ESSAYS ON THE EFFECTS OF MARKET REGULATION

BY

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DISSERTATION

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Abstract

This dissertation studies the effects of price regulation on the entry, exit and pricing decision of firms. I concentrate on the retail gasoline industry in Argentina. I study how the price regulation in place from 2004 to 2007 has affected the number of gas stations in the market and the price level after the regulation was eliminated. I approach the problem in two steps: firstly I study how the price regulation affects the entry and exit decision of firms, and secondly I study if the entry and exit decisions affect the price level once the regulation is removed.

In the first chapter I discuss a topic rarely present in regulation analysis: the effects of price regulation on the exit rate of different types of firms. Regulation studies usually focus on the efficiency and welfare consequences of regulation, but rarely on the consequences on individual types of firms. Using a discrete time survival model with time dependent covariates, unobserved heterogeneity at the firm level and a flexible proportional hazard I show that the price regulation had a non-neutral effect on the exit rate of different type of firms. Smaller firms were more likely to exit because of the price regulation. Those gas stations that belong to vertically integrated companies were more likely to survive. The exit likelihood was on average three times higher for independent gas stations and gas stations that belong to small, non-vertically integrated chains than for gas stations affiliated to vertically integrated chains. Smaller players compete mostly through prices, rather than quality or other non-price variables, so their exit may have effects on the degree of price competition and the price level in the market.

I study this question in the second chapter. I analyze the pricing decision of gas stations in Argentina using a dynamic price panel to model the retail prices under two different settings. During the first part of the sample period, firms were constrained by a maximum price imposed by the government. During the last half of my analysis firms were free to set their own prices. I find that during the regulated period prices and margins were, not surprisingly, very stable. Margins were low and there was a net exit of gas stations, particularly independent, non-vertically integrated ones. After the regulation was eliminated prices and margins increased, which is consistent with fewer firms in the market, reflecting possibly local market power.

This result may help explain why bigger firms were not opposed to the regulation when it was established, they may have anticipated the exit of smaller players and the lower degree of price competition when the regulation would be eliminated.

To Mariedisa, Ines, Ticiana and Julio, you are the most important persons in my life.

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Chapter 1

Shutting Down the Pump: Exit in the Argentine Gas Station Market

1.1 Introduction

In this paper I use a discrete time duration model with time-varying covariates to study the effects of price regulation on the exit rates of two different types of gas stations in Argentina. Using an unbalanced dynamic panel I estimate the exit hazard rate for gas stations that belong to (i) big, vertically integrated brands and (ii) small chains or that are not affiliated to any brand. During the first half of the sample period retail gasoline prices were regulated by the government while during the second half gas stations were free to choose the retail prices. I find that the exit hazard for the small type during the price regulation was significantly higher than the hazard rate for the vertically integrated gas stations and that it was significantly higher than the hazard rate of both types under no price regulation. I can say that the price regulation had a non-neutral effect on the exit rate for the two types of firms. Small, independent gas stations were more at risk of exiting during the regulation phase, which affected future market structure at the retail level.

Retail gasoline prices and margins are almost all the time in the public agenda. The market structure that generates them, not so much. Gasoline prices are a sensitive topic for the public and public officials worried about remaining in office. Each oil crises generates pressures to regulate prices as in the U.S., Canada or Mexico in the 1970s. The price spike generated by the Gulf crisis in 1991 originated initiatives in the U.S. Congress to reintroduce a price regulation on gasoline (see Deltas 2008 for the details). However, the public debates aim at discussing the price levels, not to the underlying market structure of the gasoline industry.

What if the attempts to regulate current prices have impacts beyond reducing the present retail gasoline price? What if the proposed consumer protective regulation had long lasting effects on market structure, even after the regulation was eliminated? If current price regulations have an effect on future market structure, the present benefits of lower retail prices should be weighted against the future equilibrium prices. It is possible that some future market structures feature higher prices than the prices that had been in place under the pre-regulation market structure. These possible higher future prices might generate additional pressures to regulate the price. As a consequence we would observe cycles of regulation and deregulation. This is not far from what we can observe in many countries. The U.S. is an actual example. So is Argentina, where gasoline prices were regulated for most of the 1970s and 1980s, deregulated during the 1990s and the beginning of the 2000s and then regulated again from 2004 to 2007, only to be once again deregulated by 2008.

The literature on (de)regulation focuses on the effects of deregulation upon once concentrated industries such as commercial airlines (Kahn 1988, Borenstein 1992), freight railways (Boyer 1987, Wilson 1994) or cable television (Rubinovitz 1993). The empirical literature studied the effect of deregulation on various topics, but its main focus was on price levels and price dispersion, service quality, wages and employment, industry profits and entry (Winston 1993).

However, this literature takes regulation as given and analyses how an industry changes once it is deregulated. Even though it tries to disentangle the effects from deregulation from the effects of other factors such as economic shocks, in very few cases the analyses consider how the former regulation had an effect on the way industry would react to deregulation.

To the best of my knowledge very few papers on deregulation analyze the effects of (previous) market regulation on shaping the industry structure by the time of deregulation, which may affect the way the industry receives the deregulation and how incumbents (and potential entrants) react under the new rules. An exception is Eckel and Goldberg (1984) who analyze the behavior of the beer industry in Canada. Another is Knittel and Stango (2003) who study whether price regulation can induce collusive behavior arguing that regulated firms can use the pre-announced, regulated price as a focal point for tacit collusion. The authors also present a case in which this collusion can be sustained after deregulation. Borenstein (1992) presents a very detailed analysis of entries, exits and merger in the airline industry, but he does not concentrate on how the former regulation determined the industry structure by the time of deregulation.

Moreover, the nature of deregulation in industries such as airlines, railroads or telecommunications differs from the one in the gasoline industry. Gasoline prices are regulated by maximum prices that are supposed to protect consumers from artificially high prices, from prices that are high for reasons other than costs. On the other hand, prices in most U.S. regulated industries were established by a regulator who many times was believed to protect producers.

The contribution of my paper is two-fold. First I analyze the effects of a price regulation on shaping the industry structure by the time of deregulation, which in turn may affect the way the industry receives the deregulation and how incumbents (and potential entrants) react under the new rules. I study entry and exit dynamics both during and after government regulation. The regulated period in my sample presents significant variations in entry and exits, as opposed to regulation in most U.S. industries where multiple entries and exits were rare. This variation allows me to analyze the effect of price regulation on the entry/exit pattern of different players across different geographical markets.

Second, I analyze the effects of price regulation at the retail unit level. I have detailed data at the gas station level that allows me to determine the effects of regulation at the individual level, rather than at more aggregate levels such as industry-wide, company average or regional markets.

The results show that after the price ceiling was removed, (i) there were fewer gas stations overall and (ii) exit was not neutral, certain chains were clearly more at risk of disappearing. In particular, small independent retailers and non-vertically integrated small chains faced a risk of closing about 3 times higher than the bigger, vertically integrated producers. These small retailers were considered a key factor to foster the competition in the retail gasoline market (CNDC, Argentine Antitrust Authority 1998, Hastings 2004) so a natural question is whether the disappearance of these producers changed the way firms behaved in the retail gasoline market (to be addressed in the second chapter of this dissertation).

The second section of this paper discusses the reasons for price regulation and the background of the Argentine government intervention. The third section describes the data and key industry trends. Section four presents the empirical strategy. It discusses various alternative duration models and their validity for the gasoline industry. Section 5 contains the results and section 6 concludes.

1.2 Background

1.2.1 Who benefits from regulation?

In a perfectly competitive market there are no apparent reasons to regulate market prices. Equilibrium prices are Pareto optimal and they imply an efficient allocation of resources.

The need for regulation comes from market imperfections such as the existence of market power or externalities or information asymmetries that prevent the equilibrium to be a Pareto optimum. In the case of existence of market power, regulation usually place limits on the prices to limit the use of this market power by incumbent firms.

The objective of the regulation is to replicate the first best equilibrium that may not be achieved due to the market imperfections. Government regulation was expected to correct the inefficiencies due to market failure and to improve society's welfare. The existence of market power would generate prices above the social optimal prices, so it is necessary to regulate prices to set them at the competitive level in order to achieve the social optimum.

However, regulation is not necessarily implemented by a benevolent, welfare maximizing government. Governments create regulatory authorities that may have their own objectives and/or may be captured by interest groups. Collective action can be used to capture the regulator, which is acquired by the industry and is designed and operated primarily for its benefits (Olson, 1965). According to this view, regulation is designed to protect producers (Peltzman 1976), thus the correct generalization seemed to be that regulation served the producer interest either by creating cartels where they would otherwise not exist or by failing to suppress monopoly (Jordan 1972).

A big body of the literature on regulation and deregulation of industries in the US focus on industries that were regulated to (in principle) the benefit of producers.

It is worth noting that the oil industry was a notable exception within the regulated industries. The oil industry regulation featured price caps, which were not in place to protect producers by securing high profits or preventing entry into the industry (Peltzman et al. 1989, Winston 1993). This regulation was supposed to protect consumers by establishing a limit to otherwise artificially high, non-competitive prices.

Even though this type of regulation seems not to fit into the theory of regulatory capture, this is not necessarily the case. While Olson claims that is the industry that captures the regulator, the model of regulatory capture (Stigler 1972) states that the regulator can be captured by interest groups, who in principle can be any group well organized. It is generally assumed that interest groups refer to suppliers, since they are a more compact, relatively more organized group than consumers (Becker 1983), but there is another factor that enters the equation: the pressure the government receives from consumers. If the pressure on market prices is heavy enough, as it could have been in the US following the oil crises of the 1970s, the harm to consumers of not designing a regulation to protect consumers could have outweighed the lobby capacity of the industry (Peltzman 1989). In the eyes of the politician who wants to remain in power, the political cost of not protecting consumers is so high that it more than compensates the political benefits of pleasing the industry lobby.

In Argentina the gasoline market has great political and economic importance. Gasoline prices affect the inflation rate both directly, through higher prices for all types of drivers and indirectly, affecting the cost structure in all other markets in the economy. In particular, is very important for the agricultural sector and its competitiveness: it's a key input in the cost structure, since all tractors, trucks, etc. used in the crop and distribution use gasoline. The political and economic relevance of this market historically attracts government attention. All governments of all political parties follow closely the gasoline market, whether or not they directly intervene in the market.

In 1996 the Antitrust Authority in Argentina initiated an investigation to determine if firms in the gasoline market acted in a coordinated way to intentionally raise prices above the non-cooperative levels. The concluding Report (CNDC, Argentine Antitrust Authority, 1998) found no direct and incriminating evidence of tacit collusion but suggested imposing limits on vertical contractual relations, in particular it limited the number of years a non-company owned station could be in an exclusive relationship with a wholesale brand. [1] For some years this vertical restriction was the only regulation in place in the Argentine gasoline market.

By 2004 the price has increased to unacceptable levels to the government. Fearing political costs and aware of the influence of the price of gasoline in all other prices of the economy, the government decided to regulate gasoline prices. The formal argument was that market concentration, jointly with the observed retail price well above the import parity proved there was a non-competitive conduct.

1.2.2 The mechanics of the Argentine price regulation for gasoline

Strictly speaking, there was never a law, decree or direct mandate from the government that explicitly set a (fixed) maximum price. The institutions of the price ceiling were more subtle, and even though they were never been written anywhere, they were respected by all players (see the retail price series in section 6 below) in all markets. Of course without rules, one may wonder what incentives firms have to respect the regulation. There actually were some incentives.

First, all firms sign voluntary bilateral agreements with the Government, in which they committed to maintain the prices at the pump. Since these agreements were voluntary, there was no punishable enforcement, the Government never issued a set of rules establishing what would happen if those agreements were not respected, but unofficially the firms that were suspected of deviating, or intending to deviates, received more visits by inspectors of the tax revenue enforcement office (AFIP). In second place, the government established export quotas for crude oil and its derivatives which had a huge impact on the business of the biggest players in the market, who owns many of the concessions to explore and extract petroleum in Argentina. These quotas were flexible, could be relaxed to a certain extent, if the firms proved to the government they maintained the prices in the domestic market. For these big firms, maintaining the ability to export crude oil during a period of increasing oil prices was more important than trying to increase the price of retail gasoline in the domestic market. Finally, there were direct government actions against the firms that didn't show an understanding of the situation. As an example, in 2004, when Shell was not sure about abiding by the policy, the President of the country made public appearances during the prime time,

[1] In Argentina, wholesale brands are the most important players, which are vertically integrated along all the production chain. The four biggest brands own all the refineries of the country, have wholesale distribution units and own many of the gas stations.

in national television, and with ads in the main newspapers of the country, calling the population to boycott all Shell products.

Again, this was a *de facto* price regulation, but it was a successful one. The series of domestic retail gasoline prices shows a remarkable stability from the beginning of the sample, Dec. 2004, when the price cap was in place, to July 2007 when the regulation was abandoned by the government. Even though retail gasoline prices were not formally regulated, the informal regulation was as effective as a formal one in constraining the market prices.

Was the regulation endogenous?

Since it was a *de facto* regulation, signed voluntarily by the oil companies, it is worth asking if the regulation was endogenous (that is, self-imposed by the companies) rather than exogenously established by the government. The answer to this question is not trivial and it has clear implications for the analysis. If the regulation was in fact endogenous, the findings of this paper would be biased by the fact that it is not the regulation per se that impacted the small independent gas stations.

I will argue that the regulation was exogenous. In the first place, it was imposed in a context of an increasing international crude oil price which translated into higher local prices. A higher local price for gasoline has negative political and social implications, as discussed above, and has a non negligible impact on the inflation rate, which the government was trying to control at the end of 2004. The government had incentives to impose a price regulation for political reasons.

In the second place, companies did not have reasons to accept willingly a price regulation. The increasing international crude oil price put incentives to export oil products rather than selling them in the domestic market. The way to accommodate those potential higher exports in the local market, other than big increases in production that never occurred, was to increase prices to ration the lower domestic quantity sold in Argentina. Companies had no incentives at all to ration their exports to satisfy the domestic demand at the prevailing local prices.

In the third place, the initial acceptance of the regulation was not unanimous. Shell, one of the four big players, did not accept the regulation and publicly criticized the regime. In reply, the government cut Shell's permission to exports and made a public campaign in national media to induce a boicot on Shell products. After this, Shell complied and accepted the regulated prices in its gas stations.

Finally, there was an exit clause in the regulation. This exit clause was a concession of the government to the companies, to induce them to accept the price regulation under the promise that if the international crude oil price increased above a certain level they would not be regulated any longer. The regulated prices would prevail in the domestic market until the crude oil price reached 75 US Dollars. When that happened, the regulation would be lifted and companies would be allowed to adjust their local prices to the new, higher international price. The government reserved the right to impose a new regulation (possibly at a higher regulated price) but this never happened. When the price reached 75 US Dollars in 2007 and it was clearly continue to increase in the future, the regulation was abandoned. Interestingly, the crude oil price fell sharply by the middle of 2008 and was well bellow the 75 US Dollars threshold, but the companies did not ask for another round of regulation.

For all this reasons, I can say that the price regulation was exogenous and not self-imposed by the companies.

1.2.3 Who benefited from gasoline price regulation in Argentina?

Who wins and who looses with a particular industry regulation should be carefully evaluated. Market imperfections may make market regulation desirable, but as explained before, regulation cannot be expected to improve imperfect market outcomes without further analysis. The theories outlined by Stigler, Peltzman, Becker and others suggest that the regulatory policy is an arena where the interests of different groups fight to impose their views on the regulator and to shape the laws governing the regulation. A regulatory regime will clearly influence market prices and entry and exit patterns and so it would directly affect the interests of the parties involved.

At the same time, the capture theory views consumers and producers as rather *homogeneous* groups trying to successfully influence the policy making process. However, is it fair to assume that consumers and producers are homogeneous groups? If they are not, can certain producers be more inclined towards certain consumers' interests than to those of the other producers, and viceversa?

As discussed before, many authors pointed out that the oil industry regulation seemed to side with the interests of consumers, since the price cap prevented market prices from being as high as they would have been in a free equilibrium. Is it really so? This questioned should be answered taking into consideration that consumers and producers might not be homogeneous groups and that the regulation may have both short-term, static effects and long-term, dynamic effects.

While consumers can be considered homogeneous with respect to the consumption of gasoline, producers are not homogeneous in Argentina. I can reasonably split them in two groups, based on the following characteristics: (i) vertical integration, whether gas stations belong to vertically integrated brands who refine, distribute and sell gasoline or just sell gasoline at the retail level and (ii) national presence, whether gas stations belong to a brand with national presence or to a brand who owns just a few gas stations in very few local markets. The first types of firms are the big players, the four brands that jointly have 75%

of the market, have national presence and are vertically integrated. All of them own refineries and national distribution networks and three of them own extraction facilities. The second type groups the small players: independent gas stations which are not affiliated with any brand and small chains with only a few gas stations present in just a few local markets. Gas stations or chains in this group are not vertically integrated, they do not own distribution networks and their only activity is to sell gasoline at the retail level.

Let us consider now the static and dynamic effects of the price regulation for the consumers and the two types of sellers. In the short term, a successful, under the market equilibrium price cap could generate a shortage of gasoline. In this scenario, there are two types of consumers: the ones who get the gasoline at the regulated price are better off, but there might be others who could not get gasoline who would be worse off. Additionally, some consumers may incur bigger costs in order to buy gasoline: if there is a shortage, some gas stations may not have gasoline at all times, so consumers would need to incur in bigger search and transportation costs in order to get gasoline. These bigger costs might offset some of the gains from the lowered, regulated price. To sum up, unless the shortage is significant, most of the consumers would enjoy the lower price (possibly by incurring higher costs to get the gasoline) and they do not have a reason to complain or pressure the government to eliminate the regulation.

Producers, on the contrary, are worse off. They are forced to sell at the reduced, regulated price so sales and profits are lower, for all of them. From a static view point, all sellers have incentive to exercise pressure on the government to remove the regulation.

However, the current price regulation may have effects in the long run, even after it had been eliminated. If this is true, a static setting may not tell the whole story. A dynamic setting allows uncovering long-term effects on consumers and heterogeneous producers. I will argue that in the long run, big producers benefited from the regulation, while small sellers were hurt. The price regulation generated a net exit of small independent gas stations that are known to be a key ingredient in fostering competition in the retail gasoline market (Hastings 2004, Verlinda 2008). This net exit of small players could have permanent effects on the competitive pressure in the gasoline industry, which in turns affects prices and profits. Of course, the lack of competitive pressure, higher prices and the negative effects on consumer welfare should not be taken for granted but rather studied and verified. This will be the topic for the second chapter of my dissertation. For now, I will limit the analysis to the effects of the price regulation on the entry/exit pattern of different types of sellers and state that the net exit of small players during the regulated phase planted the seed for possible non-competitive behavior and higher prices once the regulation was eliminated.

In this scenario, it would not be surprising to see big, vertically integrated players favoring the price regulation. If these type of firms could correctly anticipate the exit of the small competitors from the market, it would be in their best interest to favor a price regulation. While in the short term they are hurt by the regulated price, the future benefits of lower competition, higher prices and higher profits may be worth supporting the regulation at the beginning and enduring temporary losses. On the other hand, small producers would have all incentives, both static and dynamic, to strongly opposed to the price limit.

Actually, something along these lines was observed in Argentina. Three out of the four big players did not oppose the regulation, and even though they had no formal obligation to comply with the maximum suggested price, they quickly accommodated their prices to the government suggested levels. The fourth player complained during the first two months, but it complied after that, possibly because after all other big players accepted the regulation, it would not be optimal to be the only player who did not follow the crowd. Small players, on the other hand, repeatedly and actively complained in the news media about shortages through their corporate institution, the Argentine Federation of Retail Sellers of gasoline (Federacion de Expendedores de Combustibles de la Republica Argentina, FECRA).

Figure 1.1 show the total number of gas stations during the complete sample period. It can be seen that the number of gas stations diminishes continuously from the beginning to the end. However, the decline is slightly smaller after the regulation was eliminated. Figure 1.2 illustrates the dynamic effect of the price regulation discriminating by types of gas stations. Figure 1.2 depicts the proportion of gas stations in the market, by month, as a percentage of the number of gas stations at the beginning of the sample, for each type of player. It can be seen that while the total number of gas stations went down across all the sample period, the exit rate is significantly higher for small, independent gas stations during the regulated phase.

