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THE CHOICE OF ORGANIZATIONAL FORM IN GASOLINE RETAILING AND THE COSTS OF LAWS LIMITING THAT CHOICE

Asher A. Blass
Dennis W. Carlton

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ABSTRACT

This paper uses a new data source to analyze the choice of organizational form of retail gasoline stations. In recent years, gasoline stations have tended to be less likely to be owned and operated by a lessee dealer and more likely to be owned and operated by the refiner. Critics have alleged that company-operated stations are used to drive lessee dealer stations out of business in order to restrict competition. We examine the determinants of organizational form and find them to be based on efficiency not predatory concerns. We estimate the costs of recent laws prohibiting company ownership of gasoline stations.

Asher Blass
Bank of Israel
P.O. Box 780
91007 Jerusalem
Israel

Dennis W. Carlton
Graduate School of Business
The University of Chicago
1101 East 58th Street
Chicago, IL 60637
and NBER
dennis.carlton@gsbpop.uchicago.edu

The Choice of Organizational Form in Gasoline Retailing

and

The Costs of Laws Limiting that Choice[1]

by

Asher Blass

and

Dennis W. Carlton

Introduction

The gasoline retail industry has evolved significantly since the early 1970's. Retail outlets now sell more gasoline while the total number of outlets has declined. Whereas in the early 1970's the overwhelming majority of stations provided full-service and repair facilities, that is no longer the case. Beginning in the 1970's, many oil companies have also begun to operate some of their retail outlets directly, while the number of dealers has declined.[2]

In response, several states have banned company-operated stations in the gasoline retail industry. This unusual restriction, known as divorcement, has been legislated in six states.[3] Similarly, several recent lawsuits and other legislation have sought to impose other restrictions on company-operated stations or on refiner-dealer relationships.

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2. Company-operated stations are typically operated by salaried employees of the integrated refiner. The company sets retail price and other operating policies and retains profits. By contrast, dealers lease the station and equipment from the refiner, set retail prices and retain the profits.

3. These states include Connecticut, the District of Columbia, Delaware, Maryland, Nevada and Virginia.

Underlying many arguments for divorcement legislation and other restrictions is a belief that refiners are attempting to eliminate their retail dealers through predatory practices so that they can ultimately increase prices and profits to the detriment of consumers. The arguments deny the possibility that the company operations are simply an efficient response to changing market conditions. By contrast, the efficiency hypothesis suggests that the decision to operate a station directly or though a dealer is motivated by cost considerations and that the trend towards directly operated stations is a response to changes in the economics of gasoline marketing.

From the economic literature on franchising, we know that lessee dealers are more likely to be used in those situations where on-site monitoring is important. Lessee dealers are less likely to be used where the lessor must invest heavily in the site. The number of stations that provide full automotive service and repairs has declined. Moreover, stations today are much bigger than they were and are more likely to be configured as self service or convenience stores. Such changes would mitigate the need for on-site monitoring and so reduce the desirability of a lessee-dealer compared to a company operated station.

This study, which relies on a unique national database provided by ten large integrated refiners, examines whether the investment behavior from 1984-88 of the refiners is consistent with predatory pricing or whether it is more likely to be an efficient response to market conditions. More specifically, if integrated refiners were attempting to drive their lessee dealers from business, they would not be investing in lessee dealer stations. We find just the opposite -- refiners have been investing in these stations through new construction, improvements in existing stations and by actually converting stations from being company-operated to dealer-run.

We then attempt to measure the effects of divorcement on investment.[4] Specifically, if it is efficient under some circumstances for refiners to operate stations, then a law that restricts

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4. As mentioned earlier, there have been a number of studies that have documented the harmful effects of divorcement on gasoline prices and station hours in Maryland (Sorensen, 1988; Barron and Umbeck, 1984). More generally, the U.S. Dept. of Energy (1984) concludes (p. iv) the "Divorcement laws ... result in inefficient distribution and higher gasoline prices."

refiner-operated stations should result in refiners investing less in states passing such laws. We find that in those states the rate of investment in new stations has indeed been lower.

Next, we investigate whether the decision on whether a newly constructed station will be company-operated or dealer-operated seems to be driven by efficiency considerations. If market efficiency determined the form of retail operation, we would expect that company-operated stations might have different characteristics from dealer-operated stations. Specifically, we would expect to find relatively more company-operated stations in those instances where monitoring is less important. We indeed find that company-operated stations are relatively more prevalent if a station has no service facilities and more gasoline volume sold through self service. This confirms the findings of Shepard (1993) on a different, more narrow database. Finally, we show how to use a probit analysis to estimate the cost of divorcement legislation, first under the assumption that station characteristics are exogenous, and then under the assumption that characteristics and mode are simultaneously determined.

