Misunderstood Markets: The Case of California Gasoline

By

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Abstract

In 1996, the California Air Resources Board (CARB) implemented a new benchmark for cleaner burning gasoline that is unique to California. Since then, government officials have often expressed concern that the uniqueness of petroleum products in California segregates the industry, allowing for gasoline prices in the State that are too high and too volatile. The growing concern about the segmentation of the California markets lends itself to analysis of spatial pricing. Spatial price spreads of wholesale gasoline within the state exhibit some characteristics that seem, on the surface, inconsistent with spatial price theory. Particularly, some spatial price spreads of wholesale gasoline appear larger than accepted transportation rates and other spreads are negative, giving a price signal for transportation against the physical flow of product. Both characteristics suggest some limitation in the arbitrage process.

Proprietary data, consisting of daily product prices for the years 2000 through 2002, disaggregated by company, product, grade, and location is used to examine more closely spatial price patterns. My discussion of institutional and physical infrastructure outlines two features of the industry that limit, but do not prohibit, arbitrage. First, a look into branding and wholesale contracting shows that contract terms, specifically branding agreements, reduces the price-responsiveness of would-be arbitrageurs. Second, review of maps and documents illustrating the layout of physical infrastructure, namely petroleum pipelines, confirms the existence of some connections among markets. My analysis of the day-of-the-week effects on wholesale prices demonstrates how the logistics of the use of transportation infrastructure affect market prices. Further examination of spatial price relationships shows that diesel prices follow closely the ALOP, and that branding agreements cause gasoline prices to deviate substantially ALOP. Without branding, the gasoline prices follow as closely as diesel prices to ALOP. Finally, system-wide causality analysis finds linkages among markets. In summary, both physical and statistical linkages exist among the study markets. Arbitrage among these markets is limited by the logistics of transportation infrastructure and by branding agreements in wholesale contracting.

Chapter 1: The Gasoline Industry in California

A timeless issue in economic literature is the definition of a market. The extent of a market may be delineated according to any number of attributes, including location, quality, or use. Although it is implicit in nearly every economic analysis, market definition is itself the explicit subject of analysis in two fields of study: antitrust law and agricultural pricing. In both these fields, a delineating characteristic of market boundaries is space (or the distance between relevant depots) and the economic behavior analyzed is pricing at discrete depots. Through the years, economists have introduced, refuted, and refined many theories, laws, and assertions pertaining to spatial pricing. The literature on the spatial extent of markets is itself extensive.

Economists develop theories to explain observed behavior in industries. In the efforts to expand the theoretical base of spatial pricing, focus has shifted from explaining idiosyncrasies of a specific market to developing an ever-more general and universal theory. Early studies of both antitrust issues, such as that of Elzinga and Hogarty (1973), and agricultural pricing, such as that of Dumbell (1923), relied primarily on economic reasoning to assess market behavior. Modern studies, such as Paul, Miljkovic, and Ipe (2001) and Pinske, Slade, and Brett (2002), have evolved to develop mathematical modeling of economic theory. While both approaches are helpful to an overall analysis of a market, the context within which to interpret the predictions of economic theory lies in the specifics of the industry.

This dissertation will not contribute yet another addition to the already ample number of spatial pricing theories. Instead, this dissertation will apply theories as a part of an overall economic analysis of a specific industry, namely the petroleum products industry in Southern California. The purpose is to produce an economic perspective of the industry that makes use of multiple tools of economic analysis. In additional to the well-developed dimension of mathematical modeling, the analysis here will make use of qualitative information about the specific logistical arrangements within the industry.

The phrase "petroleum products industry" might suggest the refineries and retail facilities selling gasoline and diesel. The phrase includes these components, to be sure, but also the barges, pipelines, and tanker fleets that distribute products from refineries to retail outlets. These distributional components at the wholesale level are explicitly spatial, whether between Southern California and other refining centers or within Southern California itself. Wholesale gasoline or diesel can move from one location to another, but only in a matter of days or weeks and even then only at more that trivial expense. The spatial patterns to gasoline and diesel prices reflect the special methods of distributing petroleum products.

In 1996, the California Air Resources Board (CARB) implemented a new, more stringent benchmark for cleaner-burning gasoline that is unique to California. Since then, government officials have often expressed concern about idiosyncrasies in the California gasoline markets, suggesting that gasoline prices in the State are too high and too volatile when compared to prices in other States.[1] According to a report by the Federal Trade Commission (2005), "Rising average gasoline prices and gasoline price spikes command our attention." Every jump in gasoline prices seems to bring with it assertions of market failure and yet another government-sanctioned investigation of gasoline pricing, and

[1] Similar jumps elsewhere, such as in Chicago in Spring 2000, bring calls for investigation of collusion, although economists, e.g., Bulow et al. (2003), typically uncover natural causes.

there even seems to be a preconception that price increases are indicative of illicit price behavior. In response to higher gasoline prices in California during 2003, the California Attorney General's Office re-issued and updated a report released by the office in 2000, which itself was an investigation of higher prices that occurred during 1999.

As an example of the prices often viewed with suspicion, Figure 1.1 shows the weekly prices of gasoline in the Los Angeles spot, rack (wholesale), and retail markets from June 2000 to December 2002.[2] This study focuses on the years 2000 through 2002, which coincide with many of the studies of California gasoline prices. Among these are studies by the California Attorney General's Office (2000), the Federal Trade Commission (2001), and Hamilton (2002). While the industry is ever-changing, the government continually explains apparent oddities in pricing with the assertion that industry aspects such as unique fuel standards, growing demand, and decreasing refining capacity isolate the State. Since the year 2000, fuel production standards have become more stringent, demand has continued to grow, and refining capacity has tightened further. The discussion and analysis for the study period 2000 – 2002 is applicable to more recent years with more stringent conditions.

Underlying the concern of excessively high prices is the premise that the Law of One Price, adjusted for transportation costs, should hold among markets nationwide but may not. Thus, relative price changes exceeding relevant transportation costs appear to violate the adjusted Law of One Price, and are subsequently classified as suspicious price behavior. Interestingly, the gasoline prices in Los Angeles, although volatile, do not appear to exhibit the supposed pricing oddities.

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[2] For the purpose of comparison and data availability, Los Angeles prices are used instead of Statewide California prices. The retail price database contains only weekly prices beginning in June 2000. For consistency, the wholesale and spot series are aggregated to weekly prices as well.

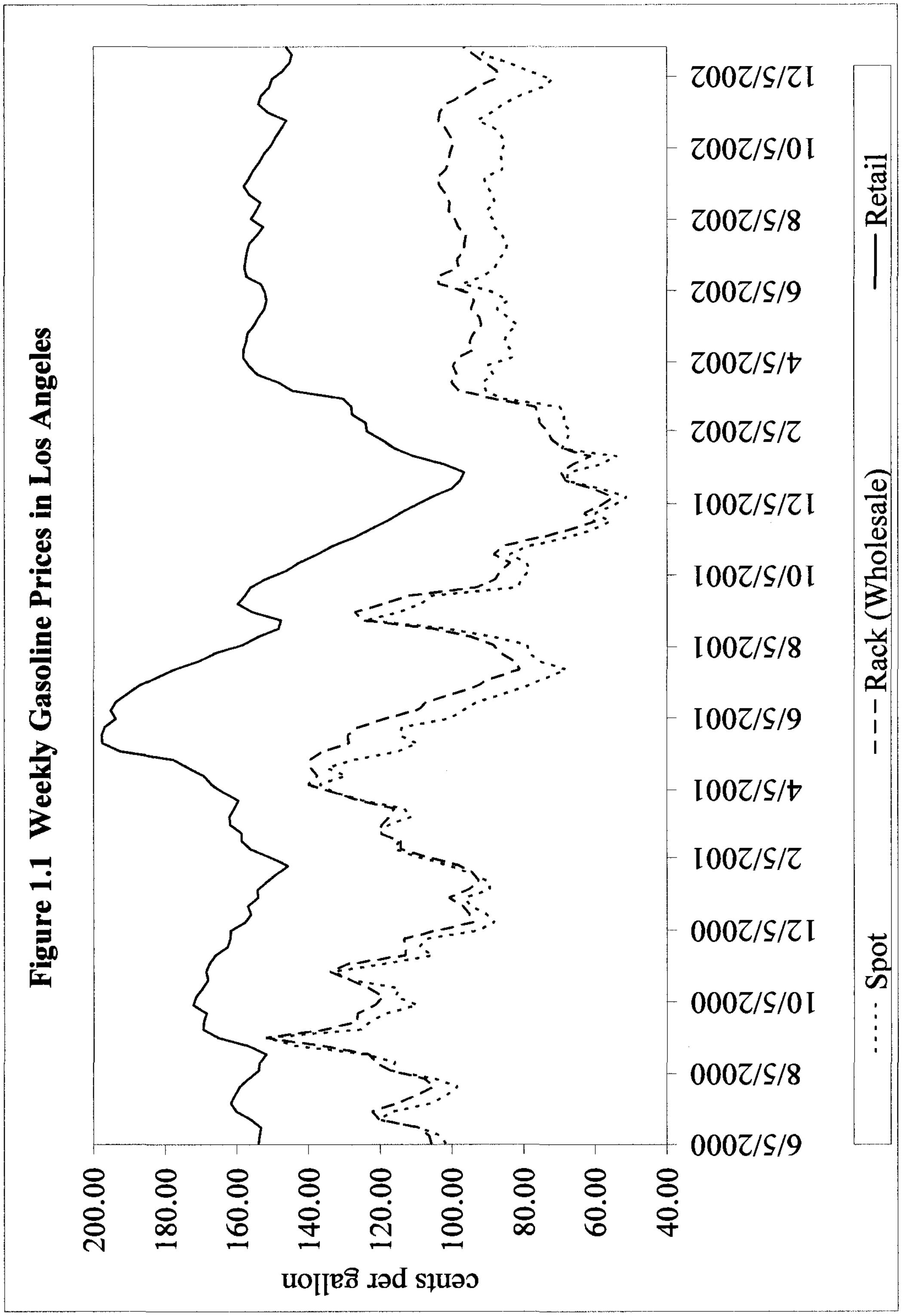

Figure 1.1: Weekly prices for spot, wholesale, and retail gasoline markets in Los Angeles. Source: Oil Price Information Service.

Price movements appear to be consistent with basic marketing theory, transmitting from spot and wholesale levels through to the retail market. Nevertheless, price spikes, such as the jump in the average retail price of over thirty percent in early 2001, receive particular scrutiny in gasoline pricing studies. Alternatively, there have been no studies about price "dips," such as the fall in the average retail price of over fifty percent in late 2001. This bias in analysis is likely to produce a subsequent bias in conclusion, regardless of the theoretical soundness of the underlying price behavior. It is not the price series per se, but the interpretation and subsequent investigations of those price series that appear odd. In this dissertation, I will describe the features of infrastructure that make the industry a special case of those in standard theoretical models, and I will discuss how institutional idiosyncrasies shed light upon some apparently odd gasoline prices in Los Angeles.

1.1 The Premise of Spatial Pricing Effects

Industry analysts, such as Hamilton (2002), profess that the uniqueness of petroleum products in California segregates the industry, creating an allegorical island of California. An implicit assumption underlying the allegorical island is the failure of the distribution system to connect California to other markets. California has a unique fuel specification, refinery capacity constraints, supposed low inventories at storage facilities, and apparent geographic isolation, all of which may hinder the equilibration of prices when a shock hits the industry. As the Energy Information Administration's May 2003 report on California gasoline prices exemplifies, these four factors are the standard determinants of the island effect, and have become the premises rather than the findings of gasoline pricing studies.

More recently, Hamilton (2006) posits that the island-effect allows in-state refiners to control prices through manipulative inventory practices. Without readily accessible out-of-state supplies to buffer low in-state inventory, prices increase to reflect the relative shortage. The assertion of market manipulation has been an issue in some twenty-five contemporary Federal and State investigations of gasoline pricing, none of which has found evidence of illegal conduct (Western States Petroleum Association, 2003).[3]

Analyses of spatially separate markets address some aspects of market segmentation. Spatially separate markets have been studied by economists for some time. Some studies focus on the criteria used to define market separation, while others examine interactions among the markets. Early studies noted price differences by location (see, for example, Taylor, 1916), but Dumbell (1923) was among the first to observe the importance of economic interactions among locations. He states, "It is impossible adequately to appreciate Liverpool's part in the trade without some knowledge of the functions performed by the Manchester cotton market and of the relationship between the two centres" (p. 366).

Dumbell's sentiment applies to California's Southwestern gasoline and diesel markets: An understanding of the relationship among all markets in the system may shed light upon the supposedly odd price behavior observed in Los Angeles. A benchmark for

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[3] In spite of the conclusions of government investigations and the absence of rigorous analysis, legislation in the State focuses on the adverse effects of refinery market power. For example, in California Senate Bill #304, submitted in February 2003, Senator Morrow States, "[Refiners'] conduct is harmful to consumers and the economy in this State, and therefore should be prohibited."

price behavior, to which observed prices can be compared, is the Augmented Law of One Price (ALOP) which is adjusted for transportation costs. Accordingly, equilibrium prices in any two markets ought not to differ by more than the cost of transacting between those two markets.

That is,

$$P_i \leq P_j + T_{j \to i},$$

where P_i is the price in Market i and $T_{j \to i}$ is the transportation cost from Market j to Market i.

The phrase "market integration" refers to the frequency with which observed price differences satisfy the no-arbitrage condition: The lower the frequency, the lower the degree of integration (and thus the greater the degree of segmentation). In California, the layout and use of the infrastructure indicates that the State is not completely segmented from other markets. Some connection exists between California and markets in other states. The objectives for the discussions and analyses that follow are to explain why California is not entirely segmented from other markets, and to discern the extent of the connections.

The discussion here of the institutional and physical infrastructure emphasizes two features of the industry that limit, but do not prohibit, spatial arbitrage. First, the common features of wholesale contracts, especially so-called branding agreements, reduce the price-responsiveness of would-be spatial arbitrageurs. Second, petroleum pipelines easily seen in maps of the industry, reveals some connections among some markets. The analysis here of the day-of-the-week effects on wholesale prices demonstrates how the logistics of the use of transportation infrastructure affect market prices. Further examination of spatial price relationships shows that diesel prices follow closely the ALOP, but that branding agreements cause gasoline prices to deviate substantially from the ALOP. Without the complications from branding, the gasoline prices follow as closely as diesel prices to the ALOP. Finally, system-wide causality analysis finds linkages among markets. In summary, both physical and statistical linkages exist among the markets within Southern California. Spatial arbitrage among these markets is limited by the logistics of transportation infrastructure and by branding agreements in wholesale contracting.

Figure 1.2 illustrates spatial price spreads in the Southwestern California wholesale gasoline markets. Spatial price spreads are the arithmetic differences between the price in Los Angeles, the refining center, and the price in each downstream market that receives product from Los Angeles. Two features stand out in this figure: the existence of negative spreads and the magnitude of both positive and negative observations. Because large quantities of gasoline are transported by unidirectional pipelines, the negative spreads produce a price signal for transportation against the physical flow of product. Transport costs along the pipelines range from 0.6 to 1.5 cents per gallon. While transport costs are only one component of transaction costs, these spatial spreads appear to be far larger in absolute value than spatial price theory would predict.

Studies of spatially separate markets have the theoretical foundation that trade linkages among the markets bind relative prices in the system. The work by Spiller and Huang (1986), who examine several years of weekly wholesale gasoline prices at a subset

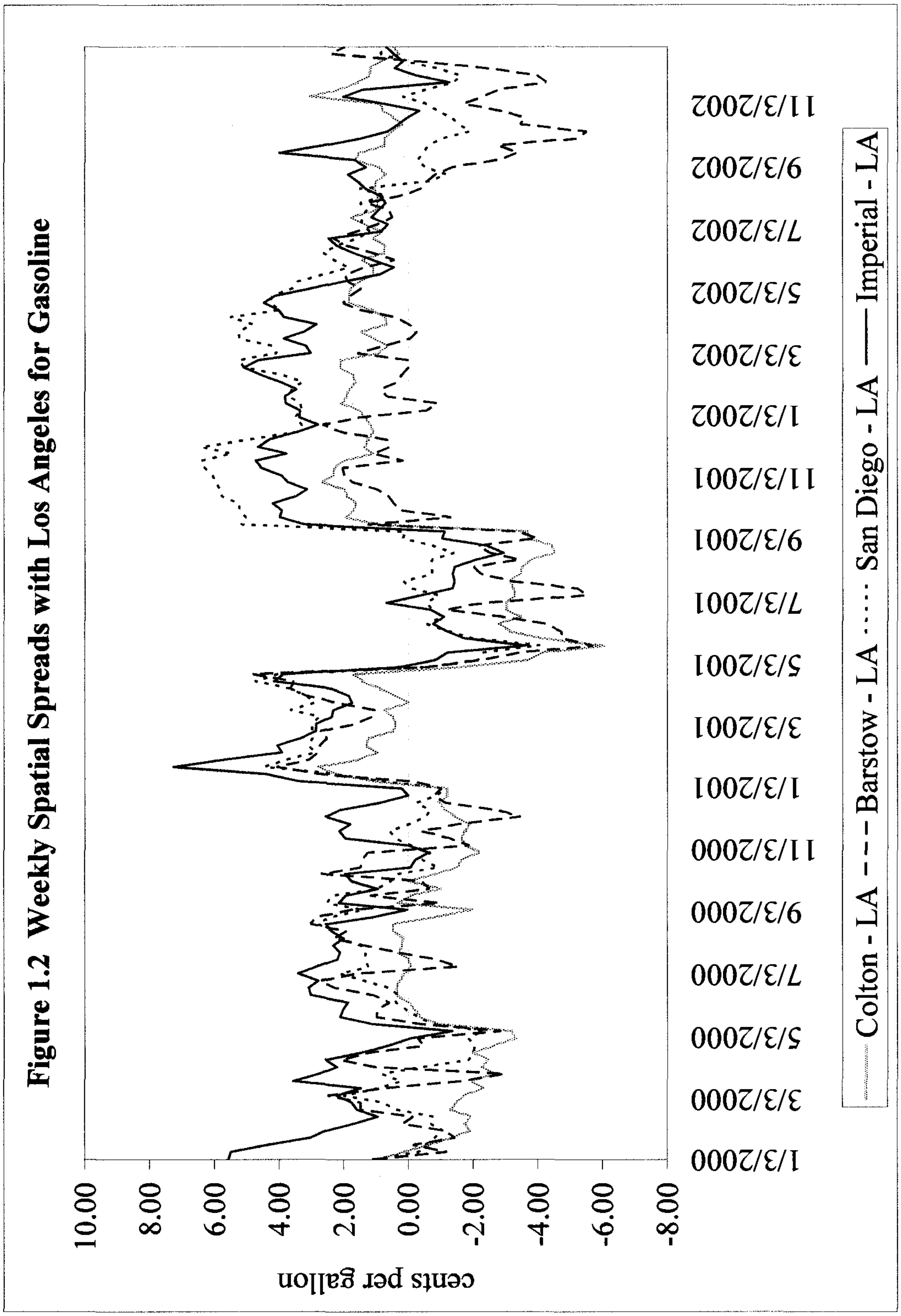

Figure 1.2: Weekly price differences among wholesale gasoline markets in Southern California. Source: Oil Price Information Service.

of five wholesale terminal areas in the northeastern United States, epitomizes studies of market integration. Such studies of market integration often do not address the transportation of the commodity, although transportation is obviously important. Models of spatial pricing are in fact models of transportation. Spiller and Huang's threshold model endogenously estimates transaction costs, of which transportation cost is an element, without using any explicit information about transportation, even its common direction. The threshold model imagines periods in which nothing is transported or even some periods in which the normal direction is reversed. Petroleum product pipelines almost always are flowing, and almost never reverse direction.

The nature of transportation played a hidden role in Slade's (1986) analysis of United States wholesale gasoline markets. Slade examined causal links among prices among six cities, Greensboro and Spartanburg in the southeast (SE), Baltimore and Boston in the northeast (NE), and Los Angeles and San Francisco in the west (WC), without accounting for modes of transportation. Slade found linkages between the NE and the SE, but none between the WC and the SE. Because Spartanburg, Greensboro, and Baltimore are terminal areas along the same pipeline, and Boston, Los Angeles, and San Francisco are terminal areas separate from one another and from the SE pipeline system, the SE is connected to the NE and is separate from the WC by industrial design.

Pinkse et al. (2002) took a different approach to explaining spatial gasoline markets. To examine the nature of spatial pricing among wholesale gasoline terminals across the United States, the authors define spatial markets by connecting all terminals that share a nearest neighbor. The nearest neighbor is the terminal closest in distance, regardless of distribution infrastructure or transportation modes. This methodology produced models of markets in California that defy the pipeline infrastructure. For example, Bakersfield is placed in the market with Los Angeles when in reality there are no bulk transportation modes between the two locations.

At first glance, the spatial prices illustrated in Figure 1.2 appear to exhibit odd behavior. However, because the petroleum product industry is inherently complex, a cursory glance at prices or spatial price spreads cannot generate enough information to establish whether pricing behavior is in fact anomalous. The nature of this complexity can help explain some of the apparent oddities. For example, one complicating factor is the existence of a second transportation mode, trucks. Unlike the unidirectional flow of the pipeline system, truck transport can flow in both directions. Even without discussing the nuances of truck versus pipeline transport, this information in its qualitative form explains some of the mystery in Figure 1.2. In light of the bidirectional transportation mode, negative spatial spreads are entirely plausible.

While some complexities concern the organization of the industry, others relate to the way in which industry data are reported. For example, data available for public use are often aggregated up to city or State levels. Consider how aggregation affects the appearance of gasoline spatial spreads. Where Figure 1.2 shows the difference between average city prices, Figure 1.3 shows the averages of individual company spatial spreads. The difference between these two figures is the aggregation. When the prices are first aggregated (averaged) and then the spatial difference taken – Figure 1.2 – there are fewer high observations and many more negative observations than when the prices are aggregated after the spatial differences are taken – Figure 1.3.

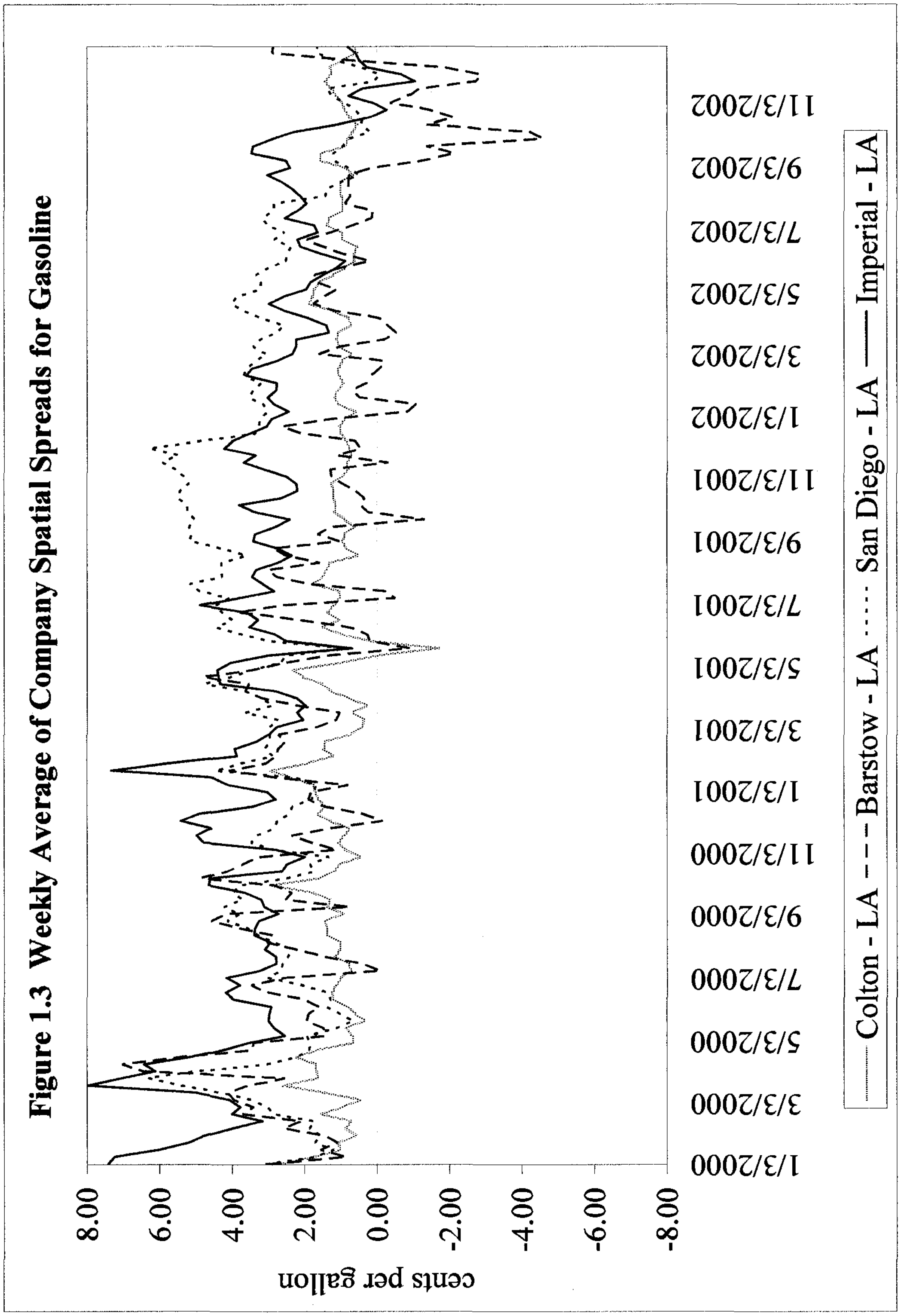

Figure 1.3: Weekly averages of spatial spreads within each company.
Source: Oil Price Information Service

1.2 Isolating California

Thirteen wholesale markets are dispersed throughout California, some more connected by infrastructure than others. However, many analysts choose to examine "the California market" as defined by the geopolitical boundaries of the State. State-level analyses are often attractive from an empirical perspective because State-level aggregates are widely available, and from a policy perspective because political borders bound regulatory reach. However, the economic geography of the California petroleum industry does not necessarily match the political geography of the State. Analysis of the political unit "California" must therefore involve some generalizations and simplifications of the economic units.

The most common and widely accepted view is of California as an island, which encompasses all three dimensions of aggregation. California is commonly represented as an island, because the slow transportation and the absence of readily available out-of-State supplies appear to isolate the State from other markets. Interestingly, these factors apply equally to diesel fuel. California even has a unique diesel specification. However, no concerns were expressed throughout the study period that these factors may be problematic for diesel markets, nor were any simple comparisons to gasoline made as an attempt to discern whether the pricing behavior observed in gasoline markets is unique to gasoline or common among all petroleum products. Figures 1.4 and 1.5 illustrate diesel prices and spatial spreads. Notable differences can be seen between the gasoline and diesel spatial spreads.

The typical analysis of gasoline prices aggregates over time, space, and form. Diesel prices do not appear to be as volatile as gasoline prices. The descriptive statistics,

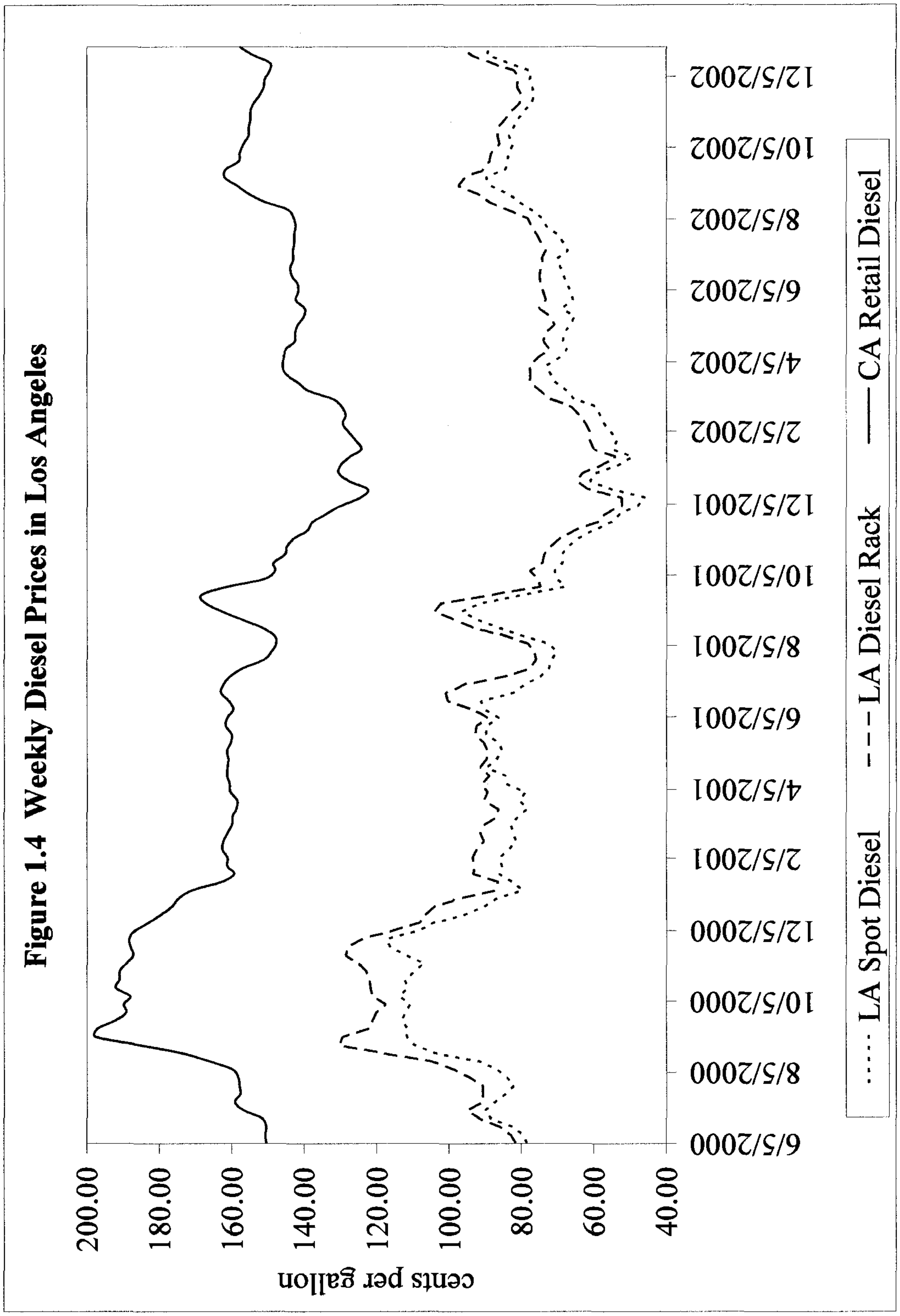

Figure 1.4: Weekly prices for spot, wholesale, and retail diesel markets in Los Angeles. Source: Oil Price Information Service.