Figure 1.1: Total number of gas stations

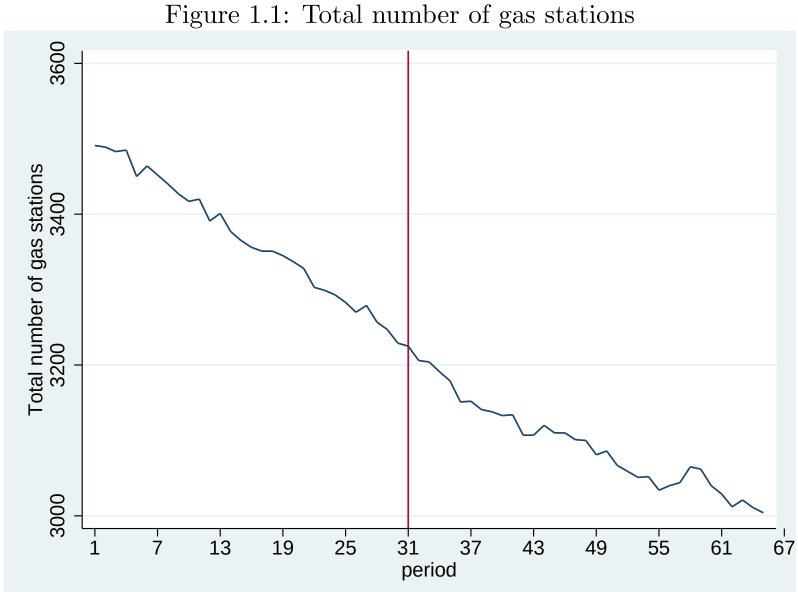
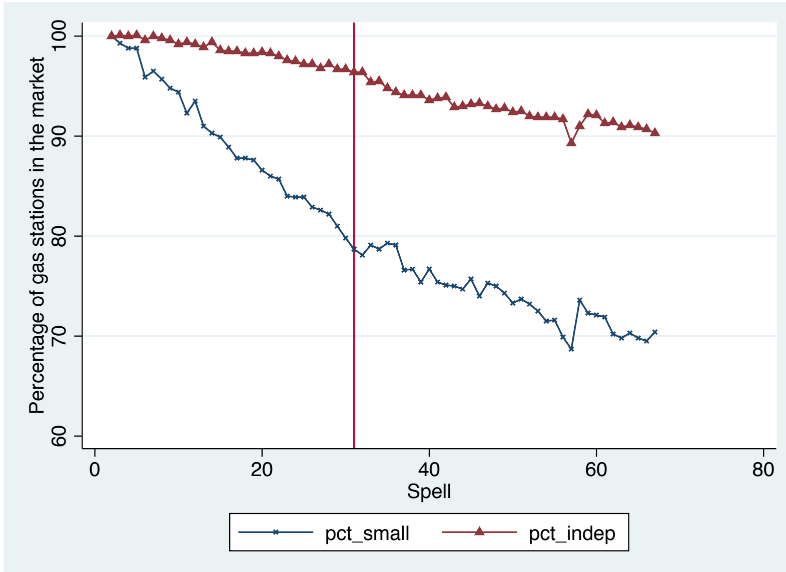


Figure 1.2: Proportion of gas stations in the market



At the beginning of the sample, in January 2005, there were 764 small gas stations and 2,727 vertically integrated gas stations. By the end of the regulated phase, in July 2007, there were 597 small gas stations and 2,621 integrated ones. These means there were 167 fewer independent gas stations and 106 fewer gas stations that belonged to the big players. The decrease in the number of gas stations was bigger for the small group in *absolute* levels, in spite of representing 30% of the market, compared to the 70% of the big players. During this phase, the exit rate of the independent brands was 22% and the exit rate of the big brands was only 4%. While the exit trend continued for both groups after deregulation, the exit rate of small players was significantly smaller once the regulation was removed. After the regulation demise, an additional 8% of the independent gas stations exited the market (59 gas stations) while another 6% of the big brand gas stations closed their business. After the regulation was removed, exit rates seemed to be similar while during the regulation, the difference in exit rates was notorious. These trends do not necessarily prove that the regulation was the cause of the exit of small gas stations, but it is a fact that deserves to be analyzed.

1.3 Data

1.3.1 Data description and variable definitions

I have data from most of the gas stations in Argentina[2], collected monthly by the Secretaria de Energia

[2] RES SE 1104/2004 requires all gas stations to submit the information, however, the information is self-reported, therefore I can't be completely sure that all gas stations submit their forms. That's why I claim to have information on most gas stations, rather than all gas stations.

from December 2004 to August 2010, that is, 69 consecutive months. All gas stations have to submit a form with the information required by the ordinance RES SE 1104/2004. If the owners of the gas stations do not submit the form for the corresponding month, they have to do it by the end of the following month or they face penalty fees.

The database contains, for each gas station, its legal name, the brand of the gasoline they sell, if any (they are considered independent if they don't sell any particular gasoline brand), the physical address with city and province and the date of closing business for those gas stations that exited the market.

I have the prices, in ARG pesos, for the following products and markets: gasoline with less than 92Ron, gasoline between 92 and 95Ron and gasoline with more than 95Ron, sold to the public, to the agricultural sector or to the transportation sector, either passengers or freight. The distinction between markets is relevant because the agricultural and transportation sectors receive their gasoline with a subsidy from the Federal Government: the gas station receives a lower price form these customers and then has the right to pay a lower price to the wholesale distributor, which in turn receives the compensation from the government.

I will concentrate on the market for gasoline between 92 and 95Ron sold to the public since it's the bigger market. Only old cars use gasoline with less than 92Ron and the main player in the market, Repsol-YPF, has announced on April 2011 that it will discontinue the production and commercialization of this type of gasoline starting on July 2011. The gasoline with more than 95 Ron is used mostly by the newest vehicles and it's a new product. It was developed and commercialized in a big, national scale only after 2007, and I can't track sales and prices for this product from the beginning of the sample. The sales to the agricultural and transportation sectors are not included in my final sample since only a few gas stations agreed to the system, about 300 of over 4000, and their exit decisions may differ from the rest.

I chose to start the sample period in January 2005 rather than in December 2004 since the latter month was the first month when gas station owners had to submit the information. As a consequence, I expect that many existing gas stations that were not familiar with the ordinance didn't submit the corresponding form. To avoid the problem of wrongly consider as entrants in January 2005 at these old gas stations, I prefer to start the sample period in January 2005. For the same reason, I dropped the last month of the sample. I don't have a way to determine if a gas station that is in the market in July 2010 but not in August 2010 actually exited the market or just didn't turn in the form in August. There were 3,065 gas stations present in July 2010 and 3003 in August 2010, that is, 62 exits, which is a much higher exit rate than in the previous months (3,085, 3,078, 3,073 for Apr., May and Jun. respectively). Probably part of these "exits" are gas stations that didn't send the information, so they are not in the sample, but they are in the market.

There were 3,477 gas stations in December 2004 and 3,569 gas stations in January 2005, that is, a net

Table 1.1: Number of gas stations by company

	Levels			percentages	
Brand	Jan-05	Aug-10	Net exits	Jan-05	Aug-10
REPSOL-YPF	1,581	1,461	120	34.4	37.6
SHELL C.A.P.S.A.	813	655	158	17.7	16.9
INDEPENDENTS	773	569	204	16.8	14.6
PETROBRAS	600	528	72	13.1	13.6
ESSO PETROLERA ARGENTINA S.R.L	507	467	40	11.0	12.0
SOL PETROLEO	149	102	47	3.2	2.6
RHASA	71	15	56	1.5	0.4
REFINOR	61	63	-2	1.3	1.6
ASPRO	10	10	0	0.2	0.3
DAPSA S.A.	8	3	5	0.2	0.1
CIS	7	1	6	0.2	0.0
PETROLERA DEL PLATA	7	3	4	0.2	0.1
CAMUZZI GAS DEL SUR	2	2	0	0.0	0.1
AGIRA	1	2	-1	0.0	0.1
CONOR	1	0	1	0.0	
FOX PETROLEO	1	0	1	0.0	
CAP	0	2	-2		0.1

entry of 92 gas stations. I don't observe that many net entrants at any other time during the observed period, so I have to assume that these are not all entrants to the market but rather existing gas stations that didn't submit the information because of lack of familiarity with the ordinance of the Secretaria de Energia. There were 3,003 gas stations in August 2010, what means a net exit of 16% of the gas stations in the market (14.5% against the 3,065 gas stations in July).

I observe 19 different players in the market over the sample period, considering all the independent gas stations as just one player. Two companies left the market, closing or selling all their gas stations. Another company that did not exist in January 2005 entered the market, but it is a very small company with only two gas stations. There are four big firms: Repsol-YPF (formerly State-owned), Shell, Petrobras (the main company in Brazil) and Esso (subsidiary of Exxon-Mobil), that account for 80% of the market and are vertically integrated. All of them have at least one refinery in Argentina and Repsol-YPF, Esso and Shell also extract petroleum in the country.

I will consider that all gas stations present in January 2005 entered the market at $t = 0$. The longest possible spell for these gas stations is $T = 67$, if they did not exit by July 2010. If a gas station entered the market after January 2005, I will consider it as an entrant of period t, $t = 1, ..., 67$. The longest possible spell for these new entrants is $T = 67 - t$, if they are still in the market in July 2010.

I have 292,632 observations in the original sample and after eliminating the problematic observations I end up with 4,592 gas stations, 1367 exits and 226,821 time-at-risk observations, including entrants after January 2005. However, there is a very important problem: I have no data before Dec. 2004, so for the

Table 1.2: Variable definitions

Variable	Definition
marketsz	market size: population in the city
Educ	% of inhabitants with highschool completed
Poverty	% of households built with durable and resilient materials
LnN	natural log of N, the number of gas stations in the city
density	density of gas stations
Indep	indicator, equal 1 if gas station is independent
Esso	indicator, equal 1 if gas station belongs to Esso
Petrob	indicator, equal 1 if gas station belongs to Petrobras
Refinor	indicator, equal 1 if gas station belongs to Refinor
Repsol	indicator, equal 1 if gas station belongs to YPF - Repsol
Rhasa	indicator, equal 1 if gas station belongs to Rhasa
Shell	indicator, equal 1 if gas station belongs to Shell
Sol	indicator, equal 1 if gas station belongs to Sol Petroleo
xx-interv	interaction term, equal 1 if gas station belongs to brand xx during price intervention
vi	indicator, equal 1 if the brand is vertically integrated
refinery	indicator, equal 1 if the brand owns a refinery
highwy	indicator, equal 1 if gas station is on a highway

gas stations that are in the market at the beginning of the sample, I have no way to follow them *before* the sample begins. This is crucial when trying to estimate the baseline hazard. Without previous information, I have to assume that the baseline hazard is constant across periods. This is a very restrictive and arbitrary assumption. On the other hand, I will try to estimate a flexible baseline hazard, using cubic splines, which is a way to mitigate the strong assumption imposed by a parametric functional form. To compare the results obtained under the flexible specification with the results of a pure, neat model, I need to concentrate on the gas stations that entered the market starting in Jan 2005. I can track all these gas stations for their entire life, so I don't have to make strong assumptions about the baseline hazard. After dropping the existing gas stations at the beginning of the sample, I have 775 gas stations, 230 exits, 66 periods and 26,156 time-at-risk observations. I loose many observations in this step but if the results are similar, I can extend the interpretation to the results obtained with the bigger sample.

1.3.2 Industry trends and stylized facts

It can be seen that independent gas stations suffered a lot more than the gas stations of big players during the regulated phase (see Table 1.1). Their exit rate was 22% compared to only 4% of the big players. It remains to be seen if this pattern is not associated to factors other than the price regulation, such as market concentration or market size. Smaller gas stations might have been located relatively more in smaller, non-profitable markets, or on more competitive markets where the competitive pressure was too much for them to survive.

Table 1.3: Survival rates

Market type	Monopoly		Oligopoly		Competitive	
Date	Indep.	Big players	Indep.	Big players	Indep.	Big players
Jan. 2005	100	100	100	100	100	100
Jul. 2007	82.9	103.1	75.9	96.8	68.4	88.7
Jul. 2010	80.4	102.6	70.5	89.1	59.6	77.3

In order to study in more detail why small players faced such a threat during the price regulation, I analyze the trends by markets, classified by size and by number of players. Market size is a strong predictor of the total demand for a market and in particular it will allow identifying small, isolated, possible non-profitable markets. The number of players can be used as a proxy (although imperfect) for the competitive pressure. I would expect that monopolies faced no or very little competitive pressure (other than from the threat of potential entry) while I would expect competitive markets to be the most difficult to survive. The situation is more difficult to assess for oligopolies. Many equilibria are possible and it is hard to predict exactly how competitive they are.

I define each type of market empirically. Markets with one gas station are monopolies by definition so these are easy to identify. I will also consider monopolies those markets with either two or three gas stations, if *all* of them belong to the same brand. However, if those two or three gas stations are independent, I will not consider the market a monopoly. Even though I consider the independent players as one group for the purposes of the regressions, I still consider them competitors in individual markets. Markets with more than 20 gas stations are considered competitive markets. While this cut-off is somewhat arbitrary, markets with more than 20 gas stations have presence from all big brands and almost all of them have independent players, and this is as competitive as it can get in my sample. The rest of the markets are, by default, oligopolies. The definition of oligopoly is somewhat loose here, reflecting that these are markets that are not monopolies, might be very competitive but also might experience collusive prices.

According to these definitions, monopolies have a median of 1 gas station and about 7,200 inhabitants, competitive markets have a median of 64 gas stations and 560,000 inhabitants and oligopolies have a median of 9 gas stations and 59,000 inhabitants.

Although with different degrees, the same pattern is present across all market types: small, independent gas stations were significantly more at risk of exit during the regulated period. They did better in monopoly markets, as it would be expected [3], while the exit in oligopolies resembles the whole sample average (75.9% survival rate in oligopolies vs 78.1% in the whole sample by the end of the regulation, 70.5% vs 70.4% by

[3] In my case monopolies seem to be natural monopolies: very small markets where there is place for only one supplier. Monopolists may survive then by a combination of being the only player and enjoying market power jointly with being in a small market, which reduces potential profits but also reduces the attractiveness of the market to other potential entrants.

Table 1.4: Exit rates in monopoly markets

Market type	1 station	2 or 3 stations, 1 brand	2 or 3 stations, more than 1 brand
Regulation	-4.2	8.8	17.8
Free market	0.7	0.8	6.4

the end of the sample period). In competitive markets, on the other hand, independent gas stations had their toughest times. By the end of the price regulation only 68.4% of these gas stations had survived and by the end of the sample about 60% were still in the market.

However, given my definition of a monopoly, it is interesting to separate the results for those pure monopolies, markets with just one gas station, from monopolies with two or three gas stations, all belonging to the same brand. Moreover, it is worth analyzing if there are differences in markets with two or three gas stations but with just one brand from other markets with two or three gas stations, but from *different* brands. In my sample, there are 275 pure monopolies, that is, markets with 1 gas station. There are 577 markets with two or three gas stations, of which 383 have only one brand and 184 have more than one brand. Table 1.4 shows the net exits by type of market and period.

Pure monopolies have the fewest exits, in all settings. During the regulated phase, gas station in pure monopolies actually exhibit a net entry (negative net exits). By July 2007, there were 4.2% more gas stations in one-station-markets than at the beginning of the sample period. Markets with two to three gas stations, but with a brand-monopoly, had net exits: 8.8% of the gas stations had exited the market by the end of regulation, while markets with two or three gas stations from different brands exhibit the highest exits: 17.8%. After the regulation the relative order is not altered, however the numbers are different. Pure monopolies now show a very low net exit, almost the same as markets with two or three gas stations from a unique brand. On the other hand, oligopolies with two or three gas stations show a net exit of 6.4% of the gas stations present in August 2007. It can be seen from these results that net exits are higher in (small) markets with more than one brand.

It is worth noting that while the exit rate for the small players is relatively higher in competitive markets, oligopolies exhibited a higher absolute number of exits: 115 exits occurred in oligopoly markets (72 during the regulated phase) while 57 exits occurred in competitive markets (47 during the regulation). Why the relative exit rate is higher in competitive markets? In theory, it would be expected that margins in competitive market were lower than concentrated or monopoly markets due to the increased competitive preassure, which in turn translated into a higher exit rate. However, in the Argentine regulated market margins were determined by the price regulation, and so they were very similar across market types.

The relatively higher exit rate in competitive markets can be explained by a quantity effect. The regulated retail margin seemed too low to cover all gas station costs. However, the regulated retail price (AR pesos 1.10) was higher than the prevailing wholesale price (AR pesos 0.77), which is an indicator that the market price was higher than the most significant component of the variable costs. The way to increase total profits (given a positive price - variable cost gap), with a fixed, regulated margin, is to increase total sales. Gas stations in competitive markets faced more difficulties to increase sales, since they had relatively more rivals which served the same potential customers. Gas stations in competitive markets sold a daily average of 1.77 m3 of gasoline, while gas stations in oligopoly markets sold an average of 1.98 m3 of gasoline (12% more, on average, than gas station in competitive markets) and gas stations in monopoly markets sold a daily average of 1.94 m3 of gasoline (most of the monopolies are natural monopolies, gas stations located in small, isolated areas that are not capable of supporting two different brands at the same time, that is why gas stations in monopoly markets sold less gasoline than gas stations in oligopoly markets, even when the price was similar). This difficulty in increasing volumes to compensate for the ability to increase the retail margin seemed to be the main cause of the higher relative exits in competitive markets. By the end of the regulation, in July 2007, the daily average quantity sold by the surviving gas stations in competitive markets had increased to 1.89 m3, which likely helped them in terms of profitability.

In competitive markets, gas stations seemed to have entered until the zero profit condition was met. The regulated price plus the diminishing quantity sold put gas stations in competitive markets below the zero-profit threshold and gas stations exited during the regulated phase. Gas stations in monopoly or oligopoly markets were relatively safer: these markets are in smaller cities, where integer constraints may have prevented firms to enter until the zero profit level is met. In small cities, it is possible to have an equilibrium with n gas stations, $\Pi(n) > 0$ and no additional entry since $\Pi(n+1) < 0$. In such markets, there is space for a regulated price and decreasing quantities with no net exit, at least for sometime, or for slightly reduced profits for a long time. The data in my sample support this hypothesis.

Gas stations that belonged to big players did significantly better than the small group in all types of markets. The exit pattern is similar across market types: there were relatively more exits in competitive markets than in oligopolies than in monopolies. Actually, the absolute number of big brand gas stations in monopolies increased in the sample period. Moreover, big players did significantly better than independents across market types during the regulated phase, while they performed similarly after the regulation was removed. Table 1.5 shows that the exit rate for small gas stations was about 20 percentage points higher than the exit rate of the big players in all markets during the price regulation. Notably, after the regulation was removed exit rates are basically equal in all markets. What's more, the exit rate of the big players was actually slightly higher in oligopolies and competitive markets.

Table 1.5: Exit rates during and after the regulation, by market type

Market type	Monopoly		Oligopoly		Competitive	
Date	Indep.	Big players	Indep.	Big players	Indep.	Big players
Regulation	17.1	-3.1	24.1	3.2	31.6	11.3
Free market	2.5	0.5	5.4	7.7	9.8	11.4

The stylized facts point to the regulation as a significant cause of the high exit rate of the independents, while at the same time seemed to have protected big brands.

1.4 Empirical model

1.4.1 A Simple Hazard Model

I will use a discrete time duration model with time-varying covariates.The hazard at time t is the probability that a gas station closes between t and $t+1$, given that it is still open at the beginning of period t. Following Lancaster (1990, Chapter 2) I can define the conditional hazard function at time t by:

$$\lambda[t, X(t)] = \lim_{h \to 0} \frac{P[t \leq T < t+h | T \geq t, X(t+h)]}{h} \tag{1.1}$$

This limit exists only if certain conditions are satisfied. One of this cases is when t is continuous and for each t, $x(t+h)$ is constant for all $h \in [0, \nu(t)]$ for some function $\nu(t)$ (Lancaster 1990, Chapter 2). The above limit exists when the covariates are constant within the observation periods.

To derive the likelihood function, consider the situation of gas station i, in market m at the beginning of period t: the gas station may decide to stay ($y_{it} = 0$) or exit the market ($y_{it} = 1$). The likelihood that gas station i remains in the sample for $j-1$ periods and has an uncensored exit in period j is:

$$\{\prod_{t=0}^{j-1} \alpha_t(x_{it}, \theta)\}\{1 - \alpha_t(x_{it}, \theta)\} \tag{1.2}$$

The first term is the probability of staying in the market during the first $j-1$ periods and the second term is the probability that firm i exits in period j, given it has stayed in in all previous periods. The log likelihood is:

$$\sum_{t=0}^{j-1} log\{\alpha_t(x_{it}, \theta)\} + d_i \, log\{1 - \alpha_t(x_{it}, \theta)\} \tag{1.3}$$

where d_i is an indicator variable equal to 1 if the observation is uncensored.

