Building Trust

A Dynamic Game of Coordinated Price Leadership

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DSE conference, 20214

Introduction

- How do firms coordinate into a new equilibrium?
- Difficult problem:
  - Communication hard
  - Agreements unenforceable
  - Uncertainty about the competitor

Introduction (cont'd)

- How may firms transit into a new equilibrium?
  $\rightarrow$ This paper, *gradually*, building trust.
- Case of collusion among retail pharmacy chains
  - Transition to a coordinated equilibrium using multimarket contacts
  - Large price increases in hundreds of medicines
  - Gradualism over 200+ products

This Paper

1. Characterize the actions of transition into a new equilibrium
   - ◇ Gradual coordination on new equilibrium
   - ◇ Collusion happened earlier in markets **more differentiated** and more asymmetric ones led by smallest chain.
2. Estimate a dynamic game of trust building with relaxed (biased) beliefs (Aguirregabiria and Magesan, 2019)
   - ◇ captures the gradual shift
   - ◇ highlight strategic uncertainty about the competitors' *willingness to coordinate*.

Related Literature

1. The emergence of cooperation among firms
   - Internal functioning of cartels. Porter (1983), Genesove and Mullin (2001), Roller and Steen (2006), Asker (2010), Clark and Houde (2013), Igami and Sugaya (2021)
   - Coordination: Byrne and De Roos (2019), Miller, Sheu, and Weinberg (2021)
2. Non-equilibrium beliefs
   - Dynamic games. Aradillas-Lopez and Tamer (2008); Aguirregabiria and Jeon (2020)
   - Empirical evidence of firms' non-equilibrium beliefs: Goldfarb and Xiao (2011), Hortaçsu and Puller (2008), Hortaçsu, Luco, Puller, Zhu (2019)
3. Use of multimarket contacts
   - Bernheim and Whinston (1990). Evans and Kessides (1994), Ciliberto and Williams (2014).
4. Uncertainty and trust
   - Relationship building: Sobel (1985), Watson (1999, 2002). Macchiavello and Miquel-Florensa (2016).
   - Cooperation in the lab: Dal Bó and Fréchette (2011).

