An Empirical Study of Within-Chain Variance in Supermarket Prices

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Un estudio empírico de la varianza en precios al interior de las cadenas de supermercados

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Abstract

Las firmas suelen tener incentivos para realizar alguna forma de discriminación de precios con el fin de apropiarse del mayor excedente del consumidor posible cobrando diferentes precios a diferentes consumidores o segmentos de consumidores. En el caso particular de los supermercados, observar una baja variación entre las tiendas de una cadena determinada podría interpretarse como paradójico, ya que la ubicación parecería ser una fuente potencial de heterogeneidad observable entre consumidores con la dimensión geográfica obstaculizando en alguna medida la sustitución entre sucursales. No obstante, si la demanda en los diferentes puntos de venta dentro de cada cadena fuera lo suficientemente homogénea, podría ocurrir que incluso siendo ávidos discriminadores, los supermercadistas terminen fijando precios (casi) uniformes para sus productos. Este trabajo profundiza empíricamente en esa hipótesis al emplear un experimento natural que forzó heterogeneidad en la demanda entre las tiendas. En particular, hace uso de un evento exógeno que impidió que muchos consumidores en un área geográfica limitada pudieran beber agua corriente, lo que hizo que la demanda de una alternativa embotellada se vuelva más inelástica. Si bien hay evidencia de que el impacto tuvo un efecto significativo en la asequibilidad (agregada) del agua embotellada en el área afectada en relación con las no afectadas, las cadenas que operan tanto dentro como fuera de los límites geográficos afectados no implementaron precios diferenciales después del *shock*. Esto sirve como evidencia en contra de la hipótesis de que la uniformidad de precios es el resultado de la homogeneidad de la demanda en los diferentes puntos de venta, ya que la intervención en el suministro de agua produjo una divergencia entre sucursales distantes sin disparar diferencias en precios.

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Abstract

Firms normally have incentives to perform some form of price discrimination in order to appropriate as much consumer surplus as possible by charging different prices to different consumers or consumer segments. In the particular case of retail firms, observing low variance across the stores of a given chain might constitute a puzzle to outsiders as location would seem like a potential source of observable consumer heterogeneity with geographical fences preventing some degree of substitution between branches. Notwithstanding, if demand at different points of sale within each chain was sufficiently homogeneous, it could occur that even avid price discriminators winded up setting (near) uniform prices for their products. This work delves empirically into that hypothesis by exploiting a natural experiment that forced demand heterogeneity between stores. In particular, it makes use of an exogenous event that prevented many in a limited geographic area to be able to drink running water making the demand for a bottled alternative more inelastic. While there is evidence that the shock had a significant effect on (aggregate) affordability of bottled water in the affected area relative to unaffected ones, the chains that operate both inside and outside of the affected geographic boundaries did not implement differential pricing in the aftermath of the event. This serves as evidence against the hypothesis that uniform pricing is the result of demand homogeneity at the different points-of-sale of each supermarket chain, as demand at distant branches diverged after the shock to the water supply took effect.

Contents

1 Introduction

Firms engage in third-degree price discrimination when they charge a different price across heterogeneous market segments in order to extract as much consumer surplus as possible. It is only natural, therefore, for a firm entering an industry and intending to serve a number of geographies to be puzzled if it observed incumbents to be enforcing a nearly uniform price.

That phenomenon, however, is often the case in the supermarket sector (see, for example, Dobson and Waterson (2008), Daruich and Kozlowski (2019) and DellaVigna and Gentzkow (2019)). This is in spite of chains usually satisfying all three requirements for being able to perform third-degree price discrimination: having market power; being able to observe heterogeneity between consumer segments; and having enforceable fences in place that prevent arbitrage between segments.

Although there are models from the field of Industrial Organization providing a rational basis for this apparently paradoxical situation —dependent upon certain conditions regarding competition between firms— (e.g. in Holmes (1989), Corts (1998), Thisse and Vives (1988) and Robinson (1969)), we need not always have to go to such theoretical lengths to devise occasions in which supermarket chains might adopt uniform pricing as an optimal policy. In particular, low within-chain price variation might be consistent with chains facing homogeneous competition and consumer characteristics at each of their stores, rendering differences with a context of price discrimination negligible. If, for example, chains where clustered in geographic areas, each of them quite homogeneous, we would probably not expect much within-chain price variation even if chains were skillful price discriminators. And even with high geographic dispersion of branches within a given chain, it might occur that areas with a high average willingness-to-pay of consumers are also exposed to more intense competition eroding market power and making overall demand for goods similar to that of other areas with both a lower average willingness-to-pay and with less intense competition.

With that in mind, a firm entering the supermarket sector and having to set a brand new pricing policy for the stores in its network might be left asking if it possible that the observed low variance in within-chain pricing be simply a result of highly homogeneous demand —understood as the combination of income and substitution forces— at the different outlet locations. But what if the prevalent uniform pricing was, instead, a deliberate decision by firms to soften competition as some Industrial Organization models suggest or, even more plainly, the result of a lack of sophistication by firms to carry out more widespread price discrimination? Uncovering whether price uniformity is a mere artifact of demand homogeneity across stores or a managerial decision is highly relevant information going into the pricing strategy of an entrant firm to the sector, but, as we will see, hard to come by without first-hand input from industry insiders. The empirical alternative is to look for evidence of whether demand homogeneity is indeed the phenomenon governing the supermarket sector. This is not, however, free of its very own intricacies.

The difficulty in devising a way to tell if demand is sufficiently homogeneous at different stores stems from the fact that consumers' utility functions, their budget constraints and competition with other firms are, all three of them together, at play. And there are mechanisms that prevent us from being able look at each of those aspects separately —take, for example, search costs, that are usually associated to both income and competition simultaneously. Needless to say, if we tried estimating demand functions, being able to call the covariates in our regressions exogenous is very likely a long-shot. In addition, and perhaps even more problematic, there is the hurdle provided by the assumption that the entrant firm does not observe quantities sold by the incumbents, but only their prices. This is yet another obstacle for estimating demand and best response functions, adding yet another layer of complexity to the already hard problem at hand.

This work tackles the aforementioned challenge by exploiting a natural experiment: during the first weeks of July 2020, the company providing running water and sewer services to most of Greater Buenos Aires, *Agua y Saneamientos Argentinos S.A.* (AySA), acknowledged a strong worsening in the smell and taste of the running water it provided, which was attributed by the company to variations in the Río de la Plata. This work makes use of that unanticipated exogenous event, leading many to turn to bottled water for at least the length that the service was affected. Given the geographic locality of the shock, it should only have influenced demand around certain stores through consumers' reduced ability to give up consumption in the face of price increases, but without affecting, in principle, the nature of competition. That way we are able to force within-chain heterogeneity in terms of demand and observe the resulting price response on treated and untreated stores. Despite only using a narrow sample of products (those in the bottled water category), this works provides novel evidence surrounding what is empirically going into the managerial decision to opt for a specific pricing policy, sorting many of the practical methodological obstacles that observational data normally presents. This is in no small part leveraged on a rich dataset constructed with proprietary software that was able to collect data identifying time-store-product-price combinations from supermarket chains in Argentina, including the geographic location of the stores and the product category of the different items.

The work is structured as follows: section 2 provides a review of previous literate on the subject; section 3 outlines the theoretical developments from industrial organization that serve as a framework for the subsequent empirical analysis; section 4 provides a description of the data and puts forward descriptive evidence of low within-chain price variation in the Argentine supermarket industry; section 5 shows empirical results; and, finally, section 6 presents some concluding remarks.

2 Related literature

Price discrimination has been widely studied in the literature from a theoretical perspective. On a general level, Stigler (1987) and Clerides (2004) associate price discrimination with contexts in which price variations between customer segments cannot be (fully) accounted for by differences in marginal costs. Reviewing theoretical explanations for such phenomenon Stole (2003) draws from the field of Industrial Organization and highlights that firms aim to price their products according to the underlying price-elasticity of demand of each market segment, thus generating greater profits by extracting relatively more surplus from inelastic consumers. This process of price discrimination, he notes, requires either that consumer heterogeneity be observable or implementing mechanisms of self-selection through menus of products and prices.

There are, however, cases where theory establishes a rationale for firms preferring a uniform pricing approach to a price discrimination one (see, for example, Thisse and Vives (1988), Corts (1998) and Holmes (1989)). The reasoning behind these seemingly counter-intuitive theoretical developments lies on the potential for increased competition caused by the strategic interaction between firms enforcing price discrimination as they intend to capture a greater share of the market.