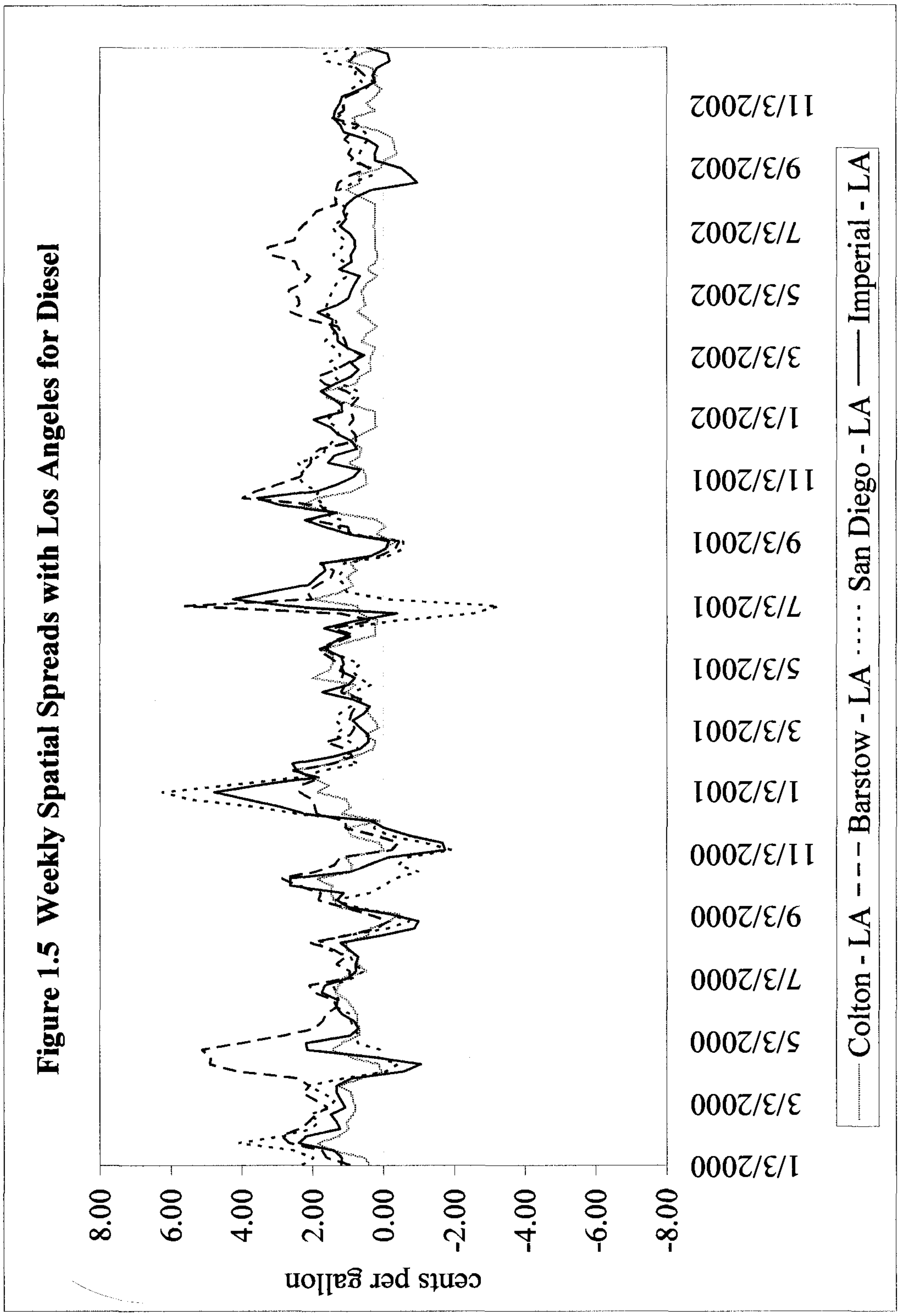

Figure 1.5: Weekly price differences among wholesale diesel markets in Southern California. Source: Oil Price Information Service.

shown in Table 1, confirm the lower variability of diesel prices. The spatial spreads also exhibit different patterns. Nevertheless, diesel spatial spreads do exhibit negative observations. Because diesel and gasoline share the distribution system, negative spreads are no more expected or theoretically consistent for diesel than for gasoline. In other words, the seemingly odd behavior of gasoline spatial spreads is not unique to gasoline.

Table 1.1 Variability of Gasoline and Diesel Prices

		Average	Standard Deviation	Coefficient of Variation
Gasoline				
	Spot	94.32	20.35	0.22
	Rack	101.89	19.59	0.19
	Retail	153.87	19.65	0.13
Diesel				
	Spot	80.32	15.88	0.20
	Rack	87.15	17.72	0.20
	Retail	155.60	17.06	0.11

Table 1.1: Descriptive statistics of the variation within the product spatial spreads.
Source: Oil Price Information Service

1.3 California's Unique Cleaner-burning Gasoline

The Environmental Protection Agency (EPA) monitors ambient air quality throughout the United States by measuring the amounts of six criteria pollutants, including ozone, and classifies areas as being in "attainment" or "non-attainment" for each of the pollutants according to the quantity present. An ozone non-attainment area is any area that does not meet the federal standard of 0.12 parts-per-million (ppm) ozone or less. Under the federal Clean Air Act of 1990, gasoline consumers in an ozone non-attainment area are required to purchase "reformulated" gasoline that burns cleaner and thus contributes less to the relatively high levels of ozone in the area.[4] California has four federal reformulated gasoline program areas: the Los Angeles area, San Diego County, the San Joaquin Valley, and the Sacramento area.

Once the EPA established the standards for reformulated gasoline, CARB revealed a reformulated fuel program specific to California. CARB's standards for reformulated gasoline in California are more stringent than the EPA's standards, resulting in "CARB-gasoline" that burns cleaner than the federal reformulated gasoline, but at a slightly higher production cost.[5] CARB-gasoline is different from all other grades in the country, and itself is different by season. A summer-grade fuel is produced for the warmer period April through September and burns cleaner than the winter-grade fuel, which is produced for the period October through March.

California refineries are the only regular producers of CARB-gasoline. Several refineries outside of the State are also capable of producing California's reformulated gasoline, but do not do so on a regular basis. It is because of the higher production costs and irregular out-of-State supply of CARB-gasoline that analysts cite California's unique fuel specification as a cause of the higher prices of gasoline in the State.

A reference to California's fuel specification as a Statewide unique formulation is a bit misleading, because CARB does not impose standards uniformly throughout the State. Rather, there are five regions in the State each with a different control period for the sale of summer-grade gasoline.[6] Additionally, the CARB-formulation produced for sale in northern California has no oxygen, while the CARB-formulation produced for sale

[4] It is important to note that these regulations pertain to gasoline sold at the retail level, not at product or wholesale levels.
[5] The California Air Resources Board estimates a 5 to 15 cents per gallon increase in production costs.
[6] The federal reformulated gasoline program requires gasoline with a low Reid Vapor Pressure (RVP), a measure relating to the vaporization of fuel in the engine, during the summer. Generally, lower RVP coincides with lower emissions of volatile organic compounds (VOCs).

in southern California contains 2% oxygen. Generalized statements regarding "the" unique California fuel specification mask these variations of CARB specifications within the State. Moreover, the existence of a unique fuel specification is itself not unique to California.[7] For example, Houston, Texas, and the State of Minnesota also require unique fuel specifications. The average retail prices in these areas are 16.24 and 6.91 cents per gallon (cpg) *below* United States averages, respectively. While it is plausible that CARB regulations have some effect on prices in California, the effect itself is not as obvious as commonly thought (e.g., Taylor and Fischer, 2003).

1.4 Refinery Capacity Constraints and Inventory

California refineries are the primary sources of CARB-gasoline. The Los Angeles and San Francisco Bay areas also serve as trans-shipment points and secondary production sources for Arizona and Nevada gasoline products. The State's refineries have just enough production capacity to meet California's demand of some 40 million gallons of CARB-gasoline per day, with marginal capacity left over to produce other gasoline products. Many studies report consistently high capacity utilization rates of the refineries in the State. When the capacity utilization rates are high, there is little slack in the system to buffer unplanned supply disruptions or demand shocks. The California Energy Commission has argued spiritedly that this inability of the in-State refineries to buffer unplanned disruptions causes higher gasoline prices in California. See, for example, California Energy Commission (2003).

[7] While it is true that no other gasoline sold in the country meets CARB standards, there are 18 other unique gasoline formulations sold in the country, including conventional gasoline.

Refining capacity in California has been growing at a rate of 0.62% annually since 1998. Capacity is typically measured as atmospheric distillation (or crude tower) capacity, but this only reflects part of refining process and is not specific to gasoline. Other so-called downstream production units within the refinery contribute to gasoline production (e.g., catalytic crackers and cokers). These units can add anywhere from 0.15% to 81.80% (from three to 1,665 thousand barrels per stream day) of additional processing capacity over atmospheric distillation capacity. These units facilitate substitution from heavier fractions like distillates to lighter products like gasoline, and their existence changes the complexity of a refinery.

Individual units have their own capacity, and when these units are not at full capacity, they do provide a refinery with the ability to buffer smaller shocks. Atmospheric distillation capacity numbers do not capture this ability. When these units are at capacity or are shut down, the refinery experiences declines in gasoline yields, although the atmospheric distillation capacity numbers remain unchanged. The ability of the State's refineries to collectively absorb a supply shock depends in part upon the capacity status of the individual downstream units at each refinery; Statewide refinery capacity may well influence prices, but standard measures may not be capturing well the true gasoline production capacity.

Another way to augment the refinery-capacity-buffer is by holding inventory. Producers, distributors, and retailers of gasoline throughout the State operate storage facilities to maintain a stock-slack in these flow processes. Different types of companies hold inventory at different facilities – refiners hold at refineries, downstream terminals, and tank farms; traders hold at tank farms; and distributors called jobbers hold at downstream terminals and are often required to operate their own bulk storage as part of their supply contract. The pipeline company also operates storage facilities that it leases to shippers. While storage tanks may have slightly different functions depending upon the facility (e.g., pipeline breakout tanks hold product temporarily to facilitate an injection queue into a main line), all have the ability to draw down or build up inventory as market conditions dictate.

About 10% of United States total finished gasoline inventory is in California, and government officials assert that this quantity is too small to serve as a buffering mechanism. However, the inventory stock does not buffer shocks. Rather, the flow, or the ability to inject into and release from a storage tank, serves as the buffering mechanism. The direction of the flow into or out of the tank depends on the price signals in the market. Gasoline should not be flowing into the tanks unless the relevant relative price indicates that inventory build-ups are optimal.

1.5 The Island of California

Gasoline imports naturally act as an additional buffer to supply disruptions and demand shocks in California. Gasoline in bulk is transported through pipelines or in barges and tankers. Currently, no pipelines carry product into California; imports only arrive on barges and tankers at the major ports in Los Angeles and the San Francisco Bay, and the small port in Eureka. Major refining areas outside of California with port access include the Gulf Coast (including refineries in Texas and Louisiana), the Pacific Northwest (including refineries in Washington), and Asia (including refineries in Singapore). A few of the refineries in these areas are capable of producing CARB-gasoline, and many are capable of producing other gasoline products for the Nevada and Arizona markets.

California is commonly viewed as an island, because the absence of readily available out-of-State supply sources appears to isolate the State from other markets. Although there are several out-of-State supply sources, the gasoline products at these locations are not readily available. Many refineries may have to make last-minute changes to their production schedules to produce California gasoline products, but even if gasoline is on hand at these locations, the transportation to California may take anywhere from several days to several weeks. The Gulf Coast to California trip takes an average of 21.5 days, including berthing and deberthing, loading and unloading, Panama Canal queues, and transit (Laughlin, 2002). Even in the worst case, though, imports are available at a time cost. The logistics generate a time delay delivery, but do not necessarily isolate California.

California itself may not be the most appropriate island to consider, because it consists of four logistically distinct areas, Eureka, Northern California, Bakersfield, and Southern California. Figure 1.6 illustrates these areas. Being landlocked with no in-flowing pipelines, Bakersfield is logistically much farther away from the Gulf Coast or Singapore than are San Francisco Bay and Los Angeles, but these differences in economic distance are only apparent when the spatial aggregate is the appropriate regional unit, rather than the geopolitical unit, California.

The connection of the California markets to out-of-State markets, and the separation of within-State markets, is illustrated in the Figure 1.6.

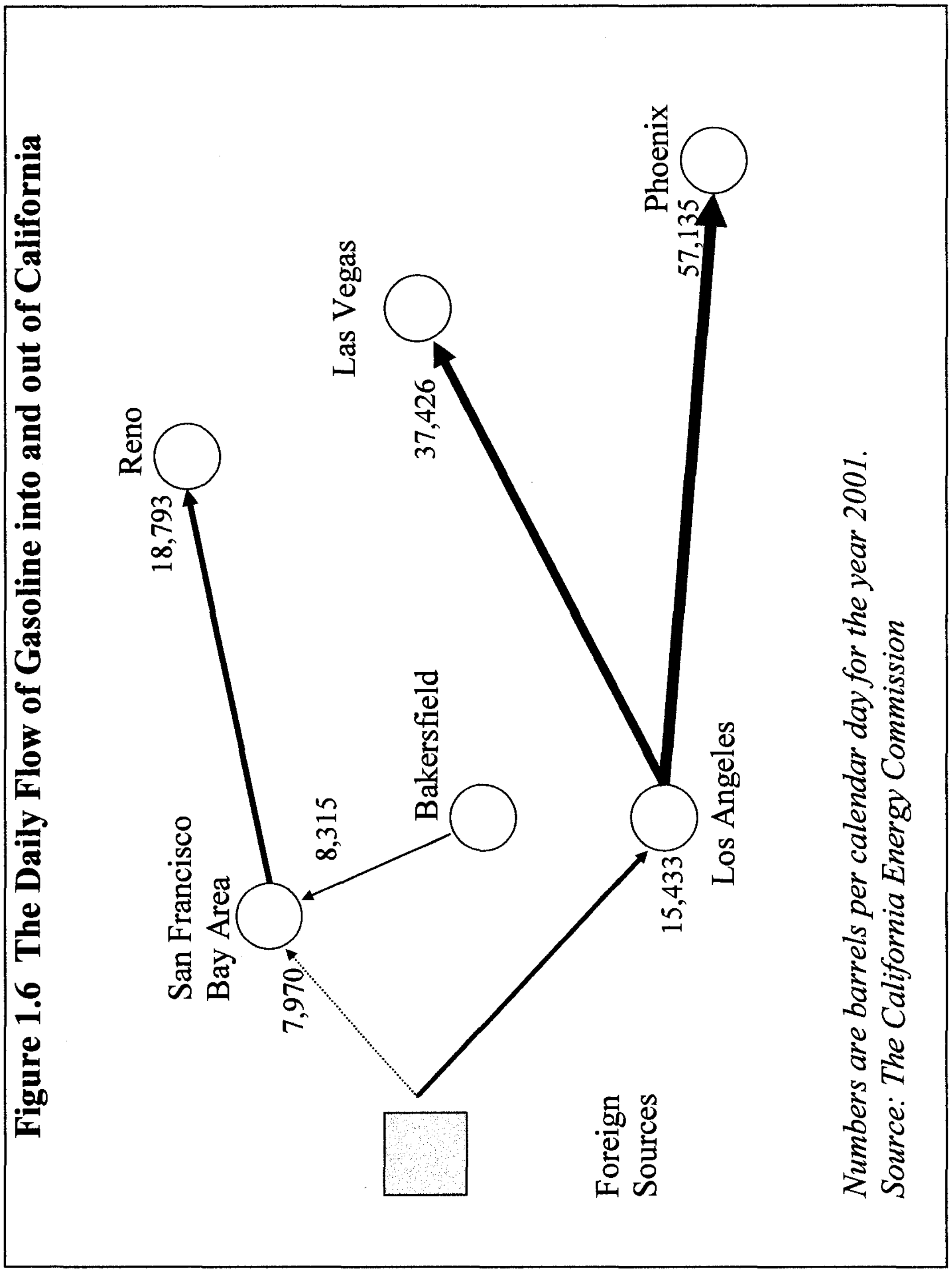

Figure 1.6: Flow diagram illustrating the direction and quantities of petroleum products in the industry.

The arrows denote the direction and flow of gasoline. In some cases, the transportation infrastructure restricts the direction of product flow. Because of the logistics of the pipeline delivery system, product must flow from California to the Nevada and Arizona markets, but cannot flow between certain markets within the State. However, the direction of waterborne deliveries is not restricted, and thus product is free to flow both ways between foreign sources and California ports.

That the product flow is positive both into and out of the State indicates that arbitrageurs are connecting the markets in the State to out-of-State markets by trading among all of the markets. The net flow from foreign sources into California and from California into Nevada and Arizona illustrates that California is not segmented from other markets, but plays an integral role in international gasoline distribution.

The concept of market integration used throughout this study refers to the extent to which trade among markets exhausts arbitrage opportunities. The concept of the converse, market segmentation, used throughout this study is the extent to which trade among markets is not capable of eliminating arbitrage opportunities. Background information about the industry, qualitative and quantitative, is used to augment the basic analysis of spatial prices. Much of the relevant qualitative information about gasoline is available publicly. This dissertation pulls together much of the relevant information to demonstrate its usefulness in understanding these seemingly odd spatial spreads of gasoline markets.

Quantitative information, such as disaggregated price data, is not as public, yet has great impact on the outcome of statistical analysis. Figures 1.2 and 1.3 demonstrate how the statistical representation of the industry varies with the type of aggregation. A secondary theme throughout this dissertation is this issue of aggregation. The dataset that is used consists of daily product prices for the years 2000 through 2002, totaling 939 observations. This dataset is proprietarty, obtained from the Oil Price Information Service. These are the most disaggregated data available, with prices being specific to each company, product, grade, and location.

Chapter 2: Petroleum Product Marketing in Southern California

The six refineries in Southern California produce five different gasoline products, two CARB-standard fuels for the in-State markets, different cleaner-burning fuels for the regulated areas in Nevada and Arizona, and a conventional blend for all non-regulated areas in Nevada and Arizona. Refiners often enter long-term supply contracts with gasoline distributors or retailers and generally give priority to meeting such contractual obligations over selling product on the open market. Refiners will use spare production capacity or storage space to provide marginal supplies to distributors or retailers not under contract, if relative prices so dictate.[8]

Because of the political sensitivity surrounding the gasoline industry, there is concern about confidentiality of data. However, government and academic analysts alike have perceived information to be far less accessible than it actually is. Substantial amounts of data and information in the public domain have yet to be incorporated in government and academic studies. Information is readily available on pipeline routes, terminal locations, and route-specific transportation rates, for example.

This additional information may help explain the mystery of apparently odd pricing behavior, and incorporating all available information and controlling for the special features of the gasoline industry need not result in an overly complex and intractable econometric model. Some features, such as pipeline infrastructure and directional flows, can inform the analysis without complicating the empirical model.

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[8] Refiners producing for and selling surplus products to outside markets are attracting the attention of the State government. A new investigation is underway to uncover the supposed anti-competitiveness of this practice.

Information in this form can help the analyst determine, for example, which subset of markets is appropriate for the analysis, or the direction of causality to test.

2.1 Overview of Gasoline Distribution

Gasoline is transported throughout the United States by means of pipelines or waterborne vessels to wholesale terminals located along the network of pipelines and marine ports, where products are then taken to retail stations by truck. Products differ by use (e.g., gasoline and diesel), grade (e.g., regular and premium), and season, and all are available at the wholesale terminals for sale to distributors under different contractual arrangements (e.g., branding agreements, payment terms, and volume restrictions). By the nature of the various transportation modes, terminals may be supplied at different times (product movements are slower in a pipeline but more regularly scheduled than on the water) and in different quantities (typically transacted in units of 25,000 barrels in a pipeline and 300,000 barrels on the water). [9]

California alone consists of four marketing systems, Eureka, Northern California, Bakersfield, and Southern California (PennWell Publishing, 1999). The marketing system of interest to this study is in the Southwest region, which includes Southern California and extends east to Las Vegas and Tucson. The western-most market in the Southwest is Los Angeles, which is a major producing and importing area. In addition, Los Angeles is the origin of the pipeline systems that serve the Southwest region, operated by Kinder Morgan. Kinder Morgan is a regulated monopoly in the pipeline distribution of petroleum products. The company does not trade products in the market,

[9] At 42 gallons per barrel, these typical wholesale quantities are huge compared to the quantities at any one retail establishment.

but rather facilitates the distribution of product through its operations of pipelines and product terminals.

There are ostensibly three systems in this region, although much of the infrastructure is shared throughout, because inter-State pipeline transportation is regulated at the federal level rather than by the State, and pipeline tariffs differ for designated inter-State pipeline segments (Kinder Morgan, 2007). Accordingly, one pipeline system serves California intra-State markets, one serves California and Nevada inter-State markets, and one serves the Arizona markets.[10]

According to Kinder Morgan's shipment policy, product suppliers nominate pipeline shipments about one month in advance of shipping, and the resulting delivery schedule "freezes" a week prior to the shipping date. Pipeline tariffs often specify minimum tenders (supply into the line) and minimum deliveries for each pipeline segment.

Kinder Morgan gathers tenders in Los Angeles and makes deliveries on a weekly basis, with each set of product tenders creating one weekly "cycle." Different pipeline segments operate on different cycles, carry different products, and terminate in different locations (Allegro Energy Group, 2001). Even though petroleum products are liquids, which could flow constantly, they cannot be mixed. They must be shipped in batches. The batching of products within a weekly cycle introduces a discontinuity in the arrival of gasoline to the terminals. Inventory practices, both upstream and downstream, must reconcile the batched influx of gasoline with the continuous market pressures to build or

[10] The Colton, CA market serves two functions. It is a wholesale market that is an intra-State destination along the pipeline system. It is also a distribution center for inter-State product, as it has been deemed the origin of the inter-State pipeline segment that serves Nevada. Thus, there are two sets of tariffs for delivery to Colton. Which of these two applies to the shipper depends upon the purpose for the shipment, which must be specified a month prior to shipment.

draw stocks. The weekly product cycles and pipeline connections among terminals also create weekly price patterns and correlations that could influence an empirical analysis of those prices.

Once at the destination, the products must be stored for the distributors, who purchase in truckloads of about 8,000-10,000 gallons. Some 85% of distributors purchase gasoline under a long-term supply contract (California Attorney General's Office, 2000). Most often, the contract includes a branding arrangement with the supplier. Unbranded supply contracts are not as common, although there is some evidence of implicit unbranded contracts, which are bound by reputation and long-term business relationships. In 2002, the Minnesota Attorney General's Office released a sample distributor contract that includes many provisions typical of distributor supply contracts. This contract is in Appendix A.

A key provision in distributor contracts is a monthly range for purchases. The monthly volumes may be based upon some minimum annual volume; some suppliers will not enter into or renew a contract with a low-volume distributor (Oil Price Information Service, 2003). The contract also places an upper limit on the distributor's purchases, and may charge a penalty if the distributor purchases more than its allotted volume. The supplier also reserves the right to allocate, or ration, this monthly volume if supplies are tight. This practice is called "allocations" at the rack (wholesale terminal).

Also specified in distributor contracts are particular purchase and distribution centers. The supply contract restricts the distributor to purchase gasoline from the terminal specified in the contract, regardless of intra- or inter-market price differences. Likewise, a distributor may be bound to serve retail outlets in particular zones of the market. For example, the sample distributor contract an Appendix A includes two schedules. One schedule specifies the assigned wholesale terminals, the products to be purchased at each wholesale terminal, and the allotted monthly quantities. The other schedule specifies the counties that define the distributor's retail marketing responsibility. These two provisions are very important to, say, studies of terminal market integration, because they inhibit spatial arbitrage by distributors.

Various pricing arrangements also appear in supplier contracts. In addition to over-purchasing penalties when allocations are implemented, also specified are terminal-specific discounts and premiums, payment terms, and pricing formulas. Each supplier selling at a terminal posts a price at its pump, not unlike the practice of posting prices at retail gasoline stations. Also like their retail counterparts, the suppliers adjust their posted prices as market conditions dictate. Typically, the prices posted at the terminals – which are the prices analysts observe – are merely base prices. The transaction prices suppliers quote to buyers are quoted as differentials to the base prices (i.e., plus or minus some cents per gallon).[11] Moreover, pricing arrangements may well be different for each distributor, and are likely endogenous to market conditions, as in the case of over-purchasing penalties under allocations.

With the various pricing arrangements, primary purchase points, branding agreements, and volume allotments, the gasoline distribution system already seems far more complex than has been allowed in analyses of gasoline markets. Even so, the description here remains incomplete, for there has been no discussion of spot cargo markets, forward markets, or storage. These three, in addition to pipeline transportation, play a role in the California petroleum industry, and all must be considered in an analysis

[11] Often, these differentials are tenths of a cent, and a one cent differential is large.

of gasoline markets before one can say with confidence (in the statistical sense) that prevailing prices are inherently odd.

The Southwestern pipeline system originates in the refining and import center of Los Angeles. From this origin, one 16-inch pipeline carries product to San Diego and three pipelines, one 24-inch and two 16-inch, carry product to Colton. From Colton, two pipelines, 8-inch and 14-inch, carry product to Barstow and beyond to Las Vegas. Also from Colton, one 20-inch pipeline carries product to Imperial and beyond to Phoenix. A six-inch pipeline carries product from Phoenix to Tucson, and an 8-inch pipeline carries product from Tucson to Phoenix. These pipelines and terminal areas constitute the Southwest pipeline system. Figure 2.1 presents a map of this part of the Kinder Morgan system.

The term "terminal" as used here is misleading, for there may be many terminals in each city. A "terminal" is any wholesale outlet where gasoline is sold in truckloads for delivery to retail outlets and bulk end users. Such outlets may exist at refineries, marine facilities, or stand-alone facilities dedicated to wholesale. The outlets that are not at refineries are terminals along a pipeline, because the pipeline system is the most feasible way to transport large quantities of product to the outlets. A terminal may be operated by a single company, several companies, or a pipeline operator. For each of the 18 terminals in Los Angeles there is at least one posted price.[12] From this cluster of facilities and product prices, "the" price of gasoline for Los Angeles emerges.

[12] Suppliers post a price for their product. If multiple suppliers operate out of the same facility, then there will be multiple prices posted at that facility.