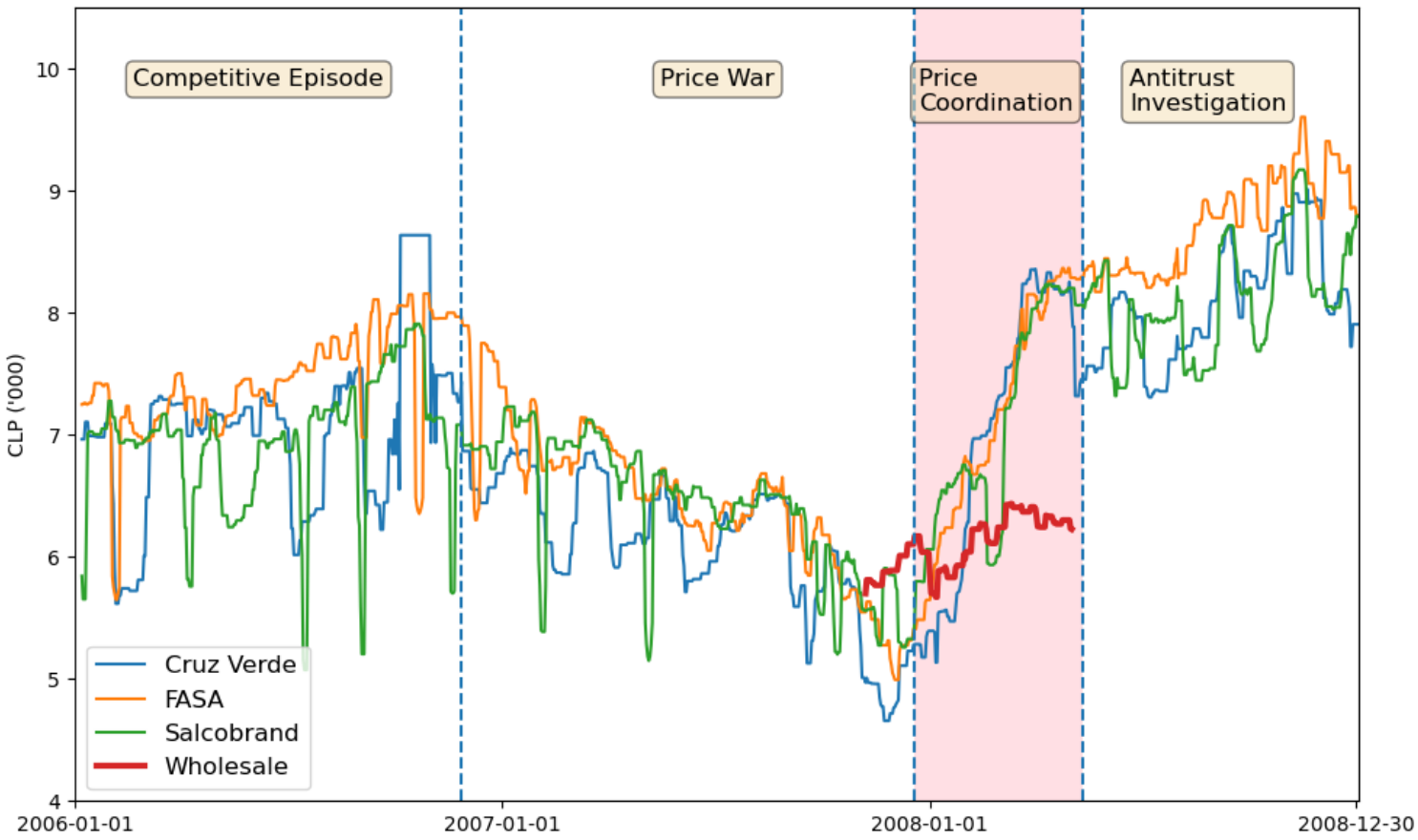
Market Overview

- Three main retail pharmacy chains (92% market share)
  - Cruz Verde, Fasa, Salcobrand
  - 8 % independent drugstores that do not carry branded drugs.
- Prices not regulated.
- Physicians prescribed brands. No brand switching allowed (prescription-only drugs).
- Insurance coverage very limited.

Data

- Transaction data 2006–2008 of the 222 brands involved in collusion.
- For each chain, each brand, we calculate total volume and sales-weighted average price (no store location in data)
- Most products are prescription drugs; 70% are treatment for chronic diseases.
- Other sources: emails, IMS data for some categories, Salcobrand wholesale prices.

