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Vertical Relationships and Competition in Retail Gasoline Markets: An Empirical Study of the Divorcement Issue in Southern California

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Abstract

This study examines how much, if any, of retail gasoline price differentials between markets is attributable to differences in the composition of vertical contract types at gasoline stations in each market. The empirical analysis uses retail station level panel data for the Los Angeles and San Diego metropolitan areas to determine the effects of discrete changes in i) the number of independent gasoline stations and ii) the number of vertically integrated branded stations on local retail gasoline prices. The purchase of the independent retail gasoline chain, Thrifty, by ARCO provides a unique opportunity to examine the effects of changes in different vertical contract types on local retail prices. The independent stations were changed to branded stations with different contractual forms, allowing a comparison between the price changes at stations affected by a change in market composition and those who experienced no such change, controlling for station-specific fixed-effects and city-time effects. Results for San Diego and Los Angeles metropolitan areas indicate that a decrease in the number of independent stations in a market has a positive impact on local retail price. However, a change in the number of totally vertically integrated branded stations does not have a significant impact on local market price.

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I. Introduction

Over the past few years, West Coast cities have experienced substantially higher retail gasoline prices than other regions of the country. For example, for the first week of August 1999, the price of reformulated gasoline in California was 39.6 cents higher than the average price in Gulf Coast States (about 10 cents of this difference can be attributed to higher taxes in California)[1]. In addition gasoline prices vary greatly between West Coast cities. Residents in San Diego have paid a consistent 5-15 cents more per gallon, on average, than Los Angeles residents. These recent price phenomena have sparked intense political debate over the causes of persistent price disparities, which have been attributed to an apparent lack of competition. Much of the debate is centered around the effect of vertical contracts between refiners and retail stations on retail competition and price levels.

Industry trade organizations, politicians, and consumer groups have noted corresponding increases in the number of fully vertically integrated gasoline stations in cities experiencing higher citywide average prices. Because of this correlation, some form of divorcement legislation or ordinance has been considered in most West Coast cities, as well as at the state level in California and Arizona. Divorcement legislation prohibits or restricts the number of stations that a refiner can own and operate directly. Proponents of divorcement argue that higher concentration of vertically integrated stations lessens competition between refiners and increases their market power since the refiner directly sets the retail price at this type of station. The fully vertically integrated station is usually referred to as a company-operated (company-op) station. Divorcement would require the refiner to convert these stations to lessee-dealer stations, or open dealer stations where a dealer sets the retail price, but is required to pay the refiner's wholesale price, under the assumption that this would result in a lower, more competitive market price.

Another explanation that has not received much attention claims that the recent decrease in the number of independent, unbranded retailers has lessened competition, since these stations typically compete on price rather than product differentiation.

[1] Source: Energy Information Administration, and California Energy Commission.

Independent stations are completely independent from the refiner in that the gasoline dealer owns the station, and sells "unbranded" gasoline. The fact that the gasoline is unbranded allows the dealer to purchase the lowest price wholesale gasoline available. They are not under contract to sell any particular brand of gasoline or purchase from any given refiner, but cannot post a refiner's brand name on their station. The unbranded station therefore competes with other stations by offering the lowest price gasoline. When these stations are replaced by branded stations (or exit the market), price competition in the market may be softened, resulting in a higher equilibrium price.

This paper assesses the impact of independent stations on retail gasoline prices using a panel of station-specific data in the greater Los Angeles and San Diego metropolitan areas. The long-term lease of over 260 independent Thrifty gasoline stations by Atlantic Richfield Company (ARCO) provides an experiment for testing the effects of a change in a station's contractual form on a nearby competitor's price. The changes in the contract types of the Thrifty stations provide an opportunity to test both the divorcement hypothesis and the effect of independent retailers on local prices, since the independent Thrifty stations were converted to ARCO stations of various degrees of vertical integration. The detail of the station-specific data and the discrete nature of the conversion of the Thrifty stations to ARCO stations allow for control of station-specific fixed effects, as well as city-time effects - both important determinants of retail prices that could confound results if not controlled for. The results indicate that stations competing with a Thrifty station had a significant increase in price, relative to unaffected stations, after the independent Thrifty was converted to an ARCO station. This increase was independent of the type of contract at the new ARCO station, indicating that the type of contract at the branded station did not affect market price, but the loss of an independent unbranded competitor did.

The paper proceeds in seven sections. The first section gives a brief industry background. The second section describes the existing empirical literature on the relationships between vertical contracts and retail gasoline prices. The third section describes the long-term lease of the Thrifty stations. The fourth details the data used in this paper and the fifth describes the research strategy employed. The sixth section presents the results and interpretation, and is followed by a conclusion.

II. Industry background

Gasoline is produced by a refiner and then transported to a main distribution center called a Distribution Rack. There are two types of gasoline: unbranded and branded. Branded gasoline has an additive that is mixed into the gasoline just before it is taken for delivery to a retail station. For example, in order to be called "Chevron" gasoline at the retail station, the gasoline must contain the additive Techron™. A similar requirement holds for Shell, Texaco, Exxon, and most of the other brands available on the market. Under these requirements, a branded retail station must sell the branded gasoline its sign displays.

A. Branded Gasoline Contract Types

If a retail station is a branded station, it can have one of three basic vertical contract types with the branded refiner. The first type is a company operated station (company-op). Divorcement legislation is targeted at this type of station. The refiner owns the station and an employee of the refiner manages the station. The refiner sets the retail price directly and pays the employee a salary. The second type of station is called a Lessee-Dealer. In this case the refiner owns the station and leases it to a residual claimant. The lessee is responsible for setting the retail price, however he or she is under contract to purchase wholesale gasoline directly from the refiner at the wholesale price the refiner sets for a station in that "zone". [2] This wholesale price is called the Dealer Tank-wagon price (DTW).[3] The refiner also sets volume discounts, the lease rate, and other operation stipulations in addition to the wholesale price for the station. At the third type of branded station, a dealer owned station, the retailer owns the station property and signs a contract with a branded refiner to sell its brand of gasoline. The station displays the sign of the brand it is under contract to carry. The retailer can either be supplied directly by the company (dealer-owned company-supplied) in which case they pay a DTW, like the lessee dealer does, or the dealer can be supplied by a "jobber". A jobber is an intermediate supplier who purchases gasoline at the distribution rack and pays a wholesale price called the rack price. The rack price is the refiner's posted price for branded gasoline at the distribution rack, and it is the same price for any jobber

[2] Zone pricing is used extensively on the West Coast. A zone can be as small as one particular station, or as large as a whole city.
[3] DTW includes delivery to the station

purchasing at that rack. One jobber often supplies and owns many different branded and unbranded stations.

B. Independent Retail Stations

The above three types of stations sell branded gasoline. For example, a typical Shell station could be any of those three types. If a station sells unbranded gasoline, it is an independent gasoline station. Examples of independent retail chains include Rotten Robbie, E-Z Serve, Gas City, and USA. These stations can sell any type of gasoline and can purchase it from any refiner selling unbranded (or branded) gasoline at the rack price. Unlike the branded stations at which the retail price of gasoline is directly set (at company-op stations) or indirectly influenced by the branded refiner through lease terms, wholesale prices and volume discount rates, the independent retailers can shop for the lowest wholesale price from any distribution rack.

Independent retailers compete on price, offering no brand differentiation, and few of the amenities (such as car washes) that are offered by integrated branded retailers. They can, however, obtain the lowest wholesale gasoline price. Slade (1986) examines models of competition and collusion using price and quantity data for 13 retail stations competing along a heavily traveled strip in Vancouver. She finds that the 3 independent retailers consistently lead price cuts, while the major branded stations lead price increases (which are not always followed by the independents).

