vertical Effects", *Journal of Regulatory Economics*, 11(3), May 1997, pp. 271-89. Schumann, L., R. Rogers, and J. Reitzes, *Case Studies of The Price Effects of Horizontal Mergers*, Federal Trade Commission, April 1992. Vita, M. and S. Sacher, "The Competitive Effects of Not-for-Profit Hospital Mergers: A Case Study," *Journal of Industrial Economics,* 49(1), March 2001, pp. 63-84.

See comment 19.

a city where the merger reduced the number of competitors and the independent variables would include the price of gasoline in a nearby city (or set of cities) that arguably has the same supply and demand characteristics but is not affected by the merger. The choice of control cities, *i.e.*, the cities where the merger should not affect prices, has to be made carefully and should be subjected to sensitivity analysis.

In the second type of regression (*see* Schumann *et al*, (1992) and (1997)), the price of the merged firm's product (or market price) is regressed on demand and supply/cost shifters plus a merger dummy. The researcher is trying to model how prices are determined in the markets at issue, and the merger is one of the factors potentially affecting price. This approach can be problematic due to the lack of available demand and supply variables that have sufficient variation over time and over geography to capture adequately the factors impacting price, thereby isolating the effect of the merger. This problem is particularly acute in gasoline markets because there are few variables that are available on a weekly basis at the city level to help explain rack price variation.

A third approach, used in Vita and Sacher (2001), combines elements of both of these approaches. In their study of a hospital merger, they examined the price of the merged firm relative to the price of a control group of firms unaffected by the merger that should be affected by the same demand and supply factors and regressed these relative prices on demand shifters, cost shifters, and the merger event to gauge the effect of the merger.

B. Approach Used By GAO

See comment 21.

The methodology described in the GAO December 2002 draft suggested that the regressions would use control cities as well as supply and demand shifters. This would have been similar to Vita and Sacher (2001). The Report, however, does not use a control city methodology. This is surprising given the following quote from page 123 of the Report and the related footnote 90, "... prices at the nearest rack could influence prices at the rack city. We did not however, incorporate this variable directly in our model because there is co-movement between the nearest price variable and prices since both variables are likely to be generated by

See comment 21.

See comment 22.

See comment 24.

See comment 23.

the same set of independent variables." Footnote 90 describes, "In fact in our preliminary estimation we found that the estimated coefficient on the nearest prices were not statistically different from 1."

The GAO appears to use these explanations as a reason for not including control cities in the analysis. On the contrary, these findings strongly suggests that prices from nearby racks (not affected by the merger) are an important, if not the important, control variable. As the quotation from the Report suggests, the price at the nearest rack and the price at the merger rack are determined by the same independent variables, *i.e.*, the demand and supply variables. Using the price at an appropriate nearby (control) rack is particularly important because demand and supply variables that are specific to control racks are not readily available and therefore unobservable. All of these unobservable demand and supply effects are measured jointly in the control rack price. We thus believe that, assuming control racks were selected appropriately[8] and additional supply and demand parameters were included to measure any price changes between the control racks and the merger racks unrelated to the merger as appropriate, the control rack approach would be superior. The GAO, however, chose not to use the control rack approach but rather to try to control for supply and demand factors directly.

C. Methodological Problems with the GAO's Approach

1. GAO's Model is Under Specified

When using the approach of controlling for supply and demand factors directly without using control cities, the independent variables in the regressions, as noted in the Report, should consist of market structure and regulatory factors, cost/supply factors, and demand factors. (P.130-31) This analysis is most similar to the approach taken in the Schumann *et al* studies. If

[8] The control rack should not be directly or indirectly affected by the merger. Both firms should not be posting at the control rack and the control rack should not be so close to the merger rack that arbitrage is likely. A control rack would have the same demand, bulk supply and fuel specifications as the merger rack.

See comment 24.

the GAO staff had been able to develop control variables for all the market structure, regulatory factors, cost/supply factors and demand factors, this approach would have been useful. The Report's regressions contain no measures of market structure factors, other than the merger dummy, no measures of regulatory factors, minimal cost/supply factors and no demand factors.

See comment 25.

The relatively low amount of variation explained by the regressions estimated in the Report (with R^2 of less than 20%) suggests that important factors explaining pricing were excluded from the regression. As a result, the approach employed by the GAO is not viable for estimating merger effects. Thus, the results are of no value for studying the effects of the mergers analyzed.[9]

See comment 26.

The basic equation estimated by the GAO is as follows[10]:

$$PRack_{i,t} - Crude_t = \beta_0 + \beta_1 DMerger_{i,t} + \beta_2 InventoryRatio_{j,t} + \beta_3 Utilization_t \qquad (1)$$

Prack (i,t)	= average rack price in city i week t
Crude (t)	= price of WTI at week t
Dmerger(t)	= merger dummy 0,1
InventoryRatio(j,t)	= inventory/estimated demand for PADD j week t
Utilization(t)	= national refiner utilization rate at week t

See comment 28.

For the GAO preferred specification, the above equation is estimated using data for just the racks directly affected by the merger. In addition, the refinery utilization variable is typically dropped in the preferred specification. The merger effect, β_1, is simply a comparison of the average price after the merger compared to the average price before the merger, controlling for the inventory and in some cases utilization. This model is under-specified. There are any

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See comment 27.

[9] The following quotation from page 85 of the Report is incorrect with respect to the economics literature and information on the petroleum industry, and it even conflicts with other parts of the Report, demonstrated by the lack of explanatory power of the variables used in the regressions: "However, we believe that our model specification have captured all the relevant variables that could affect wholesale gasoline prices. Moreover, we believe that our economic methodology is sound and generally consistent with previous studies."

[10] The preferred specification used by GAO included city fixed effects or random effects as well as a correction for autocorrelation.

See comment 28.

See comment 29.

See comment 30.

See comment 31.

See comment 32.

See comment 33.

See comment 34.

number of additional supply, demand, and regulatory variables that will differ before and after the merger. We discuss these further below.

Given all of these issues, the regression estimates clearly suffer from omitted variable bias. The effects of omitted variable bias are well documented in the economics literature.[11] Symptoms of omitted variable bias are clearly evident in the results presented in the Report. For example, footnote 87 states, "Also, the estimates with years variable (dummy variable for years) appear unreasonable. Furthermore, we did not have a good economic reason for including the years variable." The reason for including this variable is there are omitted variables that are correlated with years. It is likely that this was a highly significant variable in the regressions and was serving as a proxy for other variables. Events correlated with years include formulation changes, supply disruptions, refinery closures and, in some parts of the country, changes in imports.[12] The effect of including the years variable can be seen in Tables 15-17. As discussed more fully below, the inclusion of the years variable changes the estimated results for the two transactions affecting CARB gasoline, Tosco-Unocal and Shell-Texaco I, from finding positive effects on prices from the merger to negative effects. While not as dramatic as the change in the CARB results, many of the other estimated mergers effects change, either to increase or decrease the effect, when the years variable is added to the regression.

The rationale provided by the GAO for dropping the years variable raises another concern. Classical statistical inference – like that used in the GAO report – assumes that the regression specification is chosen independently of the results it generates. If not, then the researcher injects his beliefs into the estimation process. The consequence of such "specification searching," or, less charitably, "regression fishing" is that the estimated coefficients are biased, as

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[11] For a discussion of omitted variable bias and its effects see the literature review on returns to education in Ehrenberg, R.G. and Smith, R.S., *Modern Labor Economics,* Fourth Edition, Harper Collins, (1991), pp. 320--330.

[12] In California, an additional complication is the need to model or include a variable for a new CARB specification in 1996.

See comment 32.

See comment 35.

See comment 36.

are the standard errors.[13] It appears that, in at least one instance, the GAO report did indeed discard a specification because the "estimates appear unreasonable" (Footnote 87).

In what is deemed a sensitivity check, the prices of all the racks having the same gasoline specification are pooled, those racks affected by the merger and those presumed to be unaffected by the merger, and the effect of the merger is estimated using equation (1). When the regression is estimated using data from the merger and non-merger affected racks, the merger effect, β_1, is calculated as a comparison of the average price in the merger racks post-merger compared to the average rack price of the non-merger racks pre- and post- merger and the merger racks pre-merger. Thus, the control group price is an average of the rack price in merger cities pre-merger and the rack price in non-merger cities pre- and post-merger. This is not an appropriate control price. Since the merger effect is being calculated based on a control price equal to the average price of all the cities during different time periods in the data, this analysis provides neither a meaningful pre- and post- merger comparison nor a good sensitivity check.

Both merger affected and non-affected racks could have been used to calculate a difference in difference estimator, if implemented correctly.[14] One way for the estimator to be implemented correctly would be to add an additional variable to equation (1) as follows:

$$PRack_{i,t} - Crude_t = \beta_0 + \beta_1 DMerger_{i,t} + \beta_2 DMergtime_{i,t} + \beta_3 InventoryRatio_{j,t} + \beta_4 Utilization_t \quad (2)$$

Prack(i,t)	= average rack price in city i week t
Crude(t)	= price of WTI at week t
Dmerger(i,t)	= for racks affected by the merger 0 pre merger,1 post merger, non-merger racks 0
Dmergtime(i,t)	=for all racks 0 pre merger 1 post merger
InventoryRatio(j,t)	= inventory/estimated demand for PADD j week t
Utilization(t)	=national refiner utilization rate at week t

[13] *See* E.E. Leamer, *Specification searches: ad hoc inference with nonexperimental data*, Wiley, New York (1978).

[14] The differences-in-differences model is discussed in depth in Angrist, J.D. and Krueger, A.B, "Chapter 23: Empirical Strategies in Labor Economics," *Handbook of Labor Economics*, Vol. 3, 1999, pp. 1296--1299.

See comment 36.

The estimate of β_1 would be the merger effect controlling for the time-specific effects of gasoline prices unrelated to the merger.

Even with the difference-in-difference estimation, it is again crucial to pick the non-affected racks carefully. The control racks should have the same supply, demand and regulatory characteristics. Given that finding control racks can be difficult it is important to also include additional variables measuring supply, demand and regulatory changes to measure possible differences in the merger and control racks.

See comment 37.

2. Key Control Variables Important to Wholesale Gasoline Prices Were Excluded

There are a number of factors that affect price not currently included in the model. The FTC staff comment in December stated:

> "In addition to the number of supply outages that need to be included in the model, all areas of the country do not have the same reformulated gasoline, the formulation changes between winter and summer happen at different times of the year in various parts of the country, there have been a large number of changes in gasoline formulations in addition to RFG (reformulated gasoline) and CARB (California Air Resources Board gasoline) and phase II of RFG began in 2000. In addition, the price of conventional gasoline in any state or city may be affected by the existence of reformulated gasoline. For example, conventional gasoline on the West Coast may be higher priced than conventional in the rest of the country since conventional gasoline in the west is a substitute in production for CARB gasoline."

See comment 38.

FTC staff also gave the GAO staff copies of a map showing all the various formulations of gasoline within the country, including CARB and RFG as well as low Reid vapor pressure conventional gasoline that must be sold in various parts of the country, usually during the summer months. There is no mention in the Report of these other formulations and whether changes in these formulations possibly affected the regression results. All of these issues suggest the need for additional variables in the analysis.

See comment 39.

In addition, there are several important variables that were removed from the GAO December methodology. The original December 2002 methodology included a number of dummy variables that may have removed most of the meaningful variation from the data.

See comment 39.

See comment 40.

See comment 42.

See comment 41.

Therefore, excluding some of these variables may have been warranted.[15] But *completely* omitting measures of supply disruptions, seasonal variables, or year dummies is not appropriate.

Consider first the impact of supply disruptions on the estimation of price effects. Clearly the effect of the supply shocks that caused Midwest Gasoline price increases of the summer of 2000 and West Coast outages in various years will influence the results of the merger effect regressions because these outages were in the post-merger period for some of the mergers.[16] To the extent that prices were higher in the after period as a result of these outages, not controlling for these variables would result in an observed "effect" from the merger where there may have been a smaller effect or none at all.

