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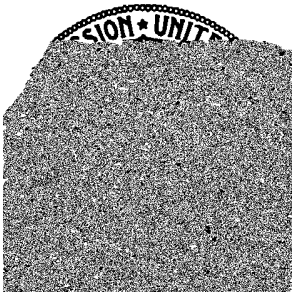

The Impact of Vertical Contracting on Firm Behavior: Evidence from Gasoline Stations

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Abstract

Analyses of organizational form's impact on economic behavior have been rarer than studies of the determinants of organizational form itself. To ll this gap, I develop a theoretical model tailored to the retail gasoline industry that endogenizes the choice of both organizational form and price. The model predicts that vertical separation should be associated with higher prices due to both e ort-induced shifts in demand and double marginalization. It also demonstrates the confoundedness of contract choice and pricing, but suggests that identi cation can be achieved by focusing on variation in monitoring costs across organizational forms. Explicitly addressing the endogeneity of contract choice, I test the model's predictions using a unique dataset containing infor-

1 Introduction

Since the seminal work of Coase (1937), firms' organizational form decisions have preoccupied industrial economists.[1] Different theoretical perspectives on the boundaries of the firm have been advanced, and empirical researchers have credibly established that these theories have considerable explanatory power in a wide variety of settings.[2] By comparison, much less empirical evidence exists for the economic implications of organizational form decisions (Mullainathan and Scharfstein, 2001, Hubbard, 2008). This scarcity may seem surprising given that economic outcomes ultimately should be of primary importance. However, as Kosova et al. (2010) explain, the problem is not a lack of scholarly interest but that the choice of form and its economic implications are likely to be simultaneously determined. This makes it difficult to empirically identify the impact of organizational form separately from its determinants.

One common approach to dealing with the identification problem has been to seek out plausibly exogenous policy or other types of shocks that affect the contract choice set. Though they have been influential and informative, studies exploiting such shocks are subject to the critique that they identify the impact of sub-optimal choices. Thus, it is not surprising that scholars have generally found effects of substantial magnitude when employing this approach (Vita, 2000, Perez-Gonzalez, 2005). The marginal impact of variation in contract choice might well differ when firms are freely optimizing.

I examine these issues in the context of the gasoline industry. My study has two distinguishing elements. First, the empirical strategy is guided by a theoretical model of contract and price choice. The model is grounded in the institutional details of retail gasoline sales, and suggests that vertically separated stations should charge higher prices as a result of both effort-induced demand shifting and double marginalization. Moreover, it emphasizes the fundamental endogeneity of con-

tract choice, while also pointing out that factors related to contractual complementarities will serve as instruments insofar as they do not separately impact economic behavior. In the model, such contractual complementarities arise from the principal's need to restrain agents' moral hazard, which is consistent with the existing literature (Klein, 1980, 1995, Brickley and Dark, 1987, Brickley, 1999).

contribution, Masten et al. (1991) employed a structural approach to identify the impact of form on naval construction projects. They found that \incorrectly" choosing to integrate a project led organizational costs to increase by 70 percent, while an erroneous outsourcing decision trebled organizational costs. More recently, Novak and Stern (2008) and Forbes and Lederman (2010) use instrumental variables approaches based on complementarities in contracting forms to exogenously identify the impact of vertical integration. Both papers nd that vertical separation has signi cant behavioral impacts on performance in the context of automobile manufacturing and air travel, respectively. Pursuing a similar identi cation strategy in a very di erent industry setting, Kosova et al. (2010) analyze the impact of vertical separation using data on a large hotel company's operations. Unlike the previous papers, they nd that organizational form choice has a negligible impact upon economic outcomes after controlling for the choice of form. In other words, the company

2 Organizational Form, Economic Behavior, and Gasoline Retailing

2.1 Theoretical Perspectives

In the context of retail transactions, the economic literature relates the boundaries of the firm to economic behavior and performance primarily through two different channels: agency theory and double marginalization.[3]

Agency problems arise when costly employee effort affects profits, and employers cannot perfectly infer employee effort from observable information. Canonical agency theory (Holmstrom and Milgrom, 1991, Laffont and Martimort, 2002) has shown that a principal (i.e., the employer) facing this situation may be able to increase profits by offering "high powered" incentives that tie agents' (i.e., employees) compensation explicitly to one or more (generally output-related) performance metrics. In most retail settings, these contracts tend to be linear with the following form: $q + \alpha$, where q represents a commission related to observable but stochastic metrics, and α is a fixed payment.[4] If two contracts have the same expected value, then the one with the higher q should be considered higher-powered as it links pay more tightly to performance. The limiting cases are instructive. When $q = 0$, the agent is a salaried employee of the principal. If q is the retail margin, then the agent is the full residual claimant. In effect, the principal has "sold the firm" to the agent.

The viability of high-powered contracts crucially depends on factors like the observability of effort, the presence of other tasks, and the possibility of incentive conflicts across tasks. When high-powered contracts are efficient, the expected effect is to increase profits. However, the contracts' impact on other economic outcomes is unclear. For example, if higher effort on the part of the local agent reduces costs (Shelton, 1967), vertical separation as a result of higher-powered contracts,

could have no (or even a negative) e ect on prices. On the other hand, if the agent's e orts raise demand, then prices might increase.

Double marginalization (Spengler, 1950), by contrast, has unambiguous behavioral implications. This theory shows that vertical separation { such as occurs with high-powered contracts { leads to higher prices than an integrated rm would choose when the upstream rm charges a wholesale price and the downstream entity has some degree of market power. These higher prices lead to lower aggregate pro ts than would be achieved by a vertically integrated rm.