By committing to compete primarily on price, the independent retail station may lower the mean and distribution of local retail prices. Consider a model of consumer search where consumers observe the price at a particular station, and must decide if they will purchase from that station, or search for a lower price. The consumer will choose to search if the expected price savings from searching is greater than the search costs. By committing to a low price, and to lead price cuts, the independent marketer changes frequent consumers' expectations over the distribution of local prices, and hence lowers the highest price that other stations can charge without inducing search.[4] The

[4] Stahl (1989) presents a consumer search model where a fraction of the consumers have positive search costs, and the rest have zero search costs. This model generates a Nash Equilibrium price distribution as a function of the fraction of consumers with zero search costs, and the search cost of those with positive search costs. He shows that as the percent of consumers with zero search costs approaches one, or as the search cost of those with positive search costs approaches zero, the distribution of prices approaches the Nash-Bertrand outcome. This would imply that independents would have a greatest effect in markets with

independent station may therefore lower the average price and the dispersion of local prices towards the competitive Nash-Bertrand outcome for differentiated products by increasing search intensity.

III. Empirical Literature

The empirical literature has focused on the choice of contract type between the refiner and the branded station: the choice between company operation or lessee dealership for the stations that a company owns. The effects of independent marketers on retail price levels have not been considered. Borenstein, Cameron, and Gilbert (1997) find evidence that average retail gasoline prices respond asymmetrically to changes in wholesale prices. This finding could be interpreted as evidence that some retailers have a degree of market power, causing city-average prices to fall slowly with decreases in wholesale prices. Borenstein and Shepard (1996), and Slade (1992) also find empirical evidence of significant market power at the retail level. If the retail price is set by a residual claimant, as is the case for lessee dealers, the dealer may set a super-competitive mark-up over the refiner's wholesale price of gasoline. A company-operated station does not have this second margin, and may therefore price more competitively by avoiding the double marginalization problem. Two monopolists supplying complementary services may be worse than one.

Because of this, many studies of contracts between gasoline stations and refiners have focused on the trade off between double marginalization and monitoring cost, and hence the choice of the refiner between company operation and lessee dealership at the stations that it owns. Shepard (1993) applies principal-agent analysis to examine the refiner's choice of vertical contractual form observed at a cross-section of retail gasoline stations in Massachusetts. She finds evidence that stations with amenities such as service bays, that would require higher monitoring costs by the principal, tend to be lessee-dealers, and those with small monitoring costs, stations that mainly sell gasoline and some convenience store products, tend to be company operated.

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repeat customers (such as local neighborhoods) where there is a larger fraction of consumer's who can incorporate the independent's price-cutting commitment in their search decision.

Rey and Stiglitz (1995) show that in a differentiated products market, wholesalers have strategic motives for vertical separation, especially when they can use quantity incentives and franchise fees (both available in the lessee-dealer contract) to extract retail profits. The vertical separation can decrease the wholesaler's perceived own price elasticity of demand, resulting in higher retail prices, wholesale prices, and profits when a two-part tariff can be used to extract retail profits. In this model, it is the lessee-dealer contract, and not company-operation, that is chosen by the wholesaler to decrease retail price competition. Using retail contract data for gasoline stations in Vancouver, Slade (1998) finds evidence supporting strategic motives for vertical separation.

Barron and Umbeck (1984) used data on retail gasoline prices from a refiner survey in Maryland to test the double marginalization hypothesis by analyzing the effects of Maryland's 1979 divorcement legislation. They used station level price data for 99 stations from a refiner survey with at least one observation before and after the implementation of divorcement legislation. They found that the price of regular self-serve gasoline at stations that were converted from company operated stations to lessee dealers increased by 1.4 cents after the divorcement took place. Their study provides evidence for the double marginalization hypothesis, and hence against divorcement legislation. However, the study does not control for station-specific fixed effects or time effects – important determinants of price in retail gasoline markets that may confound results if not included.

There is a second body of literature that attempts to analyze the effects of divorcement legislation for policy proposals or regulation. Most use city average prices to determine if divorcement legislation would increase or decrease prices. For example, Vita (1999) uses monthly statewide average gasoline prices to test if states with divorcement legislation have higher or lower prices than states without it. [5] The time period considered does not allow for a before and after comparison, since the states with divorcement had the legislation in place throughout the sample. He finds a coefficient of 2.7 cents on presence of divorcement legislation when regressed on state-average prices. This is interpreted as evidence that divorcement legislation causes higher retail gasoline prices. This correlation may not be causal, since historically, high gasoline

prices have caused the proposal and passage of divorcement legislation. We would expect to see divorcement legislation in states with higher average prices.

In fact, it is precisely higher average prices coinciding with an increase in the number of company-op stations that has spurred the recent round of divorcement proposals in some west coast cities. Pro-divorcement groups examine city average prices, and note that the cities that have experienced the most dramatic increases in prices have also experienced increases in the number of company-op stations. These examples center on Los Angeles, San Diego, Phoenix and Tucson. The following two problems with these studies will be addressed further in the following sections. First, it is true that the number of company operated stations in these cities has increased, however the correlation between this and the increase in price may not be causal. Nearly all of the increase in company operated stations in the past 4 years came from the purchase of two independent chains by integrated refiners: 1) Thrifty by ARCO, which affected Southern California, and 2) Circle K by TOSCO, which affected mostly Phoenix and Tucson. Because of this there may be a spurious correlation between the loss of independents and the increase in company-op stations.[6] The Thrifty case study allows us to separate these two effects, and this will be highlighted in the results. Second, the micro data used will illustrate that city-averages mask a considerable amount of the variation in retail prices. By using station-level data, this variation can be exploited to control for other factors that affect retail prices within each metropolitan area.

IV. Thrifty purchase

In March of 1997, ARCO announced the "long-term" lease of the majority of the independent Thrifty gasoline stations in Southern California.[7] The announcement was followed by a 60-day waiting period, after which ARCO assumed control of and

[5] Hawaii, Connecticut, Delaware, Maryland, Nevada, Virginia, and District of Columbia have all had divorcement for the sample period considered. The legislation in Nevada was passed in 1984 in response to high sustained retail prices following an expansion in the market of company-op gasoline stations.
[6] Because the Circle K purchase differed in key ways from the Thrifty purchase, it is being examined in a separate study.
[7] The specific details of the long-term lease were not disclosed. ARCO officials state that the stations were not purchased because the lease agreement was a more affordable option. The stations were re-branded and are operated like any other ARCO station. All information about the lease was obtained by conversations with ARCO and Thrifty Oil Company officials, and from press releases from ARCO.

rebranded the Thrifty stations.[8] Thrifty Oil Company was the largest independent chain of retail gasoline stations in Southern California with over 260 stations ranging from San Diego to Ventura. The next largest independent retail chain – USA - has only 32 stations in Los Angeles. In fact, the Thrifty chain was large enough that the Thrifty Oil Company often chose to import gasoline from Neste, a Finnish oil company that produces gasoline that meets the California Air Resources Board (CARB) specifications, rather than purchase gasoline in local wholesale markets supplied by integrated refiners. Thrifty stations were located all over the Los Angeles and San Diego basins. Almost all stations were included in the long-term lease by ARCO and this event accounts for practically all of the changes in the percentage of company-op stations in San Diego and Los Angeles as well as the decrease in independent retailers during 1990's. After the sixty-day waiting period, ARCO re-branded the Thrifty stations and completed the re-branding by September 1997. Some of the Thrifty stations were converted to lessee-dealer ARCO stations, some were converted to dealer-owned company-supplied stations, and some were converted to company-ops.

These events allow for identification of the effect on a station's own price of a change in the number of independents or company-op stations it competes with. If it is the case that the increase in company-op stations lowers competition and increases market price, then the stations that compete with a station that was converted to a company-op ARCO should have a larger price increase than those stations that compete with a Thrifty that was converted to a dealer operated ARCO. The data analysis presented in this study will show that this is not the case.