While the inventory ratio variable may control for these effects to some degree as the Report suggests in footnote 87, preliminary work by FTC staff suggest that inventories do not change dramatically when there are supply shocks. Our regressions of rack prices in Midwest cities on the PADD II inventory level and a supply disruption variable for the Midwest Gasoline episode shows that the supply disruption variable has a large positive coefficient and is highly significant. In December, FTC staff gave the GAO a copy of a recently published paper documenting supply outages on the West Coast and discussed the need for the GAO staff to research other supply outages.[17]

The results in the current Report do not incorporate any information on supply outages either in the regressions (where they should be) or in interpreting the results. Given the high number of supply outages in the year 2000 and that the GAO data set ends in December of 2000,

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[15] Including week, season, year and PADD level dummy variables in the same regression may remove much of the meaningful variation while controlling for seasonal effects. If the year dummies are to proxy for supply disruptions such as refinery outages, a change in the level of gasoline imports, gasoline formulation changes, or a demand change, it would be better to measure these effects directly.

[16] For at least some of the West Coast mergers, the after-merger period ends before the major supply disruptions in 1999-2000.

[17] Taylor, C., and J. Fischer, "A Review of West Coast Gasoline Pricing and the Impact of Regulations," *International Journal of the Economics of Business*, Vol. 10(2), 2003, pp. 225--243.

See comment 42.

estimating the effects of the Exxon-Mobil merger and the Marathon-UDS transaction, which occurred in 2000 and late 1999 respectively, will be very difficult even with a control methodology. Isolating the effect of the merger from the effect of supply disruptions will be difficult because both occurred during the same time period. As FTC staff noted in its December 2002 comments on the GAO's draft model (footnote 8):

> "Some of the mergers will be especially difficult to model. The Marathon Ashland purchase of Ultramar Diamond Shamrock assets in Michigan occurred in late 1999 and the data ends in 2000. The summer of 2000 includes the Midwest gasoline episode as well as major pipeline problems in Michigan. In addition a refinery closed in Michigan right before the purchase. The same lack of sufficient length of the data set applies to other mergers as well depending on which areas of the country are being examined."

See comment 43.

Another type of supply shock involves changes in fuel specifications. In 2000 the implementation of RFG phase II (one of the prime causes of the Midwest gasoline spike) began, which likely increased costs for the industry. As mentioned above, multiple fuel specifications, such as RFG and CARB, or changes in fuel specifications, such as RFG phase I to RFG phase II can cause the price of conventional gasoline to be higher in a given region because all of these products are substitutes in production.[18]

See comment 44.

Another glaring omission in the Report is the lack of controls for seasonal effects. A simple graph of the difference between the spot or rack price of gasoline and the price of crude oil will show that this margin is highly seasonal: the margin is generally wider in the summer than in the winter.[19] Given the short merger windows used by the GAO and the lack of controls for seasonal affects, some of the merger results (such as Marathon-Ashland, Shell-Texaco II (Motiva) and UDS-Total) are likely being driven by seasonal effects, not by the mergers themselves. For example, the time periods examined for the Marathon-Ashland joint venture

See comment 45.

See comment 47.

[18] In order to produce additional reformulated gasoline a refiner has to produce less conventional gasoline, all else being equal. A refiner will decide on how much reformulated and conventional gasoline to make based on the relative margins. Since making reformulated gasoline requires additional capital investment, the margin on reformulated, and hence conventional, must be higher to cover the capital investment.

See comment 48.

[19] The price-concentration analysis in the Report did use seasonal dummy variables.

See comment 45.

were four years before the merger and six months after. The six months after included the summer of 1998. The finding that prices were higher during this period is not surprising because prices generally rise in the summer. The time periods examined for the Shell-Texaco II joint venture (Motiva) were six months before the merger and six months after. In this case the comparison was between the summer of 1998, before the merger, and the winter of 1998 after. Finding that prices decreased during this time period also is not surprising. The time periods and effects for the UDS-Total merger are similar.

See comment 46.

3. Report's Use of Instrumental Variables is Problematic and Incomplete

Another methodological problem involves the use and choice of instrumental variables in the Report. There is no discussion in the Report of why the instruments used[20] are valid instruments for the given endogeneity problem.[21] Footnote 11 of the December FTC staff comments said:

> "If the controls are correlated with the HHI, then using weak (or inappropriate) instruments may give worse estimates than not using instruments. The final Report needs to explain why instruments for control variables are needed, show that the instruments are sufficiently powerful as to improve the results and discuss the changes in the results when using instrumental variables."

See comment 49.

[20] The instrumental variables include: number of suppliers at the rack, state level unemployment rate, the previous period's state level unemployment rate, the previous period's inventory ratio, the previous period's utilization, level, a time trend, and a time trend squared. The number of suppliers at the rack changes for a number of reasons including mergers. There is also no discussion in the Report of how the number of suppliers at the rack was determined. If the number of suppliers at the rack is determined by counting firms posting at the rack, this raises other issues, including: one firm posting multiple brands at a rack and traders who post infrequently at the rack and do not have their own supply but are merely reselling gasoline from another supplier to that rack.

See comment 51.

[21] The endogeneity problem in this case is that prices, inventories, and utilization (a gross measure of quantity) may be jointly (simultaneously) determined. Nevertheless, the test for endogeneity assumes that the instruments being used in the test are valid.

See comment 46.

See comment 50.

See comment 53.

See comment 54.

See comment 55.

See comment 52.

While this remark was made in the context of endogeneity in the price-concentration analysis, it also applies to endogeneity issues in the merger event analysis.

The current Report does test for endogeneity, *i.e.*, whether there is the need for instruments, but does not discuss why these are valid instruments or show that the instruments are sufficiently powerful to improve the results. There is a well known economic literature on the impact of using inappropriate or weak instruments in instrumental variables regression.[22] As a general matter, the first stage instrumental variable results should be reported to show the effects of using the instruments. The goodness of fit of the first stage regressions as well as the coefficient estimates and their significance are important in evaluating the use of instrumental variables. The Report does not provide these results, making it difficult to assess the validity of these instruments. (The suggestions that the instrumental variables estimation is appropriate because the results do not change very much when estimating the regression with and without instrumental variables is discussed in Section D below.)

4. Specification of Before and After Periods of Merger Events is Problematic

Another issue with the "event" study methodology used by the GAO involves the specification of the before and after periods when multiple mergers affect a rack in close succession. The point of an event study is to isolate the effect of a given event, in this case a merger, from all the other events that have occurred. The best way to isolate the effect in this case would have been to concentrate on the racks that did not have mergers in rapid succession. The second best way to isolate the events would be to specify overlapping merger dummy variables. In effect, the approach would be to assess whether the first merger has a price effect and then test whether the price effect of the second merger would be a price increase or decrease on top of the first merger effect. Instead, in the Report, the effect of the second merger is

[22] For an example see, Staiger, R.W. and J.H. Stock, "Instrumental Variables Regressions with Weak Instruments," *Econometrica*, Vol. 65, 1997, pp. 557--586 and Bound, J., D. Jaeger and R. Baker, "The Cure Can Be Worse Than the Disease: A Cautionary Tale Regarding Instrumental Variables," NBER Technical Paper 137, June 1993.

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See comment 55.

calculated by comparing the prices after the second merger to the prices before the first merger. This procedure will give misleading results, because the price effects of the second merger will reflect competitive conditions at the time it occurs, not competition prior to the first merger.

See comment 56.

The specification of the merger dummy variable is of crucial importance. The effect of the merger is estimated by comparing the average price before and after the merger. As mentioned earlier, in some cases the before-merger period is multiple years and the after-merger period is only six months. It is an important question whether six months of data is sufficient to reasonably calculate a merger effect. With respect to this issue, the Report states: "When mergers closely followed each other, it tended to shorten the before and after merger time periods that we could model, especially when more than one merger affected the same rack cities. Nonetheless we believe we had enough data." There is no discussion of how this conclusion was reached.

See comment 57.

The ability to do sensitivity testing on the size of the merger windows is not as problematic as the Report suggests. Additional data could have been used in the post-merger period to see if the results changed. In addition, the pre-merger period could have been shortened to see if that had any effect as well. Sensitivity tests on the duration of the pre- and post-merger periods should have been conducted; unfortunately, they were not.

D. Reports Results are Not Robust in Many Cases

See comment 58.

Because the basic methodology is fundamentally flawed, exhaustively discussing the results at length is unwarranted. One important point, however, that further undermines the reliability of the results is that many results are not robust to the different estimations used in the Report. Different specifications and estimation methodologies can frequently be used to estimate a given relationship. To the extent estimates vary significantly across specifications, assessing what is the "true" relationship is difficult (unless one has good reasons to pick a particular specification or group of specifications as more reliable and clearly explains the choice).

See comment 59.

There are several examples of lack in robustness in the results. For example, consider Tables 15-17 of the Report, which summarize the estimated merger effects from various specifications. In Table 16, the estimated price effect of the BP-Amoco merger ranges from no

See comment 60.

statistically significant price effect to 3.5 cents a gallon among the three regression specifications. In Table 17, the estimated price effects of both the Tosco-Unocal and the Shell-Texaco I transactions shift from being large, negative and statistically significant to being large, positive and statistically significant among the regression specifications. These results show that small changes in specification lead to large changes in results. The inclusion of year effects and using data on all the racks, albeit incorrectly,[23] has sizeable effects on the regression results for a number of the mergers.

See comment 61.

Other examples concerning the lack of robustness of the regression results include the results with and without instrumental variables. The Report mentions that the results using the instrumental variable estimation techniques are not very different from the fixed and random effects regression results. Examination of the regression results shows that this is not true. Tables 27-32 show the individual merger regression results. The first few columns of these tables show the results without instrumental variables and the last few columns show the results with instrumental variables. The regressions estimating the effects of the MAP-UDS merger on the price of conventional gasoline show that without instrumental variables there would have been no estimated price effect. The same is true for the estimates of the effect of the BP-Amoco merger on conventional gasoline, the BP-Amoco merger on reformulated gasoline, and Shell-Texaco I joint venture on branded CARB gasoline.

See comment 62.

Moreover, when the instrumental variables approach is used, the relationship between price and refinery capacity utilization goes from positive and significant to negative and significant. The relationship between refinery utilization and prices is strongly expected to be positive. This is yet another reason to suspect that the use of these particular instruments was problematic.[24]

See comment 64.

[23] As discussed on page 9, the pooling of all racks was incorrectly done. The merger effect is being calculated based on a control price that is an average of non-merger affected racks before and after the merger period and the merger racks before the merger.

See comment 65.

[24] The rationale for dropping the utilization variable from the preferred regression specifications does not make sense. The fact that utilization is correlated with the inventory ratio variable is not relevant. Eliminating variables from a regressions because of multicollinearity when both variables are independently significant is not appropriate. There are a number of

See comment 63.

The current results are also not robust across different racks. Comparing Tables 37 and 38 shows that the Tosco-Unocal merger did not have a statistically significant effect in the instrumental variables specification with the three racks used in the estimation in Table 38, but had a very large effect when using the six racks in California. Because the effects estimated for all six racks include the three racks where the merger had no effects, the Tosco-Unocal merger had a very large effect on those additional three other racks. The sensitivity of the results to which racks are included is an important robustness check and helps the reader to judge the quality of the results. The Report fails to report results for subsets of the racks or indicate whether such sensitivity checks were conducted.

See comment 66.

Another problem is that the very strong statement in the Report that all known variables that affect the wholesale price of gasoline have been included in the regressions cannot be supported. Few of the regressions explain more than 15-20 percent of the variation in the dependent variable. If any additional control variables that would increase the explanatory power of the regressions are correlated with the merger time periods and/or cities, which is highly likely, the merger results would change.[25]

IV. Price Concentration Methodology

See comment 67.

The Report's second econometric analysis seeks to describe the relationship between wholesale gasoline prices (adjusting for crude oil costs) and state-level concentration. While price-concentration studies were once a focus in the economics literature on market structure and industry competitiveness, these studies have been largely abandoned in favor of analyses like merger event studies that attempt to model more directly and with more precision the effects of structural change (such as mergers) upon prices. There are a number of widely recognized methodological issues with price concentration studies. These issues were highlighted by the

See comment 68.

See comment 65.

significant changes in the results when the utilization variable is excluded.

See comment 71.

[25] As mentioned earlier, variables measuring seasonality, supply outages and formulation changes will likely be correlated with the merger variable.

See comment 68.

See comment 69.

See comment 70.

See comment 73.

See comment 74.

See comment 72.

See comment 77.

FTC staff in their communications with GAO staff last December. Surprisingly, the Report does not acknowledge these problems. The results of the Report's price-concentration analysis also suffers from a lack of robustness, and there is little discussion comparing or reconciling the results from the price-concentration study and those of the merger event study.

