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An Empirical Test of Raising Rivals' Costs**

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# **Vertical Integration in Gasoline Supply: An Empirical Test of Raising Rivals' Costs**

**Justine Hastings and Richard Gilbert<sup>1</sup>**

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## **Abstract**

The “raising rivals’ costs” literature predicts that vertically integrated firms have an incentive to generate profits in downstream markets by increasing wholesale prices to competing retailers. We test this theory using data on wholesale gasoline prices. The 1997 acquisition of Unocal’s West Coast refining and marketing assets by Tosco Corporation generated discrete and differential changes in the extent of Tosco’s vertical integration into thirteen West Coast metropolitan areas. This event permits identification of the price effects of vertical integration, controlling for the effects of horizontal market structure, cost shocks and trends, and potentially confounding city-specific covariates. We find that Tosco increased the wholesale price of gasoline more in cities where it faced greater competition with independent retailers following the acquisition. These results are consistent with the strategic incentive to raise competitors’ input costs and show that the extent of a wholesaler’s vertical integration into downstream markets can have a significant impact on upstream market conduct.

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## I. Introduction

During the week of January 4-8, 1999, the average wholesale price of unbranded regular gasoline was 46.30 cents per gallon in Los Angeles, CA.<sup>2</sup> About 110 miles away, in Bakersfield, CA, the average price during the same week was about twelve cents higher, and in Houston, TX the price was about twelve cents lower.<sup>3</sup> Unbranded gasoline is a relatively homogenous product sold at wholesale in arms length transactions. Gasoline can be transported over large distances for a cost of 1-2 cents per gallon by pipeline or barge and can be moved by tanker truck over a distance of 100 miles for 2-3 cents per gallon.<sup>4</sup> Yet wholesale gasoline prices often vary across different locations by amounts that exceed transportation costs. Figure 1 shows statewide monthly average wholesale gasoline prices for January 2001. Weekly averages for different metropolitan areas show even greater dispersion. This study asks why substantial regional price differences can persist at the wholesale level and examines the consequences of vertical market structure for wholesale prices.

Regional differences in wholesale gasoline prices are often attributed to two factors: environmental regulations and wholesale market power. Environmental regulations require reformulated gasoline in areas that do not meet federal or state air quality standards. For example, all California markets require reformulated gasoline that meets the emissions specifications of the California Air Resources Board (CARB). These regulations increase the marginal cost of producing gasoline in California by an estimated 4-6 cents per gallon compared to conventional gasoline that can be sold in many other parts of the country.<sup>5</sup> This amount is substantial, but less than the price differential that

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<sup>2</sup> Gasoline is produced by a refiner and then transported to a wholesale distribution center called a distribution terminal or rack. Gasoline may be branded or unbranded. Vertically integrated refiners supply branded gasoline for distribution to their retail stations and may also supply unbranded gasoline for independent stations. Unintegrated refiners supply only unbranded gasoline. Unbranded gasoline may be sold only at independent (non-branded) stations. Branded gasoline typically contains additives that distinguish it from other types of gasoline and is sold to affiliated retailers under contractual terms that affect the wholesale price.

<sup>3</sup> Source: Wholesale Rack Data from Oil Price Information Service.

<sup>4</sup> Source: California Independent Marketers Association and Kinder Morgan Pipelines, LLP.

<sup>5</sup> Source: California Energy Commission.

often exists between California and other states with less stringent regulations. Moreover, there are large wholesale price differences between regions subject to the same regulations. For example, in the first week of September 1999, the average wholesale price of unbranded gasoline was 91 cents per gallon in Bakersfield and 72.65 cents in San Diego.<sup>6</sup> Both markets require reformulated gasoline that meets CARB specifications and both are located approximately 100 miles from refineries in Los Angeles.

A second factor that may contribute to wholesale price variation is market power at the refinery level. Producers may have the ability sustain price levels significantly above costs in markets where refining capacity is highly concentrated. However high levels of market concentration at the refinery are not indicative of the ability to maintain significant wholesale price differentials if third parties could acquire gasoline in low-priced markets and sell the gasoline in markets with high prices.

Vertical market structure is a third factor that may affect wholesale market prices. Arbitrage requires access to wholesale supply in low-priced markets and to independent retail outlets in high-priced markets. Thus the existence of independent retail outlets, which provide potential arbitragers with a market for lower cost wholesale gasoline, may be an important factor in explaining wholesale price differentials.

Vertical market structure can contribute to wholesale price differentials in another important respect. An integrated wholesale supplier competing with unintegrated rivals in the downstream (retail) market can increase its profits by raising wholesale prices to its downstream competitors. If retail prices are strategic complements, the cost-raising strategy will cause the rival retailer to increase its price, thereby increasing the integrated firm's profit.

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<sup>6</sup> Source: Oil Price Information Service. Bakersfield is located about 110 miles north of Los Angeles and San Diego is about 120 miles south of Los Angeles.

Thus, vertical market structure may be an important factor in explaining wholesale price variations for two reasons. First, the ability of third parties to arbitrage price differences is limited if the share of independent retailers is small. Second, vertical integration creates an incentive for integrated suppliers to raise wholesale prices to competing retailers as a means to increase profits in downstream markets. Wholesale prices have the most direct effect on independent dealers, who buy gasoline in arms-length transactions at distribution terminals. Thus we expect the presence of independent retailers to be a significant factor in the incentives for integrated suppliers to raise rivals' costs.<sup>7</sup>

This study analyzes the effects of vertical market structure on wholesale gasoline prices by using a unique and highly detailed data set of station-level vertical contract arrangements for retail stations in a broad panel of US metropolitan areas. Using variation in market structure generated by a wave of mergers during the 1990s, we test whether the extent of vertical integration into downstream markets varies positively with the price of unbranded wholesale gasoline. These unique micro data allow us to estimate the contribution of vertical integration to wholesale price variation in a panel of twenty-six metropolitan markets over the mid-1990s. We find that the extent of vertical integration is positively correlated with wholesale prices, controlling for measures of horizontal market structure. In our sample, in markets with few upstream suppliers, wholesale prices are an average of 2.74 cents per gallon higher when wholesaler's degree of integration into retail markets is above the median, rather than below it.

The broad panel offers a general perspective on the correlation of wholesale prices and market structure. It also documents, for the first time, the large variation in vertical market structure across US metropolitan areas. To gain a more detailed understanding of the effect of vertical market structure on wholesale prices, we focus on a particular event within the broad panel-- the acquisition of Unocal's West Coast refining and marketing assets by Tosco Corporation. This transaction generated discrete and differential changes

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<sup>7</sup> Note that both the raising rivals' costs and the arbitrage theories require market power at the refinery level to observe vertical market structure effects.

in Tosco's integration into thirteen West Coast metropolitan areas and provides a means to credibly identify the impact of vertical integration on wholesale price through the incentive to raise rival's costs. The Tosco acquisition allows us to control for other factors that might influence wholesale prices, such as cost shocks, changes in horizontal market structure, the market share of independent retailers, and any potentially confounding city-specific covariates.

According to the theory of raising rivals' costs, the effect of the Tosco acquisition on wholesale prices should depend on the extent of its competition with independent retailers. The incentive for a vertically integrated firm to charge a high wholesale price increases with the firm's share of retail sales and with the cross-elasticity of demand between the integrated firm and independent retailers. Using detailed station-level data for all thirteen metropolitan areas, we examine how Tosco's wholesale price changed with the change in competition with independent retailers resulting from the merger. We find relatively large increases in Tosco's wholesale prices in markets where its downstream competition with independents increased as a result of the merger. For example, Tosco's wholesale price in Los Angeles increased by 3.7 cents per gallon after the merger.

