United States Government Accountability Office

GAO

Report to Congressional Requesters

June 2009

ENERGY MARKETS

Estimates of the Effects of Mergers and Market Concentration on Wholesale Gasoline Prices

GAO-09-659

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GAO Accountability · Integrity · Reliability

Highlights

Highlights of GAO-09-659, a report to congressional requesters.

Why GAO Did This Study

In 2008, GAO reported that 1,088 oil industry mergers occurred between 2000 and 2007. Given the potential for price effects, GAO recommended that the Federal Trade Commission (FTC), the agency with the authority to maintain petroleum industry competition, undertake more regular retrospective reviews of past petroleum industry mergers, and FTC said it would consider this recommendation. GAO was asked to conduct such a review of its own to determine how mergers and market concentration—a measure of the number and market shares of firms in a market—affected wholesale gasoline prices since 2000.

GAO examined the effects of mergers and market concentration using an economic model that ruled out the effects of many other factors. GAO consulted with a number of experts and used both public and private data in developing the model. GAO tested the model under a variety of assumptions to address some of its limitations. GAO also interviewed petroleum market participants.

What GAO Recommends

This study reinforces the need to review past petroleum industry mergers, and GAO continues to recommend that FTC conduct such reviews more regularly and develop risk-based guidelines to determine when to conduct them. FTC reviewed a draft of this report and supports GAO's recommendation to conduct more reviews of past petroleum industry mergers.

View GAO-09-659 or key components.
For more information, contact Mark Gaffigan at gaffiganm@gao.gov, (202) 512-3841 or Tom McCool at mccoolt@gao.gov, (202) 512-2700.

What GAO Found

GAO examined seven mergers that occurred since 2000—ranging in value and geography and for which there was available gasoline pricing data (see table)—and found three that were associated with statistically significant increases or decreases in wholesale gasoline prices. Specifically, GAO found that the mergers of Valero Energy with Ultramar Diamond Shamrock and Valero Energy with Premcor, which both involved the acquisition of refineries, were associated with estimated average price increases of about 1 cent per gallon each. In addition, GAO found that the merger of Phillips Petroleum with Conoco, which primarily involved the acquisition of oil exploration and production assets, was associated with an estimated average decrease in wholesale gasoline prices across cities affected by the merger of nearly 2 cents per gallon. This analysis provides an indicator of the impact that petroleum industry mergers can have on wholesale gasoline prices. Additional analysis would be needed to explain the price effects that GAO estimated.

Seven Mergers That GAO Studied, and the Estimated Wholesale Gasoline Price Effects

Merger	Date	Value (Dollars in millions)	Cities affected	Estimated price effect
Chevron/Texaco	10/16/2000	$44,838	37	Not statistically significant
Phillips/Tosco	2/4/2001	9,828	8	Not statistically significant
Valero/Ultramar Diamond Shamrock	5/7/2001	6,442	26	+1.06 cents per gallon
Shell/Texaco	10/9/2001	3,860	35	Not statistically significant
Phillips/Conoco	11/19/2001	31,282	47	- 1.64 cents per gallon
Premcor/Williams	11/26/2002	367	2	Not statistically significant
Valero/Premcor	4/25/2005	$7,588	20	+1.13 cents per gallon

Source: GAO analysis of information from IHS Herold and Oil Price Information Service.

GAO used two separate measures of market concentration, one which measured the number of sellers at wholesale gasoline terminals and another which measured the market share of refiners supplying gasoline to those sellers, and found that less concentrated markets were statistically significantly associated with lower gasoline prices. For example, for wholesale terminals with more sellers—i.e., terminals that were less concentrated—GAO estimated that prices were about 8 cents per gallon lower at terminals with 14 sellers than at terminals that had only 9 sellers. This result is consistent with the idea that markets with more sellers are likely to be more competitive, resulting in lower prices. Using the second measure of concentration, GAO similarly found a statistically significant association between prices and the level of refinery concentration, with less concentrated groups of refineries associated with lower prices.

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Abbreviations

CARB	California Air Resources Board
CBG	Cleaner Burning Gasoline
DOJ	Department of Justice
EIA	Energy Information Administration
FTC	Federal Trade Commission
HHI	Herfindahl-Hirschman Index
MTBE	Methyl tertiary-butyl ether
OPIS	Oil Price Information Service
PADD	Petroleum Administration for Defense Districts
RFG	reformulated gasoline
RVP	Reid vapor pressure
UDS	Ultramar Diamond Shamrock Corporation

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United States Government Accountability Office
Washington, DC 20548

June 12, 2009

The Honorable Charles E. Schumer
Vice Chairman
Joint Economic Committee
United States Congress

The Honorable Herb Kohl
Chairman
Subcommittee on Antitrust, Competition
Policy and Consumer Rights
Committee on the Judiciary
United States Senate

The Honorable Henry A. Waxman
Chairman
Committee on Energy and Commerce
House of Representatives

The Honorable Dianne Feinstein
United States Senate

In 2008, GAO reported that more than 1,000 mergers occurred in the petroleum industry between 2000 and 2007.[1] These mergers were mostly between firms involved in crude oil exploration and production, and were generally driven by the challenges associated with producing oil in extreme physical environments such as offshore in deep water and increasing concerns about competition with large national oil companies. Other mergers took place in the segment of the petroleum industry that refines and sells petroleum products. These mergers were generally driven by the desire for greater operational efficiencies and cost savings. We reported that while mergers could help oil companies overcome some of these challenges, they also have the potential to increase firms' market

[1]GAO, *Energy Markets: Analysis of More Past Mergers Could Enhance Federal Trade Commission's Efforts to Maintain Competition in the Petroleum Industry*, GAO-08-1082 (Washington, D.C.: Sept. 25, 2008.)

power—allowing them to raise gasoline prices without being undercut by other firms.[2]

The Federal Trade Commission (FTC) has lead responsibility for federal reviews of petroleum industry mergers. In evaluating mergers, FTC staff try to predict the impact of a merger on gasoline prices by reviewing factors that affect competition, including the market concentration. Market areas with a number of small firms are considered to be unconcentrated or moderately concentrated, while areas with fewer, larger firms are highly concentrated. Mergers that lead to a more concentrated market might also improve efficiency and reduce costs, and firms may pass these savings on to consumers in the form of lower prices. At the same time, mergers that cause a market area to become highly concentrated potentially allow one firm, or a small group of firms, to increase consumer prices above competitive levels. However, our 2008 review was limited to FTC's efforts to maintain competition in the petroleum industry; it did not address the impacts mergers or subsequent changes in market concentration may have had on prices. In this context, we were asked to study how (1) selected mergers, and (2) market concentration, have affected wholesale gasoline prices since 2000.

To study the impacts of selected mergers and market concentration on wholesale gasoline prices, we developed and extensively tested an econometric model that examined the statistical relationship between mergers, market concentration, and gasoline prices. We limited our analysis to mergers (1) that occurred between 2000 and 2007, (2) that had transaction values of $200 million or greater, and (3) for which we had useful and complete gasoline price data where each merger occurred. These criteria provided seven mergers for our analysis. To provide context on petroleum industry mergers, we interviewed a number of petroleum industry representatives and FTC staff. In developing our model, we consulted with a number of economists in industry and academia who had completed similar studies, as well as with economists at FTC. We also varied the design of our model to ensure that our results were not highly dependent on any single assumption. Our model required data on mergers and wholesale gasoline prices, as well as other factors that might have affected gasoline markets, so that we could control for them and isolate the effects of mergers and concentration.

[2]A merger, as defined in this analysis, involves the sale of either all or part of the stock or assets of a company to another.

We purchased data from IHS Herold on the nature and size of petroleum industry mergers between 2000 and 2007.[3] We also purchased data from the Oil Price Information Service (OPIS) on historical gasoline prices at wholesale gasoline terminals located across the United States.[4] The price data provided by OPIS reflect 60 percent of the gasoline sold at these wholesale terminals.[5] We looked at prices at one terminal in each of 78 cities. We also used additional data from OPIS to control for the effects of special gasoline types that varied across cities in our analysis. Further, we used a number of data sets from the Energy Information Administration (EIA), including historical data on crude oil prices, refinery utilization rates, and gasoline sales. We assessed the reliability of the data and found them sufficiently reliable for the purposes of this report.

Despite our efforts to carefully design our analysis, there were limitations. For example, we were not able to fully account for all the conceivable factors that affect gasoline markets, including disruptions to local gasoline supply markets from weather-related events, interruptions in refinery or pipeline operations, or other changes in local gasoline supply. As such, the price impacts we present from our model are estimates. In addition, because some cities were affected by multiple mergers, may have had changes in market concentration, and may have been affected by factors for which we did not have data, we cannot describe how wholesale prices may have changed overall in each location. Therefore the strength of this analysis is to provide an indicator of the potential impacts of mergers and market concentration rather than to suggest that these factors were the sole source of gasoline price changes in the cities we chose to study. See appendix I for a more detailed description of our objectives, scope, and methodology.

We conducted this performance audit from October 2008 to June 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence

[3]IHS Herold is an independent research firm specializing in the energy sector that provides financial and operational data for, as well as analyses of, more than 400 oil and gas companies.

[4]OPIS is a private company that is a leading provider of gasoline price information.

[5]The remaining gasoline is sold directly to retailers, or through other arrangements, and price data for these sales are not always available.

obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

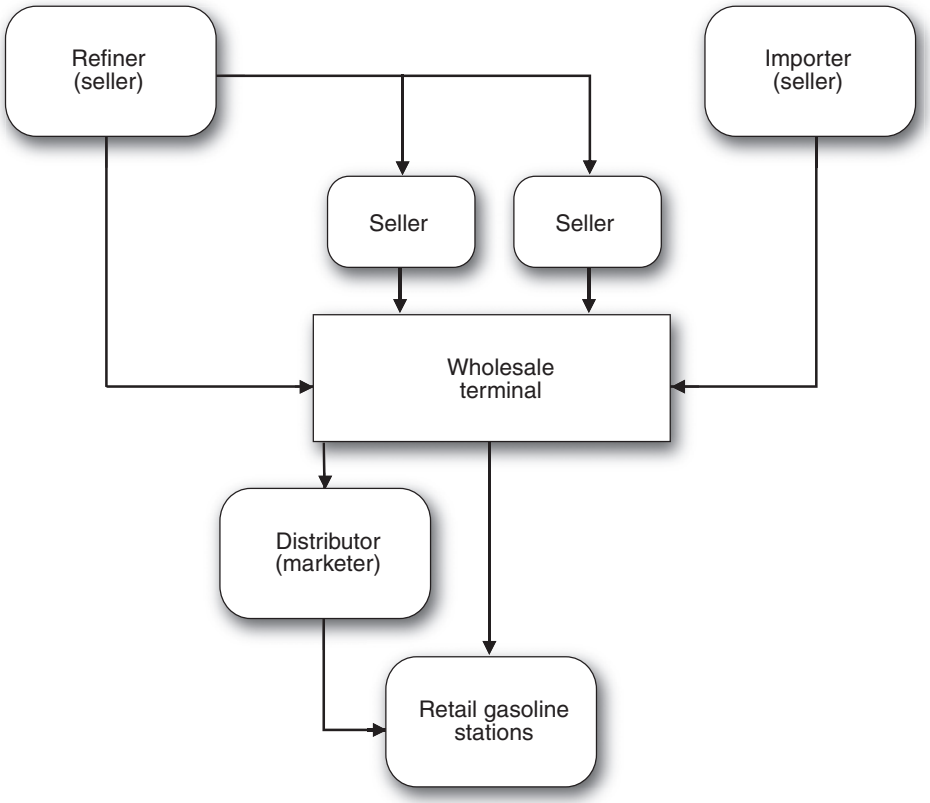
The U.S. petroleum industry consists of firms of varying sizes that operate in one or more of three broad segments—the upstream, which consists of the exploration for and production of crude oil; the midstream, which consists of pipelines and other infrastructure used to transport crude oil and refined products; and the downstream, which consists of the refining and marketing of petroleum products such as gasoline and heating oil. While some firms operate in only one or two of these segments, fully vertically integrated oil companies participate in all of them. Chevron is an example of a fully integrated petroleum company, with operations in all three segments, while Wawa—the convenience store chain—is an example of a firm operating in only one market segment as a downstream independent fuel retailer.

Refiners produce gasoline and then arrange its delivery, usually via pipeline, but also via barge, truck, or rail, from their refineries to any of the nearly 400 wholesale terminals located throughout the country. Terminals can be near refineries, pipelines, or water ports, and can involve a wide-ranging number of wholesale gasoline sellers, including refiners or importers.[6] The number of sellers at a wholesale terminal is not necessarily related to the number of refineries near the terminal; in some markets, a single refinery can produce gasoline for a number of sellers if they have supply arrangements with that refinery.[7] At wholesale terminals, the majority of gasoline is purchased by marketers or distributors, for subsequent resale at retail gasoline stations, while the rest is sold directly to retailers (see fig. 1). Market dynamics anywhere along the supply chain can influence consumer prices, beginning with upstream crude oil production, all the way through downstream refining and retailing.

[6]Major oil companies own most of the terminals, although according to OPIS, some are owned by pipeline operators or dedicated terminal companies.

[7]These additional sellers include oil companies wishing to sell gasoline in areas where they do not have refineries.

Figure 1: Example of a Gasoline Supply Chain



Source: GAO.