Price Trends: Weighted Average Price Level 2006–2008



Example of Coordinates Price Increases

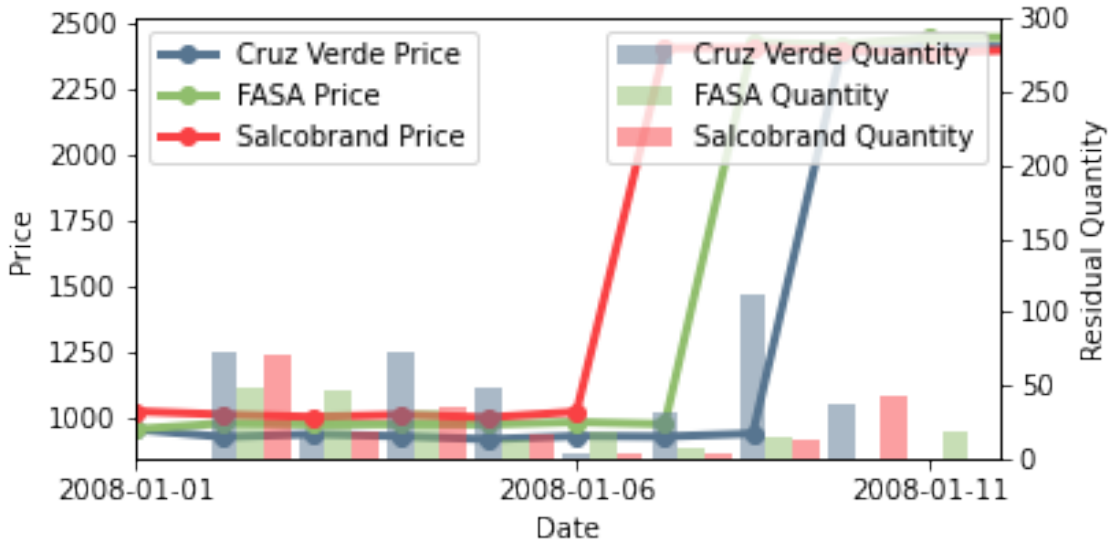


Figure: Prices and Sales of *Marvelon-20 Caja 21 Comp.*

Coordinated Price Increases happened mostly during collusion

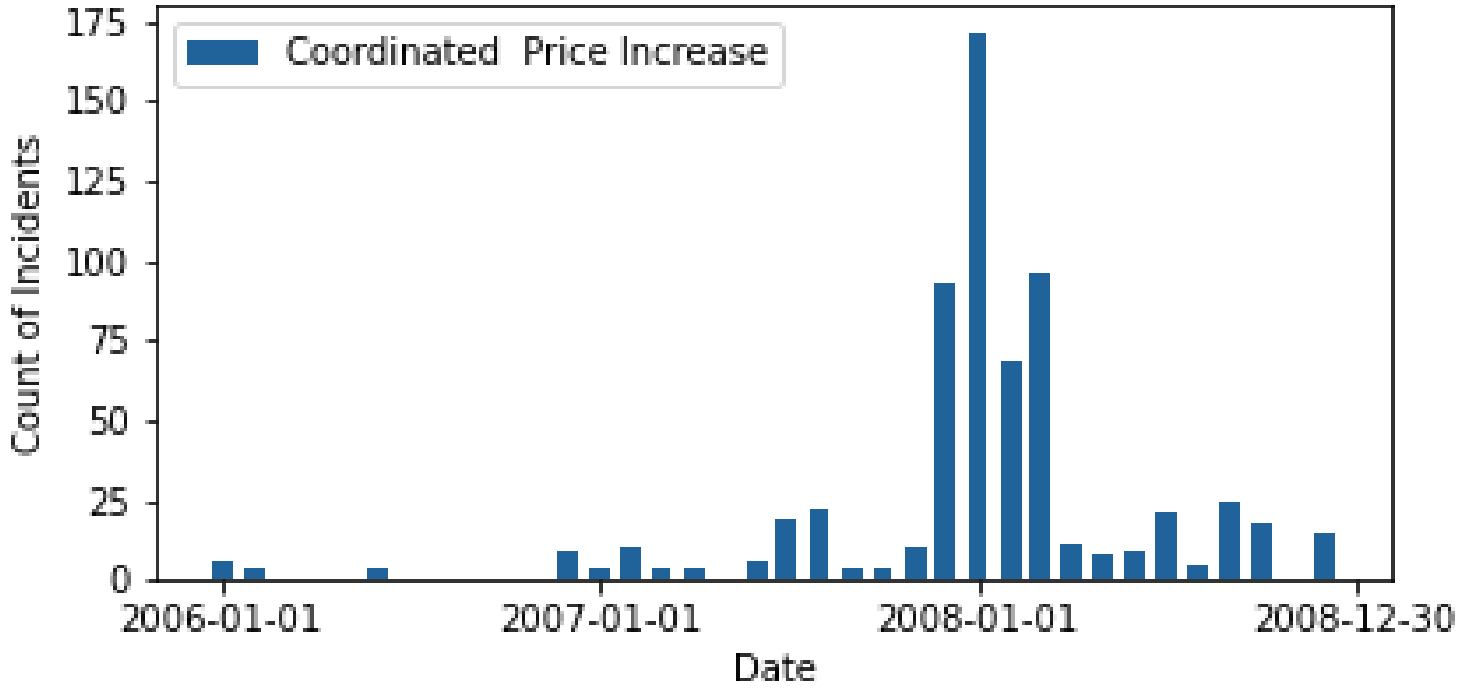


Figure: Number of Coordinated Price Increase

The Antitrust Case

1. "Competitive" stage in 2006

2. Price War on best-selling products in 2007.
   - Price cuts + heavy advertising: loss leading
   - Price cuts lasted until an advertising ban of Cruz Verde in November 2007
     "[I]t stopped making sense (...) that Cruz Verde continued the escalation of price cuts if it couldn't advertise it." (Fasa's CEO)

