Price controls and competition in gasoline retail markets*

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Abstract

We estimate the effect of a price floor regulation implemented in the Canadian province of Québec beginning in 1997 and find that it substantially reduced the entry of large-scale stations and the exit of smaller stations in local Québec markets. We show that as a result of the policy, competition was higher and prices were lower in Québec compared with a control group of unregulated markets in the neighboring province of Ontario. The study is based on a large sample of stations in Québec and Ontario before and after the implementation of the policy. Our results highlight the fact that price regulation affects market structure and can therefore have unintended consequences on productivity.

1 Introduction

The goal of this paper is to study the consequences of price floor regulations in retail markets. Our focus is on a type of price floor regulation instituted in the retail gasoline market in the Canadian province of Québec. Starting in 1997, the provincial government implemented a price floor regulation which fixed a weekly minimum price close to the estimated wholesale price. The regulation also defined a minimum margin of $0.03 per litre which can be added to the floor if it is proven that a station has been setting its price close to the level of the floor for a long enough period of time. The objective of the policy is to strengthen anti-predatory pricing laws by preventing firms from pricing below their competitors' costs.

Québec is not the only jurisdiction to have adopted some form of price floor, and so understanding the consequences of price regulation of this form is important.[1] A number of U.S states and other Canadian provinces also have some form of below-cost sales statutes in the retail gasoline market. And many states have sales-below-costs laws that apply more broadly to all products. Furthermore the debate over whether to adopt or overturn these types of restrictions is ongoing

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[1]Throughout the paper we will refer interchangeably to these types of policies as: price controls, price floors, sales-below-cost laws, below-cost-sales laws, and unfair sales acts. All refer to legislation that limits the prices firms can set either in a particular industry, or broadly across all products.

in many other jurisdictions (see for instance the debate in Virginia over Senate Bill No. 458, "Below-Cost Sales of Motor Fuels" and the February 2009 decision by a Wisconsin court to rule as unconstitutional statute s. 100.30 which guaranteed a 9.18% markup over the average posted terminal price for gasoline retailers).[2]

The advocates of these policies typically associate aggressive pricing with predatory behavior. On the other hand, detractors argue that they may protect inefficient firms and lead to higher prices and, more generally, welfare loss. Antitrust authorities typically view such legislation as unnecessary. When asked to evaluate the merit of the Virginia below-cost sales legislation the Federal Trade Commission argued that anticompetitive below-cost pricing rarely occurs, and that such legislation could harm consumers.[3] The Canadian Competition Bureau writes that regulation of this type results in higher average prices, and that, relative to competitive markets, will not provide for the highest quality products and the most efficient production.[4]

In forming their views these and other antitrust authorities make reference to the academic research on the subject of below-cost sales. They point out that, although the evidence is somewhat mixed, it is largely supportive of the notion that price floors are bad for competition and hence bad for consumers. They refer in particular to work by Anderson and Johnson (1999), Johnson (1999), and Fenili and Lane (1985). These studies evaluate the effect of sales-below-cost laws in retail gasoline markets in the U.S. and find that jurisdictions with sales-below-cost laws have higher prices and/or margins than those without. However, these studies are cross-sectional and with cross-sectional data it is hard to account for unobserved heterogeneity across jurisdictions. Findings linking sales-below-cost laws with higher prices may therefore be spurious.

More recently, Skidmore, Peltier, and Alm (2000) use a panel of state-level prices for thirty states over a twenty year period to see how changes in the status of sales-below-cost laws influence prices. In contrast to the cross-sectional studies they find that prices fall after the adoption of sales-below-cost laws. Furthermore, they find that the law impedes the exit of firms. But since they use state-level data, their approach does not use the variation induced by the policy changes and abstracts away from heterogeneity in the regulations.

For our analysis we have constructed a data set at the gasoline-station level featuring 1200 stations observed between 1991 and 2001 in five cities in the province of Québec, where the price regulation was put in effect, and five cities in the province of Ontario, where the regulation was never implemented. Our strategy is therefore to evaluate the effect of the policy on Québec stations using Ontario stations as a control group. This is something that was not possible using the previous approaches given that their sources of variation were not as rich since data were at the state or city level.

Our data contain detailed information on individual stations' sales volume, posted price and

[2]http://www.datcp.state.wi.us/trade/business/unfair-comp/unfair_sales_act.jsp
[3]http://www.ftc.gov/be/v030015.shtm
[4]http://www.cb-bc.gc.ca/eic/site/cb-bc.nsf/eng/00892.html

characteristics. They allow us to study the effect of the floor on station behavior at the local-market level. In particular, we can look at the evolution of price and how it relates to the composition of local markets.

Figure 1 motivates our empirical analysis. It compares the evolution of prices and three local market structure variables for the two provinces. Graph (a) illustrates the evolution of prices in the two provinces. Looking only at the periods immediately before and after the policy, it is easy to see that the short-run effect of the policy is to raise prices. However, looking at the average prices five years after and five years before the policy, the long-term effect of the policy in Québec has been to decrease prices relative to Ontario. This highlights our first result: in the short-run the price floor raised prices, but in the long-run prices tend to be lower.

To explain these two results, graphs (b), (c) and (d) show stark changes in the composition of local markets in Québec and Ontario. It should first be noted, that over this period, all North-American markets underwent a major reorganization characterized by massive exit of small scale stations, and entry of large capacity self-service stations. Such changes were driven by exogenous improvements in the technology used by customers to pay for gasoline and affected both provinces equally. However, graph (b) shows that local markets in Ontario shrank more after the policy. Similarly, the policy appears to have affected sharply the presence of large stations (graphs (c) and (d)). Therefore, we claim that the policy not-only affects prices directly, but also affects the composition of local markets through the entry and configuration of stations. Because in the long-run more stations are present in the regulated markets, competition is more intense and prices tend to be lower.

To formalize our analysis, we first build a model of price competition to study the impact of a price floor on entry, exit, prices, and sales. We study the decision of a potential entrant considering entry into a market featuring established incumbents when prices are constrained (price floor in effect) and unconstrained (no price floor). Incumbents are characterized by an older technology, while the potential entrant can enter with either the old technology or a new technology that features a higher fixed operating cost, but is also more efficient. We show that a price-floor regulation in this context can have two opposite effects. First, such a policy can cause crowding in markets by raising the expected profit of being active, which in turn tends to lower prices.[5] Second, by protecting small firms, the policy can block the entry of more efficient firms who must incur larger operating costs. Depending on the context, this efficiency loss will increase prices relative to unregulated markets, or strengthen the competition enhancing effect by crowding the market. The net effect in the long run is therefore ambiguous.

[5] A similar result can be found in the real option literature (e.g. Dixit and Pindyck (1994)). When firms face significant sunk entry or exit costs the price threshold at which firms enter or exit a market is typically lower than the long run average cost. In other words, firms may want to stay in a market when prices fall temporarily below average cost, even in a competitive environment. In these circumstances, fixing a price floor above this natural exit threshold will affect significantly firms' exit and entry decisions, by raising the option value of being active in the industry.

These two opposite forces can thus lead to higher or lower prices depending on the relative efficiency of firms and the size of the fixed-operating costs. We illustrate theoretically how these effects can distort firms' decisions in two ways. In Section 2 we analyze a simple 2-period model to formally define the two types of incentives, and in Appendix C we show that price floor policies can significantly affect the long-run distribution of firms using a numerical dynamic model of entry and exit similar to Ericson and Pakes (1995).

Next we perform a detailed econometric analysis of the data along two dimensions. First, using a difference-in-difference specification we study the impact of the policy on three outcomes: prices, sales volumes, and revenues from gasoline. Our results offer clear and robust predictions consistent with the figures displayed above. Comparing the period immediately after to the period immediately before the introduction of the policy, prices are higher. So in the short-run, the price floor systematically increased market prices. However, in the long run, comparing the five years after to the five years before the implementation of the regulation, prices, volumes, and profits are significantly reduced.

These results are in line with the notion that in the short run a price floor either raises the price of the firms for which the constraint binds, or has no effect. After several periods, the policy protects inefficient stations or attracts new entrants, which in turn enhances market competition. We show that most of this price effect is explained by changes in the market structure, i.e. changes in the distribution of station characteristics.

In the second part of our analysis, we compare the distribution of stations' characteristics across regulated and unregulated markets. We provide evidence that in the gasoline market the policy slowed down the industry reorganization. A significant number of stations that would have exited without the protection of the price control stayed active in Québec. Perhaps more importantly, the comparison of the two types of markets reveals that the policy discouraged large stations from entering. These stations face larger fixed costs and must sell to more consumers in order to be profitable. Since regulated markets tend to be too crowded, these stations cannot survive. A direct consequence of this is that the policy significantly lowered the productivity of stations, which can have important long-run consequences.

So do our results provide support for the advocates of sales-below-cost regulation? Was pricing in Ontario where there was no floor predatory? Our results suggest that although pricing may not have been predatory in the sense that the entrants were pricing below cost, the effects on market structure experienced in Ontario were consistent with a predation story. That is, in Ontario, following the entry of new stations in retail markets, incumbents were driven out, markets became more concentrated, and prices increased. Incumbents were driven out not because entrants priced below cost, but because they were more efficient. In this sense, although the floor resulted in lower prices for markets in Québec, it may have done so at the expense of discouraging the entry of more efficient stations.

We conclude the paper by discussing the welfare consequences of this type of policy. Although the net welfare impact of the policy cannot be evaluated without a structural model, we identify several tradeoffs that a regulator should consider. Such tradeoffs are relevant for understanding the impact of this type of price regulation in markets beyond the market for gasoline.

We are related to a small literature that studies the effect of different forms of government intervention on market structure. More specifically, there are a number of papers that evaluate the effect of various environmental regulations on pricing and market structure (see for instance Brown, Hastings, Mansur, and Villas-Boas (2008), Ryan (2006), Busse and Keohane (2009)). There are also studies evaluating the impact of price or advertising restrictions on competition in various industries (Milyo and Waldfogel (1999) study the effect of a ban on price advertising, while Clark (2007) looks at the effect of advertising on competition in the children's cereal market and Tan (2006) considers advertising restrictions in cigarette markets).

We are also related to a very broad literature on competition in the gasoline market. Two papers in particular are worth mentioning. Hastings (2004) examines the relationship between competition and firm behavior in Californian gasoline markets. Her study is related to our's in the sense that it uses a difference-in-difference analysis to isolate the effects of changes in competition on firm behavior. In our case, we examine the effects of a policy that actually induces changes in the market structure, which in turn affect firm behavior in the longer run. A recent paper by Borenstein (2008) analyzes the potential impact of a specific type of minimum gasoline price regulation in California aimed at smoothing the evolution of gas prices, but the paper does not study the potential effects of the regulation on the entry and exit of gas stations.

