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Rationalization in the Canadian Retail Gasoline Industry: The Role of Environmental Regulations

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Abstract

The number of gasoline stations in Canada fell by 40 percent between 1989 and 2000. Many demand and competition related explanations have been offered for this rationalization, while industry sources cite stiffer environmental regulations as a factor in station closures. In the late 1980s and early 1990s most Canadian provinces adopted regulations requiring that unprotected petroleum storage tanks be upgraded or replaced according to a schedule based on the age of the tank and that nearby unprotected tanks also be upgraded or removed. In this paper, we exploit provincial differences in the timing of these regulations to examine the role of upgrade and removal regulations on the timing and degree of station shutdown in 12 cities across the country.

Keywords: Petroleum Storage, Rationalization, Retail Gasoline, Underground Storage Tanks, Environmental Regulations

JEL Classifications: K20, Q58, L81

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I. Introduction

Over the 1990s, the Canadian retail gasoline industry went through a period of dramatic rationalization, with the number of gasoline stations in Canada falling by approximately 40 percent from 1989 to 2000. [1] Similar overall trends have been observed elsewhere; see Scherer (1996) for a discussion of rationalization in the U.S. in the 1970s, and Gotz and Gugler (2006) for some discussion of Austria and Germany. Many explanations have been offered as to why and how the Canadian industry rationalized.[2] The Conference Board of Canada (2001) discusses the effect of independent stations not associated with refiners, changes in demand for gasoline and repair services, and changes in land values. Carranza et al (2010) examine the impact of a price floor in Quebec on the evolution of the industry, while Eckert and West (2006) consider the role that new entry played on rationalization in the Vancouver area. Eckert and West (2005) consider whether the process of rationalization was consistent with tacit collusion. Industry sources and media reports suggest that environmental regulations may have contributed to retail closures. For example, Curran (1994) states that "downsizing was necessary … continual price wars due to oversaturation and costlier environmental regulations conspired to force retailers hands." The *Report of the Liberal Committee on Gasoline Pricing In Canada* (1988) included in the list of obstacles to financing independent business "mandated environmental investments that are unrecoverable through pump price." However, the role of environmental regulations in Canadian rationalization has not been the subject of any formal analysis.

Leaks from underground petroleum storage tanks, including those at gasoline stations, pose a threat to groundwater, with one litre of gasoline having the potential to contaminate

[1] See Conference Board of Canada (2001).
[2] The impact of rationalization in Canada on price and market structure is considered by Sen and Townley (2010).

1 000 000 litres of groundwater.[3] Groundwater is the source of drinking water for approximately 10 million Canadians, and is important for agriculture, industrial processes, and the hydrological cycle.[4] The number of leaking USTs increased during the 1970s and 1980s. By 1987 there were an estimated 7500 to 20000 leaking USTs in Canada, representing up to 10% of total tanks (Environment Canada 1987). The cause of this increase was the aging of the stock of steel tanks with no corrosion protection.[5] In response, federal and provincial governments began regulating or issuing guidelines for underground petroleum storage.

This paper uses annual data on the closure of retail stations in 12 cities across Canada to examine the association between changes in environmental regulations governing petroleum storage and the timing and degree of station closures between 1986 and 2006. The rationalization of stations coincided with a significant change to regulations regarding corrosion protection for underground storage tanks. Prior to the late 1980s, provinces required all newly installed tanks to meet corrosion protection standards but made no requirements regarding corrosion protection of existing unprotected tanks, which were the most likely to corrode. Between 1987 and 2001 most provinces adopted new regulations that required existing tanks to be either upgraded or replaced. These regulations represented an increase in the fixed costs of maintaining a gasoline station that had unprotected tanks.[6] In fact, a number of news reports regarding the closure of individual stations suggest that upgrading and replacing tanks was prohibitively expensive. Regarding the closure of a station in Uranium City, SK, Braden (1997) states "Imperial Oil is leaving because it's too expensive to dig up its underground storage tanks and replace them … to comply with new provincial environmental laws." All else equal, it is

[3] See http://www.ec.gc.ca/water/en/manage/poll/e_tanks.htm, last accessed May 9, 2008.
[4] See Government of Canada (2003).
[5] http://www.ec.gc.ca/water/en/manage/poll/e_tanks.htm, last accessed May 9, 2008.
[6] For example, Prentice (1995) reports that "retailers will also have to carry the costs of higher environmental standards, which could mean capital costs of more than $150,000 for every gas station."

expected that shutdown rates will be higher in cities facing these regulations, in years containing or immediately preceding the deadlines for removal or upgrade.