We conclude that the evidence is inconsistent with an alleged attempt to drive dealers out of business. Instead, the presence and growth of company operations appears to be an efficient response to market conditions. It is therefore highly likely that further divorcement legislature would be harmful, and that repeal of existing divorcement legislation would be beneficial.

Before describing the data and the results, we briefly review the competing hypotheses: predation vs. efficiency.

Predation

Both the proponents of divorcement and those seeking other restraints have argued that restrictions are particularly needed because of the numerous ways that integrated refiners can and supposedly have driven their dealers out of business. One dominant theme is that the major oil companies discriminate against their own retail dealers by charging them too much for gasoline either relative to the prices charged to independent wholesalers[5] or relative to the retail prices set by company-operated stations.[6] Another claim is that the refiners expropriate excessive rents from their dealers in the form of unreasonably high lease fees.[7] In addition, it has been claimed that the oil companies have imposed other burdensome operating conditions. As proof of the alleged predatory practices, the critics have pointed to the decline in the number of retail dealers and reduced profitability. They conclude that only by imposing restrictions on the majors can these predatory practices be curtailed, thereby enhancing consumer welfare in the long run.

These claims have been seriously discredited because divorcement has clearly not benefitted consumers. Maryland, the first state to legislate divorcement in 1974, has actually admitted that divorcement has been harmful to consumers because gasoline retail prices were not lower than they would have otherwise been (Department of Fiscal Services, 1988, p. 1).[8] Similarly, alleged "proof" of predatory pricing in non-divorcement states, such as the decline in

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5. As a response to that alleged practice, proposed legislation introduced into the United States Senate in 1987 would have permitted dealers to make open market purchases of up to 30 percent of sales, even though the current agreements between the companies and dealers might require all gasoline to be purchased directly from the company. Michigan has recently considered legislation in which a dealer could purchase supplies from wholesalers rather than from the company that leases the station to the dealer.

6. Shepard's (1993) results suggest lower retail prices by company operated stations.

7. It should be noted that the Petroleum Marketing Practices Act (1978) already places restrictions on the way refiners can terminate or refuse to renew leases.

8. In addition, station hours have been reduced thereby further curtailing consumer welfare (Barron and Umbeck, 1984).

the number of dealerships can easily be explained by nationwide trends that show a marked decline in the demand for car repair services at gasoline stations and a simultaneous increase in specialty shop repairs (Temple, Barker & Sloane, 1988).[9] The evidence also indicates that contrary to allegations, company-operated stations rarely sell at retail prices below the wholesale prices charged to dealers.

Perhaps most importantly, the predation hypothesis is internally inconsistent because there is no evidence to suggest that an integrated refiner could ever benefit if it were successful in driving out its dealers. The reason is that there is no compelling evidence of retail market power: entry is easy, competitors are numerous and brand value is not believed to be significant.

There are, nonetheless, testable implications of the predation hypothesis. In particular, the predation hypothesis implies that refiners will not set up any new lessee dealers and would certainly not make additional investments in existing lessee dealers. In addition, the predation hypothesis, by denying that monitoring costs differ across stations would predict that a station's configuration is unrelated to its operation mode. Indeed the predation hypothesis predicts no pattern of dealer operations at stations with repair facilities. Our dataset allows us to test these predictions directly.

Efficiency Hypothesis

The efficiency hypothesis suggests that the decision to operate a station directly or through a dealer is motivated by cost considerations. Independent dealers are businessmen who as residual claimants hire employees, set prices and retain profits. As such, they provide benefits when local supervision is required, compared to a company operated station where the manager is not the residual claimant. Dealer operations are efficient, compared to company

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9. The decline of dealerships in gasoline retailing is by no means unique. In some industries such as the automobile repair business, dealerships have declined as early as the 1960's even though in others, franchises have flourished.

operations, when they can improve a company's responsiveness to local market conditions and can limit inventory and labor costs. This could be true if automotive repairs and services are provided at the station.

It would also be true that lessee dealers are an efficient business form in a competitive environment when rapid price adjustments are required. Dealers are less efficient when labor costs are low, when customer service is unimportant, or when the refiner must make large site specific investments. Such conditions are met in high volume self service stations. In those situations, little if any entrepreneurial skills are needed, and there is a risk that a valuable expensive facility will be poorly run with no ability (because of numerous legal prohibitions on terminations) to change management.