2 Model

In this section we develop a model of entry and price competition to examine the effects of a price floor regulation on market structure. More specifically we seek to understand how such a policy can distort the reorganization of an industry, by affecting the entry of larger and more efficient firms. This analysis mimics the observed structural changes observed in the retail gasoline industry during the 1990's.

We consider a circular-city model of price competition with maximal differentiation, in which at most two firms enter the market. If both firms are active in the industry, the variable profits of firm i are given by:

$$\pi_i(p_i, p_{-i}) = (p_i - c_i)\left(\frac{1}{2} - \frac{p_i - p_{-i}}{t}\right), \tag{1}$$

where t is the transportation cost of consumers and c_i is the marginal cost of firm i. A monopolist operating in this market sets a price $p^m = v - t/2$, ensuring that every consumer buys one unit of the good.

Initially the market is composed of a single incumbent I operating the "small" technology characterized by a cost function $c_s(q) = c_s q + F_s$. The potential entrant E on the other hand has the option of entering the market with the small technology or with the "large" technology. The large technology is characterized by a low constant marginal cost and high fixed cost (i.e. $c_l < c_s$ and $F_l > F_s$). The entry game is played simultaneously and the strategies of both firms are summarized by $\{t_I, t_E\} = \{(0, s), (0, s, l)\}$.

Before firms commit to their entry/exit decisions, a regulator imposes a price floor constraint p_f. We assume that the floor is set such that:

$$c_s < p_f < p^m,$$

which implies that the floor potentially affects the equilibrium pricing game only in oligopoly markets (i.e. (s, s) or (s, l)). When two firms are active in the industry, the Bertrand-Nash equilibrim is characterized by the following Kuhn-Tucker first-order conditions:

$$\frac{1}{2t}\left(-4p_i + 2p_{-i} + t + 2c_i\right) + \lambda_i = 0,$$
$$p_i \geq p_f, \lambda_i \geq 0, \text{ and } \lambda_i(p_f - p_i) = 0,$$

for both $i = I, E$. When the market is composed of two small firms the price floor binds if $p_f > c_s + t/2$. Since $c_l < c_s$ there are three possible outcomes when both types are active: (i) the price-floor constraint does not bind ($\lambda_s = \lambda_l = 0$), (ii) only the large type is constrained by the floor ($\lambda_s = 0$ and $\lambda_l > 0$), and (iii) both firms are constrained ($p_s = p_l = p_f$). These three cases are summarized by two price-floor cutoffs ($k_1 > k_2$) defined as followed:

$$(p_s^*, p_l^*) = \begin{cases} (p_f, p_f) & \text{if } p_f > k_1 = c_s + t/2 \\ (p_s^n, p_l^n) & \text{if } p_f < k_2 = \frac{1}{3}\left(2c_l + c_s\right) + t/2 \\ (B_s(p_f), p_f) & \text{otherwise.} \end{cases} \tag{2}$$

where $(p_s^n, p_l^n) = \left(\frac{1}{3}(2c_s + c_l) + t/2, \frac{1}{3}(2c_l + c_s) + t/2\right)$ are the unconstrained Nash equilibrium prices, and $B_s(p_f) = \frac{c+p_f}{2} + t/4$ is the small-type best-response to the price floor.

Obviously the price floor will distort the equilibrium entry and exit decisions only if it is sufficiently high (i.e. $p_f > k_2$). We consider two types of distortions affecting the equilibrium market structure. In the first case the floor binds in all oligopoly markets, and induces excessive crowding relative to the unconstrained situation. In the second case, the price floor distorts the market by blocking the entry of the most efficient firm.

Case 1: Excessive crowding

Consider an example in which the price floor is high and binds even in the (s, s) market structure. Since firms are symmetric, their profits in the unconstrained and constrained cases are given by:[6]

$$\pi^c(s,s) = \frac{p_f - c_s}{2} - F_s$$
$$\pi^u(s,s) = \frac{t}{4} - F_s.$$

Notice that the constrained profits are strictly increasing in p_f. Therefore if F_s is relatively high it is possible that for the incumbent staying in is profitable only in the regulated market. In particular, the regulated market will be more crowded after the policy change if F_s is in the following range:

$$\frac{t}{4} < F_s < \frac{p_f - c_s}{2}. \tag{3}$$

As a result in this example the price floor policy will have a competition enhancing effect, and lower prices relative to the unconstrained equilibrium.

Case 2: Blockaded entry

There are two ways the policy can block the entry of the most efficient firm. As in the first example, the price floor can be set high enough such that it binds in all cases and makes the entry of a large firm less profitable. For instance, consider the case in which (s, l) is an equilibrium in the unregulated market:

$$\pi^u_I(s,l) - F_s > 0, \quad \pi^u_E(s,l) - F_l > 0, \text{ and } \pi^u_E(s,l) - F_l > \pi^u_E(s,s) - F_s.$$

When the price floor binds for both types, the incumbent is strictly better off and therefore s (i.e. staying-in) is a dominant strategy in the regulated market. However, the entrant might prefer to change its entry decision since the market is now split in half (i.e both firms charge p_f). In particular if the fixed-cost F_l is large relative to F_s it is likely that the entrant's best-response to s is now to enter with the small technology:

$$\begin{aligned} \pi^c_E(s,l) - F_l &< \pi^c_E(s,s) - F_s \\ F_l - F_s &> \frac{c_s - c_l}{2} \end{aligned}$$

In this example, the equilibrium under the price-floor regulation will therefore be (s, s) instead of (s, l). The policy thus induces efficiency losses and yields higher prices by blockading the entry of the large firm.

[6] We use superscripts c and u to indicate that the market is regulated and unregulated respectively.

When the price floor is set to a lower level, it is possible that the regulation prevents the entry of a large firm without raising prices. To see this, consider a situation in which the entry of a large firm triggers the exit of the incumbent in the unregulated market:

$$\pi_I^u(s,l) - F_s < 0.$$

In this case, if the price-floor binds only for the large firm (i.e. $k_1 < p_f < k_2$), the regulation will act as subsidy towards the incumbent by reducing the market share of the large firm. It is therefore possible for the regulator to set p_f such that the incumbent will revise its decision to exit the market:

$$\pi_I^u(s,l) - F_s < 0 \text{ and } \pi_I^c(s,l) - F_s > 0$$
$$\frac{(3t-2c_s+2c_l)^2}{36t} < F_s < \frac{(t-2c_s+2p_f)^2}{16t}.$$

If this condition is satisfied, the policy will successfully prevent the exit of the least efficient firm. This in turns can block the entry of a large firm, provided that F_l is large enough. The equilibrium price in the regulated market will thus be lower or equal to the price in the regulated market. The competition enhancing effect of the policy therefore dominates the inefficiency losses present in the previous example.

Importantly, this last example shows that the policy can have a distortive impact on market structure without actually binding in equilibrium. As long as F_l is large enough, (s,l) will not be an equilibrium and the price will be higher than the floor. That is, (s,s) or $(s,0)$ will be the resulting equilibria depending on the parameters.

To summarize, using a simple 2-period entry model we have shown that a price-floor policy can distort the equilibrium structure of retail markets in two ways. First, such a policy can cause crowding in markets by raising the expected profit of being active, which in turn tends to lower prices. Second, by protecting small firms, the policy can block the entry of more efficient firms who must incur larger operating costs. Depending on the context, this efficiency loss will increase prices relative to unregulated markets, or strengthen the competition enhancing effect by crowding the market. The net effect in the long run is therefore ambiguous.

Finally, note that these results are not specific to the simple 2-period model presented here. In fact, in the Appendix C we show using numerical simulations that the two types of distortions characterized here can be generated by a dynamic equilibrium model of entry and product choice in which firms are infinitely lived. We use three parametric examples to show that a price floor policy can easily prevent the exit of smaller firms and block entry of low-cost retailers. In one example the policy clearly tends to raise prices because competition between efficient stores in the unregulated market easily compensate for the larger number of firms in the regulated one. In the other two examples, the price floor is almost never binding in equilibrium, but successfully keep the large stores out of the market and lower prices.

3 Description of the data

The gasoline station data used in this study were collected by Kent Marketing, the leading survey company for the Canadian gasoline market. The survey offers very accurate measures of sales and station characteristics since each site is physically visited at the end of the survey period, and volume sold is measured by reading the pumps' meters. The panel spans 11 years between 1991 and 2001, and includes all 1088 stations in ten selected cities of Québec and Ontario.[7] For our analysis we take the sales volume data collected during the third quarter of each year, and price and station characteristics collected at the end of the same quarter each year.

The observed station characteristics include the type of convenience store, a car-repair shop indicator, the number and size of the service islands, the opening hours, type of service, and an indicator for the availability of a car-wash. Brand indicator variables are also added to the set of characteristics to reflect the fact that consumers might view gasoline brands as different qualities. The major retailers include five chains that are integrated in the refinery sector: Shell, Esso/Imperial Oil, Ultramar, Irving, and Petro-Canada.

An important component of our empirical analysis deals with the structure of local markets, and in particular the strength of competition between neighboring stores and various measures of product differentiation. To allow for this, we need a definition of local markets which reflects the fact that stores are competing more intensely with their immediate neighbors along the same street. Moreover to be operational this definition must allocate stores into non-overlapping markets. A common way of defining local markets is to use existing definitions of neighborhoods (e.g. census-tracts, zip codes). While these definitions typically allow researchers to get accurate measures of population characteristics, their boundaries are arbitrary and do not necessarily reflect competition between stores.

Instead, we construct local market boundaries that define a set of spatially homogeneous locations. To do so we use a clustering algorithm that groups store locations according to two criteria related to the distance between stores and whether they share a common street. The advantage of this definition is that a local market is an intersection or a major street segment. Importantly, our definition is time invariant since the set of possible locations is defined as all locations ever active throughout our sample. We describe in greater details our procedure in Appendix A.[8] Table 1 summarizes the distribution of local market sizes among the 10 cities. The median market size is 3 stations per market in the whole sample, but some cities are clearly more dense than others. For

[7] In Québec the cities are: Québec city (largest), Trois-Rivières, Chicoutimi, Drummondville, Sherbrooke. In Ontario the cities are: Hamilton (largest), St. Catharines, Kingston, Cornwall, Guelph.

[8] The size and composition of the local markets is affected by the parameters used in the clustering algorithm. It must be said that virtually all our results are robust to changes in these parameters.

instance, in Hamilton (Ontario) the median market size is 5 stations, while Chicoutimi (Québec) markets have a median size of 2 stations. Overall the algorithm constructs local markets that are very comparable across the two provinces, since the size distributions are very similar.