3. Collusion: Coordinated price increases starting in December 2007
   - Coordinate to increase prices on a few products each week
   - Concerns about competitors: Trust

Mistrust as Reason for Staggered Mechanism

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 (. . .).*

— Former Cruz Verde board member

[The staggered mechanism was chosen because of the] **big mistrust** *with respect to Cruz Verde, and due to the fact that Fasa was not going to risk raising prices so that Cruz Verde then wouldn't do so and get advantage from it.*

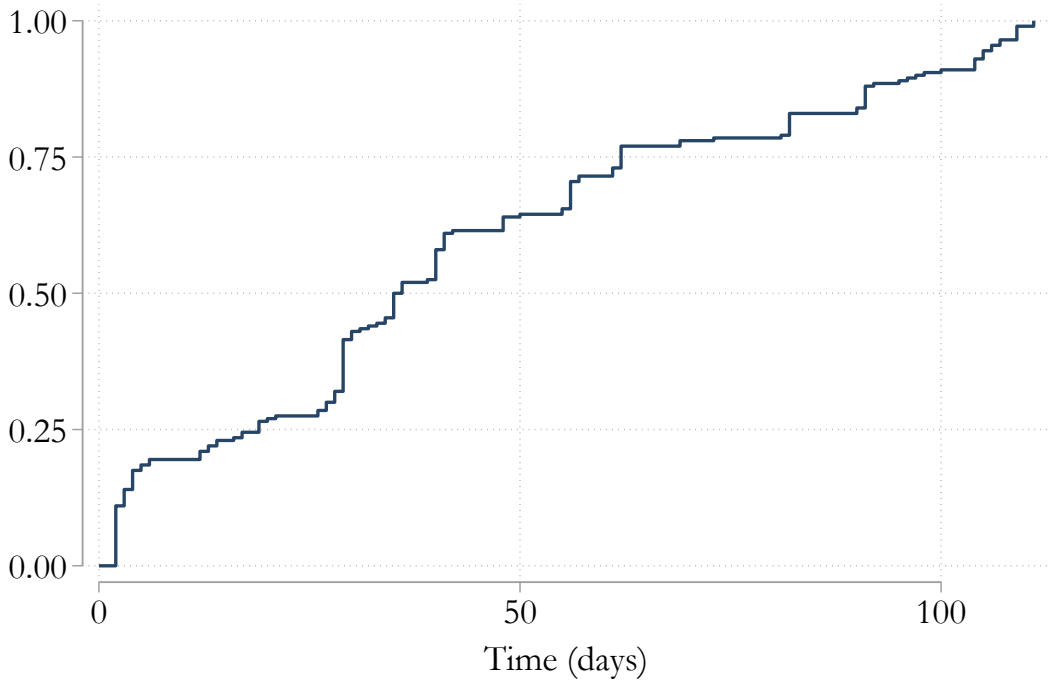
—A Fasa executive

The Emergence of Collusion

How does collusion start under uncertainty (mistrust)?

Trade-off:
$\rightarrow$ Strong signal or small risk
Failure is a coordinated price

