Collusive Price Leadership in Retail Pharmacies in Chile

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Abstract

I analyze price leadership among three retail pharmacy chains in Chile during a case of collusion. The pharmacies reached higher prices using staggered price increases on hundreds of drugs. The leader of these increases was the chain with the fewest number of stores. The same chain was the one that also relied the most on the local retail market. I find that the time it took the followers to raise prices after the leader’s increase is negatively correlated with the degree of firm dominance of the largest chain in each product. This finding is consistent with a mechanism in which the followers extracted the leader’s collusive surplus by delaying more price increases in markets where inter-firm transfers were higher, while preserving the leader’s incentive compatibility constraints.

1 Introduction

Sequential price increases are recurrent in cases of collusion. The most common reason cited for this is that simultaneous price increases raise the odds of a scrutiny from the antitrust authority. Yet, recent work has argued that delays in matching a leader’s price increase allows the implementation of profits transfers among the firms in the cartel, from the leader to the follower firms. These transfers provide incentives to the benefited firms to join and remain in the cartel (Clark and Houde, 2013). However, such delays must
occur repeatedly over time in order to achieve their purpose of accomplishing cartel stability. Thus, they may arise only in markets characterized by constant price cycles, such as retail gasoline markets.

This paper studies price leadership during a case of price fixing among retail pharmacy chains in Chile. The dynamics of price leadership that emerge from the pharmacies’ behavior suggest a complementary mechanism to the ones that exist in the literature. The transition to collusive prices featured large price increases in hundreds of products. The price increases were coordinated beforehand, and occurred one or two times in each product. In addition, in the vast majority of instances the leader of the coordinated increases was the chain that had the lowest number of stores among the cartel participants. Moreover, there was substantial heterogeneity in the time it took the followers to raise prices after the price leader. I find that the delay in the followers matching prices in a particular product was strongly and negatively correlated with the market share of the chain with the highest number of stores. In other words, when the largest chain was more dominant in a product market, it waited less time before matching the leader’s increase. The largest chain was vertically integrated, which granted it a higher degree of market power. On the other hand, the smallest chain had been acquired a few months before by new owners who wanted to end the price war. Given that the price leadership mechanism was not meant to be constantly repeated in the same product over time, these facts suggest that the empirical outcomes of the mechanism originate in the strong firm extracting the surplus from the weaker ones, while preserving the leader’s incentive compatibility constraints to lead the increases.

The three pharmacy chains, Cruz Verde, Fasa, and Salcobrand (ranked by their number of stores), were engaged in a months-long price war in blockbuster brands starting in December 2006. The price war was a consequence of increasing reliance on loss-leading pricing during which leading brands were sold at a discounted price with the aim of increasing store traffic. Prices of loss leaders plummeted further when Cruz Verde launched an advertising campaign of price comparisons in August 2007. A judicial court halted this advertising campaign in November 2007 after Fasa filed a complaint of unfair competition. A few weeks later, the three firms started increasing prices of the drugs involved in the price war coordinately. The pharmacies raised the price of each product by means of staggered, rapid price increases, which were coordinated beforehand. The distinct leader of these coordinated increases was Salcobrand. The scope of price fixing grew gradually to include more brands over a period that spanned five months. The coordinated increases lasted until the pharmacies realized that they were being investigated.
by the competition authority in May 2008. By then, the firms had raised the prices of more than two hundred medicines 50 percent on average. These medicines were largely chronic, prescription-only drugs, as well as the best-selling brands in their class.

Salcobrand’s unique role as the price leader during the coordinated increases is puzzling because leadership may entail large costs. As I will argue, my explanation for this role is that Salcobrand was the weakest firm in the cartel. Three facts support this: First, Salcobrand changed ownership in the middle of the price war. The new owners wanted to end the price war in loss-leader products and, thus, they were willing to incur the costs of being the leader during the coordinated increases. Second, Salcobrand’s competitors were in a better position to fight the price war and had, moreover, other sources of revenues besides the retail business: Cruz Verde was vertically integrated with a distributor, and Fasa had stores abroad. Finally, in many retail industries, economies of scale and of density cause marginal costs to decrease as the number of stores increase, and thus the two largest chains presumably had lower marginal costs.

Having documented that the leader’s identity was constant, I focus on the time it took the follower pharmacies to follow the leader. This is an important outcome because it is directly related to the costs born by the the leader. I find that Cruz Verde’s dominance in a given market is a strong predictor of the time it took the three firms to raise prices in each product. In particular, if Cruz Verde was larger in a product market, both Cruz Verde and Fasa increased prices after the leader, Salcobrand, faster. This suggest that despite the fact that the leader was the same firm across the collusive increases, the costs associated with leadership were larger in markets where the leader was larger. I explain this finding arguing that in these markets, the leader also expected a larger share of the collusive profits. Therefore, the leader was able to wait for a longer time period (and sustain higher losses during the delay) before the incentive compatibility constraints started to bind. Correspondingly, this fact allowed the stronger firms — the followers — to extract a higher share of the collusive surplus.

In the last section of the paper, first I show that Cruz Verde’s size is a strong predictor of the order of the two followers as well. In markets where Cruz Verde has a higher market share, Cruz Verde is more likely to be the last firm to increase price during coordination. This result is consistent with the same mechanism by which Salcobrand was the leader. Furthermore, I document the costs of leadership. I find that the market share of the last pharmacy to raise prices during a coordinated price increase was higher by 5 percent (or one percentage point) on average for a month after the increase happened.
Price leadership is a fairly common feature of price fixing cases. For example, Harrington (2006) reviews 20 European antitrust cases and refers to five instances in which the cartel resorted to staggered price increases and explicitly decided the firms’ order of move.\(^1\) Probably because of its prevalence, the literature on price leadership has a long history in economics, beginning with Nichol (1930) and Markham (1951).\(^2\) More recent articles provide theoretical support for price leadership and seek to identify the leader and understand how price leadership may facilitate collusion. Mouraviev and Rey (2011) argue that collusion is sustainable provided that the follower can be rewarded with market share that is large enough. The authors show that under cost asymmetry the firms can achieve greater collusive profits if the less efficient firm is the leader.\(^4\) Harrington and Zhao (2012) study how cooperation between firms may arise in a game of two sided asymmetric information. When firms are asymmetric, they find that the player that benefits the less from collusion is the one most likely to lead.\(^5\) The findings of my paper provide empirical guidance to papers that seek to identify the price leader during col-

\(^1\)In addition, in the cartels discussed, the leadership position was either rotated among the firms or was undertaken by the dominant firm. Whereas leadership rotation makes sense to share the costs of leading, dominant firm leadership could have been due to the cartel wanting to hide their coordination activities or to the dominant firm being also the most aggressive one. Along this line, Davies and De (2013) mention nine European cartels with a ringleader that was also a price leader aggressively pushing for higher prices, and other 10 cartels with a ringleader that was not a price leader.

\(^2\)Many of the early papers, such as Markham (1951), were spurred by changes in the stance of judicial courts regarding whether parallel conduct is in itself unlawful or not. Markham (1951) reacts to a Supreme Court’s sentence in the case American Tobacco Co. v. United States,\(^3\) and argues that not every type of parallel conduct should be deemed as forbidden by the Sherman Act. See Kovacic et al (2011) for a thorough discussion of price leadership in antitrust law. Important Court rulings are Theatre Enterprises v. Paramount Distributing, 346 U.S. 537 (1953), Brooke Group Ltd. v. Brown & Williamson Tobacco Corp., 509 U.S. 209, 227 (1993), and Bell Atlantic Corp. v. Twombly, 550 U.S. 544 (2007) in the US; and A. Ahlström Osakeyhtiö and others v Commission of the European Communities, Judgment of the Court (Fifth Chamber) of 31 March 1993, in Europe.

\(^3\)The reason for this is that leadership relaxes the incentive compatibility constrains, and the less efficient firm is the one for which this constraint is more likely to be binding.

\(^4\)Also, Ishibashi (2008) argues that a collusive leader moves first to “demonstrate its commitment not to deviate.” Rotemberg and Saloner (1990) discuss the case of asymmetrically informed firms in a collusive setting. Other theoretical models of collusion, while abstracting from leadership considerations, introduce firm heterogeneity as cost-asymmetries (Bae, 1987; Harrington, 1991; and Miklós-Thal, 2011), or as variation in the firms’ discount factors (Harrington, 1989; and Obara and Zincenko, 2017).

\(^5\)Some papers study price leadership that arises in a competitive equilibrium. Deneckere and Kovenock (1992) analyze capacity constrained firms, and van Damme and Hurkens (1999, 2004) use the risk dominance refinement of Harsanyi and Selten (1988) to find a unique equilibrium. These articles generally find that better positioned firms (larger or more efficient) should act as the competitive price leaders. Pastine and Pastine (2004) find that leadership in a competitive equilibrium should be rotated if there are costs associated to leadership.
lusion. Moreover, my results propose the endogenous delays as an additional way by which the leader may transfer part of its profits to the follower.