As noted in Wooldridge (2001), this is only a partial likelihood, because we are not necessarily modeling the joint distribution of $(y_1, ..., y_T)$ given $\{(x_1, c_1), ..., (x_T, c_T)\}$.

Summing (1.3) over all firms we get the log likelihood for the whole sample.

If the hazard rate, the probability of exit in period t given that the firm survived until $t-1$ is $\lambda(t, x_t, \theta)$, then:

$$\alpha_t(x_{it}, \theta) = \int_{t-j}^{t} \lambda(s, x_t, \theta)\, ds \tag{1.4}$$

represents the probability of exit between periods $t-j$ and t.

To proceed to the estimation I need to define the function λ. Here, λ is a function of time, observable characteristics summarized in the (possible time-varying) covariates x_t and a vector of unknown parameters θ.

$$\lambda(s, x_t, \theta) = \lambda_0(t)\kappa(x_t, \theta) \tag{1.5}$$

The first part is the baseline hazard, and it is assumed to be the same for all gas stations. This term captures factors that affect the hazard of all gas stations irrespective of the individual characteristics, the hazard for being in the market at time t. The baseline hazard captures market-wide forces, such as booms or recessions, financial crisis, sector specific policies, etc. If λ_0 varies with time, the process exhibits duration dependence. When λ_0 increases, there is positive duration dependence, when λ_0 decreases with time, there is negative duration dependence (Wooldridge 2001).

The second term depends on the specific characteristics of each gas station, such as demand or supply conditions, i.e., market size, number of competitors, etc. as well as individual characteristics of gas stations, such as location, management ability, brand, etc.

Different specifications for $\lambda_0(t)$ and $\kappa(.)$, as well as the consideration of possible individual unobserved heterogeneity generate different econometric models. Each combination of a particular specification for λ and κ, and an assumption about individual heterogeneity correspond to a different econometric model. As described below, I will use three different specifications for λ and a single specification for κ. Each specified pair (λ, κ) combines with either observed or unobserved individual heterogeneity, for a total of six different econometric models.

I am going to follow the literature and I will model $\kappa(x_t, \beta)$ as an exponential function:

$$\kappa(x_t, \beta) = exp(x_t\beta) \tag{1.6}$$

For $\lambda_0(t)$, however, I will use three different specifications: (i) a parametric distribution, (ii) a flexible specification with dummy variables, and (iii) a non-parametric approach. I will discuss the pros and cons of each specification in the next subsections.

1.4.2 Models without unobserved heterogeneity

I will consider first models where all the heterogeneity is contained within the covariates x_t, that is, all the heterogeneity is observable to the econometrician. This assumption may be too strong, but it's a good starting point to present the different ways to model λ and, if true, it generates reliable models that are easy to estimate: the computational burden is low and many statistical packages have built-in, tested codes that generate the results quickly.

The first approach without unobserved heterogeneity fits λ with a parametric distribution. The parametric distributions that are used most often in the literature are the Weibull, the Gompertz and the log-log. There are no theoretical guides as to which one should be the true distribution for the baseline hazard (Kiefer 1988). However one can inspect the data or rely in the predictions of some economic model as in Klepper (2002) to detect duration dependence, and use a distribution that accommodates the observed (or predicted) duration dependence.

The Gompertz distribution is useful to describe models with a decreasing baseline hazard. The Weibull distribution is more flexible, since for different values of its parameter one can generate a process with positive, constant or negative duration dependence. The log-logistic distribution is even more adaptable: it can accommodate processes with positive dependence for a certain number of periods and negative dependence for other periods. The advantage of these parametric specifications is that, if the correct one is used, the model is very easy to estimate and the estimators are consistent and efficient (Meyer 1990). The main disadvantage of this approach is that under misspecification the estimators are inconsistent.

To overcome this important problem, Prentice and Gloeckler (1978) and Meyer (1990) have proposed a flexible method to estimate the baseline hazard when there are no time varying covariates. Jenkins (1995) is more useful for the purpose of this paper, since he showed how to implement a flexible baseline hazard to get consistent estimates in duration models with time-varying covariates. The idea is to model the baseline hazard as $\lambda_0(t) = \lambda_t$, $t = 1, ..., J$, where J is the total number of periods in the sample. Under this approach we estimate the baseline hazard for every period, and we assume that it is constant within each period.

The main advantage of this specification is that the baseline hazard, the part common to all gas stations in the sample, is flexible and we do not have to assume a particular parametric form for its distribution. In this way we avoid the risk of not picking the correct distribution, which would bias the estimates. On the other hand, this method imposes the restriction that the baseline hazard cannot change within the given intervals. For cases where there are a few episodes per period, the normal procedure is to combine a few periods into one, for example, months instead of weeks, quarters instead of months, etc., so that we can have enough episodes per period, which in turn imposes the condition that the baseline hazard be constant for a long time.

A way to relax this assumption is to specify the baseline hazard with a non-parametric approach, for example using splines. This approach has some useful advantages. First, it is a flexible specification, so that I can avoid the risk of mispecifying the baseline's underlying distribution and getting biased estimates. Second, the splines are not subject to the constraint that they have to be constant within periods, so even when there are a few episodes per period (i) I can have a flexible (variable within the period) specification, and (ii) I do not have to define longer time periods to get enough episodes, which is important because longer periods (for example, quarters instead of months) impose stronger constraints in the shape of the flexible, non-spline specification, i.e. the baseline hazard has to be constant for three-months periods rather than a month.

Gas stations and duration dependence

Duration dependence is influenced by many industry-specific characteristics. Studies highlight the importance of technological innovations (Anderson and Klepper 2013, Klepper 2002, Jovanovic and MacDonald 1993), the quality of entrepreneurship (Ejermo and Xiao 2014) and the entry of spin-offs firms from former parent companies (Tor and Moritz Khun 2006). In industries where technology is important firms with more research and development survive more and in industries where innovation is crucial, the quality of entrepreneurship determines the survival rate. Spin-off firms have a greater survival rate than companies that did not come from a former parent in industries where experience and know-how are important, because former employees take their knowledge with them to the new spin-off and that gives them an advantage over brand new, inexperienced entrants to the industry (Buenstorf 2007).

However, there are almost no papers analyzing the duration dependence in the retail gasoline industry. There is a reason for that: the retail gasoline industry does not exhibit any of the above mentioned characteristics. Gas stations are not innovative firms: their technology is established, it does not change at a significant rate and all players in the market know it. Moreover, all players have access to state of the art technology: standard pumps and a few workers to take care of the gas station. Also, firms are not able to exploit new opportunities that arrive in the form of submarkets (Klepper and Thompson 2006). The scope of the gas stations is fairly constrained: they sell gasoline and related products, and almost all of them have established convenience stores, the scope of action for gas stations is limited and it cannot be said to affect their survival rate. Entrepreneurship experience is not a crucial factor and it is rare in this industry, since workers do not have the potential to create their own firms due to financial and regulatory constraints. Finally, market concentration does not have an impact on survival rates in the long run (Audretsch and Mahmood 1995), so the localized competition cannot be used to explain the duration dependence of gas stations in Argentina.

For gas stations, duration is determined by location. The location can be profitable or not, determined by the income level of the neighborhood, the number of competitors nearby, whether the location is on a commuter route, etc. It can be said that the station manager is uncertain about the true type of a certain location. The gas station enters the market and for the first few months is trying to realize the true type of the location. After the type is revealed, the gas station either exits the market (if the location is unprofitable) or stays in otherwise. Thus, we would observe a positive duration dependence for sometime, while gas stations learn the profitability of their location, and the a relatively constant duration for the ones who survive the first months in the market. Under this hypothesis, we would observe a non-monotone duration. The best way to estimate the duration dependence would be by using flexible methods like splines or time dummies, rather than a parametric distribution which may not be the best choice to accommodate the proposed pattern.

1.4.3 Model with unobserved heterogeneity

In the previous sections, I assumed all heterogeneity was contained within the covariates. In this section, I will relax the assumption and allow the heterogeneity to be unobservable at the gas station level. In discrete duration models it is difficult to account for the unobserved heterogeneity since it may be indistinguishable from duration dependence. In order to isolate the effect of the unobserved heterogeneity, most models assume: (1) the heterogeneity is independent of observed covariates, starting times and censoring times; (2) the heterogeneity has a known distribution and (3) the heterogeneity enters the hazard multiplicatively (Wooldridge 2001). Moreover, with discrete data, I have to assume that the covariates are strictly exogenous (Wooldridge, 2001; Kalbfleisch and Prentice, 1980) and that the covariates are independent of the unobserved heterogeneity. I will discuss the effects and implications of each of these three necessary assumptions on my study in the next paragraphs.

In my setting, conditions (2) and (3) above are important but not so critical. I can try different distributions for the unobserved heterogeneity to cover different possibilities. The multiplicative effect, although somehow restrictive, it is necessary to identify the heterogeneity from the duration dependence. The most critical assumption is the first one: I have to assume that the unobserved heterogeneity is independent of the observed covariates, starting times and censoring times.

Starting and censoring times are not important: since the sampling period is exogenous, given by the availability of the data and the dates were determined by the government when designing the rule, I can treat the starting and ending dates as exogenous and thus unrelated to any heterogeneity (Wooldridge, 2001). Moreover, since every gas station is supposed to comply with the regulation regarding information to the government, I don't have a censoring problem: there can be no gas stations that leave the sample just because the owner does not want to release information any longer, or that are not covered by the regulation after some specified time. Every single gas station has to remain on the sample until either they exit the market (in which case I observe an exit episode), or the sampling period finishes. The latter option means all remaining gas stations are considered censored at the finishing time, independently of any unobserved heterogeneity.

The most critical problem for this paper is the assumption that the unobserved heterogeneity is independent of the covariates X_{it}. I will try to overcome this problem by introducing an individual fixed effect. This individual fixed effect will capture the unobserved heterogeneity at the gas station level and it will remove the unobserved heterogeneity from the error term, which is needed to avoid correlation between the covariates and the error term due to unobserved heterogeneity. The actual coefficient and properties of the estimator of the fixed effect will not be important by themselves, they are there to remove the unobserved heterogeneity from the error term and eliminate the issue of correlation between the covariates and unobserved heterogeneity. Even in the presence of unobserved heterogeneity, after moving the heterogeneity effect to a new set of covariates (the fixed effects), the relationship between the $X_{it}s$ and the error term will be free of correlation, and then the estimates of the $X_{it}s$ are reliable again.

The hazard model with unobserved heterogeneity is:

$$\lambda(t,\nu,x_t,\theta) = \nu\kappa(x_t,\beta)\lambda(t) \tag{1.7}$$

$\lambda(t)$ can be modeled as before, either with a parametric distribution, with a flexible form as in Jenkins (1995) or with splines. I will follow the literature and model the unobserved heterogeneity with a gamma distribution.

The log likelihood for the whole sample is:

$$L(\lambda,\beta,\sigma) = \sum_{i=1}^{N} log\{[1+\sigma.\sum_{t=0}^{J_i-1} exp(x_{it}\beta+\lambda_t)]^{-\sigma^{-1}} - c_i.[1+\sigma.\sum_{t=0}^{J_i} exp((x_{it}\beta+\lambda_t)]^{-\sigma^{-1}}\} \tag{1.8}$$

where σ is the variance of the gamma distribution specified for the unobserved heterogeneity.

Why is it important to introduce models with unobserved heterogeneity, when we need many assumptions to do it? I need to take account of the unobserved heterogeneity because failure to do so can bias the estimates. Kiefer (1988) uses a simple example: there are two groups of individuals, one of which has a higher propensity to "die", all other things equal, so there is no observable heterogeneity. As time goes by, one will overestimate the probability of survival of individuals with a high propensity to die, since there are still many individuals from the low propensity group, and the covariates capture the mean effect for both types. Conditioning on observables, both types are indistinguishable from each other, so the average effect will be (wrongly) shared by both groups. Lancaster (1990, Chapter 4) proves that the estimates of a positive (negative) β_k derived from the no frailty model will underestimate (overestimate) the true estimate for the case when the frailty follows a Gamma distribution.

The main advantage of the model in this subsection is that it allows unobserved effects at the gas station level, like better of poorer management, services like car wash or the size or the gas station, which I do not observe, to be present in the estimated model. Even though the assumptions can be restrictive, it is worth estimating a model with unobserved heterogeneity and comparing its results with the models of the previous subsection. The case without unobserved heterogeneity is the limit case with $\sigma \to 0$.

1.4.4 Estimation issues

Before proceeding to the estimation, I need to address some issues. In the first place, entry and exit happen in a market, so I need to define the relevant market for each gas station. Second, I need to consider which variables are relevant for the estimation. Then, I need to consider possible endogeneity issues, specifically with the number of competitors in each market. Finally I need to address the issue of left censoring.

The first step is to define the actual market. Ideally, I would like to define the market for each gas station based on some measure of distance between that gas station and its neighbors. An individual gas station does not necessarily compete with all other gas stations in a city or metropolitan area, but rather with gas stations that are close, or located in the same avenue or commuter route.

Spatial retail competition papers show that firms do not necessarily compete with all other similar firms in an area, but rather with their closer neighbors. See for example Pennerstorfer (2009), Verlinda (2008), Hastings (2004) or Netz and Taylor (2002) for the retail gasoline industry or Mazzeo (2002) or Thomadsen (2005) for other industries. Since I do not have a measure of distance between gas stations, or data for sections of a city, I will consider the relevant market for each gas station to be the city in which it is located. I will assume that a gas station in a city c competes with all other gas stations in that city, and that it does not compete with gas stations in other cities. This is not necessarily the most convenient way to model competition, but given the structure of the data, I have no other choice. I will consider each city as a point market, where city is defined by INDEC (the Argentinean Census Bureau) in its census guidelines.

The exit decision of the gas stations is determined by their profits, which are a function of supply and demand characteristics in each market as well as individual gas station characteristics. The market characteristics that affect variable profits will be relevant demographic variables such as population, number of cars in the market, income per capita, etc. Since I only have information about the population for the cities in my sample, I will summarize all the demand information in the market size, defined as the number of inhabitants in each city.

Ideally would like to use the number of competitors present in each market as a regressor, since the number of competitors is a proxy for the competitive pressure in the market, and the competitive pressure may affect entry / exit decisions. However, N is endogenous and including N in the regressions may bias the estimates (Berry 1992). Additionally, the literature on social strategic interactions suggests that when the actions of a player directly affect the behavior of another player (external effects) we can observe simultaneous exit with positive probability (see De Paula 2009 and Honore and De Paula 2010). The authors state that continuous time duration models do not account for simultaneous exit episodes and hence the estimates of these models are biased. They cannot identify duration dependence from external effects. In my context, however, the implications of the social interaction literature are not that relevant. In the first place, I use a discrete time setting, which can handle simultaneous fails, exits in my case, without problems. Additionally, in De Paula's setting, the identification depends crucially on the (net) utility of the remaining player going *down* upon exit from another player (see Propositions 4 and 5 in De Paula 2009, p.62). In my case, an exit by a gas station will actually increase future profits for the remaining players [4] which would *lower* the probability of simultaneous exits. Of course, it may be the case that there is a negative shock that induces simultaneous exits, but in this case the simultaneity is caused by correlated effects rather than by strategic interactions, so the estimates of the duration models are correct.

My main concern is Berry's point: N is endogenous and it will bias the estimates. Hence, I will concentrate on market size (population) in each market and I will not use the number of players as a regressor. The number of inhabitants in each city comes from the National Census of 2001, and the values from 2005 to 2010 are adjusted using the adjustment method of INDEC, to make market size variable in time.

While market size is important in determining the demand, it is not the only relevant variable. Income is also extremely important in determining the demand size. As mentioned above, I do not have income at the city level since that variable is not reported in the Census Results. Income information comes from the household survey, but unfortunately this survey is just urban, and it is done only in 33 cities, which does not cover most of the cities I have in my sample. I do have, however, measures that are proxies for the income level of a city: education level of the population and housing characteristics, such as number of rooms per house, whether the house has toilet or not, the type of construction, etc. I will use the average percentage

[4] In monopoly markets an exit eliminates the market and the analysis ends. In competitive markets there are no strategic interactions by definition. The only case where strategic interactions may apply in my case is in oligopoly markets.

of inhabitants who finished high-school in each city and the proportion of houses built with durable and resilient materials as a proxy for the income level of a city. To account for other relevant variables that may be omitted, I will also include city dummy variables to capture unobserved, time invariant attributes of each city.

It is very difficult to introduce many fixed effects in a ML algorithm, which is what I am using to estimate the hazard model with time variable covariates, since the computational burden of doing that is extremely high. Then, I start by running a simple linear regression model with market (city) and individual gas stations fixed effects. This model is should be viewed as summary statistics and a motivator for the hazard model, rather than a complete model, but it has some very useful advantages. First, as I said, it is easier to estimate and it allows a great number of fixed effects that may capture unobservable effects at both the city and individual gas station levels. Second, if the models with and without fixed effects generate similar results, I can estimate the hazard models without fixed effects, which makes the estimation much easier, and still rely in their results, in the sense that I can reduce the risk of omitted variable bias.

The results of the linear regressions are presented in Table 1.6 below. The dependent variable is the indicator exit, where $exit = 1$ means the firm exits the market before the end of the sample period, $exit = 0$ otherwise. The covariates included are (i) indicator variables for each brand, (ii) an indicator variable if the chain owns a refinery, (iii) the number of competitors, (iv) market size, (v) average years of education in each city and the percentage of households with unsatisfied basic needs. The coefficients of the variables in (iv) and (v) are close to 0 and not statistically significant. Only market size is included in the table for illustrative purposes.

Table 1.6: Estimation results OLS

Variable		
Indep.	0.003	0.003
	(0.003)	(0.002)
Esso	-0.005**	-0.004*
	(0.003)	(0.002)
Petrobras	-0.006**	-0.004**
	(0.003)	(0.002)
Refinor	-0.005*	-0.004
	(0.003)	(0.003)
Repsol YPF	-0.008***	-0.010***
	(0.002)	(0.001)
Rhasa	0.024***	0.025***
	(0.004)	(0.003)
Shell	-0.005*	-0.004*
	(0.003)	(0.002)
Sol	-0.003*	-0.002
	(0.003)	(0.002)
refinery	-0.090***	-0.102***
	(0.004)	(0.006)
ncompetitors	-0.003***	-0.004***
	(0.001)	(0.001)
mktsize	0.000	0.000
	(0.000)	(0.000)
City F.E.	YES	NO
Gas stat. F.E.	YES	NO

The results indicate that gas stations of the four big players (Esso, Petrobras, Repsol YPF and Shell) face a lower risk of exit, that belonging to a chain that owns a refinery lowers the risk of exit and that market size is not relevant. Gas stations in both big and small cities face the same risk of exit, other things equal. But again, this is not the final model and it should not be interpreted as representing accurate risks of exit. Rather, it should be viewed as an indication, as a description of how each characteristic may affect the risk of exit.

The most important feature of these regressions is that the coefficients of both models are very similar. All coefficients have the same sign, their statistical significance is almost always the same, except for Refinor and Sol, which become non significant without fixed effects, and the estimated coefficients are very similar. Based on this similarity, I will estimate the hazard model without fixed effects, which will greatly reduce the computational burden of the estimation.

