Retail Characteristics and Ownership Structure[1]

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ABSTRACT. The choice of vertical relationships between an upstream manufacturer and a set of heterogeneous downstream retailers/entrepreneurs is examined using a principal-agent framework. Standard principal-agent theory predicts that as unobservable effort exerted by the retailer/entrepreneur becomes more important to the manufacturer, contracts between the manufacturer and agent will entail strong incentives and less direct control. The observability of effort is linked to retail characteristics in the gasoline industry, and station-level data on retail characteristics and ownership structure from every gasoline station in the Los Angeles retail gasoline market from 1992–1996 confirm the model's predictions.

1. Introduction

Many small and medium-size enterprises (SMEs) are downstream retailers selling products produced or marketed by upstream manufacturers. These SMEs include, for example, automobile dealerships, fast-food restaurants, local insurance offices, and gasoline stations. A variety of ownership and contracting structures can be used by the upstream manufacturer to elicit the optimal effort from the downstream retailer/entrepreneur.[2] This study examines the optimal contract from the point of view of the upstream manufacturer when the effort exerted by the downstream agent is costly to monitor. In particular, I examine whether gasoline refiners construct contracts with their downstream retailers based on the observability of the agent's effort level. Using data on every gasoline station in the Los Angeles retail gasoline market from 1992–1996, I show that refiners do choose contracts with downstream retailers that vary in the amount of direct control based on the services offered at the retail outlet and the importance of unobservable effort.

Standard principal-agent theory is often used to show that a problem of moral hazard may arise when economic entities engage in risk sharing under conditions such that their privately taken actions affect the probability distribution of the outcome. In this setting, Pareto-optimal risk sharing is generally precluded because it will not induce proper incentives for taking correct actions within the context of the economic relationship that exists between principal and agent. The source of this moral hazard is an asymmetry of information among the contracting parties that results because individual actions cannot be observed and hence contracted upon.

A natural remedy to this problem is investment in monitoring technologies. Information gained from monitoring can then be used in forming incentive-compatible contracts. In simple situations, when monitoring is perfect, a first-best solution entailing optimal risk sharing can be achieved by employing a contract that discourages non-optimal behavior. Generally, however, monitoring technologies are imperfect or too costly to achieve first-best solutions. In this case, the tradeoff between risk sharing and incentives becomes important.

Agency conflicts are often present in a vertical setting in which an upstream manufacturer (principal) contracts with a downstream retailer/entrepreneur (agent) to transform and/or sell the produced output to the end user. In the absence of contractual constraints, it is easy to show that the agent will choose a set of actions that generally will not be in the principal's best interest. The ultimate purpose of the vertical contract is to eliminate conflicting incentives and induce the

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downstream agent to take actions that maximize the profit of the upstream firm.

In this article, I empirically test some of the predictions from the standard principal-agent framework outlined above. Specifically, I examine the nature of the vertical relationship between a gasoline refiner and a set of heterogeneous retail gasoline stations. The retail gasoline industry is representative of many industries which are comprised of SMEs selling a produced product for an upstream manufacturer. While some gasoline stations are vertically integrated (i.e., owned and operated by major oil-producing refineries), many are owned and operated by entrepreneurs. These gasoline dealers can own as few as one station, or operate hundreds. I demonstrate that the contract between the principal and the agent will be customized to the kinds of choices the agent makes as the manager of the downstream asset. In the case of gasoline retailing, the principal is the refiner and the agent is a gasoline station retailer/entrepreneur who chooses how much sales and service effort to expend. It is argued that the variation in station-level characteristics (e.g., service offerings) leads to variation in the importance of the agent's effort and the extent to which that effort is observable to the upstream refiner.

The refiner then responds to this variation by choosing a contract for the station among a set of three standard (industry-specific) contractual forms. Each ownership structure has a distinct allocation of control rights that defines the ways the refiner can affect the agent's choice of effort. The refiner will choose a contractual form with strong performance incentives at stations where unobservable effort is more important and a form that allows more direct control but offers weaker performance incentives at stations where observable effort is more important. Taking the existing set of contracts as given, the model implies that heterogeneity in station characteristics will be systematically related to heterogeneity in ownership structure.