Despite the large number of theoretical works, empirical articles on collusive leadership are almost nonexistent. There are two notable exceptions. First, Clark and Houde (2013) study a cartel of Canadian gasoline retailers and find that the high-cost gasoline retailers moved first during coordinated price increases. Given that leadership by the same firms was recurrent, the authors argue that leadership was a way in which leaders transferred profits to other firms in order to incentivize them to comply with collusive prices. The second exception is provided by Byrne and De Roos (2016), who study how the largest firm in an Australian retail gasoline market was able to lead the industry to higher prices by means of price leadership, in a case where firms did not communicate with each other. The main contribution of this paper with respect to Clark and Houde (2013) is that I propose a different leadership mechanism in which the followers extract rents from the same leader, but in different products over time. However, in contrast with Clark and Houde, this did not occur in order to maintain the incentive compatibility constraints of the cartel, as the fact that prices did not collapse after the coordinated price increases stopped show. Rather, the fact that there was a unique leader seems to have been due to political economy reasons, such as the willingness to halt the price war and Salcobrand’s reliance on the local retail market. 7 Moreover, while Byrne and De Roos study a case of tacit collusion, my paper focuses on a case of explicit collusion where a intricate mechanism was put into practice. In addition, my paper studies price leadership in hundreds of product-markets. This fact, jointly with sales data, allows me to explain the heterogeneous outcomes of price leadership based on the market structure in each product, mainly each firm’s market share.8

This work also contributes to the literature on the internal workings of cartels, such as Porter (1983), Levenstein (1997), Genesove and Mullin (2001), Roller and Steen (2006), Asker (2010), and Igami and Sugaya (2017). Scott Morton (1997) studies whether an entrant’s strength (as measured by age, capacity, long-term contracts) affects shipping cartels’ decision to predate upon the entrant. Marshall, Marx, and Raiff (2008) document fundamental changes in the leader of price announcements in the vitamins

7I am also able to analyze price leadership more precisely than Clark and Houde (2013) due to the high frequency price data in hundreds of markets. Clark and Houde infer leadership from precisely timed phone calls.

8Other papers have studied leadership in industries where firms are possibly tacitly colluding: Lewis (2012) in US gasoline stations; and Seaton and Waterson (2013) in British supermarkets. See also the references in Marshall, Marx, and Raiff (2008). The identity of the price leader has been studied empirically in marketing by Roy, Hanssens, Raju (1994); and Kadiyali, Vilcassim, Chintagunta (1996).
2 Price Fixing among Retail Pharmacy Chains in Chile

I provide here a brief description of the industry and of the antitrust case with a special focus on price leadership during the price fixing period. The retail drugstore market in Chile is controlled by three chains that jointly make up roughly 92 percent of the sales. The remaining 8 percent is shared by independent drugstores and small chains, which sell mostly generic drugs. The three large chains (and their number of stores as of 2008)

9 Price announcements are not costly and, thus, are of a different nature from actual price increases.

10 The industry was reviewed in depth in Alé Chilet (2017).
are Cruz Verde (512), Fasa (also known as Farmacias Ahumada; 347), and Salcobrand (295). Cruz Verde’s market share had increased steadily from roughly 32 in 2004 to 41 percent in 2007. Fasa became an international drugstore chain in the past decade with stores in Chile, Mexico, and Peru, and with 37 percent of its revenues coming from the Chilean market. Salcobrand was formed from the merger of two chains, Salco and Brand, in 2000, and was sold to a large business group in August 2007. I plot in Panel (a) of Figure 1 the market shares of the three firms in the drugs in this study. The heterogeneity in the pharmacies’ shares over products will be important in the next sections of the paper.

Starting in 2005, the pharmacies started relying on a loss-leading strategy, which consisted of selling hundreds of chronic, branded, and best-selling drugs for prices close to or below their wholesale price. Prices starting dropping further in December 2006 in a period described by Chile’s National Economic Prosecutor (NEP) as a price war. Throughout this price war either rapid price cuts or continuous price undercutting in the loss-leading drugs were common. The price war escalated further in August 2007 as a result of a Cruz Verde’s marketing campaign that openly compared prices between itself and Fasa, and claimed that Cruz Verde had the lowest prices in the market. In November 2007 a court deemed this advertising campaign to be unfair competition. Coincidentally, price declines stopped at the same time. Some weeks later, the pharmacies started coordinating price increases. Panel (b) of Figure 1 shows the price indexes of the pharmacies over time.

During the period of coordination the pharmacies would choose a subset of drugs on which to collude. Then, the chains would raise the price of each product using a staggered mechanism, in which typically Salcobrand would lead the price increase. Then, two or three days later, one of the other two chains would raise prices. Finally, the third pharmacy would raise its price either the same day or one to three days after the second pharmacy. Therefore, in a time period of roughly one week, the price in all three chains would be similar. Panel (a) of Figure 2 shows an example of a coordinated price increase for Lady Ten x 21 coated tablets, a drug indicated for hormonal treatment therapy. Panel (b) of Figure 2 summarizes the order followed by the pharmacies during all coordinate price increases.  

11 By the time an antitrust investigation started in May 2008, the coor-
Figure 2 – Leadership in coordinated price increases

(a) A coordinated price increase.  
(b) Order in coordinated price increases

Note: Panel (a) plots the prices and units sold of Lady Ten x 21 coated tablets, indicated for hormonal treatment therapy and manufactured by Laboratorio Chile, during a coordinated price increase in 2008. Panel (b) shows the order in which the pharmacies increased the price of each brand during the coordination period. There were 189 coordinated price increases. For simplicity, I exclude from the graph a few instances of ties in the first place.

Coordinated increases had led to an average price increase of almost 50 percent in 222 best-selling brands that constituted 30 percent of the pharmacies' revenues. The pharmacies were found guilty of colluding by the Competition Tribunal in January 2012.

Reasons for Salcobrand’s Leadership

As documented earlier, Salcobrand was the clear leader during collusion. In addition, the NEP and the expert reports requested by the pharmacies agreed that Salcobrand’s leadership during the coordinated price increases was exceptional.\(^{12}\) In fact, some depositions portray Salcobrand as sending signals about its willingness to stop the price war by means of avoiding further price cuts and taking upon itself the position of market leader. For example, Fasa’s commercial manager at the time testified that

\[\text{[i]n 2007 two relevant events happened[:i] in May or June Salcobrand was acquired by the Yarur corporation (…). They started to set their own pricing strategies, so [that Salcobrand] ceased to be price follower. I realized that because [I] noticed in the [price] surveys we used to do every week that}

\[12\]The NEP saw a change in price leadership as well, and it was the subject of many reports. Observations to the evidence. NEP p. 198. In addition, in the Appendix I run panel vector autoregressions and show that the coordination period has different features from the price war and the post-collusive periods.
[Salcobrand] was increasing prices without following the market.¹³

Based on these claims, I will argue that Salcobrand initiated the coordinated price increases because, as the weakest firm in the industry, it was willing to undertake the costs of leadership in order to lead the industry to higher prices. The main argument for Salcobrand’s position as the collusive leader is its change in ownership in August 2007, in the midst of the price war. The new owners thought they could increase margins by ending the ongoing price war in loss-leader products and requested the services of a strategy consulting group to give them advice about the matter. As Salcobrand’s commercial manager explained in an internal email addressed to the CEO and other senior managers in December 19, 2007, the strategic actions that management undertook included: avoiding to follow price cuts in generics offered by Fasa in October; following the competitors’ price increases, but not their price cuts; offering to lead the (coordinated) price increases; and setting prices of loss-leader products between those of Fasa and Cruz Verde.¹⁴ The outcomes of this change of strategy are evident in the price indexes in Panel (b) of Figure 1. Notice that in the final months of 2007 Salcobrand’s average price of the drugs involved in price fixing decreased less sharply than the price of its competitors, which led ultimately to a substantial gap between Salcobrand’s prices and those of its competitors towards the end of the price war.¹⁵

In addition, the situation during the price war was better for the two largest chains, Cruz Verde and Fasa, because of their other sources of revenues besides the retail business (Cruz Verde’s distributor, and Fasa’s stores abroad).¹⁶ Furthermore, in many re-

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¹³Ricardo Ewertz. Observations to the evidence. Cruz Verde, p. 346. The narrative of Salcobrand’s defense lawyers is also in the same line. They explain that “Salcobrand provided clear signals that it was entirely decided to raise prices, run the risk that the other players would not follow, and maybe lose market share, but someone had to be the first and unambiguously conveyed to the affected manufacturers that it would be the first to raise prices.” (75 Observations. Salcobrand, p. 83)

¹⁴Observations to the evidence. NEP, p. 18.