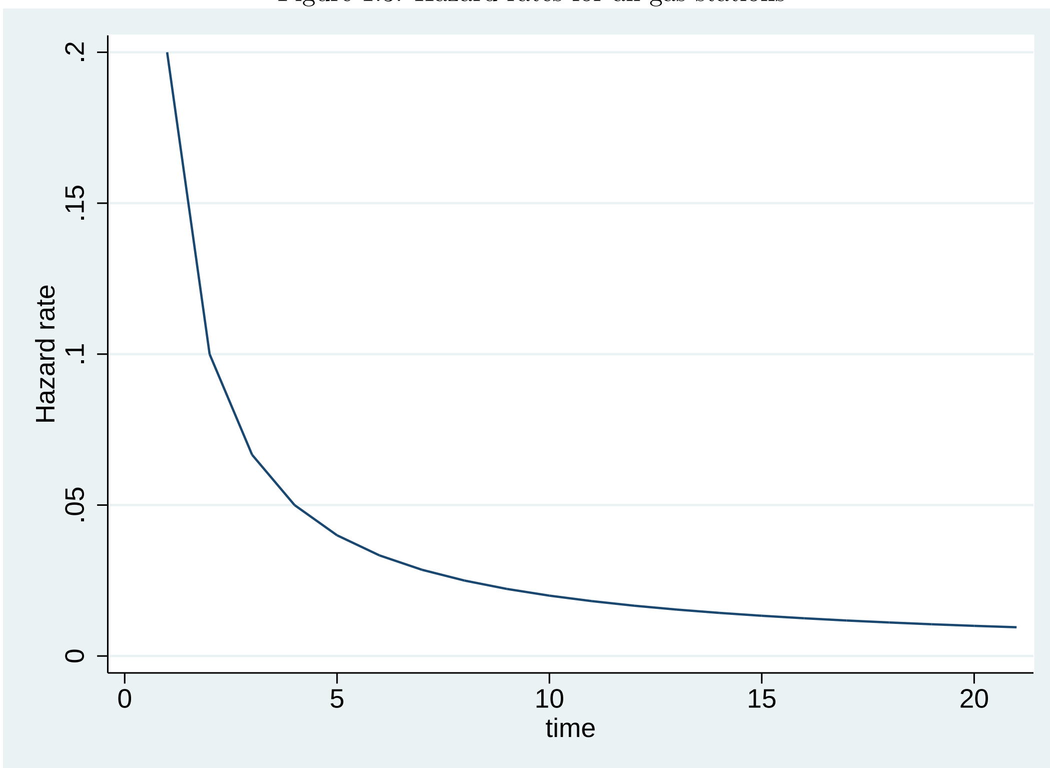
To complete the estimation, I need to introduce supply side variables. The individual gas station characteristics that affect the fixed part of the profits will be summarized by indicator variables that represent the brand of affiliation of the gas station. The independent gas stations, which are not affiliated with any particular brand, will be treated as one group. This specification, although simple, has the advantage of capturing characteristics common to gas stations of the same brand, such as interest paid for the capital (land, facilities like underground tanks, etc.) and allows profits to differ among chains. This is relevant, since some of the chains are vertically integrated, from production to final sales, while others have their own refineries. It is important to differentiate these types of firms from the ones that just sell gasoline to the public.

1.4.5 Left censoring

The last crucial issue for the estimation of the hazard model is the possibility of left censoring. In duration models, left censoring happens when we do not observe the life of individuals since its beginning, but rather since the beginning of the sample period. Suppose the life of an individual started at $t = a$, but our sample starts at $t = b$, with $b > a$. Let's say we are analyzing the risk of death of this individual at $t = c$, $c > b$. From the econometrician perspective, the individual has remained in the initial state for $c - b$ periods, when in reality the individual has been in the initial state for $c - a$ periods. The problem is that at the beginning of the sample, we get random samples of individuals who *already* are in the initial state, and we don't know for how long they have been in that initial state. Ignoring left censoring overestimate the mean duration since longer spells tend to be observed more frequently than shorter spells (Goto, 1996)

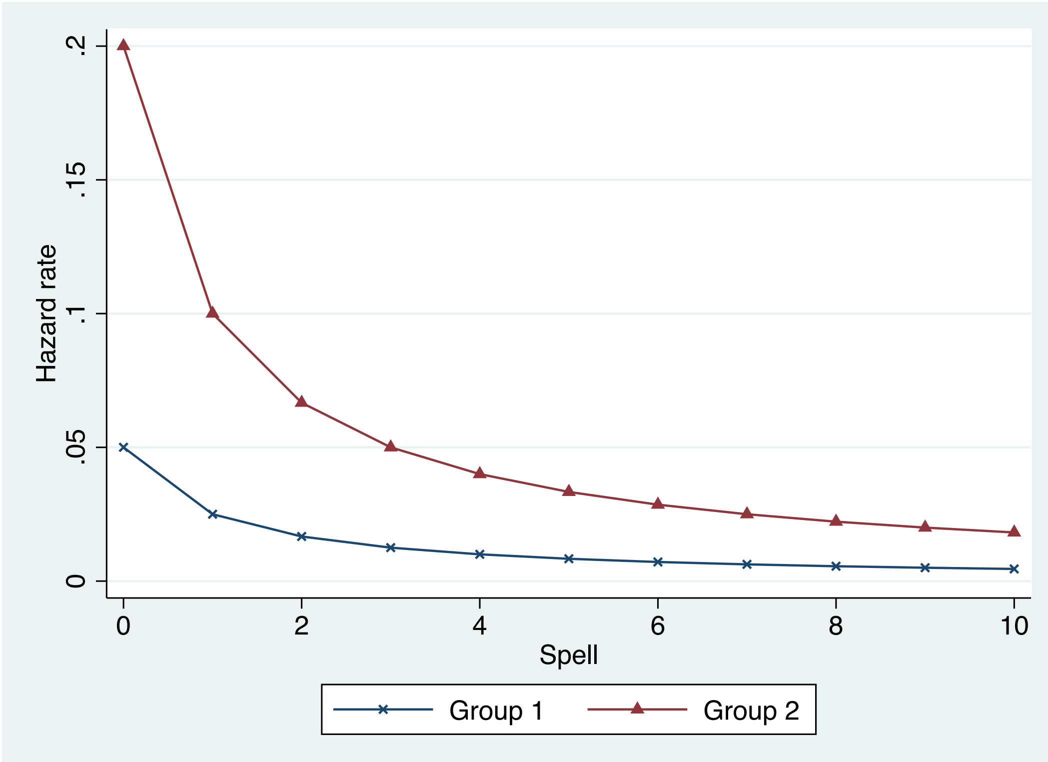
This is a problem if there is duration dependence in the model. To see why, assume the true model exhibits negative duration dependence, that is, as time goes by, the hazard risk goes down, like in Figure 1.3. When $t = 0$ the hazard rate is 0.2, when $t = 3$ the hazard rate is 0.05, when $t = 8$ the hazard is 0.025. Now suppose that we have a random sample of firms from $t = m$ to $t = n$, with $n > m$, and we observe two groups of firms, 1 and 2. Firms from group 1 are already in the market at the beginning of the sampling period. For simplicity, let's assume that they all entered the market at the same time, $t = l$, $l < m$, so when tha sample begins, type 1-firms have been in the market for $m - l$ periods. Firms from group 2, however, enter the market strictly after firms from group 1. Again, for simplicity, let's assume that they enter the market at the same time, say the beginning of the sample, at $t = m$.

Figure 1.3: Hazard rates for all gas stations



The source of the problem is that from the econometrician perspective, $m = 0$. While this is true for type 2-firms, m is not 0 for firms of type 1, m is not the beginning of their lives, they have been in the market for a while, and hence its observed baseline hazard is not comparable to the observed baseline hazard for firms of the second type. Figure 1.4 illustrates the situation from the econometrician's point of view. If we plot the duration of each group of firms, the econometrician observes two different curves, one for each group. For the second group, the observed baseline hazard is the true one, since group 2 firms are observed since their actual entries in the market. For firms of the first group, the situation is different. Even though the econometrician treats m as the entry period for type 1 firms, firms are in the market since $l < m$, so its baseline hazard at time m is *lower* than the baseline hazard at m for a firm which has just entered the market. How much lower? In order to answer this question we need to know two things: (i) the actual date of entry of firms of group 1 and (ii) the true model for the duration dependence. If we know (i) and (ii), we can specify a parametric model for the conditional distribution of starting times, and get consistent estimates (Nickell, 1979).

Figure 1.4: Hazard rates for groups 1 and 2 as seen by the econometrician



Sometime we can get information about the actual date of entry of firms already in the market at the beginning of the sample, but it's much more difficult to know the true model for the duration dependence. In general there are no theoretical guidelines (Kiefer, 1988) and the econometrician tries to infer the model from the observed data (for example, Klepper, 2002). But the data in this situation is not enough to infer the true model. Figure 1.4 shows why. Suppose that type 1 firms enter the market at $t = -3$, while type 2 firms enter the market at $t = 0$. For the econometrician, at m, when $t = 0$, the *observed* hazard rate for type 1 firms is 0.05 (since they have been in the market for 3 periods). Type 2 firms have an *observed* hazard rate of 0.2 (which is actually the true). The econometrician observes this difference, but she cannot tell if the difference is due to the fact that firms have been in the market for different times, or because there is something else, some other factor that makes the hazard rates for firms 1 and 2 different. For example, a cohort effect: the true baselines may be different because firms born at a certain time have lower (or higher) duration dependence. The previous argument assumes that the only source of differentiation in the durations is the age of the firm. Firms of group 1 have a lower baseline at $t = m$ because they were born earlier, but there remains the assumption that when firms of group 2 reach the age of 3 (the age of type 1 firms at $t = m$, the beginning of the sample), they will have the same baseline hazard than type 1 firms at $t = m$. It may not be the case. There is an identification problem.

In order to solve this problem, we need to know the actual age of type 1-firms, so that we know they are 3 years old at the beginning of the sample, and then we are able to place these firms in the right place in Figure 1.3. However this is not enough, in order to compare this baseline hazard with the baseline hazard of type 2-firms we also need to be sure that the baseline hazard for firms of group 1 follows the path depicted in Figure 1.3 from $t = 0$ to $t = 3$, which it cannot be done without information on the firms of group 1 which didn't make it to $t = 3$. To sum up, when there is duration dependence, either positive or negative, we have an identification problem and we can't separate differences in baseline hazards due to duration from differences due to heterogeneity among groups.

In my case, when the sample begins, in Dec. 2004, I can observe 3,577 gas stations that are already in the market, and I don't know how long they have been there. Besides, I don't have any kind of information on firms that were in the market before Dec. 2004 but not in Dec. 2004, so I face a possible identification problem. How to proceed? The first and probably easiest solution is to assume that there is no duration dependence, that the true baseline hazard is the same, and constant, for all firms. If this is true, then no matter the characteristics, nor the age of the firm, its baseline hazard will be the same than any other gas station at any time, so I can proceed directly to the estimation (Han and Hausman, 1990; Meyer, 1990). However, this is not realistic. At least, I cannot assume a constant baseline hazard a priori. If the estimated models confirm that there is no duration dependence, then I can proceed to estimate the model treating both existing firms at the beginning of the sample and new firms in the same way, but I have no theoretical reason or any other indication in this direction.

Some authors have tried to provide a solution. For example, Ridder (1984) says that if the vector X is exogenous to the explained variables, the likelihood can be decomposed in

$$f(y, x; \beta) = f_1(y|x; \beta_1) f_2(x; \beta_2) \tag{1.9}$$

which implies that inference on β_1 can be done with information on the conditional distribution $f_1(y|x; \beta_1)$. Goto (1996) devised a solution that partitions the likelihood function to get consistent, although less efficient estimates for duration models. Amemiya (1991) extended this solution for models with discrete, time invariant covariates. Unfortunately, the sampling design in my dataset and the existence of time varying covariates prevent me from applying any of these methods.

I have two options: either assume a constant, equal baseline hazard for all gas stations, following Han and Hausman (1990) or to drop the gas stations that are already in the market at the beginning of my sample, and to work with only the new gas stations, those that entered the market within my sample, from Jan.

2005 to Aug. 2010. As I said above, since I cannot assume a constant baseline hazard without more evidence than the one I have, I will choose to discard the existing gas stations and work with the new gas stations (as suggested by Ridder, 1984), although I will report both results to see (i) if there is actually empirical evidence of a constant baseline hazard (no duration dependence) and (ii) if the estimates are similar, in which case it may not be too problematic to assume a constant duration dependence.

1.5 Estimation Results

First I will present the result of the model with all gas stations, for informative purposes and as an introduction to the models with the gas stations for which I observe the whole life. I have estimated six models: with and without unobserved heterogeneity, and for each type with one of three specifications for the baseline hazard: parametric (logarithmic), flexible (quarterly dummies) and non-parametric (cubic splines). To estimate the model with dummy-baseline hazard, I need to define the baselines for each period. A very important point here is that it is necessary that I have enough exits in each period so the computation can be performed. Since there are some months with very few exits, I will use quarters as the unit of time to define the baseline hazard. I will assume that the hazard is constant within three months periods, so I define indicator variables for each of the 22 trimesters that span from Jan. 2005 to Jun. 2010.

To see the effect of the price regulation on the risk of exit for each firm, I will introduce an interaction term between two indicator variables. The variable $brand_j$-$intervention = brand_j * intervention$, where $brand_j = 1$ if gas station i belongs to brand j, and $intervention = 1$ during the price regulation phase, $intervention = 0$ otherwise. The definition of the variable intervention is not so straightforward. Since the regulation was de facto, based on theoretically voluntary agreements between the government and the firms, there was no specific piece of legislation that could be overturned at a specific date, so that everybody knows that the regulation phase had ended. Instead, the agreements were tacitly abandoned by June 2007, and even though there was no formal announcement about the end of the agreements by any part, it became clear that the government was no longer acting against firms which increased their prices.

However, firms may have had uncertainty with respect to the continuation (or not) of the regulated prices. By June 2007 some firms had started increasing their prices, and the government did not penalized those increases, which may have acted as a signal of the end of the regulation, and then more firms followed. In any case, the lack of a formal announcement renders the exact date of price liberalization diffuse. Some firms may have realized that prices were not regulated any longer quickly, others more slowly. The retail price series shows a remarkable stability, between AR Pesos 1.08 and AR Pesos 1.103 from Dec. 2004 to May 2007.

In June 2007 the average retail price was 1.114, in July 1.13 and in August 1.19. I use these observations to define the end of the regulation period based on observed data. It is clear that firms considered the price regulated by May 2007, and not regulated by September 2007. The problem is where to draw the cut-off.

I will use the month of July 2007, since by then most of the firms increased their prices, at least a little, and very few firms remained (close) to the then old regulated price. I take these general increases as an indication that the firms had internalized the new environment, where they could set the prices on their own without fearing retaliation by the government. As a consequence, the indicator *intervention* takes value 1 from the beginning of the sample until July 2007, and it takes a value 0 for the remaining periods.

The interaction term will capture the additional risk face by each brand during the regulation period. Suppose that for brand j the coefficient is zero and for brand k the coefficient is negative. That means that, ceteris paribus, brand k faces a lower risk of exit than brand j during the regulation period. If the price regulation affects different brands in different ways, that is, the regulation has a non-neutral effect on the exit of different gas stations, I will expect the coefficients of the interaction terms to be different. Brands with negative interaction terms are actually favored by the regulation, they would face a lower exit rate during this period. Brands with coefficients of zero are equally likely to exit the market in all institutional arrangements and firms with a positive coefficient are more at risk of exit during the regulation, vs. the non-regulated months.

Table 1.7: Estimation results, all gas stations

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Indep.	0.157	0.198	0.252*	0.276*	0.206*	0.195*
	(0.329)	(0.451)	(0.128)	(0.139)	(0.110)	(0.098)
Esso	-0.582*	-0.977*	-0.718*	-0.991*	-0.684**	-1.003**
	(0.312)	(0.506)	(0.391)	(0.526)	(0.338)	(0.488)
Petrob	-0.765**	-0.994**	-0.801**	-0.824**	-0.921***	-1.136***
	(0.372)	(0.481)	(0.393)	(0.398)	(0.402)	(0.443)
Refinor	-0.114	-0.227	0.312	0.340	-0.582	-1.062*
	(0.348)	(0.451)	(0.426)	(0.428)	(0.444)	(0.594)
Repsol	-1.273***	-1.516***	-0.924***	-0.983***	-1.241***	-1.508***
	(0.416)	(0.473)	(0.374)	(0.327)	(0.377)	(0.491)
Rhasa	1.251***	1.536***	0.966***	1.105***	1.062***	1.317***
	(0.366)	(0.518)	(0.374)	(0.415)	(0.355)	(0.480)
Shell	-0.934***	-1.318***	-0.684**	-0.946***	-0.892**	-0.977**
	(0.340)	(0.602)	(0.352)	(0.443)	(0.470)	(0.502)
Sol	-0.763*	-0.750*	-0.464	-0.759	-0.411	-0.651
	(0.399)	(0.381)	(0.452)	(0.568)	(0.396)	(0.570)
Refinery	-0.232***	-0.214**	-0.228***	-0.238**	-0.252***	-0.246***
	(0.112)	(0.121)	(0.120)	(0.117)	(0.138)	(0.128)
Mkt. size	-0.083*	-0.122*	-0.104***	-0.093***	-0.088**	-0.106**
	(0.046)	(0.067)	(0.043)	(0.037)	(0.048)	(0.057)
Heterogeneity	no	yes	no	yes	no	yes
Baseline	logarithmic	logarithmic	dummies	dummies	splines	splines

Table 1.8: Estimation results - interaction terms, all gas stations

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Indep-interv			0.529**	0.463**	0.644**	0.662**
			(0.268)	(0.248)	(0.334)	(0.347)
Esso-interv			-0.816***	-0.462*		
			(0.233)	(0.264)		
Petrob-interv			-0.866***	-0.786***	-0.524**	-0.575**
			(0.239)	(0.324)	(0.228)	(0.296)
Refinor-interv	-1.586***	-1.860***	-2.104***	-2.002***	-1.848***	-1.914***
	(0.589)	(0.636)	(0.686)	(0.673)	(0.625)	(0.631)
Repsol-interv	-0.278**	-0.338*	-0.456**	-0.428**	-0.660***	-0.649***
	(0.143)	(0.182)	(0.246)	(0.223)	(0.277)	(0.281)
Rhasa-interv						
Shell-interv	0.722***	0.739***			0.552*	0.676**
	(0.202)	(0.208)			(0.331)	(0.345)
Sol-interv	0.808***	0.717***				
	(0.355)	(0.314)				
Heterogeneity	no	yes	no	yes	no	yes
Baseline	logarithmic	logarithmic	dummies	dummies	splines	splines

Tables 1.7 and 1.8 show the estimation results. Even though the results come from the same regression, I chose to present the coefficients in two different tables. Table 1.7 includes the variables that come from the demand and cost sides. Table 1.8 shows only the interaction terms. The idea to have a separate table to show the interaction terms is to highlight what happens with each type of firm during the regulation period. To simplify the exposition, Table 1.8 only includes the coefficients that are statistically significant. When there is an empty cell in Table 1.7, it means that the corresponding coefficient is not significant.

In Table 1.7, for all models, the coefficient of the independent firms is positive (although not significant) while the coefficient of Repsol - YPF, the biggest brand, is significant and lower than zero. This means that the hazard for the biggest firm is smaller than the hazard for the independent gas stations. I found that the probability of survival is higher for the bigger players in the market. The same is valid for the second-tier chains, the other big, vertically integrated players (Esso, Petrobras and Shell): although with different degrees of significance, all of them have negative coefficients. For the gas stations in Argentina, when the number of firms diminishes, the smaller players exit first. Moreover, owning a refinery seems to be important in the survival of the firms. The coefficient of refinery is negative and statistically significant. Refinor, a small chain but with its own refinery saw the number of its gas stations increased, as opposed to the other small chains and independents, who saw their number of gas stations drastically diminished. The number of competitors seems to have a negative and significant effect on exit, although the size effect is small.

Table 1.8 shows the interaction terms, which reflect how much more (or less) likely to exit is gas station i which belongs to brand j during the price regulation phase. Results vary across models and specifications, but there are some regularities. The biggest firm has all negative and significant (to some extent) coefficients, so this firm seems to be better off under regulation, in the sense that its gas stations are less likely to exit the market. The same can be said about Refinor, a small chain, but with its own refinery. Two of the other big players, Esso and Petrobras, either have negative or not significant coefficients, so they are no worse off under price regulation. Gas stations of the smallest players (Sol and Independents) are either not particularly affected by the regulation, or worse off (their coefficients are positive and significant or statistically not different from zero, but never negative).