The paper proceeds in three sections. In the first section, we outline the profit maximizing incentive to increase input costs to downstream rivals and outline a set of testable hypotheses. The second section presents the empirical analysis of the effects of vertical integration on wholesale prices, first in the broad panel of US metropolitan areas, and then in the detailed case study of the Tosco Unocal merger. This section is followed by a conclusion.

## II. Theoretical Motivation

The theoretical industrial organization literature considers the incentives for a vertically integrated firm to increase the price of an intermediate good to its downstream rivals.<sup>8</sup> Suppose that downstream prices are strategic complements and upstream competition limits the ability of a vertically integrated upstream firm to extract all of the potential industry profit with its upstream price. Then, under certain conditions, the vertically integrated firm has an incentive to use its upstream price to raise the cost of its downstream rivals, because a higher cost leads to higher prices and profits in the downstream market.

As an illustration of the effects of vertical market structure on wholesale prices, consider a market with one integrated refiner-retailer and one independent retailer. Let  $i = 1, 2$  denote the vertically integrated refiner-retailer and the independent retailer, respectively. For simplicity, assume no direct costs of production and retailing and define:

$p_i$  = retail price for firm  $i$ .

$q_i$  = retail quantity sold by firm  $i$ .

$w$  = wholesale price.

The profits of the integrated firm and the independent retailer are

$$\begin{aligned}\pi_1 &= \max_{p_1, w} [p_1 q_1(p_1, p_2) + w q_2(p_1, p_2)] \\ \pi_2 &= \max_{p_2} [(p_2 - w) q_2(p_1, p_2)]\end{aligned}$$

The marginal benefit to the integrated firm from an increase in the wholesale price is (assuming that  $p_1$  is chosen optimally)

$$\frac{\partial \pi_1}{\partial w} = p_1 \frac{\partial q_1}{\partial p_2} \frac{\partial p_2}{\partial w} + \left[ q_2 + w \frac{\partial q_2}{\partial p_2} \frac{\partial p_2}{\partial w} \right]. \quad (1)$$

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<sup>8</sup> See, e.g., Williamson (1968), Salop and Scheffman (1987), Ordover, Saloner, and Salop (1990), and Riordan and Salop (1995).

Define  $\varepsilon_{12} \equiv \frac{\partial \ln q_1}{\partial \ln p_2}$  and re-write (1) as<sup>9</sup>

$$\frac{\partial \pi_1}{\partial w} = q_1 \left( \frac{p_1}{p_2} \right) \varepsilon_{12} \frac{\partial p_2}{\partial w} + \left[ q_2 + w \frac{\partial q_2}{\partial p_2} \frac{\partial p_2}{\partial w} \right]. \quad (2)$$

The term in brackets on the right is the first-order condition for the optimal choice of  $w$  for an unintegrated wholesale supplier. The other term is positive if  $\varepsilon_{12} > 0$  and

$\frac{\partial p_2}{\partial w} > 0$ , which are true under the usual assumptions. This term is the strategic incentive

to raise rivals' costs. The strategic incentive increases with  $q_1$  holding  $q_2$  constant and with  $\varepsilon_{12}$ . That is, the strategic incentive is relatively the share of retail sales sold by the integrated retailers is relatively large and when the cross-elasticity of demand between the integrated and independent retailers is large. The product of these two factors is the effect on the integrated firm's revenue from an increase in the downstream price of independent retailers.

Equation (2) identifies the incentive of a vertically integrated firm to choose a wholesale price that exceeds the level it would choose if it did not participate in the downstream market. The firm's ability to choose a higher price depends on its market power at the upstream level. If the upstream market were highly competitive, the wholesale price would be constrained by the actions of rival firms and the integrated firm would have little ability to raise its rivals' costs.

Thus, all else equal, we expect wholesale prices to be higher when:

- (i) integrated retailers account for a large volume of the refiner's total sales
- (ii) integrated and independent retailers are located in close proximity, so that the cross-elasticity of demand between them is large; and
- (iii) there is significant market power at the upstream, refinery level.<sup>10</sup>

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<sup>9</sup> If  $\frac{\partial(q_1 + q_2)}{\partial p_2} = 0$ , then  $\frac{\partial \pi_1}{\partial w} = (p_1 - w) \frac{\partial q_1}{\partial p_2} + q_2$ . The derivative is positive if  $p_1 > w$ , and the integrated

firm would have an incentive to increase  $w$  to foreclose its rival as noted by Salinger (1988). However, total demand should be elastic for a vertically integrated firm that competes with other firms.

In the empirical analysis that follows, we investigate whether wholesale prices for gasoline sold to independent retailers are higher in markets with these characteristics.

### **III. Empirical Analysis**

The empirical literature that deals with the effects of vertical market structure on firm conduct is sparse, and what little is available on this subject is confounded by product heterogeneity. Examples are Waterman and Weiss (1996), who examine the effects of ownership on carriage of premium cable channels (but not price) and Cuellar and Gertler (2000) who consider the effects of physician ownership on the cost of medical care. The gasoline industry has the advantage that the product is homogeneous within a particular grade, there is substantial variation in industry structure, and there is abundant price data.

We take two approaches to estimate the effect of market structure on wholesale prices. The first approach uses a broad panel of metropolitan areas in the mid-1990s. We exploit variation in market structures across markets and over time, largely as a consequence of industry merger activity. We find that the degree of vertical integration and measures of horizontal market concentration are positively correlated with wholesale prices. The second approach focuses on a specific transaction to credibly identify the effect of vertical integration and competition with independent retailers on wholesale prices. The transaction is Tosco Corporation's 1997 acquisition of Unocal's West Coast refining and marketing assets, which discretely and differentially affected Tosco's integration into a large number of markets. The acquisition allows us to better control for omitted variables, such as cost trends and shocks, which might bias estimation results in the broad panel analysis. We find that, controlling for market structure at the refinery level, Tosco's wholesale price of gasoline to independent retailers increased in proportion to the increase in Tosco's retail market share resulting from the merger, adjusted to account for

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<sup>10</sup> Equation (2) does not imply that a vertical merger necessarily increases wholesale prices. A vertical merger can reduce the integrated firm's retail price by eliminating double-marginalization. The lower price can reduce the derived demand for the upstream good and lead to a lower wholesale price. See McAfee (1999).

the proximity of its stations to independent retailers. The results suggest that the strategic incentive for vertically integrated firms to raise rivals' wholesale costs is a significant determinant of cross-sectional and inter-temporal price variation.

### **A. Empirical Analysis of a Panel of US Metropolitan Areas**

We analyze a panel of twenty-six U.S. metropolitan areas from January 1993 through June of 1997 to identify correlations between average unbranded wholesale prices and horizontal and vertical market structure.<sup>11</sup> Retail Census data from Whitney Leigh Corporation provide retail market structure and the share of vertically integrated firms for each of the twenty-six metropolitan areas in each year. The retail census includes the ownership and delivery type for each station and identifies each station's vertical relationship (if any) with an upstream refiner. Hence, the retail census data allow us to examine the degree of vertical integration of each of the upstream refiners selling unbranded gasoline to independent retailers in each metropolitan area. We identify stations that are owned by a refiner as vertically integrated stations, whether or not the retail price is set by the refiner or by a residual claimant.<sup>12</sup> Data on unbranded wholesale prices are from Lundberg Wholesale Price Reports, providing semi-monthly, average, unbranded wholesale prices for each metropolitan area. These average price data are coupled with data from Oil Price Information Service on the names of the companies supplying at each distribution rack during each time period. Thus the compiled data sets provide detailed information on the average unbranded wholesale price, the companies who are supplying unbranded gasoline at each rack, the retail market share of each company in each metropolitan area, and the market share of independent retailers who purchase unbranded gasoline at the rack.