The literature does contain several studies that examine the relationship between agent's choices and contractual form. Brickley and Dark (1987) find patterns consistent with franchising to economize on monitoring costs at remote outlets and with company ownership to minimize free riding on the reputation of the upstream firm. Additionally, Lafontaine (1992), Norton (1988), and Shepard (1993) also report results suggesting that monitoring costs and moral hazard play a role in determining contractual form.

In general, empirical work in this area is restricted because of the lack of outlet-level data. This study relies on station-level data appropriate with the theoretical setup; that is, outlet heterogeneity leads to heterogeneity in contracts. Specifically, the analysis is based on observations of outlet characteristics and ownership structure at the more than 4,000 gasoline stations in the Los Angeles Basin from 1992–1996. As predicted, stations where service involves important unobservable effort (for instance, those offering automotive repair and full-service gasoline) are more likely to be operated under a contractual form with strong effort incentives. On the other hand, stations where service involves a higher ratio of observable to unobservable effort (e.g., those offering convenience stores and those selling gasoline only) are more likely to be operated under a contract that has lower-powered incentives but allows for more direct control of observable effort.

This article is organized as follows. Section 2 explicitly models the principal-agent relationship examined. It is shown that if effort is not observable, the agent's compensation will be a function of overall performance. Section 3 presents the empirical findings from the Los Angeles data. A short conclusion ends the paper.

2. Risk sharing between the manufacturer and downstream agent

This section outlines the standard principal-agent relationship under conditions which allow the agent's effort to be observed, and conditions which prohibit the monitoring of the agent's effort. The purpose is to show that contrary to the first-best solution when effort is easily monitored, the second-best solution entails a compensation function which is based, in part, on the overall system-wide performance.

Following Laffont (1989), let y be a stochastic variable that represents the gross income of the principal, such as the output of a production process owned by the principal. The probability distribution of y is influenced by a variable e that is controlled by the downstream agent. For

example, e may be the retailer's/entrepreneur's effort level. Let $F(y, e)$ be the distribution function of y and $f(y, e)$ be its probability density function. Assume that the support of this distribution is independent of e.

The problem posed is to determine the payment t, expressed in units of y, offered to the downstream agent to compensate her for the disutility of her action e. Assume that the compensation function $t(y)$ is linear and can be expressed as

$$t(y) = \alpha + \beta y, \tag{1}$$

where α can denote salary, and β denotes the corresponding commission rate. Assume that the agent's utility function, $u(t, e)$, is separable in income and effort such that

$$u(t, e) = u(t) - c(e), \tag{2}$$

where it is assumed $u' > 0$, $u'' \leq 0$, $c' > 0$, and $c'' \geq 0$. Finally, assume that the principal maximizes expected profit, and is, thus, risk neutral.[3]

First-best

If the agent's effort is perfectly observed by the principal, it can be shown that the principal can write a forcing contract, and, thus, dictate the effort level of the agent. The principal maximizes expected profit subject to the agent's individual-rationality constraint, where the reservation utility level is normalized to zero. The program can be written

$$\begin{aligned} &\max_{e,\,\alpha,\,\beta} \int [(1-\beta)y - \alpha] f(y, e)\mathrm{d}y \\ &\text{s.t.} \quad \int u(\alpha + \beta y) f(y, e)\mathrm{d}y - c(e) \geq 0. \end{aligned} \tag{3}$$

Piece-wise optimization yields the optimal choice of effort, and it can be characterized by

$$\begin{aligned} &\int [(1-\beta)y - \alpha + \lambda u(\alpha + \beta y)] f_e(y, e)\mathrm{d}y \\ &\quad = \lambda c'(e), \end{aligned} \tag{4}$$

which shows the equality between the marginal "social" benefit of e and the agent's marginal disutility weighted by the Lagrangian multiplier, λ, which is the shadow price of effort. Note that λ is endogenous so that the individual-rationality constraint in (3) holds with equality.