Exit rates and retail margins

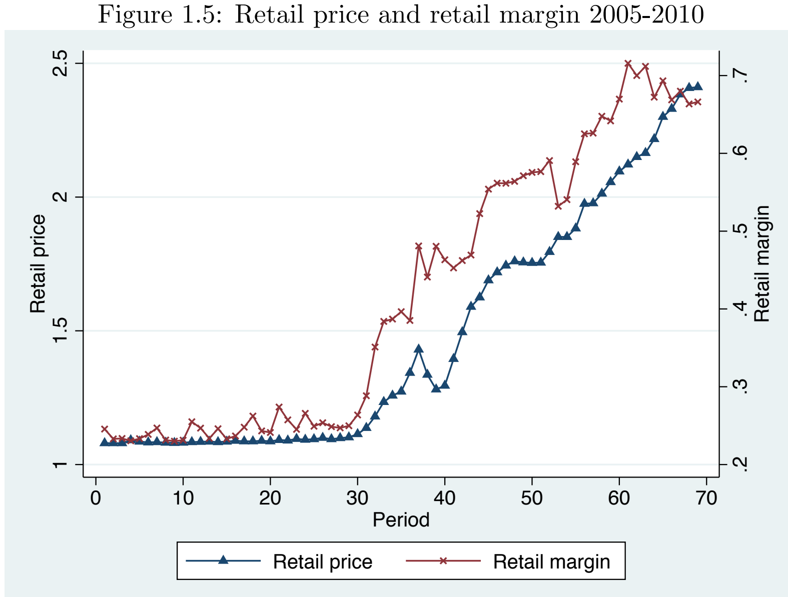
The exit rates are determined by profitability and one of the most important components of profitability is the retail margin, the difference between the retail and the wholesale prices.

At the wholesale level I have data from most of the terminals operating in Argentina (the retailer's database caveat also applies to the wholesale database, the information is self-reported). The wholesale database contains the same basic information than the retail database, hence I can identify the location and affiliation of every terminal. For each terminal in Argentina I also have information on volume (in m^3) sold per month and the prices charged to different types retailers: to the gas stations that are affiliated with the company that owns the terminal (in case it is vertically integrated, or has exclusive contracts with gas stations) and to other brands or to independent, non-affiliated retailers. Finally, I have information on the prices charged to retailers based on final sales to different segments: to the general public, to the agricultural sector or to the transportation sector. The prices are in ARG $ so they are comparable with the prices from the retailers' database. There are 103 terminals in the 24 provinces of the country, and there is at least one terminal in each province.

Even though I can observe the retail price charged by every gas station at every time in my sample, I cannot observe directly the wholesale price paid by gas stations. I have no links between the retail and the wholesale databases, in particular, I do not know which terminal sells to gas station i, nor which gas stations buy from terminal r. To determine the appropriate wholesale prices for gas station i at city c in period t I use the own-brand wholesale price at terminal r in city d, the closest city to c where a terminal who belongs to the same brand as gas station i is located. If gas station i is independent, or belongs to a brand that is not vertically integrated, I use the wholesale price in city g, the closest city to c with a terminal. I use the wholesale price charged to gas stations not belonging to the same brand of the terminal.

Figure 1.5 show the evolution of the retail margin during my sample period.

Figure 1.5: Retail price and retail margin 2005-2010



During the regulation prices were very stable and the retail margin was constant around 22 cents, or about 20% of the retail price (AR pesos 1.10 per liter). After the regulation ended both the retail price and the retail margin increased. The retail margin grew relatively more than the retail price, increasing up to 30 to 35% of the retail price.

There were 3,569 gas stations in Jan. 2005, 3,258 in Jul. 2007 (at the end of the regulation) and 3,065 in Jul. 2010, so there were 311 net exits during the regulation and 193 net exits after the regulation ended. However these exits were not symmetric across firm types and periods.

As noted in Tables 1.3 and 1.5, gas stations from small chains or independents exited much more the gas stations from vertically integrated brands during the regulation, while after the regulation ended exit rates equalized for all types, and actually there were a few more exits from gas stations belonging to big brands. Across all market types, 22% of the small brand's gas stations exited, versus only 4% for the big brands. During the deregulated phase, 8% of the small player's gas stations exited, versus 7% for the big brands (since big brands have many more gas stations in total, the absolute number of exits is bigger for vertically integrated brands after the end of the regulation).

What is the relationship between this margin pattern and the observed exits? It seems that the regulation set the regulated price, and so the retail margin, at levels that were too low for gas stations to be profitable. Since the margin was positive gas stations could cover their most important variable cost item (the gasoline itself) but it seems the regulated retail price was not high enough to cover average costs. In the short run gas stations could continue in the market, but when it became clear that the regulation would last more than a few months, gas stations that could not finance the losses until the end of the regulation were forced to exit the market. The observed exit pattern is consistent with a long purse story (Telser, 1966). Firms can operate with short run negative profits if they have resources to finance the temporary losses. This is the case for gas stations that belong to big brands, which can provide temporary financial assistance to their gas stations in form of credit advantages to acquire gasoline or to maintain the facilities.

The question is why independent gas stations could not get some type of financial assistance to survive until better times. If there are credit constraints due to asymmetric information (Fudenberg and Tirole, 1986), when a price shock adversely affects the profitability of a firm in the short run, credit constraints and beliefs of creditors prevent the troubled firm to get credit to overcome the shock, which in turn confirms the initial pessimistic beliefs and rationalizes the action of not lending to the firm in trouble. In this way, credit constrained firms cannot survive long enough to wait until better times come and they exit the market. It seems that the low regulated price combined with problems to get credits to finance the (possibly temporary) negative profits condemned the independent gas stations.

After the regulation ended, although there were still net exits, the exit rates of big and small brands basically equalized, and most of the observed exits occurred in competitive markets, where competitive pressure is higher (see discussion at the end of section 3.2, p.17). Moreover, some gas stations could had been still in trouble at the time when prices and margins started to increase and they might not had been able to take advantage of the rising margins fast enough to overcome accumulated losses, exiting the market. It can be observed that the rising margin decreased the exit rate. Unfortunately I do not have data for a longer period of time, so I am not able to verify if the persistent higher margin was enough to stop the net exits altogether.

Unobserved heterogeneity

To test the validity of the gamma unobserved heterogeneity I use a LR test whose null hypothesis is that the variance of the gamma distribution is zero. If this is true, all gas stations have exactly the same unobserved parameter (a degenerate distribution) so the unobserved part is not important, there is no variability there. On the other hand, if the variance of the gamma distribution is different from zero, there is unobserved variability and it should be included in the model. The LR tests for the significance of the heterogeneity hypothesis reject the null hypothesis at the 1% level of significance. It should be noted, however, that the coefficients in both types of models are similar: all coefficients have the same sign and the same significance, while the size effects are in general not so different.

As a consequence I cannot discard the presence of unobserved heterogeneity. The combination of unobserved heterogeneity with a non-zero duration dependence means I have to be careful about left censoring since I may have an identification problem, and I may get unreliable estimates. Given none of the methods described above adjust to my sample characteristics, I have no option but to drop all existing gas stations at the beginning of the sample (following Ridder, 1984), and to work with the gas stations that entered the market after Jan. 2005 (even though the sample starts on Dec. 2004, I cannot identify entrants in Jan. 2005 from firms that were already in the market but did not submit the information, which may appear as new entrants in Jan. 2005, so I choose to follow entrants from Feb. 2005 on). After dropping the existing gas stations at the beginning of the sample, I have 775 gas stations, 230 exits, 66 periods and 26,156 time-at-risk observations. While I loose many observations in this step, if the results are similar I can extend the interpretation to the results obtained with the bigger sample. On the other hand, since the new subsample is much smaller, I expect the standard errors to be bigger, which may impact the ability to do inference on the coefficients, but it is a risk I have to run in order to avoid the greater and much bigger problem of identification and reliability of the coefficients. With the smaller sample the coefficients will be less efficient, but I can make sure they are consistent.

Table 1.9: Estimation results, new gas stations

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Indep.	0.314	0.395	0.354	0.419	0.342	0.338
	(0.474)	(0.506)	(0.480)	(0.522)	(0.468)	(0.450)
Esso	-0.372	-0.719	-0.795 *	-1.002*	-0.869	-1.039*
	(0.518)	(0.946)	(0.442)	(0.561)	(0.924)	(0.578)
Petrob	-0.787***	-0.969**	-1.087***	-0.884**	-1.125***	-1.166**
	(0.342)	(0.512)	(0.482)	(0.465)	(0.543)	(0.593)
Refinor	-0.847	-0.857	-1.166	-1.091	-0.764	-0.946
	(0.756)	(0.816)	(0.942)	(1.004)	(0.742)	(0.913)
Repsol	-0.954**	-1.041***	-1.213***	-1.042***	-1.293***	-1.487***
	(0.493)	(0.504)	(0.596)	(0.588)	(0.603)	(0.658)
Rhasa	2.814	2.822	2.568	2.849	2.654	2.381
	(5.756)	(5.884)	(5.680)	(5.854)	(5.717)	(5.942)
Shell	-0.687*	-1.227*	-0.866**	-0.963**	-0.735*	-1.284**
	(0.384)	(0.683)	(0.456)	(0.511)	(0.412)	(0.682)
Sol	-0.238	-0.275	-0.116	-0.128	-0.605	-0.749
	(4.475)	(4.776)	(4.253)	(4.153)	(5.624)	(5.918)
Refinery	-0.282*	-0.265*	-0.274*	-0.268*	-0.295*	-0.259*
	(0.158)	(0.148)	(0.152)	(0.149)	(0.164)	(0.142)
Mkt. size	-0.002**	-0.003**	-0.002*	-0.003**	-0.003**	-0.004**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0015)	(0.002)
Heterogeneity	no	yes	no	yes	no	yes
Baseline	logarithmic	logarithmic	dummies	dummies	splines	splines

Table 1.10: Estimation results - interaction terms, new gas stations

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Indep-interv			0.641*	0.597*	0.620*	0.688*
			(0.356)	(0.332)	(0.344)	(0.382)
Esso-interv	-0.491*	-0.512*	-0.434*	-0.677*		
	(0.261)	(0.272)	(0.258)	(0.369)		
Petrob-interv	-0.562*	-0.579*	-0.846**	-0.914**	-0.624***	-0.855**
	(0.306)	(0.287)	(0.436)	(0.462)	(0.294)	(0.378)
Refinor-interv						
Repsol-interv	-0.614**	-0.699**	-0.823**	-0.806**	-0.966**	-1.054**
	(0.323)	(0.371)	(0.438)	(0.423)	(0.508)	(0.551)
Rhasa-interv						
Shell-interv	0.449*	0.419*			0.380*	0.467*
	(0.248)	(0.221)			(0.211)	(0.259)
Sol-interv						
Heterogeneity	no	yes	no	yes	no	yes
Baseline	logarithmic	logarithmic	dummies	dummies	splines	splines

Tables 1.9 and 1.10 present the results for the regressions including only the new gas stations, that is, the ones that entered the market on or after Feb. 2005, the ones I can follow during its whole life. As I said before, these models contain fewer observations and then they do not take advantage of all the information in the sample, but they provide more reliable estimates in the presence of unobserved heterogeneity and duration dependence. In these models the standard errors are relatively bigger, so the significance of the coefficient is, in general, lower than in the models estimated using the whole sample. However, qualitative results hold: signs are equal in all cases and coefficient values are similar. Before interpreting the results I will discuss each model. In every specification the LR test for unobserved heterogeneity rejected the null hypothesis of no unobserved heterogeneity, so we should look at models 2, 4 and 6 rather than 1, 3 and 5. Second, I prefer to concentrate on models 4 and 6, the ones with a flexible specification for the baseline hazard. I have no theoretical reason, nor empirical evidence, to assume the log specification of model 2 is

the true population functional form. Given some coefficients are different from the other models, I prefer to rely on the flexible models, where I do not have to assume any particular distribution, to avoid the risk of biased estimates due to misspecification.

The results of Table 1.9 show that bigger, vertically integrated firms seem to have a lower probability of exit relative to the independent firms and small chains. In general, the coefficients of Repsol YPF, Esso, Petrobras and Shell are negative and significant, while the coefficient for the independent firms and Sol are not statistically different from zero. The coefficient of the baseline hazard is negative, so the probability of exit is smaller for the newest gas stations. For the new entrants, the process exhibits negative duration dependence. In the previous models, with all gas stations included in the regressions, I got positive duration dependence. A possible explanation is that if there are fixed costs of entry, like the cost of the land, the cost of labor [5], costs of decoration of the gas station, then a gas station that just entered the market will not exit. As long as the price remains above the fixed variable cost, the gas station will not exit, while for an older gas station, with some fixed costs already depreciated, the price that induces exit is lower, so if the price goes down, they exit first. An alternative, and I think more plausible explanation, is that a new firm may not know its own performance at the beginning: suppose that the productivity of a firm is a random variable with cdf F, $F \geq 0$ over the relevant domain. A new firm that observe a negative outcome may wait to see other outcomes before concluding that its productivity is not big enough to make a profit in the market, so it stays to see how is the future like. On the other hand, an older gas station that already knows what to expect, when facing a negative outcome may think that this is a true indication of a low productivity and then exit the market without further wait.

The coefficients of education and the proxy for income are zero, so the exit process is not affected by these variables, and I do not report them in the tables. Market size has a marginal effect: firms in smaller markets have a relatively smaller hazard rate, possibly because firms in small monopoly markets are relatively safer. However the effect size is small, so it seems that market size does not have an economically significant effect, exit is equally likely for both big and small markets, when we control for the other observables.

Table 1.10 presents the most important variables for this paper, the interaction terms. In models 4 and 6 we can see that the coefficient of the independent firms is positive and significant (at the 5% confidence level), while the coefficient of Repsol YPF and Petrobras are negative. Esso has a negative and significant coefficient in model 4 but not significant in model 6. All these result point in the same direction as before, at least qualitatively: bigger, vertically integrated firms have a lower probability of exit during price regulation, while the small independent firms are more at risk. The exception is Shell, a big vertically integrated player,

[5] There are high fixed costs when hire workers in Argentina, the compensation for firing them can be very high, no matter the cause of termination.

which is more at risk, like the independent firms. This result may be explained by institutional or political factors: Shell publicly disagreed with the pricing policy of the government and made explicit statements about its opposition to the regulation, in spite of signing ẗvoluntarilyẗhe price agreement. As a result, Shell was the brand who suffered the most the *de facto* retaliation from the government and at one time, the President of Argentina call to boycott Shell products in 2005, during the prime time, on national television. The other second-tier firms didn't follow Shell's complaints, and that may have had an impact in the observed results.

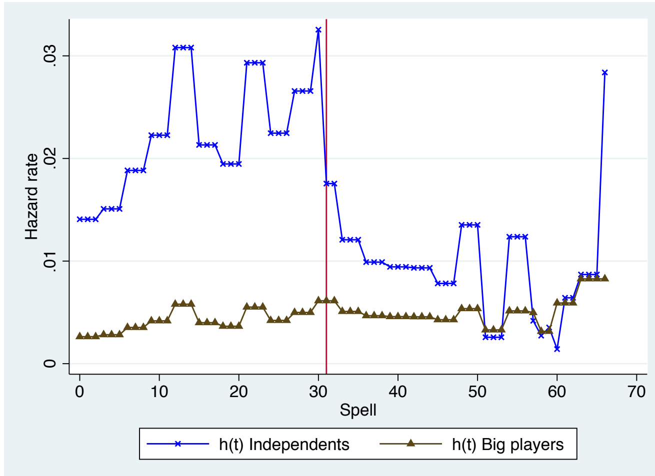
Refinor, which is vertically integrated, and Sol, the smallest chain of all, do not have enough entrants after Feb. 2005 to draw statistically significant conclusions. Most of their gas stations, and almost all of the ones that exited the market, come from before Dec. 2004 and thus are not included in this reduced subsample. The small number of observations makes the standard errors big relative to the estimated coefficients so I cannot find significant results for these two players.

However, all models present the same trend: the price regulation has non-neutral results on firms. The price regulation clearly affects the risk of exit of different brands in different ways, and it seems to favor bigger, vertically integrated firms against the smallest firms. The story seems to be consistent with a long purse story (Telser, 1966) combined with credit constraints due to asymmetric information (Fudenberg and Tirole, 1986), where a price shock adversely affects the profitability of a firm in the short run, and credit constraints and beliefs of creditors prevent the troubled firm to get credit to overcome the shock, which in turn confirms the initial pessimistic beliefs and rationalizes the action of not lending to the firm in trouble.

Another possible explanation for the results is that new firms with experience in the market tend to have higher survival rates (Eriksson and Moritz Kuhn, 2006). Their paper analyzes start-up firms and they found that firms that are born from an experienced parent firm, or start-ups created by workers with experience in the industry have higher survival rates than other start-ups. In my case, I can say that new gas stations from bigger, vertically integrated chains are new players with more experience in the market. This is certainly the case for the gas stations operated directly by the companies, but it may also be the case for the franchised gas stations. Brand companies help its franchisees with financial help, marketing tools and promotional campaigns, etc. On the other hand, independents have fewer tools and a much smaller network to draw experience from. In this sense, they have are less experienced and they face a higher risk of exit.

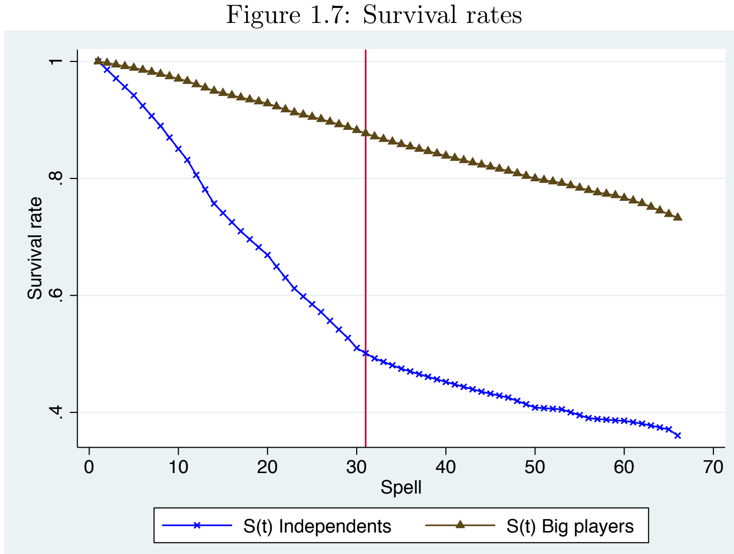
Figures 1.6 and 1.7 show the predicted hazard rates and survivor functions for the independent firms and for the big, vertically integrated firms. The figure was made for a typical firm of each brand, in market of average size. It is very clear that the independent firms are more at risk at all times, but more importantly, these firms are much more at risk during the regulated period. A typical small firm who is in the market at

Figure 1.6: Hazard rates



the beginning of the sample has a 50% chance of making it to the end of the regulated phase, while a typical big firm has a 90% chance of still being in the market by July 2007. At the same time, Figure 1.6 shows that *conditional of having reached July 2007*, the chances of being in the market at the end of the sample are much more similar for both types of firms (76% for independents, 84% for big firms).

Figure 1.7: Survival rates



It is remarkable the fall in the hazard rate for the independent firms after the regulation was removed. While during the regulation the hazard rate for the small firms is about 3 times higher than the hazard rate for the vertically integrated firms, after the regulation ends the hazard rates tend to equalize. The hazard rate of the smaller firms is still slightly higher, but the difference is negligible compared to the previous period. The independent-during-regulation interaction variable captures this effect.

Figures 1.6 and 1.7 show the predicted hazard rates and survival functions for a typical gas station in the sample. However, hazard rates may depend on age, time of entry and other gas station specific variables. It is worth analyzing if newer gas stations, the ones that entered the market after Dec. 2004 and for which I can track their whole life, follow the predicted patterns. Figures 1.8 and 1.9 show the predicted hazard rates and survival functions for a typical *new* gas station. I analyze the hazard rate and survival function of three cohorts: gas stations that entered the market during 2005, during 2006 and during 2007. I grouped the new entrants in cohorts according to the year of entry, rather than month of entry, in order to have enough individuals in each cohort. There are 199 entrants during 2005, 180 during 2006 and 114 during 2007. Choosing for example the entrants in March of 2005 only would generate a cohort of 21 gas stations, and any event (exit) within this group would represent a hazard rate of at least 5 per cent which is too high compared with the rest of the estimations, not because it is really so, but because it was estimated from a very small cohort to begin with. Note that the predicted hazard and survival rates end before for the 2007 cohort than for the 2005 or 2006 cohorts, since I can not track them in my sample for as many periods as the older cohorts.

