

When Wholesalers Join the Cartel

Vertical Coordination in Gasoline Markets

Bruno Amat - UW-Madison

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Standard view

- Vertical coordination can align incentives across tiers
- It may reduce double marginalization
- Final prices can fall in competitive settings

This paper

- In collusive settings, the same vertical links can amplify market power
- Wholesalers help coordinate, monitor, and discipline retailers
- Wholesale terms become an enforcement instrument

Vertical coordination may be efficient in competition, but harmful in collusion.

Important Definitions

Horizontal retail cartel

Collusion among retailers, with no documented evidence that wholesalers either colluded among themselves or actively participated in the downstream cartel.

Vertical cartel

Collusion involving retailers and wholesalers, where wholesalers actively participate in coordination or enforcement through the wholesale relationship.

Question. Once collusion exists, does upstream participation make the cartel more harmful?

Empirical approach

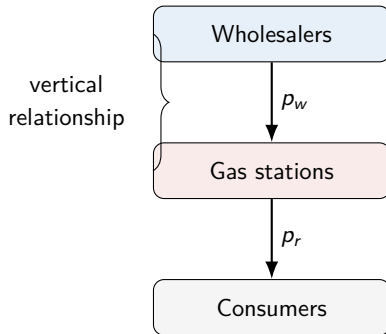
I test whether the active participation of wholesalers in a cartel changes retail prices, retail markups, and wholesale markups relative to purely horizontal retail cartels.

Theoretical approach

I develop a model incorporating the mechanisms documented in the legal evidence and ask whether these mechanisms are sufficient to rationalize the empirical results.

Institutional setting: why gasoline markets are useful

- Retail prices are publicly posted and frequently adjusted
- Stations compete locally and face capacity constraints
- Wholesalers supply many stations through repeated contractual relationships
- Formal vertical integration is prohibited, so vertical links operate through contracts and commercial terms



- Eight Brazilian gasoline cartel cases adjudicated by CADE, 2004–2020
- Four horizontal and four vertical cases. No geographic overlap
- Weekly station-level retail prices, wholesale prices and cost from ANP
- Station characteristics: storage capacity, pumps, exclusive supply agreements
- Final dataset: 7,644 stations across 156 cities
- Identification compares cartel markets to matched nearby control cities and matched stations

	Horizontal cartel	Vertical cartel
Coordination	Retail meetings, calls, associations, reference stations	Retail coordination plus wholesaler representatives
Monitoring	Posted retail prices	Posted prices plus wholesale relationships
Enforcement	Peer pressure, threats, visits	Peer pressure plus wholesale terms, discounts, financial offsets

Takeaway

The legal evidence motivates the model: wholesalers do not merely observe the cartel; they expand the enforcement technology.

City-level dissolution design

$$Y_{mct} = \alpha_m + \psi_{ct} + \beta_1 Post_{mct} + \beta_2 (Post_{mct} \times Vertical_c) + \xi_{mct}.$$

Because treatment is cartel dissolution, I report $-\beta_1$ and $-\beta_2$, so that positive values represent the **increase during cartel operation**.

Outcome	Horizontal effect ($-\beta_1$)	Additional vertical effect ($-\beta_2$)
Retail price (p_r)	1.2%***	3.2%***
Retail markup ($\frac{p_r - p_w}{p_r}$)	1.1*** pp	1.5** pp
Wholesale markup ($\frac{p_w - c}{p_w}$)	≈ 0	2.1* pp

Notes: The table reports the negative of the estimated post-dissolution coefficients, so that positive values are interpreted as increases during cartel operation. Standard errors are clustered at the city level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

$$Y_{ist} = \alpha_{is} + \lambda_{st} + \beta_1 D_{ist} + \beta_2 (D_{ist} \times Vertical_s) + \beta_3 (D_{ist} \times Small_i) + \beta_4 (D_{ist} \times Vertical_s \times Small_i) + \varepsilon_{ist}$$

- $D_{ist} = Treated_{is} \times Post_{st}$, where $Post$ is after cartel dissolution.
- Coefficients are sign-reversed and interpreted as effects during cartel operation.
- α_{is} : station-by-stack fixed effects.
- λ_{st} : stack-by-week fixed effects.
- Standard errors clustered at the station-group level.