Gasoline from a wholesale terminal can also be either branded or unbranded. Branded gasolines are those supplied from major refiners selling under their trademarks, such as BP or Marathon, and often contain special additives, while unbranded gasolines may be supplied by major or independent refiners, but are not sold under a refiner's trademark. Branded prices include a premium reflecting the recognized brand name, fuel additives, and other costs, such as advertising.[8] Unbranded prices, which tend to be lower than those for branded, are paid by distributors

[8]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 prices may also include a premium for this additional security.

who deliver gasoline to retail locations ranging from large supermarkets to small independent retailers that are not affiliated with a major refiner.[9]

FTC's merger review process is conducted by staff in various bureaus and offices throughout the agency, but mainly by the Bureau of Economics and the Bureau of Competition. In reviewing proposed mergers, FTC follows guidelines that it developed jointly with the Department of Justice (DOJ) for predicting the effects of mergers on competition. The unifying theme in the guidelines is that mergers should not be permitted to enhance a firm's market power or to make it easier for a firm to exercise market power. In its review, FTC examines whether market conditions, including market concentration, would be conducive for firms to act unilaterally or to coordinate to raise prices. Unilateral effects occur when the merged firm profitably reduces its own supply and raises prices, even though other competitors may respond by increasing their own output. Such behavior can be profitable if the merged firm has a significant share of sales and the response of competitors is limited. Coordinated behavior occurs when each firm remaining in the market reduces its output, increasing prices. In their reviews of petroleum industry mergers, FTC staff seek to avoid the possibility of price increases even as small as 1 cent per gallon because the petroleum industry sells large volumes of fuel at thin margins, and price changes of this magnitude can affect industry decisions regarding production or sales. In addition, in some markets, even 1 cent per gallon price increases can lead to more than $100 million per year in additional costs for consumers, according to FTC analysis.

After reviewing a merger, FTC has three options: (1) to not challenge the merger; (2) to challenge the merger in court; or (3) to not challenge the merger as long as certain agreed upon remedial actions are met, such as firms selling off, or divesting, overlapping assets that have the greatest potential to harm competition.[10] FTC also performs other activities to monitor petroleum markets, including monitoring fuel prices and conducting special investigations. For example, FTC's price-monitoring program tracks retail gasoline and diesel prices in 360 cities across the

[9]Buyers of unbranded gasoline may or may not have a binding contractual arrangement with a refiner. Therefore, a buyer of unbranded gasoline may not be guaranteed a secure supply or lower prices, particularly during market shocks that reduce the gasoline supply. Thus, when there is a disruption in the supply system, such as those caused by pipeline or refinery breakdowns, unbranded prices at wholesale terminals can be higher than those of branded.

[10]FTC can also challenge completed mergers if they violate antitrust laws.

nation and wholesale prices in 20 major urban areas. In addition, on April 16, 2009, FTC issued a Revised Notice of Proposed Rulemaking seeking public comment on a revised proposed rule that would prohibit market manipulation in the petroleum industry. The revised proposed rule would prohibit fraudulent and deceptive conduct that could harm wholesale petroleum markets, but it is not yet clear how this new rule will affect FTC's monitoring of petroleum industry markets. However, FTC staff indicated that because FTC is an enforcement agency, they focus on merger and antitrust enforcement, rather than ongoing monitoring of the petroleum industry, as a regulatory agency would likely undertake. According to FTC, during the latter part of 2008, approximately 125 FTC staff members—attorneys, economists, paralegals, research analysts, and others—worked to some extent on matters involving antitrust and pricing issues in the oil and natural gas sectors, and about 6 or 7 staff economists from the Bureau of Economics were involved in ongoing monitoring of the petroleum industry, although these economists also devoted a portion of their time to other industries. These staff economists also occasionally perform analysis of past mergers, and FTC has indicated retrospective merger reviews are a valuable part of antitrust decision making. If FTC finds anticompetitive behavior in retrospective reviews, it has the ability to conduct further in-depth investigations into the merger and collect substantial company-specific data in order to pursue corrective action to reintroduce competition into the market such as forced divestitures or conduct-based remedies.

However, as we reported in 2008, FTC does not regularly look back at past mergers in the petroleum industry to assess their actual effects on prices––there had been only three such retrospective reviews, between 2000 and 2007.[11] We recommended that FTC undertake more regular retrospective reviews of past petroleum industry mergers and develop risk-based guidelines to determine when to conduct them. In commenting on this, FTC noted that our recommendation was consistent with a recent self-evaluation initiative and would consider it in that regard. Although these reviews can be resource intensive, experts, industry participants, and FTC agreed that regular retrospective reviews would allow the agency to better inform future merger reviews and better measure its success in maintaining competition. In this regard, the National Bureau of Economic Research published a study in March 2009 entitled Generating Evidence to Guide Merger Enforcement, which noted the importance of conducting

[11]None of the studies found that the mergers had any adverse effects on gasoline prices.

retrospective merger reviews.[12] The study found that retrospective merger reviews can help to evaluate the impacts of past merger enforcement decisions and can allow antitrust agencies to develop better techniques to predict the effects of future mergers on competition. The study also suggested that it made sense to focus retrospective reviews on completed mergers with the greatest likelihood of anticompetitive effects, such as mergers in highly concentrated markets.[13] FTC is currently working on a fourth retrospective review of a past petroleum industry merger, which is expected to be released later this year.

Some Petroleum Industry Mergers Were Associated with Small Increases and Decreases in Wholesale Gasoline Prices

We studied the effects of seven petroleum industry mergers that occurred since 2000 on wholesale gasoline prices and found three that were associated with small changes in wholesale gasoline prices. Specifically, we developed an econometric model to isolate the effects on wholesale gasoline prices of seven mergers—(1) Chevron Corporation/Texaco, (2) Phillips Petroleum Company/Tosco Corporation, (3) Valero Energy Corporation/Ultramar Diamond Shamrock Corporation (UDS), (4) Royal Dutch Shell Group/Texaco, (5) Phillips Petroleum Company/Conoco, (6) Premcor/Williams Companies, and (7) Valero Energy Corporation/Premcor. These mergers ranged widely in the size of transaction, from the Chevron/Texaco merger, valued at about $45 billion, to the Premcor/Williams merger, valued at $367 million. Five of the seven mergers were focused primarily on the downstream sector, with refining, marketing, or retail operations as the key assets that changed ownership, while the other two mergers were concentrated in the upstream exploration and production sector, with oil reserves as the key asset that changed ownership. The rationale for some of these mergers, according to industry officials, was generally to increase operational efficiencies and reduce costs through economies of scale.[14] Summary information about the mergers is provided in table 1.

[12]The National Bureau of Economic Research is a private, nonprofit, nonpartisan research organization that disseminates unbiased economic research among public policymakers, business professionals, and the academic community.

[13]Orley C. Ashenfelter, Daniel Hosken, Matthew Weinberg, National Bureau of Economic Research, *Generating Evidence to Guide Merger Enforcement;* NBER Working Paper 14798, (Cambridge Mass., March 2009).

[14]See appendix III for more detailed information on each merger transaction.

Table 1: Summary Information for Mergers Reviewed in Model

Merger[a]	Announced date	Transaction value (U.S. dollars in millions) and key assets	Number of cities affected[b]	FTC response to merger	GAO's estimated effect on wholesale gasoline prices (cents/gallon)[c]
Chevron Corp./Texaco	Oct. 16, 2000	$44,838 oil and gas reserves	37	Challenged: divestitures required in refining and marketing	Results not statistically significant
Phillips Petroleum Company/ Tosco Corp.	Feb. 4, 2001	$9,828 8 refineries and approximately 6,400 retail stations	8	Not challenged	Results not statistically significant
Valero Energy Corp./Ultramar Diamond Shamrock (UDS) Corp.	May 7, 2001	$6,442 7 refineries and approximately 5,000 retail stations	26	Challenged: divestitures required in refining and retailing.	+1.06 (branded) Unbranded results not statistically significant
Royal Dutch Shell Group/Texaco	Oct. 9, 2001	$3,860 Texaco's share of Motiva and Equilon downstream joint ventures[d]	35	Not challenged	Results not statistically significant
Phillips Petroleum Company/Conoco	Nov. 19, 2001	$31,282 oil and gas reserves, refining and marketing assets	47	Challenged: divestitures required in refining and marketing	-1.64 (branded) -1.14 (unbranded)
Premcor/Williams Companies	Nov. 26, 2002	$367 1 refinery	2	Not challenged	Results not statistically significant
Valero Energy Corp./Premcor	Apr. 25, 2005	$7,588 4 refineries	20	Not challenged	Branded results not statistically significant +1.13 (unbranded)

Source: GAO analysis of information from IHS Herold,, FTC, and OPIS.

[a]GAO criteria for selection of mergers included (1) mergers that occurred between 2000 and 2007, (2) a minimum merger transaction value of $200 million, and (3) the availability of useful and complete gasoline price data.

[b]The cities affected include those, out of the 78 examined in GAO's model, with wholesale terminals where both companies operated before the merger.

[c]The price effects we report were statistically significant, meaning that we were able to reasonably rule out the effects of chance on the estimated impacts on wholesale gasoline prices.

[d]The Equilon Enterprises joint venture included approximately 4,500 Shell-branded and 4,500 Texaco-branded gasoline service stations, four refineries, and 65 product terminals and ports. The Motiva Enterprises joint venture included approximately 4,800 Shell-branded and 8,200 Texaco-branded stations, four refineries, seven lubricants facilities, and 50 product terminals.

As shown in table 1, the seven mergers we analyzed ranged widely in the number of cities with wholesale terminals that were affected by the merger. We analyzed the effects of the seven mergers at terminals in 78

cities across the United States. The three mergers affecting terminals in 35 or more cities each—-Chevron/Texaco, Shell/Texaco, and Phillips/Conoco—-reflect a wide geographic area, as each merger affected cities across a number of regions of the country. The Valero/Premcor and Valero/UDS mergers, each of which affected terminals in 20 or more cities, were more concentrated geographically, primarily affecting cities in the eastern and western United States, respectively. The two mergers affecting terminals in fewer than 10 cities each—-Phillips/Tosco and Premcor/Williams—-reflect narrower geographic areas, with the former affecting a few cities in the Southeast and Southwest and the latter affecting 2 cities in the Southeast. See appendix III for more information on the geographic regions affected by each merger.

Antitrust enforcement actions taken in response to the mergers varied, depending on the characteristics of the firms, the geographic areas affected, and the specifics of the transaction. As shown in table 1, the FTC challenged three of the mergers, as originally proposed, on the basis of potential threats to competition in one or more sectors of the industry.[15] In response to these potential anticompetitive threats, FTC required the merging firms to divest key assets in the sectors of identified concern. In the case of the Chevron/Texaco merger, FTC identified potential threats to gasoline marketing in 23 states across the western and southern United States, as well as potential threats to refining in California and the Pacific Northwest, among others. As a result, it ordered the divestiture of Texaco's downstream assets in marketing and refining, as well as in pipelines.[16] In the case of the Valero/UDS merger, FTC identified potential threats to the refining and supply sectors in California and subsequently required the divestiture of a UDS refinery in Avon, California, as well as the divestiture of numerous supply contracts and 70 retail outlets across the West. In the case of the Phillips/Conoco merger, FTC identified a number of potential concerns, including threats to gasoline refining and supply in various western and midwestern states. In response, FTC required divestitures in key areas of concern, including the sale of a Phillips refinery near Salt Lake City and marketing assets in northern Utah, as well as the sale of Conoco's Denver-area refinery and Phillips's

[15]Potential threats identified by the FTC can include both unilateral and coordinated threats to competition.

[16]These assets included shares of two refining and marketing joint ventures with Royal Dutch/Shell Group and Saudi Refining, as managed by Motiva Enterprises and Equilon Enterprises. Subsequent to this order, Shell became the sole owner of Equilon, and Shell and Saudi Refining became the owners of Motiva.

marketing assets in eastern Colorado. In the case of the remaining four mergers, FTC did not identify competitive concerns and consequently did not require divestitures or other remedial actions.

As highlighted in table 1, the results of our analysis suggest that two of the seven mergers were associated with small increases in wholesale gasoline prices, while one was associated with a small decrease in wholesale gasoline prices. In the case of these three mergers, the model results were statistically significant, meaning that we were able to reasonably rule out the effects of chance on the estimated impacts on wholesale gasoline prices. In addition, our model held constant the effects of a number of other key variables, including changes in gasoline inventory, refinery capacity utilization, and the type of gasoline sold, although data were unavailable on additional factors that may have affected prices. According to these results, the 2005 acquisition by Valero of four refineries owned by Premcor was associated with an increase of 1.13 cents per gallon for unbranded gasoline. Similarly, the model suggests that the 2001 acquisition by Valero of seven refineries and approximately 5,000 retail stations owned by UDS was associated with an increase in branded wholesale gasoline prices of approximately 1.06 cents per gallon.[17] By contrast, the model suggests that the 2001 merger of Phillips and Conoco, including oil reserves, as well as refining and marketing, was associated with a decrease in branded wholesale gasoline prices of approximately 1.64 cents per gallon and a decrease of 1.14 cents per gallon for unbranded gasoline. The price effects observed in these three cases reflect an average increase or decrease in wholesale gasoline prices at terminals across the cities affected by the merger for the period of time following the merger through September 2008.[18] In the case of the remaining four mergers—Chevron/Texaco, Phillips/Tosco, Shell/Texaco, and Premcor/Williams—the results of our model were not statistically significant.

[17]As noted earlier, these estimates may have been affected by the effects of localized disruptions or changes to gasoline supply. In the case of the Valero/Premcor merger, this could include potential disruptions due to events surrounding Hurricane Katrina in 2005. In the case of the Valero/UDS merger, this could include potential disruptions due to new specifications for California gasoline beginning in December 2003. To address these issues, we would have to had made judgments about the timing and regional impacts of these events without adequate data.

[18]Our model included price data that we purchased from the OPIS for gasoline sold at wholesale terminals, or racks, located in cities throughout the United States. The remaining gasoline is sold directly to retailers, or through other arrangements, and price data for these sales are not always available.

