Experimental Gasoline Markets [*]

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1. Introduction

Few industries evoke such strong sentiments by consumers, retailers, wholesalers, and policy makers as gasoline. The structure of the gasoline industry is ex entry at the retail level, thus setting a condition most unfavorable to zone pricing in terms of its potential harm to consumers. Experimental economics is an ideal tool for addressing zone pricing. Currently, gasoline wholesalers are free, as Shepard (1993, p. 63) notes, to charge "station-specific" wholesale prices. In an experiment, we can control the extent, if any, to which zone pricing can be employed in situations where explicit collusion among the wholesalers is not possible. Allowing zone pricing in one treatment serves as a benchmark for evaluating the complementary treatment, banning zone pricing by mandating uniform wholesale prices. Such a comparison affords a direct examination of the welfare effects of the proposed legislation on consumers, retailers, and wholesalers. Similarly, we can vary the degree of vertical integration to assess the impact of divorcement. A chief advantage of a controlled laboratory study is that we can precisely measure buyer welfare, which cannot be done in naturally occurring gasoline markets because consumer preferences are not observable. With an experiment we also have precise data on the actual transaction prices paid by consumers as opposed to just posted prices at retail stations.

With our data set, we also explore the phenomenon that retail gasoline prices adjust asymmetrically to cost shocks, yet another topic that has led to much public outcry. Several papers have found that gasoline prices rise more rapidly than they fall (see Johnson, 2002; Reilly and Witt, 1998; Borenstein et al., 1997; Castanias and Johnson, 1993; and Bacon, 1991).

localities place constraints on gasoline blends.[6] Chouinard and Perloff (2002) find that the price

Recently the industry has experienced considerable consolidation with the merging of large integrated companies such as BP and Amoco and Exxon and Mobil. Using simulations Manuszak (2001) investigates refiner mergers.[8] His model predicts that the merged wholesaler retailers in the market.[11] Comparing prices before and after ARCO's branding of Thrifty outlets, Hastings finds that retailers who had competed against the independent chain raised prices relative to retailers who had not been competing directly with Thrifty. One should be careful to note that the welfare effects of such a merger are unclear. While prices rose in some locations, consumers in these locations now have an additional brand of gasoline. If consumers have a preference for the branded gasoline, then this situation actually could generate additional utility.

Hastings also observes no retail price differential due to the new ARCO store being either a company operated or dealer operated station. This finding argues against the divorcement proposals issued by several communities that would force wholesalers and retailers of branded gasoline to be separate. In the event that the retailers have market power,[12] forcing retailers to be independent of the wholesaler could lead to a double marginalization problem, resulting in higher retail prices for non-integrated outlets. Barron and Umbeck (1984) and Vita (2000) find support for this hypothesis.

While vertical separation may have unfavorable price implications for consumers, the situations in which such separation will be observed are less clear. In a study comparing outlet ownership structure and the non-gasoline aspects of the outlet, Shepard (1993) finds that stations where monitoring is relatively more straightforward tend to be company operated and vice versa.

$\in$ {1, 2,…, A}. Thus each station $\rho^r_{(s,a),b_i}$ is indexed by location, brand, and retailer identity $r \in R$. Note that identifying the location and the retailer is not redundant as multiple outlets can operate at the same location. It is quite common for two stations to be located on opposite sides of the street at the same intersection. Further, the retailer identity and the brand type are not redundant as there could be multiple retailers selling the same brand, as would occur in a market with both company operated and lessee dealer stations. The per unit price charged to a consumer by a retail outlet is $p_{\rho^r_{(s,a),b_i}}$.

Each buyer has a value v for one unit of gasoline. Buyers in the market are characterized by brand preference and location. A fraction ω_{b_i} of the buyers have a preference for brand b_i, meaning that these buyers gain additional utility $\beta_{b_i} > 0$ if they consume brand b_i. The fraction of consumers who do not have a brand preference is defined as ω_{b_0} with $\omega_{b_0} = 1 - \sum_{n=1}^{N} \omega_{b_n}$. For customers with no brand preference we define $\beta_{b_0} \equiv 0$. To distinguish the location of a consumer from the location of a retailer, the buyer's location is denoted by the pair (σ, α) where $\sigma \in$ {1, 2,…, S} and $\alpha \in$ {1, 2,…, A}. The percentage of buyers at a particular location is determined by the density function $f(\cdot)$ defined over the S $\times$

A buyer with a preference for brand *j* attempts to

$$\max_{\rho^r_{(s,a),b_i} \in \mathrm{P}} v + \varsigma_{j\rho^r_{(s,a),b_i}} \beta_{b_j} - p_{\rho^r_{(s,a),b_i}} - d(\|(\mathrm{s},\mathrm{a}),(\sigma,\alpha)\|)$$

subject to $v + \varsigma_{j\rho^r_{(s,a),b_i}} \beta_{b_j} - p_{\rho^r_{(s,a),b_i}} - d(\|(\mathrm{s},\mathrm{a}),(\sigma,\alpha)\|) \geq 0$

where $\varsigma_{j\rho}$ is an indicator function that takes on the value 1 if station $\rho^r_{(s,a),b_i}$ sells brand *j* and is 0 period, one buyer enters the market at a randomly chosen location and considers purchasing a single unit of gasoline. A retailer only refills its tanks once it sells K units.

willing to travel 7 intersections to a non-preferred brand outlet. The buyers have complete information about current retail prices.[24] Each laboratory session lasts 1200 periods. In each period, which is every 1.7 seconds, a robot buyer from a randomly drawn location enters the market, observes retail prices and makes a purchase decision.