Firm-Level Heterogeneity: Station Size

	Retail price	Retail markup	Wholesale markup
<i>Panel A. Total effects</i>			
Horizontal, large	2.15***	1.87***	−0.01
Horizontal, small	2.06***	1.66***	0.10
Vertical, large	3.81***	3.19***	0.02
Vertical, small	3.27***	2.04***	0.62***
<i>Panel B. Regression components</i>			
Horizontal, large effect	2.15***	1.87***	−0.01
Small effect, horizontal	−0.09	−0.20	0.11
Vertical effect, large	1.67***	1.32***	0.03
Small effect, vertical	−0.45	−0.94**	0.49*
<i>Notes:</i> Price effects are in percent; markup effects are in percentage points. Standard errors are clustered at the station-group level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.			

Takeaway

Small stations in vertical cartels face lower retail-margin gains and higher wholesale markups.

Model: Objects and Capacity Assumptions

Goal: can the documentary mechanisms rationalize the reduced-form facts?

Objects

- Demand $D(p)$, decreasing and concave.
- N_w wholesalers with marginal cost c and discount rate δ .
- N_r retailers with capacities k_i and discount rate θ .
- Total retail capacity:

$$K = \sum_i k_i.$$

Capacity assumptions

- No single retailer can serve monopoly demand.
- The market remains competitive if one retailer is removed.

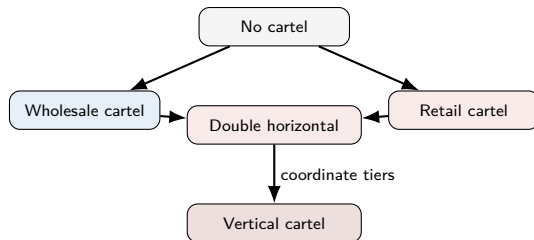
1. Cartel-formation stage

- 1.1. Retailers choose whether to form a downstream cartel Γ with capacity $K_\Gamma = \sum_{i \in \Gamma} k_i$.
- 1.2. Wholesalers choose whether to form an upstream cartel.
- 1.3. If both tiers collude, they decide whether to coordinate vertically.

2. Repeated pricing stage

- 2.1. Without vertical coordination: wholesalers choose p_w , then retailers choose p_r .
- 2.2. With vertical coordination: both tiers jointly choose p_r and negotiate p_w' .

I solve the game backwards.



Following Bos and Harrington (2010), take the cartel composition Γ and cartel capacity K_Γ as fixed during the pricing game.

Outsiders

- Undercut the cartel price: $p_r - \xi$.
- Sell their full capacity k_i .
- Benefit from the cartel price umbrella without sharing cartel surplus:

$$\pi_i^{out} \simeq (p_r - p_w)k_i.$$

Insiders

$$\pi_i^{in} = \underbrace{\frac{k_i}{K_\Gamma}}_{\text{capacity-proportional sharing}} (p_r - p_w) \left[D(p_r) - \underbrace{(K - K_\Gamma)}_{\text{fringe capacity}} \right].$$

Price below integrated monopoly

If $K - K_\Gamma \geq (p_w^{RH} - c) [-D'(p^M)]$, then $p_r^{RH} \leq p^M$.

$$p_w^O > p_w^I \geq c$$

- Insiders receive favorable wholesale terms: p_w^I .
- Outsiders face worse wholesale terms: p_w^O .

- To undercut the cartel, outsiders must satisfy:

$$p_w^O \leq p_r^V - \xi.$$

- This condition ensures outsiders are not excluded: they can remain active and undercut.
- As $\xi \rightarrow 0$, wholesalers can set $p_w^O \simeq p_r^V$, leaving outsiders with zero margin.

$$p_r^V - p_w^O \simeq 0 \quad \text{but} \quad p_r^V - p_w^I > 0.$$

Takeaway

All retailers prefer to join; the vertical cartel can charge $p_r^V = p^M$.