Our paper contributes to the rationalization literature and to the literature on industry evolution by being the first to consider the role of environmental regulations in Canadian rationalization.[7] As well, understanding the factors contributing to the nature of rationalization is important for the formulation of policy. This study also contributes to the literature examining whether environmental regulations change closure decisions of firms. A number of theoretical studies have shown that environmental regulations can alter location choices of firms, but the associated empirical work is limited and has produced mixed results.[8] Biorn *et al* (1998) finds that Norwegian manufacturing plants faced with environmental regulations are less likely to exit than others, while List *et al* (2004) conclude that New Source Review requirements under the Clean Air Act did not have an economically important effect on closure decisions.

To our knowledge, the only other study to link environmental regulations and gasoline station closure is Yin *et al* (2007) that examines rationalization in Michigan. The authors find that because of liquidity constraints, small retailers were more likely to exit than large retailers when faced with expensive environmental regulations. Our study differs from Yin *et al*. (2007) in two ways. First, rather than examine station level decisions within a single jurisdiction, we examine closure rates across jurisdictions with different environmental regulations, allowing us to identify the effect of the regulations by the provincial variation of the timing of similar regulations. Second, their study examines which types of stations are more likely to close following regulations whereas ours focuses on the question of whether UST regulations in fact

[7] The empirical literature on entry and exit is extensive. See Siegried and Evans (1994) and Berry and Reiss (2007) for surveys.

[8] See Copeland and Taylor (2006) for a discussion of the pollution haven hypothesis and related empirical work, Brunnermeier and Levinson (2004) for a review of empirical studies of environmental regulations and firm location , and Stafford (1985) for a representative survey based study.

increased closure rates.

To anticipate results, we find evidence that closure rates did respond to upgrade and removal regulations. In particular, closure rates are higher in cities and periods in which stations face an impending deadline for upgrade and removal of unprotected tanks than in the same city when such a deadline is not in place and in cities for which stations do not face such a deadline.

The paper proceeds as follows. Section 2 outlines the provincial petroleum storage regulations faced by gasoline station operators. Section 3 discusses the data. An econometric model of the city level closure rate is developed in section 4, and regression results are presented in Section 5. Section 6 concludes.

II. Environmental Regulations

Historically, the primary concern relating to the storage of petroleum products was the fire hazard they posed. As such, underground storage was preferred to aboveground storage. During the 1970s and 1980s, the environmental threat posed by leaking underground storage tanks became clear. Regulators in Canada and elsewhere began regulating underground storage tanks in order to reduce the probability and extent of leaks. In Canada, environmental regulations governing petroleum storage are under provincial jurisdiction unless the storage takes place on federally owned property. Provincial regulations included construction standards, monitoring requirements, procedures to be followed when closing a site, and corrosion protection standards. We focus on corrosion protection requirements for two reasons: corroding tanks and piping are the leading cause of leaks, and such regulations were the only ones to our knowledge to undergo a systematic change during the period of rationalization.

Prior to the late 1980s, corrosion protection regulations in most provinces required all new underground petroleum storage tanks conform to the latest edition of the relevant Underwriters' Laboratories of Canada standards (S603.1 or S603 for steel tanks and C58A for fiberglass tanks). [9] These regulations did not require changes to existing storage systems. As older unprotected tanks continued to corrode, the problem of petroleum leaks remained.