The two stories presented above both take for granted that high-powered contracts are self-enforcing, and that there is no incentive con ict between the principal and agent beyond that relating to demand- (or cost-) shifting e ort. In practice, however, this assumption often does not hold because of the impossibility of writing contracts that cause local agents' to fully internalize the e ects of their actions on the principal, and the existence of multiple local margins impacting the principal's interests. If local agents bene t disproportionately from e ort on some these margins, principals are vulnerable to moral hazard (Klein, 1980, 1995, Brickley and Dark, 1987, Brickley, 1999).

In an in uential contribution to this literature, Brickley and Dark (1987) emphasize monitoring problems in the context of reputational consequences for branded retail chains, pointing out that when customers are unlikely to visit any given outlet again, a high-powered local manager may

to monitoring. If there is a chance that highly-incentivized local managers will behave in ways contrary to the principal's interests, then the principal will wish to check that they are not doing so. Thus, having outlets under similarly organized contracts nearby reduces the marginal cost of an additional outlet under that contract. This is because the principal already needs to devote resources to ensuring the nearby contracts are being appropriately honored, making the additional monitoring cost lower than if there were no other nearby outlets being monitored.

Thus, in aggregate, economic theory produces ambiguous predictions as to the relationship between the boundaries of the rm and economic behavior. However, greater precision can be made by exploiting institutional knowledge to gain insight into e ort's impact. As a result, I now turn to an examination of the characteristics of vertical contracting in the retail gasoline sector.

2.2 Gasoline Retailing, Vertical Contracts, and Past Evidence

Gasoline stations can be divided into two categories. The rst set includes those a liated with re ners (e.g., Exxon or Shell), which accounted for 78% of the industry in 2002 (Kleit, 2005). a-333(of)-3ic

make di erent organizational forms more (less) desirable. While form decisions can be updated, it

dealers charge higher prices than salaried operations. For example, Kleit (2005, pp. 10-11) notes that Senator Carl Levin stated that his sta heard stories that lessee dealers were warned that if they charged higher prices, then their DTW price would be increased as punishment. Overall, these characteristics indicate that 0 < and 0 > for this contract.

Open Dealer Open dealer contracts closely resemble lessee dealer contracts except that the local agent owns the land and station. Previous research has found that open dealer stations tend to be rare in urban areas and more common in rural regions. This may re ect the fact that it is easier for a re ner to determine good locations to build stations in densely populated areas than in rural ones. As with lessee dealer stations, one of the advantages of using an open dealer format is that local agents are incentivized to promote demand through the most e ective channels available to them. In terms of the supply of gasoline, open dealers may procure their gasoline from the re ner as lessee dealers do. However, as noted in Meyer and Fischer (2004), they also commonly purchase their gasoline from a wholesaler who has purchased gasoline from the re ner, who purchase gasoline from the re ner and then pick the price at which they sell to stations. Overall, these results can be summarized as 0< and 0 = .

Jobber/Wholesaler

as something to be considered empirically.

2.3 Past Evidence of the Impact of Form in Gasoline Retailing

The gasoline industry has long attracted attention from scholars seeking to understand the implications of contractual variation. Researchers chie y have focused on the unambiguous prediction

3 Multitask Model of Gasoline Retailing

To gain insight into the relationship between form choice and pricing, I build on the multitask principal-agent model of Slade (1996), which incorporated price-setting into the canonical work of Holmstrom and Milgrom (1991). In the model, the agent has up to two tasks, at least one of which is selling gasoline. The other might be repairing cars or running a convenience store.[12] Assuming a linear demand curve, the model relates local e ort, output, and price in the following manner:

$$q = a \quad Bp + e + \quad ; \qquad N(0; \ ); \qquad = (\quad _{ij}); \tag{1}$$

where q, p, and e are the output, price, and e ort vectors. Demand is characterized by the vector a and matrix B, and $\quad$ is a vector of random shocks drawn from a bivariate-normal distribution. B is assumed to be a symmetric, positive de nite matrix, and the o -diagonal term b_{ij} indicates the extent of demand complementaritypo58tTj /T10 to 8(t)i377(-4)-366(j /T10)(w)2.j /T10Similarly58tTj304(whic

the agent's income can be expressed as:

$$y = {}^{0}q + \frac{e^{0}Ce}{2}: \tag{2}$$

Making the standard assumption that the agent has a negative-binomial utility function with coe cient of absolute-risk aversion r (i.e., u(y) = exp(ry)) means that the agent's certainty equivalent (CE) income is:

$$\begin{aligned} CE &= E(y) \quad \frac{r}{2}Var(y) \\ &= {}^{0}(a \quad Bp + e) + \frac{e^{0}Ce}{2} \quad \frac{r}{2}{}^{0} : \end{aligned} \tag{3}$$

subject to the agent's incentive-compatibility constraint of:

$$e = \text{argmax}_{e} \; (a - Bp + e)'\beta - \frac{e'Ce}{2} \; : \tag{5}$$

The first-order condition for the agent is $\beta - Ce = 0$, which leads to optimal effort $e = C^{-1}\beta$. Thus, Equation (4) can be rewritten as the unconstrained maximization problem:

$$\max_{;p} p'(a - Bp + C^{-1}\beta) - \frac{\beta'C^{-1}\beta}{2} - r$$

one) is determined by local market conditions and is thus not part of the choice set.[13] Second, arms-length contracts in the retail gasoline industry usually proceed as follows: the principal sells gasoline to the agent at some wholesale price, and the agent then chooses the retail price. Thus, we can re-express agents' variable wages as $= p_1$, where is the wholesale price that the agent paid. Third, in practice, principals' set of available organizational forms are rarely continuous. Instead, rms must select from a set of predetermined contracts.[14] Moreover, the levels of in the predetermined contracts tend to be closely correlated. In other words, if an agent is given high-powered incentives for one task, they will be given high powered incentives in the other.