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<sup>11</sup> The metropolitan areas are located in West Coast, Rocky Mountain, and Gulf Coast states.

<sup>12</sup> This assumption is consistent with the results in Hastings (2000), which show no significant difference in the pricing behavior between a refiner's directly operated stations and those operated by dealers. This result is also consistent with efficient contracting. The refiner can set a station-specific wholesale price based on the station's demand elasticity, and a station-specific lease rate with a volume discount to extract the retail rents. Hence the refiner's incentive to raise rival retailers' costs is similar for stations owned and operated by the refiner and for leased stations. See also Shepard (1990, 1993) and Blass and Carlton (1999).

## 1. Summary Statistics

Table 1 provides summary statistics for the market structure variables of interest. There is cross-sectional variation, as well as substantial inter-temporal variation generated by several mergers that occurred in the mid-1990s.<sup>13</sup> The degree of variation in each market structure variable is striking. All measures of vertical as well as horizontal concentration vary greatly across the city-time markets.

Table 2 presents the sample correlation between the market structure variables of interest. Note that measures of vertical and horizontal market structure variables are not highly collinear. In other words, market structures in the sample are not simply two extreme types: markets with high wholesale market concentration and very high degree of vertical integration, or markets with low wholesale market concentration and a small degree of vertical integration. This variation increases our ability to separate the correlations between wholesale prices and measures of horizontal and vertical concentration.

For example, in the third quarter of 1995, Albuquerque, New Mexico had a very concentrated upstream market and a small share of vertically integrated refiner-marketers. The distribution rack had only three refiners supplying unbranded wholesale product -- one vertically integrated with a downstream market share of about fifteen percent, and two unintegrated refiners. However, the independent retail market share was a relatively high twenty-seven percent. In the same quarter, New Orleans, Louisiana had a relatively unconcentrated upstream market and a small share of vertically integrated firms. Ten refiners supplied unbranded gasoline at the rack, eight of which were unintegrated, and the independent retail market share was about twenty-three percent. Seattle, Washington had a concentrated upstream market and a high share of vertically integrated firms. One integrated supplier and two unintegrated suppliers competed at the distribution rack, and the independent retail market share was only eight percent.

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<sup>13</sup> For example, Ultramar Diamond Shamrock, a refiner that was integrated in Gulf Coast markets, but not in others, purchased the independent retail chain Stop-N-Go. This merger affected markets in Petroleum Administration Defense Districts (PADDs) 3 and 4. Tosco, an unintegrated refiner, purchased British Petroleum's Pacific Northwest refining and marketing assets. Tosco also purchased Circle K, an unintegrated retailer in a number of Southwest gasoline markets. These mergers caused considerable variation in the horizontal and vertical market structure variables across the city-time units of observation.

## 2. Regression Analysis

Table 3 presents the data in cell means, which partition average prices according to different combinations of market structure characteristics. Each cell gives the average wholesale price of unbranded gasoline less the average spot price for crude oil for city-time observations that fall into that cell.<sup>14</sup> The cell means analysis allows us to examine the contribution of each market structure variable to wholesale price variation, holding other market structure variables constant. The data are grouped by combinations of high and low numbers of vertically integrated suppliers, high and low numbers of unintegrated suppliers, high and low market shares of independent retail marketers, and high and low average downstream market shares of the vertically integrated suppliers. For each variable, high and low are determined by above and below the median value in Table 1.<sup>15</sup> These prices are averaged over each quarter because the regressors change in discrete jumps, but are fairly constant relative to the wholesale price of gasoline over shorter time periods.

Patterns across cells indicate that the average wholesale price is positively correlated with the extent of vertical integration and horizontal concentration. For example, cell 5 (row 1 and column 2) shows the average price for city-quarters with the highest concentration values for all market structures. This cell is for city-quarters with few integrated wholesale suppliers, a large average downstream market share for the integrated suppliers, few unintegrated wholesale suppliers, and a small market share for independent retailers. It is also the cell with the highest wholesale price. Cell 12 (row 4 and column 3) is the cell for the least concentrated city-quarter markets. This cell has many integrated and unintegrated upstream suppliers, a large market share for independent retailers, and a low average downstream market share for the integrated refiners. This cell has the lowest

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<sup>14</sup> The crude price is the spot price at Cushing, Oklahoma provided by the Energy Information Administration. The dates for the crude oil prices were matched with the dates for the wholesale price observations. The crude oil price was then subtracted from the wholesale price in each metropolitan area, and those differences were averaged over each quarter in each metropolitan area to create the margins reported in the cell mean analysis.

<sup>15</sup> This selection is arbitrary, however it allows us to make some interesting comparisons.

average price. Moreover, the average margin (the difference between the wholesale price and the spot price of crude) in cell 5 is roughly twice the average margin in cell 12.

In addition, conditioned on vertical market structure, the average wholesale margin of gasoline in cells with fewer unintegrated suppliers is higher than in cells with many unintegrated suppliers. Margins also tend to be higher in markets that have few integrated suppliers, although the difference is significant only in markets that have many unintegrated suppliers. These observations support the conclusion that an increase in the number of upstream competitors is generally associated with a decrease in market price.

Holding horizontal market structure constant, the two downstream market structure variables (market share of independent retailers and the average downstream market share of vertically integrated wholesalers) display a systematic relationship. Cell means are lower in markets where a larger fraction of retailers are independent retailers, although the differences are not always statistically significant. Cell means are generally higher in markets where the integrated suppliers have a greater average downstream market share, conditioned on the other factors. This difference is pronounced in markets where integrated suppliers have the greatest ability to raise downstream rival's costs (markets where there is high upstream concentration). Comparing cells 1 and 5 (row 1, column 1 and 2 respectively) and cells 2 and 6 (row 2, column 1 and 2 respectively), we see that in markets where there are few upstream suppliers, the difference between the average price in cells with a large average downstream market share and those with a small one is large and significant. The difference between the prices in cells 1 and 5 is 2.74 cents per gallon, and is statistically significant at the seven percent level with an F value of 3.24.

The cell means suggest that a move to a small average downstream market share for integrated suppliers holding other factors constant (the movement from cell 5 to cell 1 for example) has a similar effect on the cell mean as increasing the number of unintegrated suppliers. For example, moving from cell 1 to 3 (column 1, row 1 and row 3

respectively), which corresponds to adding more unintegrated suppliers in a market where there are few independents and few integrated suppliers with a large average downstream market share, lowers the cell mean by 2.21 cents. The differences in cell means are significant at the ten-percent level. These patterns suggest that vertical market structure may have as significant an influence on wholesale prices as horizontal market structure.

A simple regression analysis is presented in Table 4. Column 2 includes city-specific fixed effects. The coefficients reflect the correlations in the cell means analysis. In Column 1, upstream concentration is positively correlated with price, for both unintegrated and integrated suppliers. One more supplier of either type is associated with a decrease in the average wholesale price. However this variable becomes insignificant when city fixed-effects are included. The market share of independents is also negatively correlated with price, but statistically insignificant when city-level fixed effects are included. The average downstream market share of the vertically integrated suppliers is positively correlated with wholesale price, and significant in both regressions. Large, discrete and differential changes in this variable from a series of mergers independently identify it from the city-level fixed effects. The coefficient implies that a one-percent increase in the average downstream market share of integrated wholesalers is associated with a wholesale price increase of 0.179 cents per gallon.