Beginning in the late 1980s, most provinces adopted regulations requiring petroleum storage facilities to upgrade or replace unprotected tanks, typically according to a schedule based on the age of the tank. In 1988, the Canadian Council of Resource and Environment Ministers (CCREM) published environmental codes of practice for the underground storage of petroleum products which included a schedule for upgrading or replacing unprotected tanks.[10] While the Codes of Practice are not binding they are intended to guide provincial regulations and "the CCME advocates that the recommendations … be adopted by the various provincial and territorial regulatory authorities as minimum requirements" (CCME 1993).

Table 1 outlines the corrosion protection regulations adopted in the 10 Canadian Provinces. Column 2 provides the first year in which all new tanks were required to be protected, with all tanks installed prior to that date being considered unprotected.[11] Column 3 provides the date that the regulation requiring upgrading or removal of unprotected tanks was adopted. Columns 4 and 5 indicate the earliest and latest upgrading and removal deadline, taking into account the age of tanks installed prior to the protection requirements of new installations. For example, the 1992 Alberta Fire Code mandates a schedule of upgrade and removal deadlines

[9] For steel tanks, the most common form of protection is cathodic protection, which is "a method of preventing or reducing a metal surface by making the metal a cathode" (CCME 1993). This can be accomplished by impressing a direct current or attaching sacrificial anodes. Another option to protect from corrosion is to install fiberglass tanks.
[10] In 1991, CCREM was renames the Canadian Council of Ministers of the Environment (CCME).
[11] It is possible that tank owners chose to install protected tanks prior to this date. In the province of Manitoba, only 1% of tanks installed prior to when protection became required while 99% installed after were protected.

which range from 2 years (1994) for tanks installed prior to 1967 to 7 years (1999) for tanks installed after 1988. However, if all tanks installed after 1984 contain corrosion protection, the last relevant deadline is 1998. If these regulations did influence shutdown decisions, this influence should be observed between the date the upgrade and removal regulations were adopted and the last relevant deadline.

Table 1. Protection, Upgrade, and Removal Regulations and Deadlines by Province

Province	Year All New Tanks Protected	Upgrade/ Removal Adoption Date	Earliest Deadline	Last Relevant Deadline
Alberta	1984	1992	1994	1998
British Columbia	1980	None		
Manitoba	1976	2001	2003	2003
Newfoundland	1982	None		
New Brunswick	1980	1987	1989	1993
Nova Scotia	1988	1988	1993	2003
Ontario	1980	1988	1991	1997
Prince Edward Island	1985	1990	1990	2000
Quebec	1984	1991	1993	1998
Saskatchewan	1988	1992	1994	2005

III. Data

Firm-level annual station counts and volumes were obtained from Kent Marketing for 1986-2006 period for the following twelve Canadian cities: Vancouver, Edmonton, Calgary, Regina, Winnipeg, Toronto, Ottawa, Quebec City, St. Johns, Halifax, Charlottetown, and St. John.[12] These data are aggregated to construct city level station counts and volumes. To calculate the

[12] Unfortunately, Kent Marketing does not collect volume data for a small number of independent retailers. These independent chains were dropped when computing average station volumes but their counts are still included in our closure rates. As well, in a few city-year cases, we were missing volume data. In these cases, market level volume is interpolated as the average of the preceding and following observations

closure rate in a city in year *t*, we calculate the percentage difference between the number of stations reported as open in January of year *t* and those reported as open in January of year *t+1*.

Average city level annual retail price data were collected from M.J. Ervin & Associates for the years 1988 - 2006.[13] Wholesale gasoline prices, by market and year, were obtained for the period 1998-2006 from M.J. Ervin & Associates, and for the period 1989 – 1995 from the Bloomberg Oil Buyers' Guide Petroleum Price Supplement. For the 22% of observations for which wholesale prices were unavailable, we used fitted values based on a regression of wholesale prices on crude oil prices, a time trend and city effects. [14] Finally, average residential property values were obtained from The Canadian Real Estate Association for all cities except Quebec City, which were obtained from the Quebec City Real Estate Association.[15]

Between 1986 and 2006, rationalization in the retail gasoline industry occurred in cities across the country. Table 2 provides, for each city, the percentage reduction in stations from the year in which the maximum number of stations existed in the city (in our sample) to January, 2006.[16] As can be seen in Table 2, the magnitude of the reduction differs across the cities, ranging from 19.8 percent in Calgary to 50.1 percent in Toronto.