These restrictions transform the principal's contract decision into a recursive discrete choice problem. The principal must consider the agent's behavior under the di erent possible contracts { conditional on the environment in which the contract will be performed { and then select the contract form that will lead to highest pro ts. Insight into how contract choice as well as the other model parameters impact pricing can be gained by focusing on speci c contract cases.

Case 1: Complete Integration.Assume that the principal decides to use a vertically integrated contract, and that the price of the second activity is exogenously determined by market conditions. Insofar as I speci ed that monitoring costs are 0 under vertical integration, this means that Equation 6 simpli es to:

$$^{I} = \max_{p_1} p_1(a_1 \quad b_{11}p_1 \quad b_{12}p_2) + p_2(a_2 \quad b_{12}p_1 \quad b_{22}p_2); \tag{9}$$

while the optimal price becomes:

$$p_1^{I} = \frac{a_1 \quad 2b_{12}p_2}{2b_{11}}; \tag{10}$$

where the superscript identi es the special case.

[13] This assumption is also consistent with the model of Lal and Matutes (1994), wherein imperfectly informed consumers make decisions about which multi-product retailer to frequent based on the advertised price of one good.
[14] See discussion in Blair and Lafontaine (2005).

Case 2: Partial Separation. Now assume that the principal makes the agent the full residual claimant for the second activity, whose price remains exogenously determined. The principal also gives high-powered gasoline-selling incentives to the agent by making them the full residual claimant after the payment of predetermined wholesale price .[15] Since the usage of a high-powered contract means that the principal now must monitor the agent's behavior, this means that Equation 6 becomes:

$$^{S} = \max_{p_1} p_1(a_1 \quad b_{11}p_1 \quad b_{12}p_2 + c_{11}(p_1 \quad) + c_{12}p_2) + p_2(a_2 + b_{12}p_1$$

$$+b_{22}p_2 + c_{12}(p_1 \quad) + c_{22}p_2) \quad \tfrac{1}{2}(c_{11}(p_1^2 \quad 2p_1 \quad + \quad ^2) + 2\,c_{12}(p_1 \quad)p_2 + c_{22}p_2^2$$

Comparing Equations 10 and 12, as well as Equations 9 and 11, also yields insight into how variation in organizational form translates to behavioral di erences. These insights can be summarized as follows.

PROPOSITION 1: Conditional on an arms-length contractual form being chosen in equilibrium for a station, its prices will on average be higher than if it was operated as a salaried operation.

PROOF: All proofs in Appendix A.

Consistent with the general intuition provided by Equation 8, Proposition 1 states that prices will be higher at stations operated under arms-length contracts conditional on the principal choosing to use an arms-length contract. The intuition for the proof is straightforward. The only reason to use a vertically separated contract is to motivate the agent to increase demand by exerting greater e ort. As shown in Equation (1), this linearly shifts the demand curve out, increasing price.

COROLLARY 1: The price increase caused by vertical separation can be decomposed into two separate in uences: i) Double marginalization; and ii) Demand-shifting. Moreover, even in the absence of double-marginalization, the demand-shifting e ect will lead { on average { to higher prices at stations operated under high-powered contracts.

Corollary 1 indicates that the higher prices at vertically separated stations is due to two distinct e ects. Equation 12 shows that the term with enters additively. This term thus directly captures the impact of double marginalization, which is driven by the wholesale price charged by the re ner. As the wholesale price increases, the retail price at stations using arms length contracts linearly increases.

The second reason for higher prices at vertically separated stations is due to demand-shifting. As stated in Corollary 1, a vertically-separated station will charge a higher price for gasoline even if = 0. This is because the local agent's e orts cause demand to shift out. The magnitude of the demand-shifting term is driven by several di erent model parameters. In particular, as e ort becomes costlier, either for gasoline retailing or in its impact on e ort elsewhere, then the increase in price from switching to an arms length contract increases. If we assume { as seems reasonable

{ that it is more costly to switch from selling gasoline to repairing cars than from selling gasoline to selling convenience store items, then this suggests that the price of gasoline should be higher in stations with repair bays than ones with convenience stores, all else equal. Uncertainty { and the agents' tastes for it { also prominently impacts the e ort-shifting gap. When demand shocks for the two services are more correlated, the magnitude of the e ort-induced price gap falls as agents have less incentive to work hard since their payo s are less certain. Relatedly, as agents' risk aversion increases, the price gap falls as their e ort decreases.

PROPOSITION 2: The factors that lead to a larger demand-shifting e ect on prices also increase the desirability of using an arms-length contract.

Proposition 2 implies that unconditional examinations of pricing di erences will overstate the true magnitude of vertical separations's marginal impact on retail pricing. This occurs because there may be regions where, in equilibrium, one form or the other is clearly preferred due to the demand-shifting e ect, which increases both pro ts and prices at vertically separated stations. However, Proposition 2 does not contradict the nding in Proposition 1 that we should expect to see a di erence in pricing { even when the wholesale cost does not include a markup over the principals' marginal cost. Instead, the Proposition emphasizes the importance of controlling for the selection of form before estimating the impact of form on economic behavior. The model suggests a way around this di culty. Insofar as the underlying drivers of monitoring costs,

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about ownership and other factor

The New Image data contain information on the operations and organization of re ner-a liated stations as well as \independent" stations.

