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The effects of price controls: EVIDENCE FROM QUEBEC'S RETAIL GASOLINE MARKET

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DECEMBER 2011

HEC MONTRÉAL

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This publication was produced with financial support from the Ministère des Finances du Québec.

ABSTRACT

In this paper we study the effect of price floor regulations on the organization and performance of markets. The textbook evaluation of these policies is concerned with short-run market distortions associated with excess supply. Since price controls prevent markets from clearing, they lead to higher prices. While this analysis may be correct in the short-run, it does not consider the dynamic equilibrium consequences of price controls. We show that price floor regulations can have important unintended consequences on prices and productivity in the longer run by distorting the structure of markets. We argue in particular that these policies crowd markets and create an endogenous barrier to entry for low-cost retailers. Taken together, these factors can lower prices and productivity. We test this in the context of an actual regulation imposed in the retail gasoline market in the Canadian province of Québec and show that the policy led to more competition, lower prices for consumers, and lower productivity. Our counterfactual welfare analysis shows that the policy was harmful to consumers in smaller cities, whereas it was neutral to the welfare of consumers in Québec city, the only big city in our sample[1].

[1] We have benefited from excellent discussions by Matt Lewis and Jeff Prince, and from helpful conversations with Victor Aguirregabiria, Jason Allen, Allan Collard-Wexler, Steven Durlauf, Gautam Gowrisakaran, Ig Horstmann, Robert Gagné, Amit Gandhi, John Kennan, Rasmus Lentz, Greg Lewis, Salvador Navarro, Jack Porter, Andrew Sweeting, Chris Taber, Joel Waldfogel, and seminar participants at Wisconsin, IIOC-2009, UBC-Sauder Summer Conference, the SITE-2009 conference, the NBER Summer Institute (IO), and the Institute for Computational Economics conference (Chicago). Correspondence to Juan Esteban Carranza, Email: juanes@ssc.wisc.edu; Robert Clark: HEC Montreal, Phone: (514) 340-7034, Email: robert.clark@hec.ca; Jean-François Houde: University of Wisconsin-Madison, Madison, Wisconsin and CIRANO; Phone: (608) 262-3805; Email: houdejf@ssc.wisc.edu

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1. INTRODUCTION

Over the last twenty years, many retail markets around the world have experienced significant restructuring, associated with the exit of small independent stores and the entry of large-scale chains. These changes were triggered by technological innovations that lowered the marginal cost of serving consumers, at the expense of higher fixed costs of operation.[2] The success of Walmart is a well documented example (see Jia (2008) and Holmes (2010)), but similar patterns exist in other markets. For instance, the North-American retail hardware and gasoline markets experienced important shifts towards fewer large volume retail outlets.

In some cases, lobbying groups were able to convince local and state governments to impose various kinds of price-control regulations in order to protect small independent retailers from this reorganization.[3] A common example of this type of regulation is a below-cost law, also known as a "fair-trade" policy, which prevents firms from posting prices below a stated level, approximating the cost of a representative firm. This effectively imposes a minimum resale-price maintenance policy common to all stores.

The impact of this type of regulation is not well understood by economists and policy makers. The traditional textbook evaluation of price floors is concerned with short-run market distortions associated with excess supply. While this analysis may be correct in the short run, it ignores the dynamic equilibrium effects of price controls on the composition of industries. The central objective of this paper is to demonstrate that price-floor regulations can have important unintended consequences on prices and productivity in the longer run by distorting the structure of markets. We argue in particular that these policies can crowd markets with smaller/less efficient retailers and create an endogenous barrier to entry for low-cost retailers. Taken together, these factors can lower prices and productivity.

To formalize our intuition for what impact the price floor has on market structure we construct a model of entry and price competition. The model shows that a price-floor regulation can have two opposite effects. First, such a policy can cause excess entry into and crowding of markets, by raising the expected profit of being active. Second, by protecting small firms, the policy can block the entry of more efficient low marginal-cost retailers who face larger fixed costs. These two opposite forces can lead to higher or lower prices depending on the relative efficiency of firms and the level of the floor. The model predicts that if the floor is low, as it is in Québec, entry of more productive stations will be prevented and prices can be lower as a result of competition between less productive stations.

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[2]See Foster, Haltiwanger, and Krizan (2006) for an empirical analysis of these trends in the context of U.S. retail markets, and Campbell and Hubbard (2010) for an analysis of the reorganization of service stations on U.S. highways.

[3]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.

We analyze this question empirically by studying a specific below-cost price regulation instituted in 1997 in the retail gasoline market in the Canadian province of Québec. The objective of the regulation is to strengthen anti-predatory pricing laws by preventing firms from pricing below their competitors' costs, thereby protecting small independent retail outlets.

For our analysis we have constructed a rich data set at the gasoline-station level featuring close to 1600 stations observed between 1991 and 2001 in five cities in the province of Québec, and nine cities in three other Canadian provinces, where the regulation was never implemented. The data contain detailed information on individual stations' sales volume, posted price, and characteristics and allow us to study the effect of the floor on station behavior at the local-market level.

We perform a detailed econometric analysis of the data along two dimensions. First, in Section 5.1, we study the impact of the policy on two store-level outcomes: markups and sales volumes. Comparing the five years after, to the five years before the implementation of the regulation, markups and volumes are significantly reduced. However, we show that once we control for market-structure variables these long-run effects disappear.

Second, in order to confirm the role of market structure in explaining the markup and volume results, in Section 5.2 we compare regulated and unregulated markets in terms of the composition of local markets, the configuration of stations, and the degree of competition faced by stations in different-sized buffer zones around them. We provide evidence that the policy slowed down 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 more crowded, these stations cannot survive.

These results are in line with the notion that in the long run the effect of the policy is to protect existing inefficient stations and to allow for the entry of new less productive stations, thereby indirectly lowering the productivity of stations through an endogenous change in market structure. This market crowding, together with the entry of higher quality stores in the unregulated market, are responsible for most of the observed markup effect.

Finally, we study the welfare consequences of the policy. To do so, we construct a model of supply and demand for gasoline that allows us to simulate the structure of the markets across Quebec cities, had the policy not been implemented. With the counterfactual market structure in hand, we can compute the counterfactual consumer welfare accounting for the effect of the policy on the entry, exit and characteristics of stations. According to our calculations, consumers in the smaller cities in our sample were harmed by the policy, because they had no access to large, high quality stations after the establishment of the policy. On the other hand, the welfare of consumers in Québec city, the only big city in our sample, was not affected by the policy.

1.1 REGULATION BACKGROUND AND RELATED LITERATURE

Our results are important for the understanding of price control regulations. Similar policies are currently in place in a large number of markets. Our analysis of the Québec gasoline market reveals that these policies can distort significantly the structure of markets and slow down the diffusion of new technologies.

Currently twenty-four states in the US have general sales-below-costs laws. In Europe, France recently strengthened a below-cost price regulation applied to all retail markets through the passage of the *Galland* law in 1997. A number of other states and countries have laws for specific industries or products. The most common are sales-below-costs restrictions in the retail gasoline market,[4] but other markets feature similar restrictions. For instance, in Tennessee there are price floors in the markets for cigarettes, milk, and frozen desserts. In Ireland, below-invoice sales were banned in the retail grocery industry until 2005. More generally, similar policies have been enacted in other contexts: wages in most labor markets are subject to explicit floors as are prices in many agricultural markets, anti-dumping policies forbid foreign firms from setting price below average variable costs, and the entry of big-box retailers is often restricted. In each case, the policies are designed to protect particular groups of firms.

The debate over whether to adopt or overturn sales-below-cost restrictions is ongoing in many jurisdictions. The advocates of these policies typically associate aggressive pricing with predatory or loss-leading behavior. On the other hand, detractors argue that they protect inefficient firms and lead to higher prices and, more generally, to welfare loss -- arguments that are consistent with the short-run distortions predicted by the textbook evaluation of price floors. Antitrust authorities typically view such legislation as unnecessary, and they point out that state governments may be too easily convinced by accusation of predation made by various interest groups. When asked to evaluate the merit of proposed below-cost sales legislation in Virginia and North Carolina in 2002 and 2003 respectively, the Federal Trade Commission argued that anticompetitive below-cost pricing rarely occurs, and that such legislation could harm consumers.[5] Similarly, in February 2009 following a lawsuit brought by gasoline retailer *Flying J*, the Wisconsin Supreme Court ruled as unconstitutional a local statute which guaranteed a 9.18% markup over the average posted terminal price for gasoline retailers.[6] In Canada, the Competition Bureau has stated that regulation of this

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[4]Currently nine U.S. states and three Canadian provinces have sales-below-cost laws in the retail gasoline market

[5]Virginia Senate Bill No. 458, ``Below-Cost Sales of Motor Fuel'', http://www.ftc.gov/be/V020011.shtm; and North Carolina House Bill 1203 / Senate Bill 787 (proposed amendments to North Carolina's Motor Fuel Marketing Act), http://www.ftc.gov/os/2003/05/ncclsenatorclodfelter.pdf

[6]The statute in question was s.100.30; http://www.datcp.state.wi.us/trade/business/unfair-comp/unfair_sales_act.jsp

type results in higher average prices, and that it does not provide for the highest quality products and the most efficient production, relative to competitive markets.[7]

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 Fenili and Lane (1985), Anderson and Johnson (1999), and Johnson (1999). 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, therefore, cannot account for the unobserved heterogeneity across jurisdictions. Their conclusion, linking sales-below-cost laws with higher prices may therefore be spurious. Not all of the prior empirical literature concluded that below-cost regulations lead to higher prices. A recent study by Skidmore, Peltier, and Alm (2005) finds that prices tend to fall after the adoption of sales-below-cost laws in US gasoline markets. Their approach involves using a monthly panel of state-level prices for thirty states, over a twenty year period. They also argue that sales-below-cost regulation changes market structure by increasing the number of stations, and that this in turn can influence prices. They provide an informal summary of the arguments for how such regulations could affect market structure and empirically show what happens to the number of stations. Our results are consistent with their conclusions, and we provide a detailed analysis, both empirical and theoretical, of the mechanisms that we argue are responsible for these aggregate price declines.[8]

Our paper is related to a large literature that studies the effect of different forms of government intervention on market structure and prices. Biscourp, Boutin, and Vergé (2008) look at the impact of the Galland law in France, focusing on the consequences of limiting intra-brand competition on prices. They find that the 1997 reform led to higher prices and softened competition from large grocery store chains. Another form of government intervention is the imposition of environmental regulations, and studies such as Brown, Hastings, Mansur (2008), Ryan (2006) and Busse and Keohane (2009) have looked at the effect of gasoline content regulation and of the Clean Air Act on market structure. There are also studies evaluating the impact of advertising restrictions on competition and prices in various industries (Milyo and Waldfogel (1999) studies the effect of a ban on price advertising, while Clark (2007) looks at the effect of a ban on advertising directed at children on competition in the cereal market and Tan (2006) considers advertising restrictions in cigarette markets). Theoretical work by Armstrong, Vickers, and Zhou (2009) points out that in markets with costly information acquisition, regulations designed to protect consumers, such as price caps or measures which enable consumers to refuse to receive advertising, could have the unintended consequence of reducing consumers' incentives to become informed, resulting in softened price competition.

[7] http://www.cb-bc.gc.ca/eic/site/cb-bc.nsf/eng/00892.html

[8] Our empirical analysis contains a lot more information about changes in market structure as our data provide us details on the characteristics of individual stations.

There is also a broader literature on competition in the gasoline market. Johnson and Romeo (2000) study the effect of bans on self-service gasoline stations in New Jersey and Oregon on prices and market structure. They find that the bans lead to higher prices, but do not seem to achieve their objective of protecting smaller stations. Two other papers are worth mentioning: Hastings (2004) examines the relationship between competition and firm behavior in Californian gasoline markets. Her study is related to ours, 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, without addressing the potential effects of the regulation on the entry and exit of gas stations.

2. DESCRIPTION OF THE REGULATION

The *law on petroleum products* was enacted at the beginning of 1997 and administered 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 by the Board to be the result of predatory pricing behavior by the major retailing chains. However, it is not actually clear that predation was the cause. Instead, the price wars were likely triggered by excess capacity, and by the decision of Québec's largest retailer (Ultramar) to implement a low-price guarantee (LPG) policy for all of its affiliated stations at the beginning of the summer 1996. Indeed, an investigation by the Canadian Competition Bureau never uncovered predatory behavior.