To capture the timing of upgrade and removal regulations, and based on the information presented in Table 1, we construct three regulatory dummy variables. if the upgrade and removal regulation for city *i* was enacted in a period before or in year *t* but the

[13] These data are available online at http://www.mjervin.com/index_PetroleumPrices.htm.

[14] Alternatively, we could use the crude oil price multiplied by a coefficient obtained from a regression of retail prices on crude oil prices. This method yielded similar results.

[15] City level property prices were unavailable for St. John's, NFLD and Charlottetown, PEI and provincial average property values were used. In both cases, the cities are expected to dominate provincial average prices. Unfortunately, we were unable to obtain usable commercial property prices, and are forced to assume that residential and commercial prices will be correlated.

[16] We use the year of the maximum number of stations for each city rather than 1986 level because many cities had net entry into the industry during the first few years of our sample, prior to the period of rationalization. These years remain in our sample because we are interested in the pattern of station counts prior to the passing of upgrade and removal regulations.

first deadline under the regulation is in year *t+1* or later. The dummy is 0 for all other years.

if the first deadline for tanks in city *i* to be upgraded and removed is before or in year *t* but the last binding deadline is in year *t* or later. The dummy is 0 for all other years. Finally, $REGULATION_{it}$= We expect that the effect that upgrade and removal requirements had on closure rates shoul d be observed when $REGULATION_{it}$=1.

Table 2. Percentage Reduction in stations from the Maximum Year to Jan.1, 2006 by City

City	% Reduction
Calgary	19.8
Charlottetown	34.6
Edmonton	30.1
Halifax	35.6
Ottawa	35.7
Quebec	30.5
Regina	29.8
St. John	44.8
St. John's	32.9
Toronto	50.1
Vancouver	31.4
Winnipeg	33.7

Figure 1 shows the average shutdown rate across cities in our sample for each year, and also the number of cities for which $REGULATION_{it}$=1. As can be seen in the average shutdown rates, the general trend involves little shutdown (and some growth in station counts) until the early 1990s, after which shutdown rates gradually tapered off. The general trend in the *REGULATION* variable is remarkably similar to that observed in shutdown rates over the sample – the number of cities with regulations in place but which have not yet reached their last deadline spikes in 1992, and then gradually tapers off. In fact, the correlation coefficient between the annual average rate of shutdown and the average value of $REGULATION_{it}$ is 0.66. The spike in closure rates in the 1992-1994 period could also reflect the effect of the recession on gasoline demand, property values, and interest rates.[17]

Table 3 outlines the average annual shutdown rate for years in which $REGULATION_{it}=0$, and . It is often suggested that these regulations are more likely to cause smaller outlets to close, so we present the shutdown rates for the entire sample of stations as well as the annual percentage rates of decline in the number of major brands associated with national vertically integrated refiners.[18] The data suggests that the closure rate is higher in years for which the upgrade and removal regulations are in place and that the time period before the first deadline involves more shutdown than in the years between the first and last deadline. This is not surprising given that the first deadlines usually apply to the oldest tanks, which are the most likely to lack protection. Although the shutdown rate in all periods is larger for major brands than other stations, the effect of regulations appears smaller for these firms.[19] Finally, unlike other stations, the period between the first and last deadlines involves as many closures as the period leading up to the first deadline for major brands.

Table 3. Average Annual Shutdown Rate, 1988-2005, By Phase of Regulation

Regulation Dummy	Number of Observations	Average Shutdown Rate	
		All Station Types	**Major Brands**
$REGULATION_{it}=0$	119	1.3%	2.7%
	79	3.0%	4.5%
	18	2.1%	4.7%

The existing literature points to a number of other possible factors influencing the

[17] It is also possible that the publication of the CCME Codes of Practice in 1993 influenced closure rates in a number of provinces.