A. Methodological Issues in Price Concentration Studies

There is a large literature on the problems with obtaining meaningful estimates from price or margin on concentration regressions.[26] Meaningful estimates are estimates that can be interpreted as causal.[27] In other words, the estimated relationship can show that increases in concentration *result* in higher prices or margins. The key issues were summarized in our December 2002 letter and are still relevant to the Report:

> The wholesale antitrust market(s) for gasoline are not likely at the state level; some markets are smaller and some larger. Unless the GAO has evidence that the changes in state level HHI's are closely correlated with changes in the concentration of relevant markets, the analysis is unlikely to provide meaningful results. The effect of aggregation on the estimated relationship is not easily predicted.
>
> The reduced form model of price/margin as a function of HHI has a number of theoretical problems. The major problem is that the coefficient on HHI can not be estimated consistently. Articles in the *Handbook of Industrial Organization* (1989) by Schmalensee and Breshnahan discuss this issue. If the GAO is going to estimate this type of relationship, the large literature on the problems with this

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[26] Examples of this literature include: Evans, W., L. Froeb, and G. Werden, "Endogeneity in the Concentration–Price Relationship: Causes, Consequences, and Cures" *Journal of Industrial Economics,* Vol. 41, 1993, pp. 431--438 and Breshnahan, T.F. "Empirical Studies of Industries with Market Power," in Schmalensee R. and Willig R. (Eds), *Handbook of Industrial Organization*, Vol. II, Ch.17, 1989, (North-Holland, Amsterdam).

[27] Given the number of well documented theoretical problems with estimating and interpreting price concentration regressions, the following statement on p. 146 of the Report cannot be supported: "Also we used the market concentration model because market concentration better represents overall market conditions than mergers."

See comment 74.

See comment 75.

See comment 76.

See comment 78.

See comment 79.

See comment 80.

See comment 81.

type of model needs to be acknowledged and addressed and/or the results should be given with appropriate caveats acknowledging these problems. The problems with estimating this type of relationship include:

(1) HHI is a function of individual firm price and quantity decisions which are affected by supply and demand shocks. The error term in the regression is also a function of these shocks. Therefore the HHI and the error term are likely to be correlated. While the GAO staff are using an instrument, number of suppliers in a state, for HHI to mitigate endogeneity issues, it is unclear why this instrument will allow the identification of the effects of competition or efficiency but is not correlated with other variables of interest. While HHI in a state and the number of suppliers will be correlated, it is likely that the number of suppliers will be correlated with barriers to entry, supply shocks, exit, etc.

(2) HHI may also be correlated with omitted variables that affect price such as various measures of fixed and variable costs and barriers to entry.

It is important to understand the source(s) of variation in the HHI both in formulating and in interpreting the model. The annual or monthly HHI's may be changing due to mergers, entry, exit, or relative price changes caused by supply disruptions or other factors. Few of the changes in the HHI's will be caused by mergers. This point needs to made clear in interpreting the results. In addition, there is evidence that HHI may only matter past a critical point. The model as currently written is testing for a linear relationship. Alternative specifications should be used to test other functional forms.

There is no basis for the suggestion in the Report that, to the extent racks are close to each other and would tend to have similar market characteristics, the available state level data on market concentration is a reasonable variable. Although the GAO staff have added additional instruments to the December 2002 methodology, the same criticisms apply. These instruments – the unemployment rate and lags of the dependent variables – are unlikely to solve the multiple endogeneity problems nor do they solve the market mismeasurement problem. In addition, the criticisms about omitted variable bias and instrumental variable issues outlined when discussing the problems with the event study methodology are applicable to the price-concentration regressions as well. No functional form other than a linear relationship between price and concentration was tested. Given this linear relationship, a 100 point change in the HHI between 900 and 1000 is treated the same as between 4900 and 5000. Because any relationship between

See comment 81.

See comment 82.

See comment 83.

See comment 84.

See comment 88.

price and concentration may not be linear (for instance, there may be only a relationship above a certain threshold), forcing a linear relationship may give misleading results. In addition, the use of year and HHI interaction terms should be discussed and justified. There is no discussion of why an interaction between the concentration and year variables for years when there was a sizeable change in the HHI is appropriate. No interpretation of these estimates is offered.

B. The Report's Price-Concentration Results are Not Robust

Abstracting from the general problems with estimating a price-concentration relationship, the price-concentration relationship as estimated in the Report is not robust in many circumstances. Tables 39 and 40 show that the relationship between price and concentration for conventional gasoline, both branded and unbranded, is negative and significant in the first fixed effect instrumental variable regressions. In each of the next two estimations a variable is dropped and the relationship becomes positive and significant. There is no reason to prefer the last two specifications. As discussed earlier, there is no reason to drop the utilization or the inventory variable because of multicollinearity. The Report could just as easily have reached the conclusion that the relationship between the price of conventional gasoline and concentration is negative based on the results presented in the Report.

While many of the specifications showed a positive and significant relationship between price and concentration, the range of the effects is very large. The effects shown on Tables 39 to 46 give a range of the price effect of a 100 point change in the HHI of 0 to approximately 3 cents per gallon. The results in Tables 18 and 19 show much larger effects. By adding seasonal dummy variables the price effect of a 100 point change in the HHI ranges from 0 to 4 cents per gallon.[28] With year interaction terms, the rationale for which is not clearly explained, the effect of a 100 point HHI change can be as large as 10 cents per gallon.

[28] It is not clear why seasonal dummy variables are included in the price-concentration regressions but not in the merger event studies. Any variable that explains variation in the price variable should be included in both studies. If seasonal effects were significant in the price-concentration analysis (and they must have had sizeable effects given the change in the results), then they should have been included in the merger event analysis.

See comment 85.

See comment 86.

See comment 87.

See comment 89.

See comment 92.

The results presented in Tables 41 and 42 show estimates of the effects of market concentration on branded and unbranded conventional prices by regions. Results are not reported for the specifications of fixed or random effects instrumental variables regressions with both control variables, utilization and inventory ratio. The results on these two tables do show that without using the instruments there would be no relationship between concentration and price in conventional gasoline in the eastern half of the United States.

There is also no discussion in the Report comparing the results of the merger analysis and the price-concentration analysis. Because concentration is affected by factors other than mergers, such as entry, exit, and expansion, the sum of the estimated merger effects should be less than the effect from the change in concentration.[29] In at least some cases, this is not true. Table 19 shows that the aggregate effect of increased concentration in California has raised the price of branded CARB by 5 cents per gallon. The combined estimated effect of Shell-Texaco I (Equilon) and Tosco-Unocal mergers on the price of branded CARB given in Tables 37 and 38 is 8.5 cents a gallon. Because these two mergers caused only a portion of the change in concentration in California, a price change associated with the mergers larger than that associated with the change in concentration is puzzling. The same comparison can be made from other mergers and regions. The GAO preferred estimate of the price effect of the Exxon-Mobil merger is approximately a nickel. The entire change in concentration in PADD's I-III is calculated to have a similar effect on price.[30]

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[29] This would be true unless the merger effects were very short lived.

[30] Even as a purely descriptive matter, the Report does a poor job in linking concentration changes to mergers. In Chapter 3, however, the Report offers a statistical correlation analysis to associate the degree or connections between merger activity and concentration. Data used for this correlation are the HHI estimates for domestic crude oil, refining capacity, and the Herold data set on merger and acquisitions. This analysis shows positive correlations between HHI and merger activity. Correlation analysis does not establish causation, however, and we suspect that similar results would have been obtained had HHI estimates been correlated with the overall merger activity in the economy or stock market indices. As far as we can tell, merger transaction value from the Herold data set are not separated out by industry segment or geographic area: thus it appears that any functional level (crude, refining, or wholesaling) and geographic area that might be affected by a given merger appears to have the same weight in the correlation against the relevant HHI. The data for crude oil and

See comment 90.

V. The Report's Documentation is Poor

In any well-performed study, the descriptions of the data work and the econometrics are sufficient to allow the reader to understand fully how to calculations were done. Such descriptions enable interpretation and replication of the results. The current Report does not include complete descriptions of a number of calculations and regressions. For example, while the merger retrospective regressions do list the number of racks included in each regression there is no list of which racks are included in each regression. By itself, this omission makes interpreting the results and replication impossible.

See comment 91.

Moreover, the Report contains no discussion of how divestitures were handled in the estimation. For example, it is unclear from the text whether the racks affected by the Exxon-Mobil divestitures are included in the regressions analyzing the impact of the Exxon-Mobil merger. The description in the Report about the Exxon-Mobil merger is simply unclear. On the one hand, there are suggestions that there was an estimated increased price from the merger in markets in PADD I where divestitures of wholesale and retail assets eliminated the overlaps. On the other hand, the report does not estimate the effects of the Exxon-Mobil merger in California where there were also divestitures. It is similarly unclear what procedure was followed for the BP-Amoco merger with divestitures in the Eastern United States or the Shell-Texaco merger with divestitures in California.

See comment 94.

Another problem is that the information in the text or in the tables on occasion seems to be contradictory. One example is the description in Table 14 that suggests that any given merger variable has a value of one at the time of the merger and stays one throughout the rest of the data

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See comment 92.

See comment 93.

refining does permit estimation of the concentration changes associated with individual mergers because the data is reported by firm. This would be the usual approach in connecting mergers with changes in HHI. While the wholesale data does not identify firm-specific data because of confidentiality restrictions imposed by EIA, this data is available monthly. Because the month when transactions are consummated is known, fairly strong inferences can be made about the effect of particular mergers on HHI. It is not clear why such an analysis was not done in the Report.

See comment 94.

See comment 95.

See comment 96.

See comment 97.

See comment 98.

See comment 99

See comment 100.

See comment 101.

See comment 102.

See comment 103.

set. This procedure would lead to overlapping merger variables. The text, however, discusses the need to avoid overlapping merger variables.

Finally, there is no discussion of how price is measured. Although the prices are rack prices from the Oil Price Information Service, there is no discussion of the exact calculation of the rack averages and which formulations are used, such as reformulated with MTBE or ethanol. How the racks were used to calculate state level averages for the price concentration analysis is also omitted.

VI. Conclusion

Omitted control variables in both of the Report's econometric analyses are fundamental flaws. Both studies: (1) fail to control adequately for exogenous factors that impact wholesale gasoline prices; (2) suffer from endogeneity problems that are not adequately addressed; and (3) have results that are not robust.

There are other problems specific to each study such as questionable pre- and post-event periods in the merger event study and the assumption that state-level wholesale markets are economically meaningful in the price-concentration study. The Report's documentation of its methodology is inadequate, particularly in view of the potential significance of the Report's findings for public policy in the petroleum industry. These flaws make the Report unable to isolate reliably either the effects of mergers or of concentration on wholesale gasoline prices. Thus, the Report cannot be used to inform public policy.

The following are GAO's comments on the Federal Trade Commission's Bureau of Economics staff letter dated August 25, 2003.

GAO's Comments

1. FTC's claim that the staff had limited ability to review the draft is inconsistent with FTC's statement that they have "spent significant resources investigating consummated mergers…" and have "accumulated substantial methodological expertise and have applied that expertise to the oil industry as part of our enforcement mission." We provided the draft report to FTC for review as a courtesy because GAO is not required to obtain formal agency comments for a report that did not specifically audit that agency's actions—in this case, FTC's merger enforcement actions. We first delivered the draft to FTC on August 5, 2003, and received their written comments on August 25, 2003, totaling 29 pages, excluding other enclosures. We had discussed our study's approach and overall methodology with FTC staff from the beginning of our study, including our meeting in December 2002, when we discussed FTC's written comments to the outline of our preliminary methodology.

2. We disagree that our econometric analyses have fundamental methodological flaws because we used sound econometric analysis that is consistent with the existing literature. We also solicited and obtained comments from experts who reviewed the econometric approach and we incorporated these comments into our model development, as appropriate. In addition, we consulted with a recognized expert in econometric modeling of petroleum markets, who peer reviewed our detailed econometric analysis and results and provided comments, which we incorporated as appropriate.

3. FTC provided us with written comments on our preliminary model outline. At the request of FTC, we met to discuss the issues in the written comments that they deemed to be crucial. At this meeting we discussed issues FTC felt might be addressed, but some of the issues FTC staff raised were so complex and theoretical that they themselves could not offer feasible solutions. In instances where it was reasonable and possible to make changes, we did so. In particular, a major point of concern FTC expressed after our December 2002 meeting was the limitation of the HHI data, based on prime suppliers' sales, that EIA provided to us—the mergers were not reflected in the HHI data until the merged firms began to file a combined report with EIA, possibly months or even years after a merger was completed. We subsequently

contacted EIA, who provided us with revised HHI data, adjusted properly for the timing of the mergers. Nonetheless, we have replaced the monthly HHI based on prime suppliers' sales with yearly HHI based on refinery capacity because we believe the latter measure better captures the ability of suppliers (refiners) in wholesale markets to control production.