The government's decision to regulate gasoline prices was therefore motivated by a desire to reduce the frequency of price wars, and to protect small independent retailers. In the lead-up to the enactment of the law, Québec's association of independent gasoline retailers conducted a very effective lobbying operation aimed at convincing the provincial government that the exit of independent retailers would adversely affect consumers in the long-run. Several consumer protection groups also supported the policy at the time. From our discussions with employees of the Board, it is clear that the objective of the policy is to protect small retailers against aggressive pricing strategies from large chains and big-box retailers, such as Walmart or Costco.[9]

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.

[9] Other provinces have also considered implementing similar policies. During the same period that the adoption of the floor was being debated in Québec, a similar regulation was discussed in Ontario, but ultimately was rejected. Nova Scotia, New Brunswick and Prince Edward Island all adopted similar regulations after 2001.

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.[10] 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.

As discussed in the model section, it is important to recognize that a price floor regulation can generate important distortions without binding in equilibrium. Our experience from studying the Québec gasoline regulation is that, although the minimum margin has been put into effect on a few occasions, the price floor is rarely observed to be binding. Figure 1 presents the evolution of weekly average price in Québec city, along with the price floor and the average retail margin. The red dots identify weeks when the average market price was equal to or smaller than the price floor, and the two vertical gray lines indicate the imposition of the additional minimum margin. Over the period studied, the floor is thus binding less than 10% of the time.

Finally, notice that the overall policy has both a short run and long run dimension. On the one hand, firms are constrained in the short run to set a price higher than the MEP. The MEP is

[10]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.

relatively low and unlikely to bind unless a low-cost retailer enters the market or firms engage in a price war. On the other hand, 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). These two aspects of the policy directly affect the option value of being in the market in the long run, as they provide an insurance against the losses incurred during a price war.

3. A THEORETICAL MODEL OF ENTRY, EXIT AND PRICE REGULATION

To understand the effect of the price floor regulation, below we construct a model of entry and price competition, and evaluate the impact of a price floor on the structure of the market. We show that a price-floor regulation has two opposite effects. First, such a policy can cause crowding of markets by raising the expected profit of being active.[11] Second, by protecting small firms, the policy can block the choice of the more efficient low-marginal-cost technology because of its larger fixed costs.

These two opposite forces can lead to higher or lower prices depending on the relative efficiency of firms and the importance of fixed operating costs. We illustrate theoretically how these effects can distort firms' technology choices in two ways. In what follows, we analyze a simple model to formally define the two types of incentives.[12]

To capture the features of the retail gasoline market we consider a market in which two types of horizontally differentiated firms compete in prices. The first type of firm, independents or convenience stores, only has access to the "small" technology, characterized by a cost function $c_s(q) = c_s q + F_s$. The second type, majors or big-box retailers, has access to both a "large" or a "small" 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 assumption that large volume stores represent the more effective technology is supported by the data, since the marginal cost of selling gasoline is decreasing with the number of pumps (see Houde (2010)). This results in a simultaneous game of complete information, in which the set of available strategies of both types of firms are summarized by $\{t_1, t_2\} = \{(0, s), (0, s, l)\}$, where 0, s, and l are out, small, and large respectively.

Before firms commit to their technology and entry decisions, a regulator imposes a price floor constraint p_f. We assume that the floor potentially affects the equilibrium pricing game only in oligopoly markets. If $D_j(p_j, p_{-j}|\omega)$ denotes the demand of a firm of type j in market structure ω, the Bertrand-Nash equilibrium is characterized by the following Kuhn-Tucker first-order conditions:

$$D_j\big(p_j, p_{-j}|\omega)\big) + \frac{\partial D_j(p_j, p_{-j}|\omega)}{\partial p_j}(p_j - c_j) + \lambda_j = 0 \qquad (1)$$

$$\lambda_j\big(p_j - p_f\big) = 0 \qquad (2)$$

[11] A similar result can be found in the real option literature (e.g. Dixit and Pindyck (1994)).

[12] We can also 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). These results are available on the authors' websites.

for each $j \in \{s, l\}$ and $\lambda_j \geq 0$. There are six possible market structures: $(0,0)$, $(0, s)$, $(0, l)$, $(s, 0)$, (s, s), and (s, l), where the first element refers to the choice of the type 1 firm and the second to the choice of the type 2 firm. Since the l technology has lower marginal costs but offers the same product quality as the s technology, in equilibrium the most efficient stores will post the lowest prices when both types compete ($p_l(\omega) \leq p_s(\omega)$). 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 consider two types of long-run 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:[13]

$$\pi^u(s, s) - F_s = D(p_s^u, p_s^u)(p_s^u - c_s) - F_s \text{ and } \pi^c(s, s) - F_s = D(p_f, p_f)(p_f - c_s) - F_s.$$

Notice that unless aggregate demand elasticity is very high, the constrained profits are increasing in p_f even for a reasonably large floor level. In this range, the presence of the price floor might increase profits sufficiently to justify staying active with the small technology. In particular, the regulated market will be more crowded after the policy change if F_s is in the following range:

$$D(p_s^u, p_s^u)(p_s^u - c_s) < F_s < D(p_f, p_f)(p_f - c_s) \quad (3)$$

As a result, in this case the policy attracts firms to the market. The equilibrium market structure with the floor is (s, s) rather than $(s, 0)$ or $(0, l)$ without. The floor will be binding, and so prices will increase or decrease relative to the unconstrained case depending on how high the floor is.

Case 2: Blockaded entry

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

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

Where $\pi(l, s)$ is the variable profit of the large firm in state (s, l), and $\pi(s, l)$ is the variable profit of type s.

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

When the price floor binds for both types, the type 1 firm is strictly better off and therefore s is a dominant strategy in the regulated market. However, the type 2 firm might prefer to enter with the small technology 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 type 2 firm's best-response to s is now to opt for the small technology:

$$\mathrm{D}(\mathrm{p_f},\mathrm{p_f})(\mathrm{p_f}-\mathrm{c_l})-\mathrm{F_l}<D(\mathrm{p_f},\mathrm{p_f})(\mathrm{p_f}-\mathrm{c_s})-\mathrm{F_s}.$$

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 with the large technology.

When the price floor is set to a lower level, it is possible that the regulation prevents the selection of the large technology, without raising prices. To see this, consider a situation in which the selection of the large technology by the type 2 firm causes the type 1 firm to stay out in the unregulated market:

$$\pi^u(s,l)-F_s<0 \; and \; \pi^u(l,s)-F_l>0$$

Assume further that the price-floor is low-enough and binds only for the large technology (i.e. only in state (s,l)). The regulation will act as a subsidy for the type 1 firm and will reduce the market share of the large-technology firm. It is therefore possible for the regulator to set p_f such that the type 1 firm will revise its decision to stay out of the market:

$$\pi^u(s,l)-F_s<0 \; and \; \pi^c(s,l)-F_s>0.$$

If this condition is satisfied, the policy will prevent the least efficient firm from staying out. This, in turn, can block the use of the large technology, provided that F_l is large enough. The equilibrium under the price-floor will therefore be $(s,0)$ or (s,s) instead of $(0,l)$. The equilibrium price in the regulated market can therefore be lower than the price in the regulated market if the resulting market structure is (s,s) and if the price in (s,s) is less than the price in $(0,l)$. In this case the competition enhancing effect of the policy will dominate the inefficiency losses present in the previous example.[14]

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, $(0,l)$ 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 equilibrium depending on the parameters. This is important since the price floor in the retail gasoline market in Québec is rarely observed to bind. The policy is unlikely to generate the first blockaded entry case. Most of the time, the floor is set close to the wholesale price and so is not

[14] In a recent paper Asker and Bar-Isaak (2010) argue that minimum resale price maintenance policies can have exclusionary effects by blocking the entry of more efficient manufacturers. Although the set-up is different, the mechanism at work in their model is very similar to ours: minimum resale price maintenance can be used by incumbent manufacturers to increase retailer profits when they deter entry.

expected to bind unless a low-cost retailer enters a very crowded area. For this reason we would also not expect to observe the result from the excessive crowding case in Québec. On the other hand, the policy can be adjusted dynamically to compensate firms for price wars. We did not add this feature to the model, but it very likely would exacerbate the third prediction. It is clearly designed to protect incumbent firms and discourage new entrants from pricing aggressively.

To summarize, using a simple two-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 by raising the expected profit of being active, which in turn can lower or raise prices depending on how hight the floor is. 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. In Québec the floor is rarely observed to bind, but entry is blocked since incumbents do not exit.

4. DATA: STATIONS, MARKETS AND TRENDS

4.1 PRICE, CHARACTERISTICS, AND MARKET STRUCTURE 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 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 eleven years between 1991 and 2001, and includes all 1601 stations in fourteen selected cities of Québec and three other Canadian provinces. 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, number and size of the service islands, 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 having different qualities. We also have detailed information about the geographic location of each station in the sample.

4.2 ADDITIONAL CONTROL VARIABLES

A potential problem with the structure of our data-set is that unobserved time-varying regional shocks might be driving the empirical results. If these shocks are important factors determining exit and reconfiguration decisions, they could create confounding effects (bias). More specifically, the introduction of the policy may have been correlated with other confounding factors (i.e. province-level time-varying shocks), which would lead to biased parameter estimates.

In an effort to address this problem we use a number of additional control variables in our empirical analysis. We have gathered information on province-level gasoline taxation, on the regional refinery markets, and on local business cycles, and in our empirical analysis include variables to control for each of these. Tax differences between Québec and the other regions were more important from 1995 on, since the Québec government decreased the consumption tax and increased the excise tax on gasoline. Also, the refinery market was reorganized during this period. In most regions refineries were closed, and the number of firms present at wholesale terminals shrunk. Finally, there were some changes in local population and employment levels during our sample period.

We have also taken care to control for two events that occurred in Québec's retail gasoline market around the time that the floor was introduced. First, in March 1996, Ultramar and Sunoco, two of the largest firms in the Canadian petrol industry, announced their intentions to swap their service stations in Québec and Ontario. The transaction involved Ultramar acquiring 127 Sunoco stations in Québec, and in exchange Sunoco acquired 88 Ultramar sites in Ontario. At the time, Sunoco did not have a refinery in Québec and chose to concentrate its retail activities in Ontario and Western Canada. Ultramar, on the other hand, adopted the strategy of increasing its dominance in the Québec market, and distributing a larger fraction of its Saint-Romuald refinery's production (near Québec City) locally.

Second, in a further attempt to increase its share of the Québec retail market, in the summer of 199, Ultramar instituted a low-price guarantee policy (ValeurPlus or ValuePlus). Since Ultramar has a greater presence in Québec than in Ontario, we might worry that any effects on prices and market structure that we attribute to the price floor policy are actually the result of one of these events. Therefore, in our empirical analysis below we include indicators for the presence of both Ultramar and Sunoco within a 2-minute driving distance of each station, before and after 1996, to control for the effects of the station swap and the low-price guarantee.

4.3 MARKETS AND NEIGHBORHOODS

The fourteen Canadian cities we study include five cities in Québec, seven cities in Ontario, and one city in each of Nova Scotia and Saskatchewan.[15] In our analysis, markets correspond to metropolitan areas. These metropolitan areas were selected because, as shown in Table 1, they are all comparable in terms of size and population growth. Table 1 also shows that the cities are similar in terms of volume of gasoline sold per capita and growth of volume per capita. Furthermore, the major players in all cities are the same. In all cities, the retailers include six chains that are integrated with the refinery sector: Shell, Esso/Imperial Oil, Ultramar, Irving, Sunoco, and Petro-Canada.

Since retail gasoline markets are spatially differentiated and stations face competition from a set of local competitors, we are also interested in quantifying the degree of competition more locally. For this, we will proceed in two ways. First, we construct neighborhood 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. With these criteria, a neighborhood approximates an intersection or a major street segment.[16] Importantly, our definition is time-invariant since the set of possible.

[15]The cities included in the data set are Québec city, Trois-Rivières, Chicoutimi, Drummondville, and Sherbrooke in Québec; Hamilton, St. Catharines, Kingston, Cornwall, Brantford, Windsor, and Guelph in Ontario; Saskatoon in Saskatchewan; and Halifax in Nova Scotia

[16]A common way of defining neighborhoods is to use existing definitions, for instance census-tracts or 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.

locations is defined as all locations ever active throughout our sample.[17] The median neighborhood size is three stations per neighborhood in the whole sample, but some cities are clearly more dense than others. For instance, in Hamilton (Ontario) the median neighborhood size is five stations, while Chicoutimi (Québec) neighborhoods have a median size of two stations. Overall, the algorithm constructs neighborhoods that are very comparable across all the regions, since the size distributions are very similar.