A key feature of the reorganization that took place in the gasoline retail industry is the increase in the size and automatization of stations. These changes took place through the entry and reconfiguration of larger and more efficient stations, and the exit of smaller stations. Over the 11 years of our panel, we observe a total of 102 new entrants, 399 exits, and about 130 major size upgrades (out of 1,200 unique stations).[9] The large number of exits relative to entrants is easily explained by the fact that the new "technology" corresponds to a larger capacity and requires more expensive equipments. Table 2 illustrates this point by comparing the characteristics of new entrants, exiting and continuing stations (i.e. stations active in 2001). The first row clearly shows that entrants and continuing firms have essentially the same set of characteristics on average. Exiting firms however are significantly smaller. On average stations that exited before 2001 had 5.5 fewer pumps and nearly one fewer service-islands than entrants and continuing firms. Similarly, exiting firms were more likely to offer full-service and not to have a convenience store attached.

Table 3 presents a set of descriptive statistics for some of the key variables used in the analysis, broken down by province and pre/post policy period. Over the period studied, the entire North-American gasoline retail industry underwent a major reorganization, associated with massive exit of existing stations and entry of new categories of stations (see for instance Eckert and West (2005)). These changes were mainly due to technological innovations common to most retailing sectors which increased the efficient size of stores (e.g. automatization of the service, better inventory control systems, etc.), as well as changes in the value of certain amenities (e.g. decreased use of small repair garages). These changes were evident in both regulated and unregulated markets. For example, the number of stations in the selected markets has decreased by about 30% in both provinces. Also, the proportion of stations with a convenience store, and the proportion of self-service stations have each increased by more than 20% in both regions.

Although both provinces experienced the same aggregate trends, the rate at which these changes occurred differed. As previewed in Figure 1, these differences are particularly important when looking at variables measuring the size of stations and the degree of local competition. Table 3 shows for instance that: (i) the number large stations,[10] and the average number of pumps both increased by about 20% in Québec and by more than 50% in Ontario, (ii) the number of neighboring competitors decreased by 17% in Québec and by 29% in Ontario. Therefore a careful econometric analysis will be necessary to isolate the changes that are due to the introduction of the policy from the changes that were occurring everywhere.

[9] It is somewhat arbitrary to define upgrades since the number of pumps can vary from year to year due to small changes that do not require sunk investments (e.g. replacing the underground tank)

[10] We define a large station as a station with more more than 4 service islands.

3.1 Description of the regulation

The *law on petroleum products* was enacted a the beginning of 1997 and administrated by the Régie de l'énergie du Québec (hereafter the "Board"). This followed the occurrence of an important price war during the summer of 1996, which was deemed to be the result of predatory pricing behavior by the major retailing chains. The mandate of the Board is threefold:

1. Monitor the gasoline industry, and gather information on prices.
2. Determine a weekly floor price or Minimum Estimated Price (MEP).
3. Prevent the occurrence of price wars by imposing a minimum margin regulation in a designated geographic market.

The determination of the MEP is given by the following simple rule which measures the average marginal cost of selling gasoline in each local market:

$$MEP_{mt} = w_t + \tau_{mt} + T_{mt}.$$

Where w_t is the minimum wholesale price at the terminal, τ_{mt} is an estimate of the transportation cost to deliver gasoline from the refinery to market m, and T_{mt} is the sum of federal and provincial taxes. The MEP is calculated and posted on the website of the Board every Monday.

The role of the MEP is to set a price floor under which a firm can sue its competitor(s) for financial compensation on the basis of excessive and unreasonable commercial practices. This new feature of the law facilitates suing procedures between competitors in the market, in a fashion similar to anti-dumping laws.

In cases where companies repeatedly fail to respect the MEP, the regulation provides the Board with the ability to impose an additional minimum margin to the MEP. It allows the Board to add \$0.03 per litre to the calculation of the MEP in a specific region after the occurrence of a period of sufficiently low prices.

The minimum margin serves two purposes. First, it establishes an implicit (or long run) price floor, under which the Board considers that stations are not covering their fixed operating costs. Second, it enables the Board to indirectly compensate stations after a price war.

The mechanics of the policy are roughly as follows. First, after the occurrence of a long enough low-price period, a gasoline retailer can ask the Board to investigate evidence of price anomalies. The Board then conducts a formal consultation of different groups (retailers, consumer protection groups), in order to evaluate the credibility of the predatory accusation. If the Board is convinced of the accusation, it can add \$0.03 per litre to the calculation of the MEP for a certain period of time in a specific geographic zone where the price war occurred. In practice the Board considers that a price is predatory if the margin (price minus the MEP) is below \$0.03 per litre for a month or more.

This minimum margin approximates the average operating cost of a representative station in the province.[11] The geographic zone typically includes all local markets which suffered from the price war. Similarly the length of time for which the minimum margin is applicable is proportional to the length of time of the price war.

The minimum margin has been put in effect three times in two different markets, St-Jérome and Québec city. In St-Jérome (north of Montréal), it was added to the MEP from April of 2002 to February of 2003, and again from December of 2003 to June of 2005. The imposition of this price floor followed the entry of Costco in St-Jérome in 2000, which drove the market price to the MEP level for more than a year. In Québec city, it was added to the MEP from July to October of 2001. Its imposition followed a severe price war in the Québec City metropolitan area, during the fall of 2000.

Finally, notice that the overall policy has both a short run and long run dimension. On the one hand, firms are constrained to set a price larger than the MEP, which is relatively low and unlikely to bind unless a low-cost retailer enters the market or firms engage into a price war. The other two aspects of the policy directly affect the option value of being in the market as they provide an insurance against the losses incurred during a price war. Indeed the regulation includes two dynamic compensation mechanisms: the legal channel (i.e. firms can sue their competitors), and extra government intervention (i.e. the additional $0.03 per litre margin).

4 Econometric analysis

The model presented in Section 2 illustrates various examples in which the introduction of the minimum price regulation in Québec's gasoline market can lead to lower prices due to the increased levels of competition favored by the policy. We showed in Figure 1 that the overall trends of the markets are consistent with this prediction. In this section we perform a rigorous statistical analysis, controlling for observed and unobserved factors that might be correlated with the introduction of the policy.

To do so, we examine in detail the effects of the price regulation on the behavior of firms and the structure of local markets. First, we perform a station-level difference-in-difference analysis, in which we compare the behavior of gas stations in Québec and Ontario before and after the introduction of the policy in 1997. We are particularly interested in the effect of the policy on store-level prices, sales-volume, and revenues. We further distinguish between the short and long run effect of the policy by looking at the periods immediately before and after the regulation change, versus the full panel.

Second, we perform a similar analysis at the neighborhood level to measure the effect of the policy on the structure of local markets. The richness of the data-set allows us to analyze the

[11] After public consultations, the Board decided that the representative station is a self-service station operating a convenience store, and having an annual sales volume of 350 million liters

impact of the policy on the number of competitors, the presence of store amenities, and the degree of differentiation between stores.

4.1 Station-level analysis

We want to evaluate the effect of the policy on the prices and profits of stations. Let y_{it} denote one of the four variables of interest: $\ln \text{Price}_{it}$, Markup_{it}, $\ln \text{Volume}_{it}$, $\ln \text{Revenue}_{it}$, where t is the time period and i is the station. For each dependent variable we estimate the following equation using station-level data:

$$y_{it} = \alpha_0 + \gamma D_{it} + \beta X_{it} + \epsilon_{it}, \tag{4}$$

where D_{it} is a dummy variable equal to one in Québec after 1996. The parameter γ captures the effect of the policy, provided that there are no additional unobserved confounding factors that are correlated with the introduction of the policy. We consider different specifications for X_{it}. In the simple difference-in-difference specification X_{it} includes only an indicator variable equal to one after 1996 and a Québec dummy. In most specifications we control for store-level fixed effects, time fixed effects, and a full set of observed characteristics of the stores and measures of competition. Adding controls is important in our context since we expect the policy to affect the composition of local markets, which are in turn correlated with the outcomes of interest. If this is the case, D_{it} will be correlated with the residuals in the simple specification. By comparing the results of various specifications with and without market structure controls we can thus indirectly test that the policy had an impact on the composition of the market.

Table 4 displays the results of the price regressions. We estimate two types of regressions. First, we estimate a "short-run" specification using only observations in 1996 and 1997, immediately before and after the introduction of the policy. Second, we estimate the regression using the whole sample so that the results capture the "long-run" effects of the policy. Columns (1)-(3) correspond to the "short run" regressions, whereas columns (4)-(6) correspond to the "long run" regressions. Columns (1) and (4) are simple difference-in-difference regressions in which we only control for the province where the station is located and add a control for all periods after 1997 to control for all the common shocks that might have affected both provinces at the time the policy was introduced. The regressions in columns (2) and (5) include controls for the number of competitors in the same market and on nearby streets that capture the intensity of very local competition, and for the number of stations and pumps per capita at the city level (both are measure in logs) that capture the level of competition at the city level. Controlling for city-level influences on competition is important in the retail gasoline market since prices are mainly driven by city-level factors in this market (see Houde (2009) for instance). In contrast, sales volume is much more affected by local market structure. These specifications also include controls for the wholesale price of gasoline (the rack price), as well as location-fixed effects and time-fixed effects to account for any unobservable shock that is either common across stations or constant for each station over time. Columns (3) and (6) include all the variables above plus additional station characteristics such as number of pumps, brand, size of convenience-store, carwash facilities, etc.

The striking result from these regressions is how the policy coefficients vary between the two samples. In particular, the effect of the policy is positive in the short run and negative over the longer span of the sample. According to the estimates, right after the introduction of the policy gasoline prices in Québec **increased** by 9% over what they would have been otherwise. Notice that this estimate is stable across all three specifications, consistent with our hypothesis that the policy did not affect the market structure immediately.

Over the whole time-span of the sample though, gasoline prices in Québec **decreased.** From Column (4) we see that the policy results in a price decrease of 7%. This effect is both economically and statistically significant. Most importantly the addition of controls decreases the magnitude of the effect by around 4.5%, which is consistent with the notion that the regulation affected market conditions in a way that favored lower prices. The interpretation of the market structure variables reveals that changes in local market conditions have little impact on prices, while a decrease in the number of competitors along a common street increases prices significantly. This is consistent with the fact that gasoline markets exhibit very little price dispersion between neighboring stores.

Table 5 displays the results using Markup_{it} as the dependent variable. Again the short-run effect of the policy appears to have been to cause prices to increase in Québec, while the long-term effect was to lower prices. The inclusion of market structure variables causes the coefficient on the policy variable to shrink from -7.5% to about -3%.