increase



The Collusive Path

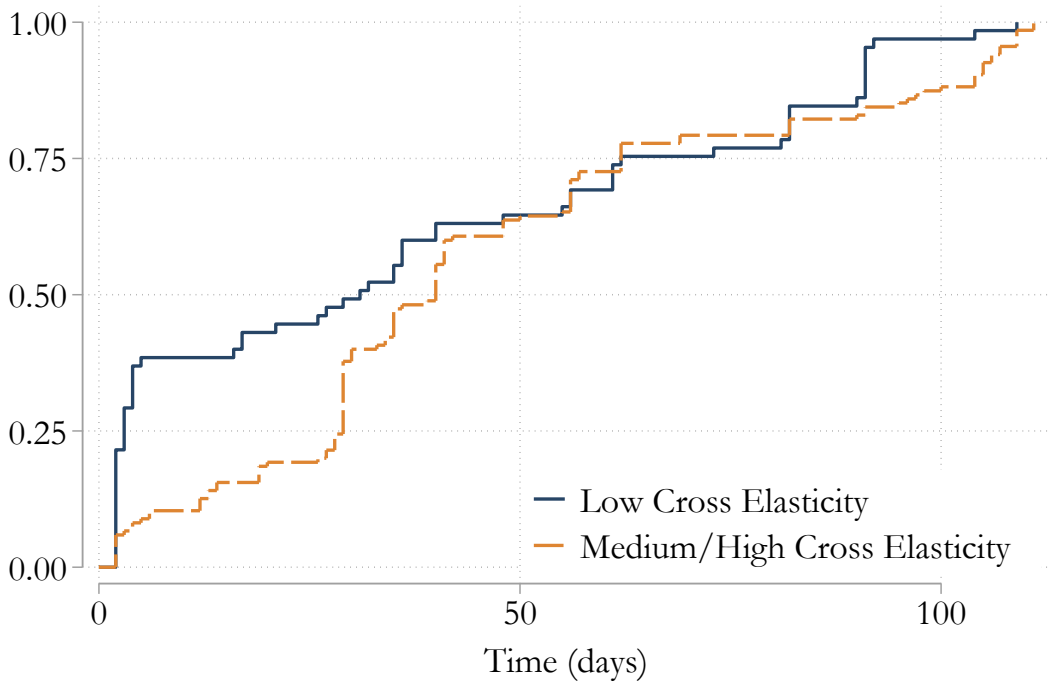
We estimate a Cox survival model:

$$h(t, x_j) = h_o(t) \exp\left\{x_j'\beta\right\}$$

Effect on the timing of collusion of:

- Pharmacy-brand differentiation (cross-price elasticity from simple logit)
- Firm asymmetry (s.d. shares)
- Market size

Result: Collusion first in differentiated and asymmetric markets



Decision Problem for the Leader

There are two equilibrium prices: high $\mathbf{x}^{\text{High}}$ and low $\mathbf{x}^{\text{Low}}$. The firms are currently in the low equilibrium.

- The low equilibrium has become unsustainable.
- The high equilibrium is more profitable.
  - $\mathbb{V}(\mathbf{x}^{\text{High}})$ is represented as $\frac{1}{1-\beta}\pi_i(\mathbf{x}^{\text{High}})$.

Decision Problem for the Leader

- As the price leader, one firm has an opportunity to increase the price first. Let the status of being the price leader be $\mathbf{x}^{\text{Lead}}$, where the profit for the leader may be lower than that of the low equilibrium.
  - If the leader chooses to lead, the value function is $\mathrm{v}(\mathrm{I}, \mathbf{x}^{\text{Low}})$.
  - If the leader chooses not to lead, the value function is $\mathrm{v}(\mathrm{O}, \mathbf{x}^{\text{Low}}) = \frac{\pi_i^{\text{Low}}}{\mathrm{I}-\beta}$.
  - The leader will lead on the first day, then the follower observes the price change and has one day to decide whether to follow.
  - The leader believes the follower's probability of following is $\mathbf{B}_i(h)$.
  - h is the history of the game.