Given the complexities of the petroleum industry's supply chain, we could not provide an explanation as to why certain mergers were associated with changes in wholesale gasoline prices. Gasoline moves through an often complicated supply network, and the efficiency gains associated with mergers, or likewise the opportunities for market participants at any level of the network to exercise market power, could play out in any number of ways. For example, some marketers we spoke with indicated that mergers sometimes spurred refiners to renegotiate the terms of their supply agreements, making them less favorable and potentially indicating the exercise of market power by an individual refiner. On the other hand, mergers can create operational efficiencies and economies of scale that can allow refiners and marketers to pass on savings, in the form of lower prices, to consumers. At the terminal level, there is limited information on gasoline's refinery of origin, including whether it was even refined domestically, further adding to the difficultly in pinpointing how and where the impacts from a merger are felt. For example, marketers we spoke with indicated that they could not be sure where gasoline shipped via pipeline came from, since similar products are intermingled in the system. In addition, refiners we spoke with indicated that they were able to exchange gasoline with each other, enabling them to have a marketing presence in a city that was not very close to one of their refineries. These "exchange agreements" add to the efficiency of the supply network, because refiners can trade fuel across locations rather than ship it, although these agreements can also greatly add to its complexity. As such, our model does not provide further explanation as to the underlying forces that contributed to any correlation between the three mergers and changes in wholesale gasoline prices, nor does it provide conclusive evidence of unilateral or coordinated behavior to influence gasoline prices. To do this we would have had to conduct in-depth investigations into each merger and collect substantial company-specific data. Nonetheless, our model provides an indicator of the impact that petroleum industry mergers can have on wholesale gasoline prices. And given the substantial size of the gasoline market, even small increases or decreases in wholesale prices can have a significant impact on consumer spending.[19]

[19]In its ruling on the Valero/UDS merger, FTC indicated that even a 1 cent per gallon increase in gasoline prices would cost California consumers an extra $150 million per year.

Analysis Suggests Less Concentrated Markets Were Associated with Lower Wholesale Gasoline Prices

We also used our model to analyze market concentration and found that less concentrated wholesale gasoline markets—i.e., wholesale terminals with more sellers—were significantly associated with lower gasoline prices at terminals located in 78 cities across the United States.[20] For example, we estimated that prices were about 8 cents per gallon lower at terminals with, for example, 14 sellers compared with prices at terminals that had only 9 sellers. We also measured the concentration of groups of refineries that supplied gasoline to sellers at wholesale terminals in these cities and similarly found that prices were lower if a terminal was supplied by a less concentrated group of refineries.

Measures of market concentration often take into account both the number of firms in a market and the market share of each firm, and one such measure, the Herfindahl-Hirschman Index, or HHI, gives proportionally greater weight to firms with larger market shares.[21] According to FTC and DOJ guidelines, an unconcentrated market has an HHI of less than 1,000; a moderately concentrated market has an HHI between 1,000 and 1,800; and a highly concentrated market, with the greater likelihood that a firm could exercise market power, has an HHI over 1,800. We measured market concentration affecting wholesale terminals in two ways: (1) by counting the number of sellers at each wholesale terminal, and (2) by calculating the HHI of refinery groups that supplied gasoline to sellers at wholesale terminals.

In our first approach, the number of sellers at wholesale terminals was inversely related to the level of concentration, with terminals with few sellers having high levels of concentration. Although this measure was not technically a measure of market concentration, it closely reflected supply conditions at wholesale terminals in the 78 cities we studied.[22] In our second approach, we moved up the supply chain and measured the number and size of the refineries that were the original source for the gasoline delivered to the sellers at each terminal. We determined the production capacity of refineries in the seven historical U.S. refinery groups known as spot markets and then determined which spot market

[20]We examined prices at 1 terminal per city.

[21]For example, if there are two firms that sell products in a market with market shares of 60 percent and 40 percent, respectively, the calculation of HHI would be $60^2 + 40^2 = 5{,}200$

[22]This approach did not allow us to capture whether there was one large seller and a number of smaller sellers or whether all the sellers sold relatively similar volumes of gasoline.

groups supplied gasoline to sellers at individual wholesale terminals, allowing us to estimate a refinery HHI for individual wholesale terminals in the 78 cities we studied.[23]

Both of our measures indicated that less concentrated markets were significantly associated with lower wholesale gasoline prices, as shown in tables 2 and 3. Although we did not observe large changes in market concentration over time, there was variation in market concentration across the wholesale terminals in our analysis. In order to demonstrate the size of the effect that market concentration had on wholesale gasoline prices, we chose to look at the expected changes in wholesale prices across two ranges of market concentration---one range was between the 25th and 75th percentiles of market concentration values in our analysis, and the other was between the 10th and 90th percentiles. We calculated the expected price differences if a terminal were to have moved from the higher end of either of these concentration ranges to the lower end.

We found that the terminals with more sellers and therefore lower levels of concentration would be expected to have lower wholesale gasoline prices (see table 2). We estimated that if a terminal were to have gained 5 wholesale gasoline sellers, we would expect prices to be 8 cents per gallon lower at that terminal. In addition, if a terminal were to have gained 11 sellers, we estimated that prices would be 18 cents per gallon lower. We present the number of sellers at each of the terminals in the 78 cities we examined, which ranged from 3 to 21 in 2008, with a median of 11, in appendix IV.

[23]Most of the nation's gasoline supply comes from one of seven groups of refineries throughout the United States, which experts refer to as spot markets. Energy traders use spot markets to price gasoline that is bought and sold at the wholesale level. These spot markets are defined by the refineries in and around San Francisco, Los Angeles, the Pacific Northwest, the Gulf Coast, Tulsa (Midcontinent), Chicago, and New York Harbor. None of the terminals in our analysis were served primarily by the Chicago market, although we considered the refineries in Alaska as a separate market. We used industry data to link these spot markets to individual wholesale gasoline terminals in the 78 cities we studied. However, we were not able to account for gasoline imported into the United States because we only had data on U.S refinery production capacity. See appendix I for more information.

Table 2: Effects of the Number of Sellers on Unbranded Wholesale Gasoline Prices at the Terminals in the 78 Cities We Studied

Change in number of sellers at the wholesale terminal	Gain of 5 sellers (9 sellers to 14 sellers)	Gain of 11 sellers (6 sellers to 17 sellers)
Change in unbranded wholesale gasoline price in cents per gallon[a]	-8	-18

Source: GAO analysis of OPIS data.

Note: We present the results for branded gasoline in appendix IV. These results were similar and also statistically significant.

[a]These results were statistically significant at the 1 percent level. The 9 to 14 seller range represents the 25th to the 75th percentile of values that we observed at terminals in our analysis. The 6 to 17 seller range represents the 10th to the 90th percentile.

We also found that terminals supplied by the refinery spot markets with the lower HHIs would be expected to have lower wholesale gasoline prices (see table 3). We estimated that if a spot market supplying gasoline to a terminal were to have become less concentrated by moving from an HHI of 930 to 790, we would expect prices to be about 2 cents per gallon lower at that terminal. In addition, if a spot market supplying gasoline to a terminal were to have become less concentrated by moving from an HHI of 1470 to 700, we estimated that prices would be about 13 cents per gallon lower at that terminal. In general, our findings were consistent with the idea that markets with more sellers or more refiners supplying those sellers are likely to be more competitive, resulting in lower prices. We present trends in spot market concentration in appendix IV that ranged from 666 to 3,729. The median HHI across all markets was 906.

Table 3: Effects of Market Concentration on Unbranded Wholesale Gasoline Prices at Terminals Supplied by Seven Spot Markets

Refinery spot market HHI	Decrease in HHI from 930 to 790	Decrease in HHI from 1,470 to 700
Change in unbranded wholesale gasoline price in cents per gallon[a]	-2	-13

Source: GAO analysis of OPIS data.

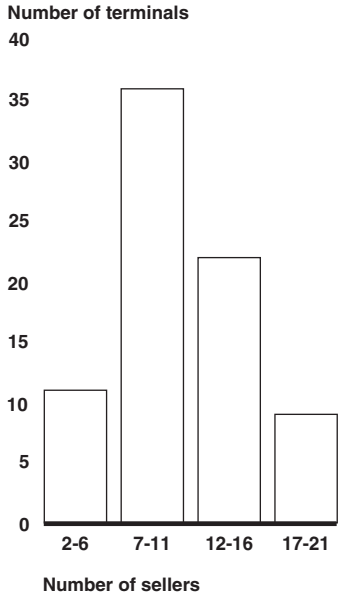
Note: We present the results for branded gasoline in appendix IV. These results were similar and also statistically significant.

[a]These results were statistically significant at the 1 percent level. The 790 to 930 range represents the 25th to the 75th percentile of values that we observed at terminals in our branded analysis. The 700 to 1,470 range represents the 10th to the 90th percentile.

In estimating these results, we treated market concentration as endogenous—meaning that changes in wholesale gasoline prices could affect market concentration in addition to changes in concentration affecting prices. For example, this could occur if high prices at one terminal spur new sellers to enter the market, thus decreasing concentration. This assumption was supported by statistical tests that we conducted, although because this assumption was likely to have a noticeable impact on our results, we also analyzed our data without it and found that the impact on prices of our concentration measures was statistically significant but smaller. For example, for unbranded prices, in the case of the refinery spot market HHI, the impact on wholesale prices was about half the size without this assumption. For the number of sellers at the terminal, the impact was about one-sixth of the size without this assumption.

As noted above, we did not observe a trend of increasing market concentration nationwide between 2000 and 2008, either in the number of sellers at wholesale terminals or in our HHI numbers calculated for refinery spot market groups. For example, the average number of sellers at terminals across the country remained almost the same since 2000, with terminals averaging 11 sellers by 2008 and most having between 7 and 11 sellers during that year (see fig. 2). However, of the terminals located in the 78 cities we studied, we did find that 8 terminals lost 5 or more sellers and 39 lost between 1 and 4—the remainder had no change or actually gained sellers since 2000.

Figure 2: Number of Wholesale Gasoline Sellers at Terminals in 2008



Source: GAO analysis of OPIS data.

Most of our refinery spot market HHI numbers remained moderately concentrated or unconcentrated during the span of our analysis, and this was consistent with the findings in our 2008 report, where we indicated that concentration was generally moderate and changed little in spot markets throughout the United States since 2000, except in the case of the New York Harbor spot market, which became more concentrated. However, as we reported, the New York Harbor trend may not be completely reflective of actual market conditions because foreign refineries ship a significant amount of gasoline into the East Coast (around 60 percent of consumption). Because we were unable to account for this fuel, the high measure of concentration probably overstates the actual concentration for the market.[24] However, in this current analysis we also found that refinery market concentration in Alaska was very high because of the isolated nature of that state.

[24]GAO, *Energy Markets: Analysis of More Past Mergers Could Enhance Federal Trade Commission's Efforts to Maintain Competition in the Petroleum Industry*, GAO-08-1082 (Washington D.C.: Sept. 25, 2008).

Concluding Observations

Because of the complexity of the U.S. petroleum industry, it can be difficult to predict the impact of mergers before they are completed. Refined products move through a complicated supply network, where it can be difficult to identify the origin of fuel supplied to wholesale markets, making it challenging to anticipate the actual impacts of petroleum industry mergers on gasoline prices before the deals are completed. In light of these difficulties, reviewing the effects of past mergers on fuel prices could allow FTC to determine whether the actual effects of a merger reflect the anticipated effects. Although there are some limitations to the analytical approaches used in isolating the effects of past mergers and market concentration on prices, we believe the approach we used in our analysis provides a starting point for potential further studies of these impacts. Conducting retrospective reviews of past mergers could also allow FTC to better understand the impacts of assumptions it makes during merger reviews and to identify the types of mergers that are potentially problematic, allowing it to improve its approach to future merger reviews.

As the authors of the recent study published by the National Bureau of Economic Research noted, it makes sense for an antitrust agency to focus retrospective reviews on completed mergers with the greatest likelihood of having reduced competition, such as mergers in highly concentrated markets, and in doing so the agency can focus its limited resources on the mergers with the greatest risk of having adversely affected prices.[25] Given the significant relationship between wholesale gasoline prices and market concentration that we found, we also conclude that it may be useful to focus retrospective merger reviews on highly concentrated market regions. Such retrospective reviews would provide FTC greater assurance that its efforts result in consumer prices that are determined in a fair and competitive marketplace. This study reinforces the need to review past petroleum industry mergers, and we continue to recommend that FTC conduct such reviews more regularly and develop risk-based guidelines to determine when to conduct them.

Agency Comments and Our Evaluation

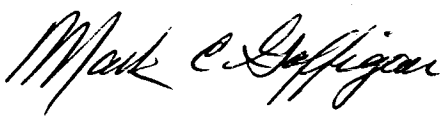
We provided a copy of our draft report to FTC for its review and comment. FTC's Chairman provided written comments, which are reproduced in appendix II, along with our responses. In general, the Chairman agreed

[25]Orley C. Ashenfelter, Daniel Hosken, Matthew Weinberg, National Bureau of Economic Research, *Generating Evidence to Guide Merger Enforcement.*

with our recommendation that FTC conduct more reviews of past petroleum industry mergers and that FTC focus those retrospective efforts on mergers that present the greatest likelihood of anticompetitive effects. The Chairman also noted some of the limitations and an apparent inaccuracy in our presentation of the effects of market concentration on wholesale gasoline prices, which we addressed in appendix II. Nonetheless, the Chairman said that FTC will continue to use risk-based criteria for identifying past mergers for review and will direct its staff to evaluate more fully GAO's contributions as it moves forward with its merger retrospectives and enforcement programs.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 14 days from the report date. At that time, we will send copies to the Chairman, Federal Trade Commission; appropriate congressional committees; and other interested parties. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions about this report, please contact us at (202) 512-3841, gaffiganm@gao.gov, or (202) 512-2700, mccoolt@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix V.



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Applied Research and Methods

Appendix I: Technical Discussion of Objectives, Scope, and Methodology

Introduction

The objectives of this study were to examine the impacts of selected mergers and market concentration on wholesale gasoline prices between 2000 and 2008.

We developed an econometric model to explain the impact of mergers and market concentration, while controlling for other important factors that may also affect gasoline prices. Our model examined how wholesale gasoline city terminal (rack) prices were affected by mergers and variation in market competition.