Next we explore the effect of the policy on stations' profitability, measured by their sales' volume and revenues. Table 6 presents the short-run specifications. With respect to sales volume, the policy did not have any statistically significant effect in the short-run, which is consistent with the fact that gasoline demand is fairly inelastic in the short-run. That is, the 9% increase in average price was not accompanied by any significant drop in aggregate demand. In the revenue specifications, we can see that once we add control variables (and fixed-effects) the policy appears to have increased revenues by about 13% on average, which is consistent with the short-run results on prices.

Table 7 contains the results for the long-run sales and revenue regressions. In this sample it is clear that both outcomes were negatively affected by the policy. Without controlling for any market structure and location characteristics the estimates reveal that volume and revenues decreased significantly, by 15% and 22% respectively. Importantly, these numbers are drastically reduced when we control for characteristics of the stations and local markets. The effect of the policy on volume is no longer significantly different from 0, and the effect on revenue is now just an 8% decrease. In other words, almost all of the decrease in volume and about two thirds of the decrease in revenue associated with the policy can be attributed to a change in the structure of local markets and the type of amenities offered by stations after the introduction of the price floor. Columns (2) and (4) also highlight the fact that competition is highly localized in gasoline markets.

The decrease in revenues from an additional competitor is statistically significant, and increases non-linearly.[12]

Table 8 further examines the effect of the policy on firms' revenue for subsamples of large and small stations. Recall that the initial objective of the Québec government was to protect small stations against aggressive pricing behavior from large low-cost retailers. The results suggest that the regulation has been a success in this respect since only large stations' revenues were negatively affected by the policy. This result is helpful in understanding the source of the negative long-run effect of the policy. Large stations that entered the market through recent technology innovations have been a lot more successful in Ontario than in Québec. The results suggest that the price floor is largely responsible for this.

We argue that the main reason for this phenomenon is that Ontario markets became less crowded relative to those in Québec after the policy change. We can see this at the level of individual stations by estimating equation 5 below, which relates the distance between each station i and its closest competitor to the policy dummy $D_{i,t}$ and a full set of fixed station- and time-effects:

$$d_{it} = -\underset{(0.011)}{0.038} \times D_{it} + \underset{(.0099)}{0.0741} \times \mathcal{I}\left(t \geq 1997\right) + \mu_i + \epsilon_{it} \tag{5}$$

The results indicate that the distance from each station to its closest competitor decreased significantly in Québec relative to Ontario after the introduction of the policy after 1996, so that markets became less crowded.

The previous sets of results on firms' profitability are consistent with the results on the effect of the policy on prices. Holding fixed the structure of markets, the short-run effect of the policy was to raise prices and firms' revenues. However, by comparing the evolution of markets in Ontario and Québec over the full sample we can conclude that the price floor lowered prices and profits. Notice that we are not claiming that prices fell in Québec as a direct consequence of the policy. Rather, we are claiming that the price controls modified the equilibrium entry and exit decisions of firms in the regulated markets compared to the control group, which in turn affected prices and profitability of stations. In the next section we further investigate this hypothesis by looking specifically at the impact of the policy change on the structure of local markets.

4.2 Market-level analysis

To study the effects of the policy on the organization of the industry we adopt a similar difference-in-difference approach as above, focussing only on the long-run features of the data. We estimate the following equation:

$$y_{mt} = \alpha_0 + \gamma D_{mt} + \beta X_{mt} + \epsilon_{mt}, \tag{6}$$

[12] Notice that the effect of additional competitors is identified through the within location variation in the number of stores. Without location fixed-effects, the local market structure coefficients are upward biased and not significantly different from zero.

where the coefficient of interest is the expected change γ in local market conditions after the policy implementation in Québec relative to the control markets in Ontario. As in the previous section, we include in all specifications a full set of time and local market fixed-effects.

The unit of observation here is a local market m observed at time t, as described in the data section.[13] The size of these markets varies between 0 and 11 stations, with a median of 3. For each local market, we construct three types of variables measuring (i) the degree of competition, (ii) the station characteristics, and (iii) the degree of differentiation (the within local market variance of station characteristics). We present the results from these regressions in Table 9.[14] For each regression we report the estimated coefficient of the policy indicator with HAC standard-errors. Each row corresponds to one regression.

We have already shown that the distance of each station to its closest competitor decreased after the introduction of the policy relative to the control group. In the first two rows of Table 9 we examine the effect of the policy on competition. Row 1 presents the effect on the number of competitors in each local market, which is our measure of competition. The result implies that on average the policy increased the number of stations in each market by 0.13 after controlling for all observed station characteristics and all unobserved market and time-specific unobservables. Row (2) shows the effect on monopoly markets and is negative and highly significant. These results strengthens our argument in favor of the hypothesis that the policy had a positive impact on competition in the market, compared with the counterfactual alternative.

Having established the positive effect of the policy on market competition, we turn to the specifics of the difference in market structure induced by the experiment. We already pointed out that gasoline markets went through a substantial reorganization during the 1990's that affected simultaneously all stations in all markets. The regression analysis allows us to test wether the regulation affected this process. Rows (3)-(11) report the results for several average characteristics of stations across markets.

Rows (3) and (4) show that the estimated coefficients of γ associated the average number of pumps and islands per station in each market respectively are negative and very significant. In other words, the average size of stations in Québec markets became significantly smaller due to the policy. The other measure of size is the proportion of stations which offer more than 2 service islands, or more than 20 pumps. The coefficient estimates reported in Rows (5) and (6) clearly show that on average Ontario stations have the capacity to serve more consumers than Québec stations after the policy.

We further evaluate the effects of the policy on the amenities offered by stations. Rows (7)-(10) describe the effects of the policy on the average number of stations per market that offer service at

[13]The results are also robust to a larger definition of local markets constructed using groups of postal-codes (i.e. FSA). Those results are available upon request.

[14]The number of observations can vary slightly between specifications due to the inclusion or exclusion of the "empty" markets.

the pump, a convenience-store, a car wash, and a repair shop. The results imply that the policy had a significant effect on all these average characteristics. Relative to Ontario, stations in Québec after the policy are less likely to offer complementary services.

Finally, Row (11) measures the effect of the policy on the ratio of the total number of pumps to the number of regular gas pumps. In other words, we measure the effect of the policy on the average variety of gasoline types offered by gas stations. The negative and significant estimate implies that Québec stations offer a smaller variety of gasoline grades as a consequence of the policy change. This reflects in part the fact that the newer types of gasoline pumps are designed to offer more than two types of grades of gasoline, and therefore that a larger proportion of stations have upgraded their equipment in Ontario after the policy.

We showed above that the policy was associated with a decrease in prices. Now we have shown that it is associated with a decrease in the scale and the variety of amenities offered by stations. To the extent that some people value these station characteristics, the net effect of the policy on the welfare of consumers is not clear. Moreover, from the firms' point of view, if these characteristics increase the value of a station, our results suggest that firms in the regulated markets are less likely to invest in vertical characteristics that would have softened price competition.

We analyze directly the idea that the regulation might have affected firms' incentive to differentiate themselves from their neighbors in Rows (12)-(19) of Table 9. The dependent variable is the standard deviation in the amenities offered by competing stations within a local market. Recall that the local markets are constructed such that the locations of stores are relatively homogeneous. An increase in the standard-deviation of a particular characteristic therefore corresponds to a net increase in the differentiation between stores.[15]

The results indicate that for all characteristics, the policy had a negative effect on differentiation. Stations within markets in Québec are becoming more similar relative to stations in Ontario along all dimensions. In particular, the results indicate that firms in the regulated markets tend to be less differentiated in terms complementary services (e.g. convenience store, car-wash) and size (i.e. number of pumps and service islands).

It must be remembered that the entire industry underwent a dramatic reorganization during this period, and that the policy was implemented in the middle of this process. The estimated effects are measured with respect to what was happening in Ontario, and the evidence suggests that markets in Ontario experienced more profound changes than Québec markets.

[15]Except for the size, all variables are qualitative and take value zero or one. The variation in size is measured as the standard deviation of the number of pumps across stations within each market, which is affected by the scale with which the size is measured. The results shown do not vary when we use the coefficient of variation, which is invariable to changes in scale, instead of the standard deviation.

5 Discussion

In this section we provide a discussion of our results, and we comment on the welfare and policy implications of the regulation.

We have shown that the impact of the price regulation on the Québec retail gasoline market was substantial. We identified the effect using a differences-in-differences approach with before and after observations in both Québec and Ontario, where the policy was never used.

First, we find that the policy significantly affected the reorganization of the markets. In Québec, there were more stations after the policy was introduced compared to Ontario, after controlling for unobserved market- and time-specific effects. Moreover, stations in Ontario became bigger and offered a wider variety of products. After the policy was introduced, Québec stations became relatively more homogeneous in terms of the type of services that they offered, mostly because new stations entering in Ontario were very different from the stations that stayed in the market.

Second, we find that these changes in market structure had an effect on the pricing behavior of firms. In the short run, before the policy had any effect on the structure of the markets, the policy seems to have increased prices, which is the standard expected effect of such price regulation. In the longer run, though, prices in Québec decreased sharply relative to Ontario, after accounting for the changes in all observed market and station characteristics and all types of location-specific and time-specific unobserved shocks.

The obvious limitation of our difference-in-difference approach is that the policy was not really exogenous and its introduction may have been correlated with other confounding factors. That is, it is possible that differences in market behavior across provinces are a consequence of region-specific factors and the policy may have been a consequence of these differences. We have exploited our very rich data set to control as much as possible both for observed and unobserved variables; however, it may be that there are other unobservables that changed concurrently with the policy.

For instance, one potentially confounding occurrence near the implementation of the price floor policy was that Ultramar, one of the leading retail chains, instituted a low-price guarantee (Programme ValeurPlus) in the summer of 1996. Since Ultramar has a greater presence in Québec than in Ontario, and to the extent that this strategy was actually implemented by Ultramar, we might worry that the effects on prices and market structure that we have attributed to the price floor policy were actually the result of the Ultramar programme. For example, if the price matching guarantee served to facilitate collusion this could explain the short run increase in prices. However, it seems unlikely that the long term effects on price that we have shown to be driven largely by changes in market structure are the result of the price matching guarantee. Theoretical work suggests that price matching guarantees cannot deter entry, since it does not represent a credible commitment from incumbent firms (see for instance Arbatskaya (2001)).