Leader Incentive I

$$\tilde{\mathrm{v}}_i(\mathrm{I}, \mathbf{x}^{\mathrm{Low}}, h) = \underbrace{\big(\mathrm{I} + \beta(\mathrm{I} - \mathrm{B}_i(h))\big)\big(\pi_i^{\mathrm{Lead}} - \pi_i^{\mathrm{Low}}\big) - \mathrm{MC}_i}_{\text{Flow payoff during the period of leading}} + \underbrace{\beta\Big(\frac{\mathrm{B}_i(h)}{\mathrm{I} - \beta}\big(\pi_i^{\mathrm{High}} - \pi_i^{\mathrm{Low}}\big)\Big)}_{\text{Future payoff difference if successful coordination}} \tag{1}$$

- When there is no trust ($\mathrm{B}_i \approx \mathrm{o}$):
  - The second component is low:

$$\underbrace{\beta\Big(\frac{\mathrm{B}_i(h)}{\mathrm{I} - \beta}\big(\pi_i^{\mathrm{High}} - \pi_i^{\mathrm{Low}}\big)\Big)}_{\text{Future payoff difference if successful coordination}} \approx \mathrm{o}.$$

  - The first component is close to $\underbrace{(\mathrm{I} + \beta)(\pi_i^{\mathrm{Lead}} - \pi_i^{\mathrm{Low}}) - \mathrm{MC}_i}_{\text{Flow payoff during the period of leading}}$.

Leader Incentive II

- From the expression, the price leader prefers markets with a smaller $\pi_i^{\text{Lead}} - \pi_i^{\text{Low}}$ (safer markets with low cross elasticity).
- When the trust is built ($\mathrm{B}_i \approx 1$):
  - The second component is close to $\frac{\beta}{1-\beta}(\pi_i^{\text{High}} - \pi_i^{\text{Low}})$:

$$\underbrace{\beta\left(\frac{\mathrm{B}_i(h)}{1-\beta}\left(\pi_i^{\text{High}} - \pi_i^{\text{Low}}\right)\right)}_{\text{Future payoff difference if successful coordination}} .$$

- The preference for safer markets is now weaker. Firms will have a higher preference for markets with more future income.

Motivating Example - Decision Rule

- Strategy on market m:

$$\sigma_{im}(\underbrace{a_{im,t-1}, \quad a_{jm,t-1}, \quad \epsilon_{imt}}_{\text{Payoff related}}, \quad \underbrace{h_t}_{\text{No payoff related}} \quad)$$

  - $\mathrm{B}_{im}(h) = \lambda(h)\mathrm{P}_{-im}(h)$, the non-payoff relevant part of the belief is multiplicatively separable.
- h_t is a function of history; for example,
  - coordination on the other market;
  - whether other firms have deviated(Fershtman and Pakes (2000))
  - Identify the **ratio of beliefs** $\lambda(h)/\lambda(h')$ across h, h'. (Aguirregabiria and Magesan (2020))

Dynamic Game Estimation

- Flow payoff

$$\Pi_i(\mathbf{x}_{mt}, \mathbf{a}_{mt}) = \mathrm{R}_{im}(\mathbf{x}_{mt}, \mathbf{a}_{mt}) - \mathrm{MC}_{im}\mathbb{1}\{a_{imt} \neq a_{imt-1}\} + \epsilon_{imt}(a_{imt})$$

- Goal: Estimate **beliefs** $\mathbf{B}_{im}$, **profit** R_{im} and **structural cost** MC_{im}.
- Make the following restrictions:
  - The decision of prices is restricted to binary price levels: low and high.
  - Beliefs are biased by a single firm-history-specific parameter $\lambda(h_t) \in [0, 1]$.
  - h_t is the number of coordinated price increases across markets. $h_t \in \{[0, 30], [31, 90], [91, 150], [151, \infty)\}$.

History ▸ Price Leadership

Panel A: Estimation of Belief Parameters $\lambda(h)$

History	Estimates	Bootstrap
History 0-30	0.1789	0.153
		(0.089)
History 30-90	0.2930	0.439
		(0.271)
History 90-150	0.5182	0.515
		(0.170)
History 150+	1.0000	-

Panel B: Estimation of Structural Costs (1000 Chilean Pesos)

	Flexible Belief			Rational Belief		
Costs	Cruz Verde	FASA	Salcobrand	Cruz Verde	FASA	Salcobrand
Menu Cost	74.619	96.044	84.711	14.218	1334.256	107.641
Leadership Cost	1602.475	2238.598	1429.974	95804.489	323648.470	4.219
90% Quantile	3985.463	5265.212	3182.917	225968.155	727003.623	282.964
10% Quantile	79.059	164.346	59.532	10971.365	52475.795	227.776