We consider three experimental treatments to identify the impact of banning zone pricing and limiting vertical integration in retail gasoline markets. In the zone pricing (or baseline) treatment, refiners have the ability to set $w_{\rho^r_{(s,a),b_i}}$ for each $\rho^r_{(s,a),b_i} \in P$, as described in the preceding section. In this treatment, each retailer observes two location specific wholesale prices but could not shift inventory between locations.[25] Our uniform pricing treatment represents the environment after legislation banning zone pricing is enacted. In terms of the model described above, the uniform pricing treatment imposes the restriction that $w_{\rho^r_{(s,a),b_i}} = w_i$ for every station selling b_i. It is important to note that uniform pricing at the wholesale level does not imply uniform retail prices. In both the zone pricing and uniform pricing treatments, refiners are able to change wholesale prices throughout the 1200 periods. We measure the effects of divorcement by comparing the baseline treatment with a company operated (company-op) treatment. In the company-op treatment all of the retail stations are vertically integrated, which essentially removes the intermediary and eliminates double marginalization. This is operationalized by automatically setting $w_{\rho^r_{(s,a),b_i}} = c_i$.[26] In all three treatments, the

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Retailer r sets $p_{\rho^r_{(s,a),b_i}}$ and could adjust this price at any time during the 1200 periods. Retailers and refiners observe all current retail prices including those set by rival outlets. However, the current DTW prices are known only by the refiner and the associated retailer. At the beginning of sessions in the zone and uniform treatments, refiners set initial wholesale prices, which the branded retailers are forced to accept for the initial inventory of K = 10 units. Once a location stocks out, the retailer completely replenishes its inventory of K = 10 units at the current wholesale price. In the event that wholesale prices fall, it is possible that a retail outlet has gas in its inventory that cost more than current rival retail prices. To avoid the retailer having to fully absorb losses, the refiners can offer rebates to the retailers for unsold units in inventory.

We conducted a total of twelve laboratory sessions, four in each treatment. Each session lasted no longer than 90 minutes and consisted of 8 subjects in the zone and uniform treatments and 4 subjects in the company-op treatment, who were recruited from undergraduate classes in economics, management, and engineering at George Mason University. In each session subjects were randomly assigned a role.[27] Prior to beginning the actual experiment, subjects were given ample opportunity to ask questions. Each subject only participated in one session and received US$1 for every 800 of experimental profit. The average payoff across all subjects was $18.25, including $5 for showing up on time. Subjects received their payments in private at the conclusion of the session.

5. Experiment Findings

In what follows we present the results of our experiment as a series of nine findings. We break down the discussion of the results into two subsections. The first subsection covers the results from the first 600 periods with stable wholesale costs. We control for learning effects by focusing our attention on the last half these periods (301-600). For this set of periods we first estimate the comparative static effects of the zone and uniform pricing treatments and the

[27] To avoid the potentially loaded terms associated with gasoline markets, the refiners and station owners were referred to as suppliers and store owners, respectively, who were buying and selling a fictitious product. A copy of the instructions is available from the authors upon request. In an attempt to aid comprehension of the environment, prior to beginning the experiment, each subject experienced the opposite role for 300 periods (except in the company-op treatment for which there is only one role). That is, a refiner (retailer) first read the instructions and participated as a retailer (refiner) for 300 periods, before reading the instructions as a refiner (retailer) and participating for 1200 periods as a refiner (retailer).

pricing) and location effect (*Center* vs. *Corner* station) and an interaction effect are modeled as zero-one fixed effects, while the 8 independent sessions and the 4 subjects within each session are modeled as random effects, e_i and ζ_{ir}, respectively. Specifically, we estimate the model

$$Price_{irlt} = \mu + e_i + \zeta_{ir} + \beta_1 Uniform_i + \beta_2 Corner_l + \beta_3 Uniform_i \times Corner_l + \varepsilon_{irlt},$$

where $e_i \sim N(0, \sigma_1^2)$, $\zeta_{ir} \sim N(0, \sigma_2^2)$, and $\varepsilon_{irlt} \sim N(0, \sigma_{3,i}^2)$. The sessions are indexed by *i*; the subjects acting as retailers within each session are indexed by *r* = 1, 2, 3, 4; and the repeated periods are indexed by *t* the clustered area by 10.9%. Transaction prices in the isolated stations are slightly higher with uniform pricing than with zone pricing ($\hat{\beta}_1 + \hat{\beta}_3$ = 4.29), but this effect is statistically insignificant (*p*-value = 0.4926). <

Given the data generated by our experiment we are able to determine that high retail prices in the isolated areas are not the *result* of high wholesale prices with zone pricing, but rather the *cause* of high wholesale prices. Figure 4 plots average wholesale prices and average posted retail prices by location for the first 300 periods when subjects are learning about the competitive pressures or lack thereof. Notice that, unlike Figure 2, wholesale prices to corner stations have a noticeable upward trend in the zone pricing treatment. Over the first 100 periods, corner station retail prices are very high. As the refiners recognize that these isolated stations are very profitable at those prices, the refiners use zone pricing to capture some of the rents from the corner stations. The clustered area stands in rather marked contrast. As station prices tumble due to the competition, wholesale prices also fall as the refiners use zone pricing to be more competitive. Only after station prices stabilize around period 250 do wholesale prices start to rise as refiners attempt to capture the retailer profits in the clustered area. Ultimately, the refiners capture more of the profits with zone pricing, but not to the detriment of consumers.

Also, we are able to gain insight as to why uniform pricing in the wholesale market actually increases transaction prices for consumers in the clustered area. Fundamentally, the reason is that uniform wholesale pricing forces the refiner to forgo profits in the corner to be red station will not sell these higher-cost units, competition in the center is weakened and gradually the prices of the other refiners and stations drift upwards. The end result is that uniform pricing at the wholesale level stymies retail competition in the clustered center. Moreover, we note that it only takes one refiner's unilateral action to initiate this process of mitigating competition.