Second, we construct a station-specific neighborhood by considering different sized buffer zones around each station. With this definition of local-market neighborhoods can be overlapping.

4.4 TRENDS: THE REORGANIZATION OF MARKETS

A key feature of the retail gasoline industry is the reorganization that took place in the 1990's. During this period, all North-American markets underwent a major reorganization characterized by the increase in the size and automation of stations (see for instance EckertWest 2005).[18] These changes took place through the entry and reconfiguration of larger and more efficient stations, and the exit of smaller stations. They were caused by technological innovations common to most retailing sectors, which increased the efficient size of stores (e.g. automation of the service, better inventory control systems, etc.); by changes in the value of certain amenities (e.g. decreased use of small repair garages); and by changes in regulations regarding the environmental safety of underground storage tanks (see Eckert and Eckert (2008) and Yin, Kunreuther, and White (2007)).

These changes were evident in both regulated and unregulated markets. The number of stations in the selected markets decreased by about 30% across the sample. Over the eleven years of our panel, we observe a total of 229 new entrants and 670 exits out of 1 601 unique stations in fourteen cities. 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 and exiting stations with each other and with the rest of stations. The first row clearly shows entrants and continuing firms have more or less the same size, but are slightly more likely to have a convenience store and less likely to offer full service. Exiting firms, however, are significantly smaller: on average stations that exited before 2001 had around 4 fewer pumps and less service-islands than entrants and continuing firms. Similarly, exiting firms were much more likely to offer full-service and not to have a convenience store attached. The proportion of stations with a convenience store, and the proportion of self-service stations have each increased by more than 20 % in all regions.

[17]The size and composition of the neighborhoods is affected by the parameters used in the clustering algorithm. We pick the bandwidth parameter in order to obtain average neighborhood sizes around 3 stations, and avoid having neighborhoods bigger than 15 stations.

[18]In the US, the number of retail outlets selling gasoline declined from approximately 202 thousand to 171 thousand from 1994 to 2001. Yin, Kunreuther, and White (2007) describe the reorganization of several US gasoline markets throughout the 1990s.

5. EMPIRICAL ANALYSIS

In this section, we examine in detail the effects of the price regulation. To do so we compare the behavior of firms and the structure of markets in Québec and in other parts of Canada, before and after the policy was implemented.

Although all of the markets we study experienced the same aggregate reorganization trends, the rate at which these changes occurred differed in Québec and the other provinces. Table 3 presents a set of descriptive statistics for some of the key variables used in the analysis, for both the pre- and post-policy periods and in both the cities inside and outside Québec (we will denote those outside Québec as Rest). The table shows, for instance, that: (i) the number of large stations with more than four service islands and the average number of pumps both increased by about 20% in Québec and by more than 50% in the rest of the cities, (ii) the number of neighboring competitors decreased by 17% in Québec and by 29% elsewhere.

Figure 2 compares the evolution of prices and three local market structure variables in Québec and in the other regions. Graph (a) illustrates the evolution of prices (net of taxes) in the two regions. Looking only at the periods immediately before and after the policy, it is easy to see that the implementation of the policy in Québec in 1997 is followed by a spike in the average price, compared to the stations in the other cities. In the longer run, however, average prices in Québec are lower. These differences are particularly important when looking at variables measuring the size of stations and the degree of local competition.

The general message from graphs (b), (c) and (d) is that the reorganization of the industry described in Section 4 above was more pronounced in the rest of Canada than in Québec, especially after the introduction of the price floor regulation. Graph (b) shows that the trend in the proportion of monopoly markets flattened in Quebec between 1996 and 1997, while in the rest of Canada it continued to increase. As seen in graphs (c) and (d), even though the average number of pumps per station and the prevalence of large stations increased everywhere, the increase was substantially larger outside Québec. These trends can be explained not just by the entry of bigger stations, with more service islands and more pumps, but also by the renovation or exit of existing stations. The impetus to reconfigure stations was the development of new technologies and the environmental regulations surrounding underground storage tanks. The latter, in particular, are likely to explain the discontinuity that is observed around 1997-98, since this coincides with the end of the federal program for the renovation of underground storage tanks. In Québec the discontinuity exists, but is not as pronounced. Because of the price-floor policy, the exit of smaller stations was not as sudden in Québec since the newer and bigger stations did not enter as much. Since many stations are jointly owned, the decision to invest in the reconfiguration or to exit would be almost simultaneous across stations of the same brand. The perception on the part of a few brands that investing in Québec was not going to be profitable, creates the sharp discontinuity that we see in the rest of Canada, but not in Québec.

Of course, these differential changes may have been driven by factors other than the price-floor policy. For instance, the move by the Québec government, mentioned above, to decrease the consumption tax while increasing the excise tax on gasoline may have played a role, as might have the reorganization of the upstream refinery markets. During this period there may also have been differences in population and business-cycle trends. Since these changes took place at different times in different regions, they might have created market-specific breaks in the trends of our characteristics variables.

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. This is what we do in the remainder of this section. First, we perform a set of station-level regressions, in which we compare the behavior of gas stations in Québec and the other cities in the sample before and after the introduction of the policy in 1997. We are particularly interested in the effect of the policy on store-level markups and sales-volume. Next, we perform a set of neighborhood-level and station-level regressions to measure the effect of the policy on the structure of local markets and the characteristics of stations. Finally we run a set of city-level regressions to test that the significance of the micro-level results is not an artifact of sample structure. As we will explain, we include fixed-effects and the controls described above to account for the effect of confounding factors. We also include time trends to control for market-level aggregate unobservable variables.

5.1 STATION-LEVEL ANALYSIS

In this section we evaluate the effect of the policy on markups and sales at the station level.[19] Let y_{it} denote one of the two variables of interest: Markup $_{it}$ and Volume $_{it}$, where t is the time period and i is the station.[20] For each dependent variable we estimate the following equation using station-level data:

$$y_{it} = \alpha_i + \theta_t + \gamma D_{it} + \beta X_{it} + \varepsilon_{it} \qquad (4)$$

where D_{it} is a dummy variable equal to one in Québec after 1996, α_i and θ_t are station and time fixed-effects respectively. 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. Results are shown in Tables 4 and 5.

Each table presents results from five specifications. From the figures above, there appear to be important differences in the short- and long-run effects of the policy, especially with respect to the evolution of prices. In light of this, in column 1 we restrict our sample to just the 1996-1997 period in order to capture the short-run effect of the policy. In columns 2-4 we turn our attention

[19] All of our results are robust to using prices rather than markups. We use markups since they naturally take into account systematic differences in wholesale prices and taxation.

[20] We calculate markups as: $(p_{jt} - c_t)/p_{jt}$.

to the long-run effect of the policy, using the full sample excluding observations from 1996. We exclude 1996 to measure the long-run effect since the introduction of the policy followed a severe price war in the Québec retail gasoline market.[21]

Each specification includes station- and time-fixed effects. Recall from our discussion of the figures above that the objective of our empirical analysis is to isolate the changes in markups and volumes that are due to the introduction of the policy. Therefore, in the long-run analysis we control for a wide range of possible confounding factors. In column 3, we add aggregate factors that could influence markups and volumes such as the log of population, the unemployment rate, the provincial excise tax rate, the number of wholesale companies at the local refinery terminal, and the log of the price of gasoline at the terminal. As mentioned above, we also include an indicator for the presence of both Ultramar and Sunoco within a 2-minute driving distance of each station, before and after 1996. We refer to these variables as "aggregate controls".

We are particularly interested in quantifying how much of the change in markup and volume is a direct effect, and how much can be explained by simultaneous changes in market structure. Therefore in column 4 we add station/market-structure controls that capture changes in the types of stations present and the level of competition faced by each. Once we have controlled for all of these factors, any remaining effect can be attributed directly to the policy change. The station/market-structure controls are, at the station level: the number of pumps, the number of islands, and indicators for the presence of amenities such as a convenience store, full service, a repair shop, an electronic payment system and car wash services, and in terms of market structure: the number stations and average station characteristics in the metropolitan area (i.e. market), the neighborhood, along common streets, and within a 2-minute and 5-minute driving distance.

Table 4 presents the markup results. In column 1, we estimate a significant short-run increase of around 11%.[22] We attribute this effect to the fact that the implementation of the policy coincided with the end of the 1996 price war that occurred in Québec. In the short-run, the policy therefore successfully ended a price war that was associated with an eleven percentage point drop in markup (since the dependent variable is in levels).

In column 2, using only station- and time-fixed effects as controls, we estimate a significant long-run decrease of around 10.5% following the introduction of the policy. In column 3, we can see that some of the long-run decrease (around 2 percentage points) is explained by the aggregate control variables. Controlling for these variables, we estimate a long-run decrease in markup of 8.5% in Québec relative to stations in the control regions. In column 4 we add station/market-structure controls. The inclusion of these variables reduces significantly the point estimate to -5.6%. The difference, roughly 3 percentage points, is statistically significant. It represents the portion of the

[21]The results presented below are qualitatively unchanged if we exclude both 1996 and 1997, or if we simultaneously estimate a ``long-run'' and ``short-run'' effect by interacting all fixed-effects with a 1996-1997 dummy. However, dropping only 1996 makes analysis more straightforward.

[22]The standard-errors in Table 4 are clustered at the neighborhood level to correct for spatial and serial correlation in the residuals. The results are robust to other assumptions (e.g. municipality or postal-code area clusters).

long-run decline in markups that can be explained by simultaneous changes in the structure of Québec gasoline markets relative to markets in the rest of the country.

Finally, motivated by the figures described above which suggest that there is a long-run convergence in markups between Québec and the control regions that began even before the policy changes, we control for linear market-level trends in column 5. The resulting point estimate is not significantly different from zero. Market-trends thus absorb the remaining markup decline, capturing the fact that markups in Québec started to decrease prior to the introduction of the policy.

In summary, except for the short-run price increase associated with the end of the 1996 price war, our results suggest that the policy did not have any direct impact on markups. Instead, we find that 3 percentage points of the observed ``unconditional'' long-run markup decline in Québec can be explained by changes in the structure of gasoline markets that resulted from the price-floor policy.[23] Importantly, we do not document any long-run price increase following the implementation of the regulation. This is a reflection of the fact that the price floor does not often bind.

Table 5 reveals a similar pattern for volume. We estimate a small short-run decrease in volumes, resulting from the end of the 1996 price-war in Québec. The total long-run estimated effect of the policy with only station- and time-fixed effects was an average reduction of daily sales of around 1350 liters, or nearly 30% of average daily volume. Including observable aggregate controls cuts this in half. In column 4 we include station/market-structure controls. Doing so causes the coefficient to fall to 62.5, and in fact the estimate is no longer significantly different from 0, suggesting that there is no direct effect of the policy on volume. As was the case with markups, the effect of the policy on volumes is indirect and associated with a decrease in productivity relative to the control group. The mixture of amenities and size, as well as measures of local competition changed following the policy. Column (5) shows that adding market-level trends does not change this conclusion.

5.2 LOCAL-MARKET STRUCTURE ANALYSIS

In this subsection we study more closely the effects of the price-floor policy on the organization of the industry. We adopt a similar approach as above, but focus on the effects of the policy on the composition of stations and the extent to which individual stations face competition. Our analysis is at the local-market level, where local market is defined in two ways: first at the neighborhood level using the clustering algorithm defined above, and second as distance buffers

[23]An alternative way of isolating the role of market structure in explaining the long-run markup decline is to control for market-level trends without conditioning on local market characteristics. When we do that, we estimate a 2 percentage point long-run markup drop that cannot be explained by the controls. This difference is statistically significant from zero only when we cluster the standard-errors at the station-level, reflecting the important spatial correlation in the residuals.

around individual stations. The objective is to confirm that important changes to market structure occurred in Québec following the implementation of the policy.