[18] According to Lederer (1989), "service station sites that do not have through-put of at least one to two million litres annually might find themselves no longer viable with the additional costs. The fact that large majors and regional refiners like Chevron were "lobbying government for more extensive regulations covering the storage of petroleum products" (Lederer, 1998) suggests that these regulations may have represented an opportunity for large firms to force smaller independents out of the industry.

[19] Note that we do not have information on how many stations within a single firm or other subset of firms shut down in a given year. The percentage decline in the number of stations within a single firm or class of firms may also include reductions due to acquisition by other firms.

shutdown of retail gasoline stations. The closure rate in cities with lower profit margins is expected to be higher than in other cities. We calculate the average variable profit excluding fixed costs in city *i* in year *t* as is the average price of regular unleaded gasoline, in real dollars.[20] is the wholesale price, in real dollars.[21] is annual average station volume. In support of this, the correlation coefficient between the annual average rate of shutdown and the annual average profit in the previous year is -0.29 for all stations and -0.22 for major brands, which are significantly different from 0 at the 5% and 10% levels.

Eckert and West (2006) find evidence that market conditions and competition can influence closure decisions. Initial evidence for our sample does not support a role for market structure. For example, the correlations between the closure rate and the concurrent or previous year's three-firm concentration ratio are both 0.04 and statistically insignificant.[22]

In summary, an informal analysis of the data provides mixed evidence regarding the relationship between upgrade and removal regulations and city-level closure rates.

IV. Empirical Model

Retail gasoline operators will choose to close a station if the expected profits from doing so are larger than the expected profits from remaining open. The profits from closing a station are comprised of the expected revenue from reusing or selling the property as well as any costs of

[20] Weekly average prices for each city, computed from a sample of stations surveyed each week in each city, were then averaged to obtain an annual average price for each city in the sample. Leaded prices are used for 1986 because unleaded gasoline prices are unavailable.

[21] Gasoline stations also earn profits on other products, such as tobacco products, and an important role of gasoline sales is in bringing customers to the station to purchase other products. Unfortunately, we lack information on how many stations in a market sell such other products, and to what extent.

[22] There were also a small number of significant mergers and entrants into particular markets that may have lead to closures, for example, ARCO's entrance into and subsequent departure from the Vancouver market. However, these events are closely associated with changes in average profitability and we do not analyze them directly.

closure such as clean-up and remediation. The expected profits from remaining open are the expected revenues from gasoline sales less the expected variable and fixed costs.[23] Therefore, the closure rate in city *i* over year *t* will depend on the proportion of stations in the city for which the expected profit from closing are higher than the expected profits from remaining open.[24]

We estimate the closure rate of city *i* in time period *t* according to the following equation

$$CLOSURE_{it} = f(PROPERTY_{it}, PROFIT_{it-1}, ER_{it}, CR3_{it}, QFLOOR)$$

$PROPERTY_{it}$ is the real average city level residential property price in thousands of dollars in year *t* and controls for city and time series variation in property values. is real average per station variable profit in city *i* in year *t-1* in millions of dollars. ER_{it} is a vector of environmental regulation variables containing , and $REGULATION_{it}$. We estimate two specifications: one containing only $REGULATION_{it}$, and a second which includes only . is the three firm concentration ratio in city *i* in year *t*.[25]

QFLOOR is a dummy variable which is equal to 1 for Quebec City starting in 1997 and controls for any effect that the price floor established in Quebec in 1997 might have had on stations.[26] In order to control for unobserved city-level and annual variation we include city and

[23] Many gasoline stations in Canada also house amenities such as car washes and convenience stores which may influence profitability. Because we are interested in city level variation in closure rates rather than station level closure, we restrict the analysis to gasoline sales.