Model Prediction - Simulated Path

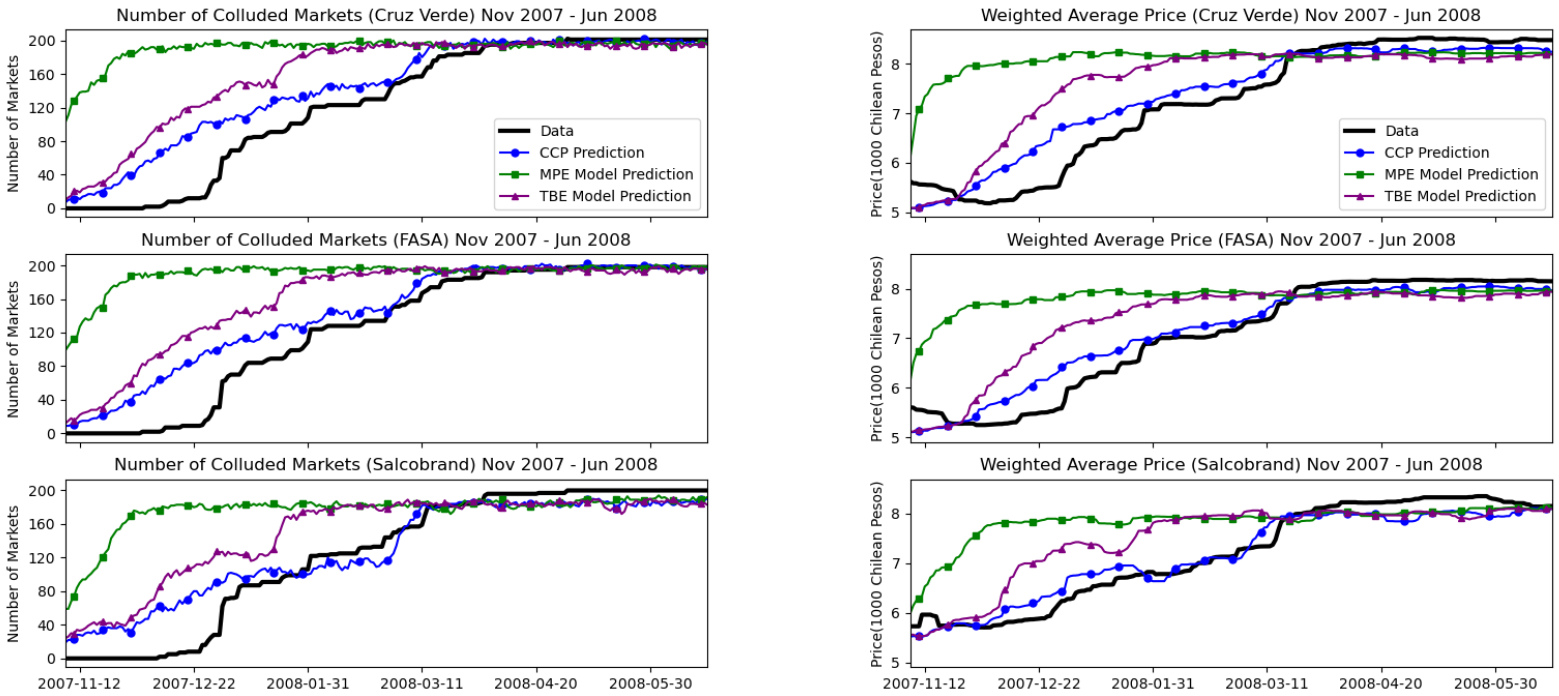


Figure: Model Prediction - Simulated Path

Contribution

- Empirical evidence of firms' transition between equilibrium.
  - successful coordination increases future coordination likelihood,
  - changing expectations of high price equilibrium adherence.
- First structural model for **equilibrium transition** with **learning-to-coordinate**.
  - Finding: the gradualism in transition explained by learning-to-coordinate.
  - Identification results.