The optimal salary level, α, can be characterized by

$$-1 + \lambda \left[\int u'(\alpha + \beta y) f(y, e)\mathrm{d}y \right] = 0, \quad \forall y. \tag{5}$$

Additionally, because (5) holds for all y, we can rewrite (5) as

$$\frac{\int u'(\alpha + \beta y) f(y, e)\mathrm{d}y}{\int u'(\alpha + \beta y') f(y, e)\mathrm{d}y} = 1. \tag{6}$$

In other words, the agent's marginal rates of substitution are equated between the different "states of nature" characterized by the value of y. Therefore risk is shared optimally. Also note that (5) can be rewritten as

$$\int u'(\alpha + \beta y) f(y, e)\mathrm{d}y = \frac{1}{\lambda}, \quad \forall y. \tag{7}$$

Thus,

$$u'(\alpha + \beta y) = u'(\alpha + \beta y'), \quad \forall y, \forall y'. \tag{8}$$

This implies that $t(y) = t(y')$, $\forall y, \forall y'$. This can be true only if $\beta = 0$. Thus, (5) dictates that the commission rate on output be set to zero. This is the result of a risk-neutral principal fully insuring the risk-averse agent.

It can also be shown that β must be zero by characterizing the optimal choice of β. This yields

$$\begin{aligned} &-\int y f(y, e)\mathrm{d}y + \lambda \left[\int y u'(\alpha + \beta y) f(y, e)\mathrm{d}y \right] \\ &\quad = 0, \quad \forall y. \end{aligned} \tag{9}$$

Using (5), we may rewrite (9) as

$$\frac{u' \int y f(y, e)\mathrm{d}y}{\int u' y f(y, e)\mathrm{d}y} = 1. \tag{10}$$

Note that (10) can hold only if u' is a constant. This is true only when $\beta = 0$.

Thus, when effort is fully observable by the principal, a forcing contract is written such that compensation is independent of the realization of y. In other words, no residual claimancy is given to the downstream agent. The agent can no longer be viewed as an entrepreneur, but simply a salaried employee of the manufacturer.

Second-best

Now consider the situation in which the principal cannot observe the agent's effort level with certainty. The principal realizes that, when faced with the compensation function t, the agent chooses the effort e that is in her best interest. Consequently, the agent solves

$$e \in \arg\max_{e'} \int [u(\alpha + \beta y) - c(e')] f(y, e')dy. \tag{11}$$

The principal's new problem is derived by adding the incentive-compatibility constraint (first-order condition of (11)) to program (3):

$$\begin{aligned} \max_{e,\,\alpha,\,\beta} & \int [(1-\beta)y - \alpha] f(y, e)dy \\ \text{s.t.} \quad & \int u(\alpha + \beta y) f(y, e)dy - c(e) \geq 0 \\ & \int u(\alpha + \beta y) f_e(y, e)dy - c'(e) = 0. \end{aligned} \tag{12}$$

The optimal choice of effort is now characterized by

$$\begin{aligned} &\int [(1-\beta)y - \alpha + \lambda u(\alpha + \beta y)] f_e(y, e)dy \\ &\quad = \lambda c'(e) - \mu[\int u(\alpha + \beta y) f_{ee}(y, e)dy - c''(e)], \end{aligned} \tag{13}$$

where μ is the Lagrangian multiplier for the incentive-compatibility constraint in (12). Note that effort e has a well-defined negative effect on the agent's utility. So that it has a well-defined positive effect on output, we assume that an increase in e generates an improvement in y in the first-order stochastic dominance sense, or $F_e(y, e) \leq 0$, with strict inequality for a set having positive probability.