¹⁵Importantly, the other pharmacies realized Salcobrand’s new intentions. As a former Fasa board member explained, “Salcobrand changed owner and the expectation was that (...) [the new owners] would introduce rationality into the levels of competition, that is, that not everything would be sold at negative margins, because it is a group that works professionally.” Deposition of Pablo Lamarca. 75 Observations. Salcobrand, p. 64. Notice the similarity to reputation effects of Kreps and Wilson (1982), for example. Similarly, as quoted in Alé Chilet (2017), a former Cruz Verde board member noted that “Salcobrand’s [new administration] came to change this dynamic (...) of big emotional aggressiveness between the companies, because, in fact, Salcobrand present[ed] itself as a neutral competitor that [made] its decisions mostly based on economic principles (...)” Deposition of Fernándo Suárez Lureda. Observations to the evidence. NEP, p. 224.

¹⁶These are similar reasons to the ones given by Clark and Houde (2013) to explain price leadership by a group of firms. Salcobrand attributes Fasa’s willingness to fight the price war explicitly to Fasa’s profits abroad (75 Observations. Salcobrand, p. 64).
etail industries, economies of scale and of density cause marginal costs to decrease as the number of stores increase (e.g., Jia 2008, Holmes 2011). Thus, Salcobrand’s competitors were in a better position to continue the price war due to their higher cash stock and lower marginal costs. As another former Fasa board member testified, “as opposed to other price wars, Fasa had this time a competitive cost position” and, therefore, “it was suggested to resist [the price war]” in order to “avoid losing [market] participation.”

3 The Data

I use transaction data for the three drugstore chains obtained from the Competition Tribunal of Chile. They include every consumer purchase of the 222 products that the pharmacies were accused to be colluding on between 2006-2008. Since the three chains have a joint market share of 92 percent of the retail market, and because other drugstores sell mostly generics, the data include virtually every retail purchase of these drugs. The data contain the name of the purchased drug, the drugstore chain, a store code (only for two of the three chains), the date and time of purchase, the list price per unit, the final purchasing price, and the number of units sold. The 222 pharmaceutical products in the data correspond to different Universal Product Codes (UPC) of 148 brands that were manufactured by 37 different pharmaceutical companies, with a mean price of $30 and prices ranging from $1.50 to $180 US dollars. I aggregate transactions into daily and weekly data. Since price varies over transactions, I generate a revenue-weighted average price. For each time period, average price is calculated as the weighted average of the final transaction price for each drug in each chain, where the weights are the share that each purchase constitutes of the total revenues of the chain for that brand. The share of the population with a drug insurance plan was extremely low at the time. Therefore, the transaction price should be seen as an out-of-pocket expense. Finally, I define coordinated price increases as instances in which the three pharmacies raised prices within ten

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18 I drop observations that do not have a date, and observations for which price or number of units bought is zero or unknown. Also, I do not have geographical information on purchases. However, I can distinguish purchases in two geographical zones: stores in the far north and the far south, and stores in the rest of the country. I drop the former (following the expert report of Nuñez, Rau and Rivera, 2010, p. 19) because many drugs do not register sales in a number of months. These account for roughly 4 percent of the total amount of transactions and 3 percent of revenues. Prices in these regions are in average 4 percent higher due to the extra costs incurred. It is not possible to distinguish purchases in the extreme zones from the rest of the country in 2006 for Cruz Verde.
The Delay in Collusion

This section studies the time it took the followers to match the leader’s prices. This delay is an important outcome because price increases that took longer were more costly for the leader. I document these costs in Section 5.

Most price increases occurred within two days, but there is substantial heterogeneity. I find that the market characteristic that explains the most the delay in the increase for each of the two followers is the asymmetry in market shares. This asymmetry is mostly due to Cruz Verde’s varying size over markets. Panel (a) of Figure 3 plots the time it took the two followers to follow a Salcobrand increase against Cruz Verde’s market share in each product. The plot shows a strong negative correlation between the following time and Cruz Verde’s market share. In other words, the larger Cruz Verde was, the less time it took Cruz Verde itself and Fasa to follow the leader.

Moreover, I consider only large price increases where the list price rose by at least 15 percent, or by more than 1,500 Chilean Pesos, roughly equivalent to $3, during the coordination stage. I do not have explicit evidence that all of these price increases were coordinated by means of explicit messages. However, this term seems the most suitable one.

Figure 3 – Order of Move and Duration of Coordinated Price Increases

Note: Panel (a) shows the time difference between the last and the first collusive price increase for each brand plotted against the pharmacies’ market shares. Panel (b) shows the order in which Fasa and Cruz Verde increased the price of each brand during the coordination period for drugs in which Cruz Verde's market share is in the bottom quartile (<42 percent) or in the top quartile (>50 percent) of the distribution. For simplicity, I exclude a few instances of ties in the first place.
The following empirical specifications check whether the result of the effect of market asymmetry on the delay is robust to the inclusion of covariates, including various measures of the potential gains of the followers from delaying collusion in each market. I show here results for the time it took until the last firm raised prices after a leader’s increase. In the Appendix I also study the intermediary delays, which are the time spanned between the first and the second, and between the second and the third firm to raise prices.

Table 1 presents the estimates of regressions of the log number of days it takes the firms to match the leader’s increases (usually Salcobrand’s). Most specifications measure firm dominance using the range of shares between Cruz Verde and Salcobrand, but I also show results when using Cruz Verde’s market share. Column (1) shows the correlation between the range of shares and the increase time, which is very significant. Column (2) adds a dummy variable for instances of ties between the second and the third firm to raise prices and shows that when the followers were tied, price increases took considerably less time. Column (3) controls for market size. The effect of market size is positive,

| Dependent Variable: ln Time of Price Increases [Days] |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| (1)       | (2)       | (3)       | (4)       | (5)       | (6)       | (7)       |
| Range of Shares | -0.956*** | -0.694*** | -0.727*** | -0.918**  | -0.383*   | -0.712*** |
|           | (0.239)   | (0.221)   | (0.220)   | (0.393)   | (0.209)   | (0.219)   |
| Share Cruz Verde | -1.071*** |
|           | (0.296)   |
| Tie       | -0.741*** | -0.732*** | -0.730*** | -0.684*** |
|           | (0.111)   | (0.107)   | (0.107)   | (0.103)   |
| Ln Revenues | 0.099**   | 0.089**   | 0.174**   | 0.026     |
|           | (0.039)   | (0.039)   | (0.074)   | (0.040)   |
|           | (0.055)   |
| Constant  | -7.248    | 58.855*   | 54.909*   | 67.425    |
|           | (33.350)  | (34.306)  | (33.087)  | (30.676)  |
|           | (27.291)  |
| Brands    | All       | All       | All       | All       | Last: Fasa|
|           | All       | All       | Last: CV  | Homog.    |
| N         | 186       | 186       | 186       | 71        |
|           | 89        | 91        |
| R-squared | 0.067     | 0.290     | 0.315     | 0.177     |
|           | 0.031     | 0.390     |
| No. of Brands | 154       | 154       | 154       | 67        |
|           | 82        | 79        |

Note: The dependent variable is measured in ln days. I exclude a few instances of two firms raising price first simultaneously. The variable Range of Shares corresponds to the difference in market shares between Cruz Verde and Salcobrand. All specifications include a quadratic time trend. Standard errors in parentheses are clustered at the brand level. * p<0.1, ** p<0.05, *** p<0.01
which means that collusion took more time when markets are larger. Column (4) includes in the regression Cruz Verde’s market share directly. In addition, Columns (5) and (6) divide the results according to the identity of the last follower, excluding ties, and they show that the dominant firm effect was stronger if Cruz Verde was the last firm to raise price. They also show that the effect of market size is mostly derived for brands in which Fasa was the last firm to raise price. Column (7) presents results for brands in which pharmacies are more homogeneous. There is no significant difference in the effect between these brands, in which pharmacies compete more with each other, and other brands.

**Discussion**

Price leadership was not rotated during the collusive increases, in spite of their cost. This is in contrast of the findings in many collusion cases (Harrington, 2006) and theoretical explanations of leadership randomization as an ex-post mechanism to transfer market shares (Mouraviev and Rey, 2011). The leadership mechanism does not fit with the mechanism used to transfer profits to stronger firms studied in Clark and Houde (2013) either. This is because the large coordinated price increases of the pharmacies were not intended to occur more than once or twice per product. Therefore, they could not be used to uphold incentive compatibility constraints of the stronger firms over time.