On the empirical front, the literature extends over a number of industries and products. Examples of those include retail gasoline (Shepard, 1991), cable TV (Crawford and Shum, 2001), breakfast cereals (Nevo and Wolfram, 2002), books (Clerides, 2002), ketchup (Besanko et al., 2003), theatre tickets (Leslie, 2004), cars (Goldberg and Verboven, 2005) and consumer goods (DellaVigna and Gentzkow, 2019), just to name a few. All of the aforementioned are centered in the US with the exception of Goldberg and Verboven (2005) that use the European integration process to empirically analyze predictions like the Law of One Price (which should occur across country borders). This broad, though not exhaustive, survey of the literature should be enough to give the idea of how the phenomenon of uniform pricing has been analyzed much more in developed countries than in developing ones.

It can be argued that the focus that the empirical literature usually puts on uniform pricing can also be nourished by the use of natural experiments allowing for identification of causal effects. The work mentioned above tends to first observe the phenomenon of uniform pricing empirically and then resort to theoretical models that aim to make sense of the seeming paradoxes found in the data. That is, they often present descriptive evidence as this work does in section 4.3 and produce models that incorporate behaviour consistent with that empirical evidence, some of which is present in this work's theoretical framework (section 3). Of course, the natural experiment approach might be hard to come by in most cases due to its data demands and its need for a truly exogenous event to take place. However, on the data issue, there exists an incipient corpus of research papers that do comprehend increasing amounts of price data collected with a high frequency. Cavallo and Rigobon (2016) review this trend in greater detail. This work is aligned with that research agenda as it uses weekly prices for a large sample of consumer products from major supermarket chains in Argentina. Although a proprietary scraper was built for obtaining those prices, this work is not the first to have used the *Sistema Electronico de Publicidad de Precios Argentinos* —a price repository managed by the Government of Argentina— as a source of data: Daruich and Kozlowski (2017) and Daruich and Kozlowski (2019) already used it to analyze some macroeconomic dynamics relating to the price propagation (or lack thereof) of shocks across regions, as opposed to the industrial organization focus that is relevant here.

A central motivation of this work relies on the observation that prices between the stores of most supermarket chains display extremely low price dispersion, which might come as a surprise to an outside observer. This phenomenon is not only true in Argentina, but has also been documented elsewhere such as in the United States —see, for example, Kaplan et al. (2019) and DellaVigna and Gentzkow (2019)—, in the UK (Dobson and Waterson, 2008), and in Germany and Japan (Greenhut, 1981) to name a few places. Stole (2003) reviews a number of models from the field of Industrial Organization that aim at explaining such phenomenon. A backbone of those theoretical proceedings is composed of a seminal paper by Holmes (1989), which is key to the next section of this work. But rather than providing conclusive answers as to what might be behind supermarkets' (near) uniform pricing in Argentina, it provides tools to make sense of different potential scenarios that need to be assessed empirically. That is where this work contributes to the literature: it exploits a natural experiment that allows to rigorously look for causal changes in the pricing policies of retail chains in order to later evaluate the theoretical fit of the empirical findings.

3 Theoretical framework

3.1 Requirements for price discrimination

Microeconomic theory states that, faced with heterogeneous consumers, firms would ideally strive to set a price for their goods in accordance to the demand elasticity of each consumer they serve. That means, everything else equal, charging a higher price to more inelastic consumers who are less willing (or able) to substitute consumption either with another good, or with a "no-product"—i.e. giving up consumption of the good altogether. This gives rise to the notion of price discrimination. The foundational principles of price discrimination have been studied in detail in the context of markets dominated by a monopolistic firm. An incomplete survey of that literature includes Varian (1989), Phlips (1983) and Tirole (1988, chapter 3). The ability—and incentives—to discriminate in the case of a monopoly are, however, quite different to the scenario of perfectly competitive firms that operate at null profits. Under the assumption of a constant marginal cost, equal for serving any consumer segment, the perfect competition equilibrium is characterized by firms setting a uniform price among all groups of consumers that coincides with that marginal cost. Neither of these two polar extremes is, *ex ante*, more likely to prevail in practice. In fact, the consensus seems to be that models which best mimic observed economic behaviour fall somewhere in between them (Cooper et al., 2004). Evidence in that direction is present in the empirical literature mentioned in the previous section.

Varian (1989) summarizes feasibility requirements to enforce price discrimination as (i) firms having (short-run) market power, (ii) the existence of heterogeneous consumers or consumer segments and (iii) enforceable fences that prevent arbitrage between those segments. For the purposes of this work, all three requirements will be assumed to hold in practice, given that the Argentine supermarket sector is composed of a finite number of firms —with varying degrees of scale and market power and many of which operate at positive profits— serving consumers in distinct market areas with observed heterogeneity in income levels and consumption patterns ((INDEC, 2022), SAIEP (2021)).

3.2 Third-degree price discrimination and competition

3.2.1 Demand homogeneity

In the monopoly case, third-degree price discrimination involves each consumer segment—or "market"—paying a different price. Assuming a constant marginal cost c, the price charged in each market i

arises from solving the monopolist's problem of maximizing profits. With some trivial algebra, the first order condition of the profit maximization problem can be arranged as

$$\frac{p_i - c}{p_i} = \frac{1}{e_i^I(p_i)} \tag{1}$$

I am following the notation used in Holmes (1989), but adapted to this monopoly case, where $e_i^I(p_i)$ is the *industry* or *market* elasticity of demand in i, defined as $e_i^I(p_i) = -\frac{\partial q_i}{\partial p_i}\frac{pi}{q_i}$.

The monopoly setting has strong limitations when extrapolating its results to a context of imperfectly competitive firms. Unlike the previous procedure, in the case of imperfectly competitive firms one ultimately seeks to compute the equilibrium that arises from their strategic behavior. In cases when competition is simultaneous, for instance, equilibrium prices between two firms is derived from the intersection of both firms' best-response functions, leading to lower aggregate profits than if both firms had colluded with one another acting as a single monopoly.

Firms interacting strategically through their best-response functions present both theoretical and empirical challenges when assessing the potential costs and benefits of committing to and enforcing a uniform price among any number of heterogeneous markets. In terms of previous literature on the subject, certain configurations of firm competition in oligopoly have been found in which moving to price discrimination from uniform pricing is not weakly profit-augmenting, like it is always the case in a monopoly setting. For instance, take the standard case of two heterogeneous markets $i = \{1, 2\}$ and two competing firms $j = \{a, b\}$. Further assume a constant marginal cost c equal for both firms in both markets which is common practice is symmetric games and can be reasonable in the context of economies of scale. Assuming symmetry between firms —a standard in a large portion of the literature for the purposes of simplifying the analysis—, the demand function faced in each market i is the same for both firms. Then $q_i(p) = q_i^j(p)\ \forall j = \{a, b\}$ and the *market* elasticity at symmetric price p can be expressed as

$$e_i^I(p) = -\frac{\partial q_i(p)}{\partial p}\frac{p}{q_i(p)}$$

whereas the *firm* elasticity for j in market i is as follows

$$e_{i,j}^F(p^a, p^b) = -\frac{\partial q_i^j(p^a, p^b)}{\partial p^j}\frac{p^j}{q_i^j(p^a, p^b)}$$

Given the symmetric nature of this game by which $p = p_i^a = p_i^b$,

$$e_i^F(p) = -\frac{\partial q_i(p)}{\partial p}\frac{p}{q_i(p)} + \frac{\partial q_i^j(p,p)}{\partial p_i^{-j}}\frac{p}{q_i(p)} = e_i^I(p) + e_i^C(p) \tag{2}$$

where the $-j$ superscript indicates the rival firm to j. This introduces an additional elasticity, $e_i^C(p)$, to the previously used $e_i^I(p)$ that captured consumers' willingness (or ability) to substitute consumption with the "no-purchase" alternative. $e_i^C(p)$, on its part, is a cross-elasticity of demand that measures how simple it is for consumers to switch between firms. Using the result in (2), one can easily extend the monopoly condition in (1) to this duopoly setting as

$$\frac{p_i - c}{p_i} = \frac{1}{e_i^I(p_i) + e_i^C(p_i)} \tag{3}$$

Hence, the interaction between firms clearly becomes a key component of the market equilibrium, relative to the monopoly condition in (1). Notice that for it to be optimal to set the same price in all markets, $e_i^I(p_i) + e_i^C(p_i)$ should have to be the same across them. And it could be the case that each of the two terms varies from one market to another, but also that the addition of both produces something much more homogeneous. Take the example of, on the one hand, a "wealthy" market with consumers having a relatively high willingness to pay but competition being fierce and, on the other hand, a less well-off market with a lower average willingness to pay but also with less intense competition between firms. It would not be surprising if those two heterogeneous areas in terms of income and competition ended up with homogeneous prices after balancing out the two aforementioned antagonistic forces affecting the overall elasticity. Whether it is reasonable to assume a scenario in which the right-hand side of equation (3) is sufficiently homogeneous within major chains in the Argentine supermarket sector to explain the low observed price dispersion is the main focus of this work and assessed in the subsequent sections with a natural experiment. Before moving on to studying this particular scenario empirically, however, some alternative scenarios will be outlined. In those, uniform pricing might be, at least theoretically, an optimal policy and thus result of high interest if the homogeneity hypothesis were to be rejected. This work does not aim to cover those contingent settings empirically but, still, they are described theoretically for the sake of completeness as they would result in natural next steps for future research if the demand homogeneity hypothesis were to be proven incorrect.