Our second finding considers the effect of mandating uniform wholesale pricing on buyer utility. The ability to collect direct measures of consumer welfare and conduct this analysis is another major benefit of a laboratory study over a field study where such measures cannot be collected. Again, we use a linear mixed-effects model to estimate the quantitative effects of the treatment (*Zone* vs. *Uniform* Pricing) on buyer utility. We classify each buyer as one of three types: interior, equidistant, and periphery. Interior buyers are those closest to the center stations. These buyers originate at one of the following intersections: (4, 3), (4, 4), (4, 5), (3, 4), or (5, 4). A buyer is equidistant from the center stations and at least one corner station if it originates at (4, 1), (4, 2), (4, 6), (4, 7), (1, 4), (2, 4), (6, 4), (7, 4), (3, 3), (3, 5), (5, 3) or (5, 5). All other buyers are relatively isolated, being lorio0 TD(e)-05o985 3(ers92 Twfand a12.0504t)-

have further to travel to the lower-price center stations ($\hat{\beta}_2$ = –17.45, p-value = 0.0000). However, with uniform wholesale pricing, the welfare for these buyers is even lower than equidistant buyers in the zone pricing treatment ($\hat{\beta}_1 + \hat{\beta}_4$ = –15.01, p-value = 0.0549). The point estimates indicate that periphery buyers are harmed by uniform pricing ($\hat{\beta}_1 + \hat{\beta}_5$ = –10.05), but this effect is statistically insignificant (p-value = 0.1555). <

These first two findings directly counter the claims that zone pricing harms consumers and that uniform pricing would benefit consumers. Uniform pricing in the wholesale market raises the actual prices that consumers pay and reduces the welfare to all buyers except those on the periphery. Our next finding reports the impact of uniform wholesale pricing on station and refiner profits.

***Finding 3*:** *Uniform pricing significantly increases station profits, but has no effect on refiner profits.*

Evidence: Figure 6 provides the qualitative support for this finding. Each marker represents the profits for one station owner from both the center and corner stations plotted against the associated refiner's profits. It is clear from the figure that station owner profits increase substantially with uniform wholesale pricing. The average station owner earns profits of 801 with zone pricing and 2304 with uniform pricing. For the quantitative support for this finding, we use a Wilcoxon rank sum test to compare the total station owner profits of the four zone pricing sessions with the total station owner profits of the four uniform sessions. We reject the null hypothesis of equal station owner profits with a two-sided test (W = 26, n = 4, m = 4, p-value

5.1.2 Zone Pricing (Lessee Dealers) versus Company-owned Stations

The effects of vertical integration are also rather striking. Figure 7 displays histograms of the posted retail prices. The mode for the corner stations is 200 in both the zone and company-owned treatments; however, there is considerably more mass in the left tail of the company-owned treatments. The effect of vertical integration on retail prices is considerably more conspicuous at the center stations. The entire distribution of posted prices shifts to the left with company-owned stations. The mode with lessee dealers is only 120, whereas the mode is 150 under zone pricing with lessee dealers.

For our quantitative analysis, we estimate a linear mixed effects for transaction prices. The treatment effect (*Lessee Dealers with Zone Pricing* vs. *Company-Owned Stations*) and location effect (*Center* vs. *Corner* station) and an interaction effect are modeled as zero-one fixed effects, while the 8 independent sessions and the 4 retailers within each session are modeled as random effects.

Finding 4*: *Retail transaction prices with company-owned stations are statistically lower in both the clustered area and the isolated areas than in the zone pricing treatment.

Evidence: The mixed effects estimation results presented in Table 3 provide the quantitative support for this finding. With company-owned stations, the average retail transaction price is $\hat{\mu} + \hat{\beta}_1$ = 130.22 at a station in the center, which is 13.2% lower than transaction prices with lessee dealers ($\hat{\mu}$ = 149.97). This effect is statistically significant ($\hat{\beta}_1$ = -19.75, *p*-value = 0.0157). In isolated areas, transaction prices with company-owned stations are -($\hat{\beta}_1 + \hat{\beta}_3$) = 31.53 less than transaction prices with lessee dealers. This effect is also statistically significant (*p*-value = 0.0022), reducing transaction prices by 16.5% from a level of $\hat{\mu}_1 + \hat{\beta}_2$ = 191.58 with lessee dealers to $\hat{\mu}_1 + \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3$ = 160.04 with company-owned stations. <

Finding 4 reports the extent to which a double markup by refiners and stations raises the prices that consumers pay vis-à-vis a single markup by company-owned stations. This finding complements the field studies of Barron and Umbeck (1984) and Vita (2000) and a laboratory study by Durham (2000), which also find that prices are lower with vertical integration than without. Our next finding quantifies the additional utility buyers receive from eliminating the double markup with company-owned stations.