The efficiency hypothesis would predict that dealerships will continue to be established, but that the decision on operation mode will be a function of cost. Indeed we should expect to see relatively more lessee dealers with service bays and at low volume stations.

Description of Data

We collected data from ten integrated refiners who comprised (as of 1986) approximately half of U.S. retail gasoline sales as well as half of U.S. refining capacity.[10] Indeed this is, to our knowledge, the first national study which examines the question at hand. For each newly constructed station in the year 1984-1987, the following variables were assembled: year of initial operation, 1988 mode of operation (dealer or company-operated), 1988 volume as well as number of service bays in 1988. In addition, we obtained data on investments in existing lessee dealers, conversions of company-operated stations, and volume data for open (i.e., dealer-owned stations) vs. lessee dealers (to test the rent predation theory) by state and year.

Results

10. Our analysis is based on data from ten of the major integrated refiners in the United States.

A. Refiner's Investments in Lessee Dealers

The predation hypothesis implies that refiners should not be setting-up any new lessee dealers. As we described earlier, the efficiency hypothesis predicts that refiners will continue to establish new lessee dealers because they are an efficient mode of distribution in certain economic circumstances. The data support the efficiency hypothesis and are inconsistent with the predation hypothesis.

Between 1984 and 1987, integrated refiners constructed 112 new lessee dealer stations in non-divorcement states, which amounts to 22 percent of the total of newly constructed stations (based on information from the nine out of ten companies that provided relevant data). See Table 1. Many newly constructed stations are run directly by the company for a brief start-up period until they are attractive enough to lease to a dealer. That is why in 1988 a smaller percentage of stations constructed in 1986 and 1987 (16 percent) were run by dealers, compared to the corresponding percentage of stations constructed in 1984 and 1985 (32 percent). The number of newly constructed stations, as described in Table 1, actually understates the number of new lessee dealer stations because it does not include stations acquired from other companies, many of which were retained as lessee dealers, nor does it include new dealerships which were previously operated as company-operated stations.

Table 1

Newly Constructed Stations in Non-Divorcement States
1984-1987

Mode of Operation in 1988	1984	1985	1986	1987	Total
Company Operated	45	95	96	165	401
Lessee Dealers	22	42	21	27	112
Percent Lessee Dealers	32.8	30.7	18.6	14.1	22.0
Total	67	137	117	192	513

Source: Data provided by nine refiners.

Perhaps more interesting is the fact that between 1986 and 1988 nine integrated refiners chose to convert a total of 646 company-operated stations to lessee dealers, as seen in Table 2. By contrast, under the predation hypothesis, refiners would never convert company-operated stations to lessee dealers. Here too, the predation hypothesis is refuted and the efficiency hypothesis confirmed.

Table 2

Conversions of Company-Operated Stations to Lessee Dealer Stations 1986-1988

Year	Number of Company-Operated Stations Converted to Lessee Dealer
1986	187
1987	192
1988	267
Total	646

Source: Data provided by nine refiners.

The predation hypothesis predicts no new investment in existing lessee dealer stations while the efficiency hypothesis does. As seen in Table 3, integrated refiners invested well over $1 billion in new and existing lessee dealer stations (based on information from the nine companies that provided relevant data).

Table 3

Capital Investment in Existing Lessee Dealer Stations 1986-1988

Year	Capital Investment in Existing Lessee Dealers
1986	$ 306,818,463
1987	377,422,438
1988	431,050,499
Total	$1,115,291,401

Source: Data provided by nine refiners.

This investment behavior is not the sort that one would expect if the refiners were engaging in predatory conduct.

B. Divorcement and Investment

An additional harmful effect of divorcement is that it could reduce the incentive for companies to invest in states that forbid the efficient ownership mode. If it is more efficient for growth to occur in company-operated stations, then rates of investment growth in newly constructed stations should be lower in states that forbid company-operated stations.

As Table 4 indicates, the hypothesis is confirmed. From 1984 to 1987, new investments increased by 153 percent in non-divorcement states (for all ten companies in our survey) but decreased by 8 percent in divorcement states.