Nevertheless, we can confirm empirically that the Ultramar programme is not driving the changes that we observe. Although Ultramar was more dominant in Quebec, it still owned roughly

5% of stations in Ontario. This fact, combined with the assumption that the low-price guarantee strategy has only a direct impact on local markets where Ultramar is present, allows us to simultaneously estimate both policy changes using a similar difference-in-difference approach. We have redone all of the regressions described in the results section above, but in addition to our policy indicator via which we compare the behavior of gas stations in Québec and Ontario before and after the introduction of the price floor policy in 1997, we also include an indicator for the low-price guarantee programme that compares the behavior of gas stations in local markets with and without Ultramar stations before and after the introduction of the guarantee. The inclusion of this indicator variable in our analysis has no impact on the price-floor policy indicator.[16]

We provide evidence supporting the argument that the reason bigger and more efficient stations do not enter in Québec is because the crowding in the market that results from the price floor implies that they will not earn sufficient profits to cover their bigger fixed costs. It should be pointed out that there are other possible means by which the price floor could negatively affect the profits that stations expect to earn upon entry. For instance it may also be that the presence of a price floor makes it difficult for firms engaged in a tacit collusion (as in Porter (1983)) to revert to a "punishing" stage and makes it increasingly difficult to sustain this type of equilibrium. The expected reduction in profit may deter the entry of new firms.

Similarly, the price floor may also reduce expected profits by making it more difficult to engage in intertemporal price discrimination. Stations may vary prices over time to take advantage of the fact that some consumers are patient and able to postpone the purchase of gasoline in anticipation of better prices in the future, while others are not. Those who are patient can wait for prices to fall, while those who cannot have more inelastic demand. A price floor limits the ability of stations to vary their prices in order to discriminate between these two groups and so may lower their overall profits.

Finally, what can be said about welfare? It seems clear that the policy decreased prices at the pump for consumers. On the other hand, there is evidence that after the policy, stations in Québec and in Ontario became increasingly dissimilar; moreover, stations in local markets in Québec became more homogeneous than stations in local markets in Ontario. Therefore, after the policy consumers in Ontario were paying for different services than consumers in Québec, in the sense that new stations in Ontario were generally bigger and offered a wider variety of products.

On the firms' side, we find that after the policy stations in Québec were charging lower prices than stations in Ontario and had lower markups. This increase in net revenues for stations in Ontario may reflect an increase in rents due to decreased competition. On the other hand, the higher prices may just reflect higher fixed or entry costs which reflect the expanded services they provide. Evaluating all these welfare effects requires the structural estimation of a precise market model, something we leave for future research.

[16] We do not include these results in the paper. They are available from the authors upon request.

The dynamic model presented in Appendix C illustrates how we plan on evaluating the equilibrium consequences of price control regulation on market structure. There we simulate the outcome of an industry subject to a price floor regulation, and compare the long-run distribution of prices and consumer welfare under three different parameterizations. The results are in line with the 2-period model discussed in Section 2. It is relatively easy to generate cases in which a price floor discourage the entry of larger, more efficient firms. In all parameterizations the policy always tend to favor consumers, essentially because the policy increase the number of products available. The overall economy might be made worse-off however by the policy since firms are much less productive because of this government intervention.

Notice that our results are specific to the Québec gasoline markets during a particular interval of years. Even though extrapolation of our results to other markets is not possible, our findings do provide evidence that such effects might be present in *any* market. Similar price regulation is not uncommon. For example, agricultural price controls that provide insurance to local producers against excessively low prices are a form of price floor. In Europe, regulation aimed at protecting small retailers from the aggressive pricing of big retailers is common. And throughout the world, anti-dumping regulation aimed at protecting local producers by forbidding foreign firms to set price below average variable costs are a subtle form of price floor. All these policies have longer run effects on market structure and performance that are not always fully recognized.

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A Description of the clustering algorithm

In this appendix we describe the construction of local markets. Consider an isolated metropolitan area composed of L potential store locations. In the data we define n as the set of geographic coordinates and street intersection pairs that were ever occupied by a gasoline station between 1991 and 2001. Because of entry and exit, n is thus larger than the total number of active station at any point in time.

The clustering algorithm proceeds iteratively by grouping stations with similar spatial characteristics until the allocation of stores in groups is stable. We define the degree of similarity between two locations using the euclidian distance (d_{ij} expressed in Km), and an indicator variable equal to one if they share at least one street. Each location can be characterized by up to two streets.

The key parameter of the algorithm is δ. It determines a threshold distance such that two locations are considered in the same local market even if they do not have street in common. This parameter is important since two stores can be very close in euclidian distance, but the survey company does not locate them along the same street. Intuitively this parameter is a penalty added to the euclidian distance between two stores that are not connected by a common street. We fix the value of δ to 1/4 Km, which is a very small distance. Note that the number of stable clusters is rapidly decreasing in δ.

We initiate the algorithm by defining initial local markets, as the set of possible street intersections in the city. Let $\mathcal{M}^t$ be the allocation at iteration t. $\mathcal{M}^t$ is a mapping from locations to local markets:

$$\mathcal{M}^t = \left\{m_1^t, m_2^t, ..., m_L^t\right\}, \tag{7}$$

where m_i^t is the local market id associated with location i.

1. At iteration t, update the assignment of store $i \in L$:

   (a) Calculate the distance between location i and the center of market m_i denoted by l_{m_i}[17]:

   $$D(i, m_i) = \begin{cases} \delta & \text{if } |m_i| = 1, \\ d(l_i, l_{m_i}) & \text{otherwise.} \end{cases} \tag{8}$$

   (b) Calculate the distance from l_i to all other local markets. For each market $m \neq m_i$:

   $$D(i, m) = \begin{cases} d(l_i, l_m) + \delta & \text{if } s_i \notin S_m, \\ d(k_i, l_m) & \text{otherwise,} \end{cases} \tag{9}$$

   where s_i is the vector of street indices of location i and $S_m = \bigcup_{j \in m} s_j$ is the union of

[17] We definite l_m as the average latitude/longitude coordinate of locations belonging to m.

streets for all locations in market m. Let $m_i^* \neq m_i^t$ the closest local market for location i.

(c) If $D_i^* < D(i, l_{m_i^t})$ set $m_i^{t+1} = m_i^*$. Otherwise leave location i assignment unchanged.

2. Repeat the previous steps for all $i \in L$.

3. If $\mathcal{M}^{t+1} \neq \mathcal{M}^t$ repeat step (1) and (2). Otherwise stop.

B Tables and figures

Table 1: Number and size distribution of local markets

MARKETS	Count	Q_5	Q_{25}	Q_{50}	Q_{75}	Q_{95}	Max
Chicoutimi, Qc	39	1	1	2	4	7	9
Cornwall, On	15	1	2	2	3	5	5
Drummondville, Qc	17	1	2	3	3	8	8
Guelph, On	14	1	2	2	5	9	9
Hamilton, On	39	1	3	5	7	10	15
Kingston, On	15	1	3	4	5	8	8
Québec, Qc	94	1	3	4	6	11	12
Sherbrooke, Qc	28	1	2	4	5	8	8
St. Catharines, On	25	1	2	3	4	7	8
Trois-Rivières, Qc	24	1	2	3	5	8	9
Total	310	1	2	3	5	9	15

Table 2: Entrants, exiters, and continuing stations

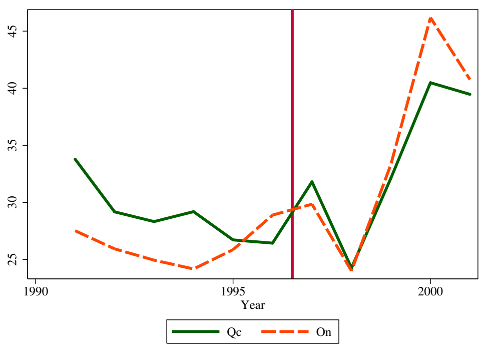
	Nb. Pumps	Nb. Islands	Conv. Store	Full service
$E(X\|\text{Entrant}) - E(X\|\text{Continuing})$	0.473	0.080	0.062	-0.020
	(0.996)	(0.145)	(0.049)	(0.052)
$E(X\|\text{Entrant}) - E(X\|\text{Exiting})$	5.5252***	0.6945***	0.4768***	-0.3705***
	(0.989)	(0.144)	(0.051)	(0.053)
$E(X\|\text{Exiting}) - E(X\|\text{Continuing})$	-5.4066***	-0.6402***	-0.4141***	0.3432***
	(0.378)	(0.070)	(0.028)	(0.028)

Robust asymptotic standard-errors are in parenthesis. Each entry corresponds to the regression coefficient $\beta = E(X|\text{Group}^1) - E(X|\text{Group}^2)$ from:

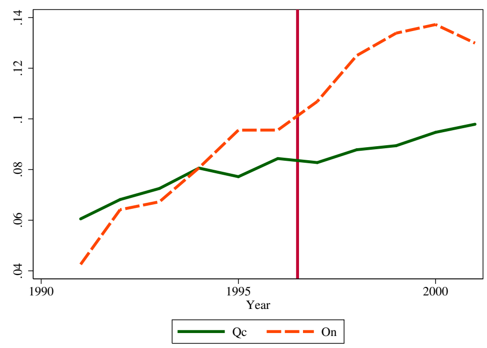
$$X_j = \alpha + \beta \mathcal{I}(j \in \text{Group}) + e_j.$$

For each row the sample corresponds to stations that part of Group^1 and Group^2, where Group corresponds to either *Entrant*, *Continuing* or *Exiting*.