[24] An alternative approach would be to estimate the number of stations open in each city as a function of profitability, property values, concentration and environmental regulations to determine if the upgrade and removal regulations resulted in a decrease in the number of stations in affected cities. We choose to estimate a model of the change in station numbers rather than the number of stations because it better answers the question we pose. Estimating a model in levels simply asks the question, is the number of stations lower after the environmental regulations. Given that existing academic research and government studies have shown that the number of stations fell over our sample period, labeling the phenomenon as a period of rationalization, this question is not the goal of our study. Rather, we want to know if, during this period of rationalization, the rate of closure was higher during the periods that stations in the cities faced upgrade and removal deadlines. This question is best answered by estimating a model of closure rate.

[25] The model was also estimated using an HHI index. Qualitative conclusions were unaffected.

[26] Carranza et al. (2010) examine the effect that the Quebec price floor on the structure of markets in Quebec cities.

year dummy variables, with Calgary and 1988 acting as our controls.[27]

Finally, we include the lagged closure rate to address autocorrelation in the errors. Including a lagged dependent variable with city fixed effects raises concerns regarding the consistency of our estimates. A number of alternative approaches were taken to ensure robustness of our results, which will be discussed in Section 5.

V. Results

We present the results from our two specifications in Table 4, omitting the city and year fixed effects. The standard errors are Huber-White robust standard errors. Our results suggest that the timing of upgrade and removal regulations did influence closure rates. The coefficients on all three regulation dummy variables are positive and significant at the 5% level. For specification B, the hypothesis that *Predeadline* and *Deadline* are jointly equal to zero is rejected at the 5% level of significance while the hypothesis that their coefficients are equal cannot be rejected at standard significance levels. Therefore, the results suggest that the closure rate is higher for provinces between the adoption of the regulation and the final deadline for upgrade or removal than before or after this period and that in provinces which are not in this period of regulation. As well, the closure rate is higher in both the pre-deadline and between deadlines periods than in other years, with these two sub periods having the same effect on closure rates.

As expected, we find that cities in which real average profits were high in the previous period undergo a lower rate of closure. As well, the higher the level of concentration in the market, the lower is the closure rate. To the extent that cities with higher concentration ratios have a lower presence of independents, this is consistent with the common assertions that independent stations

[27] One possible source of variation is municipal bylaws which can affect the operation of retail gasoline stations.

are more likely to exit in response to the environmental regulations and that the presence of independents precipitated rationalization. We find that the price floor increased the closure rate in Quebec City. Finally, we find no statistically significant effect of average property values on the closure rate. This may be due to our use of residential property values as opposed to commercial values, or may suggest that, with the high costs of reclamation, property values are not a key factor in the decision to close stations.

Table 4. OLS Fixed Effects Results, Closure Rate$_{it}$, N=216[28]

	Specification A	**Specification B**
Variable	**Coefficient (Standard Error)**	**Coefficient (Standard Error)**
Regulation	1.37** (0.53)	
Predeadline		1.41** (0.64)
Deadline		1.35** (0.61)
Profit	-0.12*** (0.04)	-0.12*** (0.04)
Property	0.02 (0.01)	0.02 (0.01)
CR3	-0.14*** (0.05)	-0.14** (0.06)
Qfloor	1.65* (0.86)	1.65* (0.86)
Lagged Closure Rate	-0.23*** (0.08)	-0.23*** (0.08)
Constant	7.11** (3.34)	7.09** (3.39)
R^2	0.3724	0.3725

The coefficient on the lagged closure rate is negative, consistent with the notion that the markets were transitioning from a state of oversaturation to an outcome with fewer stations, so that a high rate of closure in the previous period implies less closure is necessary in the current

[28] *** Corresponds to significance at the 1% level. ** Corresponds to significance at the 5% level. * Corresponds to significance at the 10% level.