Table 4

Investment in Newly Constructed Stations - 1984-1987
(Thousands of Dollars)

State	1984	1985	1986	1987	Percent Growth 1984 - 1987
AK	0	0	0	1,480	.
AL	0	1,110	639	822	.
AR	465	0	0	0	-100
AZ	3,406	1,010	11,003	21,360	527
CA	9,958	18,184	16,833	35,923	261
CO	0	361	1,200	2,938	.
* CT	0	893	3,324	1,360	.
* DC	2,200	0	1,314	400	-82
* DE	0	0	0	0	.
FL	14,979	13,751	21,718	41,841	179

Table 4

Investment in Newly Constructed Stations - 1984-1987
(Thousands of Dollars)

State	1984	1985	1986	1987	Percent Growth 1984 - 1987
GA	1,962	5,344	4,130	7,761	296
HI	0	606	0	800	.
IA	100	200	400	0	-100
ID	0	0	0	0	.
IL	3,815	20,710	7,590	5,527	45
IN	1,497	1,469	0	1,900	27
KS	2,200	500	0	1,500	-32
KY	0	0	0	0	.
LA	4,279	5,991	1,770	1,333	-69
MA	0	1,032	0	2,312	.
* MD	11,839	2,805	2,894	7,664	-35
ME	0	0	0	0	.
MI	100	600	1,959	2,960	2,860
MN	400	900	1,800	2,400	500
MO	3,110	4,020	2,050	2,597	-16
MS	0	703	476	909	.
MT	0	0	0	0	.
NC	727	544	639	3,853	430
ND	0	0	0	0	.
NE	2,000	0	0	0	-100
NH	0	0	0	1,915	.
NJ	9,364	3,834	1,410	7,924	-15
NM	0	0	0	0	.
* NV	4,426	1,066	2,484	3,400	-23
NY	2,919	300	500	4,420	51
OH	1,764	3,711	3,195	6,268	255
OK	0	0	0	0	.

Table 4

Investment in Newly Constructed Stations - 1984-1987
(Thousands of Dollars)

State	1984	1985	1986	1987	Percent Growth 1984 - 1987
OR	0	0	2,644	2,089	.
PA	4,200	3,197	4,181	1,045	-75
RI	0	0	0	1,033	.
SC	358	2,609	1,039	6,771	1,791
SD	0	0	0	0	.
TN	1,127	7,603	2,645	2,026	80
TX	19,715	26,124	33,549	51,816	163
UT	554	0	543	0	-100
* VA	3,293	2,791	3,435	7,130	117
VT	0	0	0	0	.
WA	2,727	5,049	3,350	13,356	390
WI	0	0	800	1,000	.
WV	1,662	0	2,768	0	-100
WY	800	0	0	0	-100
Total U.S.	115,945	137,017	142,282	257,832	122
Non-Divorcement	94,188	129,462	128,831	237,878	153
Divorcement	21,758	7,555	13,451	19,954	-8

Source: Data provided by ten refiners.
* Denotes states with divorcement legislation.
Note: Nevada became a divorcement state in July 1987.

Table 5 column (1) presents an OLS regression that shows that total investment by state in newly constructed stations is dependent on the level of company-operated retail sales but not on the level of dealer sales. For every gallon sold, almost 4 cents of investment will be made. Therefore, restricting company-operated sales lowers investment. Clearly any policy of divorcement is harmful to investment.

Table 5

Total New Investment by State as a Function of Divorcement and Sales

Dependent Variables	Investment (Thousands) (1)
Number of Observations	102
Sample	Total Investment by State in 1986, 1987
Constant	464 (465)
Open Dealer Sales	-0.006 (0.007)
Lessee Sales	0.000 (0.002)
Company Operated Sales	0.039 (0.003)
R^2	0.76

Source: Data on sales in gallons provided by seven refiners.
Standard errors are in parentheses.

C. Determinants of Station Mode

If predation is not the explanation for the presence of company-operated stations, it is highly likely that the mode of station organizational structure is an efficient response to market conditions. If the organization is indeed efficiency based, we would expect to see more company-operated stations where the capital-labor ratio is high and where monitoring costs are low, specifically in those stations with high volume gasoline sales but without car repair facilities. By contrast, the predation hypothesis implies that company-operated stations would be just as likely to occur at high volume as at low volume stations and that there would be no pattern of dealer operations at stations with repair facilities.

As seen in Tables 6 and 7, the evidence supports the efficiency hypothesis. Table 6 shows that newly constructed stations in non-divorcement states are more likely to be run by lessee dealers when volume is less than 1,250,000 gallons per year than when volume is above 1,250,000 gallons per year. When volume is less than 1,250,000 gallons per year, 27.8 percent of all newly constructed stations are run by dealers, compared to about 20.3 percent when volume is greater than 1,250,000 gallons.