3.2.2 Best-response symmetry

Price homogeneity does not necessarily have to reflect overall demand homogeneity at the store level. Instead, it might also arise from the mere way firms compete with one another. Stole (2003) reviewed this case using the concept of "strong" and "weak" markets proposed by Robinson (1969) but adapted to the case in which firms compete imperfectly in two markets. The idea is that, given a uniform price by rival firm $-j$, firm j would establish a higher price in its "strong" market than in its "weak" market if it did price discrimination. Formally, given two markets $i = 1, 2$, then market 2 is the strong market if $BR_1^j(p) < BR_2^j(p)$, when the rival firm sets uniform price p —BR representing best response functions. He then adopts the notion of *best-response symmetry* proposed by Corts (1998) by which both competing firms share which their strong and weak markets are (what happens in the opposite case of *best-response asymmetry* will be covered later in this work). In this particular duopoly setting, the optimality of enforcing price discrimination is dependent on the relative magnitudes of the previously highlighted elasticities. Maintaining the notation from above, the marginal profit at symmetric prices is given by

$$D\pi_i(p) = q_i^j(p) + (p-c)\frac{\partial q_i^j(p,p)}{\partial p_i^j}$$

Further assume $\frac{\partial D\pi_i(p)}{\partial p} < 0$, that guarantees that the optimal uniform price, which satisfies $D\pi_1(p_u^*) + D\pi_2(p_u^*) = 0$, is such that $p_u^* \in (p_1^*, p_2^*)$. The implication here is that while the price in market 1 increases when moving to uniform pricing from third-degree price discrimination, the opposite is the case in market 2. The effect on output is not obvious and, for resolving the ambiguity, it was Holmes (1989) who introduced a new parameter r such that the difference in flexible prices at both markets cannot exceed its value. The pricing decision is, as a result, obtained from solving $D\pi_1(p_1) + D\pi_2(p_1 + r) = 0$. For the sake of consistency, let $p_1^*(r)$ denote the solution, as it is written by Stole (2003) as opposed to Holmes (1989), and characterize aggregate demand as follows:

$$Q(r) = q_1(p_1^*(r)) + q_2(p_1^*(r) + r)$$

The two extreme scenarios here are of $r = 0$ in which firms price uniformly and, on the other hand, the traditional flexible pricing solution which arises as r increases enough so as to no longer constraint the firm's decision. The transition from the former scenario to the latter one, as long as $Q(r)$ is monotonic, is what Holmes (1989) uses to quantify the gains or losses of moving from uniform pricing to flexible pricing. In particular, for output to be increasing on r —that is, $Q'(r) > 0$—, it should be that

$$\left[\frac{(p_2-c)}{2q_2'(p_2)}\frac{d}{dp_2}\left(\frac{\partial q_2^j(p_2,p_2)}{\partial p_2^j}\right) - \frac{(p_1-c)}{2q_1'(p_1)}\frac{d}{dp_1}\left(\frac{\partial q_1^j(p_1,p_1)}{\partial p_1^j}\right)\right] + \left[\frac{e_2^C(p_2)}{e_2^I(p_2)} - \frac{e_1^C(p_1)}{e_1^I(p_1)}\right] > 0$$

Holmes (1989) calls the first term the "adjusted-concavity condition" which measures the relative curvature of the demand function in the strong and weak markets and is an extension of a condition Robinson (1969) highlighted in monopoly. The second term is referred to as the "elasticity-ratio condition". He goes on to focus on the case of linear demand functions for which the first term is equal to zero, so that it becomes easier to draw conclusions on the latter one, which is positive as long as

$$\frac{e_1^I(p_1)}{e_2^I(p_2)} > \frac{e_1^C(p1)}{e_2^C(p2)}$$

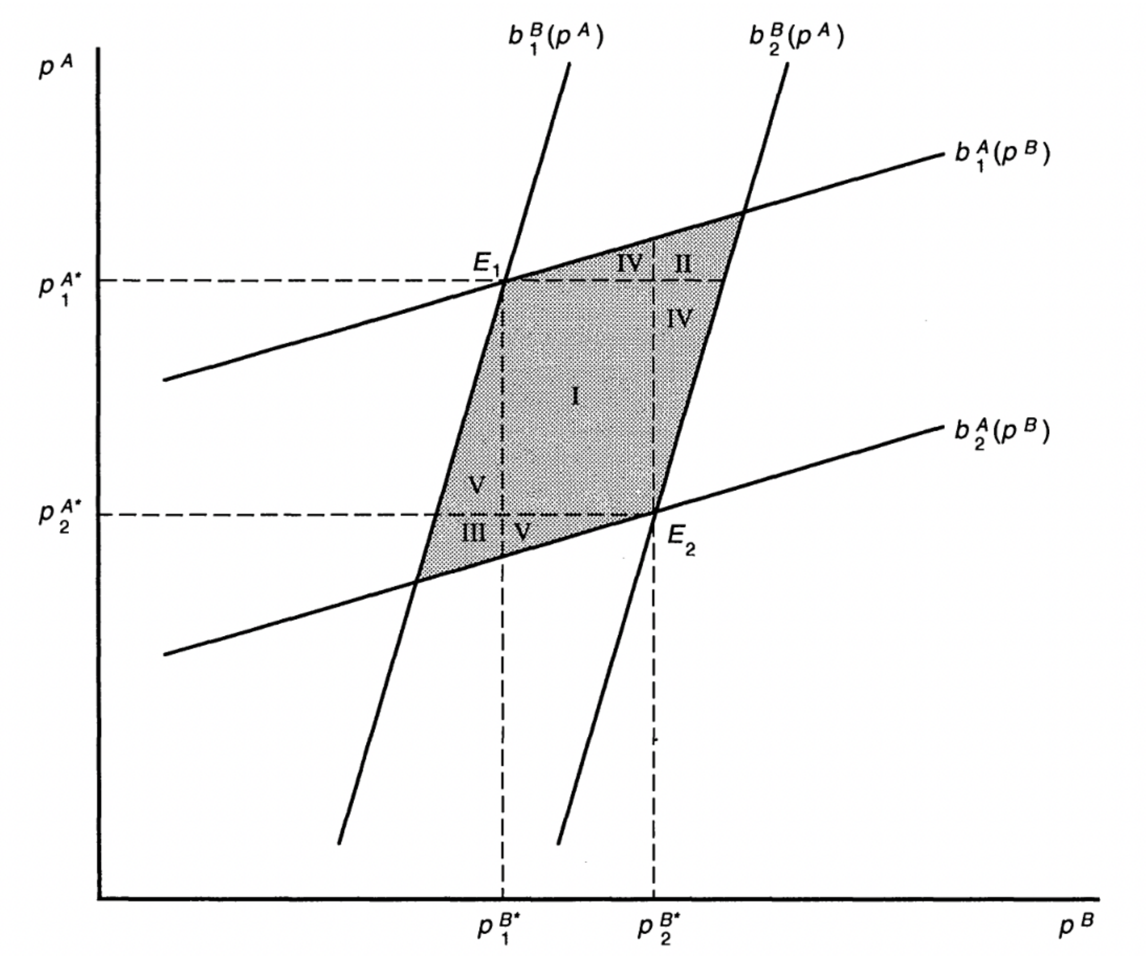
The last expression identifies a continuum of configurations of our relevant elasticities for which price discrimination always increases output. But, from the firms' stand point, however, we are interested in profits rather than output, which is not as straight-forward. Sticking to the assumption made by Holmes (1989) of linear demands, when the above inequality holds true, he finds that profits do, as well, rise with price discrimination relative to uniform pricing. But that is far from always the case when the expression gets violated. In the latter case, he finds, any particular firm moving to flexible pricing individually would always increase its profits as long as the other firms do not follow suit. Under the scenario of across the board flexible pricing, the final effect on firms is ambiguous and it could indeed occur that profits fall in the overall industry. The theoretical conclusion to be drawn thus far is that if it could be established that firms share their views on their ordering of markets —in the sense that Robinson (1969) and Corts (1998) define them as "strong" and "weak"— then we would still need to be able to tell something about both the *industry* elasticity and the *cross-elasticity of substitution* in the strong and weak markets as a necessary condition to draw conclusions on the pricing strategy. Even then, in the case the condition above gets violated, the effect is ambiguous and, as a result, not sufficient for reaching any general veredict. What we do know, nevertheless, is that the possibility of uniform pricing being an optimal policy does exist in this setting, however intricate it might result. In the following case of best-response asymmetry, we will see, uniform pricing might arise as an optimal policy more frequently.