period. To ensure that the inclusion of the lagged dependent variable is not affecting our results, we considered a number of alternative approaches to addressing autocorrelation. Arellano and Bond estimators were derived for our model with the lagged dependent variable and all qualitative results remained. The model was estimated with OLS replacing the lagged dependent variable with city specific time trends, and all qualitative results remained. The model was estimated excluding the lagged closure rate and clustering the errors by city, which allows for autocorrelated errors in each city. Our qualitative results remain with the exception that, when errors are clustered by city, the coefficient on *PROPERTY* is significant at the 5% level while the coefficient on *Predeadline* is not significant at the 10% level. However, *Regulation* is still significant at 5% and *Predeadline* and *Deadline* remain jointly significant at the 10% level. Finally, the OLS model with fixed effects is estimated allowing for an AR(1) process in the errors. The coefficient on *Regulation* remains significant at 10%, but *Predeadline* and *Deadline* are no longer individually or jointly significant at the 10% level. Because these approaches rely on large samples, which our dataset does not provide, we report the results from a simple OLS regression with a lagged closure rate.

It is possible the environmental regulations are may be endogenous if provincial regulators take into account the effect that regulations may have on firm closures when they decide their environmental regulations. For example, provinces with cities in which a large level of closure is expected may avoid putting in stricter environmental regulations.[29] If provinces are more likely to pass the regulation when they expect it to have a small impact on shutdown decisions, our estimated coefficient may be smaller than in the absence of such endogeneity. Because our estimated coefficient is positive and significant, we are confident in the qualitative result that

[29] It is also possible that regulators choose to provide later deadlines or to simply not enforce the deadlines in markets in which closure rates are expected to be high.

closure rates were higher during the regulation period. The concentration ratio may be endogenous if the pattern of closure changes the degree of concentration in the market. Given that Sen and Townley (2010) find that Canadian rationalization increased market concentration, we expect the endogeneity to be reflected in a positive association between the closure rate and *CR3*. Because our estimated coefficients on CR3 are uniformly negative and highly significant, we are confident that they are capturing the effect of concentration on closures.

Previous literature and the informal analysis presented in the previous section suggest that the effect of environmental regulations may be different for major brands, regional brands, and independently owned stations. Table 5 presents the results of estimating Specification A on the subsamples of major and non-major brands. Our ability to analyze closure rates for the different station types is limited because our dataset does not differentiate between stations that leave the market and those that change ownership type. For example, when the number of major brand stations falls over the course of a year, we cannot determine whether this station closed permanently or simply transferred to a non-major category. This may explain the insignificance of most of the covariates in the subsample regression.[30]

For major brand stations, the coefficient on *Regulation* is positive and significant at the 1% level suggesting that the rate at which stations owned by major companies are exiting or transferring ownership is higher during the period of regulation than before or after. The coefficient on *Regulation* is not significant in the non-major brand regression. These results are robust to alternative specifications as described above. These findings may indicate that major brand stations are becoming independently owned during the period.[31] It may also be that the

[30]Specification B was also estimated on the two subsamples with no coefficients begin significant at the 10% level.
[31] One possibility is that the major brand company chooses to terminate franchise agreements with stations that pose a potential liability or fail to meet certain company standards and that these stations become independently owned. Unfortunately, data regarding the legal structure governing major brand stations is not available.

costs of closing a station and reclaiming the land are sufficiently high that independently owned stations choose to remain open and perhaps fail to comply with regulations.

Table 5. OLS Fixed Effects Results, Major and Non-Major Brands, Closure Rate$_{it}$, N=216

	Major Brands	**Non-major Brands**
Variable	**Coefficient (Standard Error)**	**Coefficient (Standard Error)**
Regulation	3.00*** (0.89)	-0.61 (1.03)
Profit	-0.07 (0.07)	-0.19* (0.10)
Property Value	0.01 (0.02)	0.02 (0.02)
CR3	-0.13 (0.14)	-0.13 (0.12)
Lagged Closure Rate	0.04 (0.08)	-0.01 (0.06)
Constant	5.82 (8.31)	8.10 (7.45)
R^2	0.2178	0.2072

VI. Conclusions

Previous explanations for rationalization in the Canadian retail gasoline industry focus on what is above the ground: changes in demand and cost, the expansion of independents, and market concentration. In this paper, we exploit provincial variation in UST regulations to examine the role that changes in these regulations may have played in the rationalization. We find evidence closure rates were higher in cities and years in which stations were required to upgrade or remove unprotected storage tanks, suggesting that, the pattern and degree of rationalization in Canadian markets was influenced by environmental regulations.