These results suggest that vertical market structure may significantly impact upstream conduct through the incentive to raise input costs to downstream competitors. However, we are careful not to interpret this relationship as causal. The identification of the parameters is generated primarily from variation in market structure caused by mergers, many of which affected only one or a few geographic areas. Such mergers may have coincided with market-specific cost shocks, causing both the merger and a subsequent increase in wholesale prices relative to other markets, which may lead to biased estimates. Moreover, the panel data may not differentiate the incentive to raise rival's costs from other possible causes for wholesale price variations that depend on vertical market structure, such as different conditions for arbitrage of wholesale price

differentials.<sup>16</sup> For these reasons, we focus on a single transaction that allows us to more credibly identify the effect of an increase in competition with downstream rivals on upstream price. This is Tosco's 1997 acquisition of Unocal's West Coast refining and retail assets. The acquisition affected a relatively large number of cities on the West Coast, generating discrete and differential increases in competition with independent retailers. In addition, we are able to use the wholesale price of gasoline in an unaffected metropolitan area to control for potentially confounding cost trends or shocks. Thus the acquisition provides a cleaner research design, allowing for a more precise identification of the impact of competition with rival retailers on wholesale prices through the incentive to raise rival's costs. We find that Tosco's post-acquisition wholesale price of unbranded gasoline increased proportionately to its increase in downstream competition with independent retailers resulting from the acquisition. This effect is consistent with a strategic incentive to raise rival's costs.

### **B. Empirical Analysis of the Tosco/Unocal Acquisition**

In November of 1996 Tosco and Unocal announced the proposed sale of Unocal's West Coast refining and marketing assets to Tosco. This included all of Unocal's refineries, all of their retail outlets, and the Union 76 logo in all West Coast metropolitan areas, along with Arizona and Nevada. The purchase was completed in April of 1997. Unocal's downstream retailers were almost exclusively integrated. Its downstream market share varied from two percent to eighteen percent of the total census of retail stations in the metropolitan areas affected by the transaction. Unocal sold unbranded gasoline at the distribution rack in some metropolitan areas, but in others it did not compete in the unbranded wholesale market. The acquisition increased concentration at the wholesale level and reduced the number of suppliers of unbranded gasoline in those metropolitan areas where Unocal had supplied unbranded gasoline at the distribution rack prior to the acquisition. However, in the metropolitan areas where Unocal did not supply unbranded gasoline at the distribution rack, wholesale concentration remained unchanged.

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<sup>16</sup> Some of the mergers were purely vertical (between a refiner and an independent retail chain), while others were horizontal, but resulted in a significant change in retail market share for one or more of the parties. In addition, in some cases, one of the merging refiners exited the wholesale market as a result of the merger.

Table 5 shows the markets that were affected by the purchase, with the corresponding changes in downstream market share and upstream concentration.

Before the acquisition of Unocal's West Coast assets, Tosco had a retail market presence in a few of the cities affected by the transaction. Its retail market share varied from zero to approximately forty percent. In the few cities where Tosco had a significant downstream market share, Unocal typically did not have a significant number of downstream outlets. Consequently, the acquisition had no significant impact on the horizontal structure of gasoline retailing. Tosco's downstream assets included the British Petroleum stations and the BP brand (Tosco purchased BP's Northwest refining and marketing assets in 1993) and the Circle K convenience store and gasoline station chain, which they acquired at the end of May 1996.<sup>17</sup> Tosco had few retail outlets relative to refining capacity in most areas, and sold wholesale gasoline to independent marketers in all of the thirteen metropolitan areas considered in this analysis.

The acquisition of Unocal's downstream assets by Tosco changed the downstream market share for Tosco by varying degrees across West Coast metropolitan areas. Some markets were practically unaffected by the merger, while in others Tosco experienced an increase in downstream market share of up to sixteen percent. We empirically test if the discrete changes in the degree of vertical integration were followed by changes in Tosco's wholesale prices for unbranded gasoline as predicted by the raising rivals' costs model. In particular, we use the variation in the degree of vertical integration resulting from the acquisition to test if Tosco's wholesale price is increasing in its downstream market share and degree of competition with independent retailers, controlling for variations in costs and horizontal market structure.

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<sup>17</sup> The BP acquisition affected fewer markets than did the Unocal-Tosco merger. In addition, Tosco did not supply wholesale product in many of the affected markets prior to the merger with BP. Hence, many of these markets do not permit examination of the effects of vertical integration on Tosco's wholesale price. The vertical merger with Circle K provides an interesting opportunity to look at raising rival's costs in a purely vertical merger, however the timing coincided with the requirement of California Air Resources Board (CARB) reformulated gasoline. Hence, even though we found a discrete jump in wholesale price in affected markets after the vertical merger, this cannot be independently identified from a city-specific CARB regulation effect.

## 1. Data

Retail census data, available annually from Whitney Leigh Corporation, provide detailed characteristics and locations of every retail gasoline station in each metropolitan area. The data include each station's delivery and ownership type. This variable determines the station's relationship (if any) with the upstream refiner. It is used to construct measures of vertical integration as described in Section III.A. The retail census data reported in Table 5 provide a measure of the change in Tosco's downstream market share in each metropolitan area as result of the acquisition of Unocal's retail outlets. Detailed wholesale rack price data from Oil Price Information Service provide weekly average unbranded wholesale gasoline prices by supplier for each distribution rack. The price data are for the period July 1996 through December 1998, providing weekly observations on Tosco's average price for unbranded gasoline at each distribution rack for about one year before and a year and a half after the merger.

The model in section II predicts that the strategic incentive to raise rivals' costs is an increasing function of the degree of downstream competition as measured by the cross-price elasticity between the vertically integrated and rival retail stations. Because retail gasoline stations are geographically differentiated products, geographic proximity to rival retailers is a good measure of the degree of downstream competition.<sup>18</sup> We focus on the proximity of Tosco's post-acquisition retail stations to independent retailers because the wholesale price of unbranded gasoline directly impacts their operating costs. The detailed Whitney Leigh data make it possible to estimate the change in downstream competition with independent retailers by examining the geographic proximity of Tosco's post-acquisition stations to independent retailers.

Using the detailed retail census data, we construct a variable, which we call "downstream market contact", that provides an approximation for the degree of competition between the Tosco's integrated retail outlets and the independent retailers. This is done by

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<sup>18</sup> See Slade (1986,1992), Karrenbrock (1991), Borenstein and Shepard (1996a,b), Borenstein, Cameron, and Gilbert (1997), Blass and Carlton (1999), Hastings (2000), and Noel (2001) for analyses of spatial competition among gasoline retailers.

weighting the increase in the downstream market share from the acquisition of Unocal retail outlets by the percent of those outlets that are geographically located within one mile of an independent retailer.<sup>19</sup> This variable provides a better approximation of Tosco's post-merger incentive to increase wholesale prices than a simple measure of downstream market share, because there is no incentive to raise rival's costs if the cross-price elasticity between the Unocal stations and independent stations is zero. The cross-price elasticity would be zero if integrated and independent stations were located in geographically different markets. If most Unocal stations had an independent retailer as a close competitor before the acquisition, an increase in downstream market share from the Unocal purchase should have a significant impact on Tosco's wholesale price strategy. On the other hand, if most of the Unocal stations in a metropolitan area were geographically isolated from independent retailers, an increase in downstream market share from the Unocal purchase might not affect Tosco's optimal wholesale price at all.