A simple model that can explain the leadership mechanism employed by the pharmacies is one where the leader is the weak firm (as in Clark and Houde). After a leader’s increase the other firms extract all the rents from the leader by delaying their own increases almost until it is not incentive compatible for it to lead the increases to begin with. Formally, consider two firms, $F$ and $L$, that play an infinitely repeated price setting game on differentiated products. The firms discount the future with a known discount factor. Suppose there are only two possible price levels the firms can set: the competitive Nash price and the collusive price. Let the leader’s market share be $s$ when the two firms set the same prices and the difference in market share between the two when there is a price difference $\Delta s$. At a given time $t = 0$ one of the firms, Firm $F$, makes a take-it-or-leave-it offer to raise prices $\bar{T}$ periods after a price increase of the other firm, Firm $L$. If Firm $L$ accepts the offer, it increases its price to the collusive price immediately. If the price increase is maintained over time, then Firm $F$ matches the price increase at a time $T \geq 1$. Otherwise, the Firm $F$ never raises price. On the other hand, if Firm $F$ does not

\[20\] It has also been observed to arise in lab experiments as a way to enhance cooperation when the different outcomes do not result in large differences in payoffs (Kaplan and Ruffle, 2012).
increase its price by time $t = T_{\text{max}}$, Firm $L$ decreases its price back to $p^N$ forever. Given the take-it-or-leave-it offer, the Firm $F$, possesses all the bargaining power and can extract all the surplus. Thus, in equilibrium $T = \tilde{T} = T_{\text{max}}$.

As I show in the Appendix, in this game the equilibrium delay $T$ is inversely correlated with the leader’s per-period relative loss in a market $\Delta s/s$.\textsuperscript{21} The reason for this is that when the leader’s market share in a market $s$ is larger, the follower’s share in the collusive profits is higher. This allows the leader to afford losing more during the price increases. The follower takes advantage of this, and waits until the last period before the leader’s incentive compatibility constraints bind.

## 5 Other Outcomes of Collusive Leadership

In this section, I focus on other characteristics of price leadership during the coordinated transition to higher prices. In particular, the next subsections delve further into the order followed by the firms and the costs of leadership.

### The Order in Price Followership

Salcobrand was the leader in most coordinated price increases, while the other two chains took turns being the second and third mover. Table 2 shows the number of times in which each firm was the first, second, and third mover, including instances in which two firms raised prices simultaneously. From this preliminary evidence, it would seem that the two followers randomized their position, even if the leader’s identity stayed the

\textsuperscript{21}Actually, $T$ is correlated with the relative loss times the price difference between the competitive and the collusive period relative to the collusive period. However, I do not find a correlation between the latter and the delay, nor the results change when conditioning on it.
same. However, as I will show next, movement among the two followers is highly correlated with Cruz Verde’s market share. To see this, Panel (b) of Figure 3 presents the number of times in which Fasa and Cruz Verde were the first, second, tied second, and third firm to increase prices for two different sets of products. For each pharmacy, I show brands in which Cruz Verde’s market share is in the bottom quartile (left) or in the top quartile (right) of Cruz Verde’s market share distribution (<42 and >50 percent, respectively). The Figure shows quite clearly that when Cruz Verde was relatively larger, Fasa tended to move earlier and Cruz Verde tended to move later.

In order to check whether the effect of Cruz Verde’s market dominance on price leadership is statistically significant, I estimate ordered probit models where the dependent variable is the order in which each pharmacy increases price. As Salcobrand was the price leader in the vast majority of coordinated increases, I limit the analysis to the order followed by the other pharmacies, Cruz Verde and Fasa. I measure Cruz Verde’s dominance using three different measures of market asymmetry: the range of shares between Cruz Verde and Salcobrand (the difference in their average market shares in the two months before coordination begins); Cruz Verde’s own average market share; and the dummy variable Dominant, which indicates brands in which Cruz Verde’s market share was in the top quartile (>50 percent market share) of its shares distribution. In addition, all regressions include the variable Ln Revenues that controls for each brand’s market size and is measured by the ln total units sold in 2007 multiplied by Salcobrand’s wholesale price, so as to exclude price effects from the market size calculation. I deal with ties, where two firms increased prices in the same day, by assigning equal (half) weights in the likelihood function to each firm being in the first and the second, or the second and the third place (which is why the number of observations vary between the two pharmacies).

I show the results in Table 3. Columns (1) to (4) present the results for Fasa, and Columns (5) to (8) present those for Cruz Verde. The Table shows that when Cruz Verde’s dominance is stronger Fasa moves earlier and Cruz Verde later, even if the effect for Cruz Verde is less statistically significant. The results for one pharmacy are not the mirror image for the other one because Salcobrand is not always the leader. In addition, using demand estimates from previous work Columns (4) and (8) show that if we look only at the brands in which the cross elasticity among the pharmacies is higher than the median, the effect of Cruz Verde’s dominance is stronger. The pharmacies in these mar-

\footnote{More precisely, I plot separately the quartiles of the distribution of Cruz Verde’s average shares in the last two months before collusion started (October-November 2007). The bars show separate leadership distributions for the bottom and top quartiles. The median market share in each of these quartiles is 39.7 and 54.1 percent, respectively.}
### Table 3 – Order of Price Increase – Ordered Probit

Dependent Variable: Order in Coordinated Price Increases

<table>
<thead>
<tr>
<th></th>
<th>Fasa</th>
<th>Cruz Verde</th>
<th>Cruz Verde</th>
<th>Cruz Verde</th>
<th>Cruz Verde</th>
<th>Cruz Verde</th>
<th>Cruz Verde</th>
<th>Cruz Verde</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td>Range of Shares</td>
<td>-1.362**</td>
<td>-2.111***</td>
<td>0.708</td>
<td>1.419**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.622)</td>
<td>(0.750)</td>
<td>(0.565)</td>
<td>(0.664)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share Cruz Verde</td>
<td>-2.035**</td>
<td></td>
<td>0.842</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.990)</td>
<td></td>
<td>(0.876)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant</td>
<td>-0.412**</td>
<td></td>
<td>0.358**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.185)</td>
<td></td>
<td>(0.177)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ln Revenues</td>
<td>0.101</td>
<td>0.079</td>
<td>0.066</td>
<td>0.002</td>
<td>-0.109</td>
<td>-0.096</td>
<td>-0.085</td>
<td>-0.055</td>
</tr>
<tr>
<td></td>
<td>(0.103)</td>
<td>(0.103)</td>
<td>(0.104)</td>
<td>(0.136)</td>
<td>(0.108)</td>
<td>(0.108)</td>
<td>(0.108)</td>
<td>(0.143)</td>
</tr>
<tr>
<td>Cut 1</td>
<td>-0.756</td>
<td>-1.552*</td>
<td>-0.795</td>
<td>-1.737</td>
<td>-2.913***</td>
<td>-2.588***</td>
<td>-2.823***</td>
<td>-2.705**</td>
</tr>
<tr>
<td></td>
<td>(0.802)</td>
<td>(0.940)</td>
<td>(0.808)</td>
<td>(1.066)</td>
<td>(0.896)</td>
<td>(0.989)</td>
<td>(0.904)</td>
<td>(1.169)</td>
</tr>
<tr>
<td>Cut 2</td>
<td>0.675</td>
<td>-0.120</td>
<td>0.635</td>
<td>-0.367</td>
<td>-0.782</td>
<td>-0.462</td>
<td>-0.681</td>
<td>-0.068</td>
</tr>
<tr>
<td></td>
<td>(0.806)</td>
<td>(0.944)</td>
<td>(0.813)</td>
<td>(1.090)</td>
<td>(0.842)</td>
<td>(0.935)</td>
<td>(0.846)</td>
<td>(1.112)</td>
</tr>
<tr>
<td>Brands</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All Homog.</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All Homog.</td>
</tr>
<tr>
<td>N</td>
<td>204</td>
<td>204</td>
<td>204</td>
<td>102</td>
<td>213</td>
<td>213</td>
<td>213</td>
<td>108</td>
</tr>
<tr>
<td>No. of brands</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>81</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>81</td>
</tr>
<tr>
<td>Log-Likelihood</td>
<td>-181.05</td>
<td>-180.98</td>
<td>-180.89</td>
<td>-88.93</td>
<td>-140.81</td>
<td>-140.99</td>
<td>-139.90</td>
<td>-66.41</td>
</tr>
<tr>
<td>Pseudo R-squared</td>
<td>0.013</td>
<td>0.013</td>
<td>0.014</td>
<td>0.041</td>
<td>0.006</td>
<td>0.005</td>
<td>0.012</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Note: The table shows the results of ordered probit models that estimate the effect of various covariates on the number of times a firm increases price in a given place in the staggered mechanism excluding Salcobrand. If the two firms follow a price increase on the same day, I assign equal (half) weights to the firms being in the first and the second, or second and the third place. The variables Range of Shares and Dominant correspond to the difference in market shares between Cruz Verde and Salcobrand and to a dummy variable indicating whether Cruz Verde had a market share larger than 50 percent, respectively. Standard errors clustered at the brand level in parentheses. * p<0.1, ** p<0.05, *** p<0.01
kets are closer substitutes of one another. Thus, when one firm increases price first in more homogenous markets, the market stealing effect is stronger (see Section 5), which suggests that the pharmacies followed the price leadership mechanism more closely in markets in which leadership was more costly.