Figure 1.8: Hazard rates

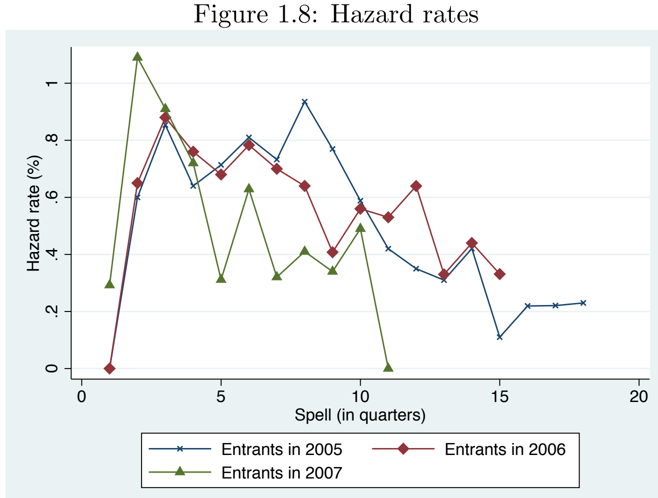
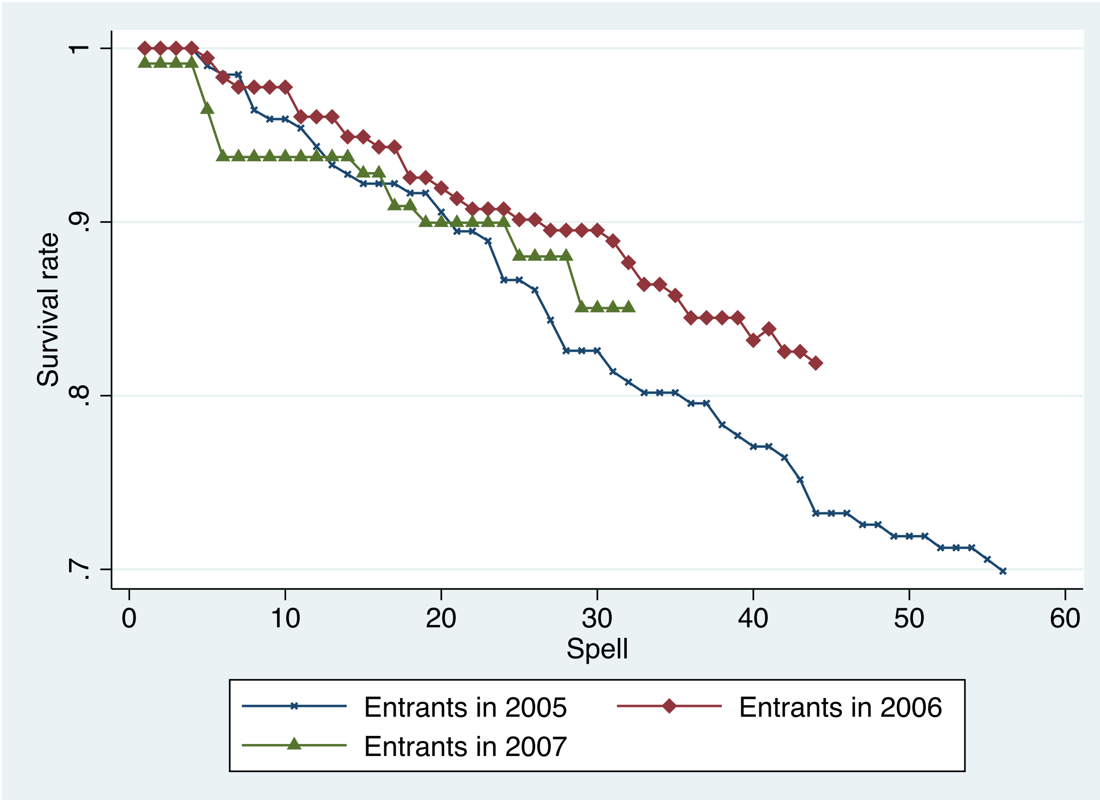


Figure 1.8 depicts the hazard rates by quarters, rather than months, because there are few exit episodes and there would be too many months with a zero hazard rate. Choosing quarterly averages smooths the estimates and generates more reliable numbers. The hazard rate of the new entrants is very small (practically zero) during the first quarter, then jumps to high levels (between 0.6% and 1%) in the following quarters. For those gas stations that did not exit by the 8th. to 10th. quarter, the hazard rate diminishes and seem to converge to the hazard rate for a typical gas station in the whole sample, around 0.2% by the 15th. quarter.

There is a clear duration pattern for gas stations. Almost no exits for the first 2 to 4 months in the

Figure 1.9: Survival rates



market, then a marked increase in the hazard rate for the next 5 to 15 months and then a decrease in the hazard rate until the 30th month in the market, after which the duration is relatively constant. The rationale behind this pattern is that for gas stations, one of the most important determinants of success is location. After three to six months in the market, gas station owners realize the true potential profitability of the location they have chosen and then they can make the stay/exit decision with more information. The hazard pattern for new gas stations show that there is no monotone duration dependence path. There is a significant positive time dependence at the beginning, when owners are still trying to determine the long term profits. After the bad locations are revealed, there is negative duration dependence for the gas stations that remained in the market, which converges to a basically constant hazard rate after 40 months in the market. The duration dependence of gas stations may actually be determined by the location choice more than by any other characteristic of gas stations. The results for the new gas stations in Argentina support this hypothesis.

For gas stations in Argentina, the biggest hazard starts a few months after entering the market. For the very first months only a few of them exit, probably because they do not know if they are really unprofitable or they are experiencing bad, transitory shocks. After three to six months in the market they seem to learn their true profitability, or they do not have additional financial capacity to bear losses and the worst performers start exiting the market. For the ones that survive two to three years, the hazard rate seems to converge to the hazard rate of the average gas station in the sample.

1.6 Conclusion

In this paper I tried to study the effect of a price regulation on incumbent firms, to determine if it affects all firms in the same way. The standard analysis of price regulation focuses on the consumer and quantities traded, but not on the long run effect of such regulations, in particular, it does not concentrate on the effect the regulation has on different types of firms in the market. My paper tried study whether the regulation was neutral or not, in terms of the probability of exit of different types of firms.

Applying a duration model for discrete, time varying covariates to a sample of gas stations from Argentina, from 2005 to 2010 I found that the exit process of the Argentine gas stations is not equal for all firms, the chances of survival are better for gas stations of big brands which own a refinery. The hazard ratio is on average 3 times higher for the independent gas stations. Moreover, small firms are relatively more at risk during the regulation phase. As time goes by the risk seems to increase for the firms that remain in the market, and it seems that firms faced a higher risk immediately after the regulation period ended, towards the end of the sample the general risk for an average firm seems to decrease.

The main result of the paper is that the price regulation seems to have had an effect in the long term market equilibrium. After the regulation ended, the geography of the market was not the same. Independent firms and smaller chains that own no refinery have disappeared, leaving the bigger players in the market in a better relative position. I can say that the price regulation is capable of altering the market shares (measured by the number of gas stations of each brand) and then it has a non-neutral impact on the behavior of firms after the regulation. More concentrated markets may have higher prices, and then consumer will be worse off in the long run. Even when it is possible that consumers are better off in the short run with a regulated price, consumers may clearly be worse off in the long run, because the market is more concentrated after the regulation is lifted. Of course, there is not a one to one relationship between market concentration and higher prices, but the likelihood of observing a higher equilibrium price is strictly positive. Hence, the dynamic effects of market regulation should be carefully considered when thinking about implementing a price regulation.

Chapter 2

Long Run Effects of Market Price Regulation: Prices in the Argentine Gasoline Market After the End of Regulation

2.1 Introduction

Very few studies analyze pricing decision under market price regulation for retail markets. While pricing decisions are very limited during a price regulation, it is important to understand how firms react when the regulated price is eliminated. I analyze the pricing decision of gas stations in Argentina under two different regimes: when they faced a maximum price imposed by the government, and when they were free to set their prices, using a dynamic panel specification.

Retail gasoline prices and margins are almost all the time in the public agenda. The public and the government are very sensitive to big changes in gasoline prices since gasoline is perceived as a critical good for the economy as a whole. Its price affects directly the cost of living of households and many industries' costs where gasoline is a key production input, hence affecting social moods and capturing political interest. This political attention sometimes translates on attempts to regulate the industry, attempts that are justified on the grounds of "strategic importance" or market concentration that requires government intervention to solve a market failure. As of the end of 2012, the gasoline market was regulated in Austria, parts of Australia, many provinces of Canada, China, Luxembourg, Mexico and Venezuela. Denmark and Germany were discussing possible plans for regulation. In the US, the issue was debated in the early 90s after the price increases that followed the crisis in Kuwait.

Prices in the retail gasoline market are also the subject of continuous attention in the empirical industrial organization literature. Key industry characteristics such as the number of players and data availability on prices, entry, exit and firm location have generated many studies regarding the nature and extent of competition. An important branch of this literature has tried to detect, or at least infer, the exercise of market power by analyzing dynamic paths of retail gasoline prices and margins. Bacon (1991) for the U.K. and

Karrenbrock (1991) for the U.S. were among the first to study the asymmetries in the responses of gasoline prices to increases and decreases in the upstream price. They found that upstream increases generated faster and bigger retail price increases than similar decreases in the upstream price. These asymmetric responses can be generated by search costs (Tapatta 2009) or by a combination of search costs and local market power (Deltas 2008), or product differentiation by branding which may be associated with market power (Verlinda 2008). Borenstein and Shepard (1996) use retail price dynamics and in particular the effects of future (predicted) changes in demand and retail margins to test for behavior consistent with collusion in the cities of U.S.

However to the best of my knowledge there are no studies of gasoline prices after an episode of government regulation. The literature on gasoline price dynamics has always focused on regulation-free markets. Since government intervention is a latent possibility from time to time in countries like the U.S. and Germany and it actually happens in many countries, both developed and developing, it is useful to understand what would change in the industry when the regulation is lifted. Regulations, as common as they are, in general are not in place forever. Changes in political parties in office, political views or society moods towards government intervention may cause regulations to be eliminated. Argentina, which removed its regulation in 2007 and China, which is discussing mechanisms to lift the regulated price are good examples that illustrate the finiteness of price interventions. An understanding of the effects of removing the regulation can be a very valuable input ex-ante, when discussing the implementation of a price intervention.

There is a huge body of literature on the effects of deregulation in other markets. Most of these studies were dedicated to understand the effects of the deregulation wave of the early 1980s in the U.S. airline, railroad and telecommunication industries. However, the nature of deregulation in these industries differs from the one in the gasoline industry. While gasoline prices are constrained by a cap which allegedly protects consumers from "unfair, above competitive prices," the prices in the regulated industries were established by a regulator which usually protected producers. Winston (1993) states that "The effects of deregulation were expected to be different in the petroleum industry form other industries discussed here. This is because, unlike the usual case in which producers were supposed to benefit from regulation at the expense of consumers, in the petroleum industry regulation was opposed by and was expected to hurt producers." On the other hand, Rubinovitz (1993) show that after deregulation cable companies were able to effectively exercise their market power. The increase in cable prices, possible due to the elimination of the regulated price, hurt consumers and was compatible with tacit collusion.

The contribution of my paper is two-fold. First I analyze retail gasoline price dynamics both during and after government regulation. While dynamics under price regulation are almost trivial, i.e. prices are strictly bound by the regulated level (assuming full compliance with the regulation) it is not clear what would happen after the price regulation ends. Do firms revert to unconstrained, market equilibrium price? In case of an affirmative answer, how long does it take to get to the new equilibrium? Or do firms remain closed to the now extinct regulated price level? Second, I use station level information on prices and margins which allows me to analyzed price dynamics at the gas station level, extending the analysis beyond Deltas (2008) and Borenstein and Shepard (1996) who are constrained to use market averages rather than individual firm information.

On the other hand, as in Deltas (2008) and Borenstein and Shepard (1996), I will search for evidence of price patterns consistent with non-competitive behavior and the exercise of market power. Long periods of price regulation may change either the market structure (i.e. there may be fewer firms in the industry or in the case of firms with many plants, either fewer plants or even fewer chains) or the conduct of the remaining firms in the market because collusion is easier to sustain with fewer firms. In the first chapter of my thesis I showed that after the price ceiling was lifted, (i) there were fewer gas stations overall and (ii) exit was not neutral, certain chains were clearly more at risk of disappearing. In particular, small independent retailers and non-vertically integrated small chains faced a risk of closing about 3 times higher than the bigger, vertically integrated producers. These small retailers were considered a key factor to foster the competition in the retail gasoline market (CNDC, Argentine Antitrust Authority 2001, Hastings 2004) so a natural question is whether the disappearance of these sellers could ex-post be associated with price dynamics consistent with non-competitive behavior .

The second section of this paper discusses the role of price regulation and explains the reasons and mechanics of the gasoline price regulation in Argentina. The third section describes the estimation methods, the fourth section presents the results and discussions and the fifth section offer concluding comments.

2.2 The Role of Price Regulation

In a perfectly competitive market there are no apparent reasons to regulate market prices. Equilibrium prices are Pareto optimal and they imply an efficient allocation of resources.

The need for regulation comes from market imperfections such as the existence of market power, externalities or information asymmetries that prevent the equilibrium to be a Pareto optimum. In the case of existence of market power, regulation usually place limits on the prices to limit the use of this market power by incumbent suppliers. The most common forms of price regulation are price caps or cost-plus rules. Both forms have been widely used across countries, industries and times. In the US, before the deregulation wave of the early 1980s industries such as railroads, telecommunications, airline travel and utilities in general were regulated. Even after the deregulation of the 1980s some industries continued to be regulated: residential energy prices, taxicab fares are examples of retail prices that face some form of regulation, and access prices in telecommunications constitute an example of a wholesale price subject to government regulation.

The objective of the regulation is to replicate the first best equilibrium that may not be achieved due to the market imperfections. Government regulation was expected to correct the allocative consequence of market failure and to improve efficiency and society's welfare. The existence of market power would generate prices above the social optimal prices, so it is necessary to regulate prices to set them at the competitive level in order to achieve the social optimum.

However the existence of market imperfections does not justify by itself the need for regulation. We know that these imperfections may cause the market equilibrium to be different from the optimal one, but there are no guarantees that government's regulation of market activities will achieve the desired first best outcome. In the first place, the government may not have all the information necessary to replicate the competitive equilibrium. Secondly, it has long been established that once a market imperfection prevents achieving the first best outcome, it is no longer sufficient to fulfill all other $(n-1)$ conditions in order to obtain the Pareto optimal equilibrium. In the words of Lipsey and Lancaster (1956):

"there is no a priori way to judge as between various situations in which some of the Paretian optimum conditions are fulfilled while others are not. Specifically, it is not true that a situation in which more, but not all, of the optimum conditions are fulfilled is necessarily, or is even likely to be, superior to a situation in which fewer are fulfilled. It follows, therefore, that in a situation in which there exist many constraints which prevent the fulfillment of the Paretian optimum conditions, the removal of any one constraint may affect welfare or efficiency either by raising it, by lowering it, or by leaving it unchanged."

Moreover, regulation is not necessarily implemented by a benevolent, welfare maximizing government. The public interest theory of regulation assumes the government and its regulatory bodies are only motivated by the whole society's interests, their only objective is to maximize the social welfare. Under this theory, governments regulate markets to correct market imperfections and they do not react to pressure from interest groups. However, it is fair to ask: Is the ultimate goal of regulation to pursue some conception of the general good, however mean-spirited, messy, and confused the process may seem at any given time? Or is regulation simply an arena in which special interests contend for the right to use government power for narrow advantage? (Levine and Forrence, 1990). Governments create regulatory authorities that may have their own objectives and/or may be captured by interest groups. The theory of regulatory capture states that collective action can be used to capture the regulator, which is acquired by the industry and is designed and operated primarily for its benefits (Olson, 1965). Additionally, an interest group has more power when its interest lies in inefficient rather than efficient regulation (Laffont and Tirole, 1991).

Welfare effects of regulation, therefore, should be carefully evaluated. Market imperfections may make market regulation desirable, but as explained before, regulation cannot be expected to improve imperfect market outcomes without further analysis. Good intentions when establishing a regulatory regime may be overcome by interest groups and asymmetric information on the part of the regulator. A regulatory regime will clearly influence market prices, entry and exit patterns and firm conduct.

2.2.1 Reasons and short-term effects of price regulation in the gasoline market

The gasoline market has always been under suspicion of non-competitive behavior. In spite of the presence of many sellers and buyers at any given market, the presence of key industry features allow, or at least make possible, non-competitive behavior. In the first place, although there are many gas stations at any given market, they generally belong to one of a few big brands, so the number of gas stations not always reflects the true number of competing firms. Secondly, competition is localized (Pinske and Slade 1998, Slade et. al 2002) which in turn reduces even more the number of players. Finally, vertical integration plays a critical role by influencing wholesale prices, vertical contractual relations and the role of small independent players in setting prevailing retail prices (Slade 1998, Hastings 2004).

A large body of literature focuses on trying to establish whether firms in this industry act competitively or collude to raise prices above the non-cooperative equilibrium. For the US, Borenstein and Shepard (1996) and Deltas (2008) found dynamic price margins that are consistent with the exercise of market power. Moreover, Borenstein (1991), Shepard (1991) and Hastings (2004) found evidence of non-competitive behavior. For Canada, Slade (1992) found evidence of tacit collusion in the city of Vancouver. For Argentina, Coloma (2002, 2003) cannot find evidence of non-competitive behavior although he did not rule out this possibility. Serebrisky (2000, 2003) found some evidence of the exercise of market power and the Antitrust Authority (2000) found that vertical integration was affecting retail prices.

In Argentina the gasoline market has great political and economic importance. Gasoline prices affect the inflation rate both directly, through higher prices for all types of drivers and indirectly, affecting the cost structure in all other markets in the economy. In particular, is very important for the agricultural sector and its competitiveness: it is a key input in the cost structure, since all tractors, trucks, etc. used in the crop and distribution use gasoline. The political and economic relevance of this market historically attracts government attention. All governments of all political parties follow closely the gasoline market, whether or not they directly intervene in the market.

In 1998 the Antitrust Authority in Argentina initiated an investigation to determine if firms in the gasoline market acted in a coordinated way to intentionally raise prices above the non-cooperative levels. The concluding Report (CNDC, Argentine Antitrust Authority, 2000) found no direct and incriminating evidence of tacit collusion but suggested imposing limits on vertical contractual relations, in particular it limited the number of years a non-company owned station could be in an exclusive relationship with a wholesale brand. [1] For some years this vertical restriction was the only regulation in place in the Argentine gasoline market.

By 2004 the price has increased to unacceptable levels to the government. Fearing political costs and aware of the influence of the price of gasoline in all other prices of the economy, the government decided to regulate gasoline prices. The formal argument was that market concentration, jointly with the observed retail price well above the import parity proved there was a non-competitive conduct. There was never an official investigation by the antitrust authority.

2.2.2 The mechanics of the Argentine price regulation for gasoline

This short subsection aims to explain the institutional arrangements of the gasoline price regulation. They were not the traditional fixed maximum price, so it is worth explaining them to help the reader understand how the regulation worked.

Strictly speaking, there was never a law, decree or direct mandate from the government that explicitly set a (fixed) maximum price. The institutions of the price ceiling were more subtle, and even though they were never been written anywhere, they were respected by all players (see the retail price series in section 6 below) in all markets. Of course without rules, one may wonder what incentives firms have to respect the regulation. There actually were some incentives.

First, all firms sign voluntary bilateral agreements with the Government, in which they committed to maintain the prices at the pump. Since these agreements were voluntary, there was no punishable enforcement, the Government never issued a set of rules establishing what would happen if those agreements were not respected, but unofficially the firms that were suspected of deviating, or intending to deviates, received more visits by inspectors of the tax revenue enforcement office (AFIP). In second place, the government established export quotas for crude oil and its derivatives which had a huge impact on the business of the biggest players in the market, who owns many of the concessions to explore and extract petroleum in Argentina. These quotas were flexible, could be relaxed to a certain extent, if the firms proved to the

[1] In Argentina, wholesale brands are the most important players, which are vertically integrated along all the production chain. The four biggest brands own all the refineries of the country, have wholesale distribution units and own many of the gas stations.

government they maintained the prices in the domestic market. For these big firms, maintaining the ability to export crude oil during a period of increasing oil prices was more important than trying to increase the price of retail gasoline in the domestic market. Finally, there were direct government actions against the firms that didn't show an understanding of the situation. As an example, in 2004, when Shell was not sure about abiding by the policy, the President of the country made public appearances during the prime time, in national television, and with ads in the main newspapers of the country, calling the population to boycott all Shell products.

Again, this was a *de facto* price regulation, but it was a successful one. The series of domestic retail gasoline prices shows a remarkable stability from the beginning of the sample, Dec. 2004, when the price cap was in place, to July 2007 when the regulation was abandoned by the government. Even though retail gasoline prices were not formally regulated, the informal regulation was as effective as a formal one in constraining the market prices.