V. The data

A. Description and Summary Statistics

The first data set used in the analysis is an annual census of retail gasoline outlets in the greater metropolitan areas Los Angeles and San Diego. The census gives detailed information on the outlet characteristics including: type of convenience store, size of convenience store, number of pumps, service bay, size of service bay, fast food chain, car wash, and location, among others. It also has the ownership and delivery type for each station, which determines if the station is a company-op, lessee-dealer, dealer-

[8] Thrifty Oil Company was a privately held company. The owner was 75, and decided to retire and sell the company's retail assets to ARCO. ARCO saw this as a good opportunity to expand market share. This is the

owned-company-supplied, or dealer-owned-jobber-supplied, or independent. The second data set contains station level average volume and price by grade and service taken over a week during the months of February, June, October, and December in 1997. These data are available for a representative sample of stations, varying by city from 20-30%. The stations in the sample were chosen to reflect the concentration of stations in the market. If Chevron stations comprise 15% of the total census of stations, then 15% of the sample are also Chevron stations that were chosen at random out of the population.[9]

The detail of the data makes it possible to separate the effects of changes in the number of company-op stations and the number of independents on local retail price. Station-level data allow a comparison between local markets that were not affected by the Thrifty purchase and those that were affected. For those that were affected, we can also compare the price changes in the markets where the new ARCO station became a company-op, with those in which it became a dealer-run station. These comparisons would not be possible with aggregated data.

In addition, the station-level data highlights the fact that there is as much price variation at the station level as there is across metropolitan areas. If the goal is to determine the causes of price differences between cities, it is important to first determine what causes persistent price differences between stations within each city. For example, price levels in this data set are consistent with the citywide averages used in industry studies. However, by examining station-level micro data, it is apparent that the distributions of gasoline prices for different cities overlap considerably. For example, the October 1997 observation on the average retail price in Los Angeles for self-serve regular unleaded gasoline was $1.40, while the average price in San Diego was $1.47.

official reason for the agreement given in all press releases and officials from either company.

[9] Data were collected by Whitney Leigh Corporation. The volume and price data were read directly form posted prices and pump meters at the stations, and is therefore more reliable than volumes and prices obtained through other methods such as telephone or manager surveys.

Table I: Average Sample Price by City

October 1997	Los Angeles	San Diego
Average	1.402	1.470
Minimum	1.269	1.359
Maximum	1.599	1.599
Stdv.	0.0665	0.0535

However, the minimum and maximum show that it was possible to buy cheaper gasoline at some stations in San Diego than in Los Angeles (and vise versa). The literature in Industrial Organization supports the fact that retail stations are geographically differentiated products, and hold some degree of market power (Borenstein and Shepard (1996), and Slade (1992)), creating many local sub-markets within each metropolitan area.

It is also interesting to note the differences in the average price of gasoline at branded stations that compete with (are located within a mile of) independents, versus branded stations that do not compete with independent stations.

Table II: Average Price by Competition type and City

October 1997	Los Angeles	San Diego
Compete with Independent	1.3838	1.4560
Do not Compete with Independent	1.4154	1.4961

This simple average indicates the presence of an independent competitor is correlated with a lower market price. This correlation cannot be determined as causal, however, since there may be a spurious correlation with other factors (such as low income levels), that are correlated with both low market prices and the presence of independents. This fact emphasizes the benefits of using the conversions of Thrifty stations to ARCO stations to determine the effect of the presence of independents on local retail price. Due to the geographical dispersion, and the discrete timing of the changes, it is possible to control for market and station-specific fixed effects that may cause a spurious correlation between the presence of an independent competitor and the local retail price level.

Furthermore, these station-specific effects account for a considerable amount of variation in retail gasoline prices. A variance components estimation determines the variability in the retail price sample attributable to different factors. By grouping the stations into small sub-city sections within Los Angeles and San Diego, it is possible to estimate the amount of retail price variation attributable to city, sub-city, month, city-month, and sub-city-month variation. The sub-city classification groups the sample stations in their local cities, such as Chula Vista (in the San Diego metropolitan area) or Pomona (in the Los Angeles metropolitan area). There are 56 sub-city regions in this analysis. The variance components estimates below show that there is as much variation at the station level over time as there is at the city level over time. The amount of variation within a sub-city contributes as much to retail price variation as does the "San Diego" effect. The variance of components estimates highlight the importance of using station-level micro data and a station-level fixed effects approach in determining the possible effects of vertical contractual forms on local market prices.

Table III: Variance Components Estimation

Component	Variance Component Estimate	Percent of Total Variance
Month	0.00308	0.26506
City	0.00334	0.287435
Sub-City	0.00032	0.027539
City*Month	0.00104	0.089501
Sub-City*Month	0.00036	0.030981
Station-time (residual)	0.00348	0.299484

VI. Research Design

A. Description of the Experiment

The previous section emphasized the importance of utilizing station-specific data in analyzing the effects of changes in vertical contract types on retail prices. The purchase of the Thrifty chain by ARCO provides an opportunity to test the effect of a change in the concentration of independent stations and the change in company operated stations on local retail price. This study uses these discrete changes in vertical relationships of gasoline stations in Southern California to determine the effects of changes in the

concentration of (I) company-op stations and (II) independent stations on local retail gasoline prices. First, the purchase of the stations occurred at a discrete point in time, allowing for a comparison of before and after effects of the contract change. Second, the purchase affected some stations in the metropolitan areas considered, and not others. The data used is a panel of station-specific prices available for the months of February, June, October, and December of 1997 in the greater San Diego and Los Angeles metropolitan areas. The gas stations are grouped into local sub-markets of stations in direct competition with each other. Some stations competed with a Thrifty, and some were not located near any Thrifty station. Therefore, the "treatment" effect of a discrete change in a competitor's contractual relationship affected some stations in the sample, and not others.

Most importantly, the Thrifty chain included hundreds of stations that were geographically scattered over the greater Los Angeles and San Diego basins. For this reason, it is reasonable to treat the change in a Thrifty station's contractual type as exogenous to a *competitor station's* pricing decision, conditioned on station-specific fixed-effects and time effects. The panel model looks at a station's price and examines how that station's price is affected by a change in a competitor's contractual type. A change in a *competitor's* contractual type is not in a station's choice set, and is therefore treated as exogenous to the individual station's pricing decision, conditioned on fixed effects and time effects. These facts allow for a credible identification of the effect on a station's own price of a change in the number of independents or company-op stations it competes with. Even though some sub-markets experienced changes in competitor's contractual types, many stations experienced no such changes. Hence, the panel model allows a comparison of how price changes over time across stations are affected by a discrete change in the number of company-ops or independents that a station competes with, controlling for station-specific fixed effects as well as time effects.

B. Retail Market Definition

The retail market definition used in the regression analysis presented below is the following: A station with a price observation competes with any station within 1 mile along a surface street or freeway. An alternative and simpler approach would be to define a circle around each price observation station of a fixed radius and assume that

the station competes with every station inside that circle. However, the detailed address information provided by the census data allows for a more realistic geographical definition sub-markets. Although it is true that people in Southern California commute a lot, making it harder to tell which stations compete with each other (stations near your house may compete with stations near your work), this definition attempts to capture the stations that compete most intensely for most consumers in their area. In order to confirm that results were not driven by geographic definitions, the same regressions were run using perturbations of these definitions, and the results were robust to these changes. The perturbations increased or decreased the scope of the definitions by half a mile. The signs and significance of explanatory variables remained the same, although the magnitudes varied slightly, by a statistically insignificant amount.