3.2.3 Best-response asymmetry

In the previous analysis, the configuration of competition was such that the uniform price always fell somewhere between the flexible pricing levels for the weak and strong markets, which was guaranteed by the assumption that $\frac{\partial D\pi_i(p)}{\partial p} < 0$, dependent, in turn, on the symmetric setting that was previously put forward. Lifting the best-response symmetry assumption, and analyzing the opposite case, allows prices to behave less intuitively. As highlighted by Stole (2003), and in the context of best-response asymmetry, "it is possible that all prices rise or fall under price discrimination, depending on the underlying market demand curves."

A seminal study dealing with best-response asymmetry belongs to Corts (1998), who detailed two antagonistic scenarios that might be triggered when the nature of competition follows the asymmetry that is being currently explored. He specifically focuses on the scheme of "all-out competition" — when all prices fall when doing price discrimination— that is juxtaposed to what we will refer to as "all-out price gouging" —all prices rising when moving to a flexible pricing strategy. In particular, he describes how, under best response asymmetry, competition can be so fierce that commitments not to enforce price discrimination might arise as firms' optimal policy to increase their profits. This result, he demonstrates, is closely related to how each firm values each of their strong and weak markets. Again, using the simplification of two markets $i = \{1, 2\}$ and two firms $j = \{A, B\}$, and also assuming that firm's A strong market is 1, that its weak market is 2, and that the opposite is true for firm B, we get that best response functions (b) must satisfy $b_1^A(p) > b_2^A(p)$ and $b_1^B(p) < b_2^B(p)$. The notation here is slightly modified from the previous one that had been borrowed from Stole (2003) and reflects the original notation from Corts (1998). The graphic depiction of this setting from the original paper is present in Figure 1.

Figure 1: Continuum of possible equilibria with best-response asymmetry.



Source: Courts (1998)

The uniform price best-response function of each firm will depend upon how much they value each of the markets —think of those valuations as weights that allow for a linear combination of a firm's best-response functions in Figure 1. The shaded area in the figure represents a continuum of possible equilibrium prices varying with the relative value of the two markets by the two firms. One of the central contributions from this work of Corts (1998) lies in his demonstration that when the equilibrium uniform price falls within region II of the figure, flexible prices result in all-out price competition by which all segment prices fall and so do profits. In that case, firms are better off sticking to a uniform pricing policy. The opposite case, he demonstrates, occurs when equilibrium uniform prices fall in region III, leading to all-out price gouging which raises all segment prices and increases industry profits when enforcing price discrimination. The intuition here is that when the uniform price best-response functions (the ones constructed as a linear combination of b_1^A and b_2^A on the one hand, and b_1^B and b_2^B, on the other) fall in region II, uniform pricing equilibrium will be greater than all of the flexible prices highlighted in the figure. Thus, if both firms started from a uniform price in region II, moving to flexible pricing would reduce all prices (the case of all-out competition). While the actual demonstration put forward by Corts (1998) is beyond the scope of this work, we can nourish ourselves from the conclusion that, under best-response asymmetry, it is possible for firms to want to commit to pricing uniformly across markets as a way to soften competition. As a result, we have found yet another theoretical setting under which uniform pricing might be consistent with firms optimally maximizing profits under competition. But the challenge that remains is how to pigeonhole the actual industry situation within the possible scenarios that theory describes. The empirical approach that follows aims at shedding some light over this challenge. Having said that, far from allowing an entrant firm to the industry to determine with absolute certainty details regarding the nature of competition, the empirical approach will provide robust evidence with respect to the issue of homogeneity at different points of sale that can make or break the theory of uniform pricing as a softener of competition: remember the condition employing $e_i^I(p_i) + e_i^C(p_i)$ and how it could lead to uniform prices despite heterogeneous consumers and/or competition given that what is important is the addition of both terms, and whether that addition is similar across stores. If the addition of the two aforementioned elasticities indeed happened to be similar across stores of a given chain, then (near) uniform pricing would be optimal *irrespective* of how firms compete with one another. If, on the other hand, that were not the case, the competition issue would not necessarily be automatically validated. It would, however, become of increased relevance to any firm with intentions of entering the industry.

4 Data

4.1 Source

Resulting from a directive issued in early 2016 by the National Government of Argentina through its Ministry of Production, supermarket chains nationwide are mandated to disclose daily prices of goods in each of their stores. These are made publicly available at `https://www.preciosclaros.gob.ar` (*Precios Claros*). The prices published on the *Precios Claros* website represent public access information but are not readily available for users to download them in bulk. Therefore, a proprietary scraper was developed in order to obtain a big sample of the website's data on prices.

Access to the data was obtained through calls to the website's internal API REST that allow for communication between the front and back ends using GET requests. As previously mentioned, the content of the *Precios Claros* website constitutes, *de jure*, public access information and the site does not forbid scraping —at least at the time when such activity was conducted for this work. However, there is no official documentation available for reference and, as a result, building the scraper and uncovering the resources, entities and relationships required a more manual approach.

Looking at the different network requests made by the website while navigating it, there are three main search dimensions:

1. stores, which are searched by indicating a pair of geographic coordinates which alter the order of results putting those closest the specified location first and the most distant ones (even from other provinces) last;

2. product categories, that have different and additive layers of aggregation indicated by two-digit identifiers. E.g., the non-alcoholic beverages category has ID "05", unflavoured bottled water is "0502" (02 is concatenated to non-alcoholic beverages' ID 05), and still water (as opposed to sparkling) is "050202" (now still water, also 02, is concatenated to the ID of its parent category). Requests to the category resource assume one already knows the category (which involves a tedious process of navigating the front end while simultaneously inspecting the corresponding API requests as no self-inspection method is available). This category searches actually return products that belong to the searched category (assumed to be known) as opposed to a list of searchable categories;

3. product prices, which takes the ID of a given product —represented by the European Article Number (EAN) and obtained from the category-wise search—, an array of store IDs —from the store-specific search— and returns the current price of the specified product at each of the stores on the store id array on the date of the search.

Tables 1, 2 and 3 show the fields and descriptions of inputs and outputs for each of the above.

Table 1: Inputs and outputs of the request to the API for the stores-specific data

Stores Request	
Field	**Description**
	Inputs
lat	Geographic latitude
lng	Geographic longitude
offset	Pagination offset
limit	Maximum result count
	Outputs
status	Request returned status (200 = Ok)
totalPagina	Total results in page
total	Total results in all pages
sucursales	List of stores with its own subset of fields (*)
*comercioId	ID of the company
*banderaId	ID of the chain
*sucursalId	ID of the store
*id	Concatenation of comercioId-banderaId-sucursalId
*comercioRazonSocial	Name of the company
*banderaDescripcion	Name of the chain
*sucursalNombre	Name of the store
*sucursalTipo	Type of store
*lat	Geographic latitude
*lng	Geographic longitude
*direccion	Address
*localidad	City/County
*provincia	Province
*distanciaNumero	Distance in km to the input coords
*distanciaDescripcion	String description of the distance to input coords
maxLimitPermitido	Maximum result count per request

Note: Self-elaboration based on data from *Precios Claros*.

Table 2: Inputs and outputs of the request to the API for the product categories-specific data

Stores Request	
Field	**Description**
	Inputs
id_categoria	Cateogry ID
array_sucursales	List of store IDs separated by commas
offset	Pagination offset
limit	Maximum result count
	Outputs
status	Request returned status (200 = Ok)
total	Total results in all pages
maxLimitPermitido	Maximum result count per request
maxCantSucursalesPermitido	Maximum number of stores in input array
productos	List of products with its own subset of fields (*)
*marca	Product's brand
*id	European Article Number (EAN)
*precioMax	Highest price for the product in the array of stores indicated as an input
*precioMin	Lowest price in the requested stores
*nombre	Description of the product
*presentacion	Size an unit measure
*cantSucursalesDisponible	Number of stores where the product is available (from the input array)
totalPagina	Number of results in the page (at the given offset)

Note: Self-elaboration based on data from *Precios Claros*.

Table 3: Inputs and outputs of the request to the API for the product prices-specific data

Stores Request	
Field	**Description**
	Inputs
id_producto	Product ID (EAN)
array_sucursales	List of store IDs separated by commas
offset	Pagination offset
limit	Maximum result count
	Outputs
status	Request returned status (200 = Ok)
total	Total results in all pages
maxLimitPermitido	Maximum result count per request
producto	Description of the searched product with its subset fields that match those present in the ”productos” field of the Product Categories Request
sucursales	List of stores where the product is available with its subset of field that match those present in the ”sucursales” field of the Stores Request. Additionally there are some other fileds (*)
*preciosProducto	Dictionary with 3 main keys (**)
**precioLista	List price of the product at the store on the given date
**promo1	Sale price with description,if available (e.g. x% discount paying with a credit card from a specific bank)
**promo2	Another sale price with description, if available
totalPagina	Number of results in the page (at the given offset)
sucursalesConProducto	Number of stores where the product is available (from the input array)

Note: Self-elaboration based on data from *Precios Claros*.