Econometric Model Specifications and Methodology

Our model examined how wholesale gasoline city terminal prices were affected by mergers and two measures of market competition. We used data from 78 (and in some cases 82) wholesale city terminals from January 2000 through September 2008.[1] We used monthly average data on wholesale city terminal gasoline prices. We believe that the increased information from higher-frequency data, for example, from using weekly data, would be outweighed by the extra noise generated by such relatively high-frequency data. Further, in general, the control variables are available only at monthly intervals, and some only at quarterly intervals. In developing our model, we consulted with a number of economists in industry and academia who had completed similar studies, as well as with economists at the Federal Trade Commission (FTC). We incorporated their suggestions when possible and where we thought appropriate. In addition, a number of economists also provided us with feedback on our preliminary results.

The Dependent Variable: Wholesale Gasoline Price

- Our dependent variable was the logarithm of the wholesale terminal price of gasoline. We used an Augmented-Dickey-Fuller test designed for panel data to test for stationarity in levels of our dependent variables, in the case of both unbranded and branded prices.[2] Our tests showed that our unbranded and branded dependent variable was stationary in levels.
- We estimated separate models for unbranded and branded products to test for the consistency of our results.

[1]See appendix IV for a list of the cities in our analysis.

[2]See Kyong So Im, M. Hashem Pesaran, and Yongcheol Shin. "Testing for Unit Roots in Heterogeneous Panels," *Journal of Econometrics*, 115, 53-74 (2003).

- There may be multiple gasoline prices reported for a given city terminal on a given date; in general, we used the wholesale terminal price of gasoline that is required in that specific locale. We believe that such a focus allows us to address the issue of what is happening in the market for gasoline in that city.

- Our model specification controls for the effects of changes in the average price level and changes in the price of crude oil over time. We controlled for this and other time-varying effects in our regressions by including a complete set of time dummy variables—one for each month's observation in the data.

Explanatory Variables That Measure the Impact of Mergers and Market Concentration on Gasoline Prices

Our primary interest was to identify the impact of (1) oil company mergers, and (2) market concentration on gasoline prices.

- We limited our analysis to mergers (1) that occurred between 2000 and 2007, (2) that had transaction values of $200 million or greater, and (3) for which we had useful and complete gasoline price data where each merger occurred. There were seven mergers that met these criteria. We used data from IHS Herold and the Oil Price Information Service (OPIS) to identify these mergers and then had FTC review the list.

- Our analysis used two measures of market concentration:

  1. The number of sellers that sold products during that month—we used OPIS data to acquire the list of sellers. Our hypothesis is that a larger number of sellers is likely to result in a more competitive market environment, in contrast to a situation where a small or a single seller might be able to engage in price setting, and hence charge higher prices. We recognize that this measure has drawbacks; in particular, it does not, in general, measure market share but rather weights each seller equally. However, it has the advantage that it is measured at the city level, namely, at the same level as our price data. Further, this measure has been used by other investigators to capture variation in local market structure.[3]

  2. Spot market Herfindahl-Hirschman Index (HHI) was measured for groups of refineries that supply wholesale terminals. We used spot markets as the basis for defining these refinery groups geographically,

[3]Joris Pinkse, Margaret E. Slade, and Craig Brett. "Spatial Price Competition: A Semiparametric Approach," *Econometrica*, Vol. 70, No. 3. May 2002, 1111-1153.

which reflect the historical grouping of U.S. refineries into seven refining centers. Energy traders consider gasoline available for delivery at these refining spot markets in order to price gasoline that is bought and sold at wholesale terminals, and gasoline production in these refining groups drives prices on the spot markets. The seven spot markets in the United States are in Los Angeles, San Francisco, the Gulf Coast, New York Harbor, Chicago, Tulsa (or Midcontinent), and the Pacific Northwest. In addition, we defined Alaska as a separate market. To define these, we collaborated with staff from OPIS, Energy Information Administration (EIA), and FTC who had expertise on petroleum product markets and who helped us to assign individual refineries to spot markets based on the regions in which they sold most of their fuel. In some cases, a refinery operated in more than one region, so its capacity was included in both regions' HHI calculation. Experts from EIA, FTC, and OPIS mentioned that refineries in states like Alaska and Hawaii primarily supply their local regions. Our study does not include any cities from Hawaii, and in the case of Alaska, as mentioned above, we treated these refineries as a separate group and created its own HHI.[4] We then used EIA-810 data on refinery operable capacity in order to make the HHI calculations.[5] Finally, we used OPIS data to match each of our cities to the spot market in which it was located.

Other Explanatory Variables

In addition to the impact of mergers and market concentration, our model includes other important variables that may influence the price of gasoline.

- Volume of inventory of gasoline relative to the volume of sales of gasoline. This could affect the availability of gasoline at the wholesale level and hence affect prices. All other things equal, gasoline prices should decrease when inventories are high relative to sales and conversely when inventories are low relative to sales. Further, inventories may themselves respond to changes in wholesale gasoline prices, so this variable may be endogenous.

[4]Our OPIS data did not contain gasoline prices from Hawaii. In addition, none of the terminals in our analysis were served primarily by the Chicago spot market.

[5]We dropped the non-gasoline-producing refineries (i.e., producers of asphalt etc.) from these calculations by identifying refineries that lacked gasoline-producing equipment. These data included only U.S. refiners until 2006. We extrapolated the data to 2008.

- Refinery capacity utilization rate—this could affect the wholesale price of gasoline through changes in the availability of gasoline product. One possibility is that when utilization rates are high, supply would be increased, resulting in lower prices, and conversely if utilization rates are low. However, it is possible that as utilization rates approach very high levels, there would be significant increases in the cost of production, which could then result in higher prices. As with the inventory-sales ratio, the capacity utilization rate may itself be affected by gasoline prices; for example, if gasoline prices are high, refineries may operate at higher capacity, so this variable may be endogenous.

- Lagged dependent variable—lagged values of the left-hand side variable. Gasoline price data are sometimes autocorrelated, and it is reasonable to include the effect of past gasoline prices on current gasoline prices.[6]

- Time fixed effects (dummy variable for each time period in the analysis)—January 2000 through September 2008 is 105 months of data. City fixed effects (dummy variables for each city in the analysis)—our analysis uses between 78 and 82 cities' data (we included a fixed effect for each city). These city fixed effects assist in controlling for unobserved heterogeneity.

- Product specification dummy variables for the different types of gasoline used for price. There are over 30 different gasoline types used in our analysis, and to control for this variation, we include a dummy variable for each type.

- Selection of cities to include in the model—the OPIS data contain 393 city wholesale terminals. Some of the cities with wholesale terminals may be close geographically so they may not represent independent markets. As a result, we used a subset of either 78 or 82 of these cities that were in the most relevant and important metropolitan areas needed to model refinery product flows and product costs. Most cities only had one terminal and we chose to examine only one terminal in the few cases where there was more than one. We determined which cities each merger affected by identifying cities where each firm had posted either branded or unbranded

[6]In commenting on GAO's prior work on oil companies, *Energy Markets: Effects of Mergers and Market Concentration in the U.S. Petroleum Industry*, GAO-04-96 (Washington, D.C.: May 17, 2004), Professor Halbert White of the University of California at San Diego suggested that rather than impose a specific error formulation such as an AR(1), it would be preferable to explicitly include lags of various variables in the model directly. We included a lagged dependent variable as a regressor but did not go beyond that in including lags of other variables in the model.

wholesale prices for 26 of the 52 weeks before the merger's announced date.

We assessed the reliability of these data and found them sufficiently reliable for the purposes of this report. This included conducting tests for missing and out-of-range values and checking for completeness and accuracy of the data.

Data Sources

Table 4: Data Used in Our Econometric Model

Variable	Description	Source
Prices	Wholesale gasoline price in cents per gallon. Branded and unbranded. Monthly data.	OPIS
West Texas Intermediate crude oil price	Price per gallon of West Texas Intermediate. Monthly data.	EIA
Spot Market HHI	Market concentration, measured by refinery capacity of corporations in each spot market. Monthly data.	EIA, GAO analysis
Number of sellers at the city terminal	Number of sellers that quoted prices at the city terminal during a given month. Monthly data.	OPIS
Merger dummy variables	Dummy variable equal to 1 from the effective date of the merger to the end of the study in September 2008.[a] Equal to 0 before the effective date of the merger. We also included dummy variables for the period of time between the announced date and the effective date of the merger.	OPIS, IHS Herold
Inventory-sales ratio	Ratio of gasoline inventories to gasoline sales. Monthly data.	EIA
Refinery capacity utilization rate	Capacity utilization rate. Monthly data.	EIA
Fuel type dummy variables	Set of dummy variables for the gasoline fuel type. Details the main fuel type, presence of additives, and Reid vapor pressure (RVP).	OPIS
Producer Price Index	Producer Price Index. Monthly data.	Department of Labor
Employment growth	Percent growth in employment at the state level. Monthly data.	Department of Labor
Unemployment rate	Percent unemployment rate at the state level. Monthly data.	Department of Labor
Real personal income growth	Percent growth in personal income at the state level deflated by the consumer price index. Quarterly data.	Bureau of Economic Analysis
Consumer price index	Consumer price index. Monthly data.	Department of Labor

Source: GAO.

[a]The effective dates correspond to the completion of the deal after announcement and are as follows: Chevron/Texaco, Oct. 9, 2001; Phillips/Tosco, Sept. 17, 2001; Valero/UDS, Dec. 31, 2001; Shell/Texaco, Dec. 31, 2001; Phillips/Conoco, Aug. 30, 2002; Premcor/Williams, Mar. 31, 2003; Valero/Premcor, Sept. 1, 2005.

Econometric model

Our fixed effects model can be written as follows:

$$y_{it} = (x_{it}, w_{it})B + c_i + f_t + u_{it}, \quad i = 1, 2, ..., N; t = 1, 2, ..., T \qquad (1),$$

where:

y_{it} is the logarithm of wholesale terminal gasoline price at city i in month t.

x_{it} is a vector of predetermined variables for city i in month t that are assumed to be independent of the error term u_{it}. This vector includes a lagged value of our dependent variable.

w_{it} is a vector of possibly endogenous variables, at city i in month t.

c_i is the fixed effect or dummy variable for city i.

f_t is the fixed effect or dummy variable for month t.

B is a vector of parameters to be estimated.

- We used xtivreg2 in the *Stata* statistical software package. Our parameter estimates are consistent given the assumptions of our model. Our standard error estimates are robust to heteroskedasticity and autocorrelation.
- We estimated the model using the logarithm of price as the dependent variable. Note that because we have time dummies, we do not need to control for variables that vary over time but not cities, such as the price of crude oil because these variables would be collinear with the time dummies.
- Measures of market concentration, such as the HHI, have been shown to be endogenous, so we tested for endogeneity and used two-stage least squares when appropriate, using merger events and other measures of economic activity as instruments.[7] It is also possible that the merger events themselves were endogenous, but in our work, we treated them as exogenous or predetermined, primarily because we had insufficient data to provide instruments for the seven separate mergers.

[7]See, for example, W. N. Evans et al. "Endogeneity in the Concentration-Price Relationship: Causes, Consequences, and Cures." *The Journal of Industrial Economics*, vol. XLI, no. 4, Dec. 1993, 431-438.

- We estimated the model with inventory-sales ratio and the capacity utilization rate as endogenous. In general, our results for the effect of market concentration and mergers were not substantively affected by whether these were treated as exogenous or endogenous.

- Some of our results for the inventory-sales ratio showed a significant positive relationship with respect to price, an outcome that was contrary to our expectations. It is possible that either the inventory-sales ratio is misspecified in our model or there may be a complex dynamic relationship that describes how inventories affect prices and vice versa, conditions that could negate the direction of this relationship.

- We estimated separate models for unbranded prices and branded prices.

Results

Table 5: Regression Results for Mergers' Effect on Unbranded Gasoline Prices—Dependent Variable Is the Logarithm of Unbranded Gasoline Price

Variable category	Variable name	Coefficient	Standard error	Significance
	Inventory-sales ratio	0.13805	0.07596	*
	Capacity utilization rate	-0.00054	0.00114	
	Log of price lagged 1 period	0.46971	0.03118	***
Merger dummies	Chevron-Texaco merger dummy	-0.00906	0.00862	
	Phillips-Conoco merger dummy	-0.00767	0.00403	*
	Phillips-Tosco merger dummy	0.00311	0.00646	
	Premcor-Williams merger dummy	0.00648	0.00747	
	Shell-Texaco merger dummy	0.00483	0.00465	
	Valero-Premcor merger dummy	0.00752	0.00244	***
	Valero-UDS merger dummy	0.00296	0.00384	
Dummies for period between announced and effective merger dates	Chevron-Texaco "mid" dummy	-0.03155	0.01420	**
	Phillips-Conoco "mid" dummy	-0.01902	0.00543	***
	Phillips-Tosco "mid" dummy	-0.01355	0.01116	
	Premcor-Williams "mid" dummy	0.01574	0.01017	
	Shell-Texaco "mid" dummy	0.00276	0.01616	
	Valero-Premcor "mid" dummy	-0.00554	0.00442	
	Valero-UDS "mid" dummy	0.00089	0.00825	
Gasoline specification dummies	CBG fuel dummy	0.00104	0.01516	
	CBG with 10% ethanol fuel dummy	0.00043	0.00810	
	CARB with 5.7% ethanol fuel dummy	-0.01857	0.02322	

Variable category	Variable name	Coefficient	Standard error	Significance
	CARB with MTBE fuel dummy	-0.01386	0.02530	
	CARB with MTBE 7.0 RVP fuel dummy	-0.01623	0.02853	
	CARB with MTBE 8.2 RVP fuel dummy	0.06125	0.03080	**
	CARB with no additive fuel dummy	-0.02359	0.02343	
	Conventional with 7.0 RVP fuel dummy	0.00642	0.01385	
	Conventional with 7.2 RVP fuel dummy	0.00057	0.01363	
	Conventional with 7.8 RVP fuel dummy	-0.00394	0.00831	
	Conventional with 8.2 RVP fuel dummy	-0.02133	0.01345	
	Conventional with 9.0 RVP fuel dummy	0.00000	0.00651	
	Conventional with 5.7% ethanol fuel dummy	-0.00389	0.02424	
	Conventional with 7.7% ethanol fuel dummy	-0.00367	0.01138	
	Conventional with 7.7% ethanol & RVP 9.0 fuel dummy	0.02101	0.01357	
	Conventional with 10% ethanol fuel dummy	0.00121	0.00886	
	Conventional with 10% ethanol & RVP 7.0 fuel dummy	0.01349	0.01523	
	Conventional with 10% ethanol & RVP 7.8 fuel dummy	0.00709	0.01108	
	Conventional with 10% ethanol & RVP 9.0 fuel dummy	0.00250	0.01175	
	Low sulfur fuel dummy	0.02275	0.00584	***
	Low sulfur 7.0 RVP fuel dummy	0.01268	0.01446	
	RFG with 10% ethanol fuel dummy	0.03312	0.01146	***
	RFG with 10% ethanol & 8.2 RVP fuel dummy	0.05801	0.01609	***
	RFG with MTBE fuel dummy	0.03958	0.01015	***
	RFG with MTBE & 7.0 RVP fuel dummy	0.03050	0.01445	**
	RFG with MTBE & 7.2 RVP fuel dummy	0.03062	0.01317	**
	RFG with MTBE & 8.2 RVP fuel dummy	0.03315	0.01539	**
	RFG with 5.7% ethanol fuel dummy	-0.00795	0.01252	
	R-squared	0.99		
	J-statistic P value	0.77		
	Observations	8112		
	Number of cities	78		

Source: GAO analysis of various data sources (see table 4 for a list of data sources).