It is clear that the risk sharing implied by this solution is not Pareto optimal (i.e, $\mu \neq 0$ and $\lambda \neq 0$) when the agent is risk averse.[4] By deviating from the Pareto-optimal risk-sharing solution, the principal can induce the agent to choose a higher level of effort. Thus, as mentioned earlier, there now exists a tradeoff between risk sharing and incentives.

Intuitively, the compensation of the agent will now be a function of the observed value of y. This is shown below. First, the optimal level of α is characterized by

$$\begin{aligned} &-1 + \lambda\left[\int u'(\alpha + \beta y) f(y, e)dy\right] \\ &\quad + \mu\left[\int u'(\alpha + \beta y) f_e(y, e)dy\right] = 0, \quad \forall y. \end{aligned} \tag{14}$$

Additionally, the optimal value of β is given by

$$\begin{aligned} &-\int y f(y, e)dy + \lambda\left[\int y u'(\alpha + \beta y) f(y, e)dy\right] \\ &\quad + \mu\left[\int y u'(\alpha + \beta y) f_e(y, e)dy\right] = 0, \quad \forall y. \end{aligned} \tag{15}$$

To see that $\beta > 0$, we must evaluate (15) at $\beta = 0$. By substituting (14) evaluated at $\beta = 0$, one can see that the sign of β depends on the relationship between f_e and f. If we assume the monotone likelihood ratio condition, i.e., $(\partial f(y, e)/\partial e)/f(y, e)$ is an increasing function of y, then it is easy to show that $\beta > 0$.

Thus, when the agent's effort is not observable by the principal, the principal will induce the agent to provide more effort by making the agent a residual claimant to the production profits. Thus, the entrepreneurial function is established.

3. Empirical evidence

Introduction

As we have seen, upstream manufactures will generally shift more risk on their downstream agents when effort is not easily monitored. Gasoline retailing is an example of a principal-agent problem in a vertical setting. One can view the station retailer/entrepreneur, who sells gasoline to the final customer, as the agent and the refiner (Mobil or Shell, for example), who supplies gasoline to the station as the principal. The refiner's contracting problem is complicated by limitations on what downstream choices can be covered by contract. In other words, the agent's efforts may not be subject to direct control because they are unobservable.

It is argued below that observability depends on station characteristics. Then, because station characteristics vary across stations, the contracting problem is station specific. Refiners respond to this station-level heterogeneity by using a mix of contractual forms. Thus, information on station characteristics should be useful for predicting the kind of contract under which the station will be managed. The empirical work in this section tests

for a relationship between observed station characteristics and observed contractual forms.

Ownership structure

There are three basic ownership structures used in gasoline retailing: company-owned (CO), lessee-dealer (LD), and open-dealer (OD) contracts. Of these, company-owned contracts approximate full vertical integration at one extreme, and at the other end, the open-dealer contracts approximate trade between independent firms.

At CO stations, all land and physical capital is owned by the refiner and the station manager is an employee of the refiner. Most station managers under CO contracts are salaried employees. However, some refiners do offer incentive plans that compensate managers for sales quotas.[5]

At stations operated under LD contracts, the land and immobile capital are owned by the refiner, but the retailer is a self-employed entrepreneur. After paying a franchise fee to the refiner and buying gasoline at wholesale prices, the lessee-dealer is the residual claimant to any profits from operation.

OD contracts are such that the refiner has no investment of capital in the station. The land and capital are owned by the entrepreneur. Although the refiner controls the wholesale price, there is no franchise or rental fee. The only substantial constraints on the OD contract are with respect to product purity and labeling.

Ownership structure and effort

There are clear differences among the contractual forms described above in their capacity to control effort directly and to provide performance incentives. The amount of direct effort control allocated to the refiner is greatest with CO stations and smallest with OD stations. Performance incentives appropriate for inducing unobservable effort, however, are most easily provided under LD and OD contracts. Thus, LD and OD contracts become more desirable when unobservable effort becomes more important. For any products supplied to these operators at marginal cost, the entrepreneur is the true residual claimant.