5.2.1 At the neighborhood level

Recall from above that we have constructed neighborhood boundaries that define a set of spatially homogeneous locations. Using these we estimate the following equation:

$$y_{mt} = \alpha_m + \theta_t + \gamma D_{mt} + \beta X_{mt} + \varepsilon_{mt} \qquad (5)$$

where the coefficient of interest is the expected change γ in neighborhood conditions after the policy implementation in Québec relative to the other regions. Similarly to the previous section, we include in all specifications a full set of time and neighborhood fixed-effects: log of population, unemployment rate, the provincial excise tax rate, the number of wholesale companies at the local refinery terminal and the log price of the price of gasoline at the terminal. We also include the indicator for the presence of both Ultramar and Sunoco within a 2-minute driving distance of each station, before and after 1996. The unit of observation here is a local market (neighborhood) m observed at time t, as described in the data section.[24]

Table 6 shows the result of the regression for variables that measure the average characteristics of stations within each market. The variables are (by column number): (1) the number of competitors, (2) the likelihood of a monopoly, (3) the number of pumps, (4) the number of different gasoline grades, (5) the number of islands, (6) the prevalence of stations with more than 4 islands, (7) the prevalence of stations with convenience stores, (8) the prevalence of "conventional" stations, (9) the prevalence of stations offering electronic payment services, and (10) the prevalence of stations offering car wash services. "Conventional stations" are stations offering full service, a repair shop and a small convenience store, which are the type of stations that the regulation intended to protect.

We have also run specifications including market-level linear trends. The results of these regressions with trends are statistically weaker, but qualitatively similar.

Column (1) presents the effect on the number of competitors in each neighborhood, which is our measure of competition. On average the policy increased the number of stations in each neighborhood. Column (2) shows that the impact of the policy on the likelihood of a local market being a monopoly is negative and significant. 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 have 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 whether the regulation affected this process. Columns (3)-(10) report the results for several average characteristics of stations across markets.

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

Columns (3) and (5) show that the estimated coefficients associated with the average number of pumps and islands per station in each market respectively are negative and 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 with more than 4 service islands. The coefficient estimate reported in column (6) clearly shows that on average stations in the control markets have the capacity to serve more consumers than Québec stations after the policy.

In column (4), 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 grades of gasoline, and therefore that a larger proportion of stations have upgraded their equipment in the control markets after the policy.

Columns (7)-(10) describe the effects of the policy on the average number of stations per market that offer certain types of services. The results imply that the policy had a significant effect on all these average characteristics. Relative to the rest of Canada, stations in Québec after the policy are less likely to offer complementary services, like a convenience-store, or a car wash. Moreover, from column (8) there is evidence that stations, which we labeled as ``conventional'', were more prevalent in Québec after the policy. This is important, because these were the stations that the policy wanted to protect.

Column (9) shows that the policy had a negative impact on the likelihood of a station offering electronic payment at the pump, which is one of the main features of the new bigger stations. The adoption of this service is possible thanks to the development across the economy of electronic payment technologies, which we think was one of the major driving forces of the overall transformation of the retail gasoline industry during the 1990's.

Note that once market trends are included the effect of the policy on these services is no longer statistically significant.

5.2.2 Within distance-buffer zones around stations

Table 7 shows the results of the regressions for a set of variables describing the extent to which individual stations face competition in different-sized buffer zones around them. Column (1) shows the effect of policy on the distance to the nearest competitor. Restricting the sample to stations with at least one competitor within 2- and 3-minute driving distances, columns (2) and (3) show the effect of the policy on the number of pumps at competing stations. Finally columns (4) and (5) show the effect of the policy on the likelihood of having no competitors within 2- and 3-minute driving distances. We include results with and without city-level trends.

The table shows that competition is increased in Québec. The distance to competitors falls, competitors have fewer pumps, and stations are more likely to have at least one competitor. These results suggest that markets are more crowded after the policy. Most of the results are robust to the inclusion of trends in the regressions; however, the effect of the policy on having no competitors inside the buffer zone is no longer significant.

5.3 MARKET ANALYSIS

In this subsection we run a set of city-level regressions to check the robustness of our results, even after discarding much of the micro-level information. The regressions are of the form:

$$y_{ct} = \alpha_c + \theta_t + \gamma D_{ct} + \beta X_{ct} + \varepsilon_{ct} \qquad (6)$$

where the subscript c is for a city and all other variables are defined as before.

We run regressions on a set of variables that measure the endogenous structure of the market, before and after the introduction of the policy. The variables of interest are the average distance to the nearest competitor within the city, the brand and station concentration indices, the volume of sales, the number of stations and the prevalence of stations with more than four islands. Results are shown in Table 8. We show results both with and without city-level trends. With the exception of the result for the number of islands, all of the results with trends are much weaker because of sample-size problems.

As was the case for the neighborhood results, the results all point towards an increase in the level of competition after the introduction of the price floor. The policy has a negative effect on the distance to the nearest competitor, on measures of concentration, on sales, and on the average size of stations (islands). It has a positive effect on the number of stations.

6. WELFARE ANALYSIS

We have already shown that the minimum price policy led to an increase in the number of smaller ``lower quality'' stations, compared with the control markets outside Quebec. The welfare effect of the policy is nevertheless ambiguous because consumers value not just the number of stations in their local markets, but also their characteristics. In order to evaluate the overall effect of the policy on consumer welfare we therefore need to formulate and estimate a model of supply and demand for gasoline.

We estimate a model that allows us to simulate the structure of the markets across Quebec cities, had the policy not been implemented in Quebec. With the counterfactual market structure at hand we can compute counterfactual consumer welfare accounting for the effect of the policy on the entry, exit and characteristics of stations. Since we found that price effects were mostly explained by changes in station attributes and exogenous factors, we focus on stations' entry, exit, and reconfiguration.

Our methodological framework is an equilibrium model of firm and consumer behavior. Specifically, we incorporate a discrete choice demand model, similar to the one developed by Houde (2010), into a dynamic entry/exit model that accounts for strategic interactions among firms in local markets and for the expectations of stations about the evolution of market structure over time.

An important feature of our data is that we observe the behavior of a sample of firms in the counterfactual environment. Specifically, not only do we observe the behavior of firms in Quebec before and after the implementation of the policy, but also the prices and characteristics of stations outside Quebec before and after. Therefore, by making assumptions about the equilibria of the dynamic games that generate the data, we can obtain the counterfactual decision rule of the Quebec stations that were subject to the policy.

The fact that the counterfactual decision rules are contained in the data allows us to bypass the full estimation of the model. All we need are estimates of demand that measure the ``value'' for firms of different markets and station configurations. More importantly, we can also avoid the computation of the counterfactual equilibrium decision rules, which can be ambiguous and complicated. To our knowledge there is no previous paper that exploits this feature of choice data.

6.1 THE EMPIRICAL MODEL

6.1.1 Demand

Consumers have preferences over the attributes of gas stations as described by the utility function:

$$u_{i,j,t} = \gamma x_{j,k,t} - \alpha p_{j,k,t} + \xi_{k,t} + \xi_{j,k,t} + \varepsilon_{i,j,k,t}$$

$$= \delta(p_{j,k,t}, x_{j,k,t}, \xi_{j,k,t}, \bar{\xi}_{k,t}) + \varepsilon_{i,j,k,t} \quad \textbf{(7)}$$

where i indexes the individuals, j the gas stations, k the neighborhood and t the time period. Each city m at time t contains $K_{m,t}$ neighborhoods, each with $J_{k,t}$ stations. Each consumer i chooses the station (and the market) that generates the highest utility. Each consumer is located in a city m and chooses the neighborhood $k \in K_{m,t}$ and within the neighborhood the station $j \in J_{k,t}$ that maximizes her utility, which depends on the price $p_{j,k,t}$, on the observed and unobserved station attributes $x_{j,k,t}$ and $\xi_{j,k,t}$, respectively. It also depends on a fixed neighborhood- and time- fixed effect $\bar{\xi}_{k,t}$ that absorbs all exogenous neighborhood-level demand shifters and an unobserved consumer attribute $\varepsilon_{i,j,k,t}$.

The empirical model of demand is based on the assumed properties of the unobserved consumer-level states $\varepsilon_{i,j,k,t}$. Conditional on choosing market k in city m, integrating over the consumers' characteristics yields the predicted market share of station j at time t within its neighborhood:

$$\bar{s}_{j/k,t} = \frac{e^{\delta(p_{j,k,t}, x_{j,k,t}, \xi_{j,k,t}, \bar{\xi}_{k,t})}}{\sum_{l \in J_{k,t}} e^{\delta_{l,k,t}(p_{l,k,t}, x_{l,k,t}, \xi_{l,k,t}, \bar{\xi}_{k,t})}}$$

$$= \frac{e^{\delta_{j,k,t}}}{e^{r_{k,t}}} \quad (8)$$

where $\delta_{j,k,t}$ is the mean utility generated by station j in neighborhood k at time t and $r_{k,t} \equiv \log \sum_{l \in J_{k,t}} e^{\delta_{l,k,t}}$ is the inclusive value associated with choosing neighborhood k.

Similarly, the share of neighborhood k among all neighborhoods and the outside option is given by:

$$\bar{s}_{k,t} = \frac{e^{r_{k,t}}}{1 + \sum_{h \in K_{m,t}} e^{r_{h,t}}} \quad (9)$$

so that the unconditional market share of station j within city m is:

$$\bar{s}_{j,k,t} = \bar{s}_{j/k,t}\bar{s}_{k,t} = \frac{e^{\delta_{j,k,t}}}{1 + \sum_{k \in K_{m,t}} e^{r_{k,t}}}$$

$$= \frac{e^{\delta_{j,k,t}}}{1+R_{m,t}} \quad (10)$$

where $R_{m,t}$ is the inclusive value associated with purchasing gasoline at *any* gas station in city m.

Notice that by combining the equations and taking logs, the demand parameters of the model can be estimated with standard linear estimation techniques. Demand is the the product of shares and market size, $q_{j,k,t} = M_{m,t}\bar{s}_{j,k,t}$. Importantly, we can estimate the vector $r_t = \{r_{k \in K_{m,t}}\}$, which is going to be the set of neighborhood-level payoff-relevant state variables. This simple logit specification is not essential for the formulation of our supply model, which can accommodate richer demand models (i.e. nested logit).

An important feature of 10 is that the inclusive value $R_{m,t}$ is the expected maximum utility from purchasing gasoline at any gas station in city m at time t before the realization of the extreme value idiosyncratic shocks. It is therefore a measure of the mean consumer welfare. When computing the counterfactual equilibria, we will use these inclusive values (also known as the *social surplus*) to evaluate the welfare of consumers across alternative equilibria.

6.1.2 Supply: pricing and profits

Firms enter and exit markets, decide over time the amenities they offer and set prices. We assume that firms interact strategically with each other in local neighborhoods, but take as given the evolution of market structure and prices in all other neighborhoods in the city. Moreover, we restrict the set of variables that firms use to forecast the evolution of neighborhood markets in order to make the problem tractable. Specifically, we will assume that firms in market k only keep track of the value $R_{-k,t} = log \sum e^{r_{l \neq k,t}}$ when forecasting the evolution of market structure in other neighborhoods. Notice that the scalar $R_{-k,t}$ is a measure of the maximum expected utility that consumers get from choosing markets different than k at t. We denote as $X_{k,t}$ the distribution of station-level observed and unobserved attributes within a neighborhood k at time t. In practice, we discretize the attributes' space and sort firms into "types".

Let $mc_{j,k,t}(x_{j,k,t}, \xi_{j,k,t}, \bar{\xi}_{k,t}, \omega_{j,k,t})$ be the marginal cost of firm j in neighborhood k at time t, which potentially depends on all station attributes, the demand shifters and an unobserved cost shifter $\omega_{j,k,t}$. We assume that prices are set flexibly each period, so that $p*_{j,k,t} = argmax[p_{j,k,t} - mc_{j,k,t}]q_{j,k,t}$, where the asterisk denotes the functions that account for the endogenous determination of prices as functions of the remaining states of the problem. Therefore, profits are just functions of station and market states as follows:

$$\pi^*_{j,k,t}(x_{j,k,t}, \xi_{j,k,t}, \bar{\xi}_{k,t}, X_{k,t}, R_{-k,t}, \omega_{j,k,t}) = M_{m,t}\bar{s}_{j,k,t}(p*_{j,k,t}, x_{j,k,t}, \xi_{j,k,t}, \bar{\xi}_{k,t}, X_{k,t}, R_{-k,t})$$

$$\times [p *_{j,k,t} - mc_{j,k,t}(x_{j,k,t}, \xi_{j,k,t}, \bar{\bar{\xi}}_{k,t}, \omega_{j,k,t})] \qquad (11)$$

Assume that $\omega_{j,k,t}$ are iid so that all station-specific persistent unobserved shocks are absorbed by the demand unobservables. We will also assume that all exogenous variables follow Markovian transitions so that their expected evolution can be conditioned on their current realizations. The important thing to notice here is that the payoffs of any firm j in market k payoffs depend on a set of states $S_{j,k,t} = \{x_{j,k,t}, \bar{\bar{\xi}}_{k,t}, R_{-k,t}\}$ and a non-persistent shock $\xi_{j,k,t}$.