4. It is not unusual for a GAO report to be published within a few weeks of giving an agency access to the report. Also, where there is concern about premature disclosure, it is not unusual for GAO to demand the return of a draft report. All drafts remain the property of GAO.

5. FTC provided us with Professor John Geweke's unpublished review of previous studies on competitive effects in the gasoline industry. We were already aware of these studies, having read them and even cited them in the model outline that we provided FTC for review in December 2002. Although we respect Geweke's scholarship and contributions in econometrics, he has not done or published any research work on the gasoline industry (based on his vita that FTC attached to his paper) to gain a thorough understanding of the gasoline market. We disagree with his overall assessment of the competitive effects of mergers in the gasoline industry. In fact, FTC's use of Geweke's expertise is inconsistent with remarks of FTC Chairman Timothy Muris in a speech entitled, "Improving the Economic Foundations of Competition Policy," dated January 15, 2003, stating that "antitrust analysis, if done correctly, uses the NIE (New Institutional Economics) approach—that is, a careful, fact-based economic analysis grounded in a thorough understanding of the relevant institutions" (p. 1).

6. We disagree with FTC's assertion that there are fundamental flaws in our models and that the results cannot be used to make inferences about the price effects from the mergers analyzed and from the effects of increased market concentration. First, our methodology was based on sound and reasonable approaches to analyzing the effects of mergers and market concentration on prices, as found in the economic literature. We appreciate FTC's concern and acknowledge that, like all econometric studies, ours is not perfect. Contrary to what FTC purports, we also believe the limitations are not "severe" because our methodology is consistent with previous studies and is in accordance with accepted econometric practice. Indeed, FTC has recognized in a speech by its (former) Director and Deputy Director of the Bureau of

Economics that "analyses can lead to different conclusions because of different data, different economic modeling, different econometric techniques, and/or fundamental mistakes" (Scheffman and Coleman, undated, p. 2). Furthermore, they stated that "there is no 'perfect' econometric study… Lack of unachievable perfection should not be a bar to an econometric study being given weight" (p. 3). FTC criticized our draft report without offering any empirical support that those criticisms are valid or providing reasons why potentially different conclusions could be obtained. FTC's comments may also be contrary to the statement by its (former) Director and Deputy Director of the Bureau of Economics that "a technically-based critique should be supported by an empirical analysis that shows that dealing appropriately with the technical issue makes a meaningful difference in the results" (Scheffman and Coleman, undated, p. 3).

7. We disagree with FTC's key comment on our econometric methodology that we do not control for important factors that affect gasoline prices. The reason given by FTC is that the amount of variation explained by our models is relatively low (reported R-squares are less than 20 percent). See comment 24. There are several reasons why FTC's characterization of the explanatory power of our models of gasoline prices is flawed. We specified the dependent variable as a price-crude cost margin (crude costs represents over 60 to 70 percent of refining costs). This approach is a generally accepted and statistically preferred technique for assessing the market power and/or efficiency effects of mergers and market concentration. Our specifications generally resulted in R-squares that ranged from about 16 to 36 percent. It is not unusual to obtain low R-squares for models that explain price-cost margins. For example, Collins and Preston[1] obtained R-squares of about 20 percent. To demonstrate that the apparently low R-squares are primarily due to having the crude costs as part of the dependent variable, we reestimated the models with the crude costs as an explanatory variable, instead of the specification that we presented in the draft report, and the R-squares for the merger and market concentration models were very high; they generally exceeded 80 percent. Second, the relatively low R-squares in the draft report were probably due to the lack of data for capital costs for refining, which FTC did not list as one of the key omitted variables, presumably

[1] "Price-Cost Margins and Industry Structure," Review of Economics and Statistics," vol. 51 (August 1969): 277, table 3.

because FTC also recognized the lack of appropriate data for this variable. With wholesale gasoline prices less crude oil prices as the dependent variable, as much as 60 percent of the variation could be due to capital costs, which we do not have data for. Therefore, we believe our models, which explain about 15 to 35 percent of the variation in gasoline prices after accounting for crude oil costs, are sound and reasonable. Third, as noted in Kennedy,[2] "In general, econometricians are interested in obtaining 'good' parameter estimates where 'good' is not defined in terms of R^2. Consequently, the measure of R^2 is not of much importance in econometrics."

Furthermore, contrary to FTC's claim, our model specifically incorporates important factors that affect the price of (wholesale) gasoline. We provide the following additional explanations for why our econometric specifications do not lack important controls.

a. First, our models, apart from including the effects of mergers or market concentration, account for key demand and supply variables, including crude oil prices (which account for about 60 to 70 percent of refining costs), gasoline inventories relative to demand, and refinery capacity utilization. In the economic literature and in suggestions of experts, all these factors have been found to be important in determining wholesale gasoline prices.

b. Second, certain factors, some suggested by FTC, are being captured by other factors that are already in the model. For instance, seasonality, which FTC suggested that we include in our models (see comments 14 and 44), is captured by the variable for gasoline inventories relative to demand. The issue of seasonality of gasoline prices is primarily related to the behavior of gasoline inventories and demand. Therefore, we prefer to use the actual data that represent seasonality rather than an indicator variable for seasonality, a proxy, which FTC seems to prefer. This same reasoning applies to FTC's suggestion in the Commission's comments that we include temperature, which is also intended to reflect seasonality. In addition, in the Commission's comments, FTC suggested that we include income in our models. However, as we stated in our draft report, the available data for income by city does not vary over time (time-invariant) and could not be estimated because we use a fixed-

[2]*A Guide to Econometrics*, Fourth Edition (The MIT Press: Cambridge, MA, 1998): 27.

effects estimator, which makes it impossible to estimate time-invariant variables, including income.

c. Third, we constructed measures of the supply disruptions in the Midwest and West Coast—albeit crude and imperfect measures—that we included in the models. The majority of results of the models changed little when the supply disruptions were included. See comment 3 in appendix V for a detailed response.

d. Fourth, FTC indicates that we failed to account for another type of supply shock involving changes in fuel specifications that affect reformulated gasoline (RFG) and CARB (see comments 14 and 37). As noted by FTC, there was a change from Phase I to Phase II RFG in the Midwest in 2000. Due to insufficient data on RFG in the Midwest, our analysis of the Midwest (PADD II) market focused only on conventional gasoline, and we believe that our estimated results are reasonable and valid. Furthermore, the RFG market in the Midwest over the period of our study was very small relative to conventional gasoline. For CARB, the change from Phase I to Phase II occurred in 1996, and our analysis reflects this change because our analysis covered the period from 1996 through 2000.

e. Fifth, the variables incorporated in the models depend on the econometric technique used for the type of data involved in our analysis, namely, panel data—data for multiple rack cities over a period of time. There are two common approaches for estimating panel data: the fixed-effects estimator and the random-effects estimator. The former is preferred when observations are not chosen randomly and there are likely to be unobservable, site-specific effects. This estimator is implemented by including an indicator variable for each rack city (city-specific effects). In wholesale gasoline markets, such unobserved differences might include (1) unmeasured supply or demand effects, such as different pricing strategies of the refiners at the different rack cities, and (2) the level of development of the transportation system in the different areas. A major advantage of the fixed-effects estimator is that there is no need to assume that the unobserved city-specific effects are independent of the included explanatory variables. Furthermore, the selection of the rack cities used in our study was not random but was based on data availability. We therefore prefer the fixed-effects estimator in the final report. On the other hand, the random-effects estimator allows one to include a time-invariant variable. Also, the random-

effects estimator allows one to make unconditional (marginal) inferences with respect to the population of all effects. However, one has to make specific assumptions about the pattern of correlation (or assume no correlation) between the unobserved effects and the included explanatory variables. The need for these assumptions is a major shortcoming of the random-effects models because there are reasons to believe that the assumption of no correlation may not be correct for wholesale gasoline markets and could bias the estimates. (See, for example, Hsiao).[3]

8. We disagree that our current methodology differs significantly, in substance, from the December 2002 preliminary methodology that we provided to the external reviewers. Furthermore, we have indicated in the report that some of the reviewers had the opportunity to review only the preliminary model outline while others reviewed the full and complete draft report.

9. FTC's criticism of our use of rack price data is unwarranted, given that FTC used the same data from OPIS (Oil Price Information Services) in its report to the Congress, *Midwest Gasoline Price Investigation*, dated March 29, 2001, on wholesale gasoline prices in the Midwest. While there are different gasoline price series at the wholesale level, as we have laid out in chapter 4 of both the draft and final reports, the rack market is still the predominant market in the United States as a whole, and there are no data to verify the extent to which wholesale gasoline markets vary geographically. Also, we stated in the draft and final reports that we did not infer from the econometric analysis what our findings on wholesale prices imply for retail prices.

10. We disagree with FTC's characterization of the interpretation of our results. We used sound econometric methodology and we carefully estimated and interpreted the econometric results.

11. We disagree. The consistency of the results we obtained from the different specifications and estimations of a particular model, as well as consistency in the results for the two different model types—the mergers' effects and the market concentration effects—support the robustness of our results. In particular, we provide the following evidence for the robustness of our results.

[3]*Analysis of Panel Data*, Second Edition (Cambridge University Press: New York, 2003).

a. First, the results with and without the supply disruptions were generally similar. We also used the HHI based on prime suppliers' sales and the majority of the results were similar qualitatively to those obtained using the HHI based on refinery capacity.

b. Second, because market concentration reflects the cumulative effect of the mergers and other competitive factors, one would expect that the results from the market concentration models and mergers models would be similar if mergers are the predominant contributing factor to market concentration. In our study, the two approaches yielded qualitatively similar results. In the draft report, we also estimated the effects of the mergers using two approaches—using data for all racks and using data for only the merger affected cities. Both approaches yielded qualitatively similar results.

12. We disagree. While there is no a priori basis for what the magnitude of the effects of the mergers and market concentration should be, we think that our estimated effects, which are generally below 5 cents per gallon (cpg) for conventional and reformulated gasoline, are reasonable given that the average levels of the wholesale price margins (wholesale gasoline prices less crude oil prices) ranged from about 20 cpg for conventional and RFG gasoline to about 30 cpg for CARB gasoline.

13. We do not agree. We provided detailed descriptions of each variable that we used, including the frequency, time period covered, gasoline specifications and brands, and sources of the data. We specified completely our basic econometric equations for both the mergers models and market concentration models, and any modifications that we made to the basic equations. We also indicated the estimation techniques used and why we used them and the various statistical tests that were performed, which are all common in the econometric literature.

14. We disagree with FTC's assertion that our econometric methodology excludes important control variables. We included key control variables, including consideration of these specific issues, given data availability. See comments 7(b)(c)(d)(e).

15. Most of the estimated effects of the mergers and market concentration are below 5 cpg, especially for conventional and RFG gasoline prices, which both averaged about 20 cpg over the sample period of our study. The estimates are above 5 cpg for both the Exxon-Mobil merger in the

case of reformulated gasoline and the Tosco-Unocal merger in the case of CARB gasoline, for which the wholesale price margin averaged about 30 cpg.

16. The FTC's test may be useful in analyzing the effects of specific mergers and may not apply to our study, which looks at the effects of multiple overlapping mergers. In fact, the apparent "one-cent per gallon increase" rule for gasoline markets used by FTC is ad hoc—it does not come from economic theory or from empirical information about gasoline markets. FTC's statement that EIA found that net refinery margins were about 4 cents per gallon is not inconsistent with our overall findings, where our price margins are only net of crude costs. Furthermore, FTC's consultant, Professor John Geweke, in his review of the study by Hastings (2002), apparently did not find any objection to the result that prices increased by about 5 cpg after the Atlantic Richfield Oil Company (ARCO) announced the long-term lease of service stations from Thrifty in 1997.

17. We disagree with FTC's characterization of how we dealt with the issue of endogenous variables in the draft report. As indicated in a previous study FTC cited, the instruments for endogenous variables may not meet the requirements for ideal instruments, but they serve to deal with the problem of endogeneity of the variables. (See Evans, Froeb, and Werden (1993).) Also, even when the instruments are possibly correlated with the stochastic disturbance term (i.e., the instruments are not ideal), the instrumental variables (IV) estimates may be preferred to the non-IV estimates when the R-squares between the endogenous regressors and the instruments are not low (exceed 0.1); see Hahn and Hausman (2003). In other words, even when the instruments are not perfect (or ideal), it is still preferable to use the instruments if they are not weak, as in our case, rather than not instrumenting at all.