For example, Table 5 indicates that Tosco's acquisition of Unocal's retail assets increased its share of retail stations in Fresno by 10 percentage points. By mapping Unocal and independent stations in Fresno, we discover that 57% of the Unocal stations were located within a mile of an independent retailer.<sup>20</sup> These stations should have relatively high cross-price elasticity with rival independent retailers, and according to the model outlined earlier, Tosco could increase retail profits at these stations by increasing input costs to the independents. The remaining acquired Unocal stations were geographically isolated from independent retailers, and hence increasing wholesale prices to independents should have a minimal effect on retail profits at these stations. Thus, in Fresno we estimate that Tosco's downstream market contact with independents increased by 5.7 percentage points. By creating this variable for Tosco's retail outlets both before and after the acquisition we can test if Tosco's wholesale price is positively impacted by this measure of downstream market competition with independents, as predicted by the raising rivals' costs model.

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<sup>19</sup> See Hastings (2000) for an analysis of the extent of geographic competition for retail gasoline stations in Southern California.

<sup>20</sup> Approximately 20 percent of the stations in the Fresno retail census were independent retailers.

In addition, in order to identify the effect of downstream competition with independent retailers on wholesale prices, we need to control for any changes in the cost of producing wholesale gasoline. Failing to control for production costs, which vary over this time period, may inhibit the identification of the key parameters of interest. We use Tosco's wholesale price of gasoline in Phoenix as an approximation of cost variables because Phoenix experienced no change in upstream or downstream market structure during the time period considered and, in particular, was not affected by the Unocal acquisition.<sup>21</sup> In addition, terminals in Phoenix receive almost all of their gasoline via common carrier pipeline from refineries in Los Angeles. Therefore, the Phoenix wholesale prices provide a better approximation of the panoply of cost factors that impact wholesale prices in interconnected West Coast markets than do crude oil prices. We use the price in Phoenix to control for costs in two ways. The regressions are run with the wholesale price in Phoenix as a regressor and with the wholesale price in Phoenix subtracted from the dependent variable. Both specifications are presented, and the parameters of interest are not statistically significantly different across these two specifications.

## 2. Empirical Specification and Results

We estimate the following regression equation to determine the effect of changes in downstream contact with independent retailers, upstream concentration, and the market share of independent retailers on Tosco's wholesale price (using the price in Phoenix as a control for costs). The changes in downstream competition with independents allow us to identify the strategic incentive to raise rival's cost separately from measures of upstream concentration, downstream concentration, and any city-specific covariates.

The regression is specified as follows:

$$p_{it} = \mu + \alpha_{it} + \beta d_{it} + \gamma u_{it} + \delta r_{it} + \varepsilon_{it}$$

$$\varepsilon_{it} = \rho \varepsilon_{i,t-1} + \xi_{it}$$

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<sup>21</sup> Only 3.5 percent of the stations in Phoenix are independent marketers. So even though Tosco's retail market share in Phoenix increased by 2 percent following the merger, its downstream contact with independent retailers did not increase at all.

where:

$p_{it}$  = Tosco's weekly average wholesale price of unbranded gasoline in city  $i$  (less the price in Phoenix in week  $t$ )

$\alpha_{it}$  = city-specific error component, fixed or random effect specification

$d_{it}$  = downstream market contact with rival independents in city  $i$  in week  $t$

$u_{it}$  = number of refiners selling unbranded gasoline in city  $i$  in week  $t$

$r_{it}$  = percent of stations that are independent retailers in city  $i$  in week  $t$

$\varepsilon_{it}$  = autoregressive error component

$\xi_{it}$  = white noise error term

The number of refiners selling unbranded gasoline is a variable that counts suppliers who posted prices at each distribution rack in each time period. There is some inter-temporal variation in this variable in many of the metropolitan areas. Some variation was due to the post-acquisition exit of Unocal from the markets where it supplied unbranded gasoline. Other variation comes from periodic entry or exit by refiners at each rack. For example, in 1998, after Shell and Texaco formed the Equilon joint venture, Texaco ceased selling unbranded gasoline in many markets where the combined firms had a significant downstream market share. This provides further variation in the number of upstream competitors over our sample period.

The error component has an autoregressive structure to capture the dynamic effect of gasoline prices. A Dickey-Fuller test rejected the hypothesis of a unit root in the wholesale price time series for each of the cities included in the regression.<sup>22</sup> In addition, the specification of an autoregressive error structure is not rejected in favor of capturing the dynamic effect with a lagged price value on the right-hand side. The error structure also has a city-specific component. A Hausman test rejects the random effects specification in favor of a fixed-effects specification, with a p-value of 0.05.<sup>23</sup>

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<sup>22</sup> This test was also performed on the wholesale price in each city less the price in Phoenix, and again the test rejected the hypothesis of a unit root.

<sup>23</sup> See Hausman and Taylor (1981).

Table 6 presents regression results. The first specification includes city-specific fixed effects and the downstream market contact variable. The variation in downstream market contact resulting from the merger allows us to separately identify the price effect of this variable from the city-level fixed effects and the other covariates included in the regression. The regression results indicate that a higher degree of downstream contact with independent retailers is associated with a higher price for unbranded gasoline.<sup>24</sup> For example, the spot estimate in the fixed-effects specification implies that for every one percent increase in the percentage of stations in direct competition with an independent retailer, the weekly average unbranded gasoline price rises by 0.44 cents per gallon. Consistent with our model, an increase in downstream market contact with rival independent firms increases the strategic incentive to raise rival's costs. The estimates imply that in Los Angeles, for example, where the acquisition of Unocal's retail assets increased the share of integrated stations that compete with rival independents and hence increased Tosco's incentive to raise rival's costs by 8.33, the estimated price increase is 3.7 cents per gallon.

In the fixed-effects specification in Table 6, the coefficients on the number of upstream competitors and the market share of independents are not significantly different from zero. However, the coefficient on the number of upstream competitors is significant in the random-effects specification presented in the second column. This specification assumes that the conditional mean of the city-specific error component is the same across all cities. The coefficient on the number of upstream competitors is negative, and would indicate that one less wholesale supplier of unbranded gasoline would lead to a 0.403-percent increase in the average wholesale price.<sup>25</sup> This parameter estimate is consistent with the expected price effect of an increase in horizontal concentration. Metropolitan areas

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<sup>24</sup> The same regression specification was run with just the downstream market share variable instead of downstream market contact. The results do not change significantly between the two specifications.

<sup>25</sup> In an alternative specification, we constructed the refiner HHI for markets defined by refinery assets rather than by the number of suppliers at metropolitan area distribution terminals. These refinery markets are the Seattle refinery system, the Northern California refinery system, and the Southern California refinery system. Each refiner's share was calculated as its share of total refining capacity in the system. The HHI was used instead of the number of upstream competitors. The coefficient on HHI was not significant in any specification. Using the HHI instead of the number of upstream competitors did not change the estimate on the downstream market contact variable.

where the acquisition caused both an increase in the downstream contact with rival independents and an increase in concentration would experience higher wholesale prices from both the vertical and horizontal effects of the merger. When the city-level fixed effects are included, the coefficient on upstream competitors becomes insignificant, probably because there is not sufficient variation in this regressor in some metropolitan areas to separately identify the change in upstream concentration from a fixed-effect. The coefficient on the market share of independent retail marketers is not statistically significant in either error component specification.