6.1.3 Supply: entry, exit and reconfiguration of stations

We assume that each period all firms in the neighborhood, including potential entrants, decide on their configuration next period, accounting for the expected response of competitors. Let firm j's attributes be $\bar{x}_{j,k,t} \equiv x_{j,k,t}, \xi_{j,k,t}$. We assume that the station-level unobserved attributes $\xi_{j,k,t}$ are independent over time, so that any unobserved persistence of demand over time occurs only at the neighborhood-level[25]. Changes in the configuration are sunk and given by the function $C(\bar{x}_{j,k,t+1} - \bar{x}_{j,k,t}, \nu_{j,k,t})$, where $\nu_{j,k,t}$ is a firm-specific (and potentially also choice-specific) unobservable state that is privately observed by each firm drawn from the distribution $\Psi(\nu)$.

We assume that firms in a neighborhood decide according to a Markov Perfect Equilibrium (MPE), such that $\sigma_j(S_{k,t}, \nu_{j,k,t})$ is the strategy followed by firm j. $S_{k,t}$ is the set of states on which all firms in market k condition their strategies at time t. Since all exogenous states are Markovian and the decision rules are also Markovian, the state $S_{k,t}$ is Markovian.

For any given strategy σ_j^0, the value of the problem for each firm is given by the following recursive representation:

$$\tilde{V}_{j,k,t}^{\sigma_j^0}(S_{j,k,t}, \nu) = \pi^a st_{j,k,t}(x_{j,k,t}, \bar{\bar{\xi}}_{k,t}, X_{k,t}, R_{-k,t}) - C(\bar{x}_{j,k,t+\delta t} - x_{j,k,t}, \nu)$$

$$+\beta E_{\xi,X,R,\nu} V_{j,k,t+\delta t}(S_{j,k,t}) d\Psi(\nu) dF(\bar{\bar{\xi}}_{k,t+\delta t}, R_{k,t+\delta t} | \bar{\bar{\xi}}_{k,t}, R_{-k,t}) dP^{\sigma}(X) \qquad (12)$$

where $F(\xi, R)$ is the joint Markovian transition of the exogenous states, and P^{σ} comprises the strategies of the competitors in neighborhood k. The set $S_{j,k,t}$ contains the publicly observed variables on which all firms condition their choice probabilities. The decisions of the firms about their characteristics are taken with an exogenous lag δt, which captures the time it takes for decisions about the configuration of stations (e.g. construction of new facilities) to be fully observed.

If we knew all the states and their transition, we could compute (12) for any strategy profile σ and any realization of the private information ν using (12). Moreover, we can construct

[25]Assuming away station-level unobserved demand persistence facilitates the estimation of the model, since it implies that the policy functions do not depend on any station-specific characteristic.

estimators of the primitives of the model based on the assumption that the observed choice probabilities come from a MPE, and any deviation from it leads to lower expected profits.

In the context of our data the Markovian assumption is not innocous, because much of the data that we observe correspond to years during which stations are actively entering, exiting and reconfiguring. Most of these decisions take time to be observed because they usually require the obtention of permits, the construction of new facilities, etc. Therefore, we have to decide the time lag δt over which decisions are made in order to estimate the strategic behavior of each firm. As we explain below, we will assume that the configuration of stations that we observe the last period of our data in 2001 corresponds to a MPE, based on the states observed five years earlier in 1996 when the price regulation was introduced.

In order to complete the specification of the model, we still need to clarify how we treat the set of potential entrants. This set cannot be estimated and assuming that it is exogenous is a common feature in the literature. Usually it is assumed that either the maximum number of competitors is fixed, or that the maximum number of entrants per period is fixed. In our case, we observe all competitors in the market over an extended period of time and the total number of competitors is declining in general. Therefore we assume that the maximum number of competitors is the actual maximum number of stations that we ever observe in the data. The stations that are out of the market, either because they left or because they have not yet entered, are type 0. In equilibrium all stations, including type 0 stations, choose to reconfigure or not based on the values (12).

The full estimation of the supply model can then be done in two steps, as suggested by the literature on the estimation of dynamic games (e.g. Aguirregabiria and Mira (2007), Bajari, Benkard, and Levin (2007), etc.). In a first step the policy functions that generate P^{σ} are estimated flexibly as functions of the payoff-relevant states, some of which are obtained from the demand and pricing models. The estimated policy functions can be used to compute choice-specific values, which in turn can be used to estimate the entry and reconfiguration costs $C(.)$ in a second step.

In our case, we observe data that contain equilibrium behavior with and without price regulation. In other words, we observe gas stations in Quebec and elsewhere before and after the implementation of the price regulation. Therefore we can use the first step policy function estimates conditioning on the region and policy regime to simulate the behavior of gas stations in Quebec in the counterfactual environment without regulation after 1997.

Define a subset of markets $\mathfrak{I}_{k,t}$, such that all stations in markets $\{k,t\} \in \mathfrak{I}_{k,t}$ are in the same equilibrium. Specifically, let $P(X)^{\mathfrak{I}}_{j,k,t}$ be the probability vector that firm j in market k at time t chooses to become type $x \in X_{k,t}$. We assume that firms within the subset $\mathfrak{I}_{k,t}$ of markets are in the same equilibrium. For example, we might want to group in one subset all stations outside Quebec or within a particular city. Therefore the policy functions are given by:

$$P(X)^{\mathfrak{I}_{k,t}}_{j,k,t} = P_{\mathfrak{I}_{k,t}}(S_{j,k,t-\delta t}) \qquad (13)$$

So, if we condition on the states $S_{j,k,t-\delta t}$, we can estimate the policy functions using non-parametric methods or flexible parametric methods.

The estimates $\hat{P}^{\mathfrak{I}_{k,t}}$ can be used to simulate the behavior of firms $\{k', t'\} \notin \mathfrak{I}_{k,t}$ in the counterfactual $\mathfrak{I}_{k,t}$. For the purposes of this paper, we will simulate the counterfactual behavior of Quebec stations had they faced no price regulation and played according to the equilibrium observed elsewhere. For the simulation of the counterfactual equilibria not observed in the data, the entry and reconfiguration costs $C(.)$ have to be estimated in a second step.

For the second step of the estimation the transition of the exogenous states z and R and the endogenous states $X_{k,\mathrm{t}}$ have to be be estimated directly. With the transition of all the states at hand, we could compute the expected value functions integrating over the distribution of ν, given the observed policy functions $\hat{P}$:

$$V_{j,k,t}(S_{j,k,t};\sigma^0) = \int \tilde{V}^{\sigma^0}_{\mathrm{j},k,t}(S_{j,k,t},\nu)d\Psi(\nu) \qquad (14)$$

For estimating the parameters of $C(.)$ we then use the Nash conditions:

$$V_{j,k,t}(S_{j,k,t});\sigma^0) \geq V_{j,k,t}(S_{j,k,t};\sigma'_j,\sigma^0_{-j}) \qquad (15)$$

For the purposes of this paper though, we are only interested in simulating the counterfactual behavior of Quebec stations had they behaved according to the policy functions of stations elsewhere. Therefore the second step of the estimation won't be necessary.

6.2 DATA, ESTIMATION AND RESULTS

6.2.1 The data

The data set contains a large number of station characteristics. As explained above, we simplify the problem by classifying firms into "types" to reduce the dimension of the state space. Therefore we will base our analysis on only the "size" of the station, measured by the number of pumps. We classify stations into three size types: "smal'" stations have four or less pumps, "mid-size" stations have more than four and up to eight pumps, and "large" stations have more than eight pumps. We also include an "inactive" type which is an accurate measure of the number of potential entrants.

We tried versions of our model with more size types and other characteristics and obtained the same qualitative results. The drawback of doing so is that the dimension of the state space increases exponentially with the number of types and complicates the estimation of the policy functions. On the other hand, station attributes tend to be correlated, so that for example "large" stations tend to have a convenience store and offer more amenities than smaller stations.

In tables 9 and 10 we show how the distribution of types among stations in Quebec and elsewhere (i.e. the "rest" of Canada) between 1996 when the policy was introduced in Quebec and 2001. The evolution of the market structure based on these simplified characterization of stations is consistent with the description of the full data set.

As explained before, the total number of active stations is decreasing in all regions. As can be seen in the bottom of the table, 8.5% of stations in Quebec become inactive, whereas 6% of stations in the rest of Canada are becoming inactive throughout the sample. Since there was substantial entry into all markets, the gross exit rates are much higher. Also, in all regions the number of small stations is falling substantially, falling from around 27% of all stations to 15% of all stations in Quebec, and falling from 13% to 4.5% of all stations in the rest of Canada.

The difference between both regions is that whereas in Quebec the number of mid-size stations stays fairly constant, it falls by almost 20% in the rest of Canada. Moreover, the number of large stations increased by 52% in Quebec and almost doubled in the rest of Canada. So, even though there is a clear shift in the whole industry toward bigger stations, this shift is more pronounced outside Quebec.

Notice that by the end of the sample the share among stations of the mid-size stations in Quebec did not fall much, being this type of stations the one that the policy aimed to protect. We take this as a fact and estimate the strategic behavior of stations across regions and time periods. Then we simulate the counterfactual behavior of Quebec stations using the policy functions of stations outside Quebec to measure the impact of the minimum price policy on the structure of the market.

6.2.2 Estimation of demand and costs

Consider the demand model generated by (7) which generates the conditional market shares 10. If we take logs we obtain:

$$log(s_j) - log(s_0) = \delta(p_{j,k,t}, x_{j,k,t}, \xi_{j,k,t}, \bar{\bar{\xi}}_{k,t}) = \gamma x_{j,k,t} - \alpha p_{j,k,t} + \bar{\bar{\xi}}_{k,t} - r_{k,t} + \bar{\bar{\xi}}_{k,t}, \xi_{j,k,t},$$

which is a regression that can be estimated using standard linear techniques with fixed neighborhood-level effects. Notice that by assumption the regression error $\xi_{j,k,t}$ is iid so that all unobserved states that are correlated with price are absorbed by the the fixed effects.

Table 11 shows the estimated coefficients of the demand model. We show the results for a model with the three types as explained above (small, midsize and large). The taste for types is measured with respect to the small stations, which is the excluded type. Estimates are statistically significant and imply that consumers value bigger stations more than smaller stations. We interpret this as meaning that consumers value the attributes correlated with the size of the station.

The price coefficient is negative and significantly different from zero. In the current simple specification, the mean markup is the constant inverse of the demand's price coefficient:

$$mc_{j,k,t} = p_{j,k,t} - \frac{1}{\alpha} \quad (16)$$

In richer models (e.g. nested logit), the computation of marginal costs is similarly simple. As can be seen in Table 12, the estimates imply a mean markup among stations of around 7.5 cents/liter and a mean marginal cost among stations of around 47 cents/liter.

We use marginal cost obtained from 16, to estimate marginal costs as functions of states. In the current specification of the model, we assume that marginal cost depend on aggregate states as follows:

$$mc_{j,k,t} = \zeta_0 + \zeta_t + \zeta_\xi \xi_{k,t} + \omega_{j,k,t} \quad (17)$$

where ζ_t is fixed time effect which captures the effect of aggregate shocks on gasoline costs, mainly the price of oil. It is also assumed that the market-level unobserved attributes $\xi_{k,t}$ affect costs. The variable $\omega_{j,k,t}$ is a station-level unobserved state that is assumed to be uncorrelated over time. Notice that in the current specification marginal costs do not depend on the characteristics of individual stations, which facilitates the computation of counterfactual equilibria. The results of this regression (not shown) are sharp and are used to predict the cost of stations in counterfactual equilibria.

6.2.3 Estimation of the policy functions

Notice that the demand and cost estimation yield estimates of the payoff relevant states that determine the behavior of firms. The only remaining feature of the firms' dynamic problem (12) that we need to know in order for us to be able to generate simulated market structures is the policy functions $P(X)^\sigma$ associated with the equilibrium strategy profile σ.