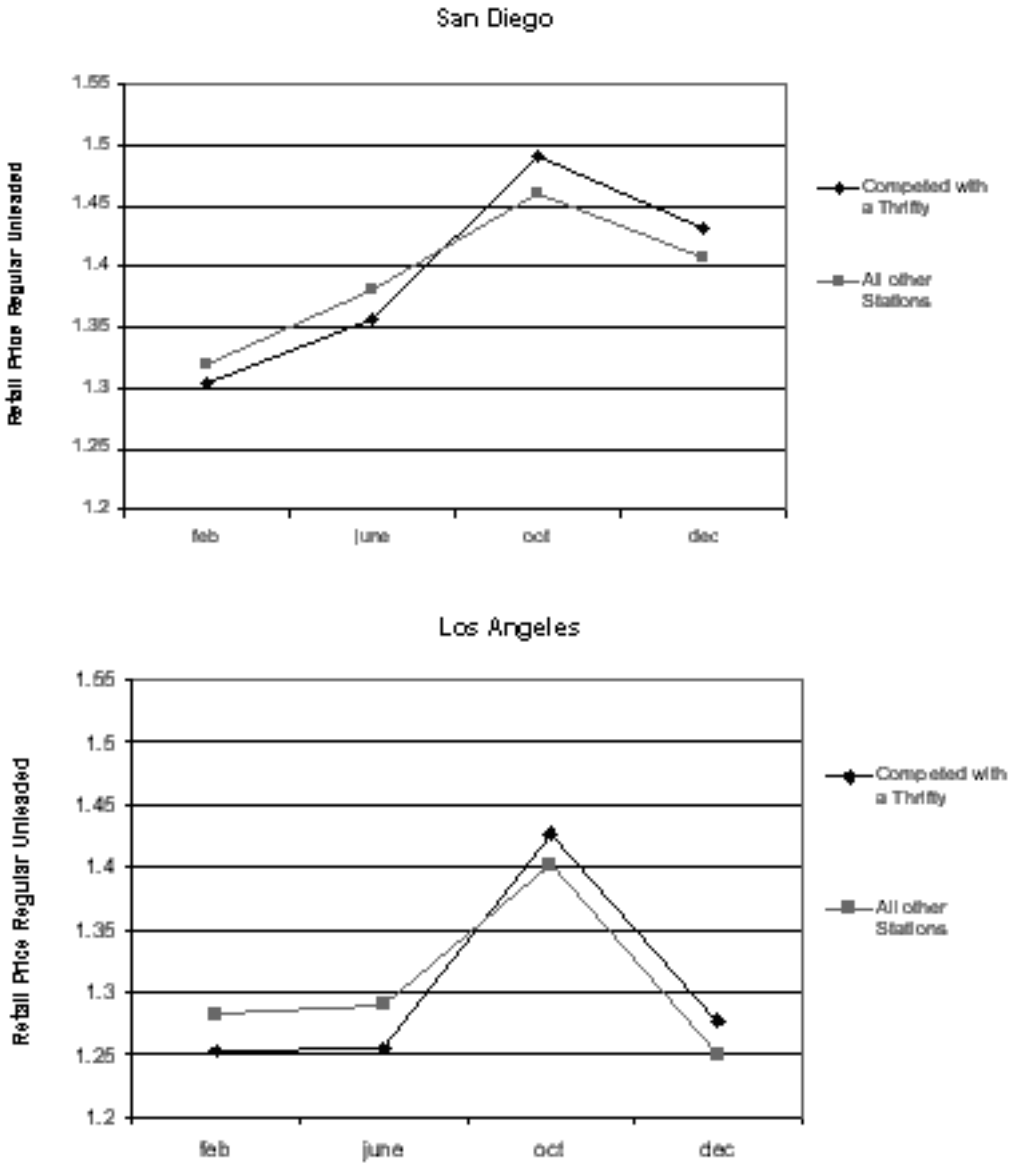
The above market definition included factors considered by dealers and refiners to be the main determinants of competition in each metropolitan area, such as traffic patterns, proximity to a freeway or a major street leading to a freeway. According to dealers, refiners, and trade groups, stations in San Diego and Los Angeles compete most intensely with any station within 1 mile.[10] This definition is further reinforced by the fact that stations of the same brand are usually located more than a mile apart. Even along the same street, it is fairly common to find stations of the same brand, but they are almost always at least a mile apart. In addition, many agreements between branded dealers and branded refiners often stipulate that the refiner will not brand another station within one mile of that dealer's location. By graphing the stations using mapping software, it is possible to examine each station's nearest competitors, and its proximity to major traffic routes – an important factor in Southern California. A more detailed description of competition groups and geographic definition is presented in Appendix A.

VII. Panel Data Estimation and Results:

Even though it is possible to include a dummy variable for every recorded station characteristic, and to control somewhat for traffic patterns by measuring a station's proximity to major commuting routes, it is impossible to control for many factors that may affect the local demand and competition that a station faces. The conversion of the

[10] This information came from various conversations with regional managers, dealer trade organization representatives, and from conversations with various dealers at retail stations.

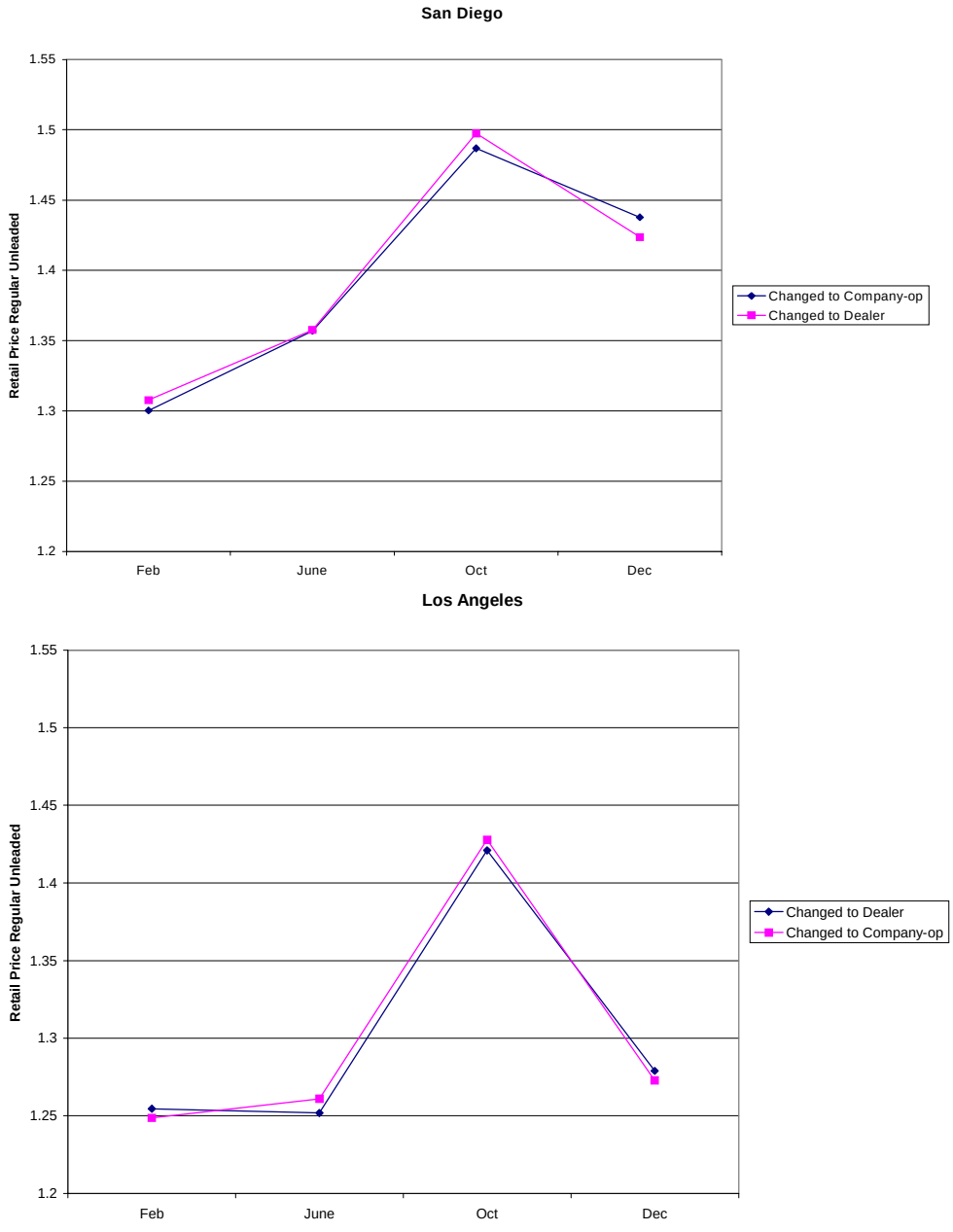
Thrifty stations to ARCO stations of various contractual types provides a quasi-experiment that allows station-specific fixed effects, as well as city-time effects to be controlled for, as previously described. A graphical analysis summarizes the effects of the purchase of the Thrifty chain on retail prices that the fixed-effects estimation captures. Before the long-term lease took effect, and the stations were still competing with a Thrifty station (the treatment group), their



prices were lower in both periods than the market averages for stations that did not compete with a Thrifty in any time period (the control group), in both San Diego and Los

Angeles. After the conversion period, the stations in the treatment group had a higher price than the average price in of stations in the control group.[11]

If the stations in the treatment group are divided into two groups: i) stations that now compete with a company-op station, and ii) those that now compete with an ARCO dealer, a similar graphical analysis can be performed.