Table 7 shows regression results when the wholesale price in Phoenix is included on the right-hand side, instead of subtracted from the dependent variable. The coefficient on Phoenix is 0.952 for the random-effects specification, and 0.945 for the fixed-effects specification. The coefficient on Phoenix and the adjusted R-squared from the regression illustrate that Tosco's wholesale price in Phoenix is a very good approximation for the cost of gasoline in the other metropolitan areas. The coefficient is significantly different from one in both columns however the estimated coefficients on the variables of interest do not change significantly from Table 6 to Table 7.

The results in Tables 6 and 7 imply that an integrated refiner's price for unbranded wholesale gasoline is an increasing function of its competition with rival independent retailers. The coefficient on the degree of downstream competition with rivals is identified mainly by the inter-temporal and cross-sectional variation generated by Tosco's purchase of Unocal's retail assets. Since this event differentially affected each metropolitan area at one discrete point in time, we can also estimate the event's price effect in each metropolitan area and examine how those changes in average prices vary with the increase in downstream contact with independent retailers. The price increase in each metropolitan area should be an increasing function of the change in downstream contact with independent retailers, and the estimated coefficient should be approximately the same as the coefficient presented in Table 6.

Figure 3 presents a scatter plot of the estimated price increase in each metropolitan area following the Unocal purchase against the increase in downstream competition with rival independent retailers. Replacing the downstream contact variable in Column 1 of Table 6 with indicators for each metropolitan area for the time period after the Unocal purchase generates the estimated price increases in Figure 3. These estimated price increases are then plotted against the increase in downstream market contact with independent retailers. Table 8 presents the slope coefficient for the OLS regression of the estimated price change on the change in downstream contact with independents. The coefficient on the downstream market contact variable is 0.3634 and is significant at the one-percent level. This coefficient is statistically indistinguishable from those in Table 6. Hence, the results again suggest that an integrated refiner's unbranded wholesale price is an increasing function of the degree of competition with independent retailers, as predicted by the raising rivals' cost model.

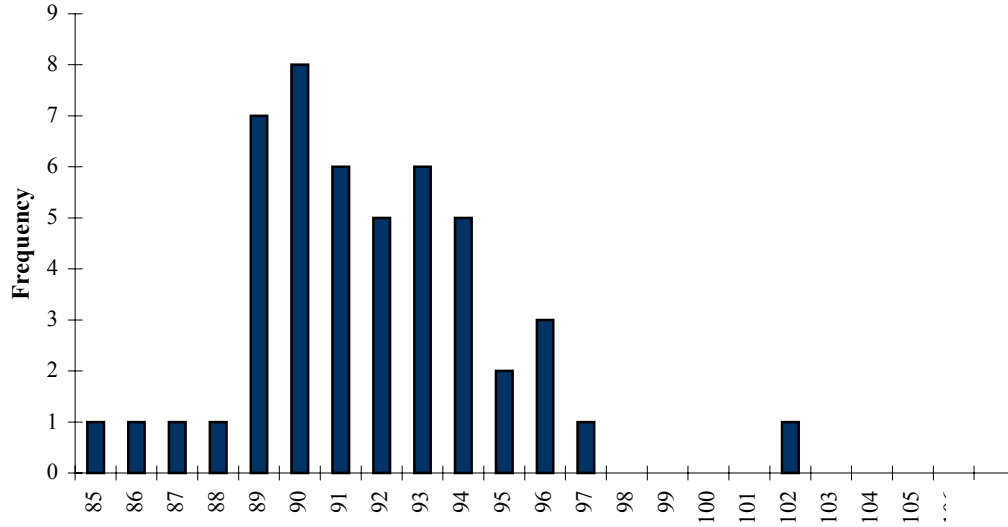
#### **IV. Conclusion**

We empirically examine the relationship of vertical and horizontal market structure to wholesale prices for unbranded gasoline. Using variation across twenty-six U.S. metropolitan areas and over time generated by a merger wave during the 1990s, we establish that the extent of vertical integration is positively correlated with wholesale prices. We then focus on the 1997 acquisition by Tosco of Unocal's West Coast refining and retail assets to more credibly identify a causal relationship between vertical market structure and upstream conduct. The acquisition allows us to examine the reaction of Tosco's wholesale prices in thirteen metropolitan areas to differential increases in competition with independent retailers resulting from the merger, while controlling for potentially confounding cost shocks and trends, as well as any city-specific covariates. We find that the degree of competition with independent retailers has significant and positive impacts on the integrated firm's wholesale prices. This result is consistent with a model of raising rival's costs.

This empirical analysis demonstrates that mergers in the gasoline industry that increase the extent of vertical integration may lead to an increase in wholesale prices as a

consequence of the incentive to raise rivals' costs. The incentive to raise input costs to rivals adds a potentially significant competitive effect that arises from changes in vertical structure, even for mergers that may be characterized as primarily horizontal. Antitrust policy has traditionally focused on measures of horizontal concentration to estimate a merger's effect on conduct and competition. Our empirical analysis confirms that increases in horizontal concentration in the gasoline industry can enhance the ability and incentive to exercise market power. Our analysis also suggests that changes in vertical market structure can have substantial impacts on wholesale prices, and that an analysis of a merger's effect on the exercise of market power should consider the potential effects of changes in vertical integration as well horizontal market structure.

**Figure 1: Histogram of State Average Wholesale Prices, January 2001**



**State Average Wholesale Price in Cents per Gallon, January 2001**

Source: Energy Information Administration

\*Right hand side outlier is Minnesota.

Table 1: Summary Statistics of Market Concentration and Vertical Integration Variables for the Entire Panel of Data

	Mean	Standard Deviation	Maximum	75 <sup>th</sup> Percentile	Median	25 <sup>th</sup> Percentile	Minimum
Percent of Stations that are Vertically Integrated*	0.49	0.13	0.84	0.58	0.47	0.39	0.27
Percent of Stations that are Independent Retailers	0.21	0.085	0.44	0.27	0.20	0.16	0.02
Number of Vertically integrated Wholesalers	2.18	1.05	5.00	3.00	2.00	2.00	0.00
Number of Unintegrated Wholesalers	2.45	1.84	9.00	3.00	2.00	1.00	0.00
Average Downstream Market Share for Integrated Suppliers**	0.10	0.05	0.39	0.12	0.09	0.07	0.01
Maximum Downstream Market Share of Integrated Suppliers	0.14	0.07	0.47	0.16	0.13	0.09	0.01

\*Percent of Stations of vertically integrated stations is defined as the number of company-owned stations in the retail census divided by the total number of stations in the retail census, for each metropolitan area.

\*\*Downstream Market share for an integrated supplier is defined as the number of integrated stations in the retail census that the refiner owns, divided by the total number of stations in the retail census, for each metropolitan area.

Table 2: Correlation Coefficients for Upstream and Downstream Market Variables for Broad Panel Regression

	Percent Vertically Integrated Retailers	Percent Independent Retailers	Number of Unintegrated Refiners	Number of Vertically Integrated Refiners	Average Downstream Market share for Integrated Suppliers	Maximum Downstream Market share of Integrated Suppliers
Percent Vertically Integrated Retailers*	1.00	-0.50	0.33	0.14	-0.15	0.12
Percent Independent Retailers	-0.50	1.00	0.24	-0.08	-0.14	-0.28
Number of Unintegrated Refiners	0.33	0.24	1.00	-0.08	-0.09	-0.12
Number of Vertically Integrated Refiners	0.14	-0.08	-0.08	1.00	-0.22	0.14
Average Downstream Market Share for Integrated Suppliers**	-0.15	-0.14	-0.09	-0.22	1.00	0.83
Maximum Downstream Market Share of Integrated Suppliers	0.12	-0.28	-0.12	0.14	0.83	1.00

\* Percent of Stations of vertically integrated stations is defined as the number of company-owned stations in the retail census divided by the total number of stations in the retail census, for each metropolitan area.