* significant at the 10 percent level.

** significant at the 5 percent level.

*** significant at the 1 percent level.

Abbreviations used to describe various gasoline types are as follows: CBG–Cleaner Burning Gasoline; CARB–California Air Resources Board; MTBE–Methyl tertiary-butyl ether; RFG–reformulated gasoline; RVP–Reid vapor pressure.

Note: the standard error estimates are robust to heteroskedasticity and autocorrelation. The regression model included fixed effects for the cities and time dummies for each month of data. The model is estimated using two-stage least squares, treating the inventory-sales ratio and the capacity utilization rate as endogenous.

Table 6: Regression Results for Mergers' Effect on Branded Gasoline Prices—-Dependent Variable Is the Logarithm of Branded Gasoline Price

Variable category	Variable name	Coefficient	Standard error	Significance
	Inventory-sales ratio	0.08322	0.06111	
	Capacity utilization rate	0.00127	0.00079	
	Log of price lagged 1 period	0.53191	0.02778	***
Merger dummies	Chevron-Texaco merger dummy	0.00509	0.00637	
	Phillips-Conoco merger dummy	-0.01098	0.00397	***
	Phillips-Tosco merger dummy	0.00372	0.00669	
	Premcor-Williams merger dummy	0.00898	0.00804	
	Shell-Texaco merger dummy	0.00309	0.00406	
	Valero-Premcor merger dummy	0.00424	0.00269	
	Valero-UDS merger dummy	0.00705	0.00327	**
Dummies for period between announced and effective merger dates	Chevron-Texaco "mid" dummy	-0.01474	0.00968	
	Phillips-Conoco "mid" dummy	-0.01494	0.00439	***
	Phillips-Tosco "mid" dummy	-0.01190	0.00713	*
	Premcor-Williams "mid" dummy	0.01418	0.00946	
	Shell-Texaco "mid" dummy	0.01059	0.01404	
	Valero-Premcor "mid" dummy	-0.01126	0.00391	***
	Valero-UDS "mid" dummy	-0.00225	0.00599	
Gasoline specification dummies	CBG fuel dummy	-0.00951	0.01344	
	CBG with 10% ethanol fuel dummy	-0.02969	0.01326	**
	CARB with 5.7% ethanol fuel dummy	-0.06737	0.02192	***
	CARB with 5.7% ethanol 7.0 RVP fuel dummy	-0.05816	0.02734	**
	CARB with MTBE fuel dummy	-0.03905	0.02751	
	CARB with MTBE 7.0 RVP fuel dummy	-0.04107	0.02400	*
	CARB with MTBE 8.2 RVP fuel dummy	-0.00534	0.01776	
	CARB with no additive fuel dummy	-0.04876	0.02465	**
	Conventional with 7.0 RVP fuel dummy	0.00547	0.01046	
	Conventional with 7.2 RVP fuel dummy	0.01217	0.01081	
	Conventional with 7.8 RVP fuel dummy	-0.00309	0.00592	
	Conventional with 8.2 RVP fuel dummy	0.00877	0.01011	
	Conventional with 9.0 RVP fuel dummy	0.00156	0.00549	
	Conventional with 5.7% ethanol fuel dummy	0.01944	0.02297	

Variable category	Variable name	Coefficient	Standard error	Significance
	Conventional with 7.7% ethanol fuel dummy	-0.00723	0.00855	
	Conventional with 7.7% ethanol & RVP 9.0 fuel dummy	0.01901	0.01180	
	Conventional with 10% ethanol fuel dummy	0.00362	0.00804	
	Conventional with 10% ethanol & RVP 7.0 fuel dummy	0.01143	0.01666	
	Conventional with 10% ethanol & RVP 7.8 fuel dummy	0.00462	0.01162	
	Conventional with 10% ethanol & RVP 9.0 fuel dummy	0.01221	0.00907	
	Low sulfur fuel dummy	0.02723	0.00516	***
	Low sulfur 7.0 RVP fuel dummy	0.01702	0.01180	
	Low sulfur 9.0 RVP fuel dummy	0.03884	0.01154	***
	RFG with 10% ethanol fuel dummy	0.05681	0.01580	***
	RFG with 10% ethanol & 8.2 RVP fuel dummy	0.08463	0.01839	***
	RFG with MTBE fuel dummy	0.05851	0.01404	***
	RFG with MTBE & 7.0 RVP fuel dummy	0.03412	0.01602	**
	RFG with MTBE & 7.2 RVP fuel dummy	0.06048	0.01625	***
	RFG with MTBE & 8.2 RVP fuel dummy	0.06052	0.01712	***
	R-squared	0.99		
	J-statistic P value	0.10		
	Observations	8528		
	Number of cities	82		

Source: GAO analysis of various data sources (see table 4 for a list of data sources).

* significant at the 10 percent level.

** significant at the 5 percent level.

*** significant at the 1 percent level.

Abbreviations used to describe various gasoline types are as follows: CBG–Cleaner Burning Gasoline; CARB–California Air Resources Board; MTBE–Methyl tertiary-butyl ether; RFG–reformulated gasoline; RVP–Reid vapor pressure.

Note: the standard error estimates are robust to heteroskedasticity and autocorrelation. The regression model included fixed effects for the cities and time dummies for each month of data. The model is estimated using two-stage least squares, treating the inventory-sales ratio and the capacity utilization rate as endogenous.

Table 7: Regression Results for Effect of Spot Market HHI on Unbranded Gasoline Prices—-Dependent Variable Is the Logarithm of Unbranded Gasoline Price

Variable category	Variable name	Coefficient	Standard error	Significance
	Inventory-sales ratio	0.28754	0.12988	**
	Capacity utilization rate	-0.00050	0.00158	
	Log of price lagged 1 period	0.41312	0.04668	***
	Spot market HHI	1.08939	0.38344	***
Gasoline specification dummies	CBG fuel dummy	0.03871	0.03917	
	CBG with 10% ethanol fuel dummy	0.01963	0.02343	
	CARB with 5.7% ethanol fuel dummy	-0.01767	0.05553	
	CARB with MTBE fuel dummy	-0.04559	0.05912	
	CARB with MTBE 7.0 RVP fuel dummy	-0.03326	0.06649	
	CARB with MTBE 8.2 RVP fuel dummy	0.09736	0.07046	
	CARB with no additive fuel dummy	-0.05538	0.05364	
	Conventional with 7.0 RVP fuel dummy	-0.01360	0.02037	
	Conventional with 7.2 RVP fuel dummy	-0.03513	0.02531	
	Conventional with 7.8 RVP fuel dummy	-0.01720	0.01315	
	Conventional with 8.2 RVP fuel dummy	-0.05693	0.02413	**
	Conventional with 9.0 RVP fuel dummy	-0.01234	0.01116	
	Conventional with 5.7% ethanol fuel dummy	-0.05425	0.04087	
	Conventional with 7.7% ethanol fuel dummy	-0.01808	0.01680	
	Conventional with 7.7% ethanol & RVP 9.0 fuel dummy	0.00361	0.02321	
	Conventional with 10% ethanol fuel dummy	-0.01459	0.01438	
	Conventional with 10% ethanol & RVP 7.0 fuel dummy	-0.01429	0.02394	
	Conventional with 10% ethanol & RVP 7.8 fuel dummy	-0.01371	0.01834	
	Conventional with 10% ethanol & RVP 9.0 fuel dummy	-0.01909	0.01976	
	Low sulfur fuel dummy	0.02051	0.00835	**
	Low sulfur 7.0 RVP fuel dummy	-0.01002	0.02154	
	RFG with 10% ethanol fuel dummy	0.01726	0.03048	
	RFG with 10% ethanol & 8.2 RVP fuel dummy	0.03990	0.03678	
	RFG with MTBE fuel dummy	0.04091	0.02955	
	RFG with MTBE & 7.0 RVP fuel dummy	0.02401	0.04173	
	RFG with MTBE & 7.2 RVP fuel dummy	0.01629	0.03185	
	RFG with MTBE & 8.2 RVP fuel dummy	0.02247	0.03317	
	RFG with 5.7% ethanol fuel dummy	-0.03001	0.03247	
	R-squared	0.98		
	J-statistic P value	0.93		

Variable category	Variable name	Coefficient	Standard error	Significance
	Observations	8112		
	Number of cities	78		

Source: GAO analysis of various data sources (see table 4 for a list of data sources).

* significant at the 10 percent level.

** significant at the 5 percent level.

*** significant at the 1 percent level.

Abbreviations used to describe various gasoline types are as follows: CBG–Cleaner Burning Gasoline; CARB–California Air Resources Board; MTBE–Methyl tertiary-butyl ether; RFG–reformulated gasoline; RVP–Reid vapor pressure.

Note: the standard error estimates are robust to heteroskedasticity and autocorrelation. The regression model included fixed effects for cities and time dummies for each month of data. The model is estimated using two-stage least squares, treating the inventory-sales ratio, the capacity utilization rate, and the spot market HHI as endogenous.

Table 8: Regression Results for Effect of Spot Market HHI on Branded Gasoline Prices—-Dependent Variable Is the Logarithm of Branded Gasoline Price

Variable category	Variable name	Coefficient	Standard error	Significance
	Inventory-sales ratio	0.22304	0.08163	***
	Capacity utilization rate	0.00137	0.00098	
	Log of price lagged 1 period	0.47259	0.03589	***
	Spot market HHI	0.67462	0.35754	*
Gasoline specification dummies	CBG fuel dummy	0.00546	0.01316	
	CBG with 10% ethanol fuel dummy	-0.03869	0.01656	**
	CARB with 5.7% ethanol fuel dummy	-0.10739	0.02891	***
	CARB with 5.7% ethanol 7.0 RVP fuel dummy	-0.12379	0.04177	***
	CARB with MTBE fuel dummy	-0.10515	0.03823	***
	CARB with MTBE 7.0 RVP fuel dummy	-0.08938	0.03365	***
	CARB with MTBE 8.2 RVP fuel dummy	-0.00762	0.01859	
	CARB with no additive fuel dummy	-0.09747	0.03220	***
	Conventional with 7.0 RVP fuel dummy	-0.01341	0.01455	
	Conventional with 7.2 RVP fuel dummy	-0.01588	0.01524	
	Conventional with 7.8 RVP fuel dummy	-0.01426	0.00863	*
	Conventional with 8.2 RVP fuel dummy	-0.01686	0.01398	
	Conventional with 9.0 RVP fuel dummy	-0.01031	0.00800	
	Conventional with 5.7% ethanol fuel dummy	-0.03183	0.02743	
	Conventional with 7.7% ethanol fuel dummy	-0.01807	0.01396	
	Conventional with 7.7% ethanol & RVP 9.0 fuel dummy	0.00432	0.01580	
	Conventional with 10% ethanol fuel dummy	-0.01362	0.01032	
	Conventional with 10% ethanol & RVP 7.0 fuel dummy	-0.02321	0.02243	

Variable category	Variable name	Coefficient	Standard error	Significance
	Conventional with 10% ethanol & RVP 7.8 fuel dummy	-0.02101	0.01558	
	Conventional with 10% ethanol & RVP 9.0 fuel dummy	-0.00775	0.01230	
	Low sulfur fuel dummy	0.02327	0.00506	***
	Low sulfur 7.0 RVP fuel dummy	-0.00468	0.01276	
	Low sulfur 9.0 RVP fuel dummy	0.01447	0.01231	
	RFG with 10% ethanol fuel dummy	0.03085	0.01638	*
	RFG with 10% ethanol & 8.2 RVP fuel dummy	0.05823	0.02164	***
	RFG with MTBE fuel dummy	0.04701	0.01341	***
	RFG with MTBE & 7.0 RVP fuel dummy	0.01448	0.01472	
	RFG with MTBE & 7.2 RVP fuel dummy	0.03414	0.01730	**
	RFG with MTBE & 8.2 RVP fuel dummy	0.04025	0.01824	**
	R-squared	0.99		
	J-statistic P value	0.37		
	Observations	8112		
	Number of cities	78		

Source: GAO analysis of various data sources (see table 4 for a list of data sources).

* significant at the 10 percent level.

** significant at the 5 percent level.

*** significant at the 1 percent level.

Abbreviations used to describe various gasoline types are as follows: CBG–Cleaner Burning Gasoline; CARB–California Air Resources Board; MTBE–Methyl tertiary-butyl ether; RFG–reformulated gasoline; RVP–Reid vapor pressure.