Restricting the sample to stations a liated with re ners leaves 4687 station-period observations a liated with 3677 di erent unique station locations. [16] Although not common, some locations do change brands during the sample period. These changes appear unrelated to changes in organizational form. [17]

As previously noted, the operations surveyed are in the Denver, Minneapolis, Toledo, Louisville, and Washington, DC metro areas, and were collected at uneven intervals between 1996 and 1999. Observations are not evenly distributed across time periods or states. Table C-1 shows the number of observations by state and year. Consistent with the fact that the di erent states have di erent laws a ecting re ners' ability to own and operate stations, the relative usage of the organizational forms in the di erent market areas varies signi cantly. This can be seen in Table C-2.[18] Pooling the observations, the Table shows that the di erent contractual types account for 13%, 40%, 24% and 23% of the sample, respectively. The share of stations operated directly by re ners is consistent with the estimated national average of 10-20% cited in Kleit (2005).

I analyze economic behavior by exploiting the listed prices of regular, super (i.e., medium), and premium quality gasolines, as well as the volume that the station employee reported being sold in the preceding month. Some caution must be attached to the nal variable, however, as it relates to the total volume sold without regard to grade or even whether the fuel was diesel or gasoline. The inability to distinguish the volumes sold of the di erent types of fuel makes it di cult to present revenue results as done in Kosova et al. (2010).[19]

[16] The retail chains included in the branded sample are: Amoco, Ashland, BP, Chevron, Citgo, Conoco, Crown, Exxon, Marathon, Mobil, Phillips, Shamrock, Shell, Sinclair, Speedway, Sunoco, Super America, Texaco, and Total.

[17] Because of the infrequency of changes in form, I am hesitant to employ xed e ects models that identify the impact of contract based solely on within-station changes. However, preliminary analyses were consistent in sign and magnitude with those presented below though sensitive to the inclusion of di erent controls.

[18] Virginia, Maryland, and the District of Columbia all have divorcement laws. As noted above, these laws limit (or prohibit) use of salaried operations.The strength of these laws varies across the di erent states, with those of Maryland and DC being much stronger than that of Virginia.

[19] Exploratory analyses that use a revenue proxy generated by multiplying regular price by volume indicate that the vertically separated stations have lower revenues, especially the open dealer and jobber-owned stations. This is consistent with the ndings about demand-shifting relative to double marginalization under the di erent contracts

Besides branding, the New Image data provide information on a large number of di erent exogenous and endogenous station features. These characteristics include the presence of a convenience store, the number of service bays, and the appearance of the station, and are used as controls in my analyses. In addition, I proxy for the intensity of local competition using the number of stations in the zipcode.[20] To supplement the station censuses, I obtain county population data from the U.S. Census and average household income (in thousands) taken from the Statistics of Income (SOI) collected by the Internal Revenue Service to further account for market variation.[21] I show descriptive statistics for all observations in Table 1.

Table 2 compares the summary statistics between vertically separated and vertically integrated stations, and indicates signi cant di erences across them. As predicted by the model presented above, the unconditional prices charged in salaried stations are much lower. The data also show that salaried stations sell larger volumes of gasoline. The null hypotheses that these behavioral di erences are statistically indistinguishable from 0 are strongly rejected. Interestingly, the data also show behavioral di erences across the vertically separated forms, which can be seen in Table 3. Although more modest in magnitude, the di erences are also statistically signi cant at conventional levels; lessee dealer stations both price more highly and sell larger volumes than the other forms. This

vious literature (Shepard, 1993, Slade, 1996, Blass and Carlton, 2001). Third, the Table indicates that the stations run by salaried employees of the re ner are notably more attractive in appearance. This is in line with the ndings of Michael (2000) and Jin and Leslie (2009) in other industries. Fourth, all of the vertically separated forms { especially the open dealer- and jobber-owned stations { are located in areas with lower income. Along similar lines, Slade (1996) found that forms with no re ner ownership stake are mainly utilized in rural communities.

Though the aggregate data patterns presented here suggest di erences in economic behavior across forms, they also indicate consistent selection of di erent forms in di erent areas or situations. Thus, it is di cult to say with con dence whether the variation in pricing and sales volume can be attributed to di erences in form as opposed to station and market characteristics. To obtain a more precise understanding of how contract type a ects behavior, it is necessary to move to a formal econometric framework. In the next section, I use methods that exploit both within- and between-station variation, as well as plausibly exogenous di erences in monitoring costs, in order to separately identify the impact of station characteristics and the impact of vertical separation.

5 Methodology and Results

5.1 Econometric Approach and Identi cation

My goal is to estimate the impact of organizational form on the behavior of gasoline stations. I focus on four di erent outcome variables: the prices of regular, super, and premium gasoline, and the total volume of fuel sold. I now discuss the econometric approaches I employ in testing how these factors are a ected by organizational form.

All of my estimating equations are variants of the following linearly separable general form:

$$Y_{it} = F_{it} + X_{it} + Z_i + u_{it}; \tag{13}$$

where i and t index stations and time of observation, respectively. Y is the economic outcome of

interest; F_{it} indicates the organizational form of station i in time t; X_{it} are time-varying station and market characteristics; Z_i are time-invariant station characteristics; and u_{it} is information unobservable to the econometrician. As in Vita (2000) and Hosken et al. (2008), I estimate the models in levels. However, the results are qualitatively identical when I employ a log-linear specification. Details are available upon request.

In addition to those observable explanatory variables discussed in the previous section, all regressions include brand and state-date indicator variables. These take account of systematic variation across chains, regions, and time periods, which is necessary as previous research has shown that different chains consistently price differently (Hosken et al., 2008). Moreover, the existence and severity of divorcement laws varies across the sample regions (Vita, 2000, Blass and Carlton, 2001). Similarly, within a given year, prices at different stations were collected at different times. However, within a region, prices were collected at similar times. By including state-date dummy variables, I ensure that my estimates are based off of variation within date and region, avoiding the possibility of confusing the impact of form with temporally or regulatorily driven differences.[22]

I assume that the unobserved information is a composite term, i.e., $u_{it} = \alpha_i + \varepsilon_{it}$, where α_i represents station-specific heterogeneity and ε_{it} is the idiosyncratic error. Depending on α's correlation with the explanatory variables, Equation 13 should be estimated in different ways. I employ different methods corresponding to different assumptions about the relationship between α_i and the observable controls.