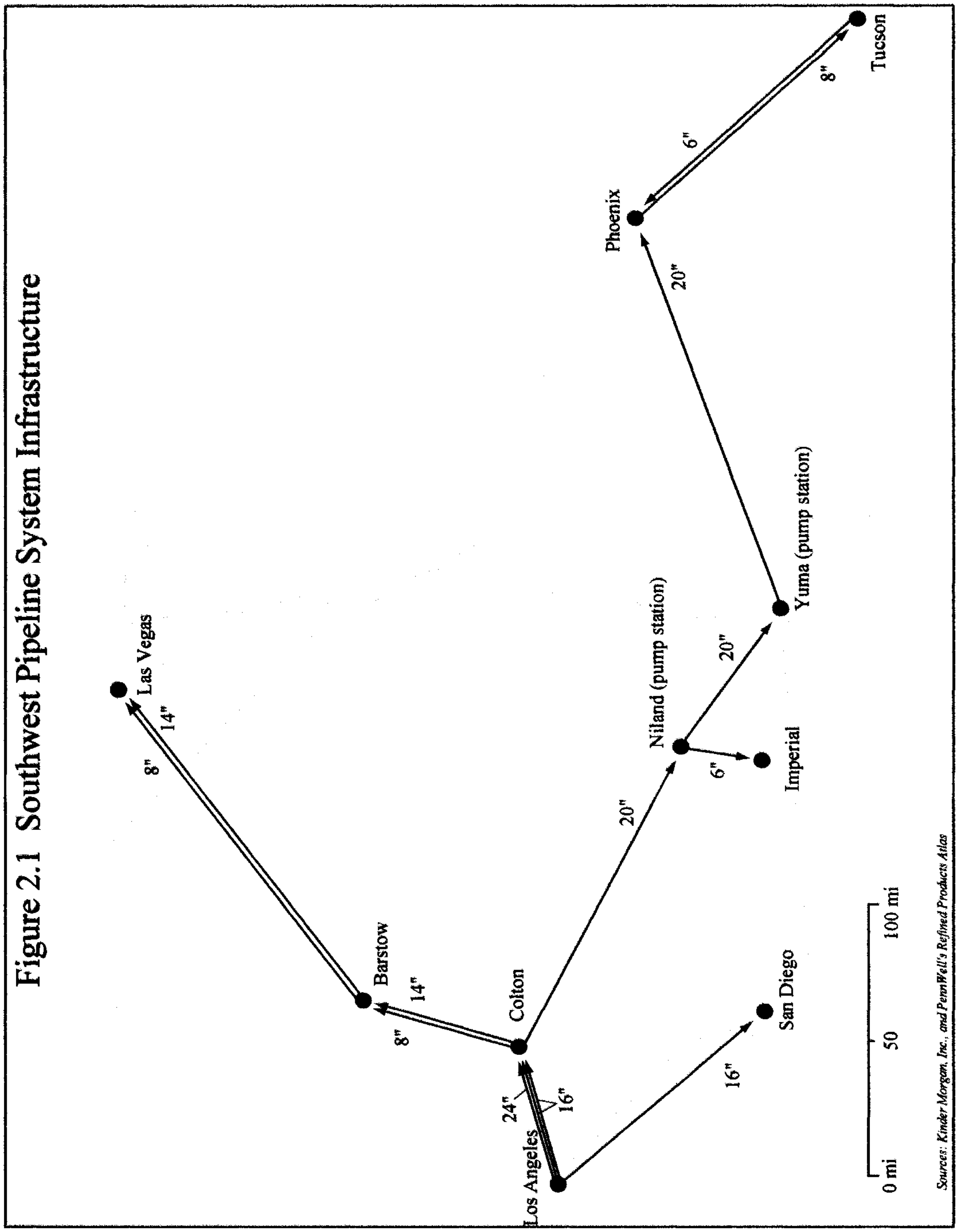


Figure 2.1: Illustration of the pipeline infrastructure in the Southwestern petroleum industry.

2.2 Data Reporting and Aggregation

The data about prices coming from the assortment of facilities in the industry are aggregated to some extent. The decisions about data aggregation, whether made by those responsible for the initial collection of the data, or those later analyzing the data, may affect the outcome of the analysis and therefore require careful consideration. The very availability of data may answer some of the principal questions. The Oil Price Information Service (OPIS) is the premier source of information about wholesale gasoline in the United States. The decisions made by OPIS about gathering data may affect analysis of the data. Among the over 1,000 petroleum product terminals located in over 700 cities in the United States, OPIS reports the prices posted in just 350 terminal areas, such as the Los Angeles area, and regards the cluster of facilities in each of these terminal areas as a "market."[13] OPIS reports price by market, brand type, product, and company. For those companies that supply more than one terminal in an OPIS-delineated market (such as occurs in Los Angeles), OPIS chooses the "primary" terminal for that company as representative and reports the price for that terminal only. OPIS does not disclose the methodology by which it determines the primary terminal.

Nor does OPIS disclose the guidelines it employs in the delineation of the market boundaries, making it difficult to resolve some perplexing market delineations. On the East Coast, for example, OPIS identifies the terminals in the Boston Harbor collectively as a single market, yet it identifies the New York Harbor terminals in Newark and New York as separate markets. The OPIS market delineations are confounded by the facts that the terminals in New York Harbor are closer together and more connected in terms of

[13] OPIS describes the data collection and verification process on the company website www.opisnet.com.

physical infrastructure than those in Boston Harbor. Figure 2.2 shows the differences in petroleum product infrastructure between Boston Harbor and New York Harbor.

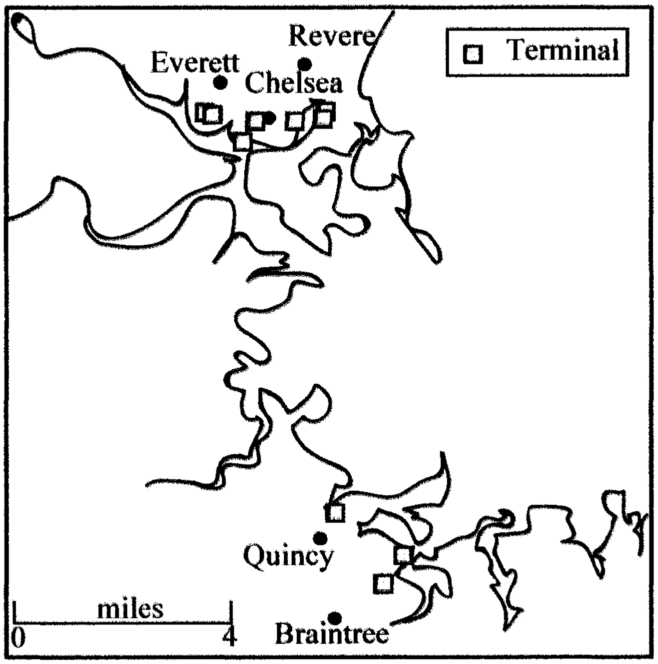
Furthermore, OPIS collects and reports data that meet the demands of traders, producers, and other members of the industry. OPIS seeks a profit. The information set that is optimal for those in the industry may not be optimal for the analyst. Rather than being constrained by the decisions of a reporting service, the analyst could collect the most disaggregated data available, and aggregate into markets as needed.[14] This is in fact what Spiller and Huang, Slade (1986), and Spiller and Wood (1988), among others, have done. These authors all acquired disaggregated, company-level daily prices from OPIS and transformed those prices into weekly prices by location. None, however, explained the advantages of their aggregation, and all followed the spatial market delineations set forth by OPIS. Spatial aggregation, whether done by the analyst or the reporting service, may influence empirical results if the consequent spatial scale is too large or small relative to the underlying spatial process (Anselin, 2001).

In addition to methodologies of data collection, physical supply, demand and distribution infrastructure determine the availability of data. That is, a location must be a market and the commodity under study must be traded at that market for a price to be recorded. For example, OPIS does not report a New London, CT, price because there are no terminals in that area. Similarly, OPIS knows of some characteristic distinguishing the terminals in Newark and New York, thus justifies treating these as two markets instead of a single "New York Harbor" market. Although the analyst may have no

[14] Even then, the analyst remains at the mercy of the methodology of the data reporting agency.

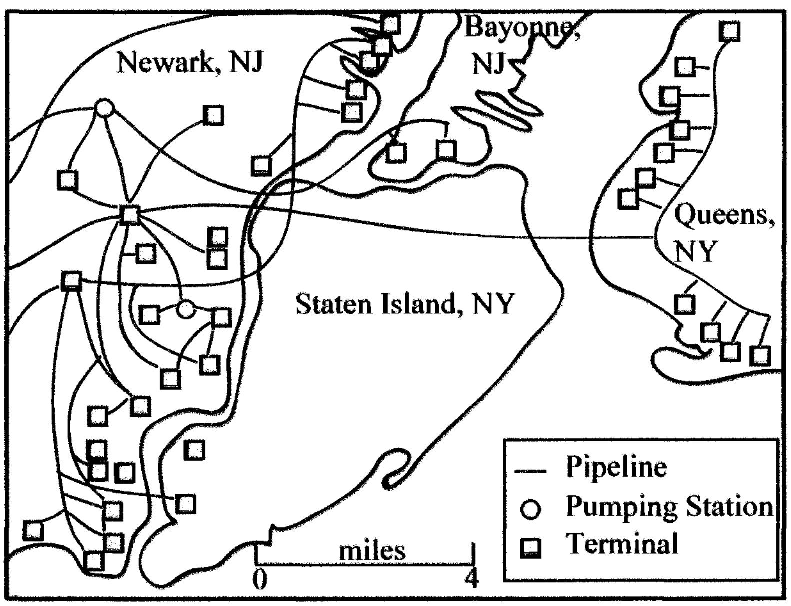
Figure 2.2 Comparison of Eastern Massachusetts and New York Harbor Infrastructure

Eastern Massachusetts Petroleum Product Infrastructure



Source: Petroleum Terminal Encyclopedia 2002/2003

New York Harbor Petroleum Product Infrastructure



Source: Kinder Morgan, Inc.

Figure 2.2: Comparison of the petroleum product infrastructure in two Northeastern United States areas.

control over the methodology of the reporting service, a quick study of the industry under examination may reveal these distinguishing characteristics.[15]

In California, OPIS aggregates over 100 terminals throughout the State into 13 terminal areas. Five of these areas are within the Southwestern pipeline system. While OPIS deems each cluster of terminals as separate markets, each market contains some number of facilities, and exhibits some degree of spatial dispersion within it. However, each cluster of terminals is different, as the clustering of terminals in an area depends a lot on the infrastructure in the surrounding area. In some areas, such as Imperial and Barstow in the Southwestern system, there is only a single pipeline and terminal. In these instances, the companies selling product share the facilities.

The reported price for each market is an average of the company-specific prices OPIS collects. This average is not volume-weighted, even though some companies purposely set high prices to discourage sales. OPIS does not disclose the specific terminals that participate in the surveys, making analysis of intra-market spatial economics difficult. While the most common analyses of spatial pricing are inter-market, intra-market analysis becomes important in settings like that for wholesale gasoline, where each so-called market comprises many spatially dispersed depots. Intra-market analysis is necessary to assess the suitability of market boundaries.

In Southern California, the terminals that OPIS defines as the Los Angeles market are themselves so spread out and, in some cases, close enough to terminals in the neighboring market of Colton that it is not obvious where the boundary between the two markets lies. Potential outliers also become an issue when examining distances between

[15] For example, a relevant difference between New Jersey and New York is State taxes. Fuel tax evasions result in an estimated loss of $1 billion each year in State and federal tax revenue. One scheme entails gasoline distributors selling gasoline promised for New Jersey in New York, where taxes are higher, for a profit.

specific terminals. Two terminals in the Los Angeles area may be outliers, judging by their geographic location and distance from the other terminals. A similar issue is present in San Diego, where there is one terminal apart from the other four. In this case, however, the distance to the outlying terminal is only 6.73 miles, about one-fifth the average distance to the outlying terminals of the Los Angeles terminals. Table 2.1 summarizes the dispersion of terminals in the Southern California system.

Table 2.1 Number and Dispersion of Terminals in Southern California

Location	Distance from Los Angeles city center	Number of Known Terminals	Statstic	Miles Between Terminals
			Minimum	0.3
Los Angeles	-	18	Maximum	27.2
			Average	11.2
			Minimum	0.1
Colton	56 miles	4	Maximum	0.5
			Average	0.3
			Minimum	0.0
Barstow	115 miles	1	Maximum	0.0
			Average	0.0
			Minimum	0.0
San Diego	121 miles	5	Maximum	6.9
			Average	1.9
			Minimum	0.0
Imperial	207 miles	1	Maximum	0.0
			Average	0.0

Table 2.1: Descriptive statistics of the clusters of terminals in Southern California cities.
Source: Petroleum Terminal Encyclopedia

Geopolitical boundaries often dictate data aggregation, whether by city, county, or State, because geopolitical boundaries provide an easy rule of thumb by which to collect, report, and analyze data. Figures 1.6 and 2.1 both illustrate that infrastructural boundaries provide another rule of thumb by which to categorize data. The prevailing picture of the industry at the State level is quite different for each rule of thumb. This logic applies to the market level as well, where the picture of each component of the whole system (i.e., the markets) may differ by the rule of thumb employed for market definition.

The identification of markets has several dimensions, including geographic considerations, the nature of the product flow, and the commodity and related products and variants. The interpretation of the empirical results depends upon the appropriateness of assumptions underlying market delineations. Because the typical spatial integration model is based upon the assumption that operative transportation infrastructure exists, a rejection of the hypothesis of market integration is actually a rejection of the hypothesis of market integration conditional upon the applicability of the assumption of operative transportation infrastructure. The transportation system is integral to analysis of spatial price relationships.

2.3 Transportation Systems and Spatial Pricing

Price-based models of spatially separate markets presume the markets are well defined, transportation infrastructure exists among the locations, and the transportation system is in use but not at capacity. Any limitation in the system, such as the absence of infrastructure, unidirectional product flows, or capacity constraints may inhibit arbitrageurs' responses to large price differences, and thus restrict the degree of integration among locations.

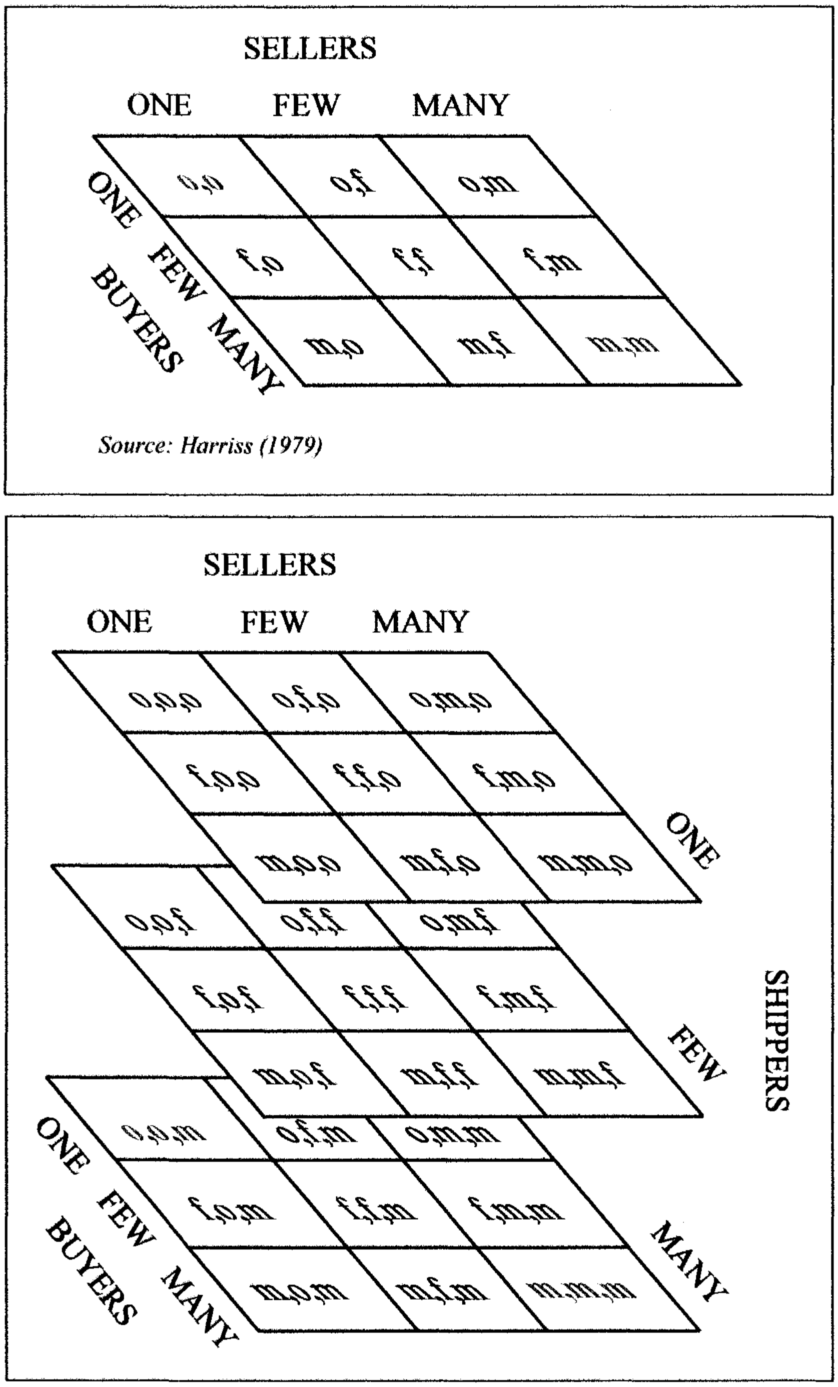
Harriss (1979) explained how analysts tend to limit themselves to markets with particular competitive structures, specifically in which there is a single buyer and seller or in which there are many buyers and sellers. The top panel in Figure 2.3 illustrates this explanation. When the markets are spatially dispersed, the transportation system linking these markets complicates Harriss' original point. With transportation, the possible combinations of Harriss' "one, few, many" classification expand three-fold. That is, the grid representing the number of buyers and sellers expands into a third dimension allowing for the extensiveness of transportation. The bottom panel of Figure 2.3 illustrates this point.[16]

With many combinations of buyers, sellers, and shippers, there are many different approaches to classifying the extent of the markets in space. The work by Pinkse et al. (2002) demonstrates one approach to identify market boundaries. The authors posit that the nature of spatial pricing among wholesale gasoline terminals across the United States is highly localized, and although many of their markets are located along pipelines, each of their four measures of closeness is a function of Euclidean distance. The model set forth by Pinkse et al. produces markets by connecting all terminals that share a nearest neighbor.[17] Each of these markets in turn represents a set of terminals whose prices are interrelated.

The approach by Pinkse et al. does not make use of the existence and structure of the pipelines connecting the terminals that are not necessarily closest in Euclidean distance, nor does it distinguish those marine terminals not on a pipeline network. Subsequently, many of their markets exclude relevant pipeline connections. For example,

[16] The "shippers" in this diagram could be interpreted literally as shippers, or more generally as a representation of the extent of the transportation system in place.
[17] Of their four measures, Pinkse et al. define the nearest neighbor as the terminal closest in Euclidean distance.

Figure 2.3 Diagram of Market Structure Possibilities



Source: Harriss (1979)

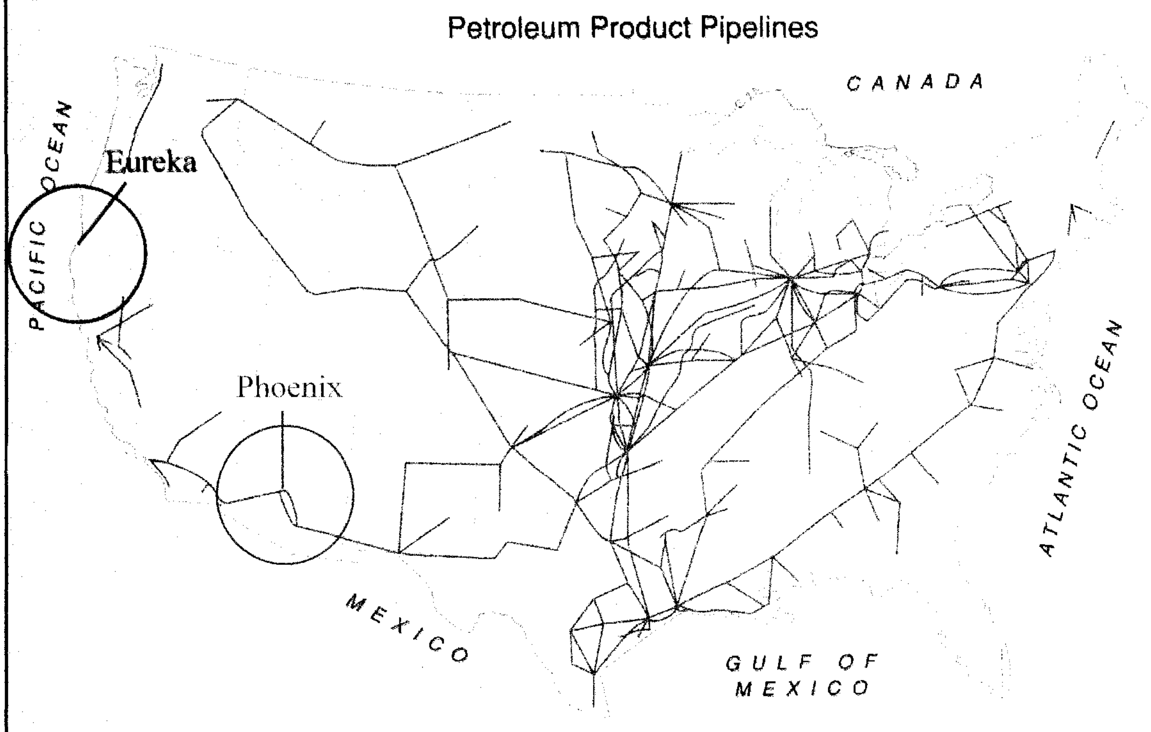
Figure 2.3: Diagram comparing market structure combinations with and without the explicit presence of transportation.

Eureka, CA, is a marine terminal area isolated from the pipeline networks in California, yet Pinkse et al. consider it part of the northern California pipeline market area. In contrast, Phoenix, AZ is a destination terminal along two pipelines, one from California and the other from Texas via Tucson, AZ. However, Pinkse et al. treat the Phoenix-Tucson pair as an isolated market. Figure 2.4 contains a pipeline map of the United States and a map of the Pinkse et al. markets. Eureka and Phoenix are located at the centers of the respective circles.

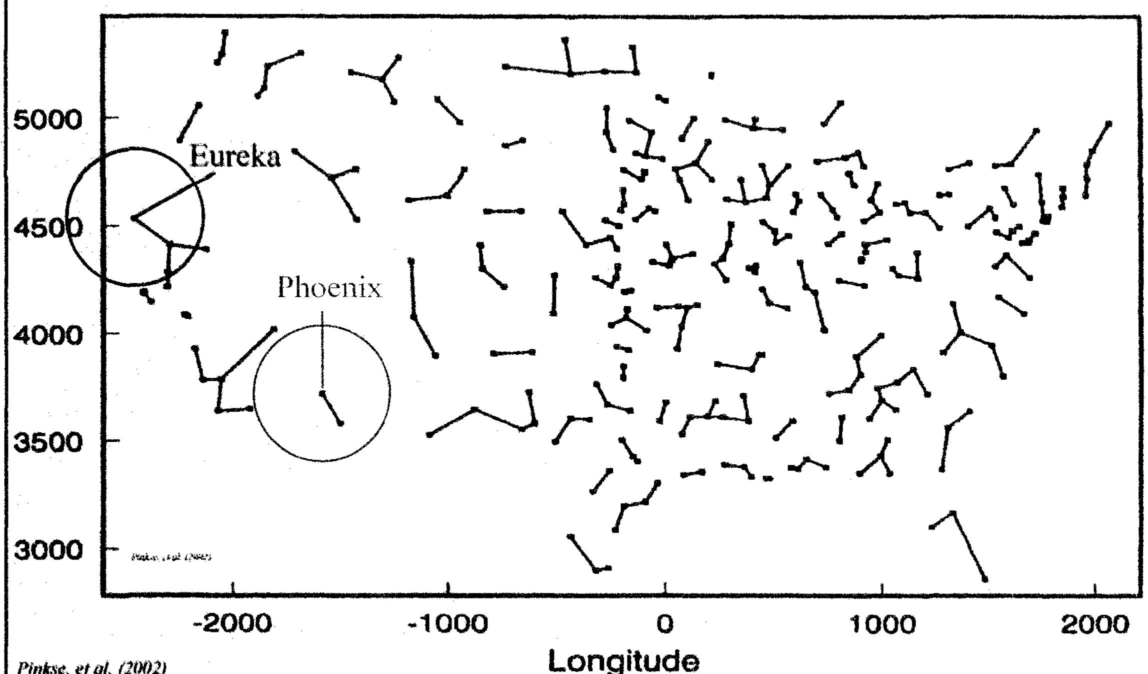
The markets Pinkse et al. define do not coincide with the market areas suggested by the layout of the infrastructure. This discrepancy is another example of how different rules of thumb for defining markets change the overall picture of an industry. The interrelatedness of prices as determined by arbitrage trades, and thus the integration of markets, ought to be related to the transportation infrastructure in some way. That is not to say that market delineations based solely on Euclidean distance must be wrong, but that such market definitions may appear contradictory to the infrastructure and organization of the industry.

A cursory glance at the spatial pricing of gasoline in Southern California engenders doubt that these prices are consistent with theoretical spatial price relationships. According to spatial price theory, product trade is a necessary condition for the integration of spatially separate markets. Implicit is the assumption that the markets themselves are well defined. The violation of any necessary conditions or implicit assumptions may produce the impression that the theory itself has been violated. However, in the case where some condition or assumption is not met, the theory becomes inapplicable. For example, if there is no product flowing between all of the markets in a

Figure 2.4 Comparison of Pipeline Markets and Nearest Neighbors



Source: National Petroleum Council, *Petroleum Storage & Transportation*, Volume V, 1989.



Pinkse, et al. (2002)

Figure 2.4: Diagram comparing the statistical markets of Pinkse, et al. to actual pipeline infrastructure.

marketing system, the markets will not be spatially integrated from a theoretical standpoint (regardless of statistical results) because a necessary condition is unmet. The prices in this system have no theoretical relationship, and may well appear to violate spatial price theory – but the theory should not apply!

2.4 Intra-market Spatial Price Relationships

In California, there is physical product flow in the marketing system, although infrastructure and supply contracting impose some restrictions on product movement. The importance of these restrictions will be examined in Chapter 3. Here, the focus will be on the implicit assumption that the markets under study are well defined. When a market comprises more than a single depot, application of spatial theory requires an assumption that the depots within that market are perfectly integrated. The very theory used to study the integration of markets in a system is assumed to hold true within each market. Could apparently odd behavior of inter-market spreads be the result of theoretically inconsistent intra-market spreads?

Spatial prices consistent with Augmented Law of One Price (ALOP) differ only by the cost of transacting between the relevant markets. Transaction costs are generally unobservable, but one known component of transaction costs is the transportation cost, which is used here as a proxy for the transaction costs. The transportation cost is commonly accepted as the fuel cost distributors incur by moving product between depots in a market, although other components contribute to transportation cost. Because OPIS does not disclose the locations of the specific terminals included in their price surveys, the precise distance between the relevant terminals is unknown. Fortunately, the locations of terminals (and, by extension, the distances between terminals) are matters of public record, available in OPIS' Petroleum Terminal Encyclopedia as well as in the phone book. Using this information, I can put bounds on the distance between terminals, and create a range of transportation costs to which to compare prices.

Table 2.2 lists some intra-market descriptive statistics for both gasoline and diesel. The first section presents descriptive statistics of the prices reported in each market. The table summarizes the market averages of the company-level statistics. Prices are reasonably consistent across markets for both commodities. The second section of Table 2.2 summarizes the transportation costs distributors bear when arbitraging across terminals within each market. This transportation cost is the same regardless of which product the distributor is transporting. The transportation cost is defined as the diesel fuel cost of traveling between terminals, per unit of product transported.[18] Specifically, for each market, the daily per-unit fuel cost is

*Daily Fuel Cost = [Distance * (Daily Diesel Price / Mileage)] / Truck Capacity.*

Because it is not known which specific terminals participate in the price surveys, the precise distance between each pair of companies is unknown. For the fuel cost calculation, a single distance, the maximum distance between two terminals within each market area, is used. By using the maximum distance, the daily fuel cost is biased upward. The resulting transportation cost is used for all companies in the same market. Distribution trucks run on diesel fuel, get between five and ten miles per gallon, and carry between 7,500 and 10,000 gallons of product. The fuel cost is calculated using a mileage of five miles per gallon and a capacity of 7,500 gallons. Use of these numbers, along

[18] Transportation costs comprise more than mere fuel costs, not least including the driver's wage. The DFC was augmented to include the national average hourly wage of liquids drivers, $15.78, which made no substantial difference to the analysis.