Finding 5**:** *Relative to the zone pricing treatment, pricing with company-owned stations increases buyer welfare for all types of buyers: interior, equidistant, and periphery.*

Evidence: Table 4 reports that with company-owned stations the utility of interior and equidistant buyers increases by $\hat{\beta}_1$ = 20.45 (*p*-value = 0.0241). (The point estimate for equidistant buyers, $\hat{\beta}_4$, is small and highly insignificant.) The utility of periphery buyers increases by $\hat{\beta}_1 + \hat{\beta}_5$ = 25.94 (*p*-value = 0.0084). These absolute increases in buyer welfare translate into percentage increases of 20.1%, 24.4%, and 50.6% in buyer welfare for the interior, equidistant, and periphery buyers, respectively. **<**

5.2 Dynamic Adjustments with Nonstationary Wholesale Costs

We now turn our attention to how prices dynamically adjust to nonstationary costs.

correction model of the first differences (φp_t and φc_t) includes a term that reflects the current "error" in the levels of p_t and c_t in achieving long-run equilibrium. To test whether prices adjust asymmetrically or symmetrically to changes in cost, we follow Granger and Lee (1989) in estimating a non-symmetric error correction model, namely,

$$\Delta p_t = \alpha_1 \Delta c_{t-1} + \alpha_2 \Delta p_{t-1} + \phi_1 z_{t-1} + \phi_2 z_{t-1}^{+} + \xi_t \,,$$

where $\xi_t \sim N(0,\sigma^2)$, z_{t-1} is the error-correction term, and $z_{t-1}^{+} = \max(z_{t-1}, 0)$. If prices adjust symmetrically, the speed of the adjustment to the long run equilibrium is captured by $-1 < \phi_1 < 0$, with $\phi_2 = 0$. If prices respond faster to cost increases than decreases, then $-1 < \phi_1 < 0$ and $\phi_2 > 0$.

We begin this analysis by considering station prices and costs averaged across all sessions and subjects for each station location (corner and center) and treatment (zone, uniform, and company-owned), as depicted in Figure 8. Augmented Dickey-Fuller tests fail to reject the null hypothesis for all series. Given that the each of series are found to be $I(1)$, we now consider whether a long run equilibrium exists between prices and costs for each location in each treatment. This is our sixth finding.

Finding 6: *With zone wholesale pricing and company-owned retail pricing, a long run relationship exists between station prices and station costs for both center and corner stations; however no such relationships exist with uniform pricing.*

Evidence: Table 5 reports the results of Johansen cointegration tests, which serve as the qualitative support for this finding.[30] Likelihood ratio (LR) tests of the number of cointegrating equations indicate that there is 1 cointegrating equation at the 1% level of significance for both corner and center stations with zone wholesale pricing and that there is 1 cointegrating equation at the 5% level of significance for both corner and center stations with company-owned retail pricing. However, the LR tests reject any cointegration with uniform pricing at the 5% level of significance for either locale. <

Finding 6 indicates that a long run equilibrium between station prices and costs with zone wholesale pricing and with company-owned retail pricing. Shocks to costs, both positive and

[30] Schwarz criteria indicate that a one period lag is superior to any other lag specification from two to thirty. The test assumption also assumes no deterministic trend in the data since none was included in the induced wholesale costs.

negative, are passed-through to customers via changes in station prices according to a stable long run relationship between the two series. In contrast, we find that uniform wholesale pricing breaks down the long run relationship between costs and prices at both center and corner stations. This means that any relationship implied by a regression of prices

Finding 7b*: *With company-owned retail pricing, station prices adjust symmetrically and much more slowly to changes in station costs.

Evidence: As reported in Table 6, the error-correction term $\hat{\phi}_1$ is significant for both center and corner stations (*p*-value = 0.0001 and 0.0353, respectively), but $\hat{\phi}_2$ is statistically insignificant (*p*-values = 0.9522 and 0.7719). Figure 9 indicates that the adjustment of prices to positive and negative cost shocks is rather slow. For the ce them in response to cost changes. Of the 16 station owners, 6 respond faster to cost increases than to decreases and 6 respond symmetrically. <

Finding 8 begs the question as to whether there are any reasons why some station owners adjust asymmetrically while others adjust symmetrically. Using a meta-analysis of several industries, Peltzman (2000) uncovers a stylized fact that more volatile input prices are correlated with less price asymmetries. In our laboratory experiment we can directly test whether the volatility of wholesale prices set by refiners affects the price adjustment behavior of station owners. This comprises our final finding.

Finding 9: *The volatility of wholesale prices is uncorrelated with whether or not a station owner adjusts prices asymmetrically or symmetrically. However, during regimes of increasing wholesale costs, more volatile wholesale prices are correlated with station owners who respond more quickly to wholesale price increases than to wholesale price decreases.*

Evidence: Using a Wilcoxon rank sum statistic we test whether the variance of the change in wholesale prices is correlated with a station owner being classified as an asymmetric ($\hat{\phi}_2 > 0$) or symmetric ($\hat{\phi}_2 = 0$) price adjuster. Specifically, we compare the variance of wholesale price changes for periods 601-1200 for the 6 asymmetric price adjusters to the 6 symmetric price adjusters and find that there is no statistical difference ($W = 43$, $n = 6$, $m = 6$, p-value = 0.5887). However, if we separately measure the variance of price changes when wholesale costs are rising (periods 778-853 and 1053-1200), volatility of wholesale prices is larger for the asymmetric price adjusters than for symmetric price adjusters ($W = 27$, $n = 6$, $m = 6$, p-value = 0.0649). When wholesale costs are falling in periods 601-777 and 854-1052, there is no statistical difference in the volatility of wholesale prices for the different retail types ($W = 43$, $n = 6$, $m = 6$, p-value = 0.5887). <

The implication of Finding 9 is that refiners who have greater volatility in wholesale prices during periods of rising crude oil costs cause their station owners to increases their prices more quickly than these same individuals decrease their retail prices when wholesale prices and oil prices are falling.

6. Conclusion

The gasoline industry is an intricate system, making the implications of policies such as prohibiting zone pricing and vertical integration unclear from anecdotal evidence alone. However, such topics are regularly debated in the political arena. Consumers and media routinely scrutinize retail gasoline prices looking for evidence of anticompetitive behavior. The sheer magnitude and social interest in this market has led numerous research studies of the industry. Unfortunately, this field research must rely on incomplete information. In this study we detail a laboratory investigation of the gasoline industry, focusing specifically on uniform directly measured in field studies) affirms the results from field studies, lending credence to our other findings.