First, I make the strong assumption that the station-specific heterogeneity is uncorrelated with the other explanatory variables. In particular, this modeling approach effectively assumes that all monitoring characteristics are captured in the observables, including the region-date controls. To account for possible correlations over time and region, I cluster the standard errors at the zipcode level, which will allow for the possibility that stations close to each other may be subject to the same unobserved factors.

[22] The results are qualitatively similar when I include more and less parsimonious sets of controls. In particular, switching to county-date variables does not change the results. Details are available upon request.

The assumption of independence between the unobserved and observed factors required for the cross-sectional models is very strong. It is intuitive to think that some element of unobserved heterogeneity not picked up by the explanatory variables (e.g., managerial talent or demand conditions) is correlated with organizational form. If this is true, then the cross-sectional estimates su er from omitted-variable bias. My second estimating approach addresses the possibility of correlation between the persistent unobserved information and the observable regressors by following Kosova et al. (2010) in specifying that the correlation can be captured through the inclusion of the station-level means of the time-varying regressors. This method stems from Mundlak (1978), who noted that the results from standard linear xed e ects (FE) models can be obtained in a random e ects (RE) model if the means of time-varying regressors are included. In other words, I assume that:

$$_{i} = X_{i} + _{i}; \tag{14}$$

where X_{i}

clustered at the station level. This allows for a more general correlation structure than RE, and hence is a conservative approach.[23]

is vertically separated. In addition to the contract share variables, in the pricing models, I also include the number of gasoline nozzles as an instrument. The past contracting literature surveyed in Lafontaine and Slade (2007) has shown that outlet size tends to be correlated with company operations, and there is no direct reason to assume that the number of pumps should have a separate impact upon demand or pricing. Obviously, this element cannot be included as an instrument in the volume models as it directly a ects overall sales and is therefore employed as a regressor in those models.

I focus on the number of a liated outlets in the county as opposed to zipcode, because I believe that conditional on traveling from their headquarters to a given county, it costs salaried employees of the principals little to travel between zipcodes to monitor di erent stations. Consistent with this argument, my results are qualitatively similar when I focus on brands' shares at the zipcode level. The estimated coe cients from the models using zipcodes are generally larger in magnitude but are no longer statistically signi cant at conventional levels. Given that brands frequently do not have more than one outlet in a zipcode, many observations are lost, making the lack of statistical signi cance unsurprising.

As noted in Wooldridge (2002), instrumental variables models can consistently be estimated using standard two-stage least squares. I estimate two variants corresponding to the pooled and Mundlak approaches described above.

5.2 Price Results

I present the price results in three separate tables, one for each grade of fuel. Tables 4, 5, and 6 show the results for regular, super, and premium quality gasolines, respectively. In each, the rst four columns simply look at di erences between vertically integrated and vertically separated stations as in Shepard (1993). Column 1 shows the result of the cross-sectional model, which does not account for possible correlations between any of the unobservable information and the choice of form. Column 2 shows the results of the Mundlak model, which controls for persistent unobserved

heterogeneity using the means of the time-varying elements plus the lag of volume sold. Column 3 returns to the cross-sectional approach to dealing with station-level heterogeneity, but accounts for the endogeneity of form using the instrumental variable approach described above. Finally, Column 4 applies the instrumental variable approach to the Mundlak model. Columns 5 through 8 take analogous estimating approaches, but allow for di erent behavioral e ects across the di erent types of organizational forms.

Overall, the results in Tables 4, 5, and 6 are quite consistent with the theoretical model's predictions, and show the importance of controlling for both unobserved time-invariant station characteristics and the endogeneity of form choice. In all twelve of the models using an indicator variable for whether a station is vertically separated or not, the estimated coe cient is positive. In the cross-sectional models, these e ects are of small magnitude and are not statistically signi cant

Interestingly, the estimated e ects for the di erent forms are never statistically distinguishable from each other when I employ the Mundlak approach. This indicates that conditional on deciding not to own and operate a station with its own employees, the re ner achieves consistent results despite using di erent contractual forms. It also suggests that it is appropriate to rely on the simple, dichotomous indicator variable model results, as they are more e cient.

Using the estimates recovered in Column 4 in the di erent Tables shows that vertical separation leads to price increases of 5 to 8 cents. Consistent with Proposition 2 of the theoretical model, which predicted that the market and station characteristics where arms-length organizational forms were used would compound the pricing gap, these di erences are markedly less than the di erences in sample means displayed in Table 2. It is interesting to compare the estimate for regular unleaded gasoline to that of Vita (2000), who found that, on average, states with divorcement laws had regular unleaded gas prices 2.6 cents higher than those without. Insofar as around 20% (or fewer) of stations are company-owned, my results would have predicted broadly comparable but slightly lower overall di erences. This smaller estimate of the marginal impact of vertical separation is consistent with the argument that identi cation based on sweeping policy changes are capturing infra-marginal as well as changes on the margin, and thus may overstate the marginal impact of contractual change.