Note: the standard error estimates are robust to heteroskedasticity and autocorrelation. The regression model included fixed effects for cities and time dummies for each month of data. The model is estimated using two-stage least squares, treating the inventory-sales ratio, the capacity utilization rate, and the spot market HHI as endogenous.

Table 9: Regression Results for Effect of the Number of Sellers at the City Terminal on Unbranded Gasoline Prices—-Dependent Variable Is the Logarithm of Unbranded Gasoline Price

Variable category	Variable name	Coefficient	Standard error	Significance
	Inventory-sales ratio	0.15181	0.08918	*
	Capacity utilization rate	-0.00100	0.00118	
	Log of price lagged 1 period	0.43843	0.03796	***
	Number of sellers at the city terminal	-0.01165	0.00340	***
Gasoline specification dummies	CBG fuel dummy	-0.03264	0.01827	*
	CBG with 10% ethanol fuel dummy	-0.03719	0.01386	***
	CARB with 5.7% ethanol fuel dummy	-0.01623	0.02612	
	CARB with MTBE fuel dummy	-0.03248	0.03018	
	CARB with MTBE 7.0 RVP fuel dummy	-0.04034	0.03383	
	CARB with MTBE 8.2 RVP fuel dummy	0.04463	0.03589	
	CARB with no additive fuel dummy	-0.02932	0.02699	
	Conventional with 7.0 RVP fuel dummy	0.00715	0.01527	
	Conventional with 7.2 RVP fuel dummy	-0.03138	0.02314	
	Conventional with 7.8 RVP fuel dummy	-0.00442	0.00929	
	Conventional with 8.2 RVP fuel dummy	-0.01883	0.01782	
	Conventional with 9.0 RVP fuel dummy	-0.00072	0.00792	
	Conventional with 5.7% ethanol fuel dummy	-0.00177	0.02786	
	Conventional with 7.7% ethanol fuel dummy	-0.00148	0.01368	
	Conventional with 7.7% ethanol & RVP 9.0 fuel dummy	0.01260	0.01689	
	Conventional with 10% ethanol fuel dummy	0.00155	0.01081	
	Conventional with 10% ethanol & RVP 7.0 fuel dummy	0.01456	0.01590	
	Conventional with 10% ethanol & RVP 7.8 fuel dummy	0.00020	0.01415	
	Conventional with 10% ethanol & RVP 9.0 fuel dummy	0.00641	0.01412	
	Low sulfur fuel dummy	0.00574	0.01174	
	Low sulfur 7.0 RVP fuel dummy	-0.00515	0.01756	
	RFG with 10% ethanol fuel dummy	0.00387	0.01598	
	RFG with 10% ethanol & 8.2 RVP fuel dummy	0.04506	0.02021	**
	RFG with MTBE fuel dummy	0.01437	0.01251	
	RFG with MTBE & 7.0 RVP fuel dummy	-0.01360	0.01697	
	RFG with MTBE & 7.2 RVP fuel dummy	0.00870	0.01573	
	RFG with MTBE & 8.2 RVP fuel dummy	-0.00514	0.02362	
	RFG with 5.7% ethanol fuel dummy	-0.02068	0.01752	
	R-squared	0.99		
	J-statistic P value	0.82		

Variable category	Variable name	Coefficient	Standard error	Significance
	Observations	8112		
	Number of cities	78		

Source: GAO analysis of various data sources (see table 4 for a list of data sources).

* significant at the 10 percent level.

** significant at the 5 percent level.

*** significant at the 1 percent level.

Abbreviations used to describe various gasoline types are as follows: CBG–Cleaner Burning Gasoline; CARB–California Air Resources Board; MTBE–Methyl tertiary-butyl ether; RFG–reformulated gasoline; RVP–Reid vapor pressure.

Note: the standard error estimates are robust to heteroskedasticity and autocorrelation. The regression model included fixed effects for cities and time dummies for each month of data. The model is estimated using two-stage least squares, treating the inventory-sales ratio, the capacity utilization rate, and the number of sellers at the city terminal as endogenous.

Table 10: Regression Results for Effect of the Number of Sellers at the City Terminal on Branded Gasoline Prices—-Dependent Variable is the Logarithm of Branded Gasoline Price

Variable category	Variable name	Coefficient	Standard error	Significance
	Inventory-sales ratio	0.08564	0.06035	
	Capacity utilization rate	0.00086	0.00083	
	Log of price lagged 1 period	0.51420	0.02868	***
	Number of sellers at the city terminal	-0.00869	0.00240	***
Gasoline specification dummies	CBG fuel dummy	-0.03247	0.01646	**
	CBG with 10% ethanol fuel dummy	-0.05299	0.01589	***
	CARB with 5.7% ethanol fuel dummy	-0.06950	0.02312	***
	CARB with 5.7% ethanol 7.0 RVP fuel dummy	-0.07087	0.03008	**
	CARB with MTBE fuel dummy	-0.05644	0.03010	*
	CARB with MTBE 7.0 RVP fuel dummy	-0.06272	0.02727	**
	CARB with MTBE 8.2 RVP fuel dummy	-0.02308	0.01900	
	CARB with no additive fuel dummy	-0.05001	0.02466	**
	Conventional with 7.0 RVP fuel dummy	0.00439	0.01015	
	Conventional with 7.2 RVP fuel dummy	-0.00966	0.01553	
	Conventional with 7.8 RVP fuel dummy	-0.00378	0.00579	
	Conventional with 8.2 RVP fuel dummy	0.01249	0.01174	
	Conventional with 9.0 RVP fuel dummy	0.00134	0.00578	
	Conventional with 5.7% ethanol fuel dummy	0.02627	0.02227	
	Conventional with 7.7% ethanol fuel dummy	-0.00632	0.00913	
	Conventional with 7.7% ethanol & RVP 9.0 fuel dummy	0.01576	0.01102	
	Conventional with 10% ethanol fuel dummy	0.00211	0.00819	
	Conventional with 10% ethanol & RVP 7.0 fuel dummy	0.01572	0.01698	

Variable category	Variable name	Coefficient	Standard error	Significance
	Conventional with 10% ethanol & RVP 7.8 fuel dummy	-0.00135	0.01164	
	Conventional with 10% ethanol & RVP 9.0 fuel dummy	0.01250	0.00928	
	Low sulfur fuel dummy	0.01225	0.00825	
	Low sulfur 7.0 RVP fuel dummy	0.00267	0.01151	
	Low sulfur 9.0 RVP fuel dummy	0.01309	0.01183	
	RFG with 10% ethanol fuel dummy	0.03960	0.01807	**
	RFG with 10% ethanol & 8.2 RVP fuel dummy	0.08056	0.02043	***
	RFG with MTBE fuel dummy	0.04405	0.01613	***
	RFG with MTBE & 7.0 RVP fuel dummy	-0.00111	0.01658	
	RFG with MTBE & 7.2 RVP fuel dummy	0.04595	0.01796	**
	RFG with MTBE & 8.2 RVP fuel dummy	0.03782	0.02071	*
	R-squared	0.99		
	J-statistic P value	0. 18		
	Observations	8528		
	Number of cities	82		

Source: GAO analysis of various data sources (see table 4 for a list of data sources).

* significant at the 10 percent level.

** significant at the 5 percent level.

*** significant at the 1 percent level.

Abbreviations used to describe various gasoline types are as follows: CBG–Cleaner Burning Gasoline; CARB–California Air Resources Board; MTBE–Methyl tertiary-butyl ether; RFG–reformulated gasoline; RVP–Reid vapor pressure.

Note: the standard error estimates are robust to heteroskedasticity and autocorrelation. The regression model included fixed effects for cities and time dummies for each month of data. The model is estimated using two-stage least squares, treating the inventory-sales ratio, the capacity utilization rate, and the number of sellers at the city terminal as endogenous.

- We found that some mergers correspond with price effects, but these effects vary in direction and significance.

- We tested for the endogeneity of our measures of market concentration: the spot market HHI and the number of sellers. With the exception of the spot market HHI in the branded price model, in both our unbranded price and branded price models our C-statistic test rejected the null hypothesis of exogeneity of our measures of market concentration. We treated these variables as endogenous in all our models, but we also estimated our model treating these variables as exogenous so we could compare the two sets of results.

- We tested for whether the inventory-sales ratio and the capacity utilization rate were endogenous. We used a C-statistic to test for the joint exogeneity

of these variables. In some cases, the null hypothesis of exogeneity was accepted and in other cases not. In order to be conservative in the sense of presenting estimates that are consistent, we modeled these variables as endogenous, although we recognize that this may not be the statistically efficient estimator in some cases.

- We used Hansen's J-statistic to test for overidentification of our instruments: namely, that they should be correlated with the regressors but uncorrelated with the regression errors. In every case, the J-statistic accepted the null hypothesis that our instruments were valid.

- In general, the results for both measures of market concentration—-the number of sellers in the city and the HHI for the spot market—-showed a significant correspondence between higher prices and a less competitive market environment.

- We used the model's results to calculate the dollar value impact on gasoline prices of the significant merger effects and changes in market concentration.

- In many cases, our results showed the effects of gasoline specification dummies to be either not statistically significant or positive, a result we would expect given that our base-case is regular clear gasoline. In some of our results, the coefficient was negative, in particular for the CARB and CBG gasoline in the branded regressions. CARB is generally sold only in California, and it is possible that in some of our regressions, the California cities' fixed-effects are picking up the effect of what we would expect to be higher-priced CARB fuel. The presence of CBG in our data was also limited to one or two cities, and a similar issue may have affected our results for this gasoline specification.

Limitations of Our Econometric Model and Data

- Our gasoline data were selected so as to generally reflect the type of gasoline that would be sold in a city, given the local fuel regulations. In most cases we were able to assign prices accordingly, but in some cases other types of fuel were used in the data. In our regression models, we control for whatever fuel type we did use.

- We used monthly data for prices and most of our control variables. State-level personal income data were available only quarterly and were applied to the appropriate months for that quarter.

- The inventory-sales ratio and capacity utilization rate were at the PADD level, so we assigned the data observation according to which PADD the city was located in.[8] Similarly, we used state-level data for personal income growth, employment growth, and the unemployment rate, and we assigned the data observations according to the state in which the city was located.

- Our analysis was performed at the city level, but some of our data were available only at more aggregated geographic levels. The capacity utilization rate and the inventory-sales ratio were available at the PADD level only. Employment growth, personal income growth rate, and the unemployment rate were available at the state level only. One of our measures of market concentration was at the spot market level. It is possible that in some cases these measures are too highly aggregated and these control variables were less precise than would be ideal.

- We used merger events as instruments for our market concentration measures, which, in general, were found to be endogenous.[9] It is possible that the merger events themselves are endogenous, but we have no further data that we could have used to instrument the merger variables.

- We also estimated our model treating the concentration measures, the inventory-sales ratio, and the capacity utilization rate as exogenous. In these results, we found that the impact on prices of our concentration measures was statistically significant but smaller. For example, in the case of the spot market HHI, the price effects were about half the size in the case of the unbranded regressions, and for the number of city sellers, about one-sixth of the size in the unbranded regressions. While our tests for exogeneity of the concentration measures generally rejected their being exogenous, we wanted to display a range of possible results.

- We are aware of the limitations of using a fixed effects model to study events such as mergers and to use dummy variables for mergers in such a model.[10] Further, we are aware that our model, or any model, is unlikely to account for all conceivable factors affecting prices. With this in mind, we

[8]There are five Petroleum Administration for Defense Districts (PADD) in the United States. EIA collects much of its data according to these regions.

[9]The tests rejected exogeneity in all cases except for the spot market HHI in the branded gasoline prices model.

[10]For example, see Halbert White, "Time-Series Estimation of the Effects of Natural Experiments," *Journal of Econometrics*, 135, 2006, 527-566.

used fixed effects for cities and time dummy variables for every time period. The former accounts for special (possibly unobservable) effects that are constant over time, affecting an individual city, and the latter for effects that are constant across cities but vary over time, such as national supply disruptions. Nevertheless, we are aware that these cannot account for every factor that, say, may affect a group of cities for a given period of time; for example, a localized supply disruption, except insofar as this is reflected in the level of inventories or capacity utilization rate in the PADD.

- The concentration measures that we used are imperfect. On the one hand, we used the number of sellers at the city terminal, a measure of concentration at the city level that does not measure market share, only market participation. Our other measure, the spot market HHI, is broader geographically than is ideal, and it is measured at the refinery level. The latter means that we are approximating market shares of the sellers at the city with shares of refineries in the spot market region.

- We used a number of methods to test our model but we recognize that our results should be viewed carefully. In particular, we are concerned that a difference in the effect of mergers may depend on whether we used the announced or the effective merger dates. In order to address this issue, our model of mergers included dummy variables for the period of time between the announced date and the effective date of the merger, as well as a dummy variable for the time following the effective date of each merger.

- We understand that our methodology is not a substitute for an event study. However, our methods could be used in conjunction with such—-in particular, as a broad means to address issues of whether an industry is overly concentrated, since we recognize that it is resource-intensive to conduct an event study for every merger. We are aware that a difference-in-differences model provides an alternative methodology but that method has its own limitations, in particular, the matching of cities for treatment and controls.

- Our analysis did not account for all gasoline that is sold at wholesale terminals. Our gasoline wholesale price data captured about 60 percent of gasoline sold in the United States, according to EIA analysis. The remaining gasoline is sold directly to retailers, or through other arrangements, and price data for these sales are not always available. These transactions likely also affect the general wholesale market for a particular city.

- Our model focused on wholesale gasoline prices, so we are unable to determine the extent to which the price effects that we found would be passed on to the retail level.