There are several key station characteristics that may play an important role in determining whether effort is, or is not observable. First, unobservable entrepreneurial effort may be relatively more important when gasoline is sold with full service. Full service involves more employee-customer interaction, and more mechanical knowledge. If the service component of full-service gasoline sales is sufficiently important, offering full-service should reduce the probability that a station is operated under a CO contract relative to the other contract types.

Second, automotive repair is very sensitive to unobservable effort. The quality of repair work is very difficult to monitor. It may also be very easy for an employee to underreport repair-service profits. Therefore, we should expect to see a relative decrease in the probability that a given station is operated under a CO contract if the station offers automotive repair services.

Finally, convenience stores can be run in ways that remove those quality dimensions most sensitive to unobservable effort from the control of the station operator. Inventory can be centrally planned, purchased, and priced. It is also fairly easy to monitor quality dimensions that the retailer's effort will influence, such as cleanliness, stocking shelves, or operating hours. Additionally, accounting controls can reduce the amount of theft. Thus, one would expect that the existence of a convenience store will increase the probability that a station will operate under a CO contract relative to the two other ownership structures.

Data

The data set used to estimate the relationships listed above was constructed using a series of annual surveys at *each* of the more than 4,000 gasoline stations operating in the Los Angeles Basin during the five year period from 1992 to 1996.[6] These surveys provide a wealth of detailed information on station characteristics, including the presence of repair services, convenience stores, and full-service gasoline. Additionally, the data contain information on brand and ownership structure.

Empirical model

Given the retail configuration of any station in the sample, the empirical model must be designed to

estimate how the heterogeneity in station-level characteristics influences the probability of any one of the three ownership structures being observed. Because the existence of any particular contract type is dichotomous in nature, the maximum-likelihood logistic regression approach is appropriate.[7] Additionally, because there are three dichotomous dependent variables that will be examined, a multinomial (polytomous) logit model will be used.

Recall that three different outcomes can be observed with respect to ownership structure: CO, LD, and OD contracts. Previously, it has been argued that the observed ownership structure will be a function of services offered at each station which, in turn, vary with respect to the observability of effort. Other control variables include whether the upstream refiner is a major brand or an independent brand;[8] county of operation;[9] and year dummy variables.

Let CONTRACT be the dependent variable which takes on three values: (1) company-owned, (2) lessee-dealer, and (3) open-dealer. In the multinomial logit model, a set of coefficient vectors, $\beta^{(i)}$ (i = 1, 2, or 3) is estimated corresponding to each outcome category:

$$\Pr(\text{CONTRACT} = i) = \frac{e^{X\beta^{(i)}}}{\sum_{j=1}^{3} e^{X\beta^{(j)}}}, \quad i = 1, 2, \text{ or } 3. \tag{16}$$

To identify the model, set the vector $\beta^{(1)} = 0$, so that the remaining coefficient vectors $\beta^{(2)}$ and $\beta^{(3)}$ measure the change in CONTRACT relative to the CO (CONTRACT = 1) group. Setting $\beta^{(1)} = 0$, the system in (16) becomes

$$\begin{aligned}
\Pr(\text{CONTRACT} = 1) &= \frac{1}{1 + e^{X\beta^{(2)}} + e^{X\beta^{(3)}}} \\
\Pr(\text{CONTRACT} = 2) &= \frac{e^{X\beta^{(2)}}}{1 + e^{X\beta^{(2)}} + e^{X\beta^{(3)}}} \\
\Pr(\text{CONTRACT} = 3) &= \frac{e^{X\beta^{(3)}}}{1 + e^{X\beta^{(2)}} + e^{X\beta^{(3)}}}
\end{aligned} \tag{17}$$

Therefore, the relative probability of, say, an LD contract (CONTRACT = 2) is

$$\frac{\Pr(\text{CONTRACT} = 2)}{\Pr(\text{CONTRACT} = 1)} = e^{X\beta^{(2)}}. \tag{18}$$

Finally, because the data are longitudinal in nature, the empirical model must account for the possibility that the residual associated with station j at time t is correlated with station j's residual at time $t + k$, $k \neq 0$. The results reported below allow for the dependence of within-station errors, but maintain the usual assumption of independence across stations. Robust standard errors are reported.