As indicated earlier, many newly constructed stations are run directly by the company for a start-up period until they are leased to a dealer. For that reason, volume differences among dealer and company-operated stations constructed during 1984-85 may be more probative than an analysis of the entire 1984-87 period. For stations constructed in 1984-85, almost half of all low volume stations are run by dealers whereas 27 percent of the other stations are run by dealers. A chi-squared text (x^2 = 8.11) rejects the hypothesis of no difference in volume by mode of operation at the 2 percent level.

Table 7 describes the difference between company-operated and dealer stations in the number of bays. Only 18 percent of newly constructed stations without service bays are operated by dealers while more than half of newly constructed stations with bays are run by dealers. The hypothesis that dealers and company-operated stations are no different and that the relative shares of bay and non-bay stations is attributable to chance is strongly rejected (X^2 = 33.04).

Table 6

Newly Constructed Stations, By 1988 Volume (Millions of Gallons)

Mode of Operation in 1988	Vol < 1.25	1.25 < Vol < 1.75	1.75 < Vol < 2.25	Vol > 2.25	Total
<u>Construction in 1984-1987</u>					
Company Operated	78	119	109	95	401
Lessee Dealer	30	31	29	22	112
% Lessee Dealer	27.8	20.7	21.0	18.8	21.8
Total	108	150	138	117	513
<u>Construction in 1984-1985</u>					
Company Operated	22	45	38	35	140
Lessee Dealer	21	16	16	11	64
% Lessee Dealer	48.8	26.2	29.6	23.9	31.4
Total	43	61	54	46	204

Source: Data provided by nine refiners.

$X^2_{(2)}$ = 8.11 (significant at 2% confidence level)

Table 7

Newly Constructed Stations, 1984-1987
Number of Bays

Mode of Operation in 1988	No Bays	2 Bays	3 Bays	4 Bays	5 Bays	Total
Company Operated	374	1	12	12	2	401
Lessee Dealer	83	0	13	15	1	112
% Lessee Dealer	18.2	0.0	52.0	55.6	33.3	21.8
Total	457	1	25	27	3	513

Source: Data provided by nine refiners.

$X^2_{(2)} = 33.04$

We can further describe the likelihood of a newly constructed station to be run by a dealer or by the company using a probit analysis. According to the efficiency hypothesis, a company chooses its mode of operations based on its profits. Profit is a function of volume and the number of bays as well as other unobserved variables.

According to the efficiency hypothesis, conditional on observing the volume and number of bays, the mode of operation can be predicted. According to the predation hypothesis, there is no necessary relationship between the mode of operation and the volume and number of bays. As seen in Table 8, the probit coefficients on volume and bays have the correct signs and are generally significant. Columns 5-7 focus on stations built during 1984 and 1985. As already described, data from these stations are the most reliable to use since mode choice in 1988 is likely to be the intended mode of operation. The results show that both volume and bays are statistically significant determinants of mode choice. Specifically, low volume and number of repair bays positively influence the likelihood of a lessee dealer mode of operation. In the remaining columns, we present results for the entire period. This data set has the drawback that the mode choice variable is not as reliably measured for stations built in 1986 and 1987 as for stations built in 1984 and 1985. Still, results generally confirm the findings in Columns 5-7. (However, to obtain statistical significant for the volume coefficient, it is necessary to add a dummy variable for one company with a proclivity to open stations that, at least initially, are lessee dealers.)

Table 8

Probit Maximum Likelihood Results
Probability of Lessee Dealer Operation

Sample Number of Observations	All 513 (1)	All 513 (2)	All 513 (3)	All 513 (4)	1984-85 204 (5)	1984-85 204 (6)	1984-85 204 (7)
Constant		-0.63	1.58	3.72	-0.06	7.05	-0.72
		(0.20)	(2.38)	(2.47)	(0.29)	(3.75)	(0.11)
	(0.19)						
Number of bays		0.28	0.25	0.28	0.16	0.16	
		(0.05)	(0.05)	(0.05)	(0.07)	(0.07)	
	(0.05)						
Bay dummy							0.61
							(0.24)
1988 Volume in		-0.22			-0.30		
millions of		(0.10)			(0.15)		
gallons	(0.10)						
Log Volume			-0.17	-0.33		-0.53	
			(0.16)	(0.17)		(0.26)	
(Volume <1,250,000) dummy							0.51 (0.22)
Company Dummy		0.74 (0.18)		0.73 (0.18)			
% Company Operated	78.56	78.56	78.56	78.56	71.08	71.08	71.08
Log Likelihood	-255	-246	-255	-247	-121	-121	-120

Source: Data provided by nine refiners.
Dependent Variable - Lessee Dealer in 1988 - 1; Company Operated in 1988 - 0
Standard errors are in parentheses.