Numerous studies have demonstrated an asymmetry in gasoline price responses. In the laboratory we are able to investigate this pattern while controlling for collusion, menu costs, and buyer search. With zone pricing, the practice in place when previous studies evaluated asymmetric price responses, we find that retail prices and retail costs are cointegrated, i.e., a long

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Table 2. Estimates of the Linear Mixed-Effects Model for Buyer Utility: Zone vs. Uniform Pricing

	Estimate	Std. Error	Degrees of Freedom*	*t*-statistic	*p*

[redacted]

Table 5. Johansen Cointegration Tests of the Equation: $p_t = \beta_0 + \beta_1 c_t$

Treatment and Location	Eigenvalue	LR statistic	5% Critical Value	1% Critical Value	No. of Cointegrating Equations
Zone Pricing, Center Stations	0.087171	55.27	19.96	24.60	0**
	0.001219	0.73	9.24	12.97	1
Zone Pricing, Corner Stations	0.054853	35.43	19.96	24.60	0**
	0.002834	1.70	9.24	12.97	1
Uniform Pricing, Center Stations	0.027930	18.03	19.96	24.60	0
	0.001816	1.09	9.24	12.97	1
Uniform Pricing, Corner Stations	0.016531	10.91	19.96	24.60	0
	0.001572	0.94	9.24	12.97	1
Company-Owned, Center Stations	0.042158	26.86	19.96	24.60	0*
	0.001847	1.11	9.24	12.97	1
Company-Owned, Corner Stations	0.036239	22.91	19.96	24.60	0*
	0.001403	0.84	9.24	12.97	1

* Denotes rejection of the hypothesis at 5% significance level.

Table 6. Estimates of Error-Correction Model for Δp_t

	Estimate	Std. Error	t-statistic	p-value
Zone Pricing				
All Center Stations				
φc_{t-1}	-0.098	0.052	-1.87	0.0620
φp_{t-1}	0.009	0.039	0.23	0.8182
z_{t-1}	-0.176	0.026	-6.82	0.0000
z^{+}_{t-1}	0.128	0.035	3.67	0.0003
				$\overline{R}^2 = 0.10$
Zone Pricing				
All Corner Stations				
φc_{t-1}	0.022	0.044	0.49	0.6243
φp_{t-1}	-0.001	0.040	-0.23	0.8182
z_{t-1}	-0.047	0.010	-4.60	0.0000
z^{+}_{t-1}	0.020	0.014	1.39	0.1650
				$\overline{R}^2 = 0.06$
Company-Owned				
All Center Stations				
φc_{t-1}	0.052	0.066	0.79	0.4298
φp_{t-1}	0.092	0.040	2.28	0.0230
z_{t-1}	-0.065	0.016	-3.98	0.0001
z^{+}_{t-1}	-0.002	0.026	-0.06	0.9522
				$\overline{R}^2 = 0.05$
Company-Owned				
All Corner Stations				
φc_{t-1}	-0.006	0.066	-0.09	0.9283
φp_{t-1}	0.038	0.041	0.92	0.3579
z_{t-1}	-0.039	0.018	-2.11	0.0353
z^{+}_{t-1}	0.007	0.025	0.29	0.7719
				$\overline{R}^2 = 0.01$

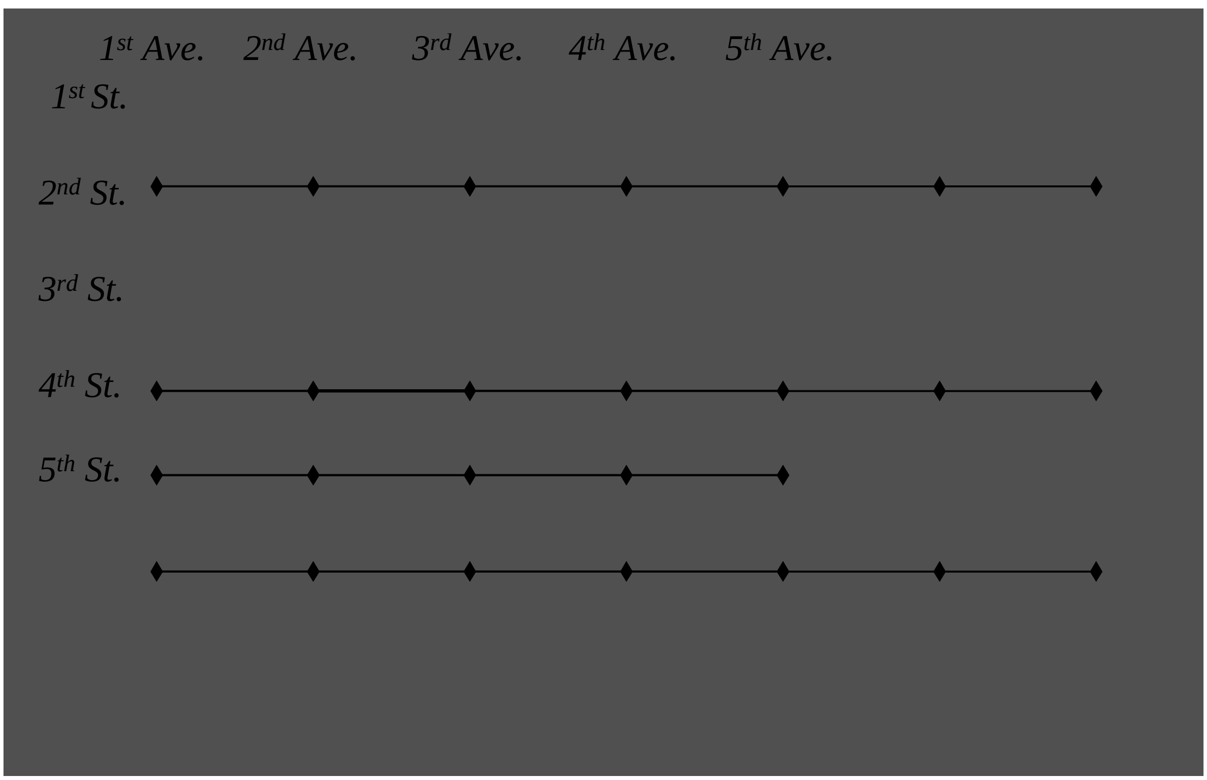
Table 7. Estimates of Error-Correction Model for Δp_t by Session for Center Stations