Notwithstanding their small magnitude, the models' coe cient estimates are of large economic signi cance. This is because gasoline retailing is a low margin and high volume industry. Thus, as discussed in Hosken et al. (2008) and Vita (2000), even modest changes in price levels can lead to sizable changes in the size and distribution of total welfare. Indeed, Hosken et al. (2008) and Kleit (2005) report that retail margins average 20 cents or less, indicating that the choice of form can change margins by 25 to 40%. However, despite the sizable magnitude of price increases due to vertical separation, it is not clear just how much consumer welfare would be lost by prohibiting salaried operations. This is because the model predicts that the price increase stems both from demand-shifting and the ine ciency of double marginalization. Without being able to separate the

two, it is impossible to quantify the welfare e ects on consumers.

Though not necessarily statistically signi cant at conventional levels, the results for the control variables reported in Tables 4, 5, and 6 also are broadly in line with the model's predictions and the prior literature. Consistent with intuition about the role of local competition, I nd that the number of nearby stations likely exerts downward pressure on price (though this e ect is not always of statistical or economic signi cance, especially when time-invariant station-level heterogeneity is accounted for). The model predicts that the presence of products with strong demand complementarities to gasoline should exert downward pressure on gasoline prices. This is consistent with the nding that the presence of a convenience store is negatively correlated with gasoline price. As in Slade (1996), I nd that service capabilities { which might reasonably be thought to be inversely correlated with gasoline demand { are associated with higher prices. Interestingly, I nd that stations with higher quality appearances tend to have lower prices, which may suggest cost complementarities between the provision of quality and other desired services. Finally, higher average household incomes are associated with higher prices. By contrast, population's impact is often negligible and inconsistently signed.

Overall, the results of the price regressions strongly support the two Propositions of the theoretical model. Vertically separated stations consistently charge higher prices { which are not necessarily di erent across contracts { than do vertically integrated stations. Moreover, this di erence is increasing in economic and statistical signi cance as the endogeneity of the contract choice is more explicitly controlled for, though it never reaches the di erences shown by a naive comparison of means. In addition, the results are robust to variation in empirical speci cation. In particular, although not shown here, the ndings remain qualitatively the same when I control for brand-state-date heterogeneity or include county-date e ects. Details on models not presented here are available upon request.

5.3 Volume Results

Table 7 presents the results of total volume of fuel sold regressions for the cross-sectional, Mundlak, and two IV models for both a dichotomous indicator variable and individual contract indicator variables.

When vertical separation is modeled using a dichotomous variable, I consistently nd that it is associated with lower volumes of fuel sold. These e ects generally are economically large and statistically signi cant, suggesting that as a result of their higher prices vertically separated stations sell lower volumes to consumers with downward sloping demand curves. The lone exception is in column 4, where the e ect is not statistically signi cant and of smaller magnitude.

The story remains largely the same when I switch to controlling for contract choice using individual indicator variables for each contract. As before, I consistently nd negative and signi cant e ects on the volume of fuel sold. However, the results are interesting, because they consistently show that stations operated under di erent contracts sell di erent volumes of fuel. These di erences are statistically signi cant at conventional levels in all models. As a robustness check that the di erences are not being driven by some correlation between organizational form and diesel sales, I estimated models with categorical variables for the di erent types of diesel sales that New Image identi es. These controls do not have a qualitative impact. Therefore, it seems unlikely that the reason that the coe cients on the di erent contract types di er is a function of the generality of the dependent variable. Instead, the results imply that the di erent vertically separated contracts lead to di erent sales volumes.

That I uncover similar price e ects yet dissimilar volume e ects across the arms-length forms is consistent with the idea that the price increase from vertical separation is due to di erent demand-

dealer tank wagon than open dealers or jobbers. Thus, their pro t margin is higher, encouraging them to exert greater e ort. This story, however, runs contrary to some anecdotal evidence, which suggests that lessee dealers feel that they are paying higher rates than open dealers. On the other hand, the lessee dealers who made these complaints may have done so in part because such a situation represented an inversion of the normal status. I hope to investigate these issues further in future work.

As before, the coe cients on the controls are sometimes statistically insigni cant but of generally intuitive signs and magnitudes. The presence of a convenience store is consistently associated with higher sales volumes, though the presence of service bays reduces volume sold. Both ndings are consistent with intuition about demand complementarities (positive and negative) among the di erent products. Similarly, attractive stations sell larger volumes of gasoline, as do those with more nozzles. The number of competitors has negative e ects on the volume of sales. Finally, higher

decision, I uncover robust evidence of signi cant price di erences between salaried operations (i.e., vertical integration) and the various arms-length organizational forms. Moreover, the magnitude of the price increases I nd between vertically integrated salaried operations and all arms-length contracts are smaller but broadly in line with previous work utilizing divorcement laws to identify the impact of organizational form. The di erence between my work and this prior literature is consistent with arguments about the downside of identifying marginal e ects o of sweeping policy changes that will impact inframarginal as well as marginal stations.

In addition, although I cannot separately identify the magnitude of the double marginalization and demand-shifting e ects on price, I nd some evidence suggesting the existence of both impacts by examining the evidence of form on sales volume. The results suggest that a greater amount of the price increase at lessee dealer stations is due to demand-shifting relative to the other arms-length

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Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Regular	4299	116.71	13.73	79.90	167.90
Super	4296	126.70	13.15	86.90	186.90
Premium	4299	134.86	12.52	88.90	193.90
Volume	4535	104.99	50.32	10.00	400.00
Competitors	4687	10.89	7.43	0.00	38.00
1(C-Store)	4687	0.72	0.45	0.00	1.00
1(Service Bays)	4687	0.39	0.49	0.00	1.00
1(Appearance)	4687	0.15	0.35	0.00	1.00
Nozzles	4535	18.13	9.95	2.00	60.00
Pop. ('000s)	4687	619.02	294.32	40.99	1109.63
Income ('000s)	4687	57.87	14.59	35.47	96.69