Table 2.2 Descriptive Statistics of Intra-Market Prices and Spatial Relationships: Gasoline

		Los Angeles	Colton	Barstow	San Diego	Imperial
Intra-Market Prices						
	Minimum	53.81	55.25	54.33	59.16	58.29
	Maximum	156.10	153.91	162.72	158.67	156.22
	Average	101.59	101.46	101.50	102.98	103.48
	Standard Deviation	19.10	18.43	19.39	18.53	18.46
Transportation Costs						
	Minimum	0.0359	0.0007	0.0000	0.0094	0.0000
	Maximum	0.0952	0.0017	0.0000	0.0240	0.0000
	Average	0.0633	0.0012	0.0000	0.0163	0.0000
	Standard Deviation	0.0121	0.0002	0.0000	0.0030	0.0000
Intra-Market Spatial Equilibrium						
	Minimum	0.00	0.00	0.00	0.01	0.00
	Maximum	27.94	24.25	21.75	27.24	22.55
	Average	5.09	4.83	5.15	6.47	5.04
	Standard Deviation	5.49	5.23	5.17	6.51	4.98

Descriptive Statistics of Intra-Market Prices and Spatial Relationships: Diesel

		Los Angeles	Colton	Barstow	San Diego	Imperial
Intra-Market Prices						
	Minimum	49.56	50.56	50.50	51.01	50.55
	Maximum	131.28	130.99	131.36	130.54	130.29
	Average	87.30	88.01	88.90	88.40	88.38
	Standard Deviation	16.66	16.71	16.48	16.33	16.45
Transportation Costs						
	Minimum	0.0359	0.0007	0.0000	0.0094	0.0000
	Maximum	0.0952	0.0017	0.0000	0.0240	0.0000
	Average	0.0633	0.0012	0.0000	0.0163	0.0000
	Standard Deviation	0.0121	0.0002	0.0000	0.0030	0.0000
Intra-Market Spatial Equilibrium						
	Minimum	0.00	0.00	0.00	0.01	0.00
	Maximum	14.88	14.25	12.05	14.77	14.50
	Average	1.10	1.08	0.89	1.16	1.07
	Standard Deviation	1.33	1.20	1.02	1.32	1.05

Table 2.2: Descriptive statistics of gasoline and diesel prices and spatial spreads, in cents per gallon.
Source: Oil Price Information Service and Kinder Morgan, Inc.

with the maximum distance between terminals within each market, creates an upward bias of the transportation cost calculation.

As an example, consider the Daily Fuel Cost for Los Angeles on July 14, 2001. The diesel price on that day was 78.39 cents per gallon. The maximum distance between terminals within Los Angeles is 27.2 miles. Thus, Daily Fuel Cost is

$$DFC = [\,27.2 * (78.39 / 5)] / 7{,}500 = 0.0569 \text{ cents per gallon.}$$

The third section in Table 2.2 summarizes the spatial relationships among company prices within each market. Intra-market spatial equilibrium occurs when[19]

$$|\,\textit{Price at terminal } i - \textit{Price at terminal } j\,| - \textit{Transportation cost between } i \textit{ and } j = 0.$$

This calculation is applied to each company pair within a market. The table summarizes the market averages of these company-level calculations. On the example date of July 14, 2001, consider two companies, B and C, supplying gasoline to their terminals in Los Angeles. The price of gasoline reported by company B was 82.00 cents per gallon, and the price of gasoline reported by company C was 73.00 cents per gallon. The intra-market spatial price relationship between the two companies in Los Angeles is

$$|\,82.00 - 73.00\,| - 0.0569 = 8.94 \text{ cents per gallon.}$$

The price of diesel reported by company B was 77.30 cents per gallon, and the price of diesel reported by company C was 78.50 cents per gallon. The intra-market spatial price relationship between the two companies in Los Angeles is

$$|\,77.30 - 78.50\,| - 0.0569 = 1.14 \text{ cents per gallon.}$$

If transportation costs are the only costs of moving product between terminals, then these intra-market spatial price relationships should be equal to zero. When there are additional costs to arbitrage that are not part of transportation costs, these intra-market

[19] These transportation costs proxy transaction costs. True spatial equilibrium pertains to all transaction costs.

spatial price relationships will be greater than zero. Notably, spatial relationships for diesel prices appear closer to the equilibrium relationship than for gasoline price. For both products, however, price spreads appear to exceed transportation rates. Figures 2.5 and 2.6 demonstrate this, by showing the average daily spatial price relationships for each market. While both gasoline and diesel demonstrate consistent violation of the basic spatial relationship applied in this chapter, gasoline shows far more variation and inconsistency than diesel.

Figures 2.5 and 2.6 illustrate the results by location, aggregating over some thirty individual company spreads. Aggregation, however, often covers some detail. To further investigate the spatial price relationships, particularly those seemingly odd price relationships of gasoline, consider a more disaggregate level of aggregation: branding designation. The products produced by well-known, name-brand refiners are classified in the industry as "branded" products, while those produced by smaller, lesser known refiners are classified as "unbranded" products. At the wholesale distribution level, branded gasoline is sold only under contract, with the rights to sell the brand as much a part of the contract as the product itself. Refer to Appendix A for an example of a branded contract.

Figures 2.7 and 2.8 show the same spatial price relationships as do Figures 2.5 and 2.6, at the company level for Los Angeles. For these figures, three representative company spreads are shown. These spreads are the arithmetic difference between company-level prices. The first spread, called the "branded spread" is the spatial price relationship between two branded companies in Los Angeles. The second spread, called the "unbranded spread" is the spatial price relationship between two unbranded

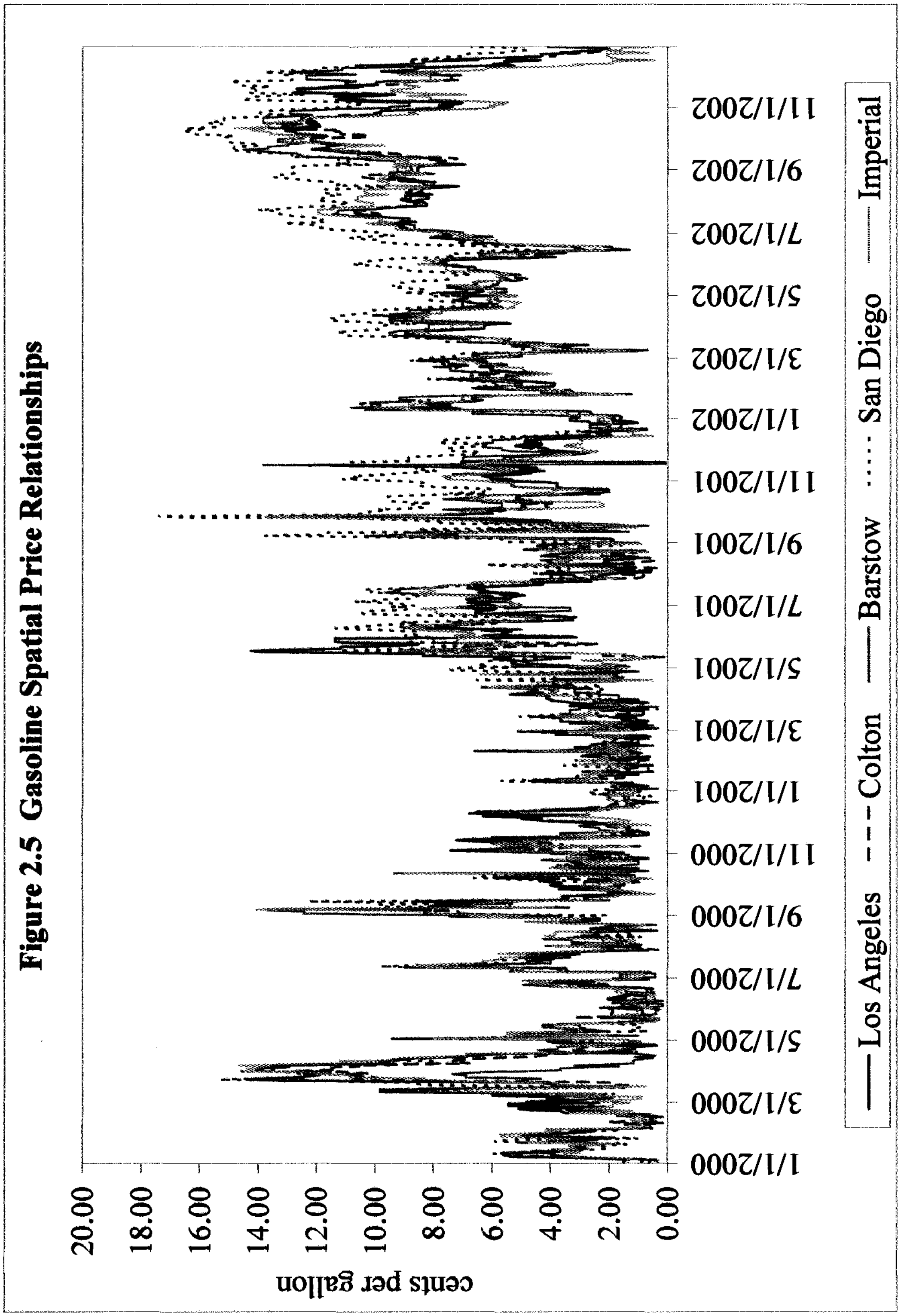


Figure 2.5: Spatial price relationships of aggregate gasoline prices.
Source: Oil Price Information Service and Kinder Morgan, Inc.

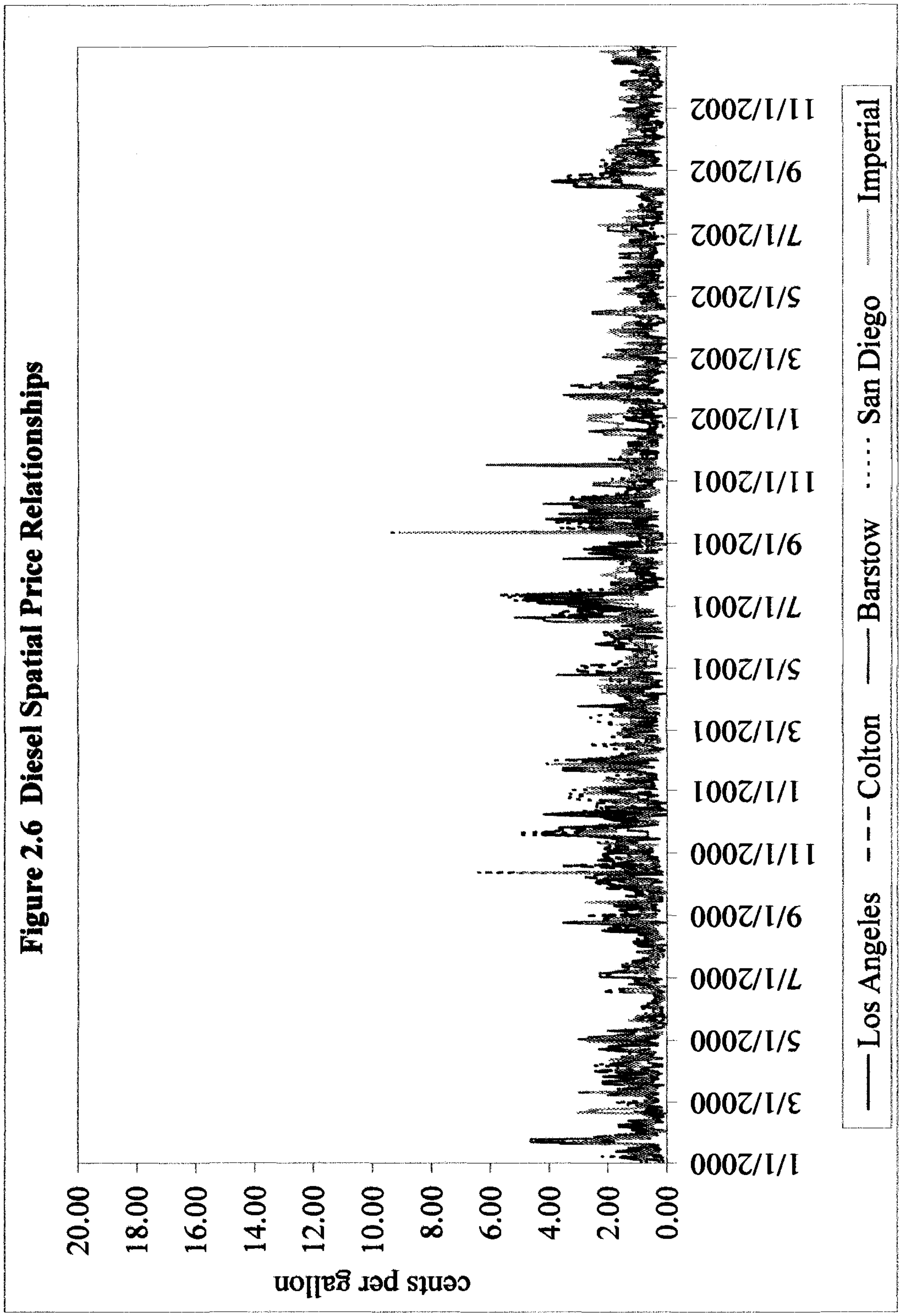


Figure 2.6: Spatial price relationships of aggregate diesel prices.
Source: Oil Price Information Service and Kinder Morgan, Inc.

companies in Los Angeles. The third spread, called the "branded-unbranded spread" is the spatial price relationship between a branded and unbranded company in Los Angeles. The difference between the prices of branded and unbranded gasoline represents the so-called brand premium, a generalized term used to describe the quantified value of franchising. The same companies are used for both the gasoline and diesel figures. Figure 2.7 demonstrates that the seemingly odd gasoline results are driven by the brand premium.

For the spreads that do not represent the brand premium, which are those spreads between companies of similar branding designation, gasoline actually appears to behave similarly to diesel, and more consistently with ALOP than aggregate the results, shown in Figure 2.5, suggest. Branding is a phenomenon that occurs only for gasoline, primarily for differentiating products at retail. There is no franchising or branding of diesel fuel. Because branding does not play a role in the diesel markets, Figures 2.6 and 2.8 are not noticeably different.

The same spatial relationships that Table 2.2 summarizes are applied to spatially nested markets centered on Los Angeles. The Los Angeles market is taken as central and the market boundary is expanded to include each successively distant market. The first nested market is Los Angeles plus Colton. The second nested market is Los Angeles plus Colton plus Barstow, and so on. Intra-market spatial price relationships, as defined on page 44, are calculated for each company pair in the nested market. The results are in Table 2.3.

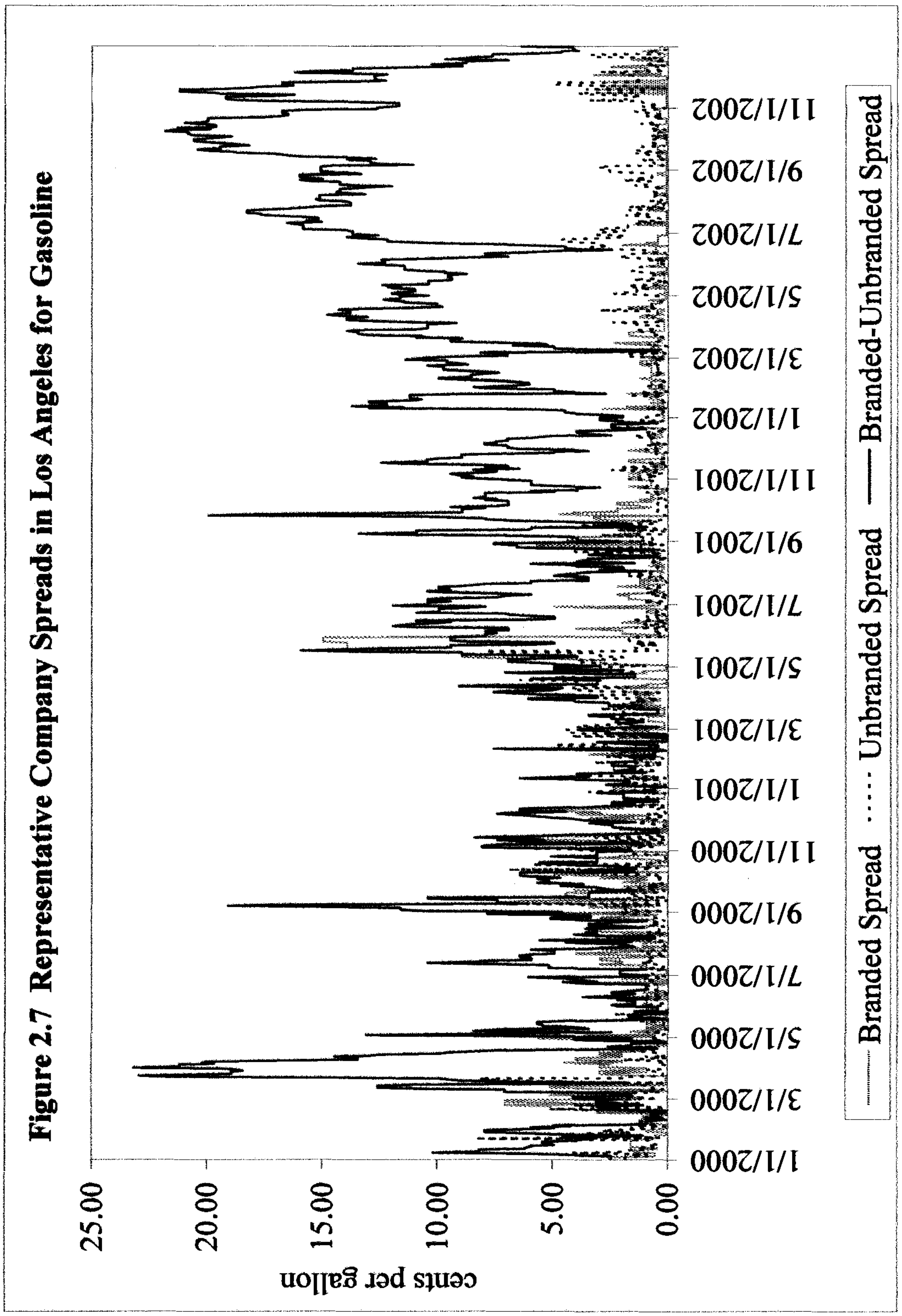


Figure 1.1: Spatial price relationships of representative company-level gasoline prices. Source: Oil Price Information Service and Kinder Morgan, Inc.

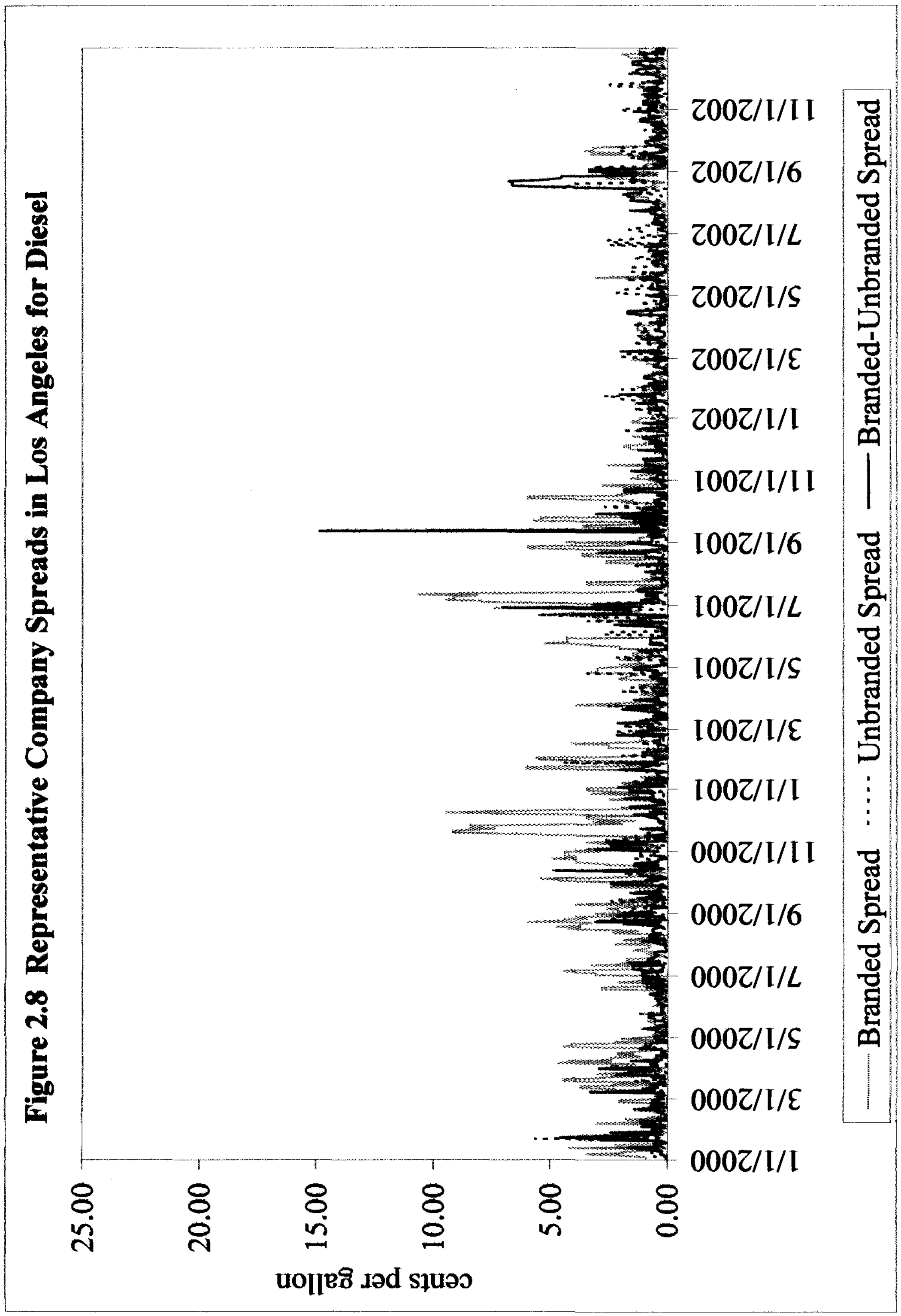


Figure 2.8: Spatial price relationships of representative company-level diesel prices.
Source: Oil Price Information Service and Kinder Morgan, Inc.

Ideally, the delineation of the nested markets would follow OPIS' own methodology for choosing representative terminals for each market. Recall that OPIS chooses the primary terminal for each supplier with multiple terminals in a market. By combining the Los Angeles market with those downstream, I am introducing multiple terminals for the same supplier. There is one price per supplier in Los Angeles, two prices per supplier in the Los Angeles – Colton nest, three prices per supplier in the Los Angeles – Colton – Barstow nest, and so on. Because I cannot replicate OPIS' method for choosing the representatives, I have chosen to keep all prices in the calculations.

The statistics in Tables 2.2 and 2.3 do not indicate any substantial problem with the delineations OPIS sets forth. All of the statistics are reasonably consistent across all markets. While the preliminary look at spatial equilibrium shows that both intra-market gasoline and diesel prices behave inconsistently with spatial theory, the transaction cost proxy may be inaccurate enough to produce a false sense of odd pricing behavior. Furthermore, the results indicate variation among products.

Table 2.3 Nested Spatial Price Relationships: Gasoline

		Los Angeles	LA + Colton	LA + Colton + Barstow	LA + Colton + Barstow + San Diego	LA + Colton + Barstow + San Diego + Imperial
Price Levels						
	Minimum	53.81	54.47	54.48	55.65	56.10
	Maximum	156.10	155.11	157.64	157.90	157.75
	Average	101.59	100.83	101.12	101.65	102.00
	Standard Deviation	19.10	18.57	18.80	18.71	18.68
Transportation Cost						
	Minimum	0.0359	0.0007	0.0000	0.0000	0.0000
	Maximum	0.0952	0.1960	0.4028	0.4254	0.7307
	Average	0.0633	0.0650	0.1339	0.1496	0.2429
	Standard Deviation	0.0121	0.0551	0.13873	0.13868	0.2517
Intra-market Spatial Equilibrium						
	Minimum	0.00	0.00	0.00	0.00	0.00
	Maximum	27.94	27.94	27.94	29.75	29.75
	Average	5.09	4.61	4.70	5.45	4.86
	Standard Deviation	5.49	5.17	4.92	5.45	4.71

Nested Spatial Price Relationships: Diesel

		Los Angeles	LA + Colton	LA + Colton + Barstow	LA + Colton + Barstow + San Diego	LA + Colton + Barstow + San Diego + Imperial
Price Levels						
	Minimum	49.56	50.06	50.21	50.41	50.44
	Maximum	131.28	130.78	130.90	130.81	130.70
	Average	87.30	87.66	88.07	88.15	88.20
	Standard Deviation	16.66	16.68	16.61	16.53	16.51
Transportation Cost						
	Minimum	0.0359	0.0007	0.0000	0.0000	0.0000
	Maximum	0.0952	0.1960	0.4028	0.4254	0.7307
	Average	0.0633	0.0650	0.1339	0.1496	0.2429
	Standard Deviation	0.0121	0.0551	0.13873	0.13868	0.2517
Intra-market Spatial Equilibrium						
	Minimum	0.00	0.00	0.00	0.00	0.00
	Maximum	14.88	15.48	15.48	15.48	15.48
	Average	1.10	1.07	1.14	1.17	1.29
	Standard Deviation	1.33	1.19	1.24	1.24	1.35

Table 2.3: Descriptive statistics of gasoline and diesel prices and spatial spreads in so-called nested markets.
Source: Oil Price Information Service and Kinder Morgan, Inc.

Chapter 3: Infrastructure and Day-of-the-Week Effects

Preliminary examination of spatial prices, as Figure 1.2 illustrates, indicates some price behavior that may be in violation of the ALOP. Further analysis, taking into account basic transportation rates, produced mixed results. According to Fackler and Goodwin (2001), a fundamental assumption of spatial price analysis is that the product under examination is homogenous, allowing location to be a differentiating factor. Transaction costs quantify spatial dispersion of locations by quantifying the economic differences between the commodities at each location. If the commodities are not homogeneous, then transaction costs comprise more than just transport costs. For example, the grade of gasoline is different in Phoenix than in Imperial. The transaction costs in this case comprise transport costs and the cost of refining California gasoline into Arizona gasoline (or vice versa).

The costs of transacting in space or time are an important aspect of market integration because they bind the equilibrium range of price differences. Although some are unobservable, "transaction costs" comprise many components beyond the widely acknowledged component of the freight cost of transportation. Other costs include those of information gathering, processing and other quality transformations, time required for delivery, and forgone opportunities in alternative locations or means of transportation. Both the physical infrastructure and the institutions surrounding the operation and use of that infrastructure contribute to transaction costs.

Methodologies, such as the threshold model implemented by Spiller and Huang (1986), have been developed to estimate transaction costs endogenously. The individual components of endogenously determined transaction costs are indistinguishable, and are collectively assumed to be random and stationary. Symmetric threshold models, as in Goodwin, Grennes, and Craig (2002), who examine perishables and refrigeration in the late 19th century, are susceptible to biases in estimation because the equilibrium price-difference band is centered on zero. Also see Bulow, et al. (2003). Outliers will tend to bias the band narrow and asymmetries in actual transaction costs, such as those resulting from unidirectional (irreversible) trade flows, will tend to bias the band wide. This is demonstrated in the work by Goodwin, Grennes, and Craig, reproduced here in Figure 3.1. The narrow and wide biases can be seen particularly in panels B and D, respectively.

Figure 3.1 Endogenous Transaction Cost Bounds

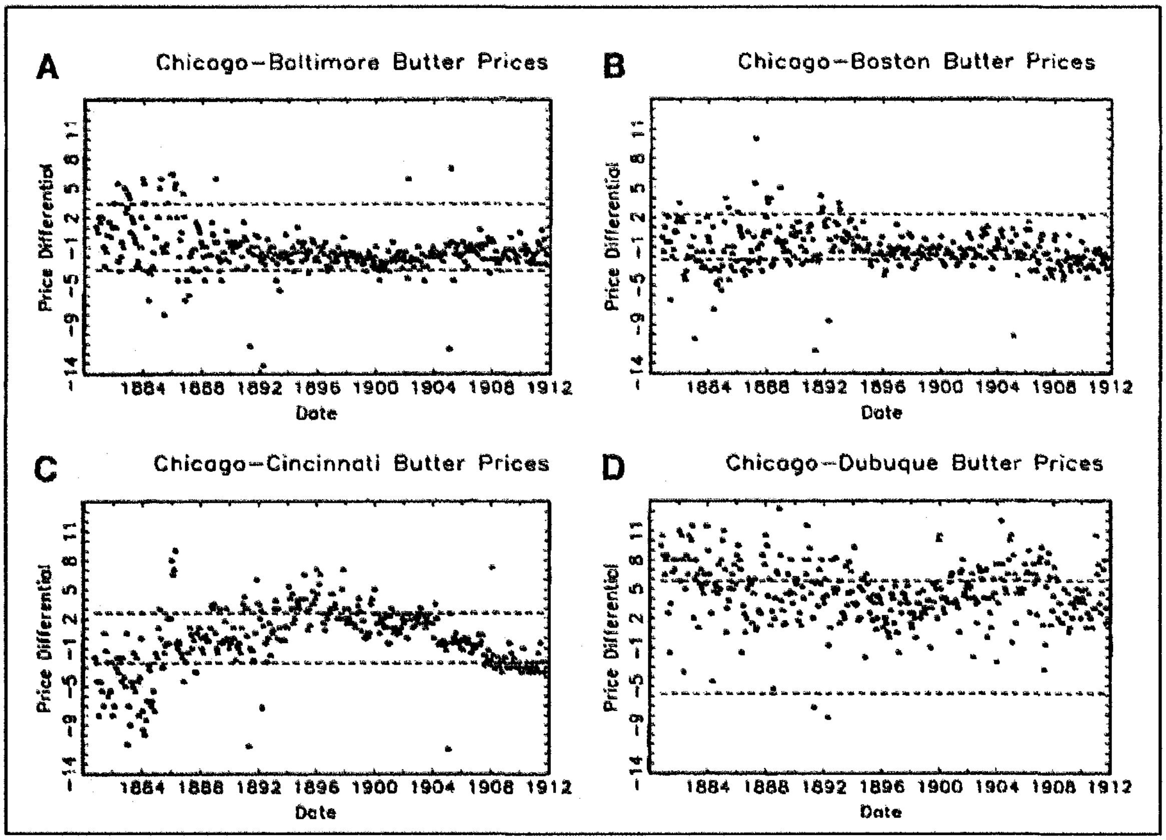


Figure 3.1: Figure of Goodwin, Grennes, and Craig showing estimated transaction cost bands. Source: Goodwin, Grennes, and Craig (2002).