The previous results show a strong dominant firm effect by which Cruz Verde pushed its main competitor, Fasa, to move earlier in markets in which Cruz Verde is more dominant. Therefore, it was not only the case that Salcobrand, the smallest firm, moved first, but also that Cruz Verde, the largest firm, moved last in markets in which it had a larger market share.\footnote{Notice the similarity of these results, in which the largest firm moved last in the coordinated increases, to Clark and Houde’s (2013) findings, where the strongest players in the cartel also moved last. In contrast, in the competitive leadership literature (e.g., Byrne and De Roos, 2016) the largest firm usually moves first and its price increases serve as a coordination device.}

**The Costs of Price Leadership**

The price increases during coordination were a result of loss leading pricing and of supply side changes at the industry level. Hence, they were exogenous to demand. This provides a good opportunity to study the costs associated with a firm taking the leadership position.\footnote{Harrington (2006) notes the large profit transfers among the firms in some European cartels that employed price leadership during the time period between the increases.} In this subsection I present evidence that leadership was costly for the firms and was, therefore, an outcome the pharmacies were concerned with. Admittedly, the large difference in retail prices across pharmacies lasted only a few days. Thus, given an inelastic demand for the pharmacies, the loss in sales in these days was negligible with respect to the extra profits the firms could obtain from a price increase. Yet, as I will show next, these short-lived price differences produced a persistent effect in the demand that lasted for more than a month.

The lack of consumer level data precludes a full estimation of the dynamic effects of price increases on the demand (as in Dubé, Hitsch, and Rossi, 2010, for example). Hence, my empirical strategy consists of estimating the effects of being the leader or a follower in the previous month on the firm’s current market shares while imposing a common price effect for all the brands. Let the dummy variables $First$, $Second$, and $Third$ indicate if the firm was the first, second, or third firm to increase price in a coordinated manner, respectively, during the previous weeks. The main specifications estimate the following regression:
\[
Sales_{ijt} = \beta_0 + \beta_1 \Delta \ln p_{ijt} + \theta_1 First + \theta_2 Second + \theta_3 Third + \lambda_i + \mu_j + \delta_t + \epsilon_{ijt}, \quad (1)
\]

where \(Sales_{ijt}\) represents different measures of sales of brand \(i\) of firm \(j\) at time \(t\); \(\Delta \ln p_{ijt}\) denotes the price difference of firm \(j\) with respect to the average price of firm \(j\)'s competitors; and \(\lambda_i, \mu_j, \) and \(\delta_t\) constitute brand, firm, and week fixed effects, respectively. Thus, \(\theta_1, \theta_2, \) and \(\theta_3\) capture the effect on future sales of having had raised price during a coordinated increase in the first, second, and third place, respectively. Given the ties, these variables are not perfectly collinear and, therefore, I can include them all in the regressions. In the main specifications, I limit this effect to 4 weeks. Since the equation includes pharmacy and brand fixed effects, the \(\theta_s\) are identified from the difference in sales just after a coordinated increase with the sales in the rest of the sample period. Therefore, to limit the effect of other price changes, especially those during the price war, I estimate Equation (1) for November 2007 to June 2008. In addition, \(\delta_t\) controls for aggregated time-specific demand shocks.

The identification of the leadership effects comes from the fact that the coordinated increases used to define the leadership indicators were a result of changes in the nature of competition in the industry, and thus were not due to unobserved pharmacy-specific demand shocks. This fact implies that the effects of leadership on market structure cannot be undone by means of unilateral, uncoordinated price changes because, in those cases, firms may respond endogenously. A possible concern is that the the order of the firms was not random. However, if the firms were minimizing the inter-firm transfers of consumers due to leadership, as could be suggested by Salcobrand’s leadership position, the estimates would provide a lower bound of the effect.\(^{25}\) I exclude the contemporaneous effect by dropping the weeks when the price increase occurs from the estimating sample.

Table 4 shows the results of various specifications of the estimation of Equation (1). All regressions include brand, week, and pharmacy fixed-effects, with standard errors clustered at the brand level. In Column (1) the dependent variable \(Sales\) is measured by the log number of units sold, and in Columns (2) to (8) it is measured by the pharmacy’s market share, either in logs or in levels. Column (2) is the baseline specification. The

\(^{25}\)Another possible concern is the lack of data on product advertising, since competitors advertising may counteract own brand loyalty effects (Shum, 2004). Yet, if the leader ramps up advertising after a price increase, my estimates also provide a lower bound of the cost of leadership. However, I do not think this is likely, since increasing advertising may have been seen as deviation from the collusive scheme.
Table 4 – The Costs of Price Leadership

<table>
<thead>
<tr>
<th></th>
<th>Ln Units Sold</th>
<th>Ln Market Share</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>First</td>
<td>-0.030</td>
<td>-0.030</td>
<td>-0.087***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.023)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Second</td>
<td>0.006</td>
<td>-0.001</td>
<td>0.068***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.019)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Third</td>
<td>0.052*</td>
<td>0.047**</td>
<td>0.139***</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.020)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Δ ln Price</td>
<td>-1.356***</td>
<td>-1.345***</td>
<td>-1.408***</td>
</tr>
<tr>
<td></td>
<td>(0.238)</td>
<td>(0.238)</td>
<td>(0.164)</td>
</tr>
<tr>
<td>Constant</td>
<td>5.304***</td>
<td>-1.429***</td>
<td>-1.340***</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.029)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Brand, Week, Pharmacy F.E.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>All</td>
<td>All</td>
<td>Lengthy Increases</td>
<td>Fasa, SB</td>
<td>Homog.</td>
<td>Cruz Verde Dominant</td>
<td>Coordinated Increases</td>
</tr>
<tr>
<td>N</td>
<td>22575</td>
<td>22575</td>
<td>11322</td>
<td>15050</td>
<td>12372</td>
<td>11244</td>
<td>15810</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.350</td>
<td>0.391</td>
<td>0.320</td>
<td>0.138</td>
<td>0.399</td>
<td>0.243</td>
<td>0.550</td>
</tr>
<tr>
<td>No. of Brands</td>
<td>221</td>
<td>221</td>
<td>110</td>
<td>221</td>
<td>121</td>
<td>110</td>
<td>156</td>
</tr>
</tbody>
</table>

Note: The table shows the results of the estimation of Equation (1). The variables First, Second, and Third are dummy variables that indicate if the firm was the first, second, or third firm to increase price, respectively, in coordinated increases during the previous 4 weeks. If the two firms increase price on the same day, I assign equal (half) weights to the firms being in the first and the second, or the second and the third place. Columns (4)-(8) estimates the model on different subsets of the data. Column (4) includes only brands in which it took 3 days or more for all the firms to raise prices. Column (5) excludes Cruz Verde from the estimating sample. Column (6) includes brands in which the pharmacies are more homogenous. Column (7) shows results for markets in which Cruz Verde was more dominant, that is, brands in which it had a market share higher than the median of the distribution. Column (8) includes only brands in which there was a coordinated increase. Standard errors clustered at the brand level in parentheses. * p<0.1, ** p<0.05, *** p<0.01
Figure 4 – The Costs of Leadership over Time

(a) All brands  
(b) Homogeneous brands

Note: The Figure presents the point estimates and the confidence intervals of the effect of being the last firm to follow a coordinated price increase on the firm’s log market share of an increasingly large number of weeks into the future. Panel (a) presents the result of all brands, and Panel (b) only for brands in which pharmacies are more homogeneous. All regressions include a brand fixed effect. Standard errors are clustered at the brand level.

results suggest that the price follower’s market share rose on average 5 percent as a result of a coordinated increase. I also show in the Appendix that when the model shown in Column (2) is estimated for each brand separately, the transfers due to leadership in each brand are increasing with respect to Cruz Verde’s market share, but concave. This finding provides support to the logit functional form used in Section A3. In addition, Columns (3) to (7) of Table 4 present estimates for different subsets of the data. They show that the transfer of market shares are higher in price increases that take three days or more (Column 3); for Fasa and Salcobrand (Column 4); in more homogenous products, as measured by the top half distribution of the cross elasticities estimated in Alé Chilet (2017) (Column 5); and for markets in which Cruz Verde is less dominant (Column 6). Column (7) shows that the results are robust when looking only at products in which there was a coordinated price increase. Column (8) measures the dependent variable in levels and shows that the follower gains a 1 percent market share (in absolute values) after a coordinated price increase.