    As indicated in the draft report, we dealt with the problem of endogenous variables as follows. First, we ran regressions of the endogenous variables on the selected instruments to ensure that the instruments were not weak. The results indicated that the estimates were highly statistically significant. Second, our tests for exogeneity of the endogenous variables generally rejected the null hypothesis that the variables were exogenous—indicating that the instruments would be preferred. Third, our tests indicated that the overidentifying restrictions of the instruments were not ideal, using standard

econometric tests. Finding ideal instruments for these endogenous variables is difficult, especially for market concentration, when modeling gasoline prices. None of the previous studies on price-concentration performed this test, including the 1993 study by Evans, Froeb, and Werden, which we, as well as FTC, cited. We also note that FTC, while criticizing us for the instruments that we used failed to provide any suggestions on what instruments would be more appropriate. Furthermore, we discussed the issue of the instruments with FTC staff during our meetings. In fact, we stated in our draft report that the issue of finding ideal instrument(s) for market concentration, if any, in a price relationship was discussed extensively in FTC's (2001b) *Empirical Industrial Organization Roundtable* (see for, example, pp. 17-18, 28, 36-37), where it was agreed that no commonly accepted solution existed and that this issue was problematic.

Nonetheless, in the final report, we have used a modified set of instruments to account for the potential endogenous regressors—ratio of inventories to demand and refinery capacity utilization rates. The instruments were 52 weekly (seasonal) dummies, time trend, and squared time trend. Our tests results of exogeneity of the endogenous regressors and overidentification of the instruments, based on the Hausman (1978) specification test, indicated that the two regressors were generally exogenous, although endogenous in some models; in those cases the instruments were found to be appropriate or valid. Furthermore, the HHI measure based on refinery capacity would more likely be exogenous to rack prices, unlike the actual flow of gasoline sales, which are more reactive to actual current gasoline prices.

18. We disagree with FTC's assertion that we did not appropriately specify the pre- and postperiods for the mergers. In fact, in the draft report, we used two approaches, where we clearly identified the pre- and postperiods of the mergers, to determine the effects of the mergers in the merger affected cities, and both approaches yielded similar results. Furthermore, in constructing the data, we used due diligence to ensure that there were enough data both before and after the mergers to estimate the mergers' effects.

    The approach suggested by FTC attempts to match the diverse merger cities to a representative nonmerger city. While this matching process might be useful in concept, it is seldom pragmatic to find a control city that has the same demand and supply characteristics, except for the merger, when one wants to consider all the available cities that were

affected by the mergers. These cities are generally diverse because in most cases a merger affected more than one broad geographic area, and the affected racks generally include large as well as small cities. Furthermore, even if one could select a nonmerger control city, that city is likely to be near the merger cities. In this case, the mergers could indirectly affect prices in the selected nonmerger control city as well, violating the requirement that the mergers should not affect the selected control city. In our study we use a statistical technique to adjust for contemporaneous error effects across the rack cities.

19. The first approach would not be feasible for analyzing the effect of mergers on gasoline markets because it was virtually impossible to select an appropriate control city for each merger because each merger affected multiple cities that are generally diverse. Although we believe the approach might be appropriate for other products—for example, in the case of hospital mergers, where control cities might be easily identified because nearby cities might have similar demand and supply characteristics, and a merger that affects one city is not likely to affect the other city. For wholesale gasoline markets, while a nearby city is likely to have similar supply and demand characteristics as the merger affected cities, the merger would very likely affect prices in the nearby city due to spatial-price competition, violating a key requirement for a control city. Furthermore, we note that despite FTC's experience in reviewing most of the mergers that we modeled, FTC did not provide any examples of control cities that would be appropriate for the mergers when we discussed with FTC staff, earlier on, the mergers that we were analyzing and our proposed methodology. Moreover, our statistical approach, the fixed-effects estimator, uses a methodology that allows us to control for the unique characteristics of each city and contemporaneous error effects across rack cities.

    For the second approach, although there are potential problems in obtaining demand and supply variables that vary over time and space, we do not believe this problem is as acute in gasoline markets. As indicated in comment 7, our models generally do a good job in explaining the variations in gasoline prices. Therefore, we believe that FTC's criticisms of these models are exaggerated. Also, based on our review of the literature, modeling, and discussions with experts, many of the supply and demand factors that FTC claims that we excluded can be captured by the variables that we included in the models, especially gasoline inventories relative to demand.

While our approach is in the spirit of the second methodology because we control for key demand and supply factors, it also reflects the first methodology since we use data for all available rack cities (merger and nonmerger affected rack cities), with the nonmerger affected rack cities serving as control cities.

20. In order to show that our methodology has been applied to many industries, we cited in the draft report all the studies FTC cited, including a study on railroad mergers published by GAO staff—Karikari, Brown, and Nadji (2002)— not cited by FTC.

21. We disagree with FTC's claim that we indicated in the December 2002 model outline that the regressions would include control cities. We rather indicated that we would include the prices in nearby cities as one of the explanatory variables to capture spatial-price competition in gasoline markets. In fact, FTC stated in its comment on our December 2002 model outline that "the use of nearby margins as a control factor is complicated by the number of gasoline specifications and other factors. The choice of the nearby margins will be difficult." A nearby city is not likely to be an appropriate control city. We explained in both the draft and final reports that we did not eventually include the variable for the nearby prices. This is because if regional and local variables that drive wholesale prices, such as transportation costs, are omitted, then prices in the nearby cities will be a strong predictor of prices in the other cities, even if the suppliers at nearby racks do not compete; this, therefore, creates statistical problems due to correlation with the error term. Furthermore, because the mergers and market concentration are likely to affect prices in the nearby cities; the nearby prices should not be included in the models when the mergers or market concentration variable is already included.

    In the final report, we have incorporated the possible effects of nearby cities through the estimation procedure—we handled this potential problem by accounting for contemporaneous cross-sectional (rack city) correlations.

22. We considered using the nearby prices to capture the spatial-price competition in gasoline markets, contrary to FTC's assertions that prices at the nearby cities would be used as control cities. The nearby cities are not likely to be appropriate control cities for the reasons we stated in comments 19 and 21, specifically the potential for indirect effects of mergers on the control cities. Based on FTC's comment on

the requirements needed to qualify as a control city, it is nearly impossible to find cities that would completely fulfill these requirements. We therefore chose an approach that did not depend upon a matching of merger cities with appropriately defined control cities.

23. While we agree with FTC that these conditions should be included in the list of requirements needed to qualify as a control city, these conditions, augmented by the concerns above, led us to conclude that it is not practical to identify an appropriate control city for the purposes of our multimerger analysis. Furthermore, the nearby rack city was based solely on distances between cities and would have served a different function in our model, as opposed to being used as a control city in the sense used by FTC.

24. We disagree. The models that we developed included regulatory factors, such as divorcement regulations, and several other supply and demand factors. However, in the final estimation, while we could not directly include all possible demand and supply factors, due to data limitations and estimation techniques, our estimated results show that our models are not under-specified. See comment 7.

25. We do not agree with FTC's characterization. As we indicate in comment 7 above, our models generally explain a high proportion of the variations in gasoline prices. FTC's comment about low R-squares is unreasonable and unwarranted because higher R-squares are obtainable but those models have less preferred statistical properties. Furthermore, experts in gasoline markets reviewed our methodology.

26. We disagree. The model specified by FTC did not represent our preferred model in the draft and final reports. In fact, we stated that "we used data for all the racks, and the specific merger dummy variables ($MERGER_{ki}$) are applicable only in the rack cities where the merging companies operated." Also, because we used data for all the rack cities, we estimated the effects of each of the multiple mergers in the same model.

27. As FTC economists have stated there is no perfect econometric model and we have replaced the word "all" with "key" in the final report. See comment 7(a).

28. We do not agree with FTC's claim that our models are under-specified. In the draft report, the refinery capacity utilization rates variable was dropped because its expected sign was inconsistent when included with the ratio of gasoline inventories to demand variable. Furthermore, when the ratio of gasoline inventories to demand was excluded, the utilization rates variable had the expected sign. Also, the data for utilization rates are available nationally, while the data for the ratio of gasoline inventories to demand are available regionally, which better captures differences in prices across markets. Nonetheless, we have included the refinery capacity utilization rates variable in all our models. For the effect of a merger, any measure of its effects using an indicator variable is a comparison of average prices before and after the merger. Our models are not under-specified as discussed in comment 7 above.

29. While we agree that if relevant variables are omitted and those variables are correlated with the included variables, the parameter estimates would be statistically biased, we disagree that our models suffer from omitted variable bias. See comment 7.

30. We disagree with these assertions by FTC. First, our study was not affected by the changes in gasoline formulations (see comment 7(d)). Second, the year effects would be poor proxies for the supply disruptions, which included disruptions and refinery closures, because the supply disruptions typically did not span the whole annual period from January to December of a year or they affected certain time periods in one year and other time periods in another year. In this case, using year dummies would overstate the impact of the supply disruptions. Third, we estimated separate models for different regions (the East and the West) of the United States to account for regional differences such as imports. In general, while the year effects would control for cyclical patterns common to all rack cities if they existed, we do not believe there is an annual cyclical phenomenon in the gasoline markets that we studied. Furthermore, the year effects were excluded because of their correlations with the key variables—mergers and market concentration. The mergers or market concentration variables are correlated with the year effects merely because these effects appeared in certain years, and the merger has a stronger conceptual basis for inclusion. FTC's inference about the effect of omitted variables on the estimates is speculative and has no econometric evidence.

31. In the draft report, the year effects were included in some of our models as part of our sensitivity analysis. However, as indicated in comment 30, there is no convincing reason to include the year effects in the models. Furthermore, we disagree with FTC's characterization of our estimates that take into account year effects. Only the results in table 17 of the draft report were affected qualitatively with the inclusion of the year effects.

32. We disagree with FTC that our econometric methodology was based on some sort of "regression fishing." In an attempt to develop a reasonable model, it is not unusual to try other specifications and use reasonable judgment based on the institutions of the market being modeled to make model selections. Indeed, the methodology suggested by FTC—selection of control cities—could be subject to FTC's critique that it involves a selection bias by the researcher.

33. While it is true that omitted variables could bias the estimates, this does not apply to our models. Also, we believe that a more relevant discussion of the statistical effects of omitted variables is captured in Greene,[4] which uses an example for gasoline markets.

34. We disagree. Our data for CARB starts in 1996 and therefore incorporates the CARB Phase II. See comment 7(d).

35. We do not agree with FTC's characterization. In the draft report, our preferred model used data for all the racks because it enabled us to control for systematic variations across all the racks, both merger affected and nonmerger affected cities. We performed a sensitivity check estimating the mergers models with data for only the merger cities. Also, we did not use a control group price (see comments 19, 21, and 22). As indicated, the nonmerger cities were included for a different purpose.

36. FTC suggests that we estimate a difference-in-difference model of the mergers' effects instead of the event-regression estimates. And, as emphasized in FTC's comments, this approach must be implemented correctly. However, FTC's proposed difference-in-difference equation is flawed. Adding "Dmergtime" (time dummy) to the merger dummy

[4]*Econometric Analysis*, Fourth Edition (Upper Saddle River, New Jersey: Prentice Hall, 2000): 334-337.

(event dummy) does not produce a difference-in-difference estimator in the present analysis that covers more than two time periods. This point is presented in standard econometric textbooks that discuss the difference-in-difference estimation (see, for example, Wooldridge, *Econometric Analysis of Cross Section and Panel Data*, 2002, pp. 129-130). The correct way to implement a difference-in-difference estimator when the sample covers multiple time periods is to include the merger dummy variable used in our study as well as group-specific and time-specific dummies (see, for example, Bertrand, Duflo, and Mullainathan).[5] The models that included the year dummies incorporate the "correct" difference-in-difference estimation. FTC's criticism is unfounded and their suggested alternative is flawed.

Furthermore, as FTC notes above, the estimation would depend crucially on how the control cities are picked. As indicated in comments 19 and 21, it is nearly impossible to have appropriate control cities for each of the mergers, as reflected in FTC's comments, where they acknowledge difficulty in choosing appropriate control cities. Also, as noted in Angrist and Krueger (1999, p.1299), the difference-in-difference technique, like other techniques, is not guaranteed to identify the merger effects.