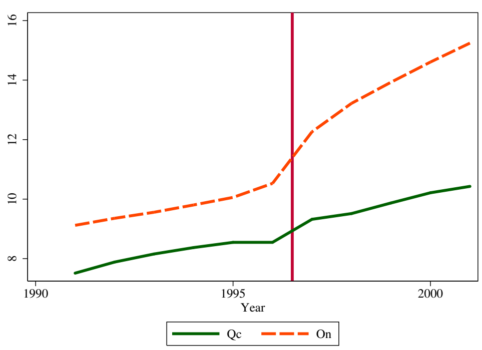
Figure 1: Evolution of prices and local market structure characteristics in Québec and Ontario between 1991 and 2001



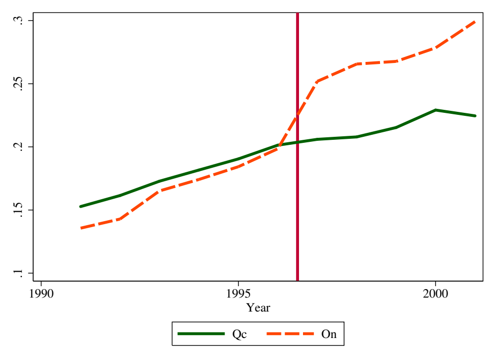
(a) Average prices (net of taxes)



(b) Fraction of local monopolies



(c) Average number of pumps



(d) Proportion of large stations

Table 3: Summary statistics of the key variables for the two Provinces before and after the policy change

VARIABLES	Before 1997				After 1997			
	Quebec		Ontario		Quebec		Ontario	
	N	Average (sd)	N	Average (sd)	N	Average (sd)	N	Average (sd)
Price (log)	3715	4.100	1747	3.969	2704	4.204	1260	4.143
		(0.044)		(0.056)		(0.110)		(0.136)
Revenue (log)	3381	12.229	1383	12.622	2431	12.615	905	13.217
		(0.741)		(0.759)		(0.747)		(0.864)
Sales volume (log)	3495	8.124	1533	8.638	2447	8.410	917	9.071
		(0.751)		(0.774)		(0.742)		(0.844)
Nb. of pumps	3840	8.148	1921	9.690	2723	9.856	1281	13.842
		(5.731)		(5.535)		(7.314)		(9.941)
Nb. Islands	3840	2.118	1921	2.339	2723	2.263	1281	2.665
		(1.271)		(1.227)		(1.342)		(1.403)
Islands > 4	3840	0.176	1921	0.164	2723	0.216	1281	0.272
		(0.381)		(0.371)		(0.412)		(0.445)
No Conv. store	3840	0.580	1921	0.674	2723	0.399	1281	0.435
		(0.494)		(0.469)		(0.490)		(0.496)
Carwash	3840	0.190	1921	0.168	2723	0.187	1281	0.219
		(0.392)		(0.374)		(0.390)		(0.413)
Pay at the pump	3840	0.001	1921	0.022	2723	0.039	1281	0.141
		(0.036)		(0.148)		(0.193)		(0.348)
Repair shop	3840	0.191	1921	0.069	2723	0.155	1281	0.061
		(0.393)		(0.253)		(0.362)		(0.239)
Self service	3840	0.369	1921	0.366	2723	0.502	1281	0.463
		(0.483)		(0.482)		(0.500)		(0.499)
Local comp.	3840	3.663	1921	3.558	2723	3.010	1281	2.539
		(2.295)		(2.718)		(1.953)		(1.997)
Street comp.	3840	10.099	1921	9.353	2723	7.701	1281	7.624
		(9.466)		(7.276)		(6.961)		(5.868)

Table 4: Long-run and short-run effects of the policy on prices

VARIABLES	(1) Short-run	(2) Short-run	(3) Short-run	(4) Long-run	(5) Long-run	(6) Long-run
Policy	0.0878***	0.0869***	0.0853***	-0.0715***	-0.0290***	-0.0251***
	(0.00247)	(0.00242)	(0.00247)	(0.00255)	(0.00362)	(0.00369)
Rack price (log)		0.213***	0.211***		0.279***	0.274***
		(0.0171)	(0.0176)		(0.0106)	(0.0108)
Local competitors (log)		-0.0105	-0.0116		0.000509	0.00198
		(0.00745)	(0.00771)		(0.00492)	(0.00488)
Size of local competitors (log)		0.00382	0.00543		-0.00397	-0.00447
		(0.00448)	(0.00458)		(0.00302)	(0.00298)
Street competitors (log)		0.00481	0.00130		-0.00183	-0.00290
		(0.00903)	(0.00923)		(0.00593)	(0.00582)
Size of street competitors (log)		0.00905	0.00990		-0.0144**	-0.0130**
		(0.00661)	(0.00693)		(0.00581)	(0.00587)
Stations per capita		-0.365***	-0.357***		-0.208***	-0.216***
		(0.0385)	(0.0383)		(0.0319)	(0.0315)
Pumps per capita		-0.143***	-0.137***		0.118***	0.121***
		(0.0163)	(0.0166)		(0.0157)	(0.0160)
Quebec	0.0203***			0.131***		
	(0.00172)			(0.00155)		
After 1996	0.0163***			0.177***		
	(0.00189)			(0.00204)		
Constant	4.049***	3.328***	3.262***	3.967***	2.949***	2.988***
	(0.000990)	(0.0804)	(0.0793)	(0.00135)	(0.0509)	(0.0511)
Observations	1683	1683	1683	9765	9765	9765
R^2	0.791	0.916	0.923	0.481	0.859	0.864
Number of kentid		880	880		1174	1174

*** p<0.01, ** p<0.05, * p<0.1

All specifications except 1 and 4 include period fixed-effects and the log rack price.

Robust standard errors in parentheses

Col. 3 and 6 also include a full set of station characteristics and location fixed-effects.

Dependent variable: log price.

Table 5: Long-run and short-run effects of the policy on markups

VARIABLES	(1) Short-run	(2) Short-run	(3) Short-run	(4) Long-run	(5) Long-run	(6) Long-run
Policy	0.132***	0.144***	0.141***	-0.0751***	-0.0350***	-0.0292***
	(0.00453)	(0.00462)	(0.00473)	(0.00308)	(0.00565)	(0.00573)
Local competitors (log)		-0.0120	-0.00885		-0.000270	0.00171
		(0.0159)	(0.0162)		(0.00694)	(0.00688)
Size of local competitors (log)		-0.00215	-0.000879		-0.00639	-0.00723*
		(0.0101)	(0.0104)		(0.00431)	(0.00426)
Street competitors (log)		0.0253	0.0191		-0.00465	-0.00599
		(0.0208)	(0.0212)		(0.00829)	(0.00815)
Size of street competitors (log)		-0.00685	-0.00938		-0.0135*	-0.0109
		(0.0163)	(0.0174)		(0.00793)	(0.00792)
Stations per capita		-0.954***	-0.942***		-0.274***	-0.286***
		(0.0570)	(0.0548)		(0.0467)	(0.0462)
Pumps per capita		-0.212***	-0.204***		0.170***	0.177***
		(0.0281)	(0.0288)		(0.0244)	(0.0251)
Quebec	-0.0562***			0.0956***		
	(0.00312)			(0.00224)		
After 1996	-0.0109***			-0.0244***		
	(0.00286)			(0.00237)		
Constant	0.157***	-0.302***	-0.351***	0.167***	-0.115*	-0.110*
	(0.00154)	(0.0765)	(0.0776)	(0.00200)	(0.0605)	(0.0602)
Observations	1683	1683	1683	9765	9765	9765
Number of kentid		880	880		1174	1174
R^2	0.527	0.808	0.825	0.261	0.559	0.573

Dependent variable: markup.
All specifications except 1 and 4 include period fixed-effects.
*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors in parentheses
Col. 3 and 6 also include a full set of station characteristics and location fixed-effects.

Table 6: Short-run effect of the policy on sales and revenues

VARIABLES	(1) Log Vol.	(2) Log Vol.	(3) Log Rev.	(4) Log Rev.
Policy	-0.0165	0.0371	0.0717**	0.126***
	(0.0349)	(0.0260)	(0.0350)	(0.0266)
Local competitors (log)		-0.105		-0.126
		(0.106)		(0.109)
Size of local competitors (log)		-0.0753		-0.0637
		(0.0647)		(0.0639)
Street competitors (log)		-0.156		-0.163
		(0.112)		(0.113)
Size of street competitors (log)		0.0824		0.105
		(0.0769)		(0.0787)
Stations per capita		-0.241		-0.543
		(0.353)		(0.365)
Pumps per capita		0.435**		0.323*
		(0.182)		(0.186)
Quebec	-0.617***		-0.598***	
	(0.0676)		(0.0675)	
After 1996	0.0816***		0.0984***	
	(0.0285)		(0.0286)	
Constant	8.886***	7.330***	12.94***	11.27***
	(0.0578)	(0.522)	(0.0578)	(0.540)
Observations	1451	1451	1451	1451
R^2	0.115	0.112	0.102	0.223
Number of kentid		784		784

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Col. 2 and 4 include station characteristics and location/time fixed-effects.
Dependent variables: log sales volume (col. 1-2) and log revenue (col. 3-4).

Table 7: Long-run effect of the policy on sales and revenues

VARIABLES	(1) Log Vol.	(2) Log Vol.	(3) Log Rev.	(4) Log Rev.
Policy	-0.147***	-0.0477	-0.221***	-0.0835***
	(0.0402)	(0.0320)	(0.0406)	(0.0315)
Local competitors (log)		-0.137***		-0.132***
		(0.0323)		(0.0315)
Size of local competitors (log)		0.0264		0.0219
		(0.0234)		(0.0231)
Street competitors (log)		-0.0855*		-0.0859*
		(0.0487)		(0.0480)
Size of street competitors (log)		-0.0675		-0.0844*
		(0.0466)		(0.0470)
Stations per capita		-0.310*		-0.494***
		(0.161)		(0.158)
Pumps per capita		-0.0634		0.0231
		(0.133)		(0.131)
Quebec	-0.514***		-0.382***	
	(0.0509)		(0.0509)	
After 1996	0.433***		0.611***	
	(0.0339)		(0.0344)	
Constant	8.638***	8.143***	12.61***	12.07***
	(0.0434)	(0.268)	(0.0434)	(0.265)
Observations	8392	8392	8392	8392
R^2	0.136	0.255	0.137	0.412
Number of kentid		1129		1129

Dependent variables: log sales volume (col. 1-2) and log revenue (col. 3-4).
*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors in parentheses
Col. 2 and 4 include station characteristics and location/time fixed-effects.

Table 8: Long-run effect of the policy on revenues for large and small stores

VARIABLES	(1) Full sample	(2) Pumps$\leq$ 4	(3) Pumps>4
Policy	-0.0835***	-0.0853	-0.0741**
	(0.0315)	(0.0873)	(0.0353)
Local competitors (log)	-0.132***	-0.235***	-0.107***
	(0.0315)	(0.0776)	(0.0359)
Size of local competitors (log)	0.0219	0.109*	-0.00245
	(0.0231)	(0.0578)	(0.0249)
Street competitors (log)	-0.0859*	-0.114	-0.0771
	(0.0480)	(0.132)	(0.0483)
Size of street competitors (log)	-0.0844*	-0.0369	-0.0877**
	(0.0470)	(0.146)	(0.0445)
Stations per capita	-0.494***	0.155	-0.601***
	(0.158)	(0.320)	(0.182)
Pumps per capita	0.0231	-0.466*	0.134
	(0.131)	(0.257)	(0.151)
Constant	12.07***	12.16***	11.40***
	(0.265)	(0.569)	(0.349)
Observations	8392	1997	6395
R^2	0.412	0.316	0.454
Number of kentid	1129	338	868

Robust standard errors in parentheses

Col. 2 and 4 include station characteristics and location/time fixed-effects.