In addition to the results above, I also estimate the varying persistence of the leadership effect on market shares over time. For this purpose, in the next specifications the variables First, Second, and Third indicate an increasingly large number of time periods after the coordinated price increase. Consequently, the coefficients of these variables indicate, respectively, what the effect of being the first, second, and third mover today will
be in the firm’s market share in an increasingly large number of weeks in the future, thus
capturing the cumulative effect of leadership over time. I show the estimates of the coef-
ficient of $\text{Third}$ in Figure 4. Panel (a) shows the results for all the brands and Panel (b)
those for more homogeneous markets (similar to the specification of Columns 2 and 7 of
Table 4, respectively). For both samples the average effect is significantly different from
zero for roughly six weeks after the coordinated increase, but the effect on homogeneous
markets seems to be more persistent over time.

Overall, the findings suggest the presence of store persistence or dynamic linkages
across demand in different periods that make consumers choose pharmacy based on
their last purchases. These dynamic effects generate larger costs of leadership than
those that could have been expected from the short price differences among the firms.
This fact has important implications for my analysis. This is, first and foremost, because
these costs suggest a trade off between the profits from ending the price war and the costs
of being the first to raise prices, in a similar way as in a war of attrition. Second, leadership
implies a profit transfer among the firms, which relates to market share allocation from
the weakest to the strongest firm observed in many antitrust cases. Finally, the costs of
leadership have a more general implication for models of collusion. When almost per-
fect monitoring is available, as in the pharmacies’ case, positive gains from undercutting
the cartel are very small. This makes cheating unlikely. However, in the presence of per-
sistence in the demand, which is common in consumer markets, deviation might still be
worthwhile because the gains will endure even after deviation is detected.

6 Conclusion

This paper documents the leadership dynamics in the same industry over hundreds of
products. This work puts emphasis on the role of the followers delays in matching the
leader as a profit transfer mechanism, which I find to be highly correlated with the degree

\[26\] Therefore, such demand linkages make temporary price changes have medium run effects. For exam-
ple, these effects appear in a model where consumers buy drugs once a month from their preferred drugstore.
However, if faced with a price increase, some consumers switch drugstore only in their next purchase due
to increasing marginal search costs, as in Stiglitz (1987). Also, Erdem (1996), Keane (1997), and mod-
els that followed them introduce state dependence in empirical consumer choice models. In addition, the
persistence of brand market shares has been attributed to loyalty by Dubé, Hitsch, and Rossi (2010). Eizen-
berg and Salvo (2015) highlight the role of entry of new consumers into a market with persistence in the
demand.

\[27\] Subcompetitive pricing à la Abreu, Pearce, and Stachetti (1986), which might deter more profitable
deviations, do not seem to occur in reality. See Levenstein and Suslow (2006) for a review, and Genesove
and Mullin (2001) and Levenstein (1997) for analyses of specific cases.
of market dominance of the largest chain. I explain the leadership mechanism as motivated by the fact that the collusive leader was the firm less ready to fight the ongoing price war.

There are two points I would like to note. First, there is a renewed interest in the literature into the ways in which leadership facilitates coordination. When firms do not communicate with each other, Byrne and De Roos (2016) suggest that it is mostly the dominant firm the one that can lead the industry to higher margins. On the other hand, the leader of the case studied in this paper was the smallest firm. Yet, the price increases were explicitly coordinated. Hence, the case of the Chilean pharmacies seems to indicate that price increases led by the smallest firm in a market are either too costly or not credible enough in the absence of communication. Second, the change in price leadership patterns coincides with the transition from a price war to collusion. These changes in price leadership may more generally suggest a change in firms conduct as well and could, potentially, be used by antitrust authorities to screen for anticompetitive behavior.

References


Appendix

A1 Figures

Figure A1 – Benefits of Followship and Market Asymmetry

Note: The Figure shows the estimates of the benefits of being the follower from a model similar to Equation (1) where brands are estimated separately. The coefficients are plotted as a function of Cruz Verde’s market share. To estimate the fits, I weight observations in an inversely proportional way to the variance of the coefficient. Notice that the fit is positive for market share values between 40 and 60, where most of the distribution mass is. The quadratic and linear terms of the fit are statistically different from zero.

A2 Price Leadership Regimes over Time

This section studies how price leadership varies with the industry’s different competitive regimes. The analysis focuses on the interaction of the dynamic pricing strategy of the pharmacies with each other, imposing as little structure as possible. The main finding is that the coordinated price increases feature very distinct leadership patterns from other price changes. In particular, while the price leader throughout the period was Cruz Verde, Salcobrand emerges as the price leader during the transition to collusion.

My empirical strategy consists of estimating panel vector autoregressions (VAR) of the percentage price change of each pharmacy on the lagged percentage prices changes of all the pharmacies. This approach allows me to infer which firm’s prices were followed by a greater extent by the other firms, which is precisely price leadership, and how these
patterns varied over time.\textsuperscript{28}

With some abuse of notation, let $\Delta p_{ijt}$ be the percentage price change of brand $i$ in pharmacy $j$ at time $t$ with respect to the previous time period, and $Y_{it} = [\Delta p_{11t}, \Delta p_{12t}, \Delta p_{13t}]$ the vector of price changes at the three pharmacies. I estimate regressions of the following type:

$$Y_{it} = \beta_0 + \sum_{\tau=1}^{T} \beta_\tau Y_{i,t-\tau} + \lambda_i + f(t) + \epsilon_{it},$$  \hspace{1cm} (A1)

where $\lambda_i$ is a fixed effect for brand $i$, and $f(t)$ is a cubic polynomial of time. The coefficients $\beta_\tau$ capture the price response to the lagged own and competitors’ prices.\textsuperscript{29}

The estimation uses weekly data and includes two lags of prices differences. I present separate regressions results for each pharmacy for the price war, the coordination, and the post-coordination period. In addition, I estimate the model for the coordination period excluding the weeks of the coordinated price increases. I plot the impulse responses of the VAR model using local projections (Jordà, Òscar. “Estimation and inference of impulse responses by local projections.” The American Economic Review, 95.1 (2005): 161-182.) in the next subsection of this Appendix.

Table A1 present the results. There are three main findings that suggest a change in the nature of price leadership during the coordination period. First, during coordination, the price response to competitors’ price changes increased. Yet, the coefficient of Salcobrand’s price changes on the price equation of the other pharmacies is almost seven times larger during coordination, while that of the other pharmacies increases two or three times. This shows that the pharmacies followed Salcobrand much more closely during the coordinated price increases. Second, although Salcobrand responds to its competitors’ lagged price changes, the coefficient during the coordination period is almost zero, which means that Salcobrand did not follow the other firms’ prices during the collusive price increases. Finally, excluding coordinated price changes (Columns 7 to 9) results

\textsuperscript{28}An alternative strategy would consist of looking at time windows around price changes, such as the one presented in Panel (a) of Figure 2. During the coordinated price increases the order in price increases this is straightforward, as in most cases the three pharmacies raised prices within days of each other. However, such clear patterns occurred only during the coordination period, and thus this approach is not feasible for the other periods.