<u>The Cost of Divorcement</u>

We can use the probit analysis to obtain a rough measure of the cost of requiring divorcement -- that is, of requiring all company operated stations to become lessee-dealer stations. We use two approaches with the second being more sophisticated and complicated than the first.

A. <u>Station Characteristics Are Exogenous</u>

Assume first that the volume (x_1) and number of repair bays (x_2) of a station are exogenous and independent of mode of operation. The choice of mode of operation will depend on whether the average cost of operation at lessee dealers (c_d) exceeds the average cost of operation at company operated stations (c_o).

Let $c_d = \boldsymbol{g}_d + \boldsymbol{a}_d x_1 + \boldsymbol{b}_d x_2 + e_d$, and

$c_o = \boldsymbol{g}_o + \boldsymbol{a}_o x_1 + \boldsymbol{b}_o x_2 + e_o$, where

e_i 1 are iid random normal variables.

It follows that the probability of a lessee dealer configuration is:

$$P = Prob\,[\, c_d < c_o \,] = Prob\,(-a - b_1 x_1 - b_2 x_2 + e < o), \text{ or}$$
$$\mathrm{P = Prob\,(+e < a + b_1 x_1 + b_2 x_2), \text{ or}}$$
$$\mathrm{P = F\,(a + b_1 x_1 + b_2 x_2), \text{ where}}$$
$$\mathrm{a} = \boldsymbol{g}_{\mathrm{o}} - \boldsymbol{g}_{\mathrm{d}}$$
$$\mathrm{b_1} = \propto_{\mathrm{o}} - \propto_{\mathrm{d}} \text{ and}$$
$$\mathrm{b_2} = \boldsymbol{b}_{\mathrm{o}} - \boldsymbol{b}_{\mathrm{d}} \text{ and}$$
$$\mathrm{e = e_d - e_o}$$

where F(.) indicates the value of the cumulative distribution that describes the distribution of differences in e_i. If we take the distribution of costs to be normal with standard deviation σ, then

$$P = N\left(\frac{a + b_1 x_1 + b_2 x_2}{\sqrt{2}\, \boldsymbol{s}}\right)$$

where N(.) indicates the value of the cumulative normal.[11]

The probit maximum likelihood results in Table 8 provide estimates of $\frac{a}{\sqrt{2}\ s}$, $\frac{b_1}{\sqrt{2}\ s}$,

and $\frac{b_2}{\sqrt{2}\ s}$. In order to estimate the difference in costs between configurations, it is necessary to know the size of σ, which represents the standard deviation of costs, conditional on mode of operation, volume and bays. We use an estimate of the standard deviation of price to figure out how to estimate this standard deviation. Shepard (1993) showed that the standard deviations of lessee dealer prices in Eastern Massachusetts in 1987 ranged from 4.75 cents to 10.5 cents per gallon for regular unleaded gas according to type of service.[12] Controlling for capacity (presumably strongly correlated with volume), bays and other variables reduces the standard deviations by about 20 percent.[13] Further removing the area specific component of price dispersion reduces the conditional standard deviation of price for regular unleaded gas at lesser dealers in the Shepard (1993) sample to a range of 4 to 5 cents.[14]

That range, however, probably understates σ. One reason is that the price variation reflects a truncated distribution of e_d as we only observe lessee dealers for whom e_d is not very high. Second, the area specific effect may not be the same across modes of operation, in which case the variation over time in price will underestimate the σ required to calculate the variation of e_d - e_o. However, in private correspondence, we have learned that an idiosyncratic time component may further reduce the range by up to 50 percent so that the range across all stations of σ could be as small as 2 to 3 cents (1987 price levels). Again, this reduction in range

11. If e_d and e_o are iid, each with variance σ, then e_d - e_o has variance 2 σ^2.

12. The standard deviations for her much smaller sample of company operated stations (38 stations vs. 452 lessee dealers) ranged from 3.56 cents to 12.80 cents. See Shephard, 1993, Table 1.