These shortcomings of endogenous threshold models may be circumvented with the incorporation of observed transaction costs. Baulch (1997b) has developed a parity bounds model in which he does not assume transaction costs to be random, but rather makes use of a series extrapolated from the actual transfer costs observed at a single point in time. Although Baulch's is a simple model of transportation, the model has the advantage of basing the transaction cost estimates on actual rates, thereby reducing the likelihood of inaccuracies associated with the estimation of transaction costs that plague the endogenous threshold models.

Models like those of Goodwin, Grennes, and Wohlgenant (1990) and Protopapadakis and Stoll (1983), which explicitly estimate the equations describing the arbitrage regimes, use observable freight rates as a proxy for transaction costs. In these analyses, the transfer costs are neither estimated nor extrapolated, but are based on an observed series of rates. However, if the other components of transaction costs, presumed to be unobservable and unimportant by the authors, are indeed substantial, the observed freight rates will understate the true transaction cost. Understated transaction costs will consequently lead to an overstatement of unexploited arbitrage opportunities, or equivalently, an underestimate of the true degree of market integration.

Whether transaction costs are incorporated explicitly, as in threshold models, or implicitly, as in causality analysis, the costs typically are assumed to be stationary in time, space, and transport mode. Particularly with regard to the transportation cost component, this assumption is rarely justified. Transportation rates vary among locations, by mode and commodity, and over time with respect to location, mode, and commodity. Though stationarity affects cointegration analysis, the most explicit discussion of this issue exists in the regime studies, where transportation costs are explicitly modeled. Some analysts, such as Baulch (1997b), and Goodwin et al. (2002), incorporate nonstationarity in transportation costs.

3.1 The Characteristics of Trade Routes

When a market is segmented, transactions among markets are insufficient to equilibrate relative prices. If no trade routes exist, then markets will be segmented. In this context, "trade route" is not restricted to physical infrastructure, but includes all possible trade mechanisms, including paper markets. However, the existence of trade routes is not sufficient for market integration. Ideally, a study of integration will include both flow and price data. Presumably, any documentation of trade flows would inform an analysis. Consider, for example, the situation in 2003, when a pipeline carrying gasoline and diesel products from Tucson to Phoenix ruptured. As prices increased, the media began covering the situation, and the California government began commenting. Claudia Chandler of the California Energy Commission explained to the Daily News of Los Angeles that, "When a pipeline in Arizona can burst that's not even connected to California and can cause this much speculation, it shows how vulnerable we are."

Recall Figure 2.2, which is a diagram of the Kinder Morgan pipeline delivery system in the Southwest. The figure illustrates that California is indeed physically connected to Arizona via pipelines. Refineries in Los Angeles produce about 70% of the fuel consumed in Arizona, which is delivered weekly through the pipeline system. Thus, not only does a physical trade route exist, but also that trade route is used regularly. The mere knowledge of the existence and use of the pipeline infrastructure contradicts the statement of the California Energy Commission representative, and this knowledge can be used to better direct future investigations. More rigorous analysis of prices could determine the extent to which California is economically connected to Arizona; the issue of whether California is connected physically has already been resolved.

Price changes reflect not only changes in the relative demand of the product, but also the flexibility or inflexibility, as the case may be, of the system to respond to changing market conditions. There are, necessarily, some inflexibilities inherent in any system. The first inflexibility, to which every industry is subject, is time. Rarely is a process instantaneous, and time is irreversible. Irreversibility in time becomes a modeling issue when transportation takes longer than one period, as defined by the frequency of the data. Between two locations with no regulatory or infrastructural barriers to trade but where physical delivery takes time to complete, the relevant price at the destination is the price at the time when the product arrives. This price may be an expected future price, or, if it exists, an explicit forward price. The price for immediate delivery at the destination is irrelevant for traders with product at the origin, since they cannot deliver the product to the destination immediately. The unidirectionality imposed by the element of time is an issue faced in all commodity markets. Most integration models, however sophisticated their accounting for transaction costs has become, do not incorporate an expected future or explicit forward price.

Goodwin, Grennes, and Wohlgenant (1990) developed a rational expectations version of the Law of One Price (LOP), which does incorporate an expected future price. The LOP typically relates the domestic spot price to the foreign spot price and the exchange rate between the two countries. The authors substitute the expected future foreign price for the foreign spot price. In a comparison of models, they find fewer statistical rejections of the null hypothesis of market integration and a lower percentage of price differences outside the transaction cost band, and conclude that the rational expectations model performs better than the standard model of spot prices.

In California gasoline, there is an explicit forward market for waterborne cargoes. There are no data on record of forward contracting at the racks (wholesale terminals), although there is anecdotal evidence of such arrangements. There is no strong statistical relationship between the signal to store in Los Angeles, signified by the temporal price difference (forward price minus spot price), and the signal to ship out of Los Angeles, signified by the spatial price difference in rack prices. This result could be because spot and rack marketing levels are not comparable, or because separate contracting arrangements exist at each marketing level.

Like irreversibility in time, irreversibility in product flows is another issue that receives little attention. Physical infrastructure imposes inflexibility. In road transport, for example, roads are not everywhere dense, and delivery vehicles do not go where there are no roads. In more restrictive forms of transportation, the inflexibilities are greater. For instance, a one-way pipeline poses more restrictions on product flow than a two-way road.

Another source of inflexibility comes in the form of industry institutions. Inflexibilities of this form are not always apparent. Contracting, scheduling, production planning, and shipment quotas are all examples of potential inflexibilities in the industry. These are only potential flexibilities because it is not their mere existence that produces the inflexibilities, but rather the ease and ability to adjust within them. That is, a schedule that is fixed poses more inflexibility than one that remains changeable. Moreover, interactions of potential inflexibilities can create further inflexibilities. For example, a schedule that is fixed months in advance is less flexible than one fixed only a day in advance.

In the petroleum product industry, examples of all types of inflexibility can be found. Production planning and technology, delivery scheduling, transportation infrastructure, and supply contracting all introduce inflexibilities into the industry. Production decisions are typically set one-and-a-half to two months in advance, and are locked in once the crude oil refining process begins. This, of course, must be coordinated with crude oil procurement. The pipeline transportation system also imposes some inflexibilities in the system. The pipeline operator requires shipments to be scheduled one month in advance, and this schedule is locked into place one week prior to scheduled shipment. The inflexibility arrives from this practice of freezing the schedule, preventing adjustments to the schedule within that final week.[20] This practice has produced so much of an inflexibility that the industry has identified the resulting "nomination day shorts," created by shippers being unable to meet their locked-in obligations.

Physical infrastructure is inherently inflexible. There are only twelve pipelines connecting Los Angeles to its downstream terminals. These pipelines flow only in one direction, from upstream to downstream. The only injection points are in Los Angeles; all downstream terminals are receiving terminals only. (Thus, all products arriving downstream must have come from Los Angeles.) Pipelines deliver only to terminals, and terminals must locate reasonably near the pipeline. Each terminal, except for the Phoenix-Tucson pair, has only one route serving it.

[20] The pipeline operator will accept emergency adjustments, as it sees fit, in extenuating circumstances.

The flow of products along trade routes is as important to integration studies as the existence of transportation infrastructure among markets. Restrictions on the use of a trade route, such as unidirectional product flows, naturally limit an arbitrageur's ability to respond to an apparent arbitrage opportunity. Analysts typically assume that each of their markets under study has a bidirectional, non-capacity-constrained, infrastructural connection with every other market in their study. Such a "perfectly connected" transportation system allows trade between any two markets in either direction. Unidirectional trade flows can exist for many reasons, such as different transport modes in either direction or the physical structure of the infrastructure.

An obvious case of a directional restriction applies to pipelines, where engineering restricts the flow to one direction. De Vany and Walls (1993), who investigated integration among natural gas city gates, did not consider the unidirectionality of the natural gas pipelines, but rather assumed that each network examined was perfectly connected.[21] Thus, they tested the integration of a restrictive, unidirectional network they implicitly assumed to be perfectly connected.

The importance of incorporating physical infrastructure into an integration model increases with the presence of restrictions on the pipeline operation (e.g., a unidirectional flow), and the hypothesis tested is actually a joint hypothesis of integration and perfectly connected infrastructure. Indeed, De Vany and Walls tend to reject integration more frequently when the assumption of perfect connectivity is more inappropriate. Their assumption about the perfect connectivity of natural gas pipelines is implicit in their VAR model, because they assumed that arbitrage is possible among every city gate in the

[21] The authors discuss a distinction between direct (physical) connections and indirect connections via additional markets, but no such distinction is made in their model.

group of markets they studied, and included the prices of each of these city gates. Had they wanted to allow unidirectionality of natural gas flows, they could have excluded the prices at the "downstream" city gates from the explanatory variables of "upstream" city gate price. The typical VAR model, however, does not account for restrictions on product flows.

Unlike pipeline delivery, product traveling by ship or truck may be diverted to alternative destinations. However, each mode has inflexibilities of its own. Waterborne transport is the slowest form of transportation, and ships can only offload at marine terminals located in water deep enough to accommodate product tankers. Road transport provides the most freedom in routing, but trucks can only carry relatively small quantities and are often contractually restricted to specific loading and delivery locations.

Analysts who impose both upper and lower bounds in their models of price differences implicitly allow reversibility in time or product flow. This is true of both symmetric bounds (where transaction costs are assumed to be the same in either direction) and asymmetric bounds, provided both boundaries are finite. It is natural, and indeed appropriate if location is truly the only difference, to imagine symmetric conditions for each direction of trade. However, if there are any "asymmetries" in reality, such as variations in transport modes or costs, symmetric conditions are no longer applicable. Irreversibility in direction or time makes even asymmetric bounds inapplicable, for irreversibility effectively means that one of the boundaries is infinite. Mistakenly allowing reversibility may increase the likelihood of empirically rejecting integration, because allowing reversibility binds otherwise infinite transaction costs.

3.2 Transportation Capacity

Capacity within the transportation system is never assumed to be a binding constraint in studies of integration, yet constrained capacity is a common occurrence. Trade routes that are fully capacity constrained are in some cases analogous to non-existent trade routes: no additional units can move between locations on routes with no excess capacity. The issues of capacity and accessibility are nearly one and the same. An inaccessibility of transportation services means the transportation sector, as a whole, has reached capacity. However, even if capacity is not binding, the possibility of capacity constraining product flow may induce behavioral changes by the relevant market agents. Imagine a threshold, which, when volumes exceed that level, triggers a change in pricing or a search for alternative trade routes.[22] If such a threshold exists, then analyses of price series that ignore such behavior may falsely reject market integration. Transaction-cost-threshold models may be particularly biased by the non-constant behavior of transactions costs implied by "capacity thresholds."

When a petroleum product pipeline reaches capacity, the carrier typically prorates shipping rights on the pipeline. This apportionment effectively restricts the ability of any one company to supply product to a terminal along the prorated line, no matter the apparent arbitrage opportunity. Product supply may also be delayed on water routes through the Panama Canal because only one ship may pass through the canal at a time. While the typical waiting time at the canal is 48 hours, delays can be as long as 192 hours (Laughlin, 2002). When such delays occur, the spot price at the destination is no longer relevant for discerning actual arbitrage opportunities. An analysis of spot prices under

[22] In gasoline, several approaches are used to deal with capacity constraints, including proration, purchase restrictions, and explicit pricing signals.

conditions of transportation delays may detect what appear to be, but are not, unexploited "arbitrage opportunities," thus increasing the likelihood of falsely rejecting the hypothesis of integration.

The issues of transport mode capacity and transportation system capacity are worth distinguishing. In multimodal transportation systems, a binding capacity in one type of transportation may induce substitution into other modes. This substitution is missed in models assuming homogeneity in transportation. If the system as a whole reaches capacity, then no further substitutions can be made, and no increases in product movements will occur.

Water transportation of gasoline could be affected by system-wide capacity constraints. The Jones Act requires all products that move between United States ports to be carried on United States flagged vessels (i.e., ships that are owned, built, and crewed by the United States firms). The Jones Act fleet consists of over 44,000 vessels, but only just over 200 of these are coastal and limited-coastal barges and tankers certified to carry gasoline and other clean petroleum products.[23] Most of these vessels are contracted on a spot, per-delivery basis, and must service over 500 coastal marine terminals in the contiguous United States. Given the limited number of vessels and large number of marine terminals, it seems possible that vessels do not continuously service each marine terminal, as is implicitly assumed in most integration studies, but rather deliver product to each terminal more sporadically.

Furthermore, the frequency of deliveries to each marine terminal may differ by location and over time. The transportation of gasoline on a barge among Spiller and

[23] Clean products include diesel, gasoil, jet fuel, kerosene, and naphtha. Alternatively, dirty products include crude oil and fuel oil.

Huang's five locations in New England requires the availability of a clean Jones Act barge that has not already been allocated to other products or locations. The absence of an appropriate United States flagged ship in the Northeast or the inaccessibility of space on a nearby vessel induces delivery lags not unlike those caused by a prorated pipeline. Though very real, these considerations are eliminated with the assumption of excess system capacity.

Capacity constraints may result in transactions extending over more than one period, which undermines the basic assumption of many market integration models that transactions are instantaneous. Indeed, models such as the transaction-cost-threshold model developed by Spiller and Huang are most appropriate when transactions are instantaneous even if the shipments are not. However, transactions are not instantaneous when it takes more than one period to gather information, arrange the transportation, and make the physical delivery. A likely source of delivery lags among northeastern gasoline terminals is the time spent arranging transportation. The limited availability of United States flagged ships certified for clean product transportation may induce delays in barging product between locations. With weekly observations of prices, one to two days each for loading and unloading the vessel along with a one-day voyage between locations leaves only two to four days slack. Further, delays in nominations may occur with different likelihoods and durations over time. Delays in nominations will be a problem if they last longer than the 2 – 4 day slack period. How such delays affect Spiller and Huang's analysis is not clear, given the asymmetry in the periodicity of their "weekly" data set.

In general, the shorter the length of time between observations, the more likely the data will contain a lagged structure. However, lengthy delivery is not the only cause for lags in price adjustments. Other causes include supply disruptions and industry market power. See, for example, Borenstein and Shepard (2002) for a discussion of the effects of industry market structure on price dynamics. Moreover, the length and duration of a lag may be endogenous to the contemporaneous market conditions. For example, delivery and transaction lags may increase when transportation capacity becomes binding or when there is a negative production shock.

The possibility of lagged structures in the data has led to the development of dynamic integration models, which use lagged variables to capture these effects. Many authors, including Slade (1986), Goodwin et al. (1990), Sexton et al. (1991), De Vany and Walls (1996), and Sajuán and Gil (2001) incorporate lagged prices to control for delivery lags, but do not discuss the reasons for lags. In most cases, these dynamic studies rely on statistical techniques to determine the optimal number of lags necessary to control for delivery, but in the presence of other causes of lags (like production shocks), the statistically determined lag length is only an average of all lag effects.

Like capacity, market power in the transportation sector is rarely addressed in studies of integration. It is typical to assume that transportation services are readily available, meaning the capacity, accessibility, and speed of all transportation modes do not restrict the arbitrageur's response to large price differences. However, the presence of imperfect competition in transportation services may inhibit arbitrageurs' responses if their access to the necessary transportation is restricted.

De Vany and Walls (1993) examine a related issue in their study of natural gas markets: the effects of deregulation in the United States. The authors' presumption is that the regulation, which restricted access to natural gas pipelines, limited the integration of natural gas markets. Based on cointegration analysis of city gate pairs over a period encompassing the deregulation, they conclude that the deregulation increased the degree of integration in the national natural gas market. In this analysis, though, they assume the natural gas network is perfectly connected throughout the period, including those years prior to the deregulation. As discussed above with De Vany and Walls (1996), this likely biased their results, particularly before deregulation, against integration.

The existence of infrastructure and the operability of that infrastructure are fundamental characteristics of inter-regional trade. Inhibitions of physical product movement, such as irreversibility of flow and time, capacity constraints, and delivery lags, delay the transmission of shocks among markets. Because of these delays, the absence of these characteristics in a model of integration likely influences the empirical results. Irreversibility of flow and time also tend to increase the likelihood of empirically rejecting integration. Prices can move independently against the irreversible direction of flow, and can give the false appearance of unexploited arbitrage opportunities when a bound is inappropriately imposed in the analysis against the irreversible direction of flow.

3.3 Day-of-the-Week Effects

Inflexibilities in the industry often affect product prices. For example, consider the institutions surrounding the scheduling and operations of the pipelines. The pipeline cycle is seven days, beginning every Thursday. Products are shipped in a particular order, on particular days, set by the pipeline operator. In the Southwestern system, the gasoline products are shipped early in the cycle, followed by distillates (i.e., diesel), and ending with more gasoline products. Each scheduled shipment can be altered up to seven days prior to shipping, at which point the schedule is "frozen", and the shipping obligation becomes firm. The product must be in queue at the pipeline pumping station 24 hours prior to shipping.

There is an asymmetry in time in the injections and withdrawals of gasoline and diesel, and in the timing of the frozen gasoline and diesel schedules. Accordingly, daily prices exhibit patterns that correlate with the day of the week. Since gasoline and diesel are shipped in separate parts of the cycle, any price effects stemming from scheduling freezes, nomination day shorts, and transportation logistics should show up on different days for the two products. Figures 3.2 and 3.3 illustrate the average prices of gasoline and diesel, by weekday of the cycle.

Gasoline and diesel exhibit the same U-shape pattern, with gasoline shifted earlier in the week. The week days on which the lowest prices occur, on average, for the two products are consistent with each product's place in the cycle. Logistics of pipeline operation preclude continuous supply of all products; while the flow within the pipe is continuous, the batching of products makes the arrival of particular products discontinuous. The lowest product prices, on average, coincide with the days on which the system is supplied with that product.

The pipeline cycle allows more days of gasoline delivery than diesel. As such, the difference between the lowest and highest average prices is smaller for gasoline than for diesel. That is, the U-shape line is flatter for gasoline. Table 3.1 lists the difference between the highest and lowest average prices by location and product. These curves retain their U-shape because of the discontinuity in supply, caused by the logistics of the delivery infrastructure.

Table 3.1 Difference in Average Weekday Prices					
Gasoline	Los Angeles	Colton	Barstow	San Diego	Imperial
Highest Price	101.54	101.35	101.39	102.89	103.39
Lowest Price	101.69	101.55	101.63	103.06	103.55
Difference	0.15	0.19	0.23	0.17	0.15
Diesel	Los Angeles	Colton	Barstow	San Diego	Imperial
Highest Price	87.11	87.82	88.70	88.18	88.18
Lowest Price	87.48	88.22	89.07	88.59	88.57
Difference	0.37	0.40	0.37	0.41	0.39

Table 3.1: Statistics showing the difference in the highest and lowest average product prices in each market .
Source: Oil Price Information Service.

The curves for Los Angeles, which is generally referred to as the source of the pipeline, retain the shape of the curves for the downstream destination markets. This is because the terminals in Los Angeles must be supplied with product just the same as terminals outside of Los Angeles. Fuel arrives to all terminals, inside and out of Los Angeles, through pipelines. Fuels must be batched in the pipelines, creating a discontinuous supply to all terminals in the system.

The institutions surrounding ordering and trucking gasoline, disallow arbitrage of the temporal price differences created by the characteristics of the pipeline system. Arbitrage of the temporal price differences would require jobbers to buy product, one truckload at a time, and hold the product for two to three days, during which they could not deliver fuel, as their truck would be converted to storage. Not only is this unlikely behavior for mere hundredths of a cent profit, but the organization and operations of truck delivery companies preclude such behavior.

Jobbers act on retailers' requests. When a retailer needs fuel, he calls the distribution company to place an order. The orders are for same-day or next-day delivery. Any attempt at temporal arbitrage is made by the retailer, who must decide whether to place an order before or after midnight (when wholesale prices change), depending upon his expectations of changing market prices. The individual jobber receives the order and delivery instructions from the dispatch center, which coordinates all orders and deliveries. Truck distribution to retailers is not forward contracted; the transactions are on-the-spot. The individual jobber is not given the option to buy low, store for two days, and sell high. Moreover, jobbers markup the product they sell, setting their margin at an average 10 cents per gallon. This markup remains earned whether the product is bought and sold at the weekly low price, the weekly high price, or some combination of the two.[24]

These day-of-the-week effects are artifacts of the logistics of pipeline delivery. Continuous spot transactions by the truckload do not counteract the discontinuous influx of large pipeline quantities of fuel.

Several economists studying gasoline market integration have chosen to aggregate daily prices to weekly by choosing for each observation the lowest price of the week. This is in fact what Spiller and Huang (1986), Slade (1986), and Spiller and Wood (1988), among others, have done. These authors justify their subset with the reasoning that the lowest price is most affected by competition, less likely to be discounted, and closest to the transaction price. Analysts participating in State-sponsored investigations choose instead to average prices by week or month. In either case, the temporal aggregates do

[24] Jobber markup is often set specific to each retailer, depending upon the business relationship.

not seem to capture as well the specifics of pipeline distribution or to acknowledge changing lags.

While the average prices show strong day-of-the-week effects, as Figures 3.1 and 3.2 demonstrate, the proportion of low prices by day of week shows more variation. Table 3.2 shows the frequency in which the low price of the week occurs on each weekday.

Table 3.2 DOW Effects: Percentage of Days on which Price is at Weekly Low

Gasoline		Los Angeles	Colton	Barstow	San Diego	Imperial
	Monday	17.27	15.04	20.00	15.93	14.16
	Tuesday	16.36	**23.01**	17.27	17.70	16.81
	Wednesday	**21.82**	18.58	**22.73**	**20.35**	17.70
	Thursday	14.55	15.04	19.09	17.70	17.70
	Friday	16.36	16.81	12.73	18.58	**23.01**
	Saturday	13.64	11.50	8.18	9.73	10.62
Diesel		**Los Angeles**	**Colton**	**Barstow**	**San Diego**	**Imperial**
	Monday	17.81	18.00	18.71	15.28	17.36
	Tuesday	19.18	**21.33**	20.14	**23.61**	20.14
	Wednesday	19.18	20.00	18.71	20.83	**22.22**
	Thursday	**24.66**	18.00	**23.02**	20.14	**22.22**
	Friday	16.44	18.00	16.55	15.97	15.28
	Saturday	2.74	4.67	2.88	4.17	2.78

Table 3.2: Day-of-the-Week effects in gasoline and diesel prices.
Source: Oil Price Information Service.

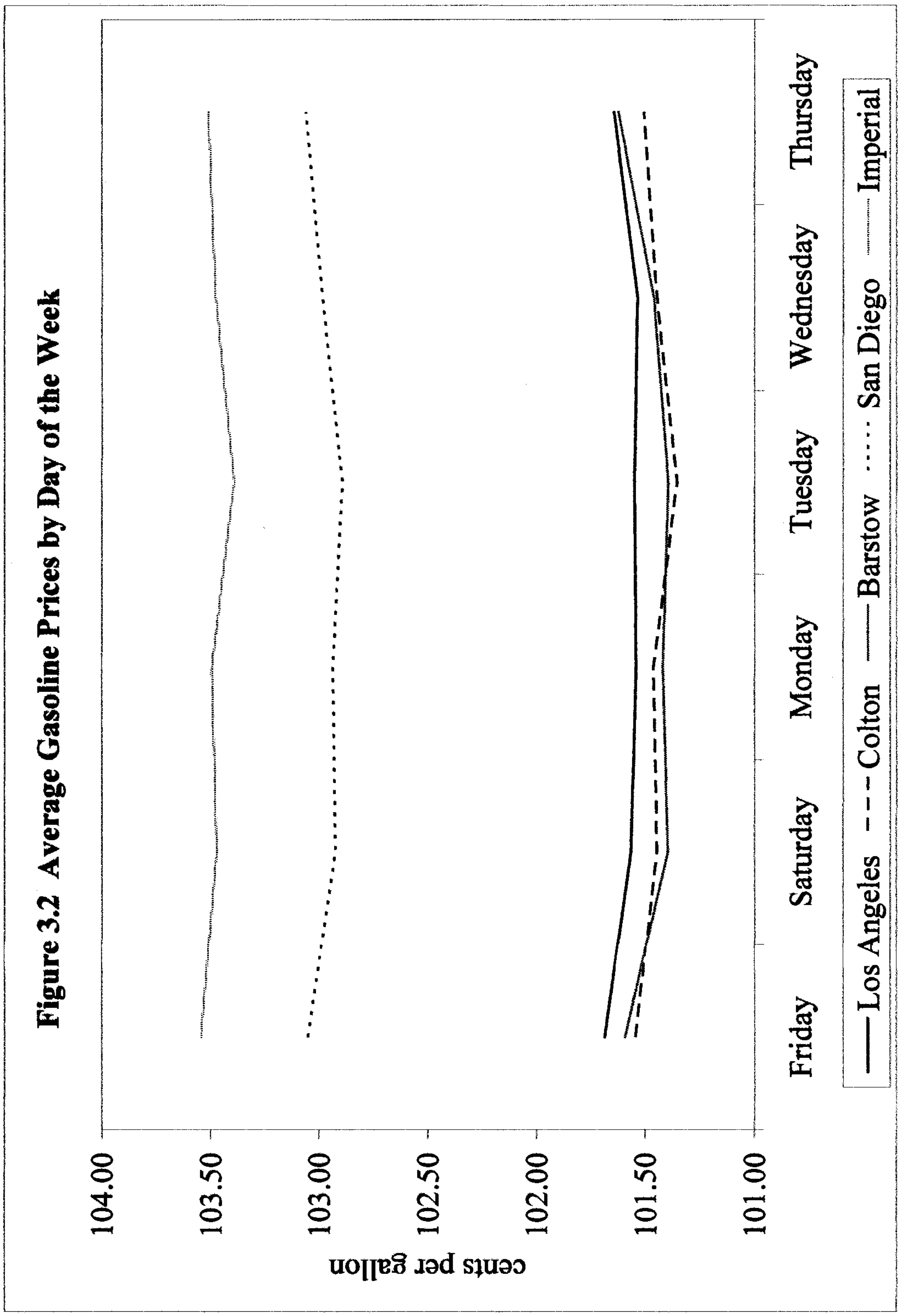


Figure 3.2: Average gasoline prices by day of the week.
Source: Oil Price Information Service.