[11] A few of the Thrifty stations in the sample were changed to ARCO stations before June. In the regression, they have the appropriate timing. These graphs show the majority of the affected stations – those that were converted between June and October.

This summarizes the price effect of the Thrifty becoming a company-op ARCO verses a dealer run ARCO that the fixed-effects estimation will capture.

The graphs above show no apparent difference in the price behavior between stations that compete with a new company-op ARCO and those that compete with a new ARCO dealer. The four graphs together lend preliminary support to the hypothesis that the presence of independent competitors, and not the presence of company-ops, has an impact on local competitor's pricing decisions.

A first attempt at estimating the effect of changes in a competitor's contractual type on another station's price is a simple pooled regression analysis. The pooled regression reflects the fact that there is a large degree of variation in the sample of stations that cannot be explained at an aggregated level. The pooled regression does not control for station-specific fixed effects, and therefore is subject to aggregation bias, even though many station amenities are included as regressors.

Pooled regression:

$$price_{it} = \mu + \gamma * t + \beta x_{it} + \phi z_{it} + \varepsilon_{it}$$

where:

μ = constant

γ = city dummy

t = quarterly dummy

x_{it} = indicator if the station competes with an independent or not

z_{it} = indicator for if a competitor becomes a company operated station

$\varepsilon_{it} \sim N(o, \sigma)$

Table IV: Pooled Regression
Dependent Variable: Retail Price for Regular Unleaded

Variable	Parameter Estimate	Parameter Estimate	Parameter Estimate	Parameter Estimate
Intercept	1.3250	1.3293	1.3293	1.4086
	(0.0019)	(0.0020)	(0.0068)	(0.0071)
Company Operated	0.0581	0.0539	0.0534	0.0116
	(0.0084)	(0.0083)	(0.0083)	(0.0060)
Independent	-	-0.0540	-0.0543	-0.0307
		(0.0072)	(0.0072)	(0.0053)
Self-Serve Nozzles	-	-	0.0000006	0.00001
			(0.0003)	(0.0002)
Ave. Quantity Food	-	-	-0.00003	-0.00006
			(0.0001)	(0.00006)
Snack Shop	-	-	0.0051	0.0052
			(0.0050)	(0.0035)
Car Wash	-	-	0.00513	0.0083
			(0.0066)	(0.0046)
Fast Food Chain	-	-	0.0250	0.0117
			(0.0138)	(0.0097)
Service Bay	-	-	-0.0039	0.0035
			(0.0051)	(0.0036)
Credit Card	-	-	0.0073	-0.0015
			(0.0055)	(0.0039)
Oil Change	-	-	-0.0062	0.0185
			(0.0120)	(0.0085)
LA*February	-	-	-	-0.1303
				(0.0063)
LA*June	-	-	-	-0.1249
				(0.0063)
LA*October	-	-	-	-0.0083
				(0.0062)
LA*December	-	-	-	-0.1470
				(0.0062)
SD*February	-	-	-	-0.0861
				(0.0077)
SD*June	-	-	-	-0.0323
				(0.0077)
SD*October	-	-	-	0.0557
				(0.0075)
Adj. R-Square	0.0199	0.0429	0.0436	0.4137

Table V: Table IV Column 4 without intercept.
February observation for Los Angles and San Diego now become basis for comparison.
Dependent Variable: Retail Price for Regular Unleaded

Variable	Parameter Estimate	T-Statistic	P-Value
Los Angeles	1.2783	231.609	0.0001
San Diego	1.3225	186.307	0.0001
Company Operated	0.0116	1.924	0.0545
Independent	-0.0307	-5.840	0.0001
Self-Serve Nozzles	0.00001	0.071	0.9983
Ave. Quantity Food	-0.00006	-1.075	0.6751
Snack Shop	0.0052	1.454	0.0872
Car Wash	0.0083	1.788	0.0740
Fast Food Chain	0.0117	1.204	0.2286
Service Bay	0.0035	0.983	0.3256
Credit Card	-0.0015	-0.394	0.6937
Oil Change	0.0185	2.188	0.0287
LA*June	0.0054	1.266	0.2058
LA*October	0.1220	27.938	0.0001
LA*December	-0.0167	-3.821	0.0001
SD*June	0.0538	7.120	0.0001
SD*October	0.1418	18.400	0.0001
SD*December	0.0861	11.175	0.0001

Company Operated changes discretely when a competitor becomes a company owned and operated station. This variable changes when a competitor Thrifty station becomes a company-op ARCO station. Independent indicates that the station competes with an independent station. This variable changes discretely when a Thrifty is changed to a branded ARCO station of any vertical relationship type. The columns in the previous table successively include different regressors in order to highlight their importance. The first column shows the pooled result if only Company Operated is included as a regressor. The coefficient is large and significant, however, as more regressors are added, it is clear that the coefficient in the first column is attributing spurious correlation to Company Operated that disappears once Independents and city-time effects are controlled for. The last two regressions include station amenities. The researcher might think, *a priori*, that theses characteristics should have an effect on a station's retail price level. The fact that they are not significant suggests that there are many confounding station-specific factors that are not controlled for, that will affect the ability of the pooled regression model to estimate the contributions of each of these variables to a station's average retail price.

The City-time dummies are all significant. Since gasoline and oil prices are relatively volatile over time, it is not surprising that controlling for time effects will considerably increase the amount of variation explained by the regression model. However, there is a large amount of cross-sectional variation that is not explained by descriptive indicators. In the final column of the pooled regression, the coefficients for Independents and Company-ops are both significant. The coefficient on Company-op is positive, and may lead one to think that the presence of a company-op station leads to a higher price in the local market, even after controlling for city-time effects. However, this coefficient becomes insignificant in the fixed-effects model.

The more robust model for estimation is the Fixed-Effects model. With the fixed-effects specification, the effects on price of any characteristics of a station group that do not change over time cannot be determined independently from the fixed effect. Hence city-wide effects cannot be estimated, nor can the effects on price of location, store size, number of pumps, or service amenities, be estimated separately from the station's fixed effect. However, since there were large discrete changes in a key variable - the competitor's ownership and contract type - during the observation period, the effects on price of variables most relevant to current policy questions can be determined. In fact, it is precisely the discrete nature of the purchase of the independent retail chain and the broad geographical distribution of its stations that allow for an analysis of the effects of these changes on retail price, conditioned on the station level fixed effects, as well as city-time effects. These changes provide an "experiment" because the events affected only some of the stations in the sample, the "treatment" group, affected them discretely, and these changes can be treated as exogenous to the individual station's pricing decision, conditioned on station specific and city-time fixed effects.

Fixed Effects with City-time dummies:

$$price_{it} = \mu + \alpha_i + \gamma^*t + \beta x_{it} + \phi z_{it} + \varepsilon_{it}$$

where: μ = constant

α_i = station-specific deviation from the mean μ

γ = city dummy

t = quarterly dummy

x_{it} = indicator if the station competes with an independent or not

z_{it} = indicator for if a competitor becomes a company operated station

$\varepsilon_{it} \sim N(o, \sigma)$

Table VI: Fixed-Effects Estimation
Dependent Variable: Retail Price for Regular Unleaded

Variable	Parameter Estimate	Parameter Estimate	Parameter Estimate
Intercept	1.3465	1.3465	1.3617
	(0.0421)	(0.0415)	(0.0287)
Company Operated	0.1080	-0.0033	-0.0033
	(0.0107)	(0.0178)	(0.0122)
Independent	-	-0.1013	-0.0500
		(0.0143)	(0.0101)
LA*February	-	-	0.0180
			(0.0065)
LA*June	-	-	0.0243
			(0.0065)
LA*October	-	-	0.1390
			(0.0064)
SD*February	-	-	-0.0851
			(0.0036)
SD*June	-	-	-0.0304
			(0.0036)
SD*October	-	-	0.0545
			(0.0036)
Adj. R-Square	0.3772	0.3953	0.7181