Table 2: Descriptive Statistics Across Vertically Integrated and Separated Stations

	Integrated			Separated			
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	T-Stat
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	T-Stat
Regular	657	106.63	16.37	3642	118.53	12.36	-70.74
Super	657	117.86	14.70	3639	128.29	12.19	-65.06
Premium	657	127.03	14.11	3642	136.28	11.66	-58.88
Volume	671	138.63	51.25	3864	99.15	47.81	132.53
Competitors	823	11.78	8.65	3864	10.70	7.14	9.66
1(C-Store)	823	0.67	0.47	3864	0.73	0.45	-2.34
1(Service Bays)	823	0.06	0.24	3864	0.46	0.50	-19.71
1(Appearance)	823	0.25	0.43	3864	0.13	0.33	4.81
Nozzles	671	20.13	10.91	3864	17.79	9.73	17.07
Pop. ('000s)	823	545.48	274.94	3864	634.68	295.96	-139.20
Income ('000s)	823	59.21	14.55	3864	57.59	14.59	11.07

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Table 4: The Price of Regular Unleaded and Vertical Contracting

	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se
Separated	0.291	1.236***	3.482***	5.211***				
	0.28	0.38	1.09	1.74				
Lessee					0.496*	1.125***	2.688***	4.191***
					[0.295]	[0.350]	[0.964]	[1.579]
Open					0.689*	1.103**	3.753***	4.704
					[0.361]	[0.447]	[1.212]	[3.289]
Jobber					-0.306	0.654	1.807**	5.327**
					[0.328]	[0.546]	[0.863]	[2.195]

Table 5: The Price of Super Unleaded and Vertical Contracting

	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se
Separated	0.174	2.080***	0.457	8.365***				
	0.37	0.54	1.41	2.25				
Lessee					0.657*	1.896***	1.879	6.367***
					[0.371]	[0.492]	[1.252]	[1.919]
Open					0.031	1.752***	-0.091	6.386*
					[0.460]	[0.596]	[1.673]	[3.809]
Jobber					-0.627	1.256*	-0.957	7.407***
					[0.475]	[0.668]	[1.323]	[2.610]
Competition	-0.051**	0.014	-0.051**	0.007	-0.053**	0.022	-0.057**	0.009
	0.02	0.09	0.02	0.09	[0.024]	[0.086]	[0.024]	[0.086]
C-Store								

Table 6: The Price of Premium Unleaded and Vertical Contracting

	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se
Separated	0.171	2.120***	1.864	7.076***				
	0.39	0.6	1.53	2.36				
Lessee					0.566	1.807***	1.123	5.503**
					[0.403]	[0.525]	[1.295]	[2.181]
Open					0.579	2.067***	0.848	4.401
					[0.468]	[0.649]	[1.721]	[4.389]
Jobber					-0.816*	1.929**	-0.275	7.438**
					[0.486]	[0.753]	[1.366]	[3.037]
Competition	-0.064**	0.043	-0.063**	0.041	-0.064**	0.054	-0.065**	0.047
	0.03	0.1	0.03	0.1	[0.028]	[0.096]	[0.028]	[0.097]
C-Store	-0.400+	-0.236	-0.491*	-0.580+	-0.355	-0.327	-0.403	-0.748
	0.3	0.37	0.29	0.35	[0.290]	[0.362]	[0.312]	[0.459]
Service Bays	1.185***	0.722**	0.998***	0.355	0.821***	0.639*	0.874**	0.892*
	0.27	0.34	0.31	0.35	[0.279]	[0.357]	[0.414]	[0.499]
Appearance	-0.071	-0.788+	0.093	-0.650+	-0.109	-0.873*	-0.066	-0.635
	0.26	0.48	0.3	0.5	[0.259]	[0.471]	[0.303]	[0.511]
Population	0	0.035	0	0.007	0	0.018	0	-0.004
	0	0.04	0	0.04	[0.001]	[0.035]	[0.001]	[0.038]
Income	0.155***	0.061	0.155***	0.064	0.156***	0.075	0.159***	0.082
	0.02	0.11	0.02	0.11	[0.020]	[0.110]	[0.019]	[0.111]
Lag9]								

Table 7: Volume of Sales and Vertical Contracting

	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se	OLS b/se	Mundlak b/se	IV b/se	IV Mundlak b/se
Separated	-28.929***	-24.228***	-31.634***	-11.726				
	[3.648]	[6.187]	[8.116]	[17.408]				
Lessee					-20.845***	-21.524***	-20.388**	-6.395
					[3.974]	[6.025]	[10.055]	[18.443]
Open					-46.017***	-45.142***	-39.084**	-8.818
					[3.701]	[6.970]	[17.748]	[41.868]
Jobber					-34.396***	-36.814***	-42.640***	-48.151*
					[3.369]	[7.858]	[9.228]	[28.867]
Competition	-0.216*	0.828	-0.218*	0.807	-0.269**	0.761	-0.265**	0.822
	[0.114]	[0.664]	[0.112]	[0.653]	[0.106]	[0.663]	[0.112]	[0.702]
C-Store	3.962**	5.134*	4.043**	4.61	1.007	2.74	2.538	4.919
	[1.950]	[2.962]	[1.963]	[2.972]	[1.812]	[2.789]	[2.071]	[4.122]
Service Bays	-10.682***	-14.293***	-10.449***	-15.275***	-9.054***	-13.090***	-12.266***	-20.215***
	[1.712]	[2.758]	[1.862]	[3.119]	[1.809]	[2.755]	[3.424]	[5.821]
Appearance	22.584***	17.803***	22.288***	18.843***	21.815***	17.984***	21.836***	17.393***
	[2.216]	[5.128]	[2.377]	[5.075]	[2.168]	[4.923]	[2.657]	[5.118]
Nozzles	2.601***	2.513***	2.590***	2.574***	2.409***	2.320***	2.474***	2.644***
	[0.094]	[0.160]	[0.099]	[0.178]	[0.095]	[0.167]	[0.151]	[0.362]
Population	0.007**	-0.088	0.007**	-0.111	0.004	-0.235	0.003	-0.103
	[0.003]	[0.331]	[0.003]	[0.310]	[0.003]	[0.313]	[0.003]	[0.282]
Income	-0.047	1.278*	-0.047	1.254**	-0.052	1.088*	-0.039	0.789
	[0.085]	[0.652]	[0.084]	[0.624]	[0.081]	[0.632]	[0.082]	[0.653]
Lag Price		0.658		0.653		0.67		0.459
		[0.519]		[0.507]		[0.551]		[0.561]
Observation	4,298	1,383	4,298	1,383	4,298	1,383	4,263	1,378
Equivalent					0	0	0	0.099
F Separated			101.654	36.363				
F Type LD							117.736	30.7
F Type OD							45.241	5.013
F Type WJ							219.572	7.172