Appendix II: Comments from the Federal Trade Commission

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

FEDERAL TRADE COMMISSION
WASHINGTON, D.C. 20580

THE CHAIRMAN

June 3, 2009

Mr. Mark E. Gaffigan
Director, Natural Resources and Environment
United States Government Accountability Office
Washington, D.C. 20548

Mr. Thomas McCool
Director, Center for Economics
Applied Research and Methods
United States Government Accountability Office
Washington, D.C. 20548

Dear Messrs. Gaffigan and McCool:

The Federal Trade Commission ("FTC" or "Commission") appreciates the opportunity to comment on the draft report on *Energy Markets: Estimates of the Effects of Mergers and Market Concentration on Wholesale Gasoline Prices* (GAO-09-659) ("Report") that the Government Accountability Office ("GAO") submitted to the Commission on May 18, 2009. The Report discusses GAO's examination of (1) the effects on wholesale gasoline prices of a select set of past oil industry mergers, and (2) the effects of market concentration on wholesale gasoline prices. This comment addresses each of these examinations in turn.

Commission staff have been pleased to work with GAO staff during the present inquiry, providing information and comments on the petroleum industry, the Commission's merger enforcement activities, and GAO's econometric methodology. GAO's draft Report provides important information on mergers in the petroleum industry and on the Commission's role in reviewing those mergers.[1] GAO recommends that the FTC undertake more regular retrospective reviews of petroleum mergers and develop risk-based guidelines to determine when to conduct such retrospectives. Citing a recent National Bureau of Economic Research working paper co-

[1] The Commission commented extensively on GAO's merger review analysis in response to your 2008 report on *Energy Markets: Analysis of More Past Mergers Could Enhance Federal Trade Commission's Efforts to Maintain Competition in the Petroleum Industry* (GAO-08-1082) (Sept. 2008), at 54-60 ("GAO 2008 Report"). The instant comments should be read in combination with the FTC comments appended to the GAO 2008 Report.

authored by two FTC economists,[2] the Report observes that the Commission might appropriately focus its retrospective analyses on completed mergers with the greatest likelihood of anticompetitive effects.[3]

We support GAO's recommendation that the FTC continue its regular reviews of past petroleum industry mergers.[4] We also agree that the Commission should focus those retrospective efforts on mergers that present the greatest likelihood of anticompetitive effects and, in that regard, should pay attention (although not exclusively) to markets that are concentrated. Further, we believe that the criteria that the Commission has used to select mergers for its previous retrospective studies satisfy GAO's recommendation to apply "risk-based criteria."

The Commission provides below some specific comments on GAO's merger and concentration analyses.

The Report's Discussion of Past Mergers

GAO studied seven large petroleum mergers between 2000 and 2007 to determine how those transactions might have affected branded and unbranded wholesale gasoline prices. GAO concluded that one merger was associated with a price increase for branded gasoline of approximately one cent per gallon, while a second merger was associated with about a one-cent-per-gallon increase for unbranded gasoline. A third merger was found to be associated with similarly small decreases in the prices of both unbranded and branded gasoline. GAO found no statistically significant change in either branded or unbranded wholesale prices for the other four mergers. Taking these findings as a whole – and in view of the large swings in gasoline prices over the period that GAO studied – the GAO analysis suggests that recent large petroleum mergers have had at most a minor impact on gasoline prices.

The Commission believes that GAO's merger analysis represents an interesting approach to identifying the possible effects of consummated mergers. Indeed, although it differs in some important respects – such as how controls are constructed – GAO's methodology is broadly similar to that used by FTC economists in their own merger retrospectives. As the FTC moves forward with new retrospectives, our efforts will be informed by GAO's econometric work and,

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[2] Orley C. Ashenfelter, Daniel Hosken & Matthew Weinberg, *Generating Evidence to Guide Merger Enforcement*, NBER Working Paper No. 14798 (Mar. 2009), *available at* http://www.nber.org/papers/w14798.pdf?new_window=1.

[3] Report at 8.

[4] The Commission staff, which conducts merger retrospectives across a number of industries, is working on a fourth retrospective review of a petroleum industry merger. That retrospective is expected to be released later this year.

See comment 1.

in particular, will devote resources to a more complete evaluation of the strengths and limitations of GAO's methodology.[5]

The Report's Price-Concentration Analyses

GAO reports that it did not observe any trend toward increasing market concentration nationwide between 2000 and 2008, either in the number of sellers at wholesale gasoline terminals or in refinery capacity concentration measures for certain "spot market groups" delineated by GAO.[6] Nonetheless, there was some significant variation in the number of sellers at certain wholesale terminals, as well as in the concentration of refiners supplying one spot market group (New York Harbor). Based on its analysis of these variations in the number of wholesale sellers and in refinery capacity concentration, GAO finds that higher wholesale prices are associated with higher concentration levels. GAO's results imply that even small concentration changes in relatively unconcentrated markets are associated with large price effects.

Inasmuch as market concentration is obviously relevant to merger enforcement,[7] the Commission takes great interest in GAO's findings. Based on its experience in petroleum markets,[8] however, the FTC finds the strength of GAO's price-concentration results –

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[5] GAO appropriately notes the limitations of its analyses. For example, the Report states that GAO did not control for all factors affecting gasoline markets, including "disruptions to local gasoline supply markets from weather-related events, interruptions in refinery or pipeline operations, or other changes in local gasoline supply." Report at 3. The Report also states that "because some cities were affected by multiple mergers, may have had changes in market concentration, and may have been affected by factors for which [GAO] did not have data," the study cannot be certain whether, or how, wholesale prices in each location were affected by particular mergers. *Id.*

[6] *Id.* at 17.

[7] *See, e.g.*, FEDERAL TRADE COMMISSION AND U.S. DEPARTMENT OF JUSTICE, COMMENTARY ON THE HORIZONTAL MERGER GUIDELINES 20 (2006) ("Market shares and concentration nevertheless are important in the Agencies' evaluation of the likely competitive effects of a merger. Investigations are almost always closed when concentration levels are below the thresholds set forth in section 1.51 of the Guidelines. In addition, the larger the market shares of the merging firms, and the higher the market concentration after the merger, the more disposed are the Agencies to concluding that significant anticompetitive effects are likely.").

[8] The central element of the Commission's role in the petroleum sector is an ongoing and vigorous law enforcement presence. The Commission maintains a program of investigating and, where appropriate, taking enforcement action against potentially anticompetitive mergers and

See comment 2.

See comment 1.

See comment 1.

particularly at relatively low levels of concentration – to be surprising. Indeed, some results set forth in the Report appear inaccurate.[9] More generally, a reliable estimate of economic relationships between price and concentration must be premised on, among other things, accurate measures of market concentration. It appears that GAO's analyses suffer from significant measurement errors in their concentration variables.[10] For example, GAO finds that approximately 60 percent of the gasoline consumed on the East Coast comes from foreign countries. If that finding is correct, then concentration based on a purely domestic measure of "New York Harbor" refining capacity is highly unlikely to reflect the true level of market concentration. In turn, such measurement errors would cast doubt on the relationship that GAO's analysis suggests exists between price and concentration.

Nonetheless, despite these and other possible shortcomings, which may render GAO's results unreliable for purposes of formulating antitrust policy, the Commission will carefully consider GAO's price-concentration results and will direct its economists to evaluate further the usefulness of GAO's findings.

Conclusion

The Commission appreciates the opportunity to comment on the Report. The

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acquisitions, as well as non-merger conduct violations, in this industry. For example, in 2007 the Commission applied for a preliminary injunction in the United States District Court in New Mexico, seeking to block Western Refining's acquisition of Giant Industries – a transaction that the Commission alleged threatened to harm competition in the bulk supply of light petroleum products in northern New Mexico. (The District Court disagreed and declined to grant the injunction.) In addition, the Commission currently is engaged in a proceeding, pursuant to Section 811 of the Energy Independence and Security Act of 2007, to determine whether to promulgate a rule prohibiting market manipulation in wholesale petroleum markets. *See* http://www.ftc.gov/opa/2009/04/rnprm.shtm.

[9] For example, GAO's findings (Report at 16, Table 3) suggest that an increase in concentration of 90 points in an unconcentrated market (a Herfindahl-Hirschman Index increase from 700 to 790) is associated with a 5.4-cent-per-gallon increase in wholesale prices. But the analysis also suggests that an identical increase of 5.4 cents per gallon is associated with a concentration increase of 540 points, beginning from a more concentrated level (from 930 to 1470). These findings would suggest, for example, that mergers with smaller structural impact (as measured by concentration changes) – and occurring at lower levels of premerger market concentration – could have adverse effects on prices equal to the effects produced by mergers yielding larger concentration changes and occurring at higher levels of premerger concentration. We find this result difficult to reconcile with economic theory and with our own antitrust experience.

[10] Report at 15, 23, 41.

Commission agrees with GAO on the need for regular merger retrospectives in the petroleum industry. We plan to continue our ongoing program with appropriately targeted retrospectives, and we will continue to use risk-based criteria to identify past mergers for review. The Commission will seriously consider GAO's findings and will direct its staff to evaluate more fully GAO's contributions as the Commission moves forward with its merger retrospectives and merger enforcement programs.

By direction of the Commission.

Jon Leibowitz
Chairman

The following are GAO's comments on the Federal Trade Commission's letter dated June 3, 2009.

GAO Comments

1. Measures of market concentration are inherently difficult to develop because information on relevant market boundaries and sales volumes by gasoline sellers is not readily available. Although we made no changes to the report based on the Chairman's comment, we wish to emphasize that to improve the robustness of our concentration analysis, we used two measures of market concentration—first, we used the number of sellers at wholesale terminals, and second, we calculated the market concentration of refineries in seven U.S. spot markets. We acknowledge the limitations of our spot market measure that the Chairman noted, especially in the case of the New York Harbor market, and stated these limitations in the draft report. However, as stated above, we did not rely solely on this one measure of market concentration, and we found a qualitatively similar and statistically significant effect when we estimated the impact of the number of sellers at wholesale gasoline terminals on prices. In addition, for both of these measures, we estimated the price effects under another set of statistical assumptions, and found and reported in the draft these similar, though smaller, price effects.[1] Although our two measures of market concentration may not be appropriate for formulating antitrust policy, as the Chairman noted, our findings indicate that the effects of market concentration on prices may occur at lower levels of concentration than previously anticipated, and FTC's access to more detailed petroleum industry data might allow them to make a more precise estimate of these potential impacts.

2. Although our draft concentration results were correct, our presentation showed that the median value of market concentration was the midpoint in the range of price effects, when in fact the price effects were not evenly spread around the median. We changed the tables and text in our

[1]As noted on page 16, we treated market concentration as endogenous---meaning that changes in wholesale gasoline prices could affect market concentration in addition to changes in concentration affecting prices. For example, this could occur if high prices at one terminal spur new sellers to enter the market, thus decreasing concentration. This assumption was supported by statistical tests that we conducted, although because this assumption was likely to have a noticeable impact on our results, we also analyzed our data without it and found that the impact on prices of our concentration measures was statistically significant but smaller. For example, for unbranded prices, in the case of the refinery spot market HHI, the impact on wholesale prices was about half the size without this assumption. For the number of sellers at the terminal, the impact was about one-sixth of the size without this assumption.

discussion of the market concentration results to better reflect these price effects.

Appendix III: Summary Information on the Seven Mergers Reviewed in GAO's Econometric Model

Additional information on the specific mergers selected for review in GAO's analysis, including the rationale for the merger, statements or remedial actions identified by the FTC in addressing potential anticompetitive concerns, and other relevant context surrounding the merger, is outlined below.

Chevron Corporation and Texaco

On October 16, 2000, Chevron Corporation and Texaco announced plans to merge, in a transaction ultimately valued at about $45 billion. Both firms were large, fully integrated firms, with operations in oil exploration, pipeline transportation, and refining and marketing of gasoline products, and were considered among the largest integrated oil firms in the world. Chevron's stated goal in pursuing the merger was to become the industry leader in total stockholder returns. Following the merger, the newly merged firm was projected to become the world's fourth largest firm in oil exploration and production. FTC's review of the merger identified a number of antitrust concerns, including coordinated threats in the refining and marketing sectors in a number of regions across the United States, as well as threats in the refining, pipeline, and marketing sectors, primarily across the West. As a result of these threats, FTC required the divestiture of a number of Texaco's downstream assets, most notably its share of a joint venture with Royal Dutch Shell Group in the refining sector, as well as its share of two major pipelines. See figure 3 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

Figure 3: Cities Affected by Chevron/Texaco Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Phillips Petroleum Corporation and Tosco Corporation

On February 4, 2001, Phillips Petroleum Corporation and Tosco Corporation announced plans to merge, in a transaction valued at $9.8 billion dollars. Prior to the merger, Phillips was a large firm with refining and retail operations in the United States, and crude oil production operations worldwide, while Tosco operated in the downstream sector, with refining and marketing operations. In the transaction, Phillips gained eight U.S. refineries and 6,400 retail stations in 32 states. According to IHS Herold information, Phillips' goal was to increase the profitability of its downstream operations and realize $250 million dollars in pretax cost savings. According to the *Oil and Gas Journal* and FTC, there was actually little overlap between the companies' refining and marketing systems, reducing the potential for competitive concerns. In fact, FTC indicated that the two merging companies substantially operated in different parts of the country, and the combined sales of the two firms would not exceed 10 percent of the oil-refining or gasoline-marketing sales across the country. In the few cities where the firms' gasoline-marketing businesses would overlap significantly, FTC indicated that the new firm would have a relatively low market share, making it unlikely that the new firm would pose a competitive threat to those markets. See figure 4 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

Figure 4: Cities Affected by Phillips/Tosco Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Valero Energy Corporation and Ultramar Diamond Shamrock Corporation

On May 7, 2001, Valero Energy Corporation announced plans to acquire Ultramar Diamond Shamrock Corporation (UDS) in a transaction valued at $6.4 billion. Prior to the merger, both firms were focused on downstream refining and retail operations, each owning seven refineries. In the transaction, Valero acquired seven UDS refineries, approximately 2,500 company-owned retail sites, and 2,500 branded gasoline stations in the United States and Canada. In a press release, Valero indicated that the merger would help create synergies and strategic benefits. However, before allowing the transaction, FTC required the divestiture of UDS's Golden Eagle refinery, located in Avon, California, so as to remedy alleged anticompetitive concerns in the gasoline-refining and supply markets in California. Without this divestiture, competition would have been reduced by giving Valero between a 40 and 45 percent market share of gasoline refining in Northern California, thus enhancing its ability to unilaterally raise prices or to coordinate with other California refiners to raise prices. FTC also indicated that the claimed efficiency gains of the merger would have been small compared with the magnitude of the potential harm to consumers in California had it not required the divestiture, which with even a 1 cent per gallon increase, would have cost consumers an extra $150 million per year. See figure 5 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