Thank You

Collusion News

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ECONOMY

'New Case of Collusion in Chilean Medicine Market'

by Boris van der Spek 20 January, 2020 0 1221

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Reading Time: 2 minutes

SANTIAGO – A recent investigation shows that the three major pharmacies in Chile are holding prices of at least 120 medicines artificially high. According to one of the journalists involved, the study shows that pharmacies are still colluding, over 10 years after a major collusion scandal struck the Chilean medicine market. The journalists in charge have handed the details to the National Prosecutor.

▶ Motivation

Definition of Expected Payoff

- Given current beliefs, we can represent a firm's best response at time t using solution from a single agent Dynamic Programming(DP) problem following Bellman's principle.

$$V_{it}^{B_{it}}(\mathbf{x}_t) = \max_{a_{it}} \{\pi_{it}^{B_{it}}(a_{it}, \mathbf{x}_t, \epsilon_{it}) + v_{it}^{B_{it}}(a_i, \mathbf{x}_t)\}$$

- The current epxected payoff

$$\pi_{it}^{B_{it}}(a_{it}, \mathbf{x}_t, \epsilon_{it}) = \sum_{\mathbf{a}_{-it}} B_{it}(\mathbf{a}_{-it}|\mathbf{x}_t)\Pi_{it}(a_{it}, \mathbf{a}_{-it}, \mathbf{x}_t, \epsilon_{it}).$$

- And the expected continuation value

$$v_{it}^{B_{it}}(a_i, \mathbf{x}_t) = \sum_{\mathbf{a}_{-it}} \beta B_{it}(\mathbf{a}_{-it}|\mathbf{x}_t) \sum_{\mathbf{x}_{t+1}} f(\mathbf{x}_{t+1}|a_{it}, \mathbf{a}_{-it}) V_{it+1}^{B_{it}}(\mathbf{x}_{t+1}).$$

▸ Equilibrium Strategy

Competition Tribunal Sentence

- The Competition Tribunal sentence Farmacias Cruz Verde Salcobrand to pay approximately US$19 million each (Maximum applicable fine).
- Collusive agreement to increase prices of at least 206 pharmaceutical drugs between December 2007 and March 2008.
- The price in real values before vs. after the break it was 16.4% for SB, 18.6% for CV and of 16.9% for FASA.

Price Trend

Table: The Coordinated Price Increase Frequency

Time periods	Frequency	Percentage	Monthly average
Jan,2006 - Nov, 2007	24	12.8%	1.04
Dec,2007 - Apr, 2008	137	72.9%	27.40
May,2008 - Dec, 2008	27	14.4%	3.86
Total	188	100%	5.22

[1] The coordinated price increase is defined by the action such that one firm make a price increase on a certain product, and the other firms follow within a reasonable short time period.

[2] The table recomputed using the method in the expert report requested by FNE. **?**.

▸ Definition of coordinated price increase ▸ Facts

Table: The 1-2-3 Price Increase/ Decrease Frequency

Sequence	Jan,2006 -Nov,2007	Dec,2007 -Apr,2008	May,2008 -Dec,2008	Total
	1-2-3 Price Increase			
SB lead	11	126	10	147
FA lead	12	8	10	30
CV lead	10	0	12	31
Total	32	143	32	188

1 The table is recomputed according to the method reported in the expert report **?**

2 Based on the foregoing, the relevance of SB on the subject is highlighted, because of the total increases 1-2-3 accounted for, 75% of them (162 increases) are made in the first movement.

▸ Definition of coordinated price increase ▸ Facts

Table: Average Quantity Level Before and After the Price Increase

	Before	After
All drugs	215.5	200.3
By Prescription		
Prescription Drugs	214.4	201.2
Over-the-Counter Drugs	221.0	195.5
By Chronic Disease		
Chronic Disease	165.8	154.0
Non-Chronic Disease	308.1	286.1

[1] For each drug, I compute the average daily sale from 14 days to 7 days before the price increase, and 7 days to 14 days after the price increase.

[2] The daily average were computed using the Dec 2007 - Apr 2008 period.

▸ Dynamic Game Estimation

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