*** p<0.01, ** p<0.05, * p<0.1

Dependent variables: log sales volume (col. 1-2) and log revenue (col. 3-4).

Table 9: Long-run effect on local-market competition, station characteristics, and differentiation

		VARIABLES	Policy coefficients	n	Number of markets	R^2
Competition	(1)	Competitors	0.126**	3399	309	0.225
			(0.062)			
	(2)	Local monopoly	-0.0754***	3399	309	0.017
			(0.025)			
Store characteristics	(3)	Total Pumps	-2.000***	3220	307	0.232
			(0.372)			
	(4)	Nb. Islands	-0.118***	3220	307	0.316
			(0.038)			
	(5)	Large pumps	-0.0821***	3220	307	0.189
			(0.019)			
	(6)	Large islands	-0.0772***	3220	307	0.116
			(0.016)			
	(7)	Full service	-0.0341**	3220	307	0.138
			(0.016)			
	(8)	Conv. store	-0.0454***	3220	307	0.185
			(0.016)			
	(9)	Car wash	-0.0458***	3220	307	0.031
			(0.012)			
	(10)	Repair shop	-0.0163**	3220	307	0.033
			(0.008)			
	(11)	Grade variety	-0.233***	3220	307	0.058
			(0.036)			
Product differentiation	(12)	Size variation	-0.0598***	2384	246	0.050
			(0.020)			
	(13)	Islands variation	-0.0564**	2384	246	0.266
			(0.025)			
	(14)	Large island variation	-0.0335*	2384	246	0.028
			(0.020)			
	(15)	Large pumps variation	-0.0204	2384	246	0.073
			(0.021)			
	(16)	Conv. store variation	-0.0428**	2384	246	0.051
			(0.018)			
	(17)	Car wash variation	-0.0491***	2384	246	0.017
			(0.015)			
	(18)	Full service variation	-0.0164	2384	246	0.011
			(0.021)			
	(19)	Repair shop variation	-0.0364***	2384	246	0.053
			(0.013)			

HAC asymptotic standard-errors are in parenthesis. All specifications also include time and location fixed-effects.

C A dynamic industry model with price controls

We describe a dynamic model of entry, exit and product choice in an industry that is subject to a price floor regulation. The model illustrates the role of price controls in distorting the structure of retail markets. We are particularly interested in characterizing the potential effects of regulation on the number of and type of competitors and the resulting prices.

The model has two components: (i) a static pricing game, and (ii) a dynamic entry and product choice game. We first describe the pricing game and then the industry dynamic equilibrium. Finally, we compare the equilibria with and without price regulation using numerical examples.

C.1 Demand and prices

In the short-run the structure of the market is constant and firms post prices simultaneously. There are two types of firms, large and small (i.e. l and s). These two types differ with respect to their quality ($\delta_l \geq \delta_s$) and their constant marginal cost ($c_l \leq c_s$). Firms face a passive outside competitor that provides a good with net value ν. The market structure is therefore described by the number of active firms of each type and the value of the outside option. The state of the industry is further characterized by the number n_s, n_l of active firms and an exogenous price floor $p_f \geq 0$ set by the government. We group these state variables in a vector $\omega = \{n_s, n_l, \nu, p_f\}$. For simplicity we assume that the state space is finite.

To characterize demand at each store, we use a logit model with congestion similar to the model proposed by Ackerberg and Rysman (2005), who suggest the addition of congestion to the logit model of product differentiation to mimic the localized nature of competition in retail markets. Since in the logit model differentiation is measured by the variance of consumers' idiosyncratic tastes for products, we let it depend on the number of competitors as follows:

$$\sigma(n) = \frac{1}{\mu} n^{-\mu}, \tag{10}$$

where $0 < \mu < 1$.

Demand for product $j \in \{s, l\}$ is therefore given by:

$$D_j\left(p|\omega\right) = M \frac{e^{(\delta_j - p_j)/\sigma(n)}}{e^{\nu/\sigma(n)} + \sum_k e^{(\delta_k - p_k)/\sigma(n)}}. \tag{11}$$

Without a price floor constraint, a symmetric price equilibrium is described by two prices $p(\omega) = \{p_s(\omega), p_l(\omega)\}$ solving the following FOCs:

$$D_j\left(p(\omega)\right) - M \frac{1}{\sigma(n)} \left(p_j(\omega) - c_j\right) s_j \left(1 - s_j\right) = 0, \quad j \in \{s, l\} \tag{12}$$

where $s_j = \frac{e^{\left(\delta_j - p_j\right)/\sigma(n)}}{e^{\nu/\sigma(n)} + \sum_k e^{\left(\delta_k - p_k\right)/\sigma(n)}}$.

When firms are constrained by a price floor $p_f > 0$ the equilibrium is characterized by four Kuhn-Tucker conditions:

$$D_j\left(p(\omega)\right) - M\frac{1}{\sigma(n)}\left(p_j(\omega) - c_j\right)s_j\left(1 - s_j\right) + \lambda_j = 0 \tag{13}$$

$$\lambda_j\left(p_j\left(\omega\right) - p_f\right) = 0 \tag{14}$$

for each $j \in \{s, l\}$ and $\lambda_j \geq 0$. Throughout the paper we focus on cases that satisfy the following two properties:[18]

$$\text{If } n_j > 0 \text{ for all } j\text{: } p_l(\omega) \leq p_s(\omega),$$
$$\text{If } n = 1\text{: } p_l(\omega) \leq p_s(\omega).$$

These conditions simply mean that the large firm always charges a weakly lower price in equilibrium, both in oligopoly and monopoly setups. As a result the price floor will generate three possible outcomes: (i) no prices are constrained ($\lambda_l = \lambda_s = 0$), (ii) both prices are constrained ($p_s = p_l = p_f$), or (iii) only the large firm is constrained ($\lambda_s = 0$ and $p_l = p_f$). We assume that a symmetric Nash equilibrium satisfying these conditions exists and is unique. Let $\pi_j(\omega)$ denote the static equilibrium profit of type j firm.

C.2 Entry and exit

In the long-run incumbents are able to adjust their configurations and new firms can enter the market. Conditional on their current type, the state of the industry and a vector of privately observed profitability shocks $\epsilon = \{\epsilon_o, \epsilon_s, \epsilon_l\}$, firms simultaneously choose between three options: (i) small configuration, (ii) large configuration, (iii) exit/stay-out. As in Rust (1987) we assume that the private information component of the state is *iid* across players and time, and distributed according to a double-exponential distribution (i.e. multinomial logit).

The timing of actions is as follows. At the beginning of the period firms observe the state of the industry ω and their private information shock ϵ. Firms then simultaneously commit to a price and a configuration choice, and profits are realized. Entry/exit and reconfiguration actions are taken at the end of the period.

Potential entrants face the same problem but live for only one period as in Pakes and McGuire (1994). For tractability we assume that only one firm can enter every period, and that no more than $\bar{n}$ firms can be active.

We follow Aguirregabiria and Mira (2007) and Doraszelski and Satterthwaite (2005) in defining

[18] These conditions are implicit constraints on the cost and quality parameters. In particular, the cost efficiency of the large firm dominates the effect of quality on prices.

a Markov-perfect Bayesian equilibrium. Because actions are stochastic (prior to observing ϵ), players use choice probabilities $\sigma_j(a|\omega)$ to form beliefs about their opponents' actions. We focus on symmetric Markovian strategies. Therefore these probabilities are symmetric and depend only on the current observed state vector ω.

Given beliefs σ, an incumbent's problem is described by the following Bellman equation:

$$V_j^\sigma(\omega,\epsilon) = \max_{a\in\{o,s,l\}} \pi_j(\omega) - F_j - K(j,a) + \epsilon_a + \beta \sum_{\omega'} EV_a^\sigma(\omega')F^\sigma(\omega'|\omega,a) \tag{15}$$

where $EV_j^\sigma(\omega') = \int V_j^\sigma(\omega',\epsilon')f(\epsilon')d\epsilon'$. The adjustment cost function $K(j,a)$ incorporates both the cost of entering and reconfiguring an existing store, as well as the cleaning cost of leaving the market. We parametrize the function as follows:

$$K(j,a) = \begin{cases} 0 & \text{if } j \neq a \\ \kappa & \text{if } j = o \text{ and } a \neq o \\ \kappa + x & \text{if } j \neq o \text{ and } a \neq j \\ x & \text{if } j \neq o \text{ and } a = o \end{cases} \tag{16}$$

Once firms leave the market, they receive a payoff ϵ_o and are not able to re-enter. The expected continuation value of being out of the market is therefore zero. The problem of potential entrants is described by:

$$V_o^\sigma(\omega,\epsilon) = \max\left\{\epsilon_o, \max_{a\in\{s,l\}} -\kappa + \epsilon_a + \beta\sum_{\omega'} EV_a^\sigma(\omega')F^\sigma(\omega'|\omega,a)\right\}. \tag{17}$$

The transition probability matrix $F^\sigma(\omega'|\omega,a)$ is constructed from the beliefs probabilities σ and the transition matrix for the outside option valuation $G(\nu_0'|\nu)$. Let $A_{-j}(\omega',\omega,a)$ be the set of possible actions that player j's opponents can take in state ω in order to reach state ω'. The transition probability function is then given by:

$$F^\sigma(\omega'|\omega,a) = \Pr\left[\{n_s',n_l',\nu',p_f\}|\omega,a,\sigma\right] = \sum_{a_{-j}\in A_{-j}(\omega',\omega,a)} \prod_i \sigma_i(a_i|\omega)G(\nu'|\nu). \tag{18}$$

Given beliefs σ and the assumed distribution of the unobserved private information, the best-response choice probability of a firm of type j takes a multinomial logit form:

$$\Psi_j(a|\omega,\sigma) = \frac{\exp\left(v_j^\sigma(a|\omega)\right)}{\sum_{k\in\{o,s,l\}}\exp\left(v_j^\sigma(k|\omega)\right)} \tag{19}$$

where $v_j^\sigma(a|\omega) = \pi_j(\omega)\times 1\,(a\neq o) - K(j,a) + \beta EV^\sigma(\omega')F^\sigma(\omega'|\omega,a)$ is the choice specific value function prior to observe ϵ_a.