37. We disagree with FTC that the formulation changes were not incorporated in our models because either (1) we did not model those fuel specifications because of a lack of data or (2) our data started in the same period when the changes went into effect. See also comment 7(d). We agree with FTC that the existence of other formulations could affect the prices of the formulations that we modeled. Nonetheless, as FTC agreed during our December 2002 meeting, the effects of other formulations could be minimal because they are typically a small percentage of the total volume of gasoline in the areas that we modeled. Furthermore, there were not sufficient data on rack prices for the other formulations to incorporate their effects.

38. We disagree with FTC that the gasoline formulation changes were not incorporated in our models. While we agree that there are various formulations of gasoline within the country, we did not model every formulation because most of them are limited to very small areas, and

[5]How Much Should We Trust Difference-in-Difference Estimates? MIT Economics Department Working Paper 2003.

there are not enough systematic rack price data for them. We stated in our draft and final reports that we modeled the three dominant gasoline formulations—conventional, reformulated, and CARB—because there were enough data in the OPIS database for these formulations. Although we did not model specifically the Reid vapor pressure, this factor is generally accounted for by seasonality, which we accounted for in our study.

39. We disagree with FTC's characterization of the scope of our December 2002 model outline and the draft report. The estimates in the draft report are based contextually on the December 2002 outline. We provided detailed discussions of why some of the variables could not be directly estimated. We did not simply decide to exclude those variables. See comments 7 and 30-32 regarding our consideration of supply disruptions, seasonal variables, and year indicator variables.

40. While we agree that these effects are important, we do not agree that they could be easily incorporated in the models due to the lack of accurate data. Nonetheless, as indicated above, we included these effects in our models (see comment 7(c)).

41. FTC appears to be inconsistent in the methodology that it thinks would be more appropriate, given the available data. FTC had indicated earlier (see comment 30) that year effects might be used as a proxy for supply disruptions, changes in imports, and gasoline formulations, but now seems to suggest that it is better to measure these effects directly. The latter reasoning leads to our preference for using the ratio of inventory to demand variable. We believe that our models have reasonably accounted for these effects, albeit indirectly, because they could not be measured appropriately with the available data.

42. We disagree with FTC's overall assessment of the relationship between inventories and supply shocks. We also disagree with FTC's claim that inventories do not change when there are supply shocks because inventories are more likely to be drawn down during supply shocks to help make up for disrupted supplies. While the ratio of gasoline inventories to demand variable might not completely account for the effects of the supply disruptions, we found that gasoline prices and inventories are inversely related. We infer also that the inventory levels variable likely used by FTC in its statement is not a useful measure of the role of inventory during supply shocks because it does not account for demand. Furthermore, we obtained a significant and positive effect

for the Midwest disruption variable when we estimated its impact using a crude and imperfect measure. We used an indicator variable for the whole of the Midwest over a certain time period when the supply disruption might have been in effect, while the disruption might have affected only specific areas with differential price effects. For the West Coast, we also constructed a crude and imperfect measure of the disruptions and incorporated it in other specifications of our models. As already indicated, the disruptions did not affect all of the mergers or all geographic markets. In particular, our estimates of the Exxon-Mobil merger effects are not affected directly because the merger did not affect rack cities in the Midwest (PADD II) for conventional or reformulated gasoline, or racks in the West Coast (PADD V) for CARB gasoline. See comment 2 in appendix V for a detailed account.

43. We disagree. We believe that we have fully addressed these issues. See comment 7(d).

44. FTC's suggestion that we use seasonality, temperature, and supply disruptions in our merger regressions means resorting to proxies when we have more direct measures of demand and supply shocks. This suggestion is inconsistent with accepted econometric practice and FTC's suggestion above. Seasons and temperature affect gasoline prices by changing demand and supply. See figures 22 and 23, which show the seasonal nature of the variable—ratio of gasoline inventories to demand—that we used to capture seasonality. Furthermore, we estimated that the price (margins) were higher in the summer driving months than in other months.

45. We do not agree with FTC's characterization of the merger results. First, the merger windows were determined by the nature of the mergers variable and the estimation. Furthermore, we believe that 6 months or more of weekly data before or after a merger are enough data for the analysis. More importantly, the idea of using the control variable for seasonality in our model (ratio of gasoline inventories to demand) is to be able to isolate the effects of the mergers. The effects of the mergers, as captured by our models, are not likely to be affected by whether the post merger period coincides with summer or winter months. Contrary to FTC's claims, as indicated in tables 15 and 16 of our draft and final reports, the months following the Marathon-Ashland merger were from January to June, and the months following the Shell-Texaco II (Motiva) merger were from July to December—these periods included only a few summer months.

46. We disagree with FTC. We stated in the draft report that the instruments were relevant to the endogenous variables. Furthermore, we performed tests of overidentifying restrictions of the instruments, which most of the previous studies FTC cited as examples of studies on price and market concentration did not perform. Although our test indicated that the restrictions for the overidentifying restrictions for the instruments were not ideal, we stated in the draft report why we believe the estimates are still sound and reasonable. Nonetheless, using the modified instruments in the final report, our tests indicated that all the instruments used in our report were appropriate and valid.

47. See comment 7(d).

48. In some of our model specifications in the draft report, we used weekly (seasonal) dummy variables in the market concentration model, but not seasonal (quarterly) dummy variables, which is likely what FTC is referring to.

49. We disagree. We stated in the draft report that the data for the suppliers were measured by the number of refiners/suppliers (posting prices) at the rack. We disagree with FTC that this is not an appropriate way to account for competition among suppliers because the number of suppliers is a key determinant of market concentration. While the number of suppliers may include traders who infrequently post prices at the rack, we think that what matters to the distributor (buyer) at the rack is the number of independently posted prices, which is reflected in the suppliers' data. We note that FTC did not indicate what would be an appropriate measurement of the number of suppliers at the racks. Nonetheless, in the final report, we use the following variables as instruments (excluded exogenous variables) for the ratio of inventories to demand and refinery capacity utilization rates—52 weekly (seasonal) dummies, time trend, and time trend squared. Our tests indicated that the instruments were appropriate.

50. We disagree. As stated in comment 17, we indicated in the draft report that the regressions for the relationship between each of the endogenous variables and the instruments were highly significant, implying that the instruments are not weak. These estimates are not necessarily reported in the economic literature (see, for example, the studies by Evans, Froeb, and Werden (1993) and Staiger and Stock (1997)). On the other hand, in the draft report, we reported the estimates with and without the instruments, where necessary. As in

indicated in the report, the instruments are used to purge the potential endogenous regressors of their correlations with the prices to obtain consistent estimates. And given that we do not have a fully specified system of simultaneous equations, we do not see the merit of reporting the "first-stage" estimates in this instrumental variables approach.

51. We agree with FTC that the endogeneity problem with inventories and utilization may be because these variables may be jointly determined with prices. We stated in the draft report that we also added market concentration to the list of potential endogenous variables. It is standard in endogeneity tests to assume that the instruments are ideal (or valid), as was done by Evans, Froeb, and Werden (1993).

    Nonetheless, in the report, the HHI data based on refinery capacity are assumed to be exogenous, and the instruments used for inventories and utilization are appropriate based on the tests performed.

52. We cited in the draft report a study by Hahn and Hausman (2003), which also deals with the issue of instruments that are not ideal, an issue more relevant to our study. FTC fails to recognize that while the issues of weak instruments and instruments that do not meet the requirements for ideal instruments are related, our results suggest that the instruments are not weak, even if not ideal. Nonetheless, in the final report, all the instruments used are appropriate and valid.

53. We disagree with FTC that the best way to isolate the effects of the multiple mergers, which FTC reviewed prior to their occurring, is to concentrate on racks that did not experience the wave of mergers. First, there is no known definition of what series of mergers would qualify as having occurred in "rapid succession," and FTC did not provide one. Second, since it is generally better to use more rather than less information, we prefer our methodology, which uses all available useful information.

54. We do not agree with the approach suggested by FTC. FTC's approach would be feasible if the rack cities affected by the mergers were the same. Again, we think this could bias the results because the sample used might not be representative.

55. We do not agree with FTC's characterization of how we estimated the merger effects. Our methodology accounts for the previous mergers by including merger dummies for all the mergers that affected the racks.

More importantly, as reflected in the draft report, for racks that had multiple mergers, the estimation of the effects of a second merger compares the prices in the premerger period (which coincides with when the first merger was in effect) to the prices in the postmerger period. (See, for example, the time modeled for the Marathon-Ashland merger, which occurred prior to the Shell-Texaco II (Motiva), and the Shell-Texaco II (Motiva) merger in table 5 of the final report).

56. While we agree that the merger dummy variable is of crucial importance, we disagree with FTC's characterization of the sufficiency of the data that we used, especially for the postmerger period. First, the length of time over which we estimated the effects was not arbitrarily determined. As stated in the draft and final reports, some of the postmerger periods were relatively short because of the wave of the mergers that FTC reviewed (see tables 15-17). Second, while FTC does not provide any evidence why 6 months of data are not enough to determine the effects of the merger, we particularly note that 6 months (actually approximately 24 observations) provide a reasonable duration to estimate merger impacts in wholesale gasoline markets where price changes can be frequent.

57. We disagree. We could not extend the study beyond 2000 because of data limitations and the scope of the study. Furthermore, in an overlapping mergers framework, given the merger variable that we used, extending the data might benefit only the latest merger and not the prior mergers. We also disagree with FTC that the premerger period could be arbitrarily shortened. It is generally better to include all useful information rather than less information. As stated in the final report, we could not reasonably perform sensitivity tests given the wave of the mergers and the relatively short merger windows that were available. Again, in our meetings, FTC did not provide an example of a merger that could benefit from such sensitivity test or suggest what alternative merger dates could be used.

58. We disagree with FTC's assertion that our methodology is fundamentally flawed, because we used sound econometric methodology that is supported by the approaches used in previous studies. Also, the outline of our preliminary methodology was reviewed by experts who provided us comments that we incorporated, as appropriate. Our expert consultant/peer reviewer also reviewed and provided comments to our estimation and interpretation of results, which we incorporated, as appropriate. We disagree that "many" results

are not robust to the different estimations used in the draft report as well as in the report—in fact, most of the estimates for the merger effects and for the market concentration effects were qualitatively and quantitatively similar. (See, for example, tables 15-17). We discussed in the draft report why a certain estimation technique was used and why a certain variable was excluded.

59. FTC incorrectly represents these results in the draft report. We provided separate results for branded and unbranded gasoline. For branded, the estimates were 1.01, 0.25, and 2.14 cents per gallon (only the last value was statistically significant), and for unbranded, the estimates were 2.03, 1.14, and 3.54 cents per gallon (only the second value was not statistically significant). Nonetheless, in the report the effects of the BP-Amoco merger are not statistically significant.

60. As already indicated, there is no specific economic rationale for including year dummies in the models, which have been dropped from our models in the final report. In the report, the effects of the Tosco-Unocal are positive for branded gasoline, and the effects of the Shell-Texaco I are negative. The effects of these mergers on the prices of unbranded CARB gasoline are not statistically significant.

61. We believe that FTC incorrectly assumed that in the draft report, only the use of the instrumental variable estimation changes between the results reported in tables 27-32 for each type of gasoline. We did not indicate that the results with the fixed- and random-effect regressions are not very different from the results using the instrumental variable techniques. The specifications for the fixed and random effects estimates included the variable for refinery capacity utilization rates, while the estimates with the instruments generally excluded this variable, particularly for our preferred models. Therefore, these two sets of results are not directly comparable. Also, we disagree with FTC's characterization of our results in tables 27-38 of the draft report. The results for the individual mergers, which are based on data for only the merger affected racks, were in tables 27-38, and not only in tables 27-32 as claimed by FTC. Apart from the few estimates cited by FTC, the estimates were similar qualitatively for the estimates of the mergers' effects on branded and unbranded gasoline. Also in the draft report, we presented the results of our preferred model for the effects of the mergers, based on data for all the racks. Although the results for using data for only the rack cities affected by a specific merger and using data for all the rack cities were qualitatively similar, the results

based on all the rack cities are preferred because of the importance of spatial competition in gasoline markets.

In the report, the estimates of the mergers and market concentration variables for the models are generally positive for the different specifications, including the models that used instrumental variables and those that did not.