The way the data can be accessed is not ideal given that (a) the design of the database, at least through the lens of how it can be queried using the API, does not even come close to the third normal form (Codd, 1972) and (b) redundant information gets sent from the server in multiple queries (see redundant outputs in the tables from above) without a way to prevent this from happening. All this produces computational overhead that, together with internal mechanisms by the website to ban traffic from IPs with “abnormal” behaviour, led to the need for a dual approach for the longitudinal and cross-sectional datasets, which are described in what follows.

4.2 Summary statistics

The scraper was initially run every week from June through August 2020 and collected prices from a sample of 362 stores in both the Province and City of Buenos Aires, which belong to 15 different chains that are, in turn, controlled by 11 parent organizations. Products comprise all available categories in supermarkets, except for "fresh" goods such meat, poultry, fish, eggs, vegetables and fruits, which do not have a unique European Article Number (EAN). In order to further analyze cross-sectional price variation in a sample closer to the Argentine supermarket population, the scraper was later ran on multiple days the week of October 25th 2020, each collecting prices of a different set of stores which, together, account for all of *Precios Claros* store-product-price combinations that were available at the moment and which have an EAN. This additional run from late 2020 was computationally more expensive and is the reason why only a sample of the website was extracted for the longitudinal dataset. The cross-sectional run collected a total of 53,354 products and account for more than 8.7 million observations, corresponding to prices in 34 corporate groups that own 48 chains which, together, operate 2,711 stores nationwide. Table 4 shows descriptive counts.

Table 4: Descriptive Counts

	Cross-sectional sample	Longitudinal sample
Number of products	53,354	48,544
Number of stores	2,711	362
Number of chains	48	15
Number of corporate groups	34	11
Number of weeks	1	12
Number of observations	8,751,446	23,608,382

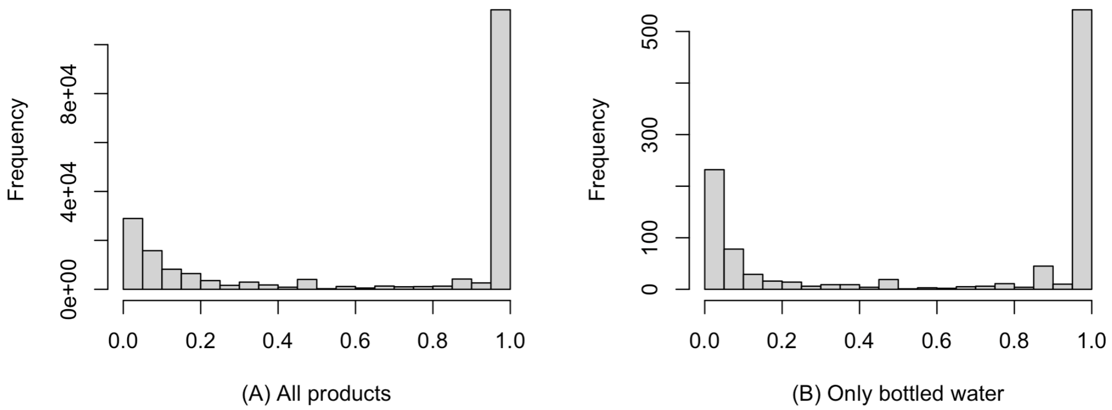
Note: Self-elaboration based on data from *Precios Claros*.

4.3 Descriptive evidence of uniform pricing

Previous work has already found evidence of near-uniform pricing in the Argentine supermarket sector. Daruich and Kozlowski (2019) used the standard deviation of log-prices for each product to compare within-chain average price dispersion with respect to across-chain average dispersion. Consistent with their findings, updated data from *Precios Claros* shows the former is less than a third of the latter in magnitude (2.1% vs. 7.2%, respectively). In addition, while the median number of stores within a chain that a product gets offered at is 7, the median number of unique prices is only 1. Taking averages instead of medians, those values are 33.8 and 2.3, respectively, all showing a pattern of low variation in within-chain pricing.

Firms displaying nearly uniform prices are likely not to only present low-to-null price dispersion at the cross-section, but also highly synchronized changes in prices throughout time. Consistent with the idea put forward by Lach and Tsiddon (1996), we could look at the proportion of stores for which a product changed in price at a given date and for a given chain. Totally synchronized prices would require such proportion to be always either 0 or 1, whereas staggered pricing demands such proportion to deviate from those extremes. But accounting for weeks with null price changes greatly biases the measure of price synchronization because, at least in Argentina and for the studied period, prices tend to increase by a significant amount but not frequently enough to compensate such bias. In particular, the median number of price changes for the entire studied period among all store-product combinations is only 1 (1.1 on average) out of the 12 weeks in scope —during that period the median and average price changes were 3.3% and 3.5%, respectively. And even ignoring the weeks for which there was absolutely no price variation at the chain-product level, such conservative measure of price dispersion still provides further evidence of low price variation within chains. More precisely, the median proportion of price changes between consecutive weeks for all chain-product-weeks (across stores) is 1 (0.66 on average). When narrowing down the sample exclusively to products in the bottled water category, the median is 0.98 and the average 0.63. Figure 2 presents the histograms of the proportions and Table 5 details the values at different quartiles of the distributions, in addition to the means.

Figure 2: Proportion of stores with price changes for chain-product-week combinations.



Note: Self-elaboration based on data from *Precios Claros*.

Table 5: Distribution of indicators of price staggering/synchronization.

	Mean	Percentiles		
		25	50	75
Store-Product combinations				
Number of price changes	1.09	1.00	1.00	1.00
Change in price	3.51%	1.81%	3.28%	4.00%
Chain-Product combinations				
Percentage of stores with simultaneous price changes	66%	14%	100%	100%

Note: Self-elaboration based on data from *Precios Claros*.

The results presented above are indicative of widespread synchronization in price adjustments within chains, and of low price dispersion at the cross-section as well. But such evidence, taken at face value, is not enough so as to claim that there is a deliberate managerial decision to commit to and enforce a uniform pricing policy. Likewise, it would be wrong to conclude —at this point— that interaction between the different demand elasticities that are at stake can lead to highly homogeneous conditions able to account for the low price variability that has been exposed thus far. The natural experiment in the next section aims at bridging —at least in part— that causality gap.

5 Empirical analysis

So far we have established that it is necessary to consider at least both the nature or inter-firm competition and consumer characteristics when looking for empirical evidence on the drivers of low within-chain price dispersion. With that in mind, this section exploits a shock to the water supply which affected the smell and taste of running water in specific area of Buenos Aires. More specifically it narrows down the shock to the geographic boundaries that are served by the water utility *AYSA* which cited variations in the Río de la Plata as the root cause of the unpalatable taste and smell of the water supply. The incident was widely brought up on social media in the first days of July 2020 and acknowledged in an official disclosure by the company on July 4th[1]. Such a shock should theoretically allow us to detach the two effects previously mentioned (inter-firm competition versus consumer characteristics), but we first need to assess whether the treatment was significant enough so as to have triggered price adjustments by firms serving affected consumers. The proposed way of looking at that evidence is to observe the prices of large-container bottled water goods in the stores of firms with a *high* presence in the affected area (above 50% of a chain's stores need to be in the City of Buenos Aires for consideration), and compare them with those of small-container bottles of water in firms practically unaffected by the disruption in the water supply of *AYSA* —firms with no stores whatsoever in the Metropolitan Region of Buenos Aires. The distinction between small- and large-container products is simply because the latter is assumed to be closer substitute to running water. The mathematical model is as follows:

$$\ln(P_{ijt}) = \sum_{t=\underline{T}}^{-2} \beta_t D_{ij} + \sum_{t=0}^{\bar{T}} \beta_t D_{ij} + \phi_{ij} + \gamma_t + \varepsilon_{ijt} \quad (4)$$

That is, the natural logarithm of the price of product j in store i at time t is modeled as a linear function where D_{ij} is a binary indicator of whether product j in store i was treated and ϕ_{ij} and γ_t are product-store and time fixed effects, respectively. This model allows to simultaneously test the assumption of parallel trends in the weeks before the treatment, and to measure the effect on prices once the treatment came into effect. The estimation is done through Ordinary Least Squares (OLS). This method consists in minimizing the sum of squared errors between the estimated response variable and its actual value across observational units (or a monotonically-increasing transformation of such a loss function). That is, given matrix X with n rows each representing an observational unit and $k+1$ columns representing each explanatory variable $1 \ldots k$ plus an additional column of