Our results are in contrast to existing studies of the role of environmental regulations on exit choices in other industries. Specifically, List *et al.* (2004) find that environmental regulations had no effect on plant closures while Biorn *et al.* (1998) find that regulations decrease the probability of closure. The difference may be that our study focuses on an industry that was facing other pressures to rationalize and the adoption of upgrade and removal regulations simply altered the pattern and degree of shutdown rather than causing closure in an otherwise healthy industry. On the other hand, Yin *et al.* (2007) find evidence that UST regulations caused closure of retail stations when stations were not facing the same pressures to rationalize. As such, the magnitude of compliance costs may also explain why the upgrade and removal requirements increased closure rates, suggesting that if compliance costs are high enough, environmental regulations can impact exit decisions of regulated firms.

Our results have implications regarding the effect that environmental regulations have on regulated markets. Sen and Townley (2010) find that rationalization led to increased prices and concentration in Canadian retail gasoline markets. Taken together with our results, this suggests that the upgrade and removal regulations may have had implications for concentration and profits in retail gasoline markets, outcomes of importance to antitrust cases.

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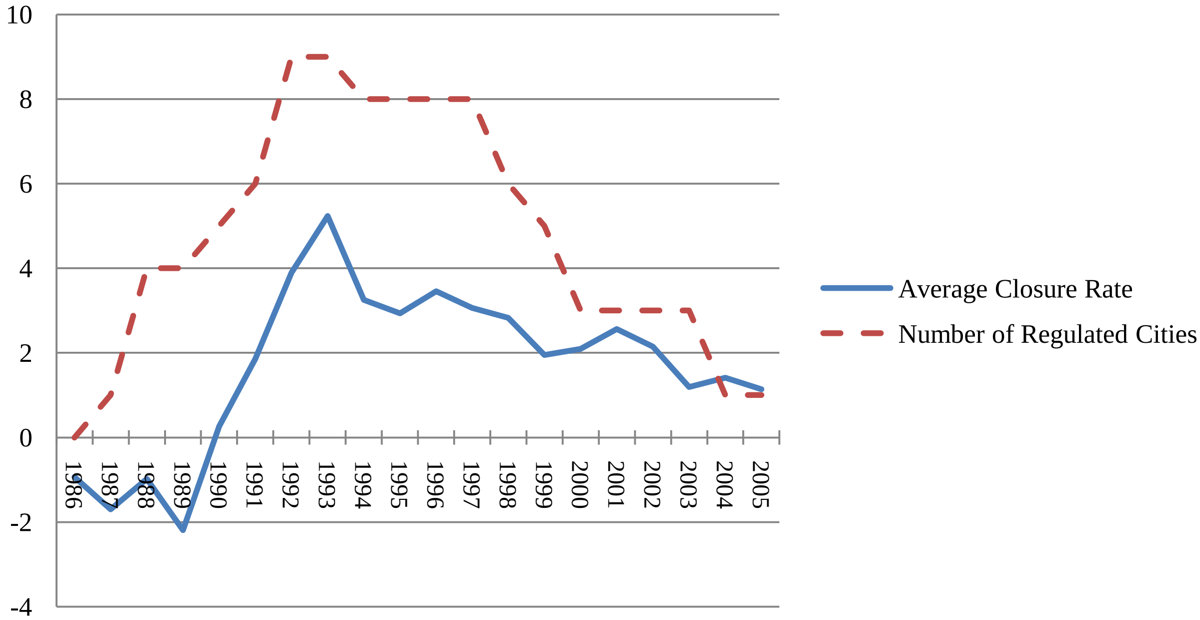
Figure 1. Annual Average Closure Rates and the Number of Cities for Which $REGULATION_{it}$ = 1, 1986-2005



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