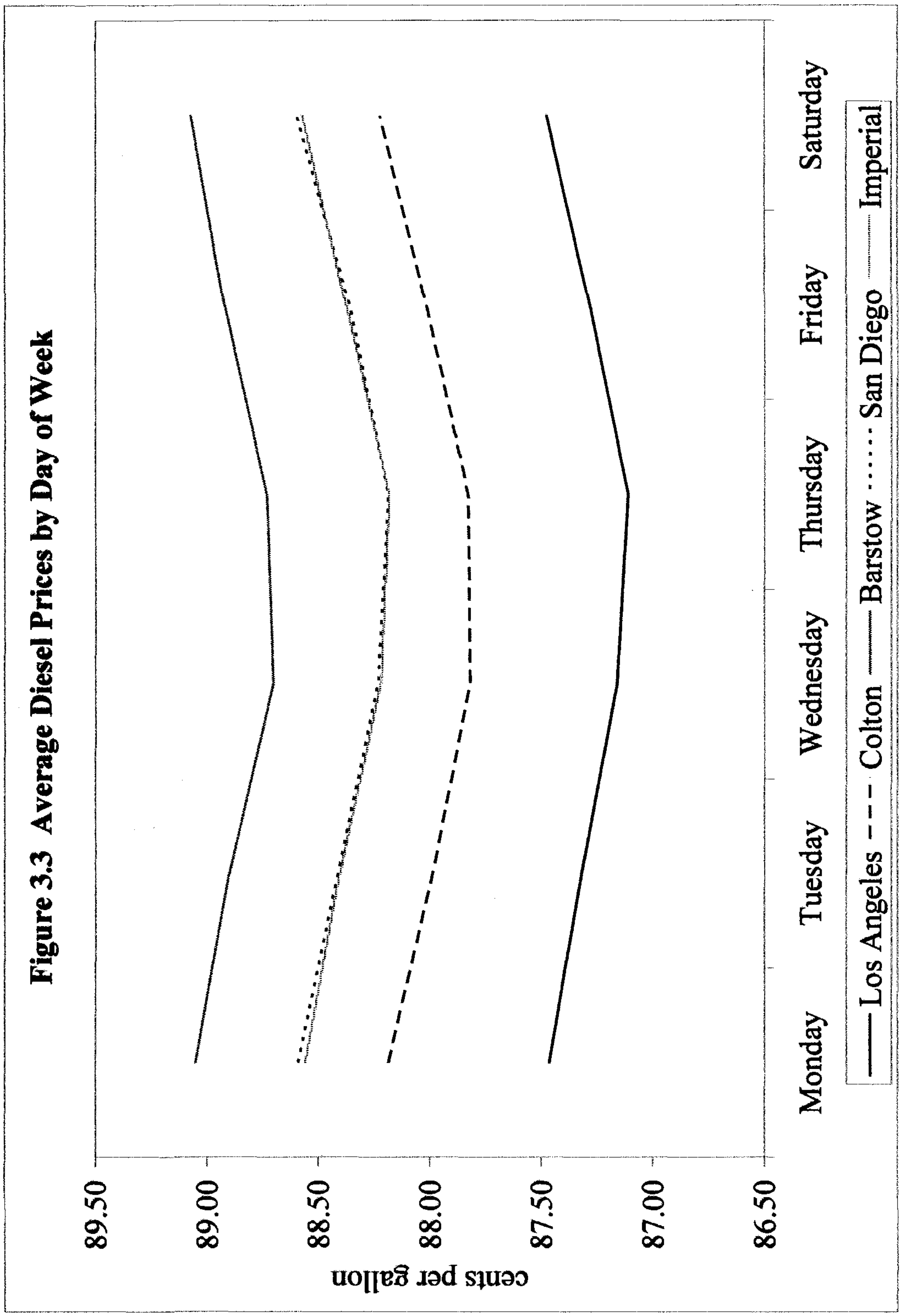


Figure 3.3: Average diesel prices by day of the week.
Source: Oil Price Information Service.

Chapter 4: Spatial Linkages

Since the advent of time-series methodologies, price series at several locations have been the center of many analyses. Availability and relative quality are the main sources of attraction to these data. The emphasis on no-arbitrage conditions, expressed as price relationships, has led to the use of time-series methods in models of market integration. Moreover, there has been a general trend to accept price-based integration models for their apparent universality in commodities. However, there are many shortcomings of the application of typical time-series analyses to models of market integration. While prices reflect conditions within a location, and price differences reflect relative conditions between locations, prices and differences by themselves do not reveal much about the underlying conditions. In fact, prices and differences cannot be decomposed into the individual causative economic components without additional information.

The presumption that an analysis of prices alone can be indicative of the nature and efficiency of trading between locations, therefore, is not well founded. Stigler and Sherwin (1985), advocates of price correspondence analysis, turned to supporting data to reinforce their analysis. Slade (1986) authenticated the results of her causality analysis with structural evidence about the transportation of gasoline and the nature of competition at wholesale terminals. De Vany and Walls (1993) predicted the results of their cointegration analysis of natural gas city gates with knowledge of the regulatory environment during their sample period. Information about the industry, even if it is not in the form of clean, high quality, quantitative data, can be of much use.

Relevant information is generally lost with the over-emphasis on specificity of an analysis. Much effort is put into narrowly defining a problem, for simplicity of modeling and ease in interpretation. However, simplifying assumptions and narrow definitions complicate interpretations, rather than easing them, when they result in the omission of pertinent information. Seemingly straightforward features of these models, such as a narrowly defined commodity, paired markets, and excess capacity in transportation, create complex biases, the individual effects of which are difficult to identify, and collective effects of which are indeterminate. Furthermore, these complexities have components that are specific to individual industries, thus refuting the notion that these models apply uniformly to any commodity.

Moreover, specificity in the benchmark analysts use to assess the performance of econometric tests of integration may cause a stronger-than-necessary criticism of such methodologies. The benchmark of a Samuelson-like perfectly competitive spatial system is seemingly implicit in most analysts' minds. This presumption is made explicit in the work of Baulch (1997a) and McNew and Fackler (1997), who use data simulated from a Samuelson-like world to assess the performance of econometric tests. Their point that a set of assumptions about the system are implicit in econometric tests is well founded. The problem, per se, does not lie in the methodology, but in the application of the methodology, which is inherently dependent upon the set of assumptions the analyst has applied, usually implicitly.

4.1 System-Wide Analysis of Daily Prices

To this point, no distinction has been made between systems of two and more than two locations. Although it is true that most analyses are of multiple locations, the locations are first paired, either with every other market (Spiller & Huang, 1986) or a pairing rule, such as proximity (Pinkse et al., 2002) or product characteristics (Sanjuán & Gil, 2001). Ultimately, all transactions over space can be simplified to a pair of markets: the source market and the destination market. The transaction between this pair comes at an opportunity cost of transacting with any other potential source or destination in the system.

Transport decisions are simultaneous in part because the transportation infrastructure is shared among locations. Recall that the five locations in Spiller and Huang's (1986) analysis all share petroleum product barges. The availability of these barges itself is likely to be endogenous to the market conditions. The availability of a barge at any given location is in part dependent upon the likelihood of that location functioning as an export market. In turn, the likelihood of a location functioning as an export market depends upon the availability of transportation services.

When several markets share transportation infrastructure, there is an opportunity cost associated with transportation to any particular market. A similar opportunity cost exists with the use of one transportation mode in systems with transportation alternatives. The opportunity costs associated with the choice of a particular location and method of transport are analogous to the opportunity costs of holding inventories in a model of storage. The decision to ship to location A using mode 1 requires a comparison between the expected gain in commodity value associated with trade to location A and the forgone value associated with not trading to location B or not using mode 2. If transportation services are always readily available, as is typically implicitly assumed in integration models, the opportunity costs of foregone alternative destinations and transport modes are not recognized. Effectively, the opportunity costs are assumed to be zero, which causes an under statement of the transaction costs and consequently increases the likelihood of an empirical model rejecting the hypothesis of market integration.

When there are alternative transportation routes and modes, the product flow may become discontinuous between any two locations. Discontinuity in trade may cause spot prices to vary independently, which is interpreted in many empirical studies based on spot prices as a lack of integration because models of integration are based on an assumption of continuous product flow. Even in a two-location, one-transport-mode system, discontinuity may arise with seasonality in crop production, absence of shocks, or increases in transport-mode demand from other systems. The subsequent independence in prices, however, is not the result of market segmentation – that there are responses in the system suggests the opposite – but is simply indicative of system-wide characteristics omitted from the empirical model.

Sanjuán and Gil (2001), who examined weekly prices of pork and lamb, recognized the potential advantages of a system-wide analysis. They estimated a simultaneous system of prices with a multivariate cointegration procedure. Though their goal was to account for the possible simultaneity among all relevant prices in their system, they resorted to pairwise restrictions on prices to identify the cointegrating vectors. In particular, they first paired the central market price with every other price, and then imposed the restrictions that each of the price pairs must be cointegrated and satisfy the parity condition.

Pairwise analyses also fail to account for the relative location, or spatial configuration, of the locations. The configuration is actually trivial between two locations, in the sense that a model of a location pair cannot distinguish any configurations in the system from that of a line. However, if there are more than two markets in a system, the interactions among those markets, which are influenced largely by their configuration, could well differ in reality from the model's predictions based on linearity. Spiller and Huang implicitly assumed a linear configuration of their locations. In their justification of pairing locations, they claimed that additional markets in the system would not affect the arbitrage trades between their main location pair. Rather, the additional market would become an intermediary, accepting the low price region's exports and exporting to the high price region. This will generally only occur with a linear configuration. Slade (1986), in justifying the use of time-series methods, also assumed a linear configuration. Her justification makes explicit use of linear configurations. Ravallion (1986) departs from the typical linearity assumption. Instead, markets are assumed to have a radial configuration, where there is one central market exporting to consuming regions that are independent of one another.

Integration analysis is typically restricted to two self-sufficient locations that continuously trade on one trade route with one transport mode in excess capacity. The presence of alternatives fundamentally changes the interactions between any two locations. If this fundamental difference in locational relationship is left unaccounted, econometric error terms become serially correlated, prices are left unexplained, and empirical results will tend to falsely reject integration.

If two identified markets are in fact self contained, and are perfectly segmented but share similar economic conditions, their prices may be highly correlated. A well-known shortcoming of price correlation and cointegration analyses is an inability to distinguish the effects of common economic conditions among segmented markets from causal price linkages among integrated markets. These shortcomings are identified in a number of studies, beginning with Harriss (1979), and are scrutinized by Baulch (1997a), and McNew and Fackler (1997). The latter two studies, for example, use data generated from simulations of integrated and segmented markets to demonstrate that cointegration analyses cannot distinguish between the two.

An interesting note here is that such a false conclusion can be avoided by using basic knowledge of the infrastructure in a system. That is, if the analyst knows that the markets are not segmented because of the existence and use of trade routes, then distinguishing the effects of common economic conditions among segmented markets from causal price linkages among integrated markets is not an issue. Those tests can be applied without risk of falsely attributing conclusions. Information about the complexities of an industry does not necessarily introduce complexities into statistical analyses. In fact, in some cases the information will simplify analysis or conclusions.

Market integration concerns the ability of trade to link markets in a system according to a spatial equilibrium relationship. That is, integration is about whether the individual components of a system respond to changes in the system. This is in fact a causal relationship: the changes in a system as a whole influence changes in the individual market relationships. While causality analysis does not test whether equilibrium conditions are satisfied, it does shed light on basic linkages among markets. It is these linkages, or lack thereof, that is the impetus of the allegorical island of California.

A causality analysis alone will not provide complete information about spatial price relationships. Taken with information about physical infrastructure and transaction costs, however, causality results will add to the overall picture of the industry. If there are no statistical causal links, then there is a fundamental disconnection within the system. A consistent violation of spatial equilibrium and no statistical causal links could suggest that there is a complete failure of the arbitrage process. If there are statistical causal links, then there is evidence of a system-wide responsiveness to industry conditions. A finding of apparent violations of spatial equilibrium along with causal price relationships would suggest that the arbitrage process is working, but features of the industry (such as brand contracting) are preventing complete arbitrage.

The causality analysis here takes into account the entire Southern California pipeline system by applying the idea of the standard Granger Causality test to a system of equations. While each destination market is paired with the source market, Los Angeles, which coincides with pipeline operations, the equations for each pair are estimated jointly to account for system relationships. The tests run three times, first on company level inter-market spreads, the second on branding-level inter-market spreads, and the third on aggregate inter-market spreads.[25]

[25] The companies A through E are representative companies. Companies B, C, and D are chosen because they are the only companies that sell in all five markets both gasoline and diesel. Companies A and E have a presence in most markets. There are more companies, which contribute to the aggregates but are not shown individually.

The data used are daily rack prices for five companies in each of the five wholesale market areas in Southern California. While other analysts have had similar data, none has used the data in this disaggregated form. The sample period covers the years 2000 through 2002, containing 939 observations. Descriptive statistics for gasoline and diesel are in Tables 4.1 and 4.2 respectively.

Table 4.1 Descriptive Statistics of Daily Gasoline Prices by Company and Location

Los Angeles		Company A	Company B	Company C	Company D	Company E
	Minimum	56.25	56.00	50.50	50.00	55.64
	Maximum	148.00	148.50	165.95	166.00	147.31
	Average	102.99	102.46	97.15	96.19	102.55
	Standard Deviation	18.15	17.66	20.65	20.31	17.78
Colton		Company A	Company B	Company C	Company D	Company E
	Minimum	57.25	57.00	51.25	50.50	56.78
	Maximum	149.00	149.50	167.50	166.50	148.20
	Average	103.71	103.53	98.61	97.35	103.74
	Standard Deviation	17.74	17.62	20.60	20.47	17.81
Barstow		Company A	Company B	Company C	Company D	Company E
	Minimum	-	59.50	52.00	51.50	-
	Maximum	-	114.00	108.50	107.60	-
	Average	-	105.75	100.11	99.45	-
	Standard Deviation	-	17.77	20.52	20.27	-
Imperial		Company A	Company B	Company C	Company D	Company E
	Minimum	-	58.90	56.25	54.50	58.86
	Maximum	-	151.50	167.20	168.50	150.23
	Average	-	105.50	101.07	99.41	105.65
	Standard Deviation	-	17.73	20.45	20.35	17.85
San Diego		Company A	Company B	Company C	Company D	Company E
	Minimum	62.75	62.50	54.00	52.50	-
	Maximum	151.90	155.00	168.55	168.50	-
	Average	106.63	106.68	99.24	98.13	-
	Standard Deviation	17.56	17.86	20.40	20.22	-

Table 4.1: Descriptive statistics of daily gasoline prices by company and location.
Source: Oil Price Information Service.

Table 4.2 Descriptive Statistics of Daily Diesel Prices by Company and Location						
Los Angeles		Company A	Company B	Company C	Company D	Company E
	Minimum	48.80	48.30	49.00	49.00	49.45
	Maximum	135.75	132.00	131.50	131.25	131.72
	Average	87.48	86.90	87.22	86.78	87.53
	Standard Deviation	17.34	16.70	16.66	16.58	16.56
Colton		Company A	Company B	Company C	Company D	Company E
	Minimum	50.35	49.30	50.50	50.00	50.04
	Maximum	134.50	132.00	132.00	131.75	134.69
	Average	88.55	87.82	88.12	87.46	88.39
	Standard Deviation	17.08	16.80	16.73	16.65	16.62
Barstow		Company A	Company B	Company C	Company D	Company E
	Minimum	-	50.50	51.50	50.00	-
	Maximum	-	132.50	133.00	132.00	-
	Average	-	88.47	89.34	88.67	-
	Standard Deviation	-	16.43	16.50	16.53	-
Imperial		Company A	Company B	Company C	Company D	Company E
	Minimum	-	49.95	50.50	50.50	49.75
	Maximum	-	130.50	133.25	130.50	131.22
	Average	-	87.88	88.66	87.96	88.95
	Standard Deviation	-	16.45	16.48	16.46	16.35
San Diego		Company A	Company B	Company C	Company D	Company E
	Minimum	51.70	49.90	50.75	50.50	-
	Maximum	134.25	131.00	131.55	131.00	-
	Average	89.17	87.87	88.54	87.95	-
	Standard Deviation	16.69	16.34	16.53	16.44	-

Table 4.2: Descriptive statistics of daily diesel prices by company and location.
Source: Oil Price Information Service.

The basic model is a system of equations. Each spatial spread taken with Los Angeles is expressed as a function of the other spatial spreads with Los Angeles. Three lags are included for all estimations. A seemingly unrelated regressions (SUR) model is used to assess the linkages among the spreads of each downstream market with Los Angeles. Because this is a system of equations involving spatial spreads, some spreads had to be eliminated due to singularity concerns. The included spreads are consistent with the existing pipeline infrastructure. The basic SUR model is:

$$X_i - LA = \alpha + \sum_{j=1}^{4}\sum_{k=1}^{3}\beta_{ji}\left(X_{j,k} - LA_k\right)$$

where X_i is downstream market i, j indexes over all downstream markets and $X_{j,k}$ is downstream market j lagged k times.

The test of causality requires estimates of both restricted and unrestricted versions of the SUR system. The unrestricted version is just as above, with each spatial spread being determined by all other spreads, lagged thrice. The restricted version of the model applies in the situation in which only lags of the spread being modeled are the determining factors. Thus, the restricted form of the model is:

$$X_i - LA = \alpha + \sum_{k=1}^{3}\beta_{ii}\left(X_{i,k} - LA_k\right)$$

The causality test compares the mean squared error (MSE) from the restricted and unrestricted models, adjusting for degrees of freedom. Table 4.3 shows the F-statistic of the causality test, with the statistically significant statistics in bold (significant at the 5% level). Recall, the purpose is to identify causal links that indicate that the changes in the system as a whole influence changes in the individual market relationships. Thus, the statistically significant statistics represent those individual market pairs that are influenced by the Southern California pipeline system.

The results show dramatic differences across products and across aggregates. There are few causal links at the company level for both products. The diesel companies demonstrate a 50% causality rate each, and the gasoline companies even lower. When the companies are aggregated into branding designation, the causal linkages increase noticeably. In these data, the branding designation of "branded" and "unbranded" denote the branding at the refining level. These designations represent whether the product is produced by a name-brand refiner, thus leading to branding agreements in distributor contracts as discussed in Chapter 2. When the company prices are aggregated further into market-level prices, the causality results diverge by product. For gasoline, the number of causal links drops substantially, while for diesel there are causal links throughout the system.

By examining spatial spreads instead of prices, the analysis focuses on the economic differences between the commodity at two locations, rather than the commonality at the two locations. This is consistent with spatial theory, as spatial price analysis is in fact about the transformation of a product from one location to another, rather than the characteristics of that commodity in each location. Table 4.3 demonstrates that the relationships among transformations vary by aggregate. One factor that is left out of that analysis, however, is seasonality. The seasonal constraints in the industry may influence the transformation of a product from one location to another. Seasonality is a major part of the cleaner-burning gasoline standards set forth by CARB. Accordingly, the causality tests were run again for the market aggregates, this time with each season accounted for by seasonal dummies. Table 4.4 shows the results.

With the seasonal dummies, the causality results change once again for gasoline. Now, there are full causal links throughout the system for both gasoline and diesel. Because seasonality was not a significant issue for diesel fuel during the study period, the inclusion of seasonal controls did not change the causality results. However, because seasonality is a major factor in gasoline production, the inclusion of dummies for seasons changed substantially the statistical results for gasoline. When the test was run on data subsets for each season, the results were strongest for the Summer 2001 season. This season coincides with the long period of negative spreads that Figure 1.2 demonstrates. In summary, these causality results show the importance of aggregation and seasonality in gasoline analysis, by demonstrating the sensitivity of the results to these factors.

Finally, the system-wide causality test was applied to intra-market spreads, in an effort to augment the intra-market analysis of Chapter 2. The test does not follow directly from the inter-market tests, because here prices are tested instead of spreads to avoid singularity issues. The results are in Table 4.5. The results indicate that there are strong causal links among the companies within each market.

In summary, the intra-market causality analysis shows that there are substantial causal linkages among the prices charged by different suppliers within each market. Within markets, the distributors primarily use truck transport, which is the more flexible transportation mode. The terminals within each market are connected visually, because their relative proximity allows truck drivers to literally see the posted prices at each terminal, and are connected by their infrastructure. Even though most of the product is sold under supply contract, there is enough flexibility in the intra-market system to allow the arbitrageurs (i.e., those without supply contracts) to respond to system-wide signals.

Table 4.3 Causality Test Results

Inter-market, Company Level: Gasoline

	A	B	C	D	E
Colton - LA	0.418	0.907	1.369	1.537	1.000
Barstow - LA		**2.150**	**2.273**	1.398	
San Diego - LA	0.979	0.042	1.144	0.914	
Imperial - LA		**2.642**	0.905	**1.825**	0.316

Inter-market, Company Level: Diesel

	A	B	C	D	E
Colton - LA	**3.157**	1.577	**5.184**	1.457	**2.237**
Barstow - LA		1.558	**2.144**	**6.203**	
San Diego - LA	0.886	**2.855**	1.334	**2.071**	
Imperial - LA		**3.634**	0.373	1.372	0.459

Inter-market, Branding designation: Gasoline

	Branded	Unbranded
Colton - LA	**7.598**	**1.964**
Barstow - LA	**1.946**	**2.004**
San Diego - LA	**2.342**	1.074
Imperial - LA	**2.875**	**3.023**

Inter-market, Branded designation: Diesel

	Branded	Unbranded
Colton - LA	**4.132**	**1.716**
Barstow - LA	1.512	**2.716**
San Diego - LA	**2.294**	**2.236**
Imperial - LA	**2.453**	1.323

Inter-market, all Companies: Gasoline

Colton - LA	0.811
Barstow - LA	**2.181**
San Diego - LA	1.740
Imperial - LA	1.382

Inter-market, all Companies: Diesel

Colton - LA	**2.228**
Barstow - LA	**2.680**
San Diego - LA	**3.172**
Imperial - LA	**2.069**

Table 4.3: Results (f-statistics) of the system-wide causality tests. Bold numbers indicate results statistically significant at the 5% level.

Table 4.4 Causality Test Results with Seasonality

	No Seasonal Controls	With Seasonality
Gasoline		
Colton - LA	0.811	**2.461**
Barstow - LA	**2.181**	**1.831**
San Diego - LA	1.740	**2.033**
Imperial - LA	1.382	**2.480**
Diesel	No Seasonal Controls	With Seasonality
Colton - LA	**2.228**	**1.221**
Barstow - LA	**2.680**	**1.989**
San Diego - LA	**3.172**	**1.936**
Imperial - LA	**2.069**	**1.266**

Table 4.4: Comparisons of the system-wide causality test results, with and without seasonality. Bold numbers indicate results statistically significant at the 5% level.

Table 4.5 Intra-market Causal Linkages

	A	B	C	D	E
Gasoline					
Los Angeles	**35.034**	**22.300**	**9.222**	1.148	**52.556**
Colton	**48.139**	**20.859**	**11.512**	**1.846**	**49.588**
Barstow		**29.606**	**18.774**	**2.499**	
San Diego	**61.407**	**26.563**	**15.646**	**2.308**	
Imperial		**26.239**	**17.655**	**2.035**	**62.497**
Diesel	A	B	C	D	E
Los Angeles	**14.530**	**15.453**	**8.071**	**5.530**	**49.819**
Colton	**21.068**	**17.043**	**8.844**	**6.001**	**45.812**
Barstow		**29.765**	**18.880**	**4.645**	
San Diego	**26.008**	**19.858**	**17.646**	**5.463**	
Imperial		**20.245**	**12.503**	**5.244**	**63.582**

Table 4.5: Statistical causality within each market area. Bold numbers indicate results statistically significant at the 5% level.

In contrast, the inter-market causality analysis is sensitive to aggregation over time (i.e., season) and company type. Even at the company level, there are not many causal linkages among the spatial spreads. The terminals across markets are not connected visually, because of their relative dispersion, but are connected via pipelines and roads. In this system there are two sets of potential arbitrageurs: suppliers and distributors. The suppliers use the pipeline system to transport large quantities of products to downstream markets, as market conditions dictate. This is a seller-side arbitrage. The distributors use truck transport to arbitrage on the buyers side, but do not have the visibility and flexibility that exists in a spatially compact system. In this system the interaction of spatial dispersion and industrial institutions inhibits arbitrage.

4.2 The Allegorical Island of California

Government officials are concerned that the idiosyncrasies of the industry in California separate the State from other petroleum markets in the country, thereby creating higher and more volatile prices within the State. "Price spikes in California are normally greater in magnitude and longer in duration compared to other regions of the United States due to the fact that alternative sources of supply are several weeks away by marine vessel." (CEC 2006) It is this concern that motivates investigations of price spikes and takes attention away from spatial pricing. Claims made by the CEC, for example, are not even entirely justified. Thus, fear brews among members of the government and media over unverified claims.

It is natural for the prices of commodities to vary as shocks hit and dissipate through the industry. The concept of market segmentation does not pertain to changes in the price level, per se, but rather to excessive changes in the relative price. What qualifies as an excessive change in relative price differs among government officials and economic analysts. According to opinions set forth by government officials to the media, no relative price exceeding zero is tolerable. Conversely, economists accept some maximum relative price as a quantification of the economic differences between the commodities, so any relative price exceeding that maximum is excessive.

Figure 4.1 illustrates relative price spikes for three commodities in three major spot markets. The height of the bars represents the average relative price during the price spikes that year, and the number of relative price spikes is above each bar. For each commodity, Los Angeles experiences the greatest number of relative price spikes. However, the average magnitudes of relative price spikes in Los Angeles are comparable to, and in some cases less than, those in the other markets. The data do not appear to support the CEC's claim that price spikes are more severe in California.

Another interesting feature of Figure 4.1 is the similarity of all three products. If the California gasoline market is segmented by heterogeneity of product, diesel fuel and jet fuel patterns need not follow suit. Moreover, jet fuel is highly fungible, more so than the other products, yet experiences similar frequencies and magnitudes of relative price spikes as the other commodities. Figure 4.1 illustrates the difference in frequency of relative price spikes in Los Angeles compared to the other markets. There are many more relative price spikes in Los Angeles, while there are fewer, and often larger, relative price spikes in the other markets.

Markets are segmented when there is no trade linking those markets. Basic knowledge of gasoline supply and petroleum product infrastructure refutes the island effect for California. There are trade routes in place and in use that connect the markets within and outside of the State. There are also, however, limitations on trade, induced by certain features of the industry. These limitations restrict the extent to which arbitrageurs can use trade to respond to and equilibrate spatial prices.

The limitations on trade relate to the extent to which a product must be transformed across space. Recall that spatial transactions in effect transform the product from "product in location A" to "product in location B". Many spatial analyses assume that the only transformation is distance, thereby justifying the use of the transportation rate as a substitute for the transaction cost in the spatial equilibrium relationship. When other transformations are required, the cost of transacting in space exceeds the transportation cost. The limitations on trade contribute to transaction costs. For example, a supply contract impedes arbitrage when the required purchase centers are specified. In this case, a spatial transformation requires a change in the contractual agreement. This particular transformation produces substantial transaction costs, as Figure 2.11 shows.

Figure 4.1 Magnitude and Frequency of Nationwide Relative Price Shocks

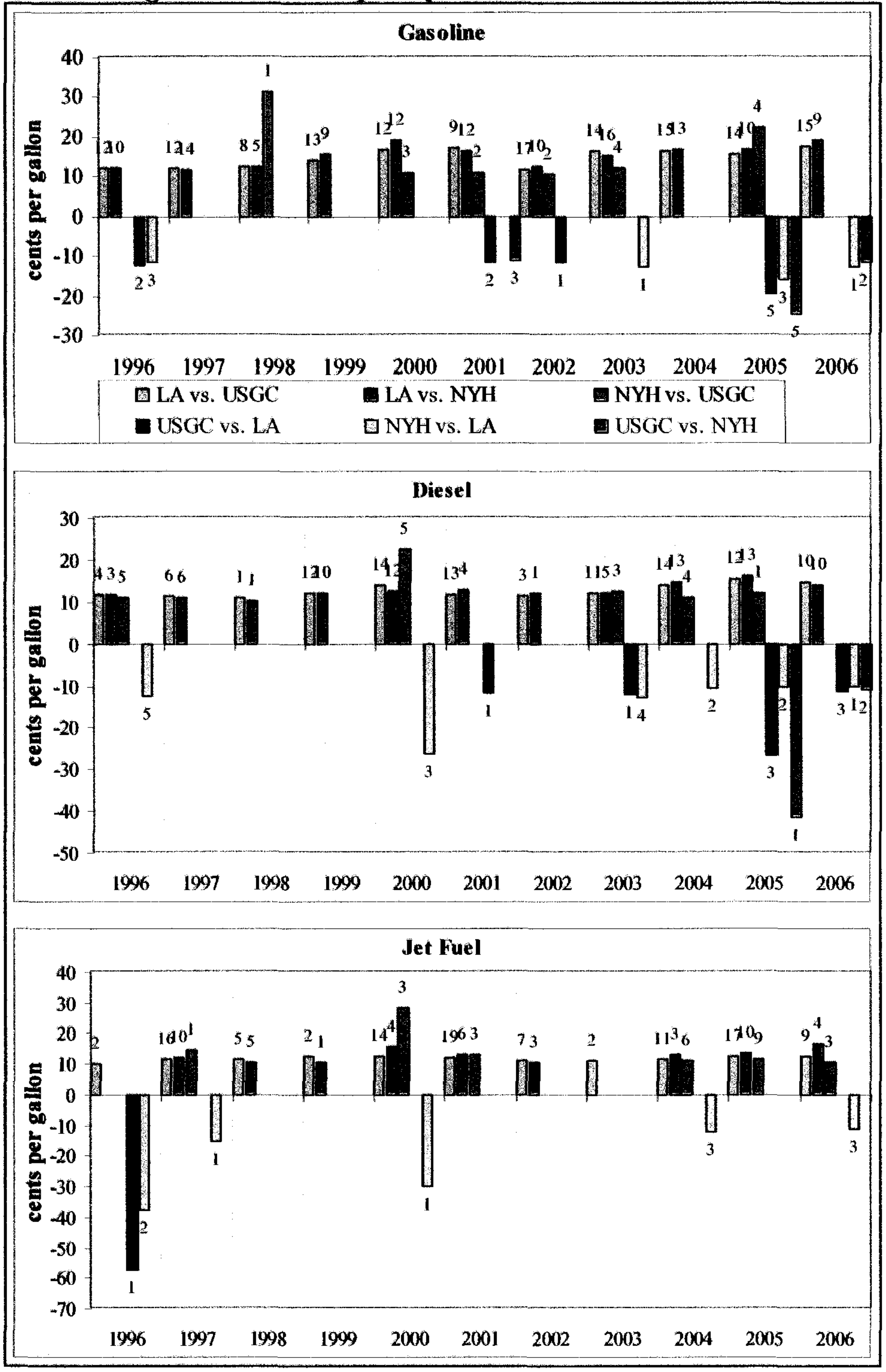


Figure 4.1: Graphic demonstration of the magnitude and frequency of relative price shocks in national petroleum product markets. The three national markets studied are Los Angeles (LA), New York Harbor (NYH), and the United States Gulf Coast (USGC).
Source: Oil Price Information Service.