[1] https://www.aysa.com.ar/usuarios/Novedades/2020/07/potabilidad_del_agua

ones to allow for the estimation of an intercept; a vector column β with $k+1$ rows that we will refer to as "coefficients"; a vector column with the response variable y, with one row per value associated to each observational unit; and a vector column also with n rows containing a stochastic error term, we could formalize a linear relationship (the linearity here is a theoretical assumption) between the explanatory variables and the column vector of actual target values as:

$$y = X\beta + \epsilon$$

From that theoretical model, term ϵ is stochastic so the estimated model we could look for is as follows

$$\hat{y} = X\hat{\beta}$$

where $\hat{y}$ and $\hat{\beta}$ represent estimates. Thus, the error of the estimation is

$$y - \hat{y} = y - X\hat{\beta} \equiv u$$

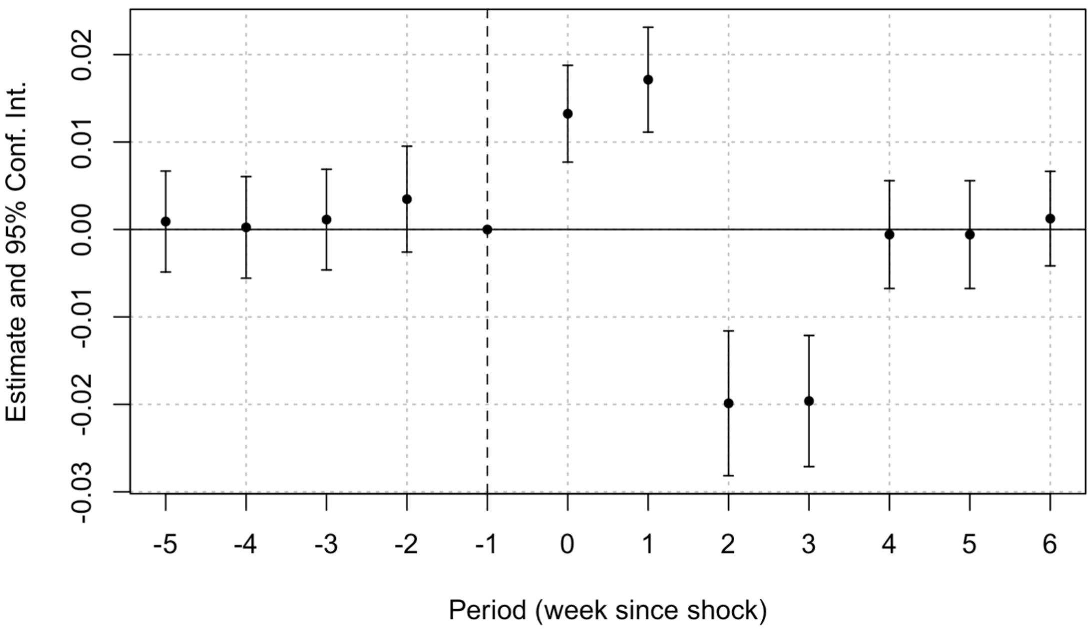
OLS establishes a particular loss function that computes the residual/error sum of squares (RSS), removing importance to the sign of each of those errors. The problem, then, is:

$$\min_{\hat{\beta}} RRS(\hat{\beta}) = u^T u = (y - X\hat{\beta})^T (y - X\hat{\beta})$$

$$\frac{\partial RSS(\hat{\beta})}{\partial \hat{\beta}} = -2X^T y + 2X^T X\hat{\beta} = 0$$
$$\hat{\beta} = (X^T X)^{-1} X^T y$$

Under some rather strong assumptions OLS can be proven to be the best linear unbiased estimator (McElroy, 1967). It is common practice in the literature, however, to use a robust estimation of the variance-covariance matrix to make statistical inference over the estimated coefficients from above. Thus, the estimation of the model from equation (4) is, by default, carried out using heteroskedasticity consistent standard errors (MacKinnon and White, 1985). Results are shown in column (i) of Table 6. Figure 3 shows the results from column (i) in Table 6 graphically, where it is clear that the assumption of parallel trends holds true in the pre-intervention period and, once the shock took place, price differentials first became positive, then negative, and finally converged to statistically insignificant values by week offset 4 from the start of the treatment.

Figure 3: Effect of the shock on the price of large-container bottles of water.



Notes: Graph shows OLS estimates and 5 percent confidence intervals for β_t coefficients of the event study model.

Given that errors might be auto-correlated as we are dealing with longitudinal data, the same approach as Perez-Vincent et al. (2021) was used as a robustness check by which heteroskedasticity and auto-correlation robust standard errors were implemented, following Newey and West (1986). The automatic lag selection proposed in Newey and West (1994) was used and the results from this additional test are presented in column (ii) of Table 6. Additionally, column (iii) is presented with standard errors clustered by store-product for yet further robustness.

Table 6: Price differentials of treated stores with respect to the control group: leads and lags.

	(i)	(ii)	(iii)
Week = -5	0.0009	0.0009	0.0009
	(0.003)	(0.002)	(0.003)
Week = -4	0.0009	0.0009	0.0009
	(0.003)	(0.002)	(0.003)
Week = -3	0.001	0.001	0.001
	(0.003)	(0.002)	(0.003)
Week = -2	0.003	0.003	0.003
	(0.003)	(0.002)	(0.002)
Week = -1	0	0	0
(base period)			
Week = 0	0.013***	0.013***	0.013***
	(0.003)	(0.003)	(0.001)
Week = 1	0.017***	0.017***	0.017***
	(0.003)	(0.005)	(0.003)
Week = 2	-0.020***	-0.020***	-0.020***
	(0.004)	(0.003)	(0.004)
Week = 3	-0.020***	-0.020***	-0.020***
	(0.004)	(0.003)	(0.004)
Week = 4	-0.0006	0.0006	0.0006
	(0.003)	(0.003)	(0.003)
Week = 5	-0.0006	-0.0006	-0.0006
	(0.003)	(0.003)	(0.003)
Week = 6	0.001	0.001	0.001
	(0.003)	(0.002)	(0.004)
S.E. type	HC (MacKinnon and White, 1985)	HAC (Newey and West, 1986)	Clustered by store-product
Store-Product FE	YES	YES	YES
Week FE	YES	YES	YES
Observations	21,120	21,120	21,120

Notes: the base period is the one immediately before the shock. Both models present the same specification detailed in equation (4). The model in column (i) was estimated with White's robust standard errors which are shown in parentheses; the one in column (ii) with heteroscedasticity and autocorrelation consistent standard errors; and in column (iii) with standard errors clustered by store-product.

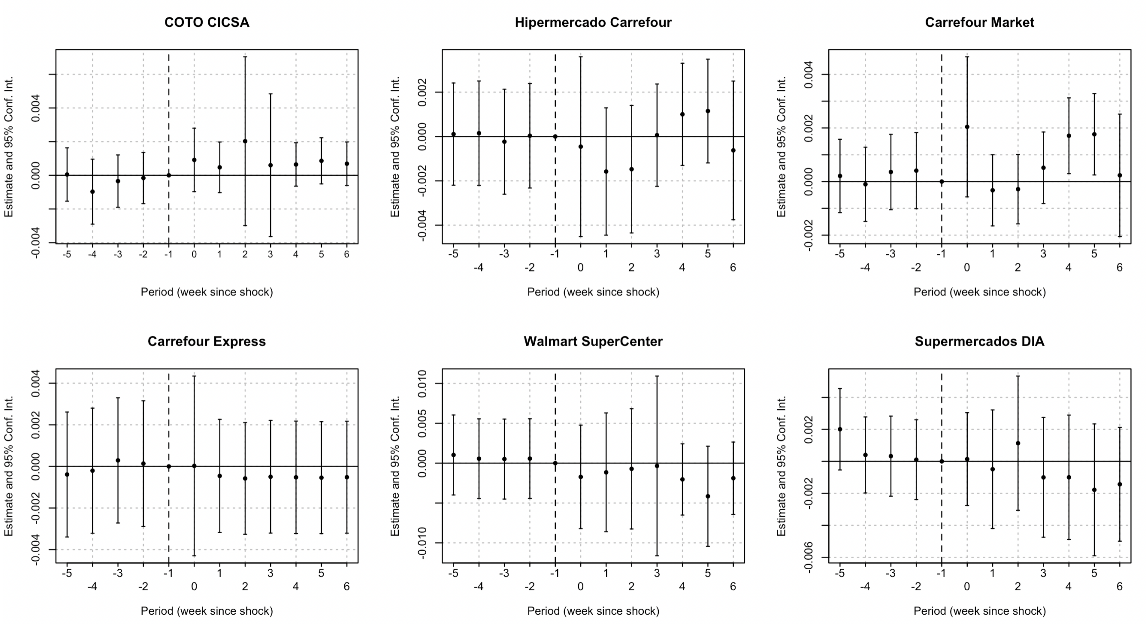
*** p<0.01, ** p<0.05, * p<0.1

The obtained results seem to add support to the hypothesis that the natural experiment being exploited has indeed had an impact on the price of the relevant product category being explored: previous to the treatment period, the price of bottled water seems to have followed statistically equal patterns in both treated and untreated observational units, but once the shock took place, prices in the treated group increased relative to the control one. This effect appears to fade a couple of weeks later with either the control units catching up with a lag (potentially with inflation hitting both groups heterogeneously as relative prices converge back to normal after the shock is phased out), or the treated ones going back to a pre-intervention price level, or a combination of both.