Results

Summary statistics are reported in Table I. Approximately 12% of the stations in the Los Angeles area were vertically integrated (CO contracts) over the sample period. The remainder was fairly evenly split between lessee-dealers and open-dealers. Approximately 44% of the stations in the sample offered repair services. Full-service gasoline was offered at approximately 27% of the stations sampled, and approximately 33% of the sampled stations had a convenience store on the premises.

Table II reports information on the distribution of station services across different ownership structures. For instance, we see from Table II that of those stations in the sample offering repair services, only 2.4% are company-owned. Similarly, only 1.4% of full-service stations are

TABLE I
Summary statistics

Variable	Mean	Std. dev.	Range
CONTRACT			
Company-owned	0.119	0.324	[0, 1]
Lessee-dealer	0.479	0.500	[0, 1]
Open-dealer	0.402	0.490	[0, 1]
Repair	0.286	0.306	[0, 1]
C-Store	0.329	0.470	[0, 1]
Full Service	0.267	0.442	[0, 1]
Major Brand	0.814	0.389	[0, 1]
Los Angeles County	0.563	0.496	[0, 1]
Orange County	0.160	0.366	[0, 1]
San Bernardino County	0.129	0.336	[0, 1]
Ventura County	0.044	0.204	[0, 1]
Riverside County	0.104	0.306	[0, 1]
1992	0.206	0.404	[0, 1]
1993	0.203	0.402	[0, 1]
1994	0.200	0.400	[0, 1]
1995	0.197	0.398	[0, 1]
1996	0.194	0.395	[0, 1]

TABLE II
Distribution of services across ownership structure

	Company-owned	Lessee-dealer	Open-dealer
Repair services	2.4%	67.7%	29.9%
Convenience store	22.2%	42.7%	35.1%
Full Service	1.4%	73.4%	25.2%

owned and operated by upstream manufacturers. For both repair services and full service, stations providing these services appear more likely to be operated as either a lessee-dealer or open-dealer. This contrasts with convenience stores, however, where approximately 22% of stations with a c-store are company-owned.

Estimated coefficients from the multinomial logit model are given in Table III (estimated coefficients on county and year dummy variables are not reported for brevity). The estimation results support the predictions of the principal-agent model presented in Section 2. The positive and statistically significant coefficients on repair services indicate that stations offering such services are significantly more likely to be operated as a lessee-dealer or open-dealer than as a company-owned station. For instance, a station in the sample with repair services is approximately 7.2 times (3.1 times) more likely to be operated as a lessee-dealer (open-dealer) than a company-owned station, *ceteris paribus*.[10] Recall that repair services entail effort by the retailer that is very costly to observe. Thus, we should not be surprised that the refineries make these entrepreneurs residual claimants to the downstream profits. Similarly, stations selling full-service gasoline, another product that has unobservable effort as a major input, are also significantly less likely to be company-owned and significantly more likely to be operated under either LD or OD contracts. Such stations are approximately 5.1 times (2.9 times) more likely to be operated under LD (OD) contracts than CO contracts, *ceteris paribus*. Finally, stations operating a convenience store are significantly more likely to be company-owned. Controlling for other factors, stations with a convenience store are approximately 1.3 times (2.3 times) less likely to be operated under LD (OD) contracts than CO contracts. Recall that convenience store operation allows less costly monitoring of effort.