2.3 Data

I used two different databases from the gasoline industry in Argentina, one with retail data collected at the gas station level and another with upstream data collected at the terminal level. Even though the databases are not directly related, that is, there is no link between observations in one database with the observations of the other one, both databases were originated from the same Government Ordinance, the Secretaria de Energia's Resolucion SE 1104/2004 (Argentina's Secretariat of Energy). The Ordinance binds gas stations and terminals to submit monthly information on prices and quantities, among other market indicators. All gas stations and terminals are required to submit a standard form with the information required by the Ordinance RES SE 1104/2004. This requirement is mandatory. If the owners of the gas stations do not submit the form for month m, they have to do it by the end of the month $m+1$ or they face penalty fees. If firms do not submit any information for a period greater than six months (and they are still doing business) their license to operate could be suspended.

At the retail level, I have data from most of the gas stations in Argentina[2], collected monthly by the Secretaria de Energia from December 2004 to August 2010, that is, 69 consecutive months.

The database contains, for each gas station, basic information which allows identification, location and affiliation (or not) with a brand: its legal name, the brand of the gasoline they sell, if any (they are considered independent if they don't sell any particular gasoline brand), the physical address, city and province. It

[2]RES SE 1104/2004 requires all gas stations to submit the information, however, the information is self-reported, therefore I cannot be completely sure that all gas stations submit their forms. That is why I claim to have information on most gas stations, rather than all gas stations.

also contains the prices, in ARG pesos, for the following products and types of buyers: gasoline with less than 92Ron, gasoline between 92 and 95Ron and gasoline with more than 95Ron, sold to the public, to the agricultural sector or to the transportation sector, either passengers or freight. The distinction between markets is relevant because the agricultural and transportation sectors receive their gasoline with a subsidy from the Federal Government: the gas station receives a lower price form these customers and then has the right to pay a lower price to the wholesale distributor, which in turn receives the compensation from the government.

At the wholesale level I have data from most of the terminals operating in Argentina (the retailer's database caveat also applies to the wholesale database, the information is self-reported). The wholesale database contains the same basic information than the retail database, hence I can identify the location and affiliation of every terminal. For each terminal in Argentina I also have information on volume (in m^3) sold per month and the prices charged to different types retailers: to the gas stations that are affiliated with the company that owns the terminal (in case it is vertically integrated, or has exclusive contracts with gas stations) and to other brands or to independent, non-affiliated retailers. Finally, I have information on the prices charged to retailers based on final sales to different segments: to the general public, to the agricultural sector or to the transportation sector. The prices are in ARG $ so they are comparable with the prices from the retailers' database. There are 103 terminals in the 24 provinces of the country, and there is at least one terminal in each province.

Both retailers and wholesalers have to follow the same procedure to report the information to the Secretaria de Energia: they have to log in the website created by RES SE 1104/2004 either as a retailer or as a wholesaler, and fill in an online form informing the spot price during the last Friday of the month, with and without taxes, as well as the average monthly price, including taxes and the quantity sold during the calendar month. All firms are required to submit the online form with data from month m within the first 10 calendar days of month $m + 1$.

I will concentrate on the market for gasoline between 92 and 95Ron sold to the public since it is the bigger market. Only old cars use gasoline with less than 92Ron and the main player in the market, Repsol-YPF, has announced on April 2011 that it will discontinue the production and commercialization of this type of gasoline starting on July 2011. The gasoline with more than 95 Ron is used mostly by the newest vehicles and it's a new product. It was developed and commercialized in a big, national scale only after 2007, and I cannot track sales and prices for this product from the beginning of the sample. The sales to the agricultural and transportation sectors are not included in my final sample since only a few gas stations agreed to the system, about 200 of over 3,500, and their exit decisions may differ from the rest.

I chose to start the analysis in January 2005 rather than in December 2004 since the latter month was the first month when gas station owners and terminals had to submit the information. As a consequence, I observe that many existing gas stations that were not familiar with the ordinance did not submit the corresponding form. [3]For the same reason, I dropped the last month of the sample. I don't have a way to determine if a gas station that is in the market in July 2010 but not in August 2010 actually exited the market or just didn't turn in the form in August. [4]

There are data problems than need to be addressed. In the retail database, there are inconsistencies in the data entries. Some price observations are outside the normal range for observed prices. For the whole sample the average price is ARG pesos, 1.44 per liter, while for the last month of the sample, July 2010 is 2.40. In the sample there are prices above 8.00 pesos, and it is hard to believe such a price can attract any buyers given the substantially lower prices available at other gas stations. To take care of this problem, I proceed in two steps: first, I take the standard deviation of gasoline prices by month, and second, I calculate average prices by months and cities. Finally, I eliminate observations for which the observed price exceeds the average month-city price plus 3 standard deviations. I calculate the standard deviation in month m using the whole sample rather than individual cities because most of the cities in my sample contain very few observations, in general less than 10, for the city-based standard deviation to be reliable. I also eliminate observations with prices or quantities equal to 0 and gas stations that are present more than once in a given month. After eliminating the problematic observations I end up with 3,569 gas stations and 452 terminals at the beginning of the analysis and 3,003 gas stations and 443 terminals at the end of the sample.

Table 2.1 contains summary statistics for the main variables. All prices are in ARG pesos and the quantity sold in m^3.

[3]There were 3,477 gas stations in December 2004 and 3,569 gas stations in January 2005, that is, a net entry of 92 gas stations. It is possible that the significantly higher number of gas stations observed in Jan 2005 were new entrants. However, there is no evidence of such a high number of entrants in any other month of the database, so it is highly likely that these new gas stations were actually gas stations still not familiar with the requirements of the Ordinance which did not submit the information corresponding to Dec. 2004. They familiarized with their obligations after some time, and by Jan 2005 they appear for the first time in the database, although they were not new to the market. Of course, some of these new sellers must actually be new to the market, but I have no way to separate these two classes of gas stations, so I prefer to drop the first month of the sample altogether.

[4]There were 3,065 gas stations present in July 2010 and 3003 in August 2010, a net exit of 62 gas stations, or about 2% of the market. Numbers for previous months (3,085, 3,078, 3,073 for Apr., May and Jun. respectively) suggest 62 exits is too much for the observed pattern. Probably part of these 'exits' are gas stations that did not send the information, so they are not in the sample, but they are still in the market.

Table 2.1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
$Retail_t$	1.467	0.439	1.078	2.413
$Wholesale_t$	1.079	0.278	0.800	1.887
$\Delta Retail_t$	0.019	0.033	-0.095	0.103
$\Delta Wholesale_t$	0.013	0.046	-0.251	0.293
$Quantity_t$	68.18	101.39	4.122	341.8

2.4 Econometric model

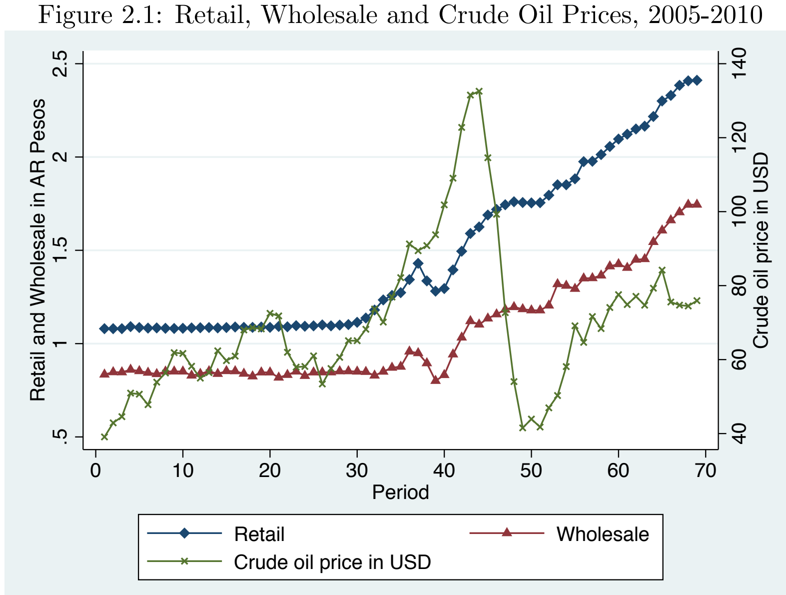
The econometric model I use follows closely the specifications used by Borenstein and Shepard (1996), Borenstein, Cameron and Gilbert (1997) and Deltas (2008). These papers use a dynamic panel specification for either retail prices or retail margins, and model the dependent variable as a function of lagged changes in wholesale and retail margins and an error correction term.

However, there are two important differences. First, I do not use an asymmetric response model, and second, I do not use world crude oil prices as a reference for either the wholesale or the retail price. I do not use an asymmetric response model because the observed price paths do not exhibit almost any drops in prices. For the first 30 months of the sample period the retail price was regulated and it exhibited no variation: the average price in the sample varies from 1.077 pesos per liter in Jan. and Feb. 2005 to 1.094 pesos by the end of the regulated period, in June 2007. During the deregulated period, from July 2007 to Aug. 2010 there were 32 monthly increases, only 3 monthly decreases and another 3 months without changes in the average retail price. Three decreases are too few to estimate any reliable separate parameter for price decreases, so I prefer to impose the restriction that the coefficients for price increases and price decreases are equal. Here I deviate from the established results in the literature, but given the observed retail price pattern in my sample, it is reasonable to assume that there are no differences in the responses of the retail price of gasoline to increments or diminutions in the wholesale price.

The second important difference with the previous literature is that I do not use the world crude oil price as a reference for wholesale or retail prices. The regulation of the gasoline industry in Argentina was not limited to the retail sector. The government correctly anticipated that a regulated domestic price could not coexist with a free import - export price: local producers would have no incentive to sell in the domestic market when they could sell in the international market for a higher price. It was necessary to separate the domestic and international markets, so the government also imposed regulations in the production sector.

Any producer who wanted to export crude oil to take advantage of the higher international prices would need to sell first a pre-fixed quantity in the domestic market, at the domestic prices, before it could obtain permission to export crude oil. Any refinery owner who decided to import crude oil to sell in the domestic market could do it, at a subsidized price, with previous authorization from the government. The importer would submit a request for permission to import crude oil and commit to sell it in the domestic market. Once the authorization was granted, the importer paid the full international price to the international seller and it would get a fiscal credit from the government in order to be compensated for the difference between the higher import price versus the lower domestic resale price. Because of the combination of quota restrictions for exporters of oil products, and tax advantages to compensate importers, the crude oil price did not affect significantly either retail or wholesale prices. The correlation coefficients between the crude oil price and monthly averages wholesale and retail prices are 0.27 and 0.21 respectively. That is why I do not include the crude oil price in the regression, or as instrument of endogenous variables. This broken relationship between crude oil and domestic prices is illustrated in Figure 2.1 below.

Figure 2.1: Retail, Wholesale and Crude Oil Prices, 2005-2010



Another important topic is how to model the possibility of non-competitive behavior. As discussed previously and as established by many other authors, gas stations can enjoy local market power. Once we know some degree of market power is possible, it is worth trying to determine whether there is tacit collusion or not.

It is very difficult to detect collusion just by using current, static information about cost and demand (Bresnahan 1989). Since non cooperative behavior is consistent with many different equilibria, it is hard to identify episodes of collusive behavior. Rotemberg and Saloner (1986) and Haltiwanger and Harrington (1991) use dynamic information to infer collusive behavior. In both models collusive margins, and hence prices, respond to future demand (and possible future cost, which also affects future profits).[5]

Collusion is possible when there exists a punishment for the firms that deviate from the collusive price. The idea is that a cheating firm will earn extra profits during the deviation phase, and it will earn lower than collusive profits during the punishment phase. In order to prevent deviation, punishers must make the discounted future value of the forgone profits due to punishment at least as big as the extra, instantaneous profits obtained by cheating today. Of course, in order to inflict the punishment the punishment itself should be optimal for punishers, who are earning, too, lower than collusive profits. The conditions under which punishments are possible or not are beyond the scope of this paper. I will just assume that some punishment is possible and rational, in order to sustain collusion at some point. [6]

Rotemberg and Saloner developed a multi period model in which firms face a demand with a random component that is i.i.d. across periods, and the punishment is a return to non-cooperative pricing. In their model when a firm faces a high demand, it has incentives to deviate, since the i.i.d. assumption implies that the unusually high demand today (and hence higher profits from deviation) will have no influence in the demand tomorrow. The expected future value of the forgone profits during the punishment phase are not big enough to compensate the current profits from deviation. Hence, during high demand periods, the only way to prevent collusion is by lowering the extra profits from deviation, that is, the maximum collusive profit during high demand periods should be lower than collusive margins during periods with normal demands.

Haltiwanger and Harrington (1991) based their model on Rotemberg and Saloner but they use a deterministic demand cycle. Borenstein and Shepard (1996) summarize very clearly the intuition behind the Haltiwanger and Harrington model:

> Consider two periods, t_i and t_j with equal demand. Because current demand is equal, the gain from deviating is equal. Suppose that demand is increasing at t_i and declining at t_j. Near-term, future collusive profits are, therefore, expected to be higher at time t_i than at t_j. Because near-term profit is weighted more heavily in evaluating the present value of future profits, the expected collusive profit forgone by deviating is higher at t_i. With punishment profit constant by assumption, this means that the loss from deviating will be higher at t_i. The highest sustainable collusive margin will therefore be higher at t_i than at t_j...

[5] Without further data or explicit proof, it is not possible to determine if there is an act of collusion that would violate antitrust laws or just an equilibrium with tacit collusion resulting from repeated interaction. Since I cannot make the distinction in my sample, I prefer to use the term tacit collusion to refer to outcomes when the observed prices are above the non-cooperative equilibrium.

[6] See Abreu, Pearce and Stacchetti (1986, 1990) to analyze the conditions under which a punishment phase may exist and it is rational for the punishers.

In both cases the conclusion is that margins and prices will react to future demand and costs, so it is worth including a term in the model that allows prices to be influenced by future changes in demand and costs.

The models discussed postulate that to study the behavior of the firms it is necessary to have information on prices, margins, costs and demand, both current and future, and possibly other variables that affect margins.

$$Margin_{ict} = f(Q_{ict}, Q_{ic(t+)}, C_{ict}, C_{ic(t+)}, X_{ct}, X_t, X_c) \tag{2.1}$$

where the $t+$ indicate future periods and X are other variables that affect margins that vary according to city and time, city only and time only.

Besides the future, which is relevant by the theoretical models, the literature emphasizes the importance of past changes in crude oil prices, wholesale prices and retail prices. The equation to be estimated is the following:

$$\begin{aligned}\Delta RET_{ict} = \beta_1 \Delta W_{ict} + \beta_2 \Delta W_{ic(t-1)} + \beta_3 \Delta W_{ic(t-2)} + \beta_4 \Delta RET_{ic(t-1)} + \beta_5 \Delta RET_{ic(t-2)} + \\ + \beta_6 EXPQ_{ic(t+)} + \beta_7 RET_{ic(t-1)} + \beta_8 W_{ic(t-1)} + \gamma_t + \gamma_c + \epsilon_{ict}\end{aligned} \tag{2.2}$$

where W_{ict} is the wholesale price for gas station i, in city c at time t, $\Delta(Z)$ represents the first difference of the variable Z, $(Z - Z_{-1})$ and the δs are time and city fixed effects. The term $EXPQ_{ic(t+)}$ captures the idea that future demand is relevant to determine the retail price under tacit collusion.

The equation models the change in the retail price for gas station i at city c during period t, as a function of current and past changes in retail and wholesale prices, as well as the expected future volume plus an error-correction term represented by $\beta_7 RET_{ic(t-1)} + \beta_8 W_{ic(t-1)}$ which captures the tendency for the retail and wholesale prices to return to their long term relationship.

The dependent variable of my analysis is the change in the retail price, which depends on changes in its own value and the changes in the wholesale price. Even though I can observe the retail price charged by every gas station at every time in my sample, I cannot observe directly the wholesale price paid by gas stations. I have no links between the retail and the wholesale databases, in particular, I do not know which terminal sells to gas station i, nor which gas stations buy from terminal r. To determine the appropriate wholesale prices for gas station i at city c in period t I use the own-brand wholesale price at terminal r in city d, the closest city to c where a terminal who belongs to the same brand as gas station i is located. If gas station i is independent, or belongs to a brand that is not vertically integrated, I use the wholesale price in city g, the closest city to c with a terminal. I use the wholesale price charged to gas stations not belonging to the same brand of the terminal.

Before continuing the discussion, it is worth noting that the retail price is influenced not only by the wholesale price, but also by other cost components. Assuming that fixed costs are relevant for the entry exit decision, but not for pricing decisions, we are left with the variable cost components. In the retail gasoline industry, the main variable cost components are the wholesale price of gasoline and labor costs. I do not have information on labor costs at the gas station level, but the labor in the Argentine gas stations is highly unionized and the collective agreements have national scope. I will also assume that the technology in this industry is standardized across gas stations and that the average labor cost is constant. Then, the only variable input able to generate changes in the marginal cost, a hence the retail price, is the wholesale price of gasoline. This assumption is common in the literature.

The next step is to clarify important concepts for the analysis. In particular, I need to define the market for each gas station, explain why gas stations production costs are represented exclusively by wholesale prices and explain how to obtain the expected quantity term.

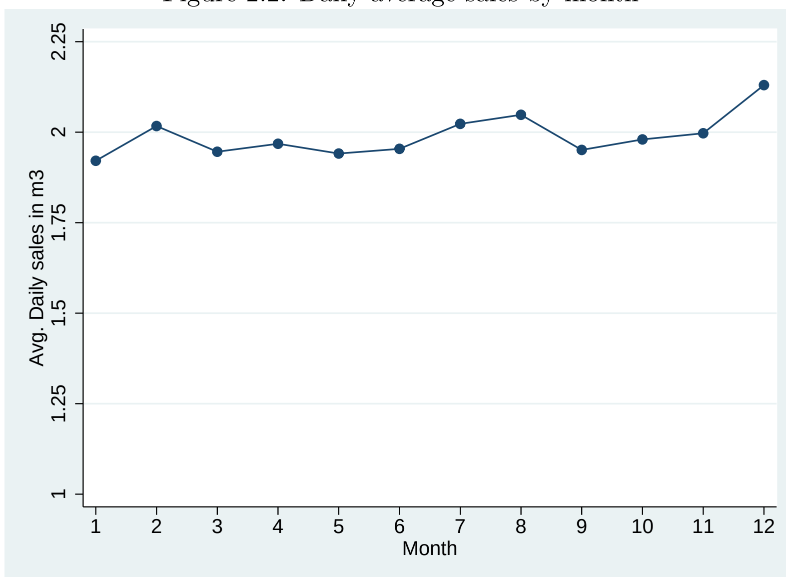
The market for gas stations is known to be localized (Hastings 2004, Verlinda 2008) with gas stations competing only with their closest (in geographical distance) rivals. However I do not have a measure of distance between gas stations, nor a reliable way of partitioning a city into neighborhoods so I will consider that the relevant market for each gas station is the city in which it is located. I will assume that a gas station in a city c competes with all other gas stations in that city, and does not compete with gas stations in other cities. I will follow the approach of Borenstein and Shepard (1996) and Deltas (2008) who use aggregate measures to define markets like cities or states, rather than localized competition. I will consider each city as a point market, where city is defined by INDEC (Argentina's Census Bureau) in its census guidelines.

To get the expected values of future demand, measured by future quantities, I follow Borenstein and Shepard (1996): they use and adaptive expectations approach in which they predict future sale values from their past values, monthly dummies and a time trend. Using their approach, I also face the same caveats. First, it is not actual quantities, but expected quantities the ones that should influence current retail prices. Second, the approach is not forward looking so it does not capture big shocks. However this model has great predictive power in my sample, for all the cities the R^2 is between 0.73 and 0.92 and my data show no big, surprising shocks, so the model seems appropriate. The expected value of the future demand is the fitted value from the following estimated equation (equation 3 in Borenstein and Shepard 1996).

$$Q_{ct} = \alpha_0 + \alpha_1 Q_{c(t-1)} + \alpha_2 RET_{c(t-1)} + \alpha_3 t + \alpha_4 t^2 + \sum_{j=2}^{12} \alpha_m + \epsilon_{ct} \tag{2.3}$$

I include monthly dummies to capture possible seasonal effects in the gasoline sales, although my data does not exhibit big gaps among months. For the whole sample, the month with the highest daily average sales is December with 2.13 m^3, while the month with the lowest average is January, with 1.93 m^3, which represents an 90% of August sales. Figure 2.2 show the average volume sales by month, in m^3. Daily sales are quite stable across months, with an average of 1.98 m^3 and a standard deviation of 0.06.