Next —and now that evidence of the significance of the shock has been collected— there is the interest in assessing whether there was within-chain differential adjustments in prices given the exogenous intervention. That is, we want to test if firms might have deliberately exploited a change in certain consumers' ability to give up consumption of a product, by (temporarily) charging a higher price to those particular consumers. If that were the case, an entrant firm to the supermarket industry could confidently assume that the predominant strategy is to enforce flexible pricing, despite observing low within-chain price dispersion.

The approach here will be almost identical to the one previously employed: the model characterized by equation (4) will be estimated, but this time for each chain that has a presence both in the affected and unaffected areas. The stores in affected zones will be considered part of the treatment group and the ones in unaffected places, the control one. Results for the six chains in the dataset with stores in both treated and untreated areas are presented in separate columns (i)-(vi) of Table 7. In that table, White's robust standard errors are shown in parentheses. For further robustness, Appendix Tables A1 and A2 show estimates with heteroskedasticity and autocorrelation consistent standard errors (Newey and West, 1986) and with standard errors clustered by store-product, respectively. Figure 4 illustrates the results from Table 7.

Figure 4: Effect of the shock on the price of bottles of water in the City of Buenos Aires.



Notes: Graphs show OLS estimates and 5 percent confidence intervals for β_t coefficients of the modified event study model for each chain.

The pattern across all chains present in this work's dataset is that firms did not seem to have enforced a differential price in areas affected by the shock, in spite of that shock being *big* as shown previously. This is consistent with a (close to) uniform pricing policy and the evidence presented is intended to allow managers from firms thinking of entering the industry to inform their pricing decisions. The exogeneity and unexpectedness of the intervention would have allowed firms to charge a higher price as the demand by affected consumers suddenly became more inelastic. What we see, however, is not only that the price differential after the shock is still not statistically significant —as it is before the intervention, thus not violating the assumption of parallel trends prior to the shock—, but also the point estimate is usually not even indicative of the phenomenon we would expect to see under flexible pricing. This results are robust to different income and competition configurations surrounding the stores of any chain: under flexible pricing a chain catering to consumers highly homogeneous in income, for instance, would still be compelled to price differently as a result of the shock, despite the high homogeneity in the income dimension. This reflects the essence of turning to a natural experiment that has intended to sort out the empirical challenge that is often problematic

Table 7: Pre- and post-intervention within-chain price differentials of treated stores.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Week = -5	0.00005	0.0001	0.0002	-0.0004	0.001	0.002
	(0.0008)	(0.001)	(0.0007)	(0.002)	(0.003)	(0.001)
Week = -4	-0.0010	0.0001	-0.0001	-0.0002	0.0006	0.0004
	(0.0010)	(0.001)	(0.0007)	(0.002)	(0.003)	(0.001)
Week = -3	-0.0003	-0.0002	0.0004	0.0003	0.0005	0.0003
	(0.0008)	(0.001)	(0.0007)	(0.002)	(0.003)	(0.001)
Week = -2	-0.0002	0.00003	0.0004	0.0001	0.0006	0.0001
	(0.0008)	(0.001)	(0.0007)	(0.002)	(0.003)	(0.001)
Week = -1	0	0	0	0	0	0
(base period)						
Week = 0	0.0009	-0.0005	0.002	0.00002	-0.002	0.0001
	(0.0010)	(0.002)	(0.001)	(0.002)	(0.003)	(0.001)
Week = 1	0.0005	-0.002	-0.0003	-0.0005	-0.001	-0.0005
	(0.0008)	(0.001)	(0.0007)	(0.001)	(0.004)	(0.002)
Week = 2	0.002	-0.001	-0.0003	-0.0006	-0.0007	0.001
	(0.003)	(0.001)	(0.0007)	(0.001)	(0.004)	(0.002)
Week = 3	0.0006	0.00006	0.0005	-0.0005	-0.0003	-0.001
	(0.002)	(0.001)	(0.0007)	(0.001)	(0.006)	(0.002)
Week = 4	0.0006	0.001	0.002**	-0.0005	-0.002	-0.0010
	(0.0007)	(0.001)	(0.0007)	(0.001)	(0.002)	(0.002)
Week = 5	0.0009	0.001	0.002**	-0.0005	-0.004	-0.002
	(0.0007)	(0.001)	(0.0008)	(0.001)	(0.003)	(0.002)
Week = 6	0.0007	-0.0006	0.0002	-0.0005	-0.002	-0.001
	(0.0007)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Store-Product FE	YES	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES	YES
Observations	43,801	24,648	25,838	10,025	4,019	12,442

Notes: the base period is the one immediately before the shock. All models present the same specification detailed in equation (4). Supermarket chains in columns (i)-(vi) are as follows: (i) COTO CICSA; (ii) Hipermercado Carrefour; (iii) Carrefour Market; (iv) Carrefour Express; (v) Walmart SuperCenter; (vi) Supermercados DIA.
Robust standard errors en parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

for establishing causality with observational data.

6 Conclusion

This work has presented evidence that supports that most supermarket chains in Argentina impose almost uniform prices throughout their network of stores and that such a result occurs despite the heterogeneity in demand faced at the different points of sale within each chain. This conclusion was reached by exploiting a natural experiment that took advantage of a rich set of retail price data, which allowed addressing endogeneity problems when estimating demand functions and also provided an exogenously heterogeneous shock on consumer capacity to renounce consumption in the face of price increases and on consumers' ability/willingness to switch between competitors. The natural experiment consisted in an unanticipated shock to the supply of running water in a concentrated area of the Metropolitan Region of Buenos Aires, which yielded a statistically significant increase in bottled water prices in treated chains relative to untreated ones, while insignificant differentials in within-chain pricing comparing stores between those two treatment zones.

The aforementioned result has a far-reaching implication in the pricing decision of an industry newcomer who observes low price variation within the stores of incumbents and wonders how much of that can be explained simply by the homogeneity of demand within the already established firms. In particular, it might be suggestive that the pricing policy that governs most incumbents, instead of being a mere artifact of demand homogeneity at different points of sale within chains, is possibly a deliberate managerial decision to opt for nearly uniform prices. Having said that, although the literature outlines some scenarios in which the uniform pricing decision might be an optimal strategy given the nature of inter-firm competition, deeming that as the ultimate underlying reason lies beyond the scope of this work. It could, in turn, be that firms discriminate through differences in assortment between branches and/or, even more plainly, that they are leaving money on the table by not adopting a more data-driven pricing strategy. What has become clear now is that (near) uniform pricing is indeed the strategy enforced almost unanimously in the Argentine supermarket sector in spite of much heterogeneity at the store-level.

References

Besanko, D., Dubé, J.-P., and Gupta, S. (2003). Competitive price discrimination strategies in a vertical channel using aggregate retail data. *Management Science*, 49(9):1121–1138.

Cavallo, A. and Rigobon, R. (2016). The billion prices project: Using online prices for measurement and research. *Journal of Economic Perspectives*, 30(2):151–78.

Clerides, S. K. (2002). Book value: intertemporal pricing and quality discrimination in the us market for books. *International Journal of Industrial Organization*, 20(10):1385–1408.

Clerides, S. K. (2004). Price discrimination with differentiated products: Definition and identification. *Economic Inquiry*, 42(3):402–412.

Codd, E. F. (1972). Further normalization of the data base relational model. *Data base systems*, 6:33–64.

Cooper, J. C., Froeb, L., O'Brien, D. P., and Tschantz, S. (2004). Does price discrimination intensify competition-implications for antitrust. *Antitrust LJ*, 72:327.

Corts, K. S. (1998). Third-degree price discrimination in oligopoly: all-out competition and strategic commitment. *The RAND Journal of Economics*, pages 306–323.

Crawford, G. and Shum, M. (2001). Empirical modeling of endogenous quality choice: The case of cable television. *Department of Economics, Duke University, working paper, November*.