\textsuperscript{29}For estimation to be consistent, $E[\epsilon_t \epsilon_t'] = \Omega$, and $E[\epsilon_t \epsilon_t'] = 0$ for $t \neq \zeta$. Given that the average number of time periods in each regression is at least 20, the Nickell bias (1981)\textsuperscript{30} introduced by the fixed effects $\lambda_i$ should be small (see Judson, Ruth A., and Ann L. Owen. “Estimating dynamic panel data models: a guide for macroeconomists.” Economics letters 65.1 (1999): 9-15.)
## Table A1 – Fixed Effect VAR

<table>
<thead>
<tr>
<th></th>
<th>Price War</th>
<th>Coordination</th>
<th>Coordination excluding coordinated increases</th>
<th>Post Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) CV (2) Fasa (3) SB</td>
<td>(4) CV (5) Fasa (6) SB</td>
<td>(7) CV (8) Fasa (9) SB</td>
<td>(10) CV (11) Fasa (12) SB</td>
</tr>
<tr>
<td>CV$_{t-1}$</td>
<td>0.026 (0.039) 0.113*** (0.027) 0.103*** (0.023)</td>
<td>-0.279*** (0.053) 0.232*** (0.051) 0.012 (0.029)</td>
<td>-0.190*** (0.066) 0.252*** (0.062) 0.068*** (0.031)</td>
<td>-0.296*** (0.035) 0.056*** (0.021) 0.054** (0.022)</td>
</tr>
<tr>
<td>Fasa$_{t-1}$</td>
<td>0.131*** (0.026) -0.108* (0.064) 0.005 (0.034)</td>
<td>0.389*** (0.064) -0.202*** (0.052) 0.033 (0.042)</td>
<td>0.426*** (0.084) -0.114* (0.067) 0.052 (0.042)</td>
<td>0.094** (0.046) -0.164*** (0.045) 0.118*** (0.033)</td>
</tr>
<tr>
<td>SB$_{t-1}$</td>
<td>0.029** (0.012) 0.025*** (0.009) -0.062** (0.029)</td>
<td>0.198*** (0.035) 0.185*** (0.034) 0.015 (0.036)</td>
<td>0.078*** (0.030) 0.085*** (0.032) -0.002 (0.038)</td>
<td>0.024 (0.018) 0.021 (0.019) -0.140*** (0.052)</td>
</tr>
<tr>
<td>CV$_{t-2}$</td>
<td>-0.159*** (0.023) 0.033* (0.019) 0.100*** (0.023)</td>
<td>-0.185*** (0.029) 0.045** (0.021) -0.007 (0.025)</td>
<td>-0.143*** (0.034) 0.029 (0.020) 0.005 (0.018)</td>
<td>-0.066*** (0.019) 0.047** (0.020) 0.036*** (0.017)</td>
</tr>
<tr>
<td>Fasa$_{t-2}$</td>
<td>0.068*** (0.020) -0.095*** (0.028) 0.050 (0.036)</td>
<td>0.040 (0.032) -0.212*** (0.028) -0.003 (0.024)</td>
<td>0.039 (0.031) -0.145*** (0.032) 0.019 (0.030)</td>
<td>0.037 (0.039) -0.174*** (0.032) 0.052 (0.037)</td>
</tr>
<tr>
<td>SB$_{t-2}$</td>
<td>0.012 (0.013) 0.032** (0.016) -0.136*** (0.017)</td>
<td>0.036 (0.031) 0.033 (0.021) -0.097*** (0.022)</td>
<td>0.059 (0.041) 0.040* (0.021) -0.135*** (0.024)</td>
<td>-0.015 (0.014) -0.005 (0.017) -0.192*** (0.032)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.284*** (0.048) 0.095* (0.048) 0.001 (0.057)</td>
<td>-21.706*** (3.664) -16.119*** (3.441) -3.444 (4.262)</td>
<td>-10.115*** (2.251) -4.578*** (1.967) 9.931*** (3.290)</td>
<td>34.826*** (8.848) -16.843*** (6.090) 12.381 (7.861)</td>
</tr>
</tbody>
</table>

| N            | 11173 11173 11171 5929 5929 5928 | 5369 5369 5368 4614 4614 4611 | 5369 5369 5368 4614 4614 4611 |
| R-squared    | 0.059 0.038 0.033 0.158 0.107 0.027 | 0.130 0.087 0.028 0.086 0.049 0.068 | 0.130 0.087 0.028 0.086 0.049 0.068 |
| No. of Brands | 220 220 220 221 221 221 | 221 221 221 222 222 222 | 221 221 221 222 222 222 |

Note: All specifications include a brand fixed effect. Standard errors clustered at the brand level in parentheses. * p<0.1, ** p<0.05, *** p<0.01
in almost the same coefficients as those during the price war and post-coordination, so that the findings described above no longer hold. This finding is stronger if all instances of large price increases (>15 percent) are excluded from the estimating sample (the results are not reported). Thus, Salcobrand’s leadership occurs almost exclusively during the coordinated increases.\footnote{\footnote{It is not clear from Table A1 whether Cruz Verde or Fasa is the price leader. Yet, testimonies gathered in the case suggest that Cruz Verde is more likely the price leader. For example, a Fasa executive explained that the increase in prices was due to the fact that Cruz Verde “stopped lowering prices and responded increasing the prices of medicines (…) and as we are price followers we also followed its price increases” (75 Observations, p. 50. Salcobrand). Fasa’s CEO also claimed that Fasa’s pricing strategy was one of “price followers of [its] two competitors” (75 Observations, p. 52. Salcobrand.). Similarly, Salcobrand’s defense lawyers claimed that pricing strategies in the price war period were that “the rules were set by Cruz Verde, [Fasa] reacted, and Salcobrand wasn’t even considered a relevant player.” (75 Observations, p. 80. Salcobrand.) In addition, monitoring of Cruz Verde was more intense than that of Fasa. For example, between May and October 2007 Salcobrand performed 7,042 monthly price quotes from Cruz Verde and 2,077 quotes from Fasa on 6,545 UPCs.}}

In addition to the analysis for the three periods above, I estimate Equation (A1) in 20-week rolling window regressions, the results of which I present in Figure A2.\footnote{The regressions also include two lags, a cubic time trend, and brand-fixed effects. Standard errors are clustered at the brand level.} The aim of these regressions is to show the change in Salcobrand’s pricing behavior over time. Panel (a) shows Salcobrand’s price response to Cruz Verde’s lagged price changes, which I calculate as the sum of the coefficients of Cruz Verde’s two lagged prices in Salcobrand’s price regression. Notice the increase in Salcobrand’s followship of Cruz Verde as a result of the price war, its decrease during coordination, and its return to the pre-price war period when coordination Stops. To know whether these patterns are a result of changes in the behavior only of Salcobrand’s or also in that of Fasa’s, Panel (b) compares Salcobrand’s and Fasa’s price responses to Cruz Verde’s price. In particular, the Panel plots the difference between Salcobrand’s and Fasa’s pricing responses to Cruz Verde’s lagged price changes. The difference in the coefficients is not significantly different from zero throughout the price war and the post-collusive period. This shows that Salcobrand followed Cruz Verde in most of the period in a similar way as Fasa did. However, during coordination Salcobrand stopped following Cruz Verde’s prices. Because Fasa’s tendency to follow Cruz Verde did not change during the period of coordinated increases, the difference plotted in the Figure becomes negative and returns to zero only after coordination stops.

To summarize, the analysis shows two types of leadership in the period under study. In the first one, competitive price leadership, the dominant firm, Cruz Verde, led price changes possibly jointly with the second largest chain, Fasa. Competitive leadership oc-
curred during most of the period in the data, both during the price war and during the post-coordination period. In the second type, collusive price leadership, the small firm, Salcobrand, led the coordinated increases. This mechanism was instrumental in the shift from the loss-leading equilibrium to the coordinated one. The findings present a clear picture of the correspondence between the leadership dynamics and the competitive state. During the price war and after the firms were caught coordinating price increases, Salcobrand was a follower of Cruz Verde’s, the dominant firm, as we would expect from the abundant literature on competitive price leadership. Yet, during coordination, Salcobrand stopped responding to the other firms’ price changes. Strong price leadership by the small firm, therefore, only occurred in the coordinated transition to the new equilibrium.

**Figure A2 – Price Leadership of Cruz Verde over Time**

(a) Salcobrand’s price response to a price change of Cruz Verde  
(b) Difference in Salcobrand’s and Fasa’s price responses to a price change of Cruz Verde

Note: Panel (a) shows the effect of Cruz Verde’s lagged price changes on Salcobrand’s current price changes and its 95 percent confidence interval using a 20-week rolling time window. Panel (b) shows the difference between the effects of Cruz Verde’s lagged price changes on Salcobrand’s and on Fasa’s current price changes, and the 95 percent confidence interval of the difference using a 20-week rolling time window. All regressions include two lags, a cubic time trend, and a brand fixed effect. Standard errors are clustered at the brand level.

**Impulse Responses**

This section shows selected impulse responses of the VAR model of System (A1). I plot the local projections of impulse responses due to Jordà (2005). In a VAR model with three variables, x, y, and z, the local projection of the impulse response of x on y at time h corresponds to the coefficient β^x_{0h} in the estimation of the equation:
\[ y_{i,t+h} - y_{i,t-1} = \alpha_h + \sum_{k=0}^{L} \rho_k x_{i,t-k} + \sum_{k=1}^{L} \gamma_k y_{i,t-k} + \sum_{k=0}^{L} \delta_k z_{i,t-k} + \lambda_i + f(t) + \epsilon_{i,t+h} \]

where the \( i \) indexes individuals (products), and \( \delta_1 \) and \( f(t) \) correspond to individual fixed effects and time controls, respectively. The main advantage of local projections is that they are more robust to misspecification than impulse responses generated from moving average representations. Also, in my setting, local projections accommodate easily to panel data and to various time and product controls and standard errors specifications.