Figure 2.2: Daily average sales by month



2.5 Results and discussion

2.5.1 Basic models

Table 2.2 presents the result of the basic models. Model 1 contains a standard dynamic panel of retail prices as a function of past changes in the wholesale price and the retail price, plus an error correction term. Model 2 incorporates the effect of future changes in the demand, trying to estimate collusion by testing the hypothesis that expected changes in demand affect current prices and margins.

Model 1 does not contain any novel features and it just replicates the previous literature in this area. However, it is a good starting point to analyze what has occurred in the Argentina gasoline market and to compare the results with findings from other countries. Model 1 can be thought of as a baseline model, a model containing just the minimum basic variables. Other versions of the model will incorporate additional features to this basic specification.

In model 1, contemporaneous changes in the wholesale price result in an increase the in retail price. A one peso increase in period t wholesale price with respect to $(t-1)$ results in a positive change of 69 cents in the retail price with respect to the previous month. [7] The effects of the increase tend to vanish over time, as the influence of past changes in the wholesale price decreases with time: values for the change in the wholesale price two periods before t and three periods before t are 32 and 23 cents respectively. The smaller than one, negative sign coefficients of the past changes in the retail price also play to smooth the effect of past changes in the current change of the retail price. The error correction term show that not all of the increases in the wholesale price are passed through to the retail price. The ratio of the coefficients is about 0.66, meaning that in the long run, roughly $\frac{2}{3}$ of the increments in the wholesale price are passed to the retail price.

The second model introduces the change in the future demand as an additional explanatory variable. The idea follows the spirit of the models of Rotenberg and Saloner and Haltiwanger and Harrington, who show that the future is important in determining the current period equilibrium under tacit collusion. Borenstein and Shepard (1996) implemented the empirical test of this idea, by introducing the expected changes in the future demand as an additional explanatory variable. Under tacit collusion, future changes in quantities influence current prices. Then, a significant and positive coefficient for the expected quantities term would be consistent with tacit collusion. [8] If future demand is increasing, then the forgone profits of deviation in the present period are bigger, the punishments penalties are also bigger and it is easier to sustain collusion today.

[7] All prices are measures in ARG pesos. A coefficient of 0.5 means half a peso, or 50 cents.

[8] As previously discussed, a significant coefficient for the expected quantities does not constitute proof of actual collusion, something that would be punished under antitrust laws. Rather, it is something it would be expected, that it is consistent with behavior in a market with tacit collusion.

Table 2.2: Estimation results. Dependent variable: $\Delta Retail$

Variable	**Model 1**	**Model 2**
$\Delta Wholesale_t$	0.693	0.648
	(0.059)	(0.057)
$\Delta Wholesale_{t-1}$	0.322	0.285
	(0.034)	(0.034)
$\Delta Wholesale_{t-2}$	0.235	0.208
	(0.032)	(0.031)
$\Delta Retail_{t-1}$	-0.314	-0.308
	(0.042)	(0.041)
$\Delta Retail_{t-1}$	-0.368	-0.356
	(0.051)	(0.048)
$Retail_{t-1}$	-0.107	-0.048
	(0.022)	(0.017)
$Wholesale_{t-1}$	0.155	0.082
	(0.036)	(0.038)
$ExpQuantity_{t+1}$		0.011
		(0.006)
ρ	0.128	0.048
	(0.112)	(0.041)
R^2	0.74	0.76
N	224307	224307

Of course, it is necessary that detection of deviation is feasible and punishing the deviators is possible. In this industry it is very easy to detect deviators, since retail prices are public: they are required by law to be published and visible in each gas station. In order to detect a deviation, it is enough to send someone to the suspect facilities and verify the prices charged at the pump, or even at the signs outside the suspected gas station. The only monetary cost of undertaking the task of detecting a suspect would be the salary of the employee sent to discover cheaters, plus possible his transportation costs. In any case, it is hard to think of these costs as significant in the monthly budget of a gas station, and it is probably a good investment for the gas stations trying to sustain collusion. The potential benefits involved from successfully detecting a cheater and preventing deviation are surely bigger than two or three days a salary of an employee plus the transportation costs. [9]

The issue of the length of the punishment should also be considered. Models of optimal punishment show that the future may not be restricted to just the next period. However, as I do not have information on the optimal length of punishments in the Argentine gasoline market, and following Borenstein and Shepard (1996) I will use just the next period as indicator for all the future influences in the current change in price.

Model 2 show very similar coefficients than Model 1, whose values and interpretations are still valid for the second model. The value added of model 2 lies on the coefficient of the future (expected) quantity. The coefficient is positive but just barely significant (it is only significant at the 11% level). According to model 2 firms in the Argentine retail gasoline market do not seem to take into account the future expected demand to make current pricing decisions.

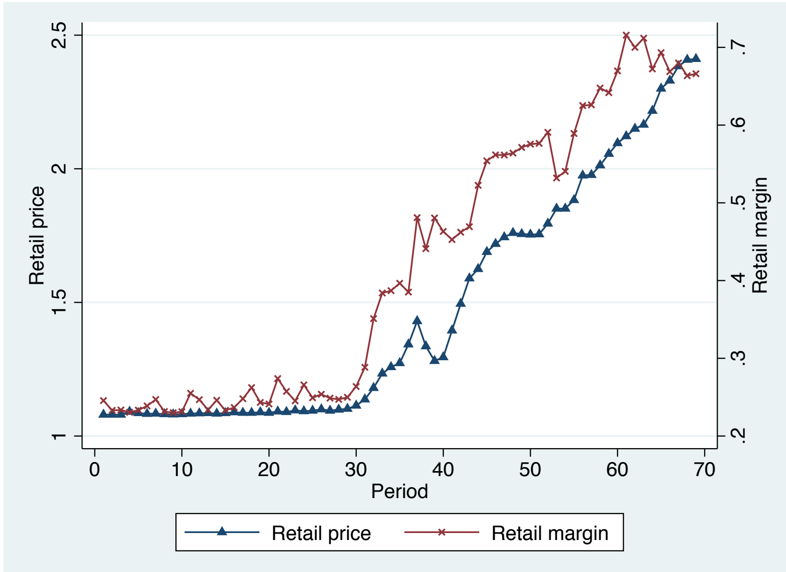
2.5.2 Extensions to the basic models: the effects of regulation

Models 1 and 2 use the whole sample and they did not distinguished periods with price regulation from periods without price regulation. The coefficient of the expected quantity was obtained using the whole sample period and given the institutional settings in the Argentine industry this is not a good strategy, since during the regulation phase, prices were remarkably stable, as it would be expected with a successful price cap.

All along the regulated phase, changes in prices were almost exclusively explained by past values of (regulated) retail prices (see Figure 2.3). In order to confirm the intuition and the graphical evidence, I run models 1 and 2 for a restricted sample considering only the regulated period, from Jan. 2005 to June 2007. The results show that the only statistically significant variables were the past changes in the retail price and the lagged value of the retail price. All other variables were not statistically significant. Moreover, the R^2 was 0.89, higher than any of the R^2s of the other models. All findings point to the fact that during the regulated period, the only variable that mattered was the regulated retail price. Firms would not react to anticipated changes in future demand because they would not be able to modify prices.

[9] I will not analyze related issues like the public good nature of detecting cheaters. For the non-cheaters as a group, it would be efficient to send only one person to detect all cheaters and then report to the whole group the findings. Making the discovery of a cheater public information it is efficient for the collusive players, rather than undertake the task individually. There are free riding issues that I will not analyze in this paper.

Figure 2.3: Retail price and retail margin 2005-2010



As a consequence, the observed coefficient for the expected quantity in model 2 represents the average of two very different environments. One with a regulated price, from Jan. 2005 to June 2007 where firms could not modify behavior nor retail prices (at least they could not increase retail prices, and assuming the price set by the government was below the collusive price, there was no possibility of observing a price path consistent with tacit collusion). The other one with a non-regulated price, where firms could set prices following their best interests, from July 2007 to July 2010. It is during this period that firms had the possibility of engaging in collusive behavior and set prices accordingly.

The estimate of the coefficient for the response of firms to expected changes in future demand using the whole sample period will average the estimate over this two different times, where firms faced different constraints. Such estimate will not have a clear interpretation, since the price setting models were not the same. There was a structural brake in the price setting mechanisms in June 2007: the regulation ended, the government was not setting a maximum retail price any longer and firms were able to set their own prices. An average of these two different periods is not representative of any particular model and it is not useful to analyze either period.

In order to recognize the fact that price formation rules are completely different under regulation and deregulation, and to get a meaningful coefficient for the expected quantities, I estimate models 3 and 4. These specifications are equal to the model specified in equation (2) plus full interaction terms. The new interaction terms are the product of an indicator variable I_t, $t = 1, ..., 67$ that takes value 1 during the deregulated phase ($t > 30$, or after July 2007), and the corresponding past changes in the retail and wholesale gasoline prices.

I interact each $\Delta Wholesale_{t-j}$ $j = 0, 1, 2$ and each $\Delta Retail_{t-k}$ $k = 1, 2$ with the indicator variable.

Model 3 is basically model 2 (apart from the interaction terms) with one change: I restrict the expected quantity variable to be activated during the deregulated phase. In this version of the model, the expected quantity is an interaction between the expected quantity in model 2 and an indicator variable, which takes value one during the deregulated phase, from July 2007 to July 2010. Table 2.3 presents the results and we can see the change in the size and significance of the expected quantity coefficient. It is now bigger and statically significant. It means that an anticipated increase in 1 cubic meter in the next period demand translates into a 3.1 cents positive change in this period retail price. The coefficient has a clear interpretation. It is not an average of periods with very different institutions and firm behavior. Note that Table 2.3 reports only the full interaction terms. Non interacted terms are activated during the regulated phase and are all non-significant since there were almost no changes in retail prices.

Table 2.3: Estimation results. Dependent variable: $\Delta Retail$

Variable	**Model 3**	**Model 4**
$\Delta Wholesale_t$, $t > 30$	0.878	0.819
	(0.083)	(0.077)
$\Delta Wholesale_{t-1}$, $t > 30$	0.418	0.406
	(0.054)	(0.068)
$\Delta Wholesale_{t-2}$, $t > 30$	0.249	0.241
	(0.029)	(0.033)
$\Delta Retail_{t-1}$, $t > 30$	-0.546	-0.538
	(0.072)	(0.071)
$\Delta Retail_{t-1}$, $t > 30$	-0.495	-0.481
	(0.066)	(0.065)
$Retail_{t-1}$	-0.074	-0.071
	(0.028)	(0.028)
$Wholesale_{t-1}$	0.101	0.096
	(0.034)	(0.033)
$ExpQuantity_{t+1}$, $t > 30$	0.031	0.026
	(0.014)	(0.011)
ρ	0.059	0.045
	(0.054)	(0.041)
R^2	0.83	0.81
N	224307	224307

The coefficient of the expected quantity in model 3 was obtained using the whole sample of gas stations. The whole sample contains different types of markets in terms of size, number and affiliation of players and of course geographical location. In particular, it contains a mix of concentrated and non-concentrated markets. It is possible that the concentrated markets, where it is easier to find collusive behavior, are influencing the results for the whole sample. If this is true, I cannot affirm that all markets are engaging in collusive behavior. It may be the case that gas stations in concentrated markets are colluding, gas stations in competitive markets are not colluding, but the coefficient in model 3 captures everything and gives the false impression that collusion is present in all markets.

In order to test for this hypothesis, I estimate model 4, which is model 3 with a restricted sample that includes only potentially competitive markets. I include only potentially competitive markets because firms in these markets are the least likely to engage in strategic behavior. I eliminate monopoly markets because monopolists do not collude by definition, and I eliminate the concentrated markets because they are the most likely to exhibit strategic pricing.

To estimate model 4, I need to define three types of markets, monopoly, concentrated and potentially competitive. I will consider markets with just one gas station, or with up to three gas stations *all belonging to the same brand* as monopolies. Technically a market with two or three gas stations should not be considered a monopoly, but if they all belong to the same brand, and considering that many times all gas stations are operated and owned by the brand company, I will assume there is only one player in the market and hence it is a monopoly for the purposes of model 4. It is more difficult to define concentrated markets because there is not a clear-cut definition for a concentrated market, as for monopolies. However I need to define concentrated markets to estimate model 4. I will assume a market c is concentrated if it has less than 10 gas stations and the city where it is located has less than 50,000 inhabitants. This definition is somewhat arbitrary, but it restricts the number of players so there are a few players and it limits the city size, which makes easier to consider the whole city as one market, eliminating the possibility of local markets within a city. The remaining markets are labeled competitive markets, and are the ones I use to estimate model 4.

The coefficient of the expected quantity in model 4 is still positive and significant, although a little smaller than in model 3. In the markets I consider potentially competitive, firms do take into account changes in future demand when setting current retail prices. An anticipated increase in 1 cubic meter in the next period demand translates into a 2.6 cents positive change in this period retail price.

2.5.3 The effects of regulation

The price regulation has affected the entry / exit decision of firms as well as market prices and margins. The effect on prices was trivial. A price cap imposed a maximum price that cannot be exceeded by retailers. As discussed in Section 3, the regulation was never formalized into a law, but in spite of its *de facto* nature was very successful, as shown by the stability of prices up to June / July 2007. Margins were also very stable (see Figure 2.3). I have analyzed the effects of the regulation on the entry / exit decision in the first chapter of my dissertation so here I will just say that the regulation generated a net exit of firms, and that this exit was not neutral across firm types. Independent or small chains of non-vertically integrated gas stations were more likely to exit than big, vertically integrated chains.

My data do not allow me to answer directly the question of whether the regulation increased the possibility of successful collusion after its demise because I have no data before the regulation was established. Ideally I would need data from before the price cap was established which I could use as a baseline for the likelihood of regulation (in my model, the coefficient for the expected quantity). I could then compare the evolution of this coefficient and answer my question. Since it is now possible for me due to data limitations, I will try to answer the question using other evidence.

In the first place, in the first chapter of my dissertation I established that the regulation was a significant variable when explaining the probability of exit of gas stations. Ceteris paribus, gas stations were more likely to exit during the regulation than after the regulation. More importantly, the effect of the regulation on the probability of exit was not neutral across types of gas stations. Gas stations that belonged to vertically integrated brands were more likely to survive, while small, non-vertically integrated chains or independent gas stations were relatively more at risk of exiting.

Market studies and the literature demonstrated that exit by independent gas stations harms competition in the market, making easier to sustain collusive outcomes. Hastings (2004) supports this point of view:

> The increases in vertically integrated (company-op) stations in cities experiencing higher citywide average prices have come from a decrease in independent retailers. Integrated refiners have purchased independent retailers, converting the stations to both integrated company-op and franchise stations. The decrease in the number of independent unbranded retailers offers a competing explanation for increased prices. Independent stations typically compete on price with little non-price product differentiation. These stations are completely independent from the refiner in that the gasoline dealer owns the station, and sells "unbranded" gasoline that can be purchased from any supplier. The unbranded station typically competes with other stations by offering the lowest price gasoline. When these stations are replaced by branded integrated stations (or exit the market), price competition in the market may be softened, resulting in a higher equilibrium price.

Although the evidence is far from conclusive, the findings in my sample are consistent with previous results that highlight the importance of the independent players to foster competition in the retail gasoline industry. Unfortunately my data is not frequent enough to test for collusive behavior, but given my results I can conjecture that the fact that the price regulation increased the probability of exit of the independent players may have played a role in the observed behavior after the regulation was eliminated.

Another way to look for evidence of cooperative behavior is to analyze the margins before and after the regulation. Retail prices begun to increase almost immediately after the regulation was eliminated, and except for a few months at the end of 2007, continued to increase for the remaining of my sample (see Figure 2.3). The retail price increase is not enough to conclude, or even to suspect that there exists collusive behavior. The price increase is compatible with non-cooperative behavior and cost increases. Figure 2.4 shows that wholesale prices also went up after the regulation was eliminated, and they seem to follow a pattern that resembles the path of retail prices.

Closer analysis show that retail prices begun to increase by Apr. 2007, actually two months before the formal end of the regulation. The retail price, which has been around 1.08 pesos per liter from the beginning of the sample, jumped to 1.10 in May 2007 and to 1,12 in June 2007. After June 2007 it started its ascending path that lasts until the end of my sample period, with very few exceptions. It is possible that firms had anticipated the end of the regulation sometime by April 2007, and they had assumed the government would not enforce maximum prices any longer before the formal announcement of the end of the price cap.

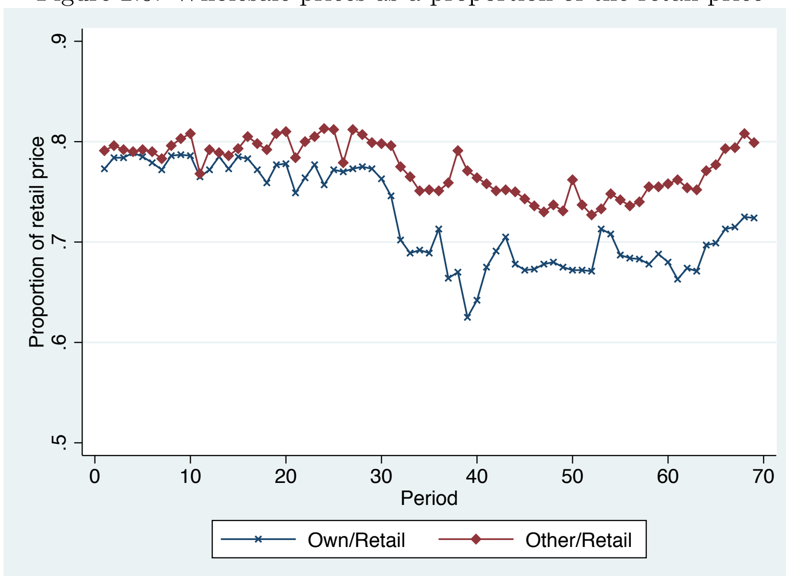
It is worth noting that while the path of wholesale prices follows roughly the same trend than the retail price, the timing of the changes is different. Retail prices begun to increase in May 2007 and increased consistently after July 2007. Wholesale prices, on the other hand, begun to increase by 2 cents only in September 2007 and to consistently increase only by November 2007. Wholesale prices lagged retail price increases by 5 months. During the first five months after the regulation was eliminated, firms were able to increase the retail margin.

Figure 2.4: Retail and wholesale prices

Figure 2.5 shows the evolution of the retail margin for two measures of the wholesale price: the price charged to the own stations, to stations that belonged to the same brand that the terminal, and the price charged to other, non-affiliated gas stations. In this figure wholesale prices are expressed as a proportion of the retail price, and the unit retail margin at period t is $1 - \frac{Wholesale_t}{Retail_t}$. Note that these proportions begun

to fall around May, June 2007, by the time firms realized that they were not bound by the regulation any longer. The falls are the result of higher retail prices with stable wholesale prices. Falls in these relationships mean higher retail margins. It can be observed that the retail margin increased from around 20% to 30% 35%.

Figure 2.5: Wholesale prices as a proportion of the retail price



Moreover, the retail margin was higher for the vertically integrated brands than for the independent gas stations. Vertically integrated terminals charged lower retail prices to their own gas stations. This was not the case during the regulation, when the wholesale prices charged to own gas stations and to independent gas station were very similar.

Firms begun to consider changes in future demand when setting retail prices at the same time the retail margin went up, a few months after the regulation was eliminated. Independents had less influence in the market after suffering a higher exit rate during the regulation period, and the higher retail price they faced gave a market advantage to the vertically integrated gas stations.

2.6 Conclusion

In this paper I have described the behavior of retail prices and margins in the Argentine gasoline industry from Jan. 2005 to July 2010. I have shown the behavior of prices and margins both during and after a price regulation established by the government. When the price cap was in place, retail prices and margins were very stable, while firms exited the market, although not all firms exited the market at the same rate: independent gas stations were more at risk of exit.

The demise of the price regulation brought retail price increases almost immediately, while wholesale prices begun to increase five to six months after the price cap was removed. This delay helped gas stations to increase their margins. The increase in the retail margins can be associated with gas stations taking into account future changes in demand when setting prices. Considering the earlier exit of independent gas stations and their effects on market competition, I can conjecture that the observed behavior is consistent with the exercise of market power, and that exercise of market power was facilitated by the price regulation in place until June 2007.

As in other papers studying the presence of collusive behavior, I cannot say I have found hard evidence of strategic behavior, but the price and margins paths are consistent with local market power, which may have been facilitated by a price regulation that induced exit by independent gas stations.

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