Chapter 5: Concluding Remarks

The analysis here has demonstrated that there are efforts by arbitrageurs to respond to market signals. In spite of these efforts, spatial pricing does not conform to standard spatial equilibrium theory, particularly for gasoline. That is, what arbitrage that does occur is insufficient. A major difference between gasoline and diesel is the proportion of the wholesale product volume that changes hands at so-called rack prices. For gasoline, only about 20% of the volume of wholesale gasoline in the delivery system is sold through the racks, while for diesel all of the wholesale volume is sold through the racks. Moreover, only 15% of the 20% gasoline volume sold through the racks is sold to distributors without contracts specifying the locations and quantities they can acquire. These uncontracted distributors are the principal agents free to arbitrage spatially.

Although spatial gasoline pricing appears incongruous at first glance, with many price differences opposite the actual flow of product, there are many complexities of the industry that preclude conclusions based on a simple analysis. That said, the evidence of incomplete spatial arbitrage does not appear to be one of segmentation, for there is too much evidence that supports the connectivity of the spatial markets in the industry. Most likely the issue is that of illiquidity, caused by too few arbitrageurs able to respond sufficiently to market signals.

Los Angeles is the terminal market at the origin of the pipeline system serving the Southwest. In addition to refineries and bulk marine terminals, Los Angeles has some 18 to 20 terminals capable of loading trucks. These racks are dispersed throughout the Los Angeles area, with distances between racks ranging from 0.27 miles to 45 miles. There are six companies selling wholesale at these racks to truck transporters. The Colton and San Diego markets are the only two downstream wholesale markets with direct pipeline connections to Los Angeles. There are four truck racks dispersed within Colton, with distances ranging from 0.05 miles to 0.54 miles. Five companies sell product at the racks in Colton. In San Diego, the five terminals are dispersed with distances ranging from 0 miles to 6.37 miles, and five companies sell at those racks. The Barstow and Imperial markets are connected to Los Angeles via Colton. There is only one terminal in each location, with two companies selling in Barstow and four companies selling in Imperial. The spatial arbitrages can be often within a so-called market as between them. The spatial arbitrages are further complicated by the different suppliers serving each market.

As with the inter-market spreads in Chapter 3, the intra-market causality analysis of Chapter 4 sheds light upon the efficiency of arbitrage within locations. The existence of causal links, together with the information known about the existence and use of trade routes and the spatial price relationships, will form a picture of the efforts of arbitrageurs to respond to price signals in the industry. Table 5.1 summarizes information about causality within each market.

Table 5.1	# uni-directional causal links	# bi-directional causal links	Total # of causal links	Percent of causal links in market	Distance in miles from Los Angeles
Los Angeles	5	1	6	60%	-
Colton	6	3	9	90%	55.9
Barstow	1	2	3	100%	114.6
San Diego	8	1	9	90%	120.6
Imperial	5	5	10	100%	207.9

Table 5.1: Summary of statistical linkages among gasoline prices within each market area. Source: Oil Price Information Service.

This information about price movements, in conjunction with the known participation at racks, gives the following picture of the Southern California region: With movement from Los Angeles downstream along the pipeline system, as the distance increases from the pipeline origin, the number of terminals decreases, the dispersion of those terminals decreases, and the interconnectivity of the companies' prices increases. The decreasing number and dispersion of terminals may be the result of infrastructural streamlining. In Los Angeles, there are many refineries, marine terminals and bulk storage facilities, all with an extensive pipeline distribution network in place, which makes it possible to have more wholesale terminals over a larger region. Such an intricate distribution network does not exist in the downstream markets, probably because it is more efficient to build fewer terminals (requiring fewer connections to the main trunk line), and to have those terminals closer together (minimizing connecting infrastructure costs and maintenance). The interconnectivity of companies' prices might increase in those markets because the closeness of terminals increases visibility and competition. The buyers at the terminals are wholesale distributors; for arbitrage opportunities to be exploited, relative prices must exceed the truckers' transaction costs, which at a minimum is the fuel cost per mile.

The results of the causality analysis are not surprising in light of the infrastructural design of the Southwestern system. Much of this information is readily available, and requires little study to inform the analysis. By incorporating the abundant qualitative data available on the industry, the nature of the empirical question regarding gasoline markets changes from "Are the markets economically linked" to "What are the inflexibilities inhibiting arbitrage in this theoretically and infrastructurally linked system?"

While the qualitative data are abundant and the price data are adequate, an analysis would be more informed with more data. Spatial price theory explicitly models the prices at markets in some system, yet implicitly assumes positive inventory and implicitly assumes flows, often in large quantities, between markets. A natural extension to a study about spatial pricing is the incorporation of quantities. Of course, the standard spatial price models would have to be modified to make use of the now explicit quantity flow information.

Hamilton (2006) explains that gasoline prices are very sensitive to local inventories. This suggests that a more complete analysis of gasoline pricing ought to include some information about inventory at each wholesale rack. Inventories measured as part of the weekly shipment cycle would be helpful but even more so would be daily inventories, given the strong pattern of price variability associated with the shipment cycle. In addition to the inventories at each rack, data regarding the quantity of gasoline and diesel transported through the pipeline each cycle, and transported via truck would be informative. The information about pipeline flows would be useful even if it only came in a binary manner, that is, "yes" if a rack received a shipment that cycle and "no" if it did not, because the implicit assumption underlying spatial price models is that the binary code is "yes" all of the time.

With the data available, I have emphasized in this dissertation two features of the industry that influence arbitrageurs' ability to respond to relative price changes: The institutional and physical infrastructure. An overview of maps and documents illustrating the layout of physical infrastructure, namely petroleum pipelines, confirms the existence of some connections among markets. Thus, California is physically connected to other markets, and policy recommendations ought to take the infrastructure into account rather than assume that the State is physically isolated. The causality test developed in Chapter 4 differs from the standard causality tests in that it specifically acknowledges the potential interconnectivity of all the markets in the system, instead of assuming independence of each market pair. The system-wide causality analysis showed that there are statistical linkages among markets. Therefore, both physical and statistical linkages exist among the study markets.

Arbitrage among these markets is limited by the logistics of transportation infrastructure and by branding agreements in wholesale contracting. My analysis of the day-of-the-week effects on wholesale prices has demonstrated that the logistics of pipeline scheduling and terminal supply affect market prices. A closer look at wholesale contracting shows that contract terms, specifically branding agreements, lock wholesale distributors into specific purchase and distributing centers, thereby preventing arbitrage across space. Taken together, logistics and contracting introduce inflexibilities into the wholesale marketing system. In Chapter 3, spatial price relationships, defined as the difference between market prices and relevant transportation rates, for gasoline and diesel are compared. Spatial price relationships among diesel markets were reasonably consistent with the Augmented Law of One Price, but branding agreements caused gasoline prices to deviate substantially ALOP. This evidence further supports that contracting at the wholesale level introduces the inflexibilities that generate the prices perceived to be odd by the public. Why these branding arrangements exist is a matter left for future research.

Appendix A: Sample Distributor Contract

Jobber Number
80001538

Branded Jobber Contract
Form 26-930-GD (3-96) E

(State "Trial Franchise," if applicable)

This branded jobber contract ("Contract"), dated 12-3-98 , is by and between with a principal office located

at
(State complete [redacted] address including street address, city and zip code)

and ("Jobber"),
(State exact legal name of Jobber)

a with its principal offices located at
(State type of legal entity: sole proprietorship, partnership or corporation)

(State complete address of Jobber's principal office including street address, city and zip code. A post office box is not sufficient.)

Now, Therefore, [redacted] and Jobber, intending to be legally bound, agree to the following:

1. **Term.** The term covered by this Contract shall be for a period beginning on January 1 1999 and ending on December 31 2001 , unless terminated earlier by law or by the terms of this Contract or unless extended by [redacted] upon written notice, subject to Jobber's rights under Schedule A.

2. **Products and Quantities (Schedule A).** [redacted] agrees to sell and Jobber agrees to purchase and receive [redacted] currently offered and available branded petroleum products ("Products"), as determined and designated by [redacted] in its sole discretion and as more fully and specifically set forth in Schedule A, a copy of which is attached to and incorporated in this Contract. Jobber agrees to purchase these Products in the quantities set forth in Schedule A, as amended from time to time.

3. **Purchase and Sale of Products.**

   (a) **Prices.** The price per gallon which Jobber shall pay for each Product sold under this Contract shall be [redacted] Jobber Buying Price, as recorded at the applicable [redacted] regional office, business unit office or such other office as [redacted] may designate from time to time, in effect on the date of sale from the respective [redacted] terminal(s) assigned to Jobber ("Jobber's Assigned Terminal(s)"). Jobber's Assigned Terminal(s) shall be determined and designated by [redacted] in its sole discretion and set forth in Schedule A, as amended from time to time.

   (b) **Title and risk of loss.** Title and risk of loss to all Products sold to Jobber under this Contract shall pass to Jobber f.o.b. Jobber's Assigned Terminal(s).

4. **Payment Terms.**

   (a) **Credit.** Nothing in this Contract shall be construed as obligating [redacted] to extend credit to Jobber. In the event [redacted] does extend credit to Jobber, such extension of credit shall be subject to the following requirements, including but not limited to: paying for all Product purchases by electronic funds transfer ("EFT"); submitting an annual financial statement; and executing an unlimited personal guaranty. Jobber shall also provide [redacted] with a letter of credit or other form of security, upon [redacted] request. [redacted] reserves the right to change its credit terms at any time either for the class of trade generally or for Jobber individually. In no instance shall the terms of any sale discounts apply to taxes, inspection fees and the like. One or more incidents of failure by Jobber to make payment according to established credit terms, including checks or EFTs which are dishonored for nonsufficient or uncollected funds, or failure to supply financial information or documentation as required, shall entitle [redacted] to suspend deliveries, impose C.O.D. terms, and/or terminate this Contract, in addition to exercising any other rights [redacted] may have under this Contract or at law.

   (b) **Finance and service charges.** [redacted] shall, at its election, assess finance charges on all amounts not paid by Jobber on the net due date. Finance charges shall be assessed at the monthly periodic rate established by [redacted] for Jobber's class of trade and the respective Product. [redacted] shall impose a service charge for each check and/or EFT which is dishonored for nonsufficient or uncollected funds, whether or not subsequently paid by Jobber.

5. [redacted] Trademarks.

(a) **Use of Marks generally.** Jobber shall be permitted to use, and shall be permitted to allow the reseller/dealer-customers it supplies with Products purchased under this Contract ("Jobber-Dealers") to use, on a limited and non-exclusive basis, [redacted] trademarks, service marks, companion marks, trade names, brand names, trade dress symbols, logos, color schemes, design schemes, insignia, image standards and the like ("Marks") in connection with the advertising, distribution and/or resale of the Products authorized by, supplied by and/or purchased from [redacted] under this Contract.

(b) **Use of Marks governed by this Contract and related agreements.** The permission to use [redacted] shall be governed by the terms and conditions of this Contract and all related contracts, including all schedules, appendices and amendments attached to and incorporated in those agreements. In addition, [redacted] shall only be used in accordance with the guidelines, policies, procedures, requirements, specifications and standards issued by [redacted], as amended from time to time, including but not limited to [redacted] Policy for Proper Handling of [redacted] branded Motor Fuels by [redacted] Jobbers.

(c) **Use of Marks on signage.** Jobber shall be permitted to acquire and display approved signage bearing [redacted], in connection with the advertising, distribution and/or resale of Products under this Contract, on a retail site specific basis. Under no circumstances will Jobber be allowed to relocate signage bearing [redacted] to another retail site without [redacted] consent. Jobber shall provide [redacted] with a list of all signage bearing [redacted] in Jobber's possession and/or control and the location of said signage, upon [redacted] request. In addition to the terms and conditions of this Contract, the use of [redacted] on all signage and the use of that signage generally shall be governed by a Trademark Agreement (Jobber) (form 26-950-TA), a copy of which is attached to and incorporated in this Contract.

(d) **Use of Marks in conjunction with the sale of Representative Amounts of certain Products.** At all times and at each retail site, including Jobber-Dealer sites, Jobber shall offer for sale, or cause to be offered for sale, representative amounts of each grade of [redacted]-branded gasoline, currently offered to Jobber, necessary to satisfy public demand ("Representative Amounts"). If Jobber ceases to offer or make available one or more of these gasolines in the required Representative Amounts at a retail site supplied by Jobber, Jobber shall cease using or displaying, or cause its Jobber-Dealer to cease using or displaying, [redacted] at that site.

(e) **Use of Marks in conjunction with [redacted] image programs and standards.** At each retail site, including Jobber-Dealer sites, Jobber shall comply with, and ensure that all of its Jobber-Dealers comply with, [redacted] image programs and standards, as amended from time to time. If a retail site fails to conform to [redacted] image standards, [redacted] may revoke its approval to identify the retail site as provided in paragraph 6(b) below in which case Jobber shall cease using or displaying, or cause its Jobber-Dealer to cease using or displaying, [redacted] at that site.

(f) **Use of Torch and Oval in conjunction with Jobber's name.** Jobber shall be permitted to display the [redacted] (or, if applicable, Standard) torch and oval trademark ("T&O") in conjunction with Jobber's name on equipment and materials directly related to the advertising, distribution and/or resale of Products under this Contract. The words "Products Jobber" or "Products Distributor" must, however, appear adjacent to the T&O so as to read: [T&O] Products Jobber or [T&O] Products Distributor. [redacted] shall have the right to approve such use of the T&O in advance or to revoke its approval at any time and for any reason.

(g) **Misuse of Marks with Jobber's name.** Jobber shall not use any of [redacted] as part of Jobber's corporate name or as part of Jobber's own trademarks. If Jobber has incorporated using any of [redacted], it shall be required to amend its articles of incorporation so as to delete [redacted] from its corporate name.

(h) **Misuse of Marks in connection with certain sales.** Jobber shall not use any of [redacted] in connection with the advertising, distribution and/or resale of: (1) any dilution or adulteration of a Product authorized by, supplied by and/or purchased from [redacted] (2) any mixture or blend of Products authorized by, supplied by and/or purchased from [redacted], without [redacted] prior written consent (which consent may be revoked at any time and for any reason); (3) any Product authorized by, supplied by and/or purchased from [redacted] but sold under an incorrect or inappropriate [redacted] or sold through unapproved or disapproved packages, containers or equipment; or (4) any product not authorized by, supplied by and/or purchased from [redacted].

(i) [redacted] **right to audit.** As part of [redacted] compliance program(s), Jobber agrees and acknowledges that [redacted] shall have the right, at all times, to audit records in the possession or control of Jobber or its Jobber-Dealers and the right, at all times, to inspect and sample all Products in the possession or control of Jobber and/or its Jobber-Dealers. Jobber shall cooperate fully and completely throughout the audit and inspection processes, and ensure that its Jobber-Dealers cooperate fully and completely also.

(j) **Discontinued use of Marks upon expiration or termination of this Contract.** Upon the expiration or termination of this Contract, for any reason, Jobber shall immediately cease using or displaying, and cause its Jobber-Dealers to cease using or displaying, [redacted] and shall dispose of all signage in accordance with the Trademark Agreement. All remaining evidence of [redacted] shall be immediately obliterated by Jobber. If Jobber does not immediately cease using or displaying, and cause its Jobber-Dealers to cease using or displaying, [redacted], [redacted] shall have the irrevocable right to use any means necessary to remove, cover or obliterate the Marks, including entering upon the relevant premises or filing a legal action, with Jobber's full and complete cooperation and at Jobber's expense.

6. **Site Approval.**

(a) **Use of [redacted] at each retail site.** It is and shall be a condition of the right to use [redacted] that Jobber must first obtain [redacted] prior written consent for each and every retail site which Jobber intends to identify, or causes to identify, with [redacted], including Jobber-Dealer sites. This approval shall be within [redacted] sole discretion and shall be based, among other things, upon the appearance, location and mode of operation of the site. [redacted] also expressly reserves the right to determine the appropriate geographic density of all sites identified and/or to be identified with [redacted]. [redacted] right of approval shall apply to all requests to identify regardless of the site's intended location within or outside Jobber's Schedule B area of primary marketing responsibility ("Schedule B area"). In order to obtain [redacted] approval to identify a retail site outside Jobber's Schedule B area, it shall be a further requirement that Jobber has used and/or is using its best efforts to develop Jobber's Schedule B area as provided in paragraph 8(a) below.

(b) **Site approval revoked.** [redacted] shall have the right, in its sole discretion, to revoke its approval to identify any retail site if the site fails to conform to the terms or conditions of this Contract or [redacted] policies or to any relevant law or regulation. If [redacted] revokes its approval, Jobber shall immediately cease using or displaying, or cause to cease using or displaying, [redacted] at that location.

(c) **Jobber's right to supply disapproved or revoked sites.** Nothing in this Contract shall prevent Jobber from supplying a disapproved retail site or a retail site at which [redacted] approval has been revoked provided that Jobber does not permit [redacted] to be displayed at that location.

(d) [redacted] **right to have signage removed.** [redacted] shall have the right to cause any and all signage bearing [redacted] to be removed, or to cause [redacted] on said signage to be removed, covered or obliterated, from any disapproved retail site or from any retail site at which [redacted] approval has been revoked. If Jobber does not immediately cease using or displaying, or cause its Jobber-Dealer to cease using or displaying, [redacted] after [redacted] request to do so, [redacted] shall have the irrevocable right to use any means necessary to remove, cover or obliterate the Marks, including entering upon the relevant premises or filing a legal action, with Jobber's complete cooperation and at Jobber's expense.

(e) **Jobber to provide list of all approved sites.** Jobber shall provide [redacted] with a list, upon [redacted] request, which shall indicate all retail sites supplied by and/or operated by Jobber which are identified with [redacted].

7. [redacted] **Directly-Supplied Reseller/Dealer Retail Sites.** Jobber shall not sell Products covered by this Contract to any retail site which is directly-supplied by [redacted] or which is designated by [redacted] as a directly-supplied site.

8. **Area of Primary Marketing Responsibility (Schedule B).**

(a) **Jobber to use best efforts to market in the Schedule B area.** Jobber shall use its best efforts to market the Products covered by this Contract and develop its Schedule B area, as determined and designated by [redacted] in its sole discretion and as more fully and specifically set forth in Schedule B, a copy of which is attached to and incorporated in this Contract.

(b) **Schedule B area not exclusive.** Subject to [redacted] site approval and direct supply rights as provided above in paragraphs 6 and 7 respectively, nothing shall prevent Jobber from selling or soliciting the sale of the Products covered by this Contract outside its Schedule B area or confer upon Jobber exclusive marketing and/or trademark rights within such area. [redacted] shall, at all times and for any reason, maintain its sole and unlimited right to make other provisions for the marketing of its Products under any of its Marks within Jobber's Schedule B area including, but not limited to, establishing its own directly-operated retail sites, establishing its own directly-supplied reseller/dealer retail sites, and/or approving retail sites to be operated or supplied by other jobbers.

9. **Additional Jobber Responsibilities.**

(a) **Bulk plants.** Jobber shall operate, where necessary, one or more bulk storage plants so as to efficiently perform its supply and distribution functions under this Contract.

(b) **Transport and tank trucks.** Jobber shall operate or cause to operate, where necessary, a sufficient number of transport and/or tank trucks so as to efficiently perform its delivery functions under this Contract.

(c) **Deliveries for [redacted].** From time to time, [redacted] may request that Jobber make deliveries, from Jobber's inventories of Products purchased under this Contract, to other [redacted] customers. If Jobber elects to make any such deliveries, [redacted] shall pay Jobber a mutually agreed upon handling fee. Jobber shall invoice [redacted] for the quantities of product delivered, at [redacted] price for the respective Product applicable to Jobber and in effect on the date Jobber makes delivery, plus the handling fee.

10. Jobber as Independent Business/Sale of Competitive Products.

(a) **Independent business.** [redacted] and Jobber are and shall remain separate and independent businesses. None of the provisions of this Contract are intended to provide [redacted] with any management direction or control over the Jobber's business or business operations. Likewise, Jobber shall not place or allow the placement of any signage upon or near any premises owned, operated or supplied by Jobber which might indicate that [redacted] is the owner or operator of the business conducted by Jobber.

(b) **Sale of competitive products.** Nothing in this Contract shall prevent Jobber from purchasing and reselling the Products of [redacted] competitors. In the event that Jobber does purchase and resell competitive-brand Products, it shall comply with the applicable terms and conditions of this Contract and all applicable guidelines, policies, procedures, requirements, specifications and standards issued by [redacted], as amended from time to time, including [redacted] Policy and Dealer and Jobber Guidelines for Proper Handling of [redacted] Motor Fuels.

11. Jobber-Dealers.

(a) **Acts and omissions of Jobber-Dealers imputed to Jobber.** Jobber shall inform those Jobber-Dealers permitted to use [redacted] of the specific terms and conditions of this Contract and all related contracts, including all schedules, appendices and amendments attached to and incorporated in those agreements which pertain to the use of [redacted] and related matters. In addition, Jobber shall inform those Jobber-Dealers of the specific guidelines, policies, procedures, requirements, specifications and standards periodically issued by [redacted], as amended from time to time, which pertain to the use of [redacted] and related matters. Notwithstanding the Jobber's best efforts to ensure its Jobber-Dealers' compliance, and regardless of any contractual relationship between Jobber and its Jobber-Dealer, any act or omission by a Jobber-Dealer that, if committed or omitted by Jobber would place Jobber in violation of this Contract or related contracts, shall be imputed to Jobber and may cause [redacted], at its sole discretion, to take appropriate action against Jobber up to and including the termination of this Contract.

(b) **Actions against Jobber-Dealers.** Nothing in this Contract shall prevent or preclude [redacted] from exercising any legal or equitable rights against a Jobber-Dealer directly, separate and apart from any actions taken against Jobber.

12. Right of First Refusal and Right to Purchase Jobber's [redacted] Branded Assets.

(a) [redacted] **Right of First Refusal.** Jobber shall not sell, lease or otherwise transfer the assets in its possession or control, or portions thereof, which are related to this Contract and which, at any time during the franchise relationship, have been identified with or by [redacted] including but not limited to Jobber-owned retail sites; bulk plant and terminal facilities; transport and tank trucks; and all related real and personal property, contract rights, or good will ("Jobber's [redacted] Branded Assets") without first giving [redacted] a right to purchase or otherwise acquire the assets for consideration consisting solely of cash, or cash and notes, upon the same terms and conditions as set forth in a bona fide, arms' length agreement executed by and between Jobber and a third-party purchaser ("Right of First Refusal").

(b) [redacted] **Right of First Refusal/Information Jobber must provide.** Pursuant to paragraph 12(a) above, Jobber agrees to promptly submit to [redacted] complete and fully executed copies of all contract documents which comprise the proposed agreement and any additional information, facts and data required by [redacted] (1) to evaluate the bona fide nature of the agreement and, (2) should the proposed agreement include Jobber's request to assign the Contract, to evaluate the third-party purchaser's qualifications to be an [redacted] jobber. [redacted] shall thereafter have sixty (60) days within which to exercise its Right of First Refusal, by written notice to Jobber. Closing shall be held at a time and place agreeable to [redacted] and Jobber, but no later than sixty (60) days after [redacted] elects to exercise its Right of First Refusal. Jobber shall convey all real property with good and marketable title and all other property in contractual form(s) acceptable to [redacted], subject only to such liens and encumbrances which were acceptable to the third-party purchaser.

(c) **Exception to [redacted] Right of First Refusal.** Notwithstanding paragraph 12(a) above, Jobber shall be permitted to sell, lease or otherwise transfer Jobber's [redacted] Assets to: (1) a spouse, child, stepchild, parent, brother or sister ("Immediate Family Member"), if Jobber is a sole proprietorship; (2) an Immediate Family Member of a partner's immediate family, if Jobber is a partnership; or (3) an Immediate Family Member of a stockholder's immediate family, if Jobber is a corporation, without providing [redacted] with a Right of First Refusal; provided, however, that each Immediate Family Member who receives assets hereunder, is at least twenty-one (21) years of age with at least one (1) year of active management experience in Jobber's business and, provided further, that no agreement executed in accordance with this paragraph 12(c) shall operate as a mere means or device to transfer control or ownership of the assets to a non-Immediate Family Member without providing [redacted] with its Right of First Refusal.

(d) [redacted] **Right to Purchase if Jobber is a corporation or partnership.** If Jobber is a corporation, any sale, conveyance, alienation, transfer or other change of legal or beneficial interest in, or legal or beneficial title to, more than fifty percent (50%) of its voting stock, or, if Jobber is a partnership, any sale, conveyance, transfer or other change of partnership interest resulting in a change in control of the partnership, at any time during the franchise relationship, either voluntarily or involuntarily, by operation of law, by merger or by or through any other type of proceedings: (1) shall trigger [redacted] right to purchase the entirety of Jobber's [redacted] Assets for a cash price equal to the fair market value of those assets ("Right to Purchase"), as determined by the average of three independent appraisals made pursuant to paragraph 12(e) below, and (2) shall be considered a request to assign the Contract.

(e) **[redacted] Right to Purchase/[redacted] election to appraise/Information corporation or partnership must provide.** Pursuant to paragraph 12 (d) above, Jobber shall promptly provide [redacted] with written notice of a change in stock ownership or partnership control, whichever the case may be. [redacted] shall thereafter have sixty (60) days within which to exercise its Right to Purchase, by written notice to Jobber. Upon [redacted] written request, made no later than ten (10) days after the commencement of this sixty (60) day exercise period, three independent Appraisal Institute MAI - designated ("MAI") appraisers (one chosen by [redacted] within ten (10) days of the commencement of the exercise period, one chosen by Jobber within twenty (20) days of said commencement and one chosen by the other two MAI appraisers within thirty (30) days of said commencement) shall appraise the entirety of Jobber's [redacted]-Branded Assets. Each appraiser shall provide [redacted] with a written appraisal within ten (10) days of being chosen and the average of these appraisals shall be the price [redacted] shall pay, should [redacted] elect to purchase. Jobber shall cooperate fully and completely with [redacted] and provide any information, facts and data required by [redacted] and/or the appraisers to evaluate and appraise Jobber's [redacted]-Branded Assets. [redacted] and Jobber shall each pay for their own appraiser and shall each pay one-half (1/2) of the third appraiser's fee. Closing shall be in accordance with paragraph 12(b) above.

(f) **Exception to [redacted] Right to Purchase.** Notwithstanding paragraph 12(d) above, Jobber shall be permitted to: (1) effect a sale, conveyance, alienation, transfer or other change of legal or beneficial interest in, or legal or beneficial title to, more than fifty percent (50%) of its voting stock to an Immediate Family Member of a stockholder's immediate family, if Jobber is a corporation, or (2) effect a sale, conveyance, transfer or other change of partnership interest resulting in a change in control of the partnership to an Immediate Family Member of a partner's immediate family, if Jobber is a partnership, without triggering [redacted] Right to Purchase; provided, however, that each Immediate Family Member who receives stock or a partnership interest, whichever the case may be, is at least twenty-one (21) years of age with at least one (1) year of active management experience in Jobber's business and, provided further, that no transaction executed in accordance with this paragraph 12(f) shall operate as a mere means or device to transfer control or ownership of the assets to a non-Immediate Family Member without providing [redacted] with its Right to Purchase.

(g) **[redacted] right to verify Jobber's corporate or partnership interest.** From time to time, [redacted] may request and Jobber shall provide a confirmation of all shareholder interest (legal and beneficial) or partnership interest, whichever the case may be, on a form acceptable to and/or provided by [redacted] Such confirmation shall include the names of all shareholders or partners, whichever the case may be.

(h) **Status of Contract after sale of Jobber's [redacted] Branded Assets.** In the event of any sale of Jobber's [redacted]-Branded Assets, this Contract shall continue in full force and effect unless terminated by [redacted] upon written notice, or unless assigned by Jobber, upon [redacted] written consent. [redacted] decision not to exercise its Right of First Refusal or its Right to Purchase in accordance with this paragraph 12 shall not prevent [redacted] from withholding its consent to assign this Contract to any third-party purchase. Likewise, any sale of Jobber's [redacted] Branded Assets to an Immediate Family Member in accordance with paragraph 12(c) above shall not prevent [redacted] from withholding its consent to assign this Contract to said Immediate Family Member.