Daruich, D. and Kozlowski, J. (2017). Retail prices: New evidence from argentina. *Available at SSRN 2989324*.

Daruich, D. and Kozlowski, J. (2019). *Macroeconomic implications of uniform pricing*. Federal Reserve Bank of St. Louis, Research Division.

DellaVigna, S. and Gentzkow, M. (2019). Uniform pricing in us retail chains. *The Quarterly Journal of Economics*, 134(4):2011–2084.

Dobson, P. W. and Waterson, M. (2008). Chain-store competition: customized vs. uniform pricing. Technical report.

Goldberg, P. K. and Verboven, F. (2005). Market integration and convergence to the law of one price: evidence from the european car market. *Journal of international Economics*, 65(1):49–73.

Greenhut, M. L. (1981). Spatial pricing in the united states, west germany and japan. *Economica*, 48(189):79–86.

Holmes, T. J. (1989). The effects of third-degree price discrimination in oligopoly. *The American Economic Review*, 79(1):244–250.

INDEC (2022). Encuesta de supermercados y autoservicios mayoristas. *Technical Reports*, 6(112).

Kaplan, G., Menzio, G., Rudanko, L., and Trachter, N. (2019). Relative price dispersion: Evidence and theory. *American Economic Journal: Microeconomics*, 11(3):68–124.

Lach, S. and Tsiddon, D. (1996). Staggering and synchronization in price-setting: Evidence from multipro-duct firms. *American Economic Review*, 1:1175–1196.

Leslie, P. (2004). Price discrimination in broadway theater. *RAND Journal of Economics*, pages 520–541.

MacKinnon, J. G. and White, H. (1985). Some heteroskedasticity-consistent covariance matrix estimators with improved finite sample properties. *Journal of econometrics*, 29(3):305–325.

McElroy, F. (1967). A necessary and sufficient condition that ordinary least-squares estimators be best linear unbiased. *Journal of the American Statistical Association*, 62(320):1302–1304.

Nevo, A. and Wolfram, C. (2002). Why do manufacturers issue coupons? an empirical analysis of breakfast cereals. *RAND Journal of Economics*, pages 319–339.

Newey, W. K. and West, K. D. (1986). A simple, positive semi-definite, heteroskedasticity and autocorrelationconsistent covariance matrix. *Econometrica*, 55:703–08.

Newey, W. K. and West, K. D. (1994). Automatic lag selection in covariance matrix estimation. *The Review of Economic Studies*, 61(4):631–653.

Perez-Vincent, S. M., Schargrodsky, E., and García Mejía, M. (2021). Crime under lockdown: The impact of covid-19 on citizen security in the city of Buenos Aires. *Criminology & Public Policy*.

Phlips, L. (1983). *The economics of price discrimination*. Cambridge University Press.

Robinson, J. (1969). *The economics of imperfect competition*. Springer.

SAIEP (2021). Annual report 2020-2021. *https://cdn.laanonima.com/web/pdf/saiep_memoria_2021.pdf*, 113.

Shepard, A. (1991). Price discrimination and retail configuration. *Journal of Political Economy*, 99(1):30–53.

Stigler, G. J. (1987). *The Theory of Price*. New York (USA) Macmillan.

Stole, L. (2003). Price discrimination and imperfect competition. *Handbook of industrial organization*, 3:34–47.

Thisse, J.-F. and Vives, X. (1988). On the strategic choice of spatial price policy. *The American Economic Review*, pages 122–137.

Tirole, J. (1988). *The theory of industrial organization*. MIT press.

Varian, H. R. (1989). Price discrimination. *Handbook of industrial organization*, 1:597–654.

Appendix

Table A1: Pre- and post-intervention within-chain price differentials of treated stores: HAC standard errors

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Week = -5	0.00005	0.0001	0.0002	-0.0004	0.001	0.002**
	(0.0007)	(0.001)	(0.0006)	(0.002)	(0.003)	(0.001)
Week = -4	-0.0010	0.0001	-0.0001	-0.0002	0.0006	0.0004
	(0.001)	(0.001)	(0.0006)	(0.002)	(0.003)	(0.001)
Week = -3	-0.0003	-0.0002	0.0004	0.0003	0.0005	0.0003
	(0.0007)	(0.001)	(0.0007)	(0.002)	(0.003)	(0.0009)
Week = -2	-0.0002	0.00003	0.0004	0.0001	0.0006	0.0001
	(0.0007)	(0.001)	(0.0007)	(0.002)	(0.003)	(0.0009)
Week = -1	0	0	0	0	0	0
(base period)						
Week = 0	0.0009	-0.0005	0.002	0.00002	-0.002	0.0001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.0008)
Week = 1	0.0005	-0.002	-0.0003	-0.0005	-0.001	-0.0005
	(0.0007)	(0.001)	(0.0006)	(0.001)	(0.004)	(0.001)
Week = 2	0.002	-0.001	-0.0003	-0.0006	-0.0007	0.001
	(0.002)	(0.001)	(0.0006)	(0.001)	(0.004)	(0.002)
Week = 3	0.0006	0.00006	0.0005	-0.0005	-0.0003	-0.001
	(0.002)	(0.001)	(0.0007)	(0.001)	(0.004)	(0.001)
Week = 4	0.0006	0.001	0.002**	-0.0005	-0.002	-0.0010
	(0.0006)	(0.001)	(0.0007)	(0.001)	(0.002)	(0.002)
Week = 5	0.0009	0.001	0.002**	-0.0005	-0.004	-0.002
	(0.0006)	(0.001)	(0.0008)	(0.001)	(0.003)	(0.001)
Week = 6	0.0007	-0.0006	0.0002	-0.0005	-0.002	-0.001
	(0.0006)	(0.002)	(0.0009)	(0.001)	(0.003)	(0.0009)
Store-Product FE	YES	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES	YES
Observations	43,801	24,648	25,838	10,025	4,019	12,442

Notes: the base period is the one immediately before the shock. All models present the same specification detailed in equation (4). Supermarket chains in columns (i)-(vi) are as follows: (i) COTO CICSA; (ii) Hipermercado Carrefour; (iii) Carrefour Market; (iv) Carrefour Express; (v) Walmart SuperCenter; (vi) Supermercados DIA.
Heteroskedasticity and auto-correlation robust standard errors in parentheses, following Newey and West (1986) and the automatic lag selection proposed by Newey and West (1994).
*** p<0.01, ** p<0.05, * p<0.1

Table A2: Pre- and post-intervention within-chain price differentials of treated stores: standard errors clustered by store-product.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Week = -5	0.00005	0.0001	0.0002	-0.0004	0.001	0.002***
	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0009)	(0.0004)
Week = -4	-0.0010	0.0001	-0.0001	-0.0002	0.0006	0.0004
	(0.0007)	(0.0002)	(0.0002)	(0.0003)	(0.0009)	(0.0004)
Week = -3	-0.0003	-0.0002	0.0004**	0.0003	0.0005	0.0003**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0009)	(0.0001)
Week = -2	-0.0002	0.00003	0.0004***	0.0001	0.0006	0.0001
	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0009)	(0.0001)
Week = -1	0	0	0	0	0	0
(base period)						
Week = 0	0.0009	-0.0005	0.002	0.00002	-0.002	0.0001
	(0.0007)	(0.002)	(0.001)	(0.002)	(0.004)	(0.001)
Week = 1	0.0005	-0.002	-0.0003	-0.0005	-0.001	-0.0005
	(0.0006)	(0.002)	(0.0008)	(0.002)	(0.005)	(0.002)
Week = 2	0.002	-0.001	-0.0003	-0.0006	-0.0007	0.001
	(0.003)	(0.002)	(0.0008)	(0.002)	(0.005)	(0.002)
Week = 3	0.0006	0.00006	0.0005	-0.0005	-0.0003	-0.001
	(0.002)	(0.001)	(0.0008)	(0.002)	(0.006)	(0.002)
Week = 4	0.0006**	0.001	0.002*	-0.0005	-0.002	-0.0010
	(0.0003)	(0.001)	(0.0009)	(0.002)	(0.002)	(0.002)
Week = 5	0.0009**	0.001	0.002*	-0.0005	-0.004	-0.002
	(0.0004)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)
Week = 6	0.0007**	-0.0006	0.0002	-0.0005	-0.002	-0.001
	(0.0004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Store-Product FE	YES	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES	YES
Observations	43,801	24,648	25,838	10,025	4,019	12,442

Notes: the base period is the one immediately before the shock. All models present the same specification detailed in equation (4). Supermarket chains in columns (i)-(vi) are as follows: (i) COTO CICSA; (ii) Hipermercado Carrefour; (iii) Carrefour Market; (iv) Carrefour Express; (v) Walmart SuperCenter; (vi) Supermercados DIA.
Standard errores clustered by store-product in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$