I present the estimation results in the figure at the end of this appendix. The main result is that the impulse responses of a price increase in Salcobrand on the other pharmacies’ prices is much larger during the collusive period. Admittedly, during the pre-price war period the contemporaneous impulse response on Cruz Verde is 15 percent, almost the same as the impulse response during collusion. Yet, the effect during collusion is more persistent, which makes the cumulative impulse response during collusion more than two times larger than that during the pre-collusive period (and statistically significantly larger; p-value=3.11 for lags 0-1 and p-value=2.51 for lags 0-3).
Figure A3 – Local Projections of Selected Impulse Responses

Note: The Figure shows selected impulse responses of the VAR model of System (A1). I plot local projections of impulse responses due to Jordà (2005). Standard errors are clustered at the product level.
A3  **Theoretical Framework**

In this section I suggest a theoretical framework to understand the pharmacies’ costs of leadership during collusion. The aim is to determine the leader’s incentives to raise its price and the follower’s decision to follow suit. Therefore, the leader’s identity is predetermined. The fundamental reason for leadership in the model is the asymmetry in the firms’ strength, which is due to difference in the firms’ ability to fight the price war and stems from resources from other markets or from marginal costs differences. I refer to Section 2 for more details.

Consider two firms, which play an infinitely repeated price setting game on differentiated products. The firms sell to consumers who buy every period and who have no outside option. For simplicity, suppose there are only two possible price levels the firms can set: the competitive Nash price $p^N$, and the collusive price $p^C$, where $p^N < p^C$. Prices are perfectly observed. The firms can be asymmetric in size, for example, due to differences in their number of stores. Therefore, if firms set the same price, the firms’ market shares are $s$ and $1 - s$. In addition, if there is a difference in the firms’ prices the cheapest firm steals $\Delta s$ share of consumers from the more expensive firm. One of the firms is weak and the other one is strong. I will refer to the firm with a market share of $s$ as the weak one. Finally, firms have the same marginal cost, which is normalized to 0.

Suppose that until $t = 0$ the two firms have set a price $p^N$. How can the firms coordinate on the high price? Consider the following collusive mechanism: At $t = 0$ the strong firm makes a take-it-or-leave-it offer to raise prices $\tilde{T}$ periods after a weak firm’s price increase. If the weak firm accepts the offer, it increases its price to $p^C$ immediately. If the price increase is maintained over time, then the strong firm matches the price increase at a time $T \geq 1$. Otherwise, the strong firm never raises price. On the other hand, if the strong firm does not increase its price by time $t = T_{\text{max}}$, the weak firm decreases its price back to $p^N$ forever. This setting determines a game in which the strategy of the weak firm, the leader, consists of choosing a maximum waiting time of $T_{\text{max}} \in [0, \infty)$ and the strategy of the strong firm, the follower, consists of a time by which to raise price $T \in [1, \infty)$. Notice that the leader prefers small $T$ and that the follower prefers large $T$. However, given the take-it-or-leave-it offer, the follower possesses all the bargaining power and can extract all the surplus. Thus, in equilibrium $T = \tilde{T} = T_{\text{max}}$.

The following proposition states the individual rationality constraint for which the leader will accept the follower’s offer, which is a function of the leader’s relative market share loss and of the relative price change, akin to the elasticity of demand.
**Proposition 1.** The leader leads a price increase that is followed the other firm at $t = T$ iff

$$\delta^T \geq 1 - \frac{1}{\eta}$$

(A2)

where $\eta = \frac{\Delta s}{s} \cdot \frac{p^C}{p^C - p^N}$.

**Proof.** The condition that the leader prefers to lead a price increase rather than to continue setting the competitive price is

$$\sum_{t=0}^{T-1} \delta^t (s - \Delta s)p^C + \sum_{t=T}^{\infty} \delta^t sp^C \geq \sum_{t=0}^{\infty} \delta^t sp^N$$

$$\frac{1}{1 - \delta} sp^C - \frac{1 - \delta^T}{1 - \delta} \Delta sp^C \geq \frac{1}{1 - \delta} sp^N$$

$$\delta^T \geq 1 - \frac{s}{\Delta s} \cdot \frac{p^C - p^N}{p^C}$$

from which the proof follows immediately.

If $\eta \leq 1$ the delay should be infinite. However, notice that this is the case when the relative loss in market share $\Delta s/s$ is smaller than the collusive markup $(p^C - p^N)/p^C$. Hence, for a given level of price sensitivity, the latter condition is more likely to happen when $s$ is large. This provides justification for the leader being also the small firm in the market and relates to the conditions about when we should see this leadership mechanism being used in reality.\footnote{In addition, we can assume that, in practice, $T_{max}$ is bounded.}

In equilibrium, when the follower extracts all the leader’s rents, we obtain that

$$T = \left\lfloor \frac{\ln \left(1 - \frac{1}{\eta} \right)}{\ln \delta} \right\rfloor.$$  

(A3)

This equation establishes a relationship between the time $T$ the leader is willing to wait, and the elasticity of demand. In particular, there will be more delay in more inelastic markets. More generally, the implication of these results is that there will be more delay in markets where the per-period costs of leading collusion are lower. This is because the leader can afford to lose more in such markets relative to the collusive profits. Hence, under some assumptions on the demand, there will also be more delay in markets where
the leader’s market share is larger because the relative loss in market share when leading is lower.\textsuperscript{34}

\section*{A4 Intermediate Price Increases}

The aim of the following section is determining whether the same results I previously found apply to the intermediate steps, that is, the delays between the first and the second firm, and that of the second and the third firm. Since in many instances the two followers raise prices on the same day, I estimate Poisson regressions in order to account for the zero intermediate time of ties. I show the results in Table A2. These reveal a similar effect of Cruz Verde’s dominance, as measured by the range of shares, on intermediate increases. Column (1) shows the time between the first and the third firm to raise prices, mimicking the analysis in Table 1. Columns (2) to (5) estimate the effect of Cruz Verde’s dominance on the time spanned between the leader’s and the first follower’s increase. Column (3) also includes a dummy variable indicating whether the two followers increase price simultaneously. The effect is not significant, suggesting that ties are equivalent to the potential third follower raising price before its due time, as opposed to the first follower delaying a price increase. Columns (4) and (5) separate products according to the pharmacy that moved last. Finally, Columns (6) to (8) analyze the time spanned between the first and the second follower, considering ties as cases in which the dependent variable is zero.

The results, both those of the total and the intermediary delays, reveal a strong dominant firm effect, similar to that found in the previous subsection, by which collusive leadership in markets where the dominant firm is larger takes more time. This finding is consistent with the prediction of the leadership model of Section A3 that a less dominant follower delays more its price increase. The reason for this is that in these cases truthful information is more costly for the leader to convey and, thus, require a larger following time.

\textsuperscript{34}For example, in the logit model $\eta = \nu(1 - s)p^C$, where $\nu$ denotes the degree of price sensitivity.
### Table A2 – Time of Coordinated Increase – Intermediate Increases

| Dependent Variable: Time between Intermediate Price Increases [Days] |
|---|---|---|---|---|
| 1st-3rd | 1st-2nd | 2nd-3rd |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Range of Shares | -1.003*** (0.281) | -1.236*** (0.389) | -1.225*** (0.387) | -1.173* (0.646) | -0.560 (0.378) | -1.187*** (0.393) | -0.818* (0.441) | -2.184*** (0.465) |
| Tie | -0.691*** (0.125) | -0.0256 (0.143) | |
| Ln Revenues | 0.133** (0.055) | 0.176** (0.086) | 0.176** (0.087) | 0.378*** (0.145) | -0.008 (0.080) | 0.091 (0.062) | 0.086 (0.075) | 0.107 (0.099) |
| Constant | 70.83* (37.99) | 54.51 (43.75) | 56.71 (47.67) | 94.40 (94.18) | 94.40 (70.51) | -62.71 (29.75) | -53.15* (38.28) | -163.8*** (55.20) |
| Last Follower | Any | Any | Any | Fasa | CV | Any | Fasa | CV |
| N | 186 | 186 | 186 | 71 | 89 | 186 | 115 | 97 |
| Pseudo LL | -310.1 | -263.4 | -263.4 | -108.6 | -115.0 | -222.5 | -136.3 | -108.4 |
| No. of Brands | 154 | 154 | 154 | 67 | 82 | 154 | 98 | 89 |

Note: The table present results of Poisson regressions. The dependent variable is measured in days. I exclude a few instances of two firms raising price first simultaneously. The variables Range of Shares corresponds to the difference in market shares between Cruz Verde and Salcobrand. All specifications include a quadratic time trend. Standard errors in parentheses are clustered at the brand level. * p<0.1, ** p<0.05, *** p<0.01