(i) **[redacted] may assign its Right of First Refusal and/or its Right to Purchase.** [redacted] shall have the right to assign its Right of First Refusal and/or its Right to Purchase to a third-party purchaser of its choosing.

13. Assignment.

(a) **Jobber's prior written request and [redacted] written consent required.** Jobber acknowledges and understands that the current ownership and control of Jobber is a material element in [redacted] willingness to enter into this Contract. Jobber, therefore, agrees that it shall not assign or transfer its interest in this Contract, or any franchise relationship attendant thereto, without a prior written request and without [redacted] corresponding written consent; provided, however, that [redacted] shall not unreasonably withhold its consent, and further provided, that in giving its consent to any assignment, whether voluntarily or by operation of law, [redacted] may, at its election, condition the consent upon: (1) the agreement of the proposed assignee or transferee to enter into a trial franchise; (2) the agreement of the Jobber to simultaneously enter into a mutual cancellation of this Contract and related contracts; and (3) the satisfaction of all indebtedness owed by Jobber to [redacted].

(b) **[redacted] may withhold consent.** Refusal of the proposed assignee or transferee to enter into a trial franchise and/or the Jobber to enter into a mutual cancellation shall be adequate reason for [redacted] to withhold its consent to the assignment. In addition, nothing stated in this paragraph 13 shall limit [redacted] right to withhold its consent to any assignment proposed by Jobber or limit [redacted] right to impose other or additional conditions on its consent.

(c) **Effect of assignment without [redacted] consent.** Jobber agrees and acknowledges that any attempted or purported assignment or transfer of this Contract without [redacted] knowledge and/or [redacted] prior written consent may result in the termination of this Contract and the non-renewal of any franchise relationship.

14. Indemnity. Jobber shall, to the fullest extent permitted by law, indemnify, defend and hold [redacted], including but not limited to [redacted] parent, affiliates and all officers, directors, shareholders, employees and agents of [redacted], its parent and affiliates, harmless from and against any and all losses, suits, claims, demands, causes of action, liabilities, fines, penalties, costs or expenses (including reasonable attorney's fees and all other costs of defense) of whatever kind or nature, directly or indirectly arising in whole or in part out of: (a) any default or breach by Jobber of any obligation contained in this Contract or any other agreement with [redacted]; (b) the receipt, shipment, delivery, storage, handling, use, sale, dispensing, labeling, invoicing, advertising or promoting of the Products by Jobber; (c) the use of any [redacted] property (real or personal) by Jobber or its Jobber-Dealers; (d) any allegation of agency or other alleged legal relationship by which [redacted] is being held or might be held responsible for the acts or omissions of Jobber or its Jobber-Dealers; (e) the use of [redacted] by Jobber or its Jobber-Dealers, including the use of said Marks on signage and in the advertising or promoting of Products sold or services rendered by Jobber or its Jobber-Dealers; (f) the violation of any federal, state or local law, rule, regulation, court order or government directive by Jobber, its Jobber-Dealers or its other customers; (g) all taxes incurred and owed by Jobber or its Jobber-Dealers of whatever kind and nature; (h) or any other act or omission of Jobber, its Jobber-Dealers, or its other customers, or their agents, employees, contractors, invitees, licensees, customers or business associates, regardless if caused by the joint, concurrent, or contributory fault or negligence of [redacted] except that Jobber shall assume no liability for the sole acts, omissions, negligence or fault of [redacted].

15. Insurance.

(a) **Types of coverage required.** Jobber shall obtain and maintain, at its sole cost and expense, primary insurance coverage through an insurer and in a form acceptable to [redacted] as follows: (1) Comprehensive/commercial general liability insurance of not less than One Million Dollars ($1,000,000) combined single limit, including coverage for contractual liability, bodily injury, property damage, fire liability, premises and operations liability, products completed operations hazard liability, independent contractor's liability, garage keeper's liability, medical expense liability, liquor liability and personal and advertising injury; (2) Worker's compensation and employer's liability insurance, as required by law, but in no event less than One Million Dollars ($1,000,000) combined single limit; (3) Business automobile liability insurance, including coverage on all vehicles owned, hired or used in the performance of this Contract, of not less than One Million Dollars ($1,000,000) combined single limit.

(b) **Requirements for each type of coverage.** All insurance policies required under this Contract shall: (1) name [redacted] as an additional insured; (2) include an endorsement containing an express waiver of any right of subrogation or other recovery, by Jobber or any insurance company, against [redacted]; (3) include an endorsement stipulating that Jobber's insurance policies are primary to, not contributory with and not excess to any other policies or self-insurance; (4) provide that no policy shall be materially changed, amended or cancelled except after thirty (30) days' written notice to [redacted]; and (5) provide that Jobber shall be solely responsible for the payment of any premium or assessment, with no recourse against [redacted].

(c) **Proof of coverage required.** Each time Jobber renews the insurance coverage required under this Contract, but no less than annually, and at any time requested by [redacted], Jobber shall provide such proof of coverage as [redacted], in its sole discretion, determines is necessary for verification purposes including, but not limited to certificates of insurance or copies of the policies themselves. If Jobber fails to provide acceptable proof of insurance, as determined by [redacted], then [redacted] may, at its option and in addition to all other remedies available to it under this Contract or at law, after ten (10) days notice to Jobber, obtain coverage to protect [redacted] interests only and charge the cost of such coverage to Jobber.

(d) **Environmental coverage.** If required by any applicable law, Jobber must obtain environmental impairment coverage in the amount and of the type required by such law.

(e) **Indemnity not limited by insurance.** The existence or non-existence of any insurance as required by this Contract shall not limit the Jobber's indemnity or other obligations under this Contract.

16. Termination and Non-Renewal.

(a) [redacted] **breach.** Jobber may terminate this Contract if [redacted] fails to comply with any material provision of this Contract, upon ninety (90) days prior written notice; provided, however, that Jobber shall provide [redacted] with a reasonable opportunity to exert good faith efforts to carry out such provision.

(b) **Jobber's breach/PMPA.** [redacted] may terminate this Contract and non-renew any franchise relationship in accordance with Title I of the Petroleum Marketing Practices Act ("PMPA"), 15 U.S.C. 2801 et seq., as amended, and/or other applicable federal, state and/or local laws of the same nature and effect. [redacted] expressly reserves all of its respective rights under the PMPA and Jobber acknowledges and agrees that no omission by [redacted] of any specific reference to any specific PMPA right shall constitute a waiver of that right. In addition, Jobber agrees and acknowledges that [redacted] rights and remedies under the PMPA shall be without prejudice to all other rights and remedies available to [redacted] at law or in equity.

(c) **Procedures for termination and non-renewal by [redacted].** If Jobber fails to comply with any of the terms and conditions of this Contract and/or related contracts, including all schedules, appendices, and amendments attached to and incorporated in those agreements, or if any other ground for termination and/or non-renewal shall present itself, [redacted] shall, at its election, terminate this Contract and/or non-renew any franchise relationship upon ninety (90) days written notice (or upon less than ninety (90) days notice as may be reasonable under a particular circumstance). In the case of a market withdrawal, as defined in the PMPA, [redacted] shall terminate this Contract and/or non-renew any franchise relationship upon 180 days written notice.

(d) **Physical or mental incapacity and death.** For purposes of emphasis and elaboration, but without limitation, it is acknowledged and agreed by and between [redacted] and Jobber that the following shall constitute grounds for termination of this Contract and non-renewal of any franchise relationship, subject to the applicable provisions of any relevant state law: death or continuous, severe physical or mental disability (of at least three months duration) (1) of the owner of the business, if Jobber is a sole proprietorship; or (2) of one of the partners, if Jobber is a partnership; or (3) of the beneficial owner(s) of more than fifty percent (50%) of Jobber's voting stock if Jobber is a corporation unless the death or other incapacity of said beneficial owner(s) results in the contemporaneous transfer of more than fifty percent (50%) of said voting stock to an Immediate Family Member at least twenty-one (21) years of age with at least one (1) year of active management experience in the Jobber's business.

(e) **Failure to purchase Product quantities.** For purposes of emphasis and elaboration but without limitation, it is acknowledged and agreed by and between [redacted] and Jobber that the following shall constitute grounds for termination of this Contract and non-renewal of any franchise relationship: failure of Jobber to purchase the applicable stated quantity of any Product during any 12-month period, or portion thereof, as set forth in Schedule A.

(f) **[redacted] equitable remedies.** Jobber agrees that money damages may not be a sufficient remedy for its breach of this Contract and that, therefore, in addition to all remedies available at law, [redacted] shall be entitled to specific performance, injunctive relief, declaratory judgment and/or other equitable remedies, as appropriate. Jobber agrees to waive any requirement for the posting of any bond in connection with [redacted] effort to seek an equitable remedy.

17. Deliveries.

(a) **[redacted] right to limit monthly delivery quantities.** Unless otherwise specified in the schedules, appendices or amendments to this Contract, deliveries of each Product hereunder shall be in relatively equal monthly quantities, subject to weekly or daily prorating. [redacted] shall not be obligated to deliver to Jobber in any given month more than an amount equal to one-twelfth (1/12) of the respective 12-month quantity for each such Product as set forth on Schedule A. Should Jobber at any time or for any month order in quantities less than such prorated amount, [redacted] shall not be obligated to deliver the deficiency at any time. Should Jobber at any time or for any month require more than said prorated amount, [redacted] shall have the right, at its option, to supply such excess requirement, but if [redacted] supplies same it shall not be obligated to do so again in the future.

(b) **[redacted] right to specify minimum delivery quantities.** [redacted] shall have the right to specify minimum delivery quantities and either refuse to make deliveries in quantities less than such minimums or, at [redacted] option, charge extra for making such deliveries.

(c) **Changes in and at Jobber's Assigned Terminal(s).** [redacted] shall have the right at any time to change Jobber's Assigned Terminal(s) and/or to limit the quantity of Product that [redacted] shall make available to Jobber at any of said terminals. [redacted] shall have the right to determine and designate the percentage of Jobber's Schedule A quantities that [redacted] will make available to Jobber at Jobber's Assigned Terminal(s).

18. Determination of Quantities. The quantities of Products sold hereunder shall be determined on the basis of the temperature thereof at 60°F in accordance with "Table No. 6B of API Standard 2540, Manual of Petroleum Measurement Standards, Chapter 11.1--Volume Correction Factors--Volume II" (or any API/ASTM reissue or replacement thereof in effect at the time of measurement), or at [redacted] option, on the basis of gross volume, as established by [redacted] for Jobber's class of trade in the applicable geographic area, or as otherwise required by law.

19. Demurrage. Jobber shall pay any and all demurrage accruing on any barges, tank cars, transport and/or tank trucks or other means of transportation at the prevailing rates therefor, at the time of the particular delay. Jobber shall also pay to [redacted] a tank car and/or truck transport rental at [redacted] then prevailing rates for each chargeable demurrage day.

20. Rejection of Products and Notice of Breach.

(a) **Rejection must occur within 48 hours of receipt.** Jobber shall have 48 hours after receipt of the Products sold under the Contract to inspect and either accept or reject said Products. If Jobber retains the Products in its possession for a period in excess of 48 hours after receipt without rejecting said Products, this shall be regarded as an irrevocable acceptance by Jobber.

(c) [redacted] right to monitor compliance. As part of [redacted] compliance programs, Jobber acknowledges and agrees that [redacted] shall have the right to enter upon any premises in or upon which any records necessary to demonstrate Jobber's compliance with the contractual obligations required in paragraph 24(b) above are kept. Jobber also grants to [redacted] the right to obtain and/or copy any records, inspect any monitoring equipment or method and sample any Products covered by this Contract.

25. **Taxes.** Jobber shall pay, or shall reimburse [redacted] for [redacted] payment of, any tax, inspection or environmental fee, duty, tariff or other like charge (including penalty and interest, if any) imposed, levied, or assessed by federal, state, local, Native American, or foreign authority upon the Products covered by this Contract, or upon the import, manufacture, storage, sale, use, transportation, delivery, or export of the Products covered by this Contract, or upon the privilege of doing any of these activities, whether imposed on or measured by the volume, price, or proceeds of sale of the Products covered by this Contract.

26. **Notices.** All notices given under this Contract shall be deemed properly served if delivered in writing personally or sent by certified mail (return receipt requested) to [redacted] or Jobber at the addresses indicated in the introduction to this Contract. The date of notice shall be the date deposited in the U.S. mail or, if delivered personally, the date of delivery. Any change of address of a party shall be communicated to the other party by written notice in accordance with the terms of this paragraph 26.

27. **Entire Agreement.** This Contract cancels and supersedes all prior written and unwritten agreements, schedules, appendices, amendments and understandings between the parties pertaining to the matters covered in this Contract and contains the entire agreement between the parties. No representations or statements, other than those expressly set forth in this Contract were relied upon by the parties in entering into this Contract. No modification or waiver of, addition to, or deletion from the terms of this Contract shall be effective unless reduced to writing and signed by Jobber and a representative of [redacted] authorized to execute this Contract.

28. **Severability.** In the event one or more paragraphs of this Contract, or portions of any paragraph, are declared or adjudged invalid or void by a court of competent jurisdiction, the remaining paragraphs of this Contract, or remaining portions of any paragraph, shall remain in full force and affect. [redacted] may, in the alternative and at its sole discretion, cancel this Contract with due notice to Jobber.

29. **No Waiver.** No course of dealing and no failure to act on any incident of breach under this Contract shall be construed against [redacted] as a waiver of its right to act in the future. The waiver of any breach of any term or condition in this Contract shall not be construed as a waiver of any subsequent breach of the same or other term or condition. Any failure by [redacted] to enforce its rights or to seek remedies under this Contract shall not prejudice its rights or available remedies for any subsequent breach by Jobber.

30. **Paragraph Titles.** The titles and subtitles of paragraphs in this Contract are for reference end identification purposes only. They are not intended to modify, restrict or expand upon the content of the paragraphs themselves.

31. **Execution.** This Contract shall not be binding upon [redacted] unless and until it is signed by [redacted] authorized representative and a fully executed copy is returned to Jobber.

In Witness Whereof, the parties hereto have executed this Contract on the date stated.

Jobber: ______________________

By: ______________________

Title: ______________________

By: ______________________

Title: ______________________

SCHEDULE A TO BRANDED JOBBER CONTRACT
PRODUCT, QUANTITIES AND
JOBBER'S ASSIGNED TERMINAL(S)

This schedule A ("Schedule A") dated the twenty-eighth day of October, 1998 is made part of and shall be attached to the branded jobber contract ("Contract") dated the first day of January, 1999 by and between and ("Jobber") pursuant to the applicable paragraphs of said Contract.

NOW, THEREFORE, [redacted] and Jobber, intending to be legally bound, agree to the following:

1. THIS SCHEDULE A SUPERSEDES ALL PRIOR SCHEDULES. This Schedule A shall cancel and supersede any and all prior Schedule A schedules.

2. PRODUCTS AND QUANTITIES.

   (a) CONTRACTS LONGER THAN ONE (1) YEAR. The branded petroleum products ("Products") and the quantities of those Products covered by the Contract shall be as set forth below for twelve (12) month periods beginning on the first day of the Contract term and each anniversary thereof. These Products and quantities shall be subject to changes at the end of each twelve (12) month period, at [redacted] option, with the submission to Jobber of an amended Schedule A. Within twenty (20) days after receiving an amended Schedule A, Jobber shall have the right to cancel the Contract upon thirty (30) days written notice. If Jobber does not cancel within this twenty (20) day period, it is expressly agreed and understood the Jobber shall abide by the terms and conditions of the amended Schedule A.

   (b) CONTRACTS OF ONE (1) YEAR OR LESS. In the case of a Contract with a term of one (1) year or less, the Products and the quantities of those Products covered by the Contract shall be as set forth below for the twelve (12) month period beginning on the first day of the Contract term and ending on the last day of said term.

3. JOBBER'S ASSIGNED TERMINAL(S). The [redacted] terminals assigned to Jobber ("Jobber's Assigned Terminal(s)") shall be as set forth below. [redacted] shall have the right at any time or times to change Jobber's Assigned Terminal(s) and/or to limit the quantity of any Product that [redacted] shall make available to Jobber at Jobber's Assigned Terminal(s) including, but not limited to, the right to limit Jobber's supply of any Product to the monthly quantities set forth below and the right to further limit Jobber's supply of any Product by prorating said monthly quantities on a weekly or daily basis.

4. SUBMISSION OF SCHEDULE A DOES NOT GUARANTEE RENEWAL. No language in this Schedule A or any amendment shall be considered a commitment by either party that the franchise relationship will be renewed upon the expiration of the current Contract.

Total Gasoline:			12,893.5 MGals
Total Distillate:			1,745.9 MGals
Terminal:	07367-057		
LS NO2 DISTILLATE		May-1999	2.5 MGals
		Total	2.5 MGals
Terminal:	00207-058		
PREMIER DIESEL FUEL		Apr-1999	7.6 MGals
		May-1999	7.7 MGals

(b) **Required procedures if Products rejected.** If Products are rejected, notice must be given to [redacted] so that it is received no later than five (5) business days after delivery of the Products to Jobber, fully specifying all claimed shortages, defects and/or nonconformities. The failure to specify any shortage, defect and/or nonconformity shall constitute a waiver of that shortage, defect or nonconformity.

(c) **Required procedures if breach discovered after acceptance.** In the event that the Products are accepted pursuant to the terms of this paragraph 20, Jobber agrees to notify [redacted] in writing of any subsequently discovered breach of warranty which\ could not have reasonably been discovered by careful inspection at the time of delivery. Such notice shall be given within seven (7) days after discovery of the breach and must specify the facts constituting the alleged breach. Failure to give such notice shall be deemed conclusive evidence that Jobber has no valid claim for breach of warranty.

21. Express Warranties, Disclaimers and Damage Limits.

(a) [redacted] **warranties.** [redacted] warrants that the Products sold to Jobber under this Contract shall meet [redacted] then current specifications for the respective Product and that said Product shall be in merchantable condition.

(b) **NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, ARE MADE.**

(c) **Right to damages limited.** Under no circumstances shall [redacted] be liable for incidental, special, punitive or consequential damages whether under warranty, tort, contract, strict liability or otherwise.

22. Force Majeure and Allocation.

(a) **Force majeure.** [redacted] shall be excused from delay or nonperformance in the event of a refinery turnaround, whether partial or complete, or if it is otherwise unable to meet the demand for its Products at [redacted] normal and usual distribution points for supplying Jobber (regardless of whether or not [redacted] may have diverted certain supplies from such distribution points in order to alleviate shortages at other distribution points), or in the event of failure or delay in delivery due to exhaustion, reduction or unavailability of Product, or stock or component necessary in the manufacture or production of such Product. Either party shall be excused from delay or nonperformance in the event of any condition whatsoever beyond said party's reasonable control, including without limitation: unavailability, failure, or delay of transportation; Acts of God; labor difficulties; explosions; storms; breakdown of machinery or equipment; fire; riots; war conditions in this or any other country; and compliance with any law or governmental order, regulation, recommendation, request or allocation program (whether voluntary or involuntary) affecting directly or indirectly said party's ability to perform hereunder.

(b) **Allocation.** In the event of any of the contingencies or conditions referred to in paragraph 22(a) above, [redacted] shall have the right to curtail deliveries or allocate its supply of Product for sale among its customers in any manner which in its sole discretion is fair and reasonable in the circumstances, and shall not be obligated to obtain or purchase other supplies of Product or to in any way make up any Product not delivered. Jobber shall not hold [redacted] responsible in any manner for any losses or damages which Jobber may claim as a result of any such curtailment or allocation by [redacted].

23. Discontinuance of Product or services. [redacted], at its sole option, at any time may: (a) discontinue the production or sale of any Product covered hereby; (b) change the specifications of any such Product; (c) replace any such Product with another Product; (d) change or withdraw the trademark applicable to any such Product; (e) change or withdraw services offered in connection with any such Product, including but not limited to; credit card privileges; and/or (f) withdraw from marketing any such Product in the geographic area encompassing Jobber's Schedule B area and/or in which Jobber's bulk plants or any of Jobber's Assigned Terminal(s) are located. [redacted] shall not be liable to Jobber by reason of any such discontinuance, replacement, change or withdrawal.

24. Compliance with Laws.

(a) **Compliance with laws generally.** Jobber shall comply fully, and require its Jobber-Dealers and other customers to comply fully, with any and all applicable laws and regulations of any and all governmental authorities regarding the receipt, shipment, delivery, storage, handling, use, sale, dispensing, labeling, invoicing, advertising and/or promoting of the Products purchased under this Contract. Without limiting the foregoing, Jobber shall comply fully, and require its Jobber-Dealers and other customers to comply fully, with any and all applicable laws and regulations, promulgated by any and all governmental occupational, health and safety agencies and/or environmental protection agencies.

(b) **Compliance with Clean Air Act regulations.** Jobber shall comply with all of the obligations imposed by the following federal Clean Air Act regulations and any corresponding state counterparts, as amended: (1) 40 C.F.R. Part 80, Subpart D, regarding reformulated gasoline; (2) 40 C.F.R. Part 80, Subpart C, regarding oxygenated gasoline (3) 40 C.F.R. Part 80, Subpart B (specifically 40 C.F.R. sections 80.27 and 80.28), regarding gasoline volatility; (4) 40 C.F.R. Part 80, Subpart B (specifically 40 C.F.R. sections 80.29 and 80.30), regarding sulphur content in diesel fuel; and (5) 40 C. F.R. Part 80, Subpart G, regarding deposit control additives in gasoline.

	Jun-1999	7.5 MGals
	Jul-1999	7.8 MGals
	Sep-1999	7.5 MGals
	Oct-1999	8.6 MGals
	Total	46.6 MGals

Terminal: ʕ 00406-058

REGULAR GASOLINE	Jan-1999	156.2 MGals
	Feb-1999	141.0 MGals
	Mar-1999	156.8 MGals
	Apr-1999	178.2 MGals
	May-1999	223.5 MGals
	Jun-1999	202.1 MGals
	Jul-1999	222.6 MGals
	Aug-1999	205.0 MGals
	Sep-1999	171.8 MGals
	Oct-1999	192.5 MGals
	Total	1,849.6 MGals
REGULAR OXYGENATED	Jan-1999	704.3 MGals
	Feb-1999	686.9 MGals
	Mar-1999	586.1 MGals
	Apr-1999	678.2 MGals
	May-1999	829.3 MGals
	Jun-1999	860.9 MGals
	Jul-1999	996.1 MGals
	Aug-1999	979.3 MGals
	Sep-1999	836.4 MGals
	Oct-1999	848.0 MGals
	Total	8,005.4 MGals
MID-GRADE GASOLINE	Jan-1999	17.5 MGals
	Feb-1999	14.0 MGals
	Mar-1999	11.7 MGals
	Apr-1999	18.1 MGals
	May-1999	20.2 MGals
	Jun-1999	17.6 MGals
	Jul-1999	26.3 MGals
	Aug-1999	22.5 MGals
	Sep-1999	18.6 MGals
	Oct-1999	22.6 MGals
	Total	189.3 MGals
MID-GRADE OXYGENATED	Jan-1999	79.8 MGals
	Feb-1999	78.7 MGals
	Mar-1999	69.5 MGals
	Apr-1999	67.1 MGals
	May-1999	124.5 MGals
	Jun-1999	107.5 MGals
	Jul-1999	134.1 MGals
	Aug-1999	117.7 MGals
	Sep-1999	126.2 MGals
	Oct-1999	109.2 MGals
	Total	1,014.3 MGals
PREMIUM GASOLINE	Jan-1999	58.8 MGals
	Feb-1999	52.0 MGals
	Mar-1999	43.1 MGals
	Apr-1999	59.2 MGals
	May-1999	122.3 MGals
	Jun-1999	80.2 MGals
	Jul-1999	104.5 MGals
	Aug-1999	88.9 MGals

	Sep-1999	104.4 MGals
	Oct-1999	96.9 MGals
	Total	810.3 MGals
PREMIUM OXYGENATED	Jan-1999	44.3 MGals
	Feb-1999	38.6 MGals
	Mar-1999	39.6 MGals
	Apr-1999	41.0 MGals
	May-1999	69.8 MGals
	Jun-1999	58.3 MGals
	Jul-1999	65.4 MGals
	Aug-1999	67.5 MGals
	Sep-1999	63.3 MGals
	Oct-1999	61.8 MGals
	Total	549.7 MGals
HS NO1 DISTILLATE	Jan-1999	2.5 MGals
	Feb-1999	4.6 MGals
	Mar-1999	1.0 MGals
	Oct-1999	2.3 MGals
	Total	10.4 MGals
HS NO2 DISTILLATE	Jan-1999	43.7 MGals
	Feb-1999	48.8 MGals
	Mar-1999	31.9 MGals
	Apr-1999	25.6 MGals
	May-1999	16.0 MGals
	Jun-1999	38.9 MGals
	Jul-1999	24.7 MGals
	Aug-1999	10.9 MGals
	Sep-1999	17.5 MGals
	Oct-1999	43.2 MGals
	Total	301.2 MGals
LS NO1 DISTILLATE	Jan-1999	45.5 MGals
	Feb-1999	27.3 MGals
	Mar-1999	14.9 MGals
	Apr-1999	8.1 MGals
	May-1999	2.0 MGals
	Jun-1999	6.0 MGals
	Jul-1999	3.0 MGals
	Aug-1999	2.3 MGals
	Sep-1999	1.3 MGals
	Oct-1999	12.2 MGals
	Total	122.6 MGals
LS NO2 DISTILLATE	Jan-1999	68.0 MGals
	Feb-1999	59.1 MGals
	Mar-1999	94.6 MGals
	Apr-1999	77.7 MGals
	May-1999	123.9 MGals
	Jun-1999	181.5 MGals
	Jul-1999	144.5 MGals
	Aug-1999	137.8 MGals
	Sep-1999	151.3 MGals
	Oct-1999	157.3 MGals
	Total	1,195.7 MGals

Terminal: 00208-058

REGULAR OXYGENATED	Jan-1999	23.5 MGals
	Feb-1999	30.1 MGals
	Mar-1999	31.1 MGals

	Apr-1999	32.4 MGals
	May-1999	49.1 MGals
	Jun-1999	40.3 MGals
	Jul-1999	56.7 MGals
	Aug-1999	47.5 MGals
	Sep-1999	41.4 MGals
	Oct-1999	39.7 MGals
	Total	391.9 MGals
MID-GRADE OXYGENATED	Jan-1999	3.6 MGals
	Feb-1999	3.6 MGals
	Mar-1999	3.0 MGals
	Apr-1999	6.6 MGals
	May-1999	5.5 MGals
	Jun-1999	5.5 MGals
	Jul-1999	10.5 MGals
	Aug-1999	6.5 MGals
	Sep-1999	6.5 MGals
	Oct-1999	4.6 MGals
	Total	56.0 MGals
PREMIUM GASOLINE	Jan-1999	2.6 MGals
	Feb-1999	1.0 MGals
	Mar-1999	2.6 MGals
	Apr-1999	2.0 MGals
	May-1999	2.5 MGals
	Jun-1999	2.5 MGals
	Jul-1999	3.5 MGals
	Aug-1999	3.5 MGals
	Sep-1999	3.0 MGals
	Oct-1999	2.9 MGals
	Total	26.1 MGals
PREMIUM OXYGENATED	Aug-1999	1.0 MGals
	Total	1.0 MGals
LS NO2 DISTILLATE	Feb-1999	1.5 MGals
	Mar-1999	5.5 MGals
	Apr-1999	10.1 MGals
	May-1999	5.5 MGals
	Jun-1999	11.0 MGals
	Jul-1999	5.5 MGals
	Aug-1999	9.5 MGals
	Sep-1999	7.9 MGals
	Oct-1999	10.3 MGals
	Total	66.9 MGals

Schedule B

Area of Primary Marketing Responsibility

Form 29-830-B (12-94) E

This schedule B ("Schedule B") dated 12/3/98, is made a part of and shall be attached to the branded jobber contract ("Contract") dated 12/3/98, by and between

and ______________________________ ("Jobber")
(State exact legal name of Jobber)

pursuant to paragraph 8(a) of said Contract.

Now, therefore, [redacted] and Jobber, intending to be legally bound, agree to the following:

1. **This Schedule B supersedes all prior schedules.** This Schedule B shall cancel and supersede any and all prior Schedule B schedules.

2. **Schedule B area.** Jobber's Schedule B area of primary marketing responsibility ("Schedule B area") shall be the counties, or portions thereof, listed below. In addition, a map may be attached to and made a part of this Schedule B to further state Jobber's Schedule B area.

Jobber's Schedule B Area of Primary Marketing Responsibility

County If Jobber's Schedule B area includes only a portion of a county, indicate that portion in parentheses after listing the county name.	State
ST LOUIS	MN
COOK	MN
CARLTON	MN
PINE	MN
DOUGLAS	MN
BAY FIELD	WI
ASHLAND	WI
SAWYER	WI
WASHBURN	WI
LAKE	MN

Jobber: [redacted]

By: ______________________

Title: ______________________

By: ______________________

Title: ______________________

References

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