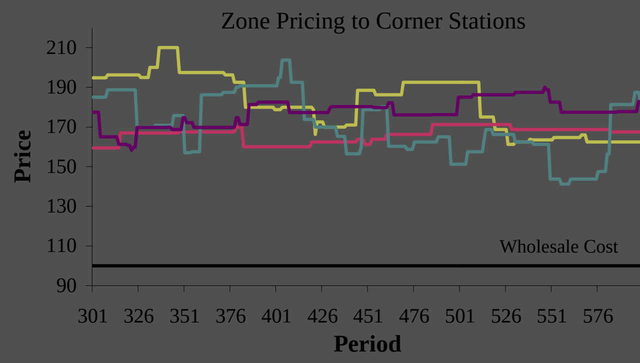
	Estimate	Std. Error	*t*-statistic	*p*-value
Session 1				
φc_{t-1}	-0.048	0.047	-1.01	0.3129
φp_{t-1}	0.008	0.040	0.20	0.8415
z_{t-1}	-0.152	0.027	-5.65	0.0000
z^{+}_{t-1}	0.101	0.036	2.81	0.0051
				$\bar{R}^2 = 0.07$
Session 2				
φc_{t-1}				

Table 8. Types of Station Owners

	Asymmetric $\hat{\phi}_2 > 0$	Symmetric $\hat{\phi}_2 = 0$	Asymmetric $\hat{\phi}_2 < 0$	p_t and c_t are not cointegrated
Session 1	X*			
No. Subjects	3	1		
Session 2	X			
No. Subjects	1	1		2**
Session 3	X			
No. Subjects	2	1	1	
Session 4			X	
No. Subjects		3	1	
Totals	6	6	2	2

*See Table 7 for estimates.
**The refiners for these station owners maintained somewhat high prices that did not vary much over time.




Zone Pricing to Corner Stations
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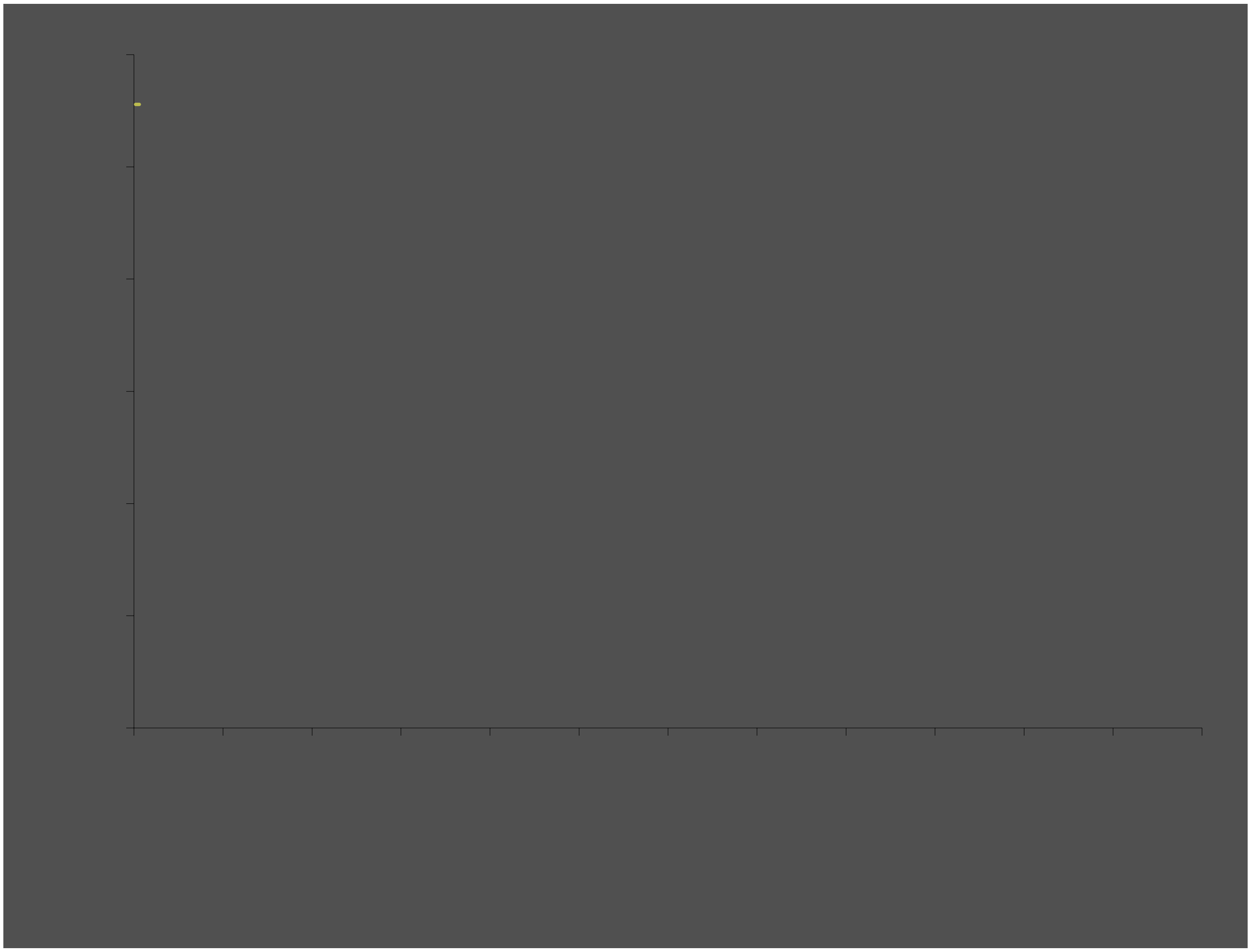