A Markov-perfect Bayesian Nash equilibrium is defined as a fixed point in the belief choice probabilities:

$$\sigma_j(a|\omega) = \Psi_j(a|\omega, \sigma) \tag{20}$$

The computation of the equilibrium is eased by the fact that model contains an absorbing state (i.e. being out). Using Hotz and Miller (1993) inverse representation, the expected continuation value can be written solely as a function the choice probabilities and static payoffs:

$$\log\left(\frac{\sigma_j(a|\omega)}{\sigma_j(o|\omega)}\right) = \pi_j(\omega) - K(j,a) + K(j,o) + \beta\sum_{\omega'} EV_a^\sigma(\omega')F^\sigma(\omega'|\omega, a). \tag{21}$$

Using this representation we can write the expected value-function as follows:

$$EV_j^\sigma(\omega) = \sum_a \sigma_j(a|\omega)\left[e^\sigma(a,\omega) + \log\left(\frac{\sigma_j(a|\omega)}{\sigma_j(o|\omega)}\right)\right] - K(j,o), \quad j \neq o \tag{22}$$

where $e^\sigma(a,\sigma) = E\left[\epsilon_a | v_j^\sigma(a|\omega) + \epsilon_a \geq v_j^\sigma(a'|\omega) + \epsilon_{a'}, \forall a'\right] = \gamma - \log(\sigma_j(a|\omega))$. The value of $EV_j^\sigma(\omega)$ can be substituted in equation 19 to represent the best-response choice probability mapping as a function of σ.

C.3 Numerical examples

In this section we discuss several numerical examples to illustrate the properties of the dynamic game and the impact of price floor constraints on the dynamics of the industry. Table 10 presents the three sets of parameters that are used. The first one illustrates an industry with moderate fixed-costs and little turnover, and the second one has larger fixed-costs and a higher turnover rate. The third specification adds a quality difference dimension between large and small firms, and raises the fixed cost of type l firms to 3.5. We set the maximum number of firms to 5. Without large firms the long run average number of firms is always smaller than 5, so this constraint does not affect the results. Note also that in all examples we fixed the value of the outside option to -1.5. Therefore, only entry, exit and reconfiguration decisions generate randomness in the industry. Moreover, the adjustment cost parameters κ and x are set to relatively high levels which creates infrequent turnover in the industry.

In all specifications we set the price floor to 1. At this level, the price floor does not bind in equilibrium unless a large firm is active in the industry. Figures 2(e) and 2(f) graph the average market prices with and without a price floor. Because of the congestion term, prices fall sharply with the number of firms. In the unconstrained case, large firms set their prices very close to the marginal cost of the small firms when there are more than four firms active. The price floor regulation therefore protects the small type and restores the price that would be observed if large

Table 10: Parameter values for the numerical simulations

	Specification 1	**Specification 2**	**Specification 3**
Demand parameters			
M	5	5	5
δ_s	0	0	0
δ_l	0	0	0.15
ν	1.5	1.5	1.5
μ	3/4	3/4	3/4
Marginal costs			
c_s	1/2	1/2	1/2
c_l	0	0	0
Fixed costs			
F_s	1.2	1.25	1.25
F_l	2.7	2.85	3.5
Entry/exit costs			
κ	5	5	5
x	5	5	5

firms were not present in the industry (see top left corner of Figure 2(e)).

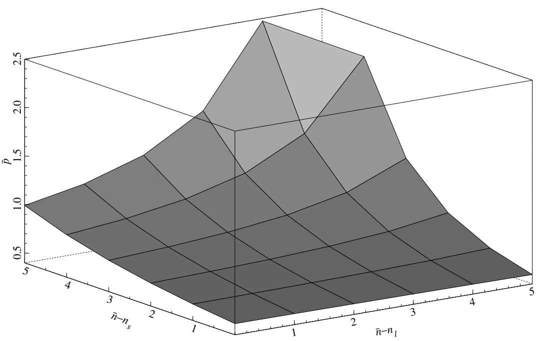
To analyze the long-run effect of a price floor constraint we simulate the evolution of the industry for $10,000$ periods and calculate the proportion of time that the industry spends in each discrete state. In order to compare across specifications we use exactly the same sequence of random numbers.

Table 11 illustrates the simulation results for the first specification. In this specification, the fixed costs of both types are relatively small and the steady state level of competition is important. Without the regulation (left panel), the most likely industry structure has one small and two large firms. Because the large firm is significantly more efficient, the average price in that state is 1.

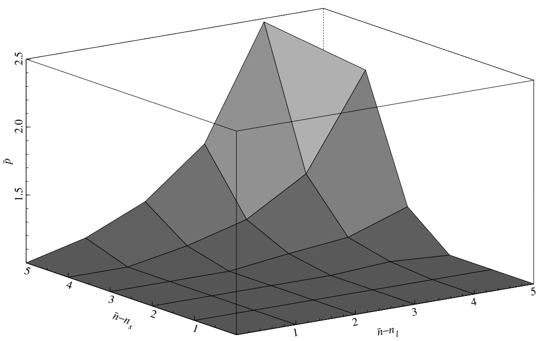
The second panel of Table 11 shows that a price floor regulation can significantly distort the structure of the industry. Since fixed costs are relatively small, the equilibrium number of firms is large and competition is intense. This implies that the price floor binds for at least one firm in about 40% of the simulated periods. This offers a lot of protection for the small types.

This protection implies that in the most likely industry structure, no large firm enters the market. This is because the efficient technology has large fixed costs and is not profitable unless two or three small firms leave the market. Since the regulation protects the small types, firms correctly anticipate that they would not be profitable by entering with the most efficient technology.

Because competition is intense in both cases and the floor blocks entry of the more efficient technology, the regulation tends to raise prices on average. The bottom lines of the Table show that the average and median pries are about 10% higher with the price floor regulation. Therefore,



(e) Average prices ($p_f = 0$)



(f) Average prices ($p_f = 1$)

Figure 2: Equilibrium average price and market structure under specification 1

Table 11: Long run distribution of industry structure for specification 1

Unconstrained equilibrium				**Constrained equilibrium ($p_f = 1$)**			
Market structure	Freq.	Prices	Welfare	Market structure	Freq.	Prices	Welfare
$(N_s = 1, N_l = 2)$	0.73	1	2.11	$(N_s = 4, N_l = 0)$	0.59	1.11	2.32
$(N_s = 2, N_l = 1)$	0.1	1.16	1.88	$(N_s = 3, N_l = 1)$	0.16	1.08	2.38
$(N_s = 0, N_l = 2)$	0.06	1.25	1.32	$(N_s = 2, N_l = 1)$	0.16	1.2	1.82
$(N_s = 0, N_l = 3)$	0.06	0.84	2.33	$(N_s = 3, N_l = 0)$	0.04	1.3	1.65
Others	0.051			Others	0.055		
Mean price		1.063	1.951			1.127	2.219
Median price		1.002	2.113			1.109	2.320

Table 12: Long run distribution of industry structure in specification 2

Unconstrained equilibrium				**Constrained equilibrium** ($p_f = 1$)			
Market structure	Freq.	Prices	Welfare	Market structure	Freq.	Prices	Welfare
$(N_s = 2, N_l = 1)$	0.86	1.16	1.88	$(N_s = 4, N_l = 0)$	0.71	1.11	2.32
$(N_s = 3, N_l = 1)$	0.06	1	2.58	$(N_s = 3, N_l = 0)$	0.27	1.3	1.65
$(N_s = 4, N_l = 0)$	0.03	1.11	2.32	$(N_s = 5, N_l = 0)$	0.01	1	2.92
$(N_s = 3, N_l = 0)$	0.02	1.3	1.65	$(N_s = 3, N_l = 1)$	0.01	1.08	2.38
Others	0.021			Others	0.000		
Mean price		1.115	2.073			1.158	2.151
Median price		1.158	1.880			1.109	2.320

in this example the regulation creates large inefficiencies both because consumers pay higher prices on average and because too many firms are active in the industry.

The simulation results from the second specification are reproduced in Table 12. In this example the fixed costs of both types are increased by 0.05, which leads to fewer large firms in equilibrium. In the unregulated market the more likely industry structure is the one with two small firms and one big firm, which leads to higher prices on average than in the first specification. With the price floor regulation, the distribution of equilibrium states in the long-run is similar to the previous example. In nearly 100% of the simulation periods, the industry has three or four small firm, but no large firm. As a result, the regulation completely blocks the adoption of the large technology.

In terms of average prices however, the two examples differ. The mean simulated prices are almost the same with or without the regulation, but the median and the mode are smaller **with** the price floor. As before two opposite forces are in action. On the one hand the presence of the price floor makes the market relatively more competitive because it blocks the entry of large firms. On the other hand, firms tend to be more efficient in the unregulated market. In the first example, the efficiency gains were dominant and prices were higher with the price floor. The second example shows that when the fixed cost of the efficient type is large enough, the competitive effect can dominate and prices can be higher without the floor.

Another interesting feature of the second example is that the price floor binds only in 2% of the simulated periods. Therefore, the price floor can significantly distort the structure of markets without actually binding in equilibrium. This is an important feature of the model that we observe in the gasoline example.

Table 13 reproduces the simulation results for the third example. This specification is very similar to the second one, but introduces quality differences between the two technologies. In order to distort the market in this case, we need to raise the fixed cost of operating a large firm, since the

Table 13: Long run distribution of industry structure in specification 3

Unconstrained equilibrium				**Constrained equilibrium ($p_f = 1$)**			
Market structure	Freq.	Prices	Welfare	Market structure	Freq.	Prices	Welfare
$(N_s = 2, N_l = 1)$	0.63	1.17	1.95	$(N_s = 4, N_l = 0)$	0.64	1.11	2.32
$(N_s = 4, N_l = 0)$	0.21	1.11	2.32	$(N_s = 3, N_l = 0)$	0.24	1.3	1.65
$(N_s = 3, N_l = 0)$	0.11	1.3	1.65	$(N_s = 2, N_l = 1)$	0.1	1.19	1.94
$(N_s = 3, N_l = 1)$	0.04	1	2.67	$(N_s = 3, N_l = 1)$	0.02	1.07	2.49
Others	0.009			Others	0.001		
Mean price		1.163	2.030			1.162	2.125
Median price		1.169	1.953			1.109	2.320

combination of the low cost and high quality makes this type even more dominant. With $F_l = 3.5$, the long-run properties are very similar to the ones from Table 12. The policy therefore blocks almost completely the entry of large firms, and favors the presence of more small firms in the market relative to the unregulated case. Prices are therefore lower on average with the policy.

The effect of the policy on consumer welfare is not trivial, however. In the second example, consumer welfare is likely to be higher with the policy since prices are typically lower. In the third example, the high quality option is not available which tends to lower consumer welfare. In addition to this quality/price tradeoff, the welfare impact of the policy depends on consumers' valuation for variety. In all three examples the number of products is larger on average with the policy. Since consumer valuation for variety is important in logit models, the average consumer welfare is larger with the policy in all three cases.