The policy function of each firm describes the decision rule that governs the entry and reconfiguration of firms. Given the assumption that firms follow Markovian strategies, the policy functions depend on the publicly observed payoff-relevant state variables $S_{j,k,t} \equiv \{x_{j,k,t-\delta t}, X_{k,t-\delta t}, \xi_{k,t-\delta t}, R_{-k,t-\delta t}\}$. Therefore, we can estimate a flexible parametric probability to map the observed states into the observed choice probabilities.

As usual with any empirical dynamic oligopoly, we have to set the limits of the sets $\mathfrak{I}_{k,t}$. It is assumed that within each set of markets, all firms are engaged in the same equilibrium, so that the policy functions can be recovered. Since all strategic interactions occur within each local market, we could estimate neighborhood-specific policy functions if we had infinite data, under the assumption that the dynamic equilibrium is different for each neighborhood.

In our analysis below, we assume that stations within the same region were behaving according to the same equilibrium strategies, which is a common assumption in the literature on dynamic game estimation. Therefore, we estimate Quebec-specific policy functions and rest-of-Canada-specific policy functions. We also estimate Ontario-specific policy functions under the assumption that the equilibrium strategies shared by stations in Ontario were different that the equilibrium strategies followed by stations elsewhere.

We focus on the decisions made by firms everywhere after the introduction of the policy in 1996. We assume that the outcomes observed in 2001 were the result of decisions made in 1996. Therefore the policy functions map the states observed in 1996 into the choices observed in 2001. This amounts to assuming that choices observed in 2001 are the result of a stationary MPE which is observed with a δt lag of five years.

Let $\mathfrak{J}_Q$ and $\mathfrak{J}_{-Q}$ be the set of markets in Quebec and outside Quebec, respectively. We are interested in estimating the policy functions $P(X)^{\mathfrak{J}_Q}$ and $P(X)^{\mathfrak{J}_{-Q}}$. To facilitate the analysis we estimate the the policy functions separately for different subgroups of firms within the set of firms $\mathfrak{J}_{k,t}$. Specifically, we estimate multinomial choice probabilities for (i) firms that are not active and that are considering entering markets where no other firm is active; (ii) firms that are not active and that are considering entering markets with active firms; and, finally, (iii) firms that are active and consider reconfiguring, exiting or staying the same.

The three sets of policy functions that we estimate are:

$$P(X)_{j,k,t}^{\mathfrak{J}_{0,W}}(x_{j,k,t-5} = 0, X_{k,t-5} = \emptyset, \bar{\xi}_k, R_{-k,t-5})$$

$$P(X)_{j,k,t}^{\mathfrak{J}_{1,W}}(x_{j,k,t-5} = 0, X_{k,t-5} \neq \emptyset, \xi_{k,t-5}, R_{-k,t-5})$$

$$P(X)_{j,k,t}^{\mathfrak{J}_{2,W}}(x_{j,k,t-5} > 0, X_{k,t-5} \neq \emptyset, \xi_{k,t-5}, R_{-k,t-5}), \quad (18)$$

where $t = 2001$ and $W \in \{Q, -Q\}$ indicates whether the market is located in Quebec or outside Quebec. Notice that the main difference among these policy functions is that firms entering an empty market do not know the market-level shock $\xi_{k,t-5}$. Instead, they condition their behavior on an estimate $\bar{\xi}_k$ which we assume of the mean market shock observed at any point throughout the sample.

We estimate the policy functions using multinomial logit models. We use the discretization of the space of station characteristics described above to characterize the market-level state $X_{k,t}$. Also, instead of using the discrete $x_{j,k,t}$, we use the estimated scalar value of the observed characteristics of the station $\hat{\gamma} x_{j,k,t}$ obtained from the demand model. We also add year-fixed effects to account for aggregate states not captured by the city-level state $R_{-k,t}$.

The estimation yields four set of estimates (one for each choice) for each six choice probabilities (three for each region). We observe very few entries in our data, much less into empty markets. Therefore, most of the action comes from the policy function of active stations. We do not show the estimates of the policy functions, due to their size. We can say that, consistent with the description of the data above, exit probabilities are lower in Quebec. Moreover, stations in Quebec are less likely to transform into bigger stations.

6.2.4 Simulation: Counterfactual market structure

We are interested in simulating the behavior of Quebec stations in the counterfactual environment without a minimum price policy. In this section we predict the counterfactual market structure and, in the next, we evaluate the effect of the policy on consumer welfare.

As we have pointed out, the policy affected market structure by allowing more stations to stay in the market, but inhibited the entry of large stations. Even though the effects of the policy are more or less clear in the data, computing the exact counterfactual equilibrium is difficult, even if we knew the whole structure of the stations' problem. The complexity arises mainly from the multiplicity of equilibria which makes it hard to pin down one particular counterfactual equilibrium or even to put bounds on the set of plausible equilibria..

Nevertheless, in our case we have data about the behavior of firms in what amounts to the counterfactual environment. Specifically, we can assume that the Quebec stations would have adopted the equilibrium strategies that generated the policy functions that we observed during the same years outside Quebec.

The results that we show below correspond to two simulations. First, we simulate the choices of stations in Quebec in 2001, given the states observed in 1996 using the estimated Quebec policy functions to obtain a baseline simulation which should resemble the observed data.

Second, we simulate the choices of Quebec stations in 2001 given the states observed in 1996 using the estimated policy functions corresponding to the stations elsewhere in Canada, assuming that stations in all regions outside Quebec followed the same equilibrium Markov strategies.

The simulations are performed as follows: for each station in each market, the policy functions imply a profile of choice-specific probabilities. These probabilities are obtained from projecting the payoff-relevant states of each station in 1996 into the four possible choices using the estimated policy functions. With these probabilities, for each station, we construct the cumulative distribution of choices, over the four possible choices.

Then for each station an independent uniform (0,1) draw is obtained that "chooses" among the three choices according to the computed cumulative distribution of choices. We do this for every station in every market, and repeat the simulation 1000 times.

We show the summary of these simulations in Table 13. It contains the distribution of stations across the four possible choice (out, small, mid-size and large) in 2001. The first line shows the observed distribution of stations and the following lines show the average shares of choices across simulations. The standard errors correspond to the simulation error which are in general are quite low.

The second and third line show the baseline distribution, which more or less accurately replicates the observed distribution. The fourth and fifth lines show the distribution obtained from simulating the Quebec market structures using the rest of Canada policy functions. The simulations imply that of stations in Quebec had followed the strategies of stations elsewhere in Canada, there would have been less active stations and more large stations. Most of reconfiguration and exit would have come from small stations. Perhaps surprisingly, the share of mid-size stations would have been only slightly lower.

As can be seen on the table, had the stations in Quebec followed the policy functions shared by stations in the rest of all Canada, the share of large stations would have increased from 13% to 25%, the share of inactive stations would have increased from 33% to more than 38% and the share of small stations would have fallen from 15% to less than 5%. Even the share of mid-size stations would have decreased from more than 38% to 32%.

6.2.5 Simulation: Counterfactual consumer welfare

The market structure results are consistent with the premise of the model, which was that the price policy in Quebec induced firms into a dynamic equilibrium which inhibited the entry of large stations and protected smaller stations, allowing them to survive more successfully than elsewhere in Canada. As a result consumers had access to fewer large stations than in the rest of Canada. On the other hand, consumers in Canada were served by more stations than in the rest of Canada.

The impact of this counterfactual market structure on consumer welfare is ambiguous. On one hand, the policy favored product variety in terms of the availability of *many* gas stations, which is something that consumers value. On the other hand, the price floor regulation was detrimental to quality, since it inhibited the entry of large stations which are considered by consumers to be of higher quality (according to our demand estimates).

In our model the measure of consumer welfare in each market k at any time t is given by the inclusive values $R_{k,t}$, which are the expected maximum utility a consumer can get from stations within each city, before the extreme value shocks are realized. From 10 we can see that these inclusive values are affected positively both by the total number of active stations (i.e. product variety) and the type of the active stations (i.e. product quality). Since product quality decreases with the policy, but product variety increases with the policy, the net effect of the policy on welfare depends on the effect of the policy on market structure and the preferences of consumers.

Since consumers have access to the same set of gas stations within each given city, we computed the baseline and counterfactual inclusive values for each of the five Quebec cities in our data set, which are Chicoutimi, Drummondville, Sherbrooke, Trois-Rivieres and Quebec City. Of these cities, Quebec City is much larger than the rest.

In table 14, we show the mean inclusive values in our simulations for each of these five Quebec cities. For each city we show the baseline simulation and the rest-of-Canada-based simulation. We can see that the effect of the different policy functions on consumer welfare vary across cities. In Chicoutimi, Drummondville, Sherbrooke and Trois-Rivieres the welfare of consumers measured by the inclusive values increases when the model is simulated with the counterfactual policy functions. This means that if the policy had not been implemented so that stations had followed the policy functions implied by the dynamic equilibrium prevalent in the rest of Canada, the welfare of consumers would have been higher.

In Quebec City, on the other hand, the welfare is more or less the same as in the observed equilibrium. This means that according to our model the price floor was not detrimental to the welfare of consumers in the city of Quebec, which was the biggest city in the sample.

The results imply that in Quebec City the benefits of the relative increase in variety are just offset by the relative decrease in quality, compared with the counterfactual equilibria. Since Quebec City is large, consumers had access to some large high quality stations, even with the policy. In the smaller cities, on the other hand, there are very few large stations with the policy. Therefore, the benefits of increased variety are more than offset by the relative decrease in quality. In other words, according to our model in the smaller cities consumers would have preferred less stations but some more larger stations.

In order to give a sense of the magnitude of the changes in welfare we computed the equivalent change in price that would make consumers indifferent between the observed equilibrium and the counterfactual equilibrium. For each simulated equilibrium we computed the factor by we would have to multiply prices across the board in each city to make the simulated inclusive value equal to the inclusive value corresponding to the mean baseline equilibrium.

We show the results of this exercise in table 15. We show results of the baseline simulations and of the counterfactual simulations. Numbers in this table greater than one mean that baseline prices would have to be bigger than counterfactual prices for the inclusive value to be equivalent. Similarly, numbers lower than one mean that baseline prices would have to be lower than counterfactual prices for the inclusive values to be equivalent.

For example, prices in each baseline equilibrium in Chicoutimi would have to be multiplied by 1.02 in average across the baseline simulations to make each simulated inclusive value equal to the inclusive value of the mean baseline simulation. Similarly, baseline prices in the other cities would have to be multiplied by numbers very close to one in order to make each baseline inclusive value exactly equal to the mean baseline inclusive value. The reason these numbers are not exactly one is the non-linearity of the inclusive values. The results are nevertheless reassuring that the baseline is replicating well the observed equilibrium.

According to our model, had stations in the four smaller cities behaved as stations in the rest of Canada, the increase in consumer welfare would have been equivalent to the one obtained by multiplying prices by a factor of between 0.63 to 0.81. In other words, the results imply that the counterfactual increase in consumer welfare in the four smaller cities in the sample is equivalent to a decrease of observed prices of 46% to 18%. In Quebec City, on the other hand, prices in the baseline would have to be lower by around 1.5% in order to make consumers indifferent with the counterfactual, but this effect is statistically negligible.

Notice that the standard errors of the means are high, more so in the smaller cities. The reason is that inclusive values are very sensitive to the presence of more or less large stations in each simulated equilibrium, especially when the markets are smaller. Therefore inclusive values vary a lot across counterfactual equilibria in the smaller cities, but not so much in Quebec City.

We conclude that the policy was detrimental to consumers in the smaller cities but was mostly neutral for consumers in the bigger city in our sample. The reason for this difference is that consumers in the big city had access to enough large high quality stations even in the observed equilibrium in which product variety was high. Consumers in the smaller cities would have been willing to sacrifice some of the product variety of the observed equilibrium in exchange for more of the large stations.

Since so many more consumers live in the big cities than in small cities, the aggregate effect of the policy on consumer welfare should be closer to what happened in Quebec City than to what happened in the smaller cities. Nevertheless, since the welfare effects are so heterogeneous across cities, the total depends on how the welfare of consumers in different cities is weighted.

7. DISCUSSION AND CONCLUSION

We have shown that the price floor regulation established in the Québec retail gasoline market has had a substantial effect on prices and market structure. We identified this effect comparing the evolution of the market in Québec and other provinces where the policy was never used, before and after 1997.

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 outside Québec 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 the rest of Canada were very different from the stations that stayed in the market. Moreover, there is evidence that the policy caused an increase in prices.