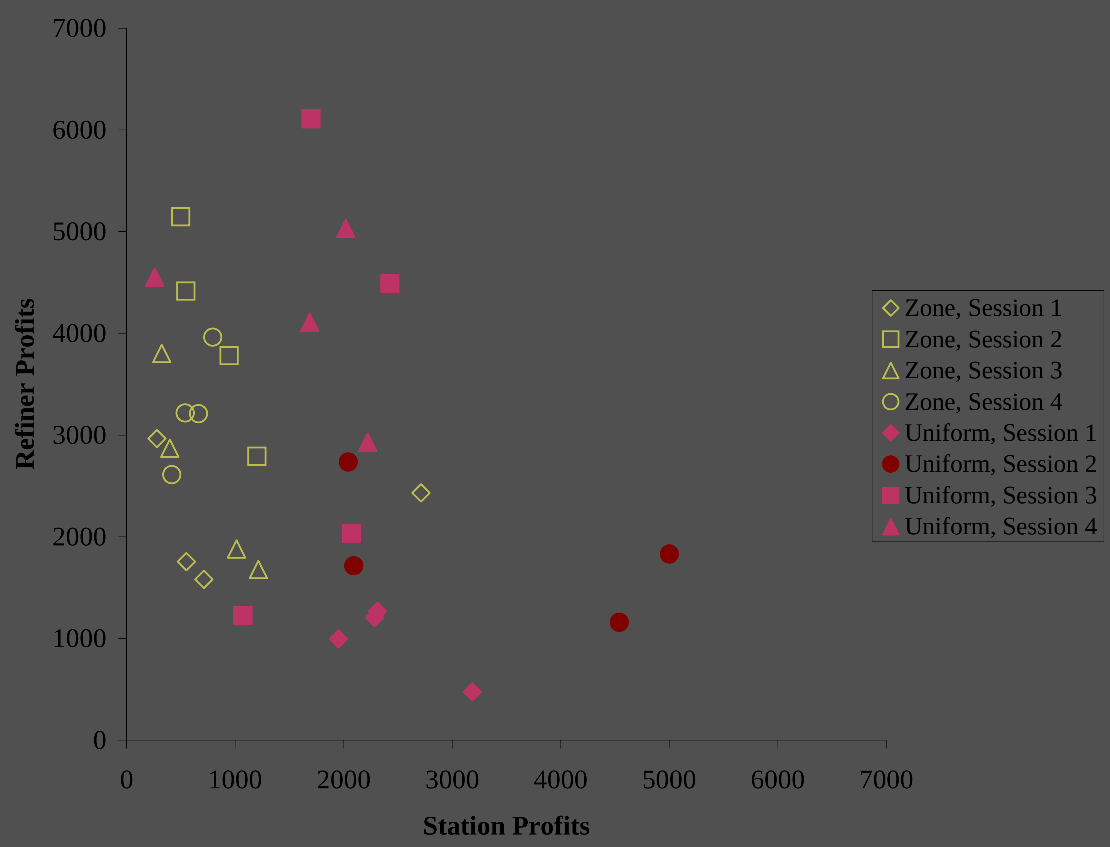
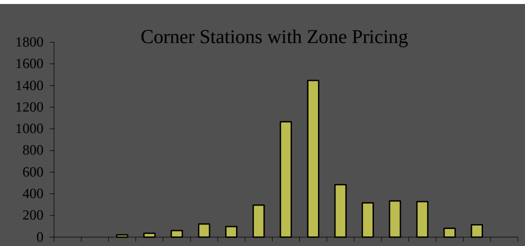
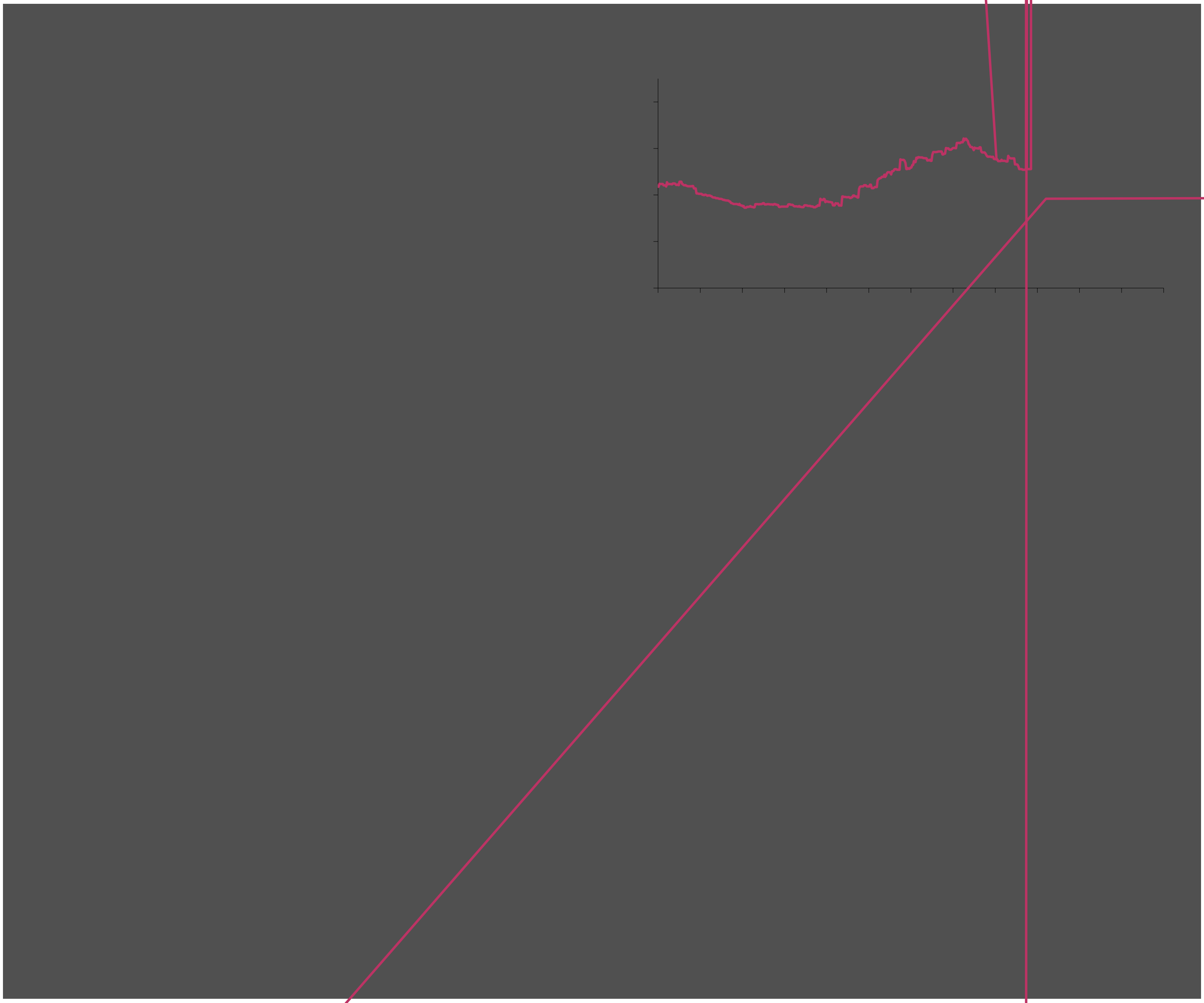