62. We agree with FTC that the effect of high refinery capacity utilization rates is likely to be positive, as we stated in the draft and final reports (see table 13). However, we disagree with FTC's claim that the inconsistency in the effects of this variable is due to the instruments used; rather, we discussed in the draft report that the inconsistency is more likely due to its correlation with the ratio of gasoline inventories to demand variable. In fact, as we indicated in the draft report, the adjusted R-squares increased marginally when the refinery capacity utilization rates variable was excluded, which is one of the reasons we excluded that variable in our preferred models. Nonetheless, in the final report, we did not exclude the utilization variable in any of our models, and all the instruments used were valid.

63. We do not agree with FTC's characterization that the results are not robust across different racks. In the draft report, as we indicated in the titles for tables 37 and 38, the results are primarily for the effects of the Tosco-Unocal and Shell-Texaco I (Equilon), respectively. It was therefore inappropriate to infer the complete results of the effects of the Tosco-Unocal merger from table 38 in the draft report. Furthermore, the results in tables 25 and 26 of the draft report, based on all the racks, were generally consistent with the estimates in table 37 of the draft report for the Tosco-Unocal merger, which were based on only the merger affected cities. These results were also consistent with the findings from previous studies. (See Hastings and Gilbert, 2002).

64. We disagree. See comments 19, 21, 35 and 36.

65. As we indicated in comment 63, like FTC, we believe that the utilization variable would have a positive effect. Nonetheless, the utilization variable is not excluded from any of our models in the final report.

66. We disagree with FTC that our models exclude important relevant variables, although since "all" in this context might be overstated, we have dropped it from the final report. Our models, as specified and

estimated, are not under-specified and do not exclude key variables, as we explained in detail in comment 7. Low R-squares are not unusual in studies of price-cost margins like ours. We have fully explained the reasons for the low R-squares and have also explained how higher R-squares can be produced for our models but at the cost of creating statistical problems. See comment 7.

67. We disagree with FTC's characterizations of price-concentration studies. Contrary to what FTC stated, the studies that both we and FTC cited are price-concentration and not merger event studies. See for example, the studies by Evans, Froeb, and Werden (1993) and Kim and Singal (1993). It is our understanding that such studies continue to underlie FTC's *1992 Horizontal Merger Guidelines*, which imply a causal link between concentration and market power. In addition, alternative methodological approaches to the same question can provide a type of robustness analysis.

68. We disagree. In the draft report, we acknowledged and discussed the methodological issues associated with price-concentration studies, including a citation of the study by Evans, Froeb, and Werden (1993). In addition, we stated, "Generally, there are potential problems in estimating a relationship between prices and market concentration."

69. We disagree. Our results are sound and reasonably robust. Furthermore, in the draft report, we explained why we used certain specifications and why some results differed. We disagree with FTC's assertion that we did not compare or reconcile the results from the price-concentration study with those of the merger event study. First, throughout the draft and final reports, we stated that the market concentration effects would capture the effects of the mergers as well as other competitive conditions. Second, while we did not directly compare the two results because of possible intervening factors that we could not measure—such as entry and exit into the market—our results for the mergers and market concentration are broadly consistent. We found that most of the mergers were associated with price increases and that increased market concentration was generally associated with price increases.

70. While we are aware of the potential problems with price-concentration studies, and therefore reported the analysis as supportive of the results of the merger-event studies, we disagree with FTC's characterization that we did not discuss these issues. In the draft report we recognized

and discussed the limitations of modeling price-concentration. See comments 68 and 69.

71. As we have explained earlier, we have directly or indirectly accounted for the effects of seasonality, supply outages and formulation changes in our models. See comment 7(d).

72. In the draft report, we cited the study by Evans, Froeb, and Werden (1993), which is the most recent study. This study cites and even quotes statements from the study by Bresnahan regarding price-concentration studies. We also cited FTC's *Empirical Industrial Organization Roundtable* (2001b), which discussed some of these issues. Nonetheless, these problems do not negate the use of market concentration in price studies.

73. We agree that it is generally difficult to identify the "true" markets for wholesale gasoline and that some wholesale markets could be larger or smaller than a state. However, we believe that using the state level HHI in the draft report was reasonable. During our meetings, FTC, despite its claimed expertise, did not suggest any feasible alternatives for determining where it makes sense to use state level data and where it does not. We noted in the draft report the limitations of using HHI at the state level, which was the only market concentration data on wholesale gasoline markets available to us and which we obtained only by working closely with EIA. FTC has not provided any reason or evidence for why our results would be biased. More importantly, the merger effects are generally consistent with the market concentration effects. Nonetheless, in the final report, we use refinery capacity data rather than state level data for prime suppliers because we believe this is a better indicator of market power in wholesale gasoline markets. See also comment 3.

74. We recognized the limitations of using the HHI in our models. See comments 68 and 69.

75. We disagree. In the draft report, our choice of instruments was fully evaluated, as discussed in comment 17. We appropriately recognized and cited the study by Evans, Froeb, and Werden (1993), which provides a detailed account of the issues that FTC outlines here. Nonetheless, in the final report, all the instruments are appropriate, based on the tests performed.

76. While changes in HHI may reflect other factors in addition to mergers—such as entry, exit, and relative price changes—we believe, and FTC has not provided evidence to the contrary, that the numerous mergers that occurred in this industry during the period that we modeled significantly increased market concentration. We disagree that mergers will cause "few" of the changes in the HHIs. We show in chapter 3 of the final report that the changes in HHI are associated with mergers in many geographic regions and market segments. Furthermore, the HHI is the core data of FTC/DOJ horizontal merger guidelines, and we are surprised at the criticism that FTC has focused on the use of this variable in our analysis.

77. We disagree. See comment 70.

78. We stated in the draft report that our results are generally consistent with other specifications, including squared HHI. Furthermore, it is common to use linear functions in price-concentration studies; see, for example, Evans, Froeb, and Werden (1993). In the report, using the preferred HHI measure based on refinery capacity, the preferred specification for our models was linear and consistent with previous studies.

79. We believe it is reasonable to assume that racks that are nearest to each other would tend to have similar prices that move together due to spatial-price competition. As we indicated in 17, we used the instruments to deal with the potential endogeneity problems, albeit imperfectly, and conducted tests that we report. In the final report we deal with the issue of nearby racks in the estimation technique—we accounted for contemporaneous cross-city correlations.

80. We believe the criticisms are unwarranted in this instance as discussed in comments 7 and 17.

81. In the draft report, we used other functional forms and found similar results. Consequently, we disagree with FTC. See comment 79. As indicated in comment 79, the linear specification is consistent with previous studies.

82. In the draft report, in exploring why the year dummies were significant, we observed a significant shift in the HHI in a certain year, which seems to be related to the mergers. We therefore used an interaction term to determine if the effects of the HHI before and after the shift in HHI

were different. The results were generally consistent with the results presented in the draft report. A similar shift was found with our preferred HHI measure, but the findings were generally unchanged and are not reported.

83. As already indicated in 17, we preferred the instrumental variables estimates that include the utilization rates on econometric grounds. Also, we disagree with FTC's characterization that the price concentration results are not robust.

84. We disagree. We believe that the estimated effects are reasonable in terms of the average levels of the prices as well as the estimated effects found in previous studies of gasoline markets. For instance, Hendricks and McAfee (2000) simulated that the Exxon-Mobil merger would have resulted in price increases for CARB gasoline. These estimates are generally consistent with our findings.

85. We disagree. As indicated in the draft report, we provided reasons why we believe that the specifications excluding national refinery capacity utilization rates were better. Also, as indicated in comment 17, the results with the instruments are statistically preferred. We note the inconsistency in FTC's criticisms—FTC had indicated that some of the variables could be endogenous (see, for example, comments 75 and 76), which implies that instruments should be used, but they now seem to prefer the estimates without the instruments. Nonetheless, in the final report, we have provided results that include both utilization and inventory ratio and used instruments for these variables, where appropriate.

86. We disagree. Generally, the results for the merger effects and market concentration cannot be systematically compared. Specifically, FTC's assertion that the merger effects should be less than the effects from changes in concentration is not necessarily correct, since the other factors affecting concentration could have both positive and negative directional effects. However, there is evidence that these results are generally consistent because market concentration is closely related to the mergers, as shown in chapter 3, and the increase in concentration implies an increase in the price cost margins, other factors held constant.

87. We disagree with FTC's assessment of the relationships between the effects of mergers and market concentration. FTC erroneously implies

that the market concentration effects are a simple summation of the mergers effects. They are not. This is because, as FTC noted, there are intervening factors, such as entry and exit, between the merger and market concentration effects. However, because market concentration is closely related to the mergers, we found the two effects to be generally consistent (see comment 70).

88. We disagree with FTC's characterization of the variable that we used. In the draft report, we used weekly (seasonal) dummies, not quarterly seasonal dummies as FTC claims. The variable was tried to see if it would make a difference in our results, even though we already had the ratio of gasoline inventories to demand variable, which was available weekly. Given that it did not make a significant difference to our results, we did not include it in our mergers models. In the final report, the weekly (seasonal) dummies are used as instruments. See comment 17.

89. FTC's questioning of any relationship between mergers and market concentration is puzzling, given that the *1992 Horizontal Merger Guidelines*, jointly issued by FTC and DOJ, and FTC's merger review process prominently highlight the link between mergers and market concentration. As we noted in the draft report, the correlation coefficient is a statistical measure of the strength of association or relationship between two variables. While we believe that there is a logical and foundational link between mergers and market concentration based on economic theory, we did not state in the draft report that our correlation analysis establishes causation. Also, because of a lack of detailed data on mergers by segment or geographic area, we used correlation analysis to determine, at broad levels, the association between overall merger activity and market concentration for the various petroleum market segments. While correlation does not infer causation, it is an acceptable statistical method to determine the direction and extent of relationship between two variables. Because many large mergers during this period involved firms that were highly vertically integrated, we believe that the correlation between concentration and overall merger activity reflects market realities. Overall, while we did not infer causality from this analysis, the results indicate that mergers and market concentration are broadly related in the segments that we analyzed.

90. It is not clear what FTC is saying here about documentation in a "well performed study." If FTC is taking issue with our documentation, our

draft report fully provided and discussed characteristics of the data used, including data sources, construction of the data, frequency, gasoline formulations and brands, and time periods. See, for example, tables 13 and 14 of the final report (which were also in the draft report). For the regressions, we provided in the draft and final reports the basic model specifications, the specific variables used in each equation, as well as the estimation techniques. We do not believe it is worth listing the almost 300 racks that were used in the analysis because FTC should be able to identify all racks that the mergers they reviewed affected. We believe that with the data in hand and our descriptions, a researcher should be able to replicate the results.

91. We disagree with FTC that our analysis does not indicate how we handled FTC's divestitures. In the draft and final reports we stated that our study did not assess the appropriateness of FTC's review and actions they took regarding the mergers, including divestiture requirements. All the estimates of the mergers' effects—including the Exxon-Mobil, BP-Amoco and Shell-Texaco I (Equilon) mergers—are conditioned on any divestitures required by FTC. We note that apparently to account for the effect of divestitures, FTC suggested that the effective date of the Exxon-Mobil merger be changed from 11/30/99, which was the merger completion date, to 3/1/00. Accordingly, in the draft report where the market concentration data were based on prime suppliers' sales, we used the EIA's revised HHI calculations to reflect the change in the merger effective date. Our analysis was based on wholesale markets (racks) where the mergers overlapped based on the OPIS data—there were no data for the Exxon-Mobil merger for the racks in California.

92. This procedure would not appropriately measure the size of the merger, particularly in the case of refining, because as correctly indicated by FTC, the Herold data are not separated out by geographic area. For crude oil, there were many mergers for which there are no production data to construct market concentration.

93. We do not believe that this is an appropriate way to determine the links between mergers and market concentration. For instance, the data would not appropriately measure the size of the merger in each geographic market, nor would it be useful in capturing the effects of the intervening factors, such as entry and exit, on market concentration over time. Nonetheless, in the final report, we used data on refinery

capacity to measure market concentration—these data are available only annually.

94. We disagree with FTC's characterization of our econometric methodology and results. While each merger dummy variable is turned on throughout the postmerger period in racks affected by the merger, the estimation procedure generates a parameter estimate for the postmerger period up to the onset of the next merger that affected the same racks as the previous merger. See the postmerger periods identified for each merger in tables 15-17.

95. We disagree with FTC's assertions about the price data we used. We stated in the draft report and final reports that the prices are the average prices at the racks. We also indicated that the three formulations used are conventional, reformulated, and CARB gasoline, and the data were available for regular gasoline, branded and unbranded, as well as the relevant time periods. We state in the report that based on the available data, the product type used for conventional gasoline is clear and the type for reformulated and CARB gasoline is MTBE. In the draft report, we did not state that we used state-level rack prices in the price-concentration analysis. We used the average prices at the rack city level.