\*\* Downstream Market share for an integrated supplier is defined as the number of integrated stations in the retail census that the refiner owns, divided by the total number of stations in the retail census, for each metropolitan area.

Table 3: Cell Means by Combinations of Market Structure Variables

Dependent Variable: Quarterly average price of unbranded wholesale gasoline by rack less the spot price of crude oil<sup>1</sup>

		Few Integrated Suppliers		Many Integrated Suppliers	
		Small Downstream Market Share <sup>1</sup>	Large Downstream Market Share <sup>2</sup>	Small Downstream Market Share	Large Downstream Market Share
Few Unintegrated Suppliers	Few Independent Retailers <sup>2</sup>	19.75 (1.02)	22.49 (1.13)	20.70 (1.40)	22.22 (1.54)
	Many Independent Retailers <sup>3</sup>	18.33 (2.36)	22.29 (2.36)	17.31 (0.96)	18.65 (2.59)
Many Unintegrated Suppliers	Few Independent Retailers	17.54 (0.86)	19.29 (0.88)	13.10 (1.11)	13.19 (1.09)
	Many Independent Retailers	15.30 (0.71)	16.27 (0.66)	11.61 (1.29)	14.38 (1.40)

<sup>1</sup> Standard errors in parentheses.

<sup>1</sup> Average downstream market share of the vertically integrated suppliers.

<sup>2</sup> Measured by share of all retail outlets.

Table 4: Broad Panel Regression Results

Dependent Variable: Quarterly average unbranded wholesale price by metropolitan area, less the spot price of crude oil

	(1) OLS with Robust Standard Errors*	(2) City-Specific Fixed-Effects Regression
Intercept	22.56 (1.118)	21.770 (3.123)
Number of Vertically Integrated Suppliers	-1.588 (0.244)	-0.117 (0.381)
Number of Unintegrated Suppliers	-1.006 (0.152)	-0.429 (0.334)
Average Downstream Market share for Integrated Suppliers	12.309 (5.613)	17.902 (7.896)
Market Share of Independent Retailers	-6.485 (3.512)	-1.786 (5.204)
California Reformulated Gasoline Requirement	5.782 (1.055)	6.328 (0.874)
Adjusted R-Square	0.287	0.460
Number of Observations	N=26 T=18	N=26 T=18

Standard Errors in parentheses.

\*Newey-West standard errors are reported, correcting for serial correlation and heteroskedasticity. First order autocovariances for the wholesale margin time series were insignificant in each metropolitan area. Second order autocovariances were negative and significant, but small, in a few of the metropolitan area time series. Higher order autocovariances were all insignificant.

Table 5: Characteristics of Markets affected by Tosco-Unocal Merger  
Downstream Market Share is measured as percent of total stations in the metropolitan area

Distribution Rack	Tosco's Pre-Merger Downstream Market Share	Unocal's Pre-Merger Downstream Market Share	Tosco's Post-Merger Downstream Market Share	Change in Downstream Market Share Times Percent of Stations within a Mile of an Independent	Unocal Competed with Tosco at the Distribution Rack
San Jose	0.00	0.15	0.15	5.56	
San Francisco	0.08	0.07	0.15	3.32	
Fresno	0.01	0.11	0.12	5.69	Yes
Los Angeles	0.02	0.16	0.18	8.33	Yes
Sacramento	0.06	0.08	0.14	2.77	Yes
San Diego	0.03	0.11	0.14	4.40	Yes
Stockton	0.03	0.07	0.11	3.47	Yes
Santa Barbara	0.01	0.19	0.20	9.12	
Phoenix	0.29	0.02	0.31	0.00	
Tucson	0.39	0.06	0.45	0.66	
Reno	0.00	0.08	0.08	4.20	Yes
Las Vegas	0.06	0.05	0.11	0.51	
Seattle	0.22	0.02	0.24	0.10	
Portland	0.13	0.05	0.18	1.11	

Table 6: Regression of Effects of Raising Rival's Costs

Dependent Variable: Weekly average unbranded wholesale rack price for Tosco less the rack price in Phoenix.

	<i>Fixed Effects</i>	<i>Random Effects</i>
	Parameter Estimate	Parameter Estimate
Intercept	-2.95 (0.484) [0.000]	-0.572 (1.365) [0.675]
Downstream Market Contact with Independent Retailers	0.445 (0.089) [0.000]	0.369 (0.080) [0.000]
Number of Wholesale Suppliers	-0.083 (0.278) [0.766]	-0.403 (0.203) [0.048]
Market Share of Independent Retailers	0.129 (0.166) [0.437]	0.084 (0.059) [0.156]
Autocorrelation Coefficient	0.824	0.824
Adjusted R-squared:	0.814	0.237
Hausman Test: $\chi^2 = 7.83$ Prob. > $\chi^2 = 0.0497$		
Number of Observations	N=12 T=128	

Standard Errors in parentheses. P-Values in brackets.

Table 7: Regression of Effects of Raising Rival's Costs  
 Dependent Variable: Weekly average unbranded wholesale rack price for Tosco

	<i>Fixed Effects</i>	<i>Random Effects</i>
	Parameter Estimate	Parameter Estimate
Intercept	-0.041 (0.487) [0.933]	2.475 (1.565) [0.114]
Tosco's Unbranded Wholesale Price in Phoenix	0.945 (0.012) [0.000]	0.952 (0.012) [0.000]
Downstream Market Contact with Independent Retailers	0.372 (0.090) [0.000]	0.296 (0.082) [0.000]
Number of Wholesale Suppliers	-0.010 (0.278) [0.971]	-0.378 (0.203) [0.062]
Market Share of Independent Retailers	0.177 (0.166) [0.288]	0.094 (0.059) [0.110]
Autocorrelation Coefficient	0.827	0.827
Adjusted R-squared:	0.982	0.926
Hausman Test: $\chi^2 = 16.01$ Prob. $> \chi^2 = 0.0030$		
Number of Observations	N=12 T=128	

Standard Errors in parentheses. P-Values in brackets.