Figure 5: Cities Affected by Valero/UDS Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Royal Dutch Shell Group

On October 9, 2001, Texaco signed a memorandum of understanding with Royal Dutch Shell Group and Saudi Refining to sell Texaco's shares of the Equilon Enterprises and Motiva Enterprises joint ventures with Shell and Saudi Refining.[1] The joint ventures included the refining, transportation, and marketing activities of Shell and Texaco in the United States, as operated by Equilon Enterprises in the West and Midwest and Motiva Enterprises in the East. The memorandum of understanding came about in response to FTC's review of the proposed merger between Chevron Corporation and Texaco and subsequent concern about unilateral and coordinated threats posed by the merger in the refining and marketing sectors. Specifically, FTC found that, absent any divestitures, the Chevron/Texaco merger would violate antitrust law by reducing competition in markets such as the following: gasoline marketing in the West; refining, marketing, and bulk supply of CARB (California Air Resources Board) gasoline in California; and the terminaling and bulk supply of gasoline in a number of states in the West and Southwest. In response, FTC issued a decision and order requiring Texaco to divest all of its interests in the joint ventures, which included gasoline marketing in numerous western states, including CARB gasoline, as well as refining and bulk supply of gasoline in California and the Pacific Northwest, among others. Under the terms of the memorandum of understanding, Shell received 100 percent interest in Equilon, including approximately 9,000 retail stations and four refineries, and Shell and Saudi Refining each 50 percent interest in Motiva, including approximately 13,000 stations and four refineries. FTC approved the divestiture as proposed in the memorandum of understanding, subsequently allowing for the approval of the Chevron/Texaco merger. See figure 6 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

[1]Saudi Refining was only a partner, and subsequent buyer, in the joint venture with Motiva Enterprises.

Figure 6: Cities Affected by Shell/Texaco Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Phillips Petroleum Corporation and Conoco

On November 19, 2001, Conoco and Phillips Petroleum Corporation announced plans to merge in a deal worth $31 billion. Prior to the merger, Philips was the third largest refiner in the United States, with approximately 10 percent of U.S. capacity, and Conoco was approximately the 11th largest refiner, with 3 percent of U.S. refining capacity. Following the merger, the new company became the third largest integrated energy company in the United States. Through the merger, Conoco and Phillips stated that they hoped to realize major synergies, more capital for upstream investment, and operational efficiencies in the downstream sector. Prior to the completion of the transaction, FTC analyzed the markets and assets involved in the merger and identified a few areas of competitive concern. More specifically, FTC determined that the new firm would have had sufficient market share to be able to coordinate or to act unilaterally to raise gasoline prices in eastern Colorado; northern Utah; Spokane, Washington; and Wichita, Kansas. As a result, FTC required divestitures in the areas of concern, namely the sale of Phillips's Woods Cross refinery near Salt Lake City and marketing assets in northern Utah, as well as the sale of Conoco's Denver-area refinery and eastern Colorado marketing assets. FTC also required the sale of Phillips's gasoline terminal in Spokane and required an agreement related to the use of Phillip's gasoline terminal in Wichita. See figure 7 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

Figure 7: Cities Affected by Phillips/Conoco Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Premcor and Williams Companies

On November 26, 2002, Premcor announced its intention to acquire a refinery located in Memphis, Tennessee owned by Williams Companies, in a transaction valued at $367 million. Prior to the merger, both companies were relatively small, with Premcor operating a few refineries around the country and Williams a refinery in Alaska, in addition to the Memphis facility. As part of the transaction, Premcor acquired the refinery, as well as the related supply and distribution assets in and around Memphis owned by Williams. In an initial press release, Premcor noted that the Memphis refinery would help Premcor grow its presence in the Southeast, in addition to providing the firm with a strong, competitively positioned refinery, because of extensive upgrades and improvements to the facility in previous years by Williams. Furthermore, Premcor noted that, because of the refinery's location, it expected to benefit from synergies with Premcor's Lima, Ohio, refinery, as well as its midcontinent distribution system. In its review of the merger, FTC did not identify any potential threats to competition, either unilateral or coordinated. As such, the acquisition proceeded as planned, without any challenge from FTC. See figure 8 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

Figure 8: Cities Affected by Premcor/Williams Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Valero Energy Corporation and Premcor

On April 25, 2005, Valero Energy Corporation and Premcor announced plans to merge in a deal worth $7.6 billion. At the time, Valero was the fourth largest U.S. refiner, while Premcor was a smaller refiner that owned only four U.S. refineries, which were located in Port Arthur, Texas; Memphis, Tennessee; Lima, Ohio; and Delaware City, Delaware. After this merger, Valero became one of the largest refiners in the United States. Valero noted in a press release that the acquisition would allow for synergies in the two companies' refining operations. As we noted in our 2008 report, operational efficiencies at refineries were reported as the rationale for some mergers, because refinery operators can achieve cost savings by purchasing crude in bulk, among other things.[2] According to EIA, the acquisition significantly increased Valero's refining presence on the East Coast and in the Midwest. FTC conducted a nonpublic investigation of this merger, which FTC staff indicated was closed with no action to challenge the merger. See figure 9 for the cities in our analysis where we identified competitive overlaps between these firms before they merged.

[2] GAO, *Energy Markets: Analysis of More Past Mergers Could Enhance Federal Trade Commission's Efforts to Maintain Competition in the Petroleum Industry*, GAO-08-1082 (Washington D.C.: Sept. 25, 2008).

Figure 9: Cities Affected by Valero/Premcor Merger

Source: Copyright © Corel Corp. All rights reserved (map); GAO analysis of OPIS data.

Appendix IV: Additional Market Concentration Information

The estimated effects of the measures of market concentration on branded wholesale gasoline prices are shown below.

Table 11: Effects of the Number of Sellers on Branded Wholesale Gasoline Prices at the Terminals in the 82 Cities We Studied

Change in number of sellers at the wholesale terminal	Gain of 6 sellers (8 sellers to 14 sellers)	Gain of 12 sellers (5 sellers to 17 sellers)
Change in branded wholesale gasoline price in cents per gallon[a]	-8	-15

Source: GAO analysis of OPIS data.

[a]These results were statistically significant at the 1 percent level. The 8 to 14 seller range represents the 25th to the 75th percentile of values that we observed at terminals in our branded analysis. The 5 to 17 seller range represents the 10th to the 90th percentile

Table 12: Effects of Market Concentration on Branded Wholesale Gasoline Prices at Terminals Supplied by Seven Spot Markets

Refinery spot market HHI	Decrease in HHI from 930 to 790	Decrease in HHI from 1,470 to 700
Change in branded wholesale gasoline price in cents per gallon[a]	-1	-8

Source: GAO analysis of OPIS data.

[a]These results were statistically significant at the 10 percent level. The 790 to 930 range represents the 25th to the 75th percentile of values that we observed at terminals in our branded analysis. The 700 to 1,470 range represents the 10th to the 90th percentile.

Table 13: Number of Sellers at Wholesale Terminals in 2008

City name	State	Number of sellers	City name	State	Number of sellers
Anchorage	Alaska	4	Newark	N.J.	20
Fairbanks	Alaska	3	Albuquerque	N. Mex.	11
Mobile	Ala.	6	Bloomfield	N. Mex.	11
El Dorado	Ark.	8	Las Vegas	Nev.	3
Fort Smith	Ark.	17	Sparks/Reno	Nev.	8
Phoenix	Ariz.	8	Albany	N.Y.	15
Tucson	Ariz.	10	Syracuse	N.Y.	15
Los Angeles	Calif.	7	Cincinnati	Ohio	4
Sacramento	Calif.	10	Cleveland	Ohio	9
San Diego	Calif.	6	Columbus	Ohio	9
San Francisco	Calif.	8	Lima	Ohio	5
Denver	Colo.	11	Toledo	Ohio	9

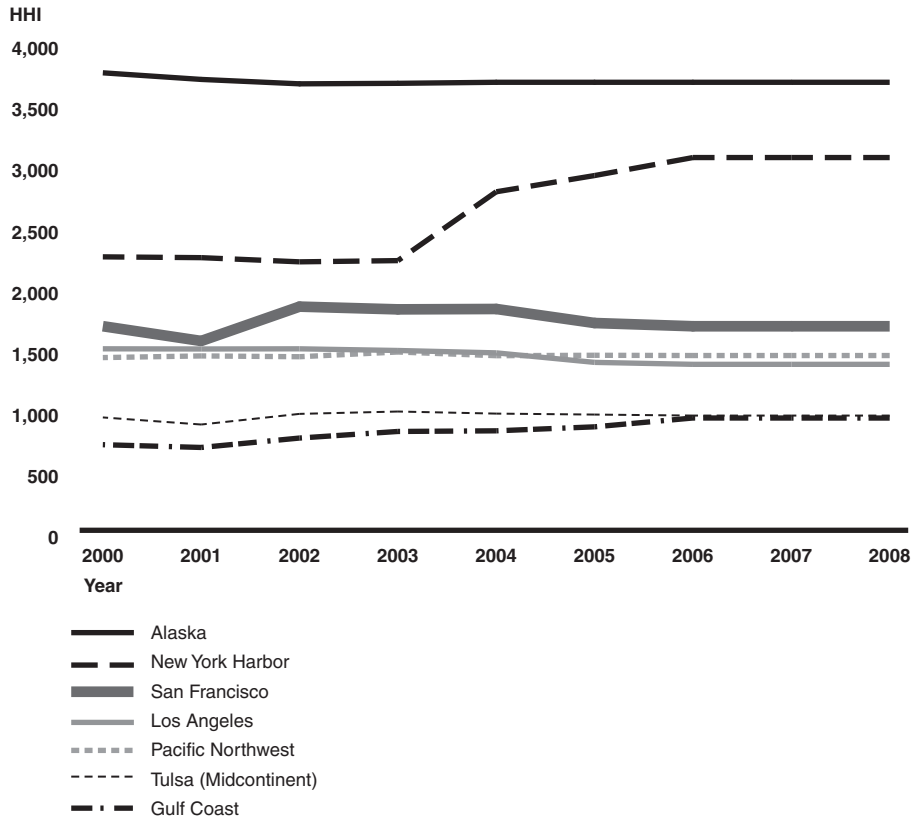
City name	State	Number of sellers	City name	State	Number of sellers
Miami	Fla.	14	Oklahoma City	Okla.	17
Tampa	Fla.	14	Tulsa	Okla.	13
Atlanta	Ga.	14	Portland	Ore.	12
Des Moines	Iowa	21	Harrisburg	Pa.	15
Boise	Idaho	12	Philadelphia	Pa.	14
Champaign	Ill.	5	Pittsburgh	Pa.	12
Chicago	Ill.	8	Spartanburg	S.C.	14
Robinson	Ill.	9	Sioux Falls	S.D.	17
Rockford	Ill.	10	Knoxville	Tenn.	14
Evansville	Ind.	8	Memphis	Tenn.	11
Indianapolis	Ind.	13	Nashville	Tenn.	13
Kansas City	Kans.	19	Amarillo	Tex.	8
Louisville	Ky.	6	Beaumont	Tex.	11
Paducah	Ky.	4	Corpus Christi	Tex.	10
Baton Rouge	La.	9	Dallas	Tex.	9
Lake Charles	La.	9	El Paso	Tex.	10
New Orleans	La.	10	Houston	Tex.	12
Baltimore	Md.	17	Tyler	Tex.	7
Bay City	Mich.	7	Salt Lake City	Utah	9
Detroit	Mich.	11	Richmond	Va.	14
Minneapolis	Minn.	16	Seattle	Wash.	10
Columbia	Mo.	16	Spokane	Wash.	7
Springfield	Mo.	18	Green Bay	Wis.	11
St. Louis	Mo.	8	Madison	Wis.	12
Greensboro	N.C.	13	Milwaukee	Wis.	9
Fargo	N.Dak.	14	Superior	Wis.	6
Omaha	Nebr.	21	Cheyenne	Wyo.	9

Source: GAO analysis of OPIS data.

Note: We studied the price relationship to the number of sellers at wholesale terminals in 78 cities throughout the United States. These cities reflect a broad geographic range of locations where gasoline is sold out of our data's nearly 400 wholesale terminal locations in the United States. Most cities had only 1 terminal, and we chose to examine only 1 terminal in the few cases where there was more than 1. The 82 cities we used in our analysis of branded gasoline were the same as for unbranded, but included Great Falls, Mont.; Bismarck/Mandan N.Dak.; Casper Wyo.; and Sinclair, Wyo.

As shown in figure 10, trends in refinery spot market concentration were fairly stable over time, and most markets remained either unconcentrated (below 1,000) or moderately concentrated (below 1,800), with the exception of New York Harbor and Alaska, which were both highly concentrated.

Figure 10: Yearly Concentration Levels in the Seven Spot Markets That We Analyzed



Source: GAO analysis of EIA data.

Source: GAO analysis of EIA data.

Note: We had data on market concentration up to 2006 and we extrapolated them to 2008. In addition, none of the terminals we studied were primarily served by the Chicago spot market, and we did not calculate concentration for this spot market.

Appendix V: GAO Contacts and Staff Acknowledgments

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Staff Acknowledgments

In addition to the individuals named above, Daniel Haas (Assistant Director), Shea Bader, Divya Bali, Frank Cook, Michael Kendix, Robert Marek, Michelle Munn, Alison O'Neill, Susan Offutt, Frank Rusco, Rebecca Sandulli, and Barbara Timmerman made important contributions to this report.