TABLE III
Multinomial logit estimation results

	Coefficient (Robust std. error)
CONTRACT = 2 (Lessee-Dealer)	
Constant	–4.032 (0.327)
Repair	1.974 (0.080)
C-Store	–0.252 (0.055)
Full service	1.636 (0.121)
Major brand	5.266 (0.320)
CONTRACT = 3 (Open-Dealer)	
Constant	2.167 (0.077)
Repair	1.125 (0.077)
C-Store	–0.814 (0.049)
Full service	1.081 (0.121)
Major brand	–0.805 (0.050)
N	21,240
Chi square	3,436.93*
Log-likelihood	–15,526.77

Notes: Company-owned stations (CONTRACT = 1) are the excluded group. Therefore, all coefficients are relative to CO stations. Estimated coefficients on county and year dummy variables are not reported for brevity. All coefficients reported in the table are statistically significant at the 1 percent (two-tail) significance level.
* Wald test statistic (24 d.f.)

In summary, the empirical results suggest that downstream retailers are substantially more likely to be residual claimants to downstream profits as the effort level exerted to market certain products becomes more costly for the upstream manufacturer to monitor.[11]

4. Conclusion

The role of observability of effort has been examined within a vertical principal-agent framework. The principal-agent model predicts that as monitoring becomes less effective, either because of high cost or the nature of the activity, principals will likely offer incentive contracts that induce desired effort levels, but at the expense of direct control.

Station-level data were examined for the retail gasoline market in Los Angeles from 1992–1996. Empirical results confirm that as the unobservability of effort becomes more important, refiners offer contracts to downstream retailers that include

relatively more performance incentives, but less direct control.

Notes

[1] I thank Jack Barron, Jim Henderson, Chuck North, and an anonymous referee for helpful comments and suggestions on earlier drafts of this paper. Of course, the usual disclaimer applies.

[2] As I point out later, those agents performing entrepreneurial functions are all retailers, but not all retailers are entrepreneurs. It is optimal for the manufacturer to make some retailers salaried employees.

[3] The model involves two seemingly ad hoc assumptions. First, it is assumed that the parties agree to a contract that specifies a wage payment that is a linear function of measured performance. Second, it is assumed that the agent is required to make a once-and-for-all choice of how he will allocate his efforts during the relationship without regard to the arrival of performance information over time. A remarkable fact, illustrated in Holmstrom and Milgrom (1987), is that these two simplifying assumptions are exactly offsetting in this model.

[4] Holmstrom (1979) proves that when $u'' < 0$, then $\mu > 0$.

[5] This type of compensation scheme is not optimal when effort affects an output that is hard to define or can easily be disguised by the manager.

[6] These surveys were collected by Whitney-Lee Corporation.

[7] See Hosmer and Lemeshow (1989) or Greene (1997) for a discussion of logistic regression.

[8] Major brands in the Los Angeles area are Arco, Chevron, Exxon, Mobil, Shell, Texaco, and Unocal. All other brands are considered independents.

[9] Counties in the sample are Los Angeles, Orange, San Bernardino, Ventura, and Riverside.

[10] While it is common to write the estimating equation with the dichotomous variable CONTRACT on the left-hand side, the dependent variable in the logit regression is actually the natural log of the odds ratio,

$$\ln\left(\frac{P_i^{(j)}}{1 - P_i^{(1)}}\right), \quad j = 2, 3,$$

where $P_i^{(j)}$ is the probability of station i being operated under either a lessee-dealer contract ($j = 2$) or an open-dealer contract ($j = 3$), and $P_i^{(1)}$ is the probability that station i is a company-owned station. The change in the odds ratio given a change in the kth independent variable is simply the antilog of the logit coefficient, e^{β_k}.

[11] Interestingly, the constants reported in Table III indicate that when there is no repair service, no convenience store, no full service, and no major brand, open-dealer contracts are approximately 8.7 times more likely than company-owned contracts. The abundance of open-dealer contracts relative to company-owned contracts, in the absence of the control characteristics, seems to contradict the theory. There may exist heterogeneity across stations that is not captured by the available data but is reflected in the signs and magnitudes of the constant terms.

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