13. Shepard, 1993, Table 2, and Table 1.

14. The comparable range for company-operated stations is 3 to 6 cents.

likely understates the true σ because the idiosyncratic component likely varies across station types. This range (which likely underestimates σ) translates into a range of about 3 to 4 cents in 1998 dollars because the consumer price index rose by approximately 42 percent from 1987 until the first quarter of 1998. Accordingly, we assume conservatively that σ equals 3 cents. However, our results can readily be scaled to higher, and probably more realistic estimates of σ.

The average difference in average cost (i.e., E [c_d - c_o]) between a station now

$$\sqrt{2}\, s\, [E(a^* + b^* x_1 + c^* x_2) + E(e_d - e_o / \text{station was not lessee dealer})],$$

company operated and one that is switched over to become a lessee dealer is therefore

which exceeds

$$\sqrt{2}\ s\ (a^* + b^* x_1 + b_2^* x_2) = .03\ \sqrt{2}\ (a^* + b_1^* x_1 + b_2^* x_2)$$, where

a^*, b^*_1, b^*_2 are the (negative of) the estimated probit coefficients from Table 8. The total cost difference for a 2 million gallon station (a typical volume for company operated stations) with no bays is between \$50,000 to \$90,000 depending upon the specification.[15] Based on these estimates, the costs of divorcement legislation, (based on about 15,000 company operated stations) could easily exceed \$1 billion annually.[16]

The foregoing analysis assumed that station characteristics are exogenous and independent of the mode of operation. Indeed, other work such as Shepard (1993) also

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15. For example, using column 5 of Table 8, the total cost difference is $\sqrt{2}\ (.03)(.06 + .3 \bullet 2)\ 2 \bullet 10^6$ or about \$55,000.

16. Stations could also cease operation. We ignore the operating cost savings from closure and ignore the harm to consumers from closure.

assumed that characteristics were exogenous and that firms choose the type of station to build based on traffic flow and the level of competition *and only later* decide the optimal organizational form for the station. For older stations, it might be appropriate to assume that configuration is exogenous since the layouts of such stations were presumably chosen long ago and once built it is hard to enlarge a station. For new stations, however, we expect that the mode of operation will; be chosen simultaneously with volume and the number of bays. Indeed, we understand from industry participants that it would be incorrect to assume otherwise. So for those stations it would be inaccurate to use the coefficients of a probit regression that predicts mode choice as a function of volume in order to estimate costs, since the probit model explicitly assumes that volume is exogenous. Instead, it would be appropriate to devise a different model in which configuration and mode of operation were determined simultaneously in order to estimate the cost of divorcement legislation.

B. Characteristics and Mode Simultaneously Determined

We now construct a model in which configuration and mode of operation are determined simultaneously. In our model, company-operated and lessee-dealer stations profit functions are quadratic with respect to volume. The cost incurred from converting company operated stations to lessee dealer stations is the difference between expected profits under company operation and dealer management. In order to identify all the parameters, we must impose some assumptions about zero-profit volumes for company-operated and lessee dealer stations respectively. A station will be chosen to be company operated if $\Pi_o > \Pi_d$ where Π_i indicates profit to the oil company and i indicates the mode of operation (o = company operated, d = dealer operated). Assume that Π is a quadratic function of volume so that

$$\Pi_i = a_i V^2 + b_i V + c_i + e_i ,$$

where V = station volume,

a_i, b_i, c_i = unknown parameters, and

e_i = error.

For any mode i, we know that the station will choose to operate at volume $V_i^* = \frac{-b_i}{2a_i}$,

at which point, $\Pi_i = (c_i - \frac{b_i^2}{4a_i}) + e_i$. Company operation instead of dealer operation is chosen if $\Pi_o > \Pi_d$, or if

$$(c_o - \frac{b_o^2}{4a_o}) - (c_d - \frac{b_d^2}{4a_d}) > e_d - e_o \qquad (1)$$

Once all parameters are estimated, we can calculate the extra cost from converting an already built station from one ownership mode to another but, unlike the previous calculation, we have explicitly accounted for the simultaneous choice of volume and mode of operation in estimating the parameters. Since the station is already built, its volume can, as a rough approximation, be taken as exogenous for purposes of estimating extra costs (though not for parameter estimation) and we can calculate $\Pi_o(V_o^*) - \Pi_d(V_o^*)$ as the extra cost incurred to switch each company owned station to a dealer owned. (Notice that Π_o is evaluated at V_o^* not V_d^*).