Our results also suggest that consumers in smaller cities were harmed by the minimum price regulation, because the policy inhibited the entry of the large "high quality" stations that entered markets elsewhere in Canada. The welfare of consumers in the largest city in our sample was mostly unaffected by the regulation, because they had access to some large "high quality" stations that entered the market and to a relatively large number of smaller stations.

These results are consistent with our interpretation of the effect of the price floor on market structure. As we have shown in our theoretical model, even when it does not bind, the policy can block the entry of more efficient firms who must incur larger operating costs. Prices can therefore be lower than in unregulated markets as observed in the Québec retail market. In what follows we present four other possible explanations for the empirical pattern we observe.

7.1 ALTERNATIVE EXPLANATIONS

7.1.1 Tacit collusion

Theoretically, 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 tacit collusion (as in Porter (1983)) to revert to a "punishing" stage. By limiting the extent to which firms can punish defectors Québec's price floor may restrict the severity of price wars. In doing so it may make pricing strategies less stable and make it increasingly difficult to sustain this type of equilibrium. The expected reduction in profit may deter the entry of new firms. Consistent with what we observe in the data.

However, the floor may actually serve as a facilitating device. It clearly provides a focal price to coordinate price changes, and can facilitate communication because it permits firms to sue their competitors if they charge low prices. Indeed, collusion has taken place in Québec since the arrival of the floor. Stations in four cities in Québec were charged with price fixing in 2006.[26] However, collusion in Sherbrooke does not seem to have started until after our sample period as the market experienced severe price wars in 1998 and 1999. The price wars are consistent with the market being in excess capacity, and evidently help to explain some of our markup results.

It may also facilitate collusion when firms are asymmetric in terms of costs. The floor may allow high-cost firms to punish low-cost firms when this would not be possible otherwise. The existence of the floor means that punishment is at the floor rather than at some even lower price. So if the floor is sufficiently low that reverting to it represents a punishment, but is high enough that it is above the marginal cost of the high-cost firm, then it may in fact facilitate collusion.

7.1.2 Underground storage tank policy

Another concern is changes in the regulations regarding underground storage tanks.[27] As mentioned above, one of the factors influencing the reorganization in the retail gasoline industry in the 1980's and 1990's was the advent of regulations on the environmental safety of underground storage tanks -- more specifically, regulation on the removal of older tanks. Legislation requiring new tanks to meet certain standards had already been enacted in both provinces before 1991. In 1988, an Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products was published in Canada providing guidance on appropriate upgrading and removal behavior for storage tanks. It was up to individual provinces as to whether they adopted these guidelines or established their own regulation. In both Québec and Ontario, regulation came into effect around 1991 regarding approval of unprotected tanks. In terms of timing these restrictions seem to be very similar. In Québec all tanks not meeting the protection standards were to be removed within two to seven years, depending on the age of the tank as of July 1991. In Ontario, no approval was to be given for unprotected tanks that had not been upgraded and they would have to be removed by 1997. Given the similarity in terms of timing, the only remaining concern would be with regard to the extent to which these regulations were enforced in the two provinces. If Québec was more lenient in its enforcement of the upgrading and removal policy, this could explain some of the pattern that we observe. We have found no evidence that this is the case.

7.1.3 Ultramar's low-price guarantee policy

Another potential explanation for the market structure changes we observe is Ultramar's low-price guarantee. In our empirical analysis we control for Ultramar's low-price guarantee, but it is possible that it had global effects that were not picked up by the controls. Specifically, the concern is that the low-price guarantee, if credible, might in fact be responsible for the entry distortion that we observe. New firms may be reluctant to enter the market with the "large" technology -- low

[26]See Clark and Houde (2010) for a detailed analysis of these cartels

[27]We thank Heather Eckert for providing us with the following information.

variable, but high fixed costs -- since this technology demands that firms set lower-prices than their competitors in order to grab market share. Ultramar's low-price guarantee might prevent entrants from selling enough volume to cover their fixed costs.

However, since Ultramar's policy is essentially a price-matching guarantee (their claim is that if they spot a lower price than theirs in any particular zone, they quickly lower their price), they may not be able to deter entry. Arbatskaya (2001) shows that with price-matching guarantees an incumbent cannot deter entry into the market. Entry occurs in any subgame perfect equilibrium of the sequential move entry game and the incumbent is accommodating. However, the price-matching guarantee is shown to be valuable for the incumbent as an incentives management device. In any subgame perfect equilibrium the firms share the market equally and the price-matching guarantee serves to facilitate collusion.

Furthermore, Ultamar's commitment to the low-price guarantee may not be credible, such that if new firms actually enter with the "large" technology, Ultramar will retreat from its guarantee. That is, should a sufficient number of "large"-type entrants actually enter the market, it may not actually be credible for Ultramar to stick with its low-price guarantee.

7.1.4 Price cycles

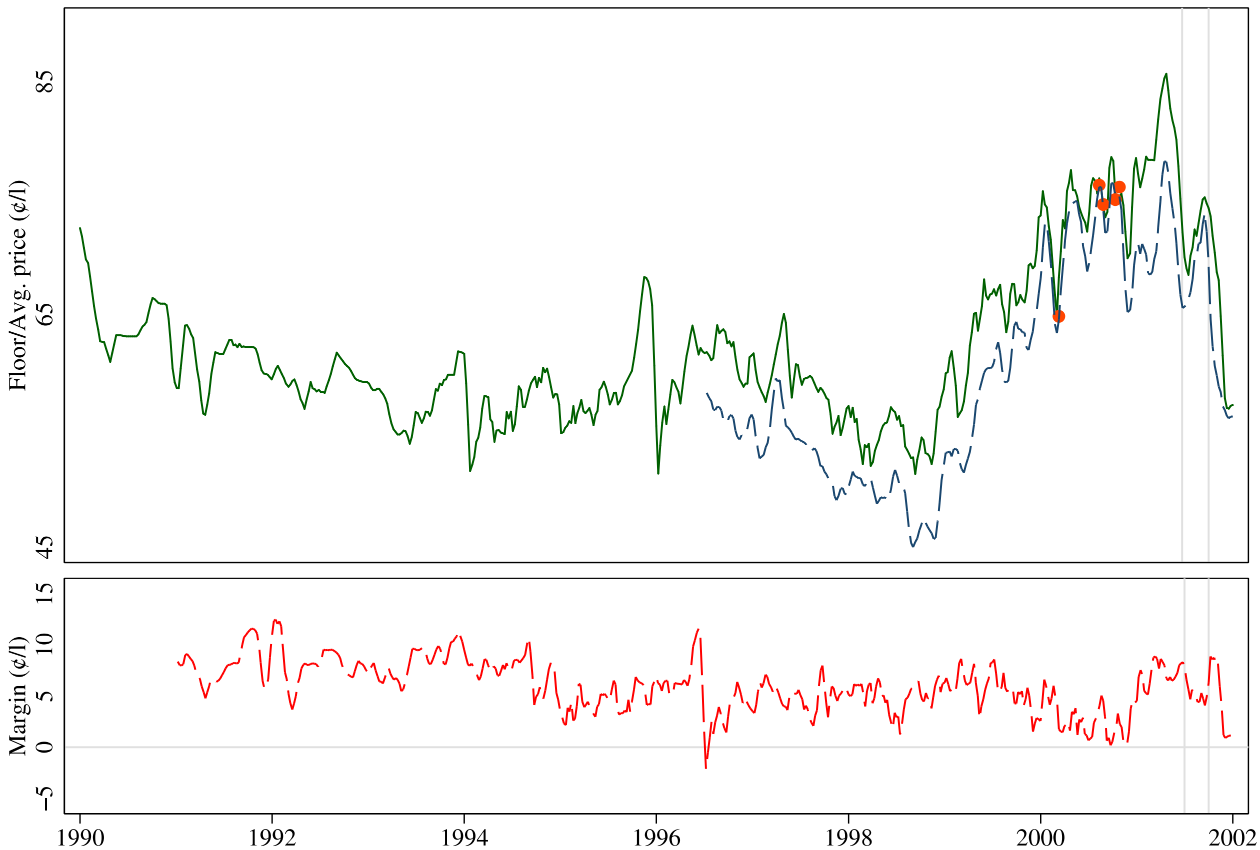
Another possible explanation for the differential effect on prices is that the floor has an impact on the price cycle occurring in Québec. The existence of predictable asymmetric cycles akin to Edgeworth cycles (Edgeworth (1925)) in which price increases are both simultaneous and large (relenting phase), and are followed by a sequence of small decreases (undercutting/matching phase) has been documented by Castanias and Johnson (1993) in U.S. markets, and later by Eckert (2002) and Noel (2007) in Canada.

It is possible that the price floor affects what the cycle looks like in Québec. More specifically, the cycles may be shorter in Québec because of the floor. This in turn makes it more likely that a price at the bottom of the cycle will be sampled in Québec than in other regions. This might explain the lower long-run markups we find in Québec.

However, the price cycle explanation does not provide a convincing account of the market structure changes we observe. The extent to which the existence of cycles increases or decreases profits is ambiguous. The literature on price cycles has not established a firm relationship between price cycles and competition, although in recent work Lewis and Noel (2010) show that in gasoline markets featuring cycles cost changes are passed on two to three times faster than in non-cycling markets, suggesting that cycling markets are more competitive.

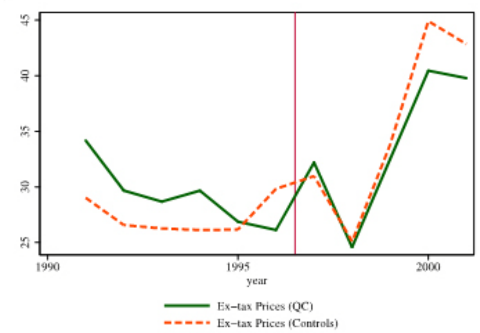
TABLES AND FIGURES

FIGURE 1. EVOLUTION OF AVERAGE PRICES, MARGINS AND FLOOR IN QUÉBEC CITY BETWEEN 1991 AND 2001

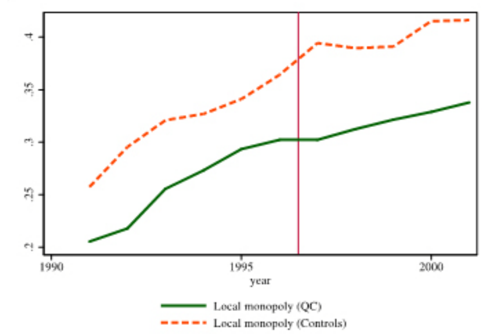


Vertical grid lines = added 3¢/l minimum margin ; Red dots = binding price floor.

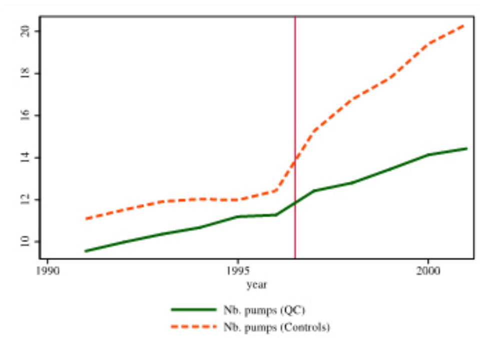
FIGURE 2. EVOLUTION OF PRICES AND LOCAL MARKET STRUCTURE CHARACTERISTICS IN QUÉBEC AND CONTROL CITIES BETWEEN 1991 AND 2001



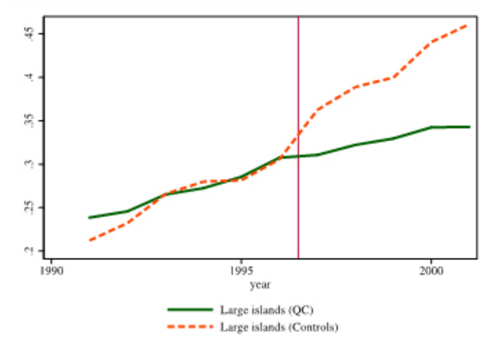
(a) Average prices (net of taxes)



(b) Fraction of local monopolies



(c) Average number of pumps



(d) Proportion of large stations

TABLE 1. MARKET CHARACTERISTICS

	Population	Δ Population %	Volume per cap. (litres/day)	**Δ** Volume per cap. (%)
Cornwall (On)	45 726	0.29	3.38	0.32
Guelph (On)	101 163	1.67	2.66	-0.57
Hamilton (On)	483 981	0.91	2.51	1.70
Kingston (On)	145 090	1.10	2.62	0.11
St Catharines (On)	129 144	0.41	3.10	2.21
Chicoutimi (Qc)	162 410	-0.42	2.08	0.49
Drummondville (Qc)	64 241	0.99	2.86	2.05
Quebec (Qc)	512 746	0.33	3.34	1.39
Sherbrooke (Qc)	138 957	0.70	2.80	1.20
Trois-Rivieres (Qc)	140 847	0.05	2.37	1.29
Halifax (NS)	352 548	0.95	2.35	1.17
Saskatoon (Sk)	224 014	0.74	2.59	-0.02
Brantford (On)	89 615	0.79	2.56	1.18
Windsor (On)	233 709	1.49	2.61	4.91

TABLE 2: ENTRANT, EXITING, AND CONTINUING STATIONS

	Nb. Pumps	Nb. Islands	Conv. Store	Full service
$E(X \mid Entrant) - E(X \mid Continuing$	0,816 (0.587)	0.029 (0.092)	0.317 (0.080)	-0.070 (0.033)
$E(X \mid Entrant) - E(X \mid Exiting)$	4.130 (0.601)	0.565 (0.099)	0.884 (0.087)	-0.297 (0.037)
$E(X \mid Exiting) - E(X \mid Continuing)$	-3.256 (0.156)	-0.544 (0.039)	-0.573 (0.037)	0.231 (0.018)

Population and *Volume per capita* are market (i.e. city) averages taken over the period $1991 - 2001$. The change variables are averages of year-to-year log-changes taken over the same period and expressed in percentage ($\times$ 100).