With full participation, the cartel jointly chooses the retail price:

$$p_r^V = p^M \in \arg \max_p (p - c)D(p).$$

The insider wholesale price p_w^I divides surplus:

$$\Pi_w^V(p_w^I) = D(p^M)(p_w^I - c), \quad \Pi_r^V(p_w^I) = D(p^M)(p^M - p_w^I).$$

Let (Π_r^0, Π_w^0) be the disagreement payoffs: the best no-vertical outcome available if bargaining fails.

$$\max_{p_w^I} [\Pi_w^V(p_w^I) - \Pi_w^0]^{1-\lambda} [\Pi_r^V(p_w^I) - \Pi_r^0]^\lambda.$$

subject to ICs and no-deviation constraints

Takeaway

p_w^I size depends on the bargaining leverage of the wholesale cartel

The pricing stage can support multiple feasible cartel structures. The cartel-formation stage acts as an **equilibrium-selection mechanism**

1. Wholesalers' response

- Given the downstream cartel capacity K_F and anticipating pricing strategies, wholesalers decide whether to collude.

2. Retailers select the equilibrium

- Retailers move first, choosing K_F , anticipating the wholesalers' response.
- They select the downstream configuration that leads to the feasible equilibrium with the highest retail-cartel payoff.

- The evidence shows that vertical cartels are not simply horizontal retail cartels with one extra layer of collusion. When wholesalers participate, the cartel generates larger retail-price and retail-markup effects, while wholesale markups increase more weakly.
- The model rationalizes this pattern through cartel organization. Horizontal cartels are limited by fringe capacity and by the participation incentives of smaller retailers.
- Vertical cartels change these incentives by using wholesale terms to make staying outside less attractive, expanding participation and allowing the cartel to sustain higher retail prices.
- Vertical participation therefore matters because it changes how the cartel is enforced, who joins the agreement, and how the gains from collusion are divided along the supply chain.

Thank you!

Comments and suggestions welcome

`bamat@wisc.edu`

Current Draft:

`bruno-amat.github.io`

No cartel

- Retailers compete à la Bertrand.
- Wholesalers compete à la Cournot.

$$p_r^N = p_w^N = c + \mu_w^N.$$

Wholesale-only cartel

- Wholesalers coordinate; retailers remain Bertrand competitors.
- Retailers pass through the wholesale price:

$$p_r^{WC} = p_w^{WC}.$$

- Wholesalers solve:

$$p_w^{WC} \in \arg \max_{p_w} (p_w - c) D(p_w).$$

Retail-horizontal cartel

- Retailers collude downstream.
- Wholesalers do not collude; they compete à la Cournot.
- They face derived demand from the retail cartel's pricing response.

Double-horizontal cartel

- Retailers form a downstream cartel.
- Wholesalers also form an upstream cartel.
- The two cartels choose prices independently:

$$p_w^{DH} \in \arg \max_{p_w} (p_w - c) D(p_r^{RH}(p_w)).$$

Takeaway

Retail-horizontal collusion has one downstream collusive margin; double-horizontal collusion adds an upstream cartel.

1. Vertical cartels generate larger retail-price effects than horizontal cartels.
2. Vertical cartels generate larger retail-markup effects.
3. Wholesale-markup effects may be positive but need not be large because p_w^I divides surplus. It depends on wholesalers' bargaining leverage.
4. Small stations are key because they are the marginal fringe/deviation firms.

1. Empirical cartel organization

- Cartels differ in internal rules, monitoring, and enforcement.
- Asker (2010); Genesove and Mullin (2001); Byrne and De Roos (2019).

2. Hub-and-spoke and vertical collusion

- Upstream firms can facilitate or discipline downstream coordination.
- Jullien and Rey (2007); Harrington (2017); Clark, Horstmann, and Houde (2024).

3. Vertical bargaining

- Wholesale terms allocate surplus across vertically related firms.
- Horn and Wolinsky (1988); Crawford et al. (2018); Collard-Wexler et al. (2019).

Takeaway

Contribution: vertical participation changes not only cartel stability, but also cartel composition, enforcement, and the size of overcharges.