Figure 3: Scatter Plot of Estimate Price Increase in Each Metropolitan Area Following Purchase, Against the Increase in Retail Market Share Weighted by Proximity to Independent Retailers

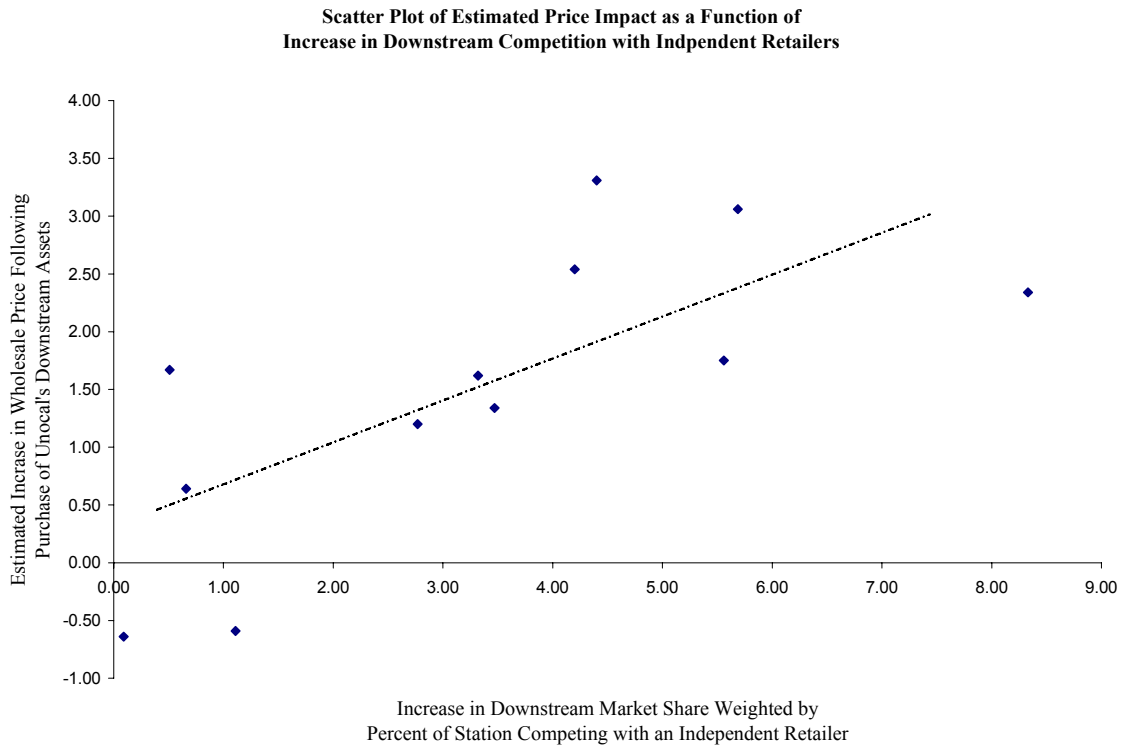


Table 8: Ordinary Least Squares Regression of Scatter Plot in Figure 3

	Parameter Estimate	Standard Deviation	T-Statistic	P-Value
Intercept	0.3055	0.4551	0.6713	0.5172
Downstream Market Contact with Independent Retailers	0.3634	0.1108	3.2786	0.0083
Adjusted R-Square = 0.4699				
N = 12				
F = 10.71				
Probability > F = 0.008				

## Bibliography

Blass, Asher and Dennis Carlton (1999), "The Choice of Organizational Form in Gasoline Retailing and the Costs of Laws Limiting That Choice," National Bureau of Economic Research Working Paper No. 7435 (December).

Borenstein, Severin Colin Cameron and Richard Gilbert (1997), "Do Gasoline Prices Respond Asymmetrically to Crude Oil price Changes?," Quarterly Journal of Economics, Vol. 112, no. 1 (February), pp. 306-339.

Borenstein, Severin and Andrea Shepard (1996a), "Dynamic Pricing in Retail Gasoline Markets," RAND Journal of Economics, Vol. 27, no. 3 (Autumn), pp.429-251.

Borenstein, Severin and Andrea Shepard (1996b), "Sticky Prices, Inventories, and Market Power in Wholesale Gasoline Markets," National Bureau of Economic Research Working Paper No. 5468.

Chouinard, Hayley and Jeffrey Perloff (2001), "Gasoline Price Differences: Taxes, Pollution Regulations, Mergers, Market Power, and Market Conditions," University of California Working Paper, August.

Cuellar, Alison and Paul Gertler (2000), "Physician-Hospital Vertical Integration," University of California at Berkeley Working Paper.

Hastings, Justine (2001), "Vertical Relationships and Competition in Retail Gasoline Markets: Empirical Evidence from Contract Changes in Southern California," University of California Energy Institute Power Working Paper, PWP-075.

Hausman J. and W. Taylor (1981), "Panel Data and Unobservable Individual Effects," Econometrica, Vol. 49, pp. 1377-1398.

Karrenbrock, Jeffrey D. (1991), "The Behavior of Retail Gasoline Prices: Symmetric or Not?" Federal Reserve Bank of St. Lewis Review, Vol. 73 (July/August), pp.19-29.

McAfee, R. Preston (1999), "The Effects of Vertical Integration on Competing Input Suppliers," Federal Reserve Bank of Cleveland Economic Review, Vol. 35 no. 1, pp. 2-8.

Noel, Michael (2001), "Edgeworth Cycles, Cost-Based Pricing and Sticky Pricing in Retail Gasoline Markets," MIT Working Paper (November).

Ordover, Januzs A., Garth Saloner, and Steven C. Salop (1990), "Equilibrium Vertical Foreclosure," American Economic Review, Vol. 80, pp. 127-142.

Riordan, Michael H. and Steven C. Salop (1995), "Evaluating Vertical Mergers: A Post-Chicago Approach," Antitrust Law Journal, Vol. 63, Issue 2, pp. 513-568.

Salinger, Michael A. (1988), "Vertical Mergers and Market Foreclosure," Quarterly Journal of Economics, Vol. 103, pp. 345-356.

- Salop, Steven C. and David T. Scheffman (1987), "Cost-Raising Strategies," Journal of Industrial Economics, Vol. 36 no. 1, pp. 19-34.
- Shepard, Andrea (1990), "Pricing Behavior and Contracts in Retail Markets," American Economic Review, Vol. 80 no. 2 (May), pp.427-431.
- Shepard, Andrea (1991), "Price Discrimination and Retail Configuration," Journal of Political Economy, Vol. 99 no. 1 (February), pp. 30-53.
- Shepard, Andrea (1993), "Contractual Form, Retail Price, and Asset Characteristics in Gasoline Retailing," Rand Journal of Economics, Vol. 24 no. 1 (Spring), pp.58-77.
- Slade, Margaret E. (1986), "Exogeneity Tests of Market Boundaries Applied to Petroleum Products," Journal of Industrial Economics, Vol. 34 no. 3 (March), pp. 291-303.
- Slade, Margaret E. (1986), "Conjectures, Firm Characteristics, and Market Structure: An Empirical Assessment," International Journal of Industrial Organization, Vol. 4 no. 4 (December), pp. 347-369.
- Slade, Margaret E. (1987), "Interfirm Rivalry in a Repeated Game: An Empirical Test of Tacit Collusion," Journal of Industrial Economics, Vol. 35 no. 4 (June), pp.499-515.
- Slade, Margaret E. (1992), "Vancouver's Gasoline-Price Wars: An Empirical Exercise in Uncovering Supergame Strategies," Review of Economic Studies, Vol. 59 no. 2 (April), pp. 257-76.
- Slade, Margaret E. (1995), "Empirical Games: The Oligopoly Case," Canadian Journal of Economics, Vol. 28 no. 2 (May), pp. 368-402.
- Slade, Margaret E. (1996), "Multitask Agency and Contract Choice: An Empirical Exploration," International Economic Review, Vol. 37 no. 2 (May), pp. 465-486.
- Slade, Margaret E. (1998), "Strategic Motives for Vertical Separation: Evidence from Retail Gasoline Markets," Journal of Law, Economics, and Organization, Vol. 14 no. 1 (April), pp. 84-113.
- Waterman, David and Andrew A. Weiss (1996), "The Effects of Vertical Integration Between Cable Television Systems and Pay Cable Networks," Journal of Econometrics, Vol. 72, pp. 357-395.
- Williamson, Oliver (1968), "Wage Rates as a Barrier to Entry: The Pennington Case in Perspective," Quarterly Journal of Economics, Vol. 82, pp. 85-116.