Reported for model in Column 4:

R-Square: .7181
F-Test for No Fixed Effects:
Numerator DF: 668
Denominator DF: 1999
F value: 3.262 Prob. > F: 0.000
Hausman Test For Random Effects:
M Value: 622.2957 Prob. > M: 0.000

An F-test for no fixed effects rejects the hypothesis that there are no station-specific fixed effects. The Hausman test for random effects rejects the random effects specification as well.[12]

The above results indicate that there is a large and significant effect on a station's price if an independent in its competition group changes ownership type. If an independent down the street from a Mobil station, for example, becomes a branded station of any contractual type, the Mobil's price would rise, on average, 5 cents a gallon. This supports the theory that the loss of independent chains significantly raised retail gasoline prices in affected markets in San Diego and Los Angeles. However, the results indicate that changing a station to a company-op station in a competition group does not have a significant positive impact on price. For example, if a Thrifty station became a company-op ARCO station, it would not have a different impact on a competitor's price than if it had become a lessee-dealer ARCO station instead. Furthermore, if a Chevron station and an Exxon station competed, and the Chevron became a company operated station, this would have not have a significant effect on the Exxon station's price.[13]

The results indicate that the increase in the concentration of company operated stations in a market does not have a significant impact on retail prices. The divorcement hypothesis rests on the assumption that retail prices rise significantly with an increase in

[12] Hausman's m value is $m=q'Var(q)^{-1}q$, where $q = \beta_{FE} - \beta_{RE}$ and $Var(q) = Var(\beta_{FE}) - Var(\beta_{RE})$. The null hypothesis is that $E(\alpha_i|X_i) = 0$ versus the alternative that it is not equal to zero. Under the null hypothesis, the statistic is distributed chi-squared with K degrees of freedom. If the null is rejected, the Random Effects specification is incorrect.

[13] Even though the Thrifty stations' locations were predetermined to the ARCO purchase decision, allowing the loss of an independent to be treated as exogenous to the competitor's pricing decision, ARCO decided which stations to turn into company-ops. As long as the there was not a change in something besides company-op at the stations that now compete with a company-op, and not at others, at the same time that ARCO changed the station to a company-op, the estimate of company-op is unbiased. For example, if ARCO chose company-ops in high income areas, and also changed the pricing strategy to one of greater price discrimination only at these stations at the time that they became company-ops, then it could be the case that company-ops lower local market prices in general, but the correlation of the change in this sample with this specific pricing strategy would bias the estimate towards zero. A Probit model of the choice of contract type at the new ARCO's was run on zip-code level census data, and local market characteristics. Income was not a significant explanatory variable. Whether the Thrifty stations accepted credit cards, or whether there was an ARCO dealer-run competitor decreased the probability of choosing company-op, and were significant at the 5% level. This supports ARCO's claim that they chose dealers if there was a good one available, or if the station was too close to another dealer. The number of cars per household was the only census variable that was significant. It was positively correlated with company-op choice, and significant, but only at the 10% level.

the number of company operated stations. However, these results show that it is the loss of independent stations, and not their subsequent contractual form with a branded refiner, that has significant positive effect on competitor's prices.

VIII. Conclusions

This study used exogenous shocks to a panel of retail station prices in Los Angeles and San Diego to determine and differentiate between the effects of the concentration of company owned stations and independent stations on retail price differentials across markets. The experiment does not find support for Divorcement legislation. An increase in the concentration of company operated stations in a market does not lead to an increase the retail price level relative to other markets over time. However, the loss of an independent station does have a significant positive impact on the retail price in Los Angeles and San Diego markets. This finding is logical. Independent retailers are the only retailers that can purchase gasoline from the lowest price wholesaler, and they are also the only stations that can completely determine their retail price independently of the upstream refiner. Even though lessee dealers and branded dealers can set the retail price, because the branded refiner can set the wholesale price specific to the station in the case of the lessee dealer, they can effectively set the lowest retail price that the station can charge. In the case of the lessee dealer, the refiner can set the lease rate, a volume discount, and the station-specific dealer tank-wagon price. These are sufficient tools for setting the retail price, as is evidenced in Shepard (1993). However, the independent station is the only type of station that can purchase gasoline from any refiner, thus increasing competition at the wholesale and retail levels. The impact of the loss of large chains of independent stations on retail price may be even larger that presented in this paper if the loss affected the competition at the *wholesale* level, and therefore the market-wide wholesale price. This effect would impact both the treatment and control groups in this study. An examination of the effect of the "long-term lease" of the Thrifty chain on wholesale prices in Los Angeles and San Diego markets presents an interesting and important further empirical study, particularly in light of the fact that Thrifty Oil Company often imported gasoline before the lease of their stations by ARCO.

The results from this study suggest policy aimed at restoring independent retailers to West Coast markets would be more effective than divorcement policy at encouraging

retail price competition. The Federal Trade Commission required the divestiture of some retail outlets on the west coast as a stipulation of the Exxon Mobil merger, and may consider similar requirements for future mergers affecting west coast markets. The findings in this paper suggest that divesting these stations to another integrated, branded refiner will not increase competition, however, divesting these stations to independent chains may increase competition and lower retail prices, but only if the independent chains are viable over the long term.

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Appendix A: Retail Market Definitions

The variance of components estimation indicates that there is significant variation in retail gasoline prices with in sub-city regions. This implies that competition occurs between stations in smaller geographic regions with in each sub-city. Retail dealers and refiners state that these competition groups have quite narrow geographic definitions. The dealer's definition of competition groups was adopted for the main results presented in the paper, and this section explores how these results are affected by changes in this definition, and what this implies for competition in retail markets. Although a rigorous economic exploration of the determinants market definitions is beyond the scope of this paper, the conclusion proposes two research extensions that focus on studying market definitions in the retail gasoline industry.

Dealers state that geographic competition is fairly narrowly defined. Although there is some spill-over, dealers claim that they compete mostly with stations within a mile on the same street, within half a mile on cross streets, and with in a mile and a half if both stations along a freeway. (These definitions are driven by commute patterns, and may vary across markets depending the preferences of the underlying consumer base, and the percent of consumers that regularly travel on that given route.) "Compete with" in this case means that if the competitor lowers his price, for example, by three cents a gallon, then the dealer will notice a drop in his volume demanded. This definition is further reinforced by the fact that stations of the same brand are located more than a mile apart (see Graph III). Even along the same street, it is fairly common to find stations of the same brand, but they are almost always at least a mile apart. In addition, many contracts between branded dealers and branded refiners stipulate that the refiner will not brand another station within one mile of that dealer's location.[14]

In order to illustrate the relationships between competition intensity and station location, Fullerton is used as a representative sub-city in the Los Angeles metropolitan area. Graph II shows a map of this example. The stations with price observations are labeled on the example map. These comprise roughly 25 percent of the stations in this area. In

[14] Barron and Umbeck (1984) ask refiners to list stations that they believe compete with stations in their data sample. The refiners list 3-4 stations as competitors for each station, and the authors use these groups as market definitions. Again, the market is defined narrowly – 3-4 stations usually fall within a mile of eachother.

Fullerton, the Beacon station, and the ARCO and Chevron stations are included in the treatment group, since they are within a mile away from the Thrifty station that was converted to an ARCO station. Applying this definition to the whole sample of stations in Los Angeles and San Diego yields the results presented earlier in the paper.

Suppose that the definitions are broadened by half a mile so that the stations compete with any stations within one-and-a-half miles along main roads, and two miles if both stations are along a freeway. This definition will now include more stations in the treatment group: stations that competed with an independent station that became a branded station of any contractual type. This now implies that ARCO station at 401 N. Placentia Avenue is in the treatment group. When this geographic definition change is applied to the whole sample of stations in the Los Angeles and San Diego metropolitan Areas, the results of the paper are not significantly affected.