Appendix A: Proofs of Propositions

PROPOSITION 1: Conditional on an arms-length contractual form being chosen in equilibrium for an station, its prices will on average be higher than if it was operated as a salaried operation.

PROOF:
In order for prices under vertical separation to be higher than under vertical integration, then:

by company. [I reordered this as Type 1, so that salaried operations represented the baseline.]
3) - Open Dealer - Land and operation owned by individual who is supplied product by major/non major oil company.
4) - Jobber/Wholesaler Operation owned by a local company that owns several operations in the area. (EXP distributor) or a franchise/chain organization (EXP a convenience store chain)

Regular Unleaded Price: Numerical variable corresponding to non-constrained answer to the following question. OCT REGULAR UNLEADED)(UO) - Price Reg Unleaded)(RUP)

Super Unleaded Price: Numerical variable corresponding to non-constrained answer to the following question. OCT MIDGRADE UNLEADED)(MO) - Price mid Unleaded)(MUP)

Premium Unleaded Price: Numerical variable corresponding to non-constrained answer to the following question. OCT SUPER)(SO) - Price Super Unleaded)(PUP)

Volume: Numerical variable corresponding to non-constrained answer to the following question. MONTHLY VOLUME)(GV) - Enter average number of gallons sold in one month. (last completed month)

C-Store: Dummy variable which takes value of 1 if an answer other than 0 chosen for the following question. INTERIOR C-STORE APPEARANCE)(INAP) As it appears to consumer.
0) - No snack shop
1) - Outstanding (top 102) - Excellent
3) - Better than average
4) - Equal to average
5) - Below average
6) - Poor
7) - Unacceptable (bottom 10

Service Bays: Dummy variable which takes value of 1 if a number other than 0 chosen for the following question. SERVICE BAYS)(NOSB) - Total number of service bays. If not in operation mention in comments.

Appearance: Dummy variable which takes value of 1 if the answer to the following question takes the value of 1 or 2. APPEARANCE OF BUILDING)(AOB) -
0) - N/A
1) - Outstanding (top 10%)
2) - Excellent
3) - Better than average
4) - Equal to average
5) - Below average
6) - poor
7) - Unacceptable (bottom 10%)

Nozzles: Numerical variable corresponding to non-constrained answer to the following question. GASO-LINE NOZZLES)(GN) - Total number of gasoline only nozzles. Do not include diesel or kerosene.

Appendix C: Additional Tables

Table C-1: Station-Period Observations by State and Year

	1996	1997	1998	1999	2000	Total
CO	0	0	0	630	0	630
	0	0	0	100	0	100
DC	0	117	0	109	0	226
	0	51.77	0	48.23	0	100
KY	239	237	0	244	0	720
	33.19	32.92	0	33.89	0	100
MD	0	437	0	444	0	881
	0	49.6	0	50.4	0	100
MN	0	0	0	600	0	600
	0	0	0	100	0	100
OH	0	0	0	0	185	185
	0	0	0	0	100	100
VA	0	478	482	485	0	1,445
	0	33.08	33.36	33.56	0	100
Total	239	1,269	482	2,512	185	4,687
	5.1	27.07	10.28	53.6	3.95	100

Rows in italics represent percentages.

Table C-3: First Stage of Mundlak Instrumental Variables Price Model

	Type = 2 b/se	Type = 3 b/se	Type = 4 b/se
Share Type 2	0.774***	-0.173**	-0.012
	0.087	0.075	0.051
Share Type 3	0.145	0.181	0.199**
	0.117	0.111	0.094
Share Type 4	-0.046	-0.148	0.699***
	0.101	0.114	0.105
Nozzles	0.001	-0.003**	0.001
	0.002	0.001	0.001
Competitors	-0.001	0.004	-0.003
	0.005	0.006	0.004
C-Store	0.080***	-0.106***	0.048***
	0.027	0.027	0.018
Service Bays	0.072**	0.115***	-0.130***
	0.028	0.024	0.018
Appearance	-0.089**	0.040	0.011
	0.037	0.028	0.020
Population	0.007*	-0.005***	0.001
	0.004	0.002	0.002
Income	-0.003	0.002	-0.004
	0.007	0.007	0.006
Lag Volume	-0.001	0.001	0.000
	0.001	0.001	0.000
Brand E ects	Yes	Yes	Yes
State-Date E ects	Yes	Yes	Yes
Observations	1604	1604	1604

* p<0.10, ** p<0.05, *** p <0.01.