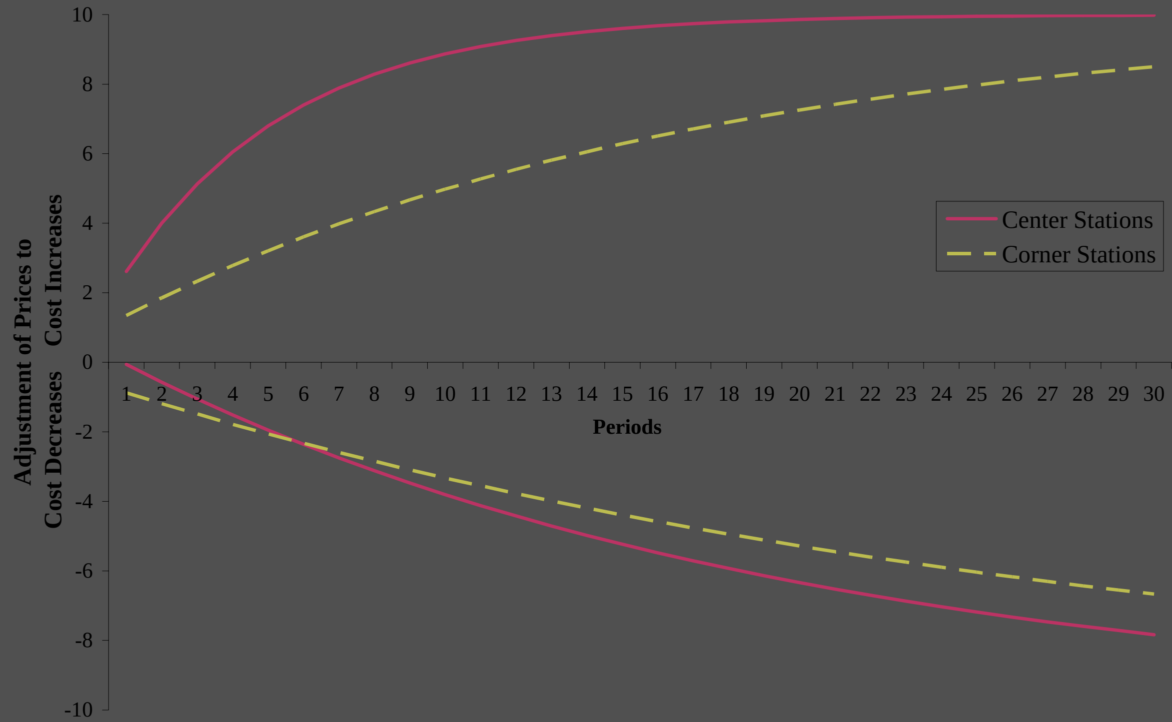


Figure 6. Station vs. Refiner Profits for Periods 301-600







Zone Pricing Treatment