Dependent Variable: Retail Price for Regular Unleaded
R-Square: 0.7201
F-Test for No Fixed Effects:
Numerator DF: 668
Denominator DF: 1999
F value: 3.2855 Prob. > F: 0.000

Hausman Test For Random Effects:
M Value: 622.2957 Prob. > M: 0.000

Variable	Parameter Estimate	T-Statistic	Standard Deviation	P-Value
Intercept	1.3599	47.5736	0.0285	0.0001
Company Operated	0.0023	0.2306	0.0102	0.8176
Independent	-0.0444	5.5611	0.0087	0.0001
LA*February	0.0180	8.5576	0.0036	0.0001
LA*June	0.0243	4.9583	0.0036	0.0001
LA*October	0.1389	39.0635	0.0035	0.0001
SD*February	-0.08512	-13.037	0.0066	0.0001
SD*June	-0.0304	-4.6878	0.0065	0.0001
SD*October	0.0545	8.5576	0.0063	0.0001

Further increasing the scope of competition would expand the bounds of geographic competition to 2 miles along streets and cross streets. If this is done, then the Exxon station at 1200 N. East Street is included in the same market as the Thrifty station. If the

same definition is applied to the whole sample, then the estimate of the effect of an independent competitor on a station's own price drops to –3.61 cents per gallon, indicating that adding these stations brings the mean change in price of the treatment group closer to that of the control group. This estimate is significantly different that the initial estimate of –5 cents at the 95% confidence level. This indicates that including these station lowers the average treatment effect, however the coefficient on Independent is still relatively large and significantly different than zero. Even if market definitions are increased by 100% of the industry definition, the result is still significant.

Dependent Variable: Retail Price for Regular Unleaded
R-Square: 0.7155
F-Test for No Fixed Effects:
Numerator DF: 668
Denominator DF: 1999
F value: 3.2054 Prob. > F: 0.000

Hausman Test For Random Effects:
M Value: 629.1963 Prob. > M: 0.000

Variable	Parameter Estimate	T-Statistic	Standard Deviation	P-Value
Intercept	1.3787	47.537	0.0290	0.0001
Company Operated	-0.0071	-0.7709	0.0092	0.4408
Independent	-0.0361	-4.4406	0.0081	0.0001
LA*February	0.0194	5.1504	0.0037	0.0001
LA*June	0.0256	6.8631	0.0037	0.0001
LA*October	0.1389	38.886	0.0035	0.0001
SD*February	-0.0827	-12.2679	0.0067	0.0001
SD*June	-0.0288	-4.3585	0.0066	0.0001
SD*October	0.0545	8.5188	0.0064	0.0001

One more increase can be made before reaching the sub-city level. The final group increases the market definitions out to 3 miles along streets. Industry evidence suggests that stations in such a large geographic range do not compete directly with each other. There are geographically differentiated markets within this range according to industry, and therefore the treatment group will include stations that did not directly compete with the affected Thrifty stations. In the Fullerton example, the Shell and Mobil stations will now be included in the treatment group. Applying this definition to the entire sample

lowers the average treatment effect further, however it is still significantly different than zero.

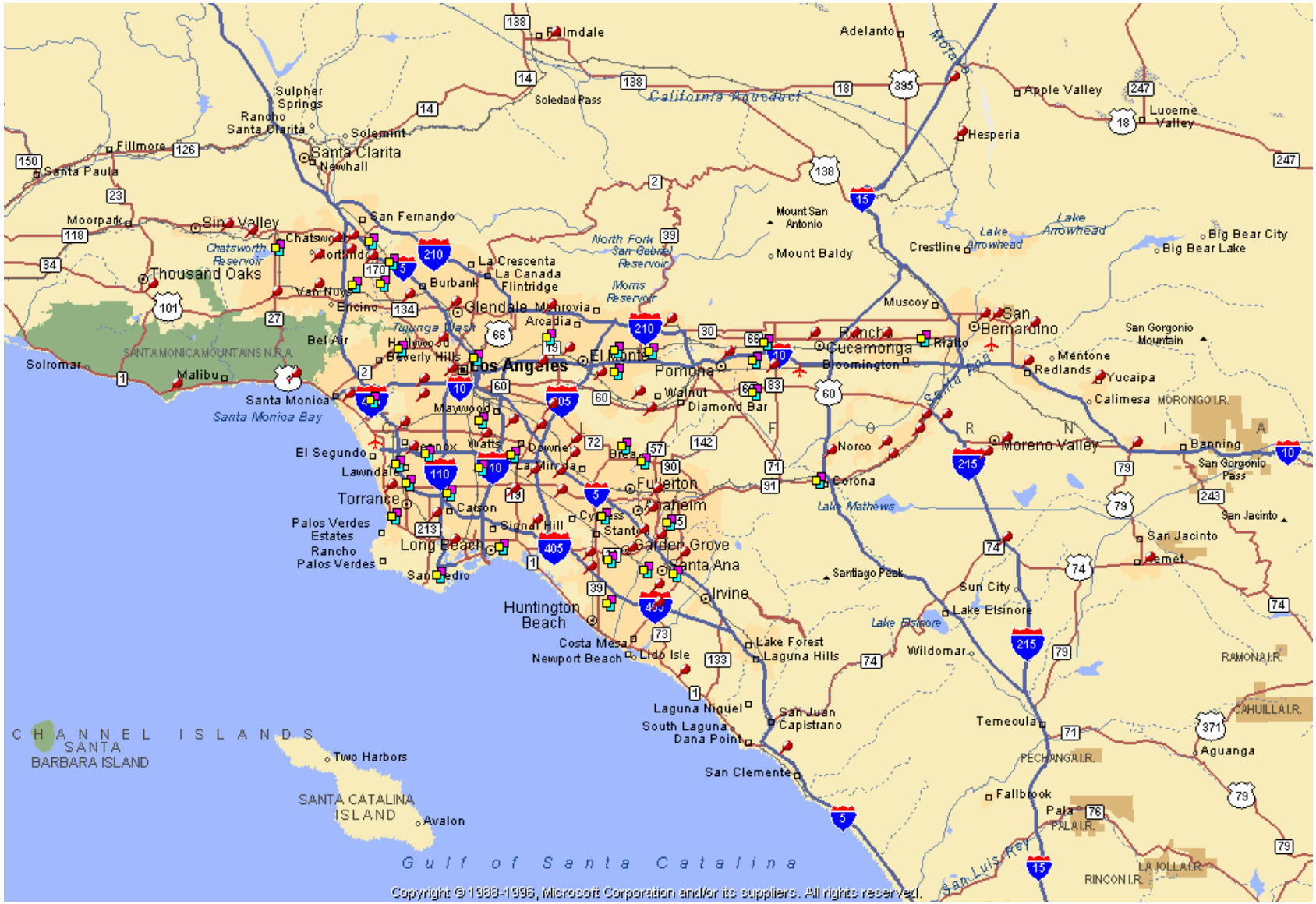
Dependent Variable: Retail Price for Regular Unleaded
R-Square: .7181
F-Test for No Fixed Effects:
Numerator DF: 668
Denominator DF: 1999
F value: 3.262 Prob. > F: 0.000

Hausman Test For Random Effects:
M Value: 622.2957 Prob. > M: 0.000

Variable	Parameter Estimate	T-Statistic	Standard Deviation	P-Value
Intercept	1.3729	47.1558	0.0290	0.0001
Company Operated	-0.0008	-0.1022	0.0092	0.9186
Independent	-0.0220	-2.8844	0.0081	0.0040
LA*February	0.0179	4.7027	0.0037	0.0001
LA*June	0.0244	6.4533	0.0037	0.0001
LA*October	0.1389	38.6995	0.0035	0.0001
SD*February	-0.0851	-12.3840	0.0067	0.0001
SD*June	-0.0309	-4.6131	0.0066	0.0001
SD*October	0.0545	8.4778	0.0064	0.0001