96. The underlying modeling issues raised by FTC in its discussion of omitted variables were addressed. Our models address this specific conceptual concern about omitted variables and adequately account for the key variables that affect wholesale gasoline prices. See comment 7 for more details.

97. We disagree. Our models adequately control for exogenous factors that impact wholesale gasoline prices using variables that directly, instead of indirectly, address behavioral issues. See comment 7 for more detail.

98. We disagree. Our models treat the issue of endogeneity extensively and are consistent with previous studies, including the study by Evans, Froeb, and Werden (1993). See comment 17 for more detail.

99. We disagree. Our models are generally robust, and we carefully explain any differences for the specifications. See comments 58-64 and 67 for more detail.

100. We disagree. We clearly specified the pre- and postevent periods for the merger event studies, estimated the mergers' effects and provided the appropriate interpretation. FTC's approach of seemingly "matching" rack cities to nonrack cities would not be appropriate for this study. See comments 18 and 19 for more detail.

101. We disagree. We carefully discussed the problems with market concentration in the price-concentration studies, including the data used for market concentration. We believe the results are sound and reasonable and are consistent with the results of the mergers' effects. See comment 74 for more detail.

102. We disagree. We have provided sufficient documentation of our methodology that, we believe, experts in the gasoline markets, including FTC, would find useful in undertaking similar studies. Given the potential significance of our findings for public policy, we believe that FTC, the agency that reviews mergers in the gasoline markets, should undertake an independent and public study of the effects of the wave of mergers that it has reviewed in the second half of the 1990s.

103. We disagree. Our results are based on sound econometric methodology—they are consistent with previous studies, and external peer review experts who reviewed various stages of the report generally approve of it. Our models have reasonably isolated the effects of the mergers, as well as the effects of markets concentration, which captures the cumulative effects of the mergers and other competitive factors. The effects of the mergers and market concentration on wholesale gasoline prices are generally consistent. The debate is about differences in approach and data, and does not involve fundamental flaws, and therefore can be useful for public policy. Other approaches may be informative, and we encourage independent analysis of this important policy issue by FTC or other other parties.

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Bibliography

Angrist, J. and A. Kruger, "Empirical Strategies in Labor Economics," in *Handbook of Labor Economics*, edited by O. Ashenfelter and D. Card, vol. 3A, (New York: Elsevier, 1999): 1277-1366.

Arellano, M. and S. Bond, "Some Tests of Specification for Panel Data: Monte Carlo Evidence and An Application to Employment Equations," *The Review of Economic Studies*," vol. 58, no. 2 (1991): 277-297.

Azzeddine, A. and D. Rosenbaum, "Differential Efficiency, Market Structure and Price," *Applied Economics*, vol. 33 (2001): 1351-1357.

Baffes, J., "Explaining Stationary Variables with Non-Stationary Regressors," *Applied Economic Letters*, vol. 4, no. 1 (1997): 69-75.

Barton, D. and R. Sherman, "The Price and Profit Effects of Horizontal Merger: A Case Study," *The Journal of Industrial Economics*, vol. 33, no. 2 (1984): 165-177.

Bertrand, M., E. Duflo, and S. Mullainathan, "How Much Should We Trust Difference-in-Difference Estimates?" unpublished paper, June 2003.

Bhargava, A., L. Franzini, and W. Narendranathan, "Serial Correlation and the Fixed Effects Model," *The Review of Economic Studies*, vol. 49, no. 4 (1982): 533-549.

Borenstein S., A. Cameron, and R. Gilbert, "Do Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes?" *The Quarterly Journal of Economics*, vol. 112, no. 1 (1997): 305-339.

Borenstein, S. and A. Shepard, "Sticky Prices, Inventories, and Market Power in Wholesale Gasoline Markets," National Bureau of Economic Research, Inc., Working Paper 5468, 1996a.

Borenstein, S. and A. Shepard, "Dynamic Pricing in Retail Gasoline Markets," *RAND Journal of Economics*, vol. 27, no. 3 (1996b): 429-451.

Chouinard H., and J. Perloff, "Gasoline Price Differences: Taxes, Pollution Regulations, Mergers, Market Power, and Market Conditions," unpublished paper, 2001.

Collins, N. and L. Preston, "Price-Cost Margins and Industry Structure," *Review of Economics and Statistics*, vol. 51, no. 3 (1969): 271-286.

Considine, T., "Inventories and Market Power in the World Crude Oil Market," unpublished paper, 2002.

Creswell, Jr., J., S. Harvey, and L. Silvia, **"***Mergers in the U.S. Petroleum Industry 1971-1984: An Updated Comparative Analysis*,**"** *FTC Economic Report* (May 1989).

Davidson, R. and J. MacKinnon, *Estimation and Inference in Econometrics* (New York: Oxford University Press, 1993).

Dickey, D., and W. Fuller, "Distribution of the Estimators for Autoregressive Time Series With a Unit Root," *Journal of the American Statistical Association*, vol. 74 (1979): 427-431. Evans, W., L. Froeb, and G. Werden, "Endogeneity in the Concentration Price Relationship: Causes, Consequences, and Cures," *The Journal of Industrial Economics*, vol. XLI (1993): 431-438.

Federal Trade Commission, *Midwest Gasoline Price Investigation: Final Report of the Federal Trade Commission* (Washington, D.C., March 29, 2001a).

Federal Trade Commission, *Empirical Industrial Organization Roundtable* (Washington, D.C., September 11, 2001b).

Focarelli, D. and F. Panetta, "Are Mergers Beneficial to Consumers? Evidence from the Market for Bank Deposits, *American Economic Review* (September 2003): 1152-1172.

Geweke, John, "Empirical Evidence on the Competitive Effects of Mergers in the Gasoline Industry," unpublished paper, July 16, 2003.

Greene, W., *Econometric Analysis*, Fourth Edition (Upper Saddle River, New Jersey: Prentice Hall, 2000).

Hahn, J. and J. Hausman, "Weak Instruments: Diagnosis and Cures in Empirical Econometrics," *American Economic Review* (May 2003): 118-125.

Hansen, L. "Large Sample Properties of Generalized Method of Moments Estimators," *Econometrica*, vol. 50, no. 4 (1982): 1029-1054.

Hastings, J. and R. Gilbert, "Vertical Integration in Gasoline Supply: An Empirical Test of Raising Rivals' Costs," Program on Workable Energy Regulation (POWER), PWP-084, 2002.

Hastings, J. "Vertical Relationships and Competition in Retail Gasoline Markets: Empirical Evidence from Contract Changes in Southern California," Program on Workable Energy Regulation (POWER), PWP-075, 2002.

Hausman, J. "Specification Tests in Econometrics," *Econometrica*, vol. 46, no. 6 (1978): 1251-1271.

Hausman, J. and W. Taylor, "Panel Data and Unobservable Individual Effects," *Econometrica*, vol. 49, no. 6 (1981): 1377-1398.

Hendricks, K. and R. Preston McAfee, "A Theory of Bilateral Oligopoly, With Applications to Vertical Mergers," unpublished paper, 2000.

Hsiao, C., *Analysis of Panel Data*, Second Edition (New York: Cambridge University Press, 2003).

Im, K., M. Pesaran, and Y. Shin, "Testing for Unit Roots in Heterogeneous Panels," *Journal of Econometrics*, vol. 115, no. 1 (2003): 53-74.

Karikari, J., S. Brown, and M. Nadji, "The Union Pacific/Southern Pacific Railroads Merger: Effect of Trackage Rights on Rates," *Journal of Regulatory Economics*, vol. 22, no. 3 (2002): 271-285.

Kennedy, P., *A Guide to Econometrics*, Fourth Edition (Cambridge, MA: The MIT Press, 1998).

Kim, E. and V. Singal, "Mergers and Market Power: Evidence from the Airline Industry," *The American Economic Review*, vol. 83, no. 3 (1993): 549-569.

Manuszak, M., "The Impact of Upstream Mergers on Retail Gasoline Markets," unpublished paper, 2001.

Muris, T., "Improving the Economic Foundations of Competition Policy," Remarks at George Mason University Law Review's Winter Antitrust Symposium, Washington, D.C., January 15, 2003.

Newey, W. and K. West, "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, vol. 55 (1987): 703-708.

Pinkse, J., M. Slade, and C. Brett, "Spatial Price Competition: A Semiparametric Approach," *Econometrica*, vol. 70, no. 3 (2002): 1111-1153.

Royer, J., "Market Structure, Vertical Integration, and Contract Coordination," in *The Industrialization of Agriculture: Vertical Coordination in the U.S. Food System*, edited by J. Royer and R. Rogers (Aldershot, England: Ashgate, 1998).

Sargan, J., " The Estimation of Economic Relationships Using Instrumental Variables," *Econometrica*, vol. 26 (1958): 393-415.

Scheffman, D. and M. Coleman, "Current Economic Issues at the FTC," *Review of Industrial Organization*, vol. 21 (2002): 357-371.

Scheffman, D. and M. Coleman, "FTC Perspectives on the Use of Econometric Analyses in Antitrust Cases," unpublished paper, undated, http://www.ftc.gov/be/ftcperspectivesoneconometrics.pdf (September 5, 2003).

Scheffman, D. and P. Spiller, "Geographic Market Definition Under the U.S. Department of Justice Merger Guidelines," *Journal of Law and Economics*, vol. 30, no. 1 (1987): 123-147.

Scherer, F., *Industrial Market Structure and Economic Performance*, Second Edition (Chicago: Rand McNally, 1980).

Schumann, L., J. Reitzes, and R. Rogers, "In the Matter of Weyerhaeuser Company: The Use of a Hold-Separate Order in a Merger with Horizontal and Vertical Effects," *Journal of Regulatory Economics*, vol. 11, no. 3 (1997): 271-289.

Spiller, P. and C. Huang, "On the Extent of the Market: Wholesale Gasoline in the Northeastern United States," *The Journal of Industrial Economics*, vol. 35, no. 2 (1986): 13-145.

Staiger, D. and J. Stock, "Instrumental Variables Regression with Weak Instruments," *Econometrica*, vol. 65, no. 3 (1997): 557-586.

Stock, J., and M. Watson, *Introduction to Econometrics* (Boston, MA: Addision-Wesley, 2003).

Taylor, C. and J. Fischer, "A Review of West Coast Gasoline Pricing and the Impact of Regulations," unpublished paper, 2002.

Taylor, C. and D. Hosken, "The Economic Effects of the Marathon-Ashland Joint Venture: The Importance of Industry Supply Shocks and Vertical Market Structure," FTC Bureau of Economics Working Paper 270, March 2004.

U.S. Department of Energy, Energy Information Administration, "Petroleum Product Prices and Supply Disruptions," in *Electricity Shortage in California: Issues for Petroleum and Natural Gas Supply*, June 2001.

U.S. Department of Justice and Federal Trade Commission *1992 Horizontal Merger Guidelines*, http://www.ftc.gov/bc/docs/horizmer.htm (July 22, 2002).

U.S. General Accounting Office, *Energy Prices: Gasoline Price Increases in Early 1985 Interrupted Previous Trend*. GAO/RCED-86-165BR, Washington, D.C., September 25, 1986.

U.S. General Accounting Office, *Energy Security and Policy: Analysis of the Pricing of Crude Oil and Petroleum* Products. GAO/RCED-93-17, Washington, D.C., March 19, 1993.

U.S. Senate, *Gas Prices: How Are They Really Set?* Report prepared by the Majority Staff of the Permanent Subcommittee on Investigations, released in conjunction with the Permanent Subcommittee on Investigations' Hearings on April 30, 2002 and May 2, 2002.

Vita, M., "Regulatory Restrictions on Vertical Integration and Control: The Competitive Impact of Gasoline Divorcement Policies," *Journal of Regulatory Economics*, vol. 18, no. 3 (2000): 217-233.

Vita, M., and S. Sacher, "The Competitive Effects of Not-for-Profit Hospital Mergers: A Case Study," *The Journal of Industrial Economics*, vol. XLIX (2001): 63-84.

White, H., *Asymptotic Theory for Econometricians* (San Diego, CA: Academic Press, 2001).

Wooldridge, J., *Econometric Analysis of Cross Section and Panel Data* (Cambridge, MA: MIT Press, 2002).

Wu, D. "Alternative Tests of Independence Between Stochastic Regressors and Disturbances," *Econometrica*, vol. 41, no. 4 (1973): 733-750.

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