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

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

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*.

TABLE 3. SUMMARY STATISTICS OF THE KEY VARIABLES FOR MARKETS IN QUÉBEC AND THE REST OF CANADA BEFORE AND AFTER THE POLICY CHANGE

	Before 1997				**After 1997**			
	Quebec		Rest		Quebec		Rest	
	N	Average (sd)	N	Average (sd)	N	Average (sd)	N	Average (sd)
Price	3873	29.48 (3.082)	3926	27.62 (3.964)	2739	34.12 (6.815)	2689	35.72 (7.934)
Markup	3873	0.27 (0.114)	3926	0.19 (0.120)	2739	0.17 (0.103)	2689	0.17 (0.073)
Sales volume (x1000 lt/day)	3495	4.29 (2.971)	3130	6.70 (4.535)	2447	5.73 (4.043)	1979	10.12 (6.792)
Nb. of pumps	3873	8.14 (5.723)	3926	9.80 (5.914)	2739	9.85 (7.307)	2690	13.73 (9.739)
Nb. Islands	3873	2.11 (1.268)	3926	2.42 (1.275)	2739	2.26 (1.341)	2690	2.77 (1.453)
Islands > 4	3873	0.17 (0.380)	3926	0.20 (0.396)	2739	0.22 (0.412)	2690	0.30 (0.457)
No Conv. store	3873	0.58 (0.494)	3926	0.59 (0.492)	2739	0.40 (0.490)	2690	0.36 (0.480)
Carwash	3873	0.19 (0.392)	3926	0.18 (0.383)	2739	0.19 (0.390)	2690	0.22 (0.413)
Pay at the pump	3873	0.00 (0.000)	3926	0.02 (0.124)	2739	0.00 (0.019)	2690	0.02 (0.140)
Repair shop	3873	0.19 (0.393)	3926	0.08 (0.265)	2739	0.16 (0.362)	2690	0.07 (0.247)
Self service	3873	0.37 (0.482)	3926	0.31 (0.463)	2739	0.50 (0.500)	2690	0.40 (0.491)
Local comp.	3873	4.30 (0.459)	3926	4.18 (1.291)	2739	4.03 (0.893)	2690	3.43 (1.332)
Street comp.	3873	10.20 (9.423)	3926	13.36 (15.677)	2739	7.43 (6.245)	2690	11.58 (13.575)

TABLE 4. REGRESSIONS OF MARKUP ON POLICY AND CONTROLS

VARIABLES	(1) Markup	(2) Markup	(3) Markup	(4) Markup	(5) Markup
Policy	0.110 ^{a} (0.0152)	-0.107 ^{a} (0.00531)	-0.0847 ^{a} (0.00716)	-0.0559 ^{a} (0.00724)	-0.00490 (0.0119)
Observations	2,289	12,068	12,068	12,068	12,068
Sample period	1996-1997	Excl. 1996	Excl. 1996	Excl. 1996	Excl. 1996
Group FE	Station	Station	Station	Station	Station
Control variables	NO	NO	YES	YES	YES
Station & market variables	NO	NO	NO	YES	YES
Market trends	NO	NO	NO	NO	YES

Clustered standard-errors in parenthesis, cluster=Local markets (528).
Year fixed-effects are included, along with other time-varying controls (see details in text).

TABLE 5. REGRESSIONS OF SALES VOLUME ON POLICY AND CONTROLS

VARIABLES	(1) Volume	(2) Volume	(3) Volume	(4) Volume	(5) Volume
Policy	-350.3 ^{b} (156.9)	-1,354 ^{a} (197.5)	-698.0 ^{b} (278.6)	62.52 (269.9)	-115.8 (240.9)
Observations	1,856	10,010	10,010	10,010	10,010
Sample period	1996-1997	Excl. 1996	Excl. 1996	Excl. 1996	Excl. 1996
Group FE	Station	Station	Station	Station	Station
Control variables	NO	NO	YES	YES	YES
Station & market variables	NO	NO	NO	YES	YES
Market trends	NO	NO	NO	NO	YES

Clustered standard-errors in parenthesis, cluster=Stations (1509).

Year and station fixed-effects and MV selection probability (log) are included, along with other time-varying controls (see details in text).

TABLE 6. REGRESSIONS OF AVERAGE PRODUCT CHARACTERISTICS ON POLICY AND CONTROLS

VARIABLES	(1) Competitors	(2) Monopoly	(3) Pumps	(4) Variety	(5) Islands
Policy	0.0355 ^{a} (0.00919)	-0.0869 ^{a} (0.0161)	-0.927 ^{a} (0.203)	-0.203 ^{a} (0.0262)	-0.126 ^{a} (0.0275)
Policy (w/ trends)	0.0226 ^{c} (0.0131)	-0.0448 ^{c} (0.0231)	-0.731 ^{b} (0.296)	-0.166 ^{a} (0.0435)	-0.130 ^{a} (0.0365)
Observations	5,305	5,305	5,305	5,268	5,305

VARIABLES	(6) >4 Islands	(7) Store	(8) Conventional	(9) E-pay	(10) Carwash
Policy	-0.0465 ^{a} (0.00909)	-0.0490 ^{a} (0.0113)	0.0521 ^{a} (0.0111)	-0.0311 ^{a} (0.00913)	-0.0185 ^{b} (0.00765)
Policy (w/ trends)	-0.0414 ^{a} (0.0120)	-0.0332 ^{b} (0.0146)	0.0106 (0.0134)	5.98e-05 (0.0121)	-0.00185 (0.0100)

Clustered standard-errors in parenthesis (cluster=local market).

Year and market fixed-effects are included, along with other time-varying controls (see details in text).

TABLE 7. REGRESSIONS OF MARKET CHARACTERISTICS ON POLICY AND CONTROLS

VARIABLES	(1) Distance to nearest competitor	(2) Pumps (2 min)	(3) Pumps (3 min)	(4) Monopoly (2 min)	(5) Monopoly (3 min)
Policy effect	-0.0971 ^{b} (0.0438)	-0.567 ^{a} (0.195)	-0.573 ^{a} (0.161)	-0.0324 ^{b} (0.0155)	-0.0360 ^{a} (0.00919)
Policy effect (with trends)	-0.0689 ^{b} (0.0344)	-0.489 ^{a} (0.163)	-0.599 ^{a} (0.129)	-0.0143 (0.0109)	-0.0122 (0.00755)
Observations	13228	11063	12411	13228	13228

Year and market fixed-effects are included

Clustered standard-errors in parenthesis (cluster=station id).

along with other time-varying controls (see details in text

TABLE 8. REGRESSIONS OF CITY-LEVEL MARKET CHARACTERISTICS ON POLICY AND CONTROLS

VARIABLES	(1) Distance to nearest competitor	(2) Brand concentration	(3) Market concentration	(4) Sales volume	(5) Log of stations	(6) Large islands
Policy	-0.0362 [a] (0.00861)	-101.1 [b] (49.66)	-86.92 [a] (24.50)	-2,112 [a] (270.7)	0.0648 [a] (0.0192)	-0.0694 [a] (0.00910)
Policy (w/ trends)	-0.0229 (0.0146)	40.88 (57.74)	-18.95 (31.13)	-458.9 [c] (242.4)	0.00431 (0.0284)	-0.0272 [a] (0.00981)
Observations	154	154	154	154	154	

Robust standard-errors in parenthesis.
Year and market fixed-effects are included
All specifications include time-varying controls (see details in text).

TABLE 9. OBSERVED DISTRIBUTION OF STATIONS' CHARACTERISTICS (QUEBEC)

	Inactive	Small	Mid-size	Large
1996	24.32 %	26.77 %	40.03 %	8.88 %
1997	26.25 %	20.46 %	41.96 %	11.33 %
1998	27.54 %	19.43 %	41.06 %	11.97 %
1999	27.54 %	19.43 %	41.06 %	11.97 %
2000	31.79 %	16.60 %	38.35 %	13.26 %
2001	32.82 %	14.93 %	38.74 %	13.51 %
Change 2001 vs 1996	34.92 %	-44.23 %	-3.22 %	52.17 %

TABLE 10. OBSERVED DISTRIBUTION OF STATIONS' CHARACTERISTICS (REST OF CANADA)

	Inactive	Small	Mid-size	Large
1996	29.49 %	13.14 %	45.51 %	11.86 %
1997	31.20 %	8.23 %	44.12 %	16.45 %
1998	33.01 %	6.94 %	41.45 %	18.59 %
1999	33.01 %	6.94 %	41.45 %	18.59 %
2000	34.72 %	4.81 %	37.71 %	22.76 %
2001	35.58 %	4.49 %	36.43 %	23.50 %
Change 2001 vs 1996	20.65 %	-65.85 %	-19.95 %	98.20 %

TABLE 11. DEMAND ESTIMATES

VARIABLES	
Cons.	2.325873 (0,859254)
Price	-0.1343479 (0,015646)
Medium	0.4472283 (0,0197458)
Large	0.9201485 (0,0251997)

TABLE 12. MARKUP AND COST ESTIMATES

VARIABLES	
Markup/lt	7.496773 (0,0720596)
mc/lt	47.35757 (6,976422)

TABLE 13. SIMULATED MARKET STRUCTURE IN QUEBEC (2001)

	Inactive	Small	Mid-size	Large
Observed	0.3282	0.1493	0.3874	0.1351
Baseline	0.3287 (0.0124)	0.1534 (0.0125)	0.3881 (0.0149)	0.1298 (0.0078)
As in roc	0.3826 (0.0132)	0.0463 (0.0070)	0.3203 (0.0156)	0.2508 (0.0133)

Based on 1000 simulations. Standard errors shown in parenthesis.

TABLE 14. SIMULATED INCLUSIVE VALUES ACCROSS SCENARIOS

	Chicoutimi	Drummondville	Quebec	Sherbrooke	Trois-Rivieres
Baseline	5.6370 (0.2418)	7.0871 (0.5944)	6.1011 (0.1109)	7.6256 (0.1528)	6.1504 (0.3185)
As in roc	6.2446 (0.2373)	7.2417 (0.4738)	6.0120 (0.1343)	7.8925 (0.1394)	6.1743 (0.2980)

Based on 1000 simulations. Standard errors shown in parenthesis.

TABLE 15. EQUIVALENT CHANGE IN PRICES ACROSS SCENARIOS

	Chicoutimi	Drummondville	Quebec	Sherbrooke	Trois-Rivieres
Baseline	1.0254 (0.2153)	1.0355 (0.4080)	1.0059 (0.1096)	1.0002 (0.1396)	1.0384 (0.2737)
As in roc	0.6291 (0.1249)	0.6400 (0.2807)	0.9828 (0.1024)	0.5383 (0.0968)	0.8151 (0.2333)

Based on 1000 simulations. Standard errors shown in parenthesis.

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