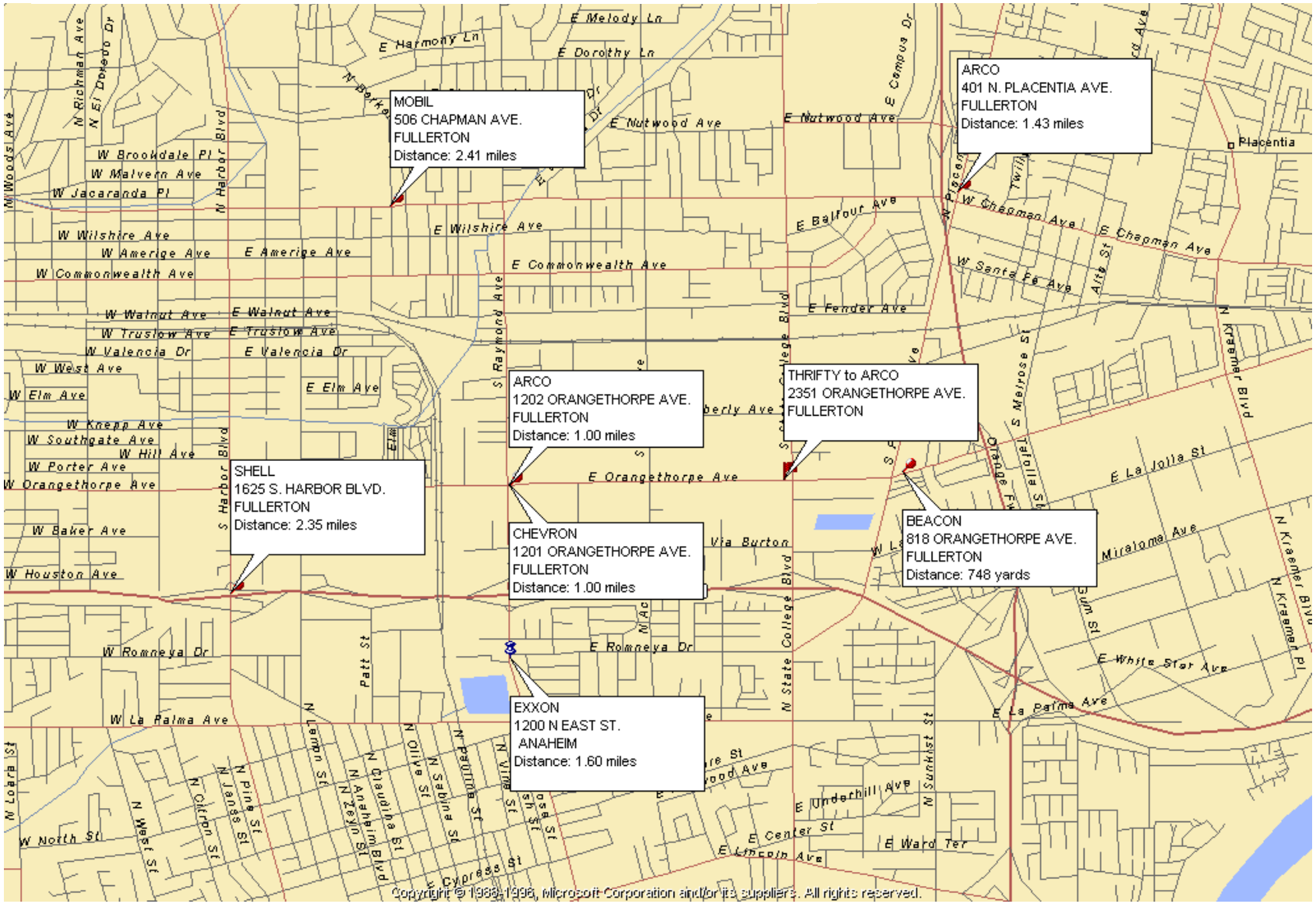
Past three miles, the competition groups are equivalent to the sub-city definition used in the variance of components estimation presented earlier. In fact, in the case of Fullerton, the 3 mile definition includes all but one of the price observation stations in the sub-city sample. At the next level, the sub-city level, there is a significant variation that is not being controlled for. Retail dealers state that the first definition is the correct model of local competition, however increasing this definition by 50% does not significantly change the results.

GRAPH I: Thrifty Stations in Los Angeles



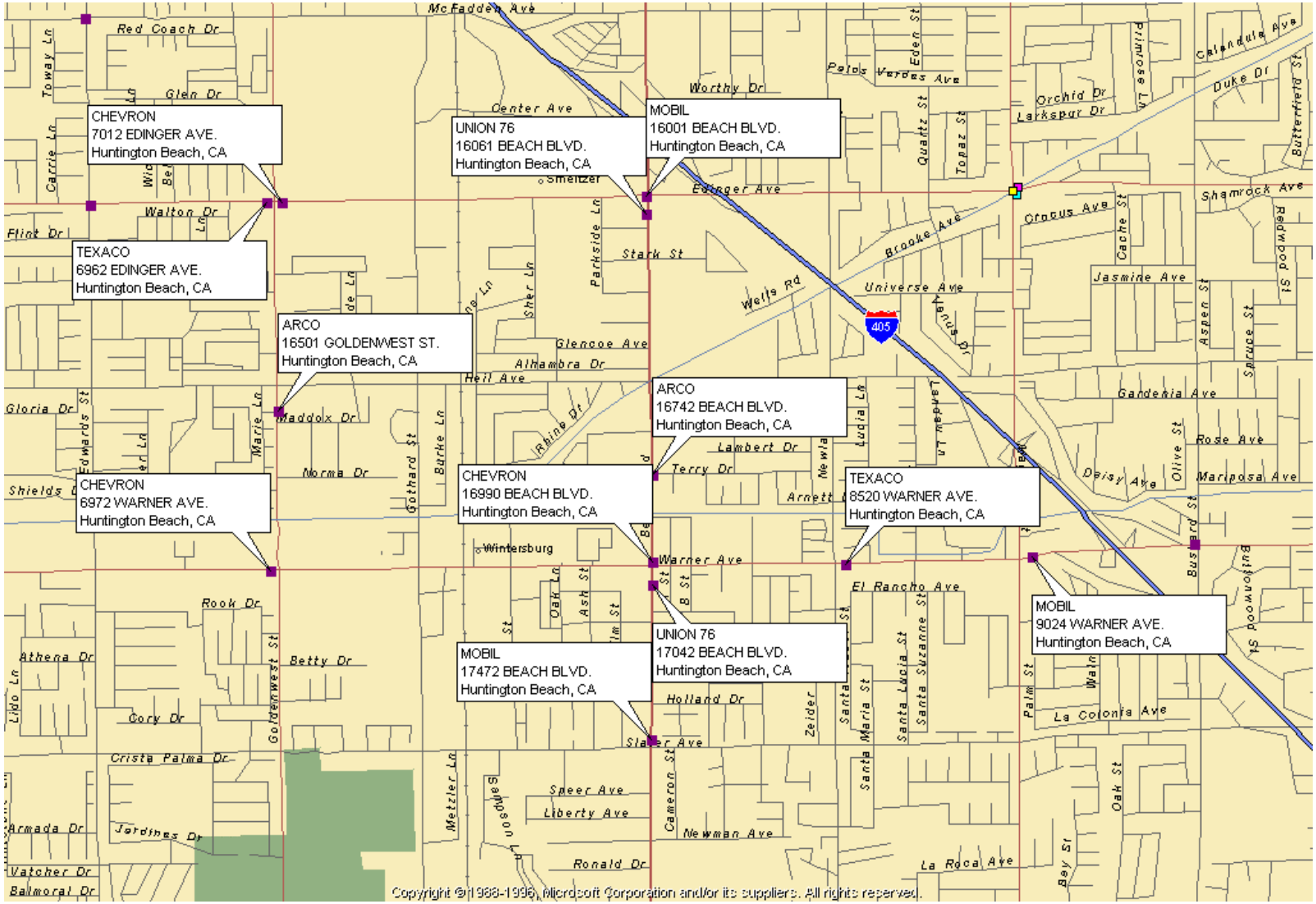
Thrifties that were affected are shown pushpins. Multicolored dots indicate more than one pushpin that are too close to show separately at this wide view.

GRAPH II: Sample Thrifty Station in Fullerton



Graph of sample stations in Fullerton, CA. The flag denotes the Thrifty station that was converted to an ARCO station.

GRAPH III: Sample Census Stations in Huntington Beach



Census data in Huntington Beach, CA shows the distances between stations of the same brand. Stations of the same brand are 1.01 to 1.50 miles apart in this sample map. |_____| = 1 mile