Documented Mechanisms by Case

[◀ Back to evidence](#)

Case	Type	Wholesaler reps.	Upstream pressure	Wholesale terms
1	Vertical	Yes	Partial	Yes
2	Horizontal	No	No	No
3	Vertical	Yes	Partial	Partial
4	Horizontal	No	No	No
5	Horizontal	No	No	No
6	Vertical	Yes	Yes	Yes
7	Horizontal	No	No	No
8	Vertical	Partial	Partial	Partial

Note: “Partial” denotes evidence that is weaker, indirect, alleged, archived, or not central to the final legal characterization.

- **Step 1: Match cartel cities to control cities**

- Potential controls: cities 50–200 km from cartel market
- Exclude cities within 50 km to reduce spillovers
- Nearest-neighbor matching on:

Retail HHI, Wholesale HHI, Population, Vehicles

- **Step 2: Match stations within treated–control city pairs**

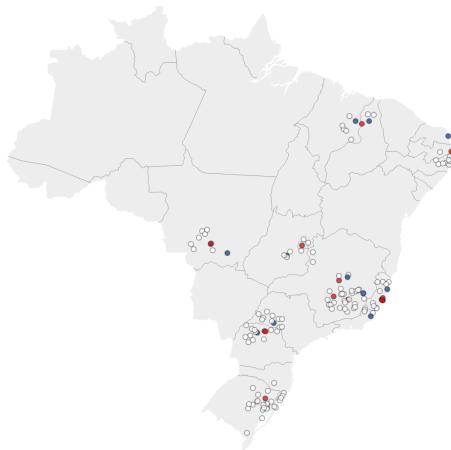
- Coarsened Exact Matching by calendar week
- Match on storage capacity, number of pumps, and exclusive supply status

- **Estimation sample**

- Compare treated stations to similar stations in matched control cities
- Difference-in-differences around cartel dissolution

Geographic Market

[◀ Back to matching](#)



■ Matched Control Group ■ Treatment Group ○ Control Group

	All cities	Cartel markets	Matched cities
Retail price	2.78	2.73	2.83
Wholesale price	2.41	2.41	2.45
Retail markup	0.13	0.12	0.13
Wholesale markup	0.47	0.46	0.48
Retailer HHI	1,204	317	418
Wholesaler HHI	2,023	1,586	1,329
Cars	78,823	362,738	147,292
Population	213,067	815,219	401,542

Takeaway

Matched control cities are closer to cartel markets than the full set of potential controls.

Market Characteristics by Cartel Type

[◀ Back to data](#)

	Horizontal	Vertical	Vertical excluding Brasília and Belo Horizonte
Retailer HHI	350.6 (305.0)	279.1 (153.7)	298.1 (126.7)
Wholesaler HHI	1,454.5 (580.8)	1,736.9 (681.4)	1,457.5 (595.5)
Number of cars	160,970 (73,956)	593,332 (711,450)	182,364 (64,898)
Population	482,961 (227,712)	1,194,944 (1,056,923)	593,090 (225,317)
Observations	8	7	5

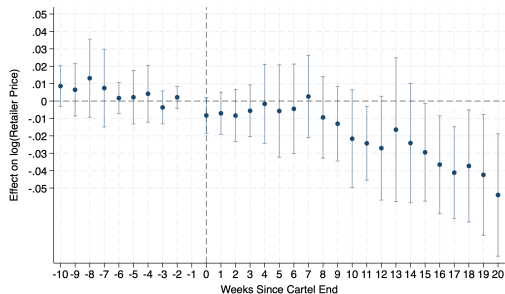
Notes: The table reports means by cartel type, with standard deviations in parentheses. The final column excludes Brasília/DF and Belo Horizonte/MG from the vertical-cartel sample.

- Within each treated-control city pair, treated stations are matched to controls observed in the same calendar week.
- Coarsened Exact Matching uses storage capacity, number of pumps, and exclusive supply status.
- Each stack contains one treated station and its matched controls.
- Station-by-stack and stack-by-week fixed effects compare each treated station with contemporaneous, observationally similar controls.
- Matching weights are used in estimation; standard errors are clustered at the station-group level.