In order to identify all parameters, we must either have some exogenous variable or impose some assumptions. Because we have no exogenous variable, we are forced to impose some simplifying assumptions to illustrate our approach. Our calculations should be regarded as preliminary. Let $a_0 = a_d = a$. Then, using the average volume at stations of each type, we know that

$$\bar{V}_o = \frac{-b_o}{2a} \quad \text{and} \quad \bar{V}_d = \frac{-b_d}{2a}, \tag{2}$$

where $\bar{V}_i$ = average annual volume at stations in operation mode i.

In our sample, $\bar{V}_o$ approximately equals 2 million gallons and $\bar{V}_d$ approximately equals 1.25 million gallons.

In our sample, we find very few owner operated stations at an annual volume of 1 million gallons or below and very few lessee dealer stations at an annual volume of .5 million gallons or below. Accordingly, we impose the conditions that

$$\Pi_O(1) = 0 \text{ and } \Pi_d(.5) = 0, \tag{3}$$

Using (1) to estimate the probit, we can estimate (up to a scalar) the constant $c_o - c_d - \frac{b_o^2}{4a} + \frac{b_d^2}{4a}$ as .47[17]. We identify the scalar, as before, by using an estimate of price dispersion to estimate in this case the conditional dispersion of profits per unit. Using the same assumption as before (σ = $0.03), it follows that on average the standard deviation of the error term in the profit equation equals .03 times average station volume (approximately 1.5 million gallons).[18] (This implies that the standard deviation of the probit error is at least $\sqrt{2} \bullet 0.03 \bullet 1.5 \bullet 10$.)

17. I.e., F(.47) = .69 where F is the cumulative normal and .69 is the fraction of stations that are lessee dealers in 1988 of stations built in l984-85.

18. If the standard deviation of profit per gallon is .03, then the standard deviation of profit for a typical station is .03 times typical volume.

Using the probit together with equations (2) and (3), we are able to estimate all the parameters. Therefore, we can calculate the extra cost resulting from converting company operated stations to lesser dealer stations as $\Pi_d(V_o) - \Pi_o(V_o)$. That cost is estimated to be about $70,000 per station. This leads to an overall annual cost estimate (based on 15,000 company operated stations) of about one billion dollars.[19]

Using a series of alternative reasonable assumptions, we obtain cost estimates ranging from 0.6 to 2.1 billion dollars. In the table below, we present alternative cost estimates of divorcement based on varying assumptions regarding zero profits.[20]

Table 9

Cost Estimates Of Divorcement Under Different Assumptions

Company zero profit volume (million gallons)	1.0	1.1	0.8	1.0	1.1	1.2
Dealer zero profit volume (million gallons)	0.5	0.5	0.4	0.4	0.6	0.6
Cost of divorcement ($ billion)	1.02	1.81	0.62	1.61	1.16	2.06

We regard both our approaches to measuring the cost of divorcement as crude but illustrative of the large cost likely to accompany a policy of divorcement. Moreover, we calculate the cost of divorcement only for major refiners. The cost for non-major refiners is likely higher because non-majors typically rely more heavily on company operations than majors in marketing their brand of gasoline. Divorcement therefore creates a barrier to entry for the non-majors.

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19. Since our estimates were based on the conditions imposed by equation (3), we performed a sensitivity analysis to determine how changes in the assumptions about the quantities at which profits are zero might affect our estimates. See Table below. Our cost estimates range from .06 to 2.0 billion dollars.

20. A necessary condition for our method to work is that the difference between the average and minimum station volume for company operated stations is larger than the difference for dealer operated stations. This condition is satisfied in our data set.

Lastly, we note that, in a recent FTC study using cross-sectional data (across states), Vita (1999) estimated the overall annual consumer cost (based on 1999 volumes) following divorcement to be even higher than our estimates (based on early 1990 volumes) -- $2.5 billion.

Conclusions

We find no evidence to indicate that predation is a motivating factor in the choice between company operation and dealer operation of gasoline service stations. Indeed, every test provides robust support for the hypothesis that the refiners are motivated by efficiency considerations. A policy of divorcement adversely affects investments in gasoline stations and ultimately consumers. We present two empirical analyses to estimate the likely cost of divorcement. In one estimate we ignore the simultaneous choice of mode of operation and station characteristics, while in the other we explicitly account for this simultaneity. Though each calculation is crude, each indicates that a policy of divorcement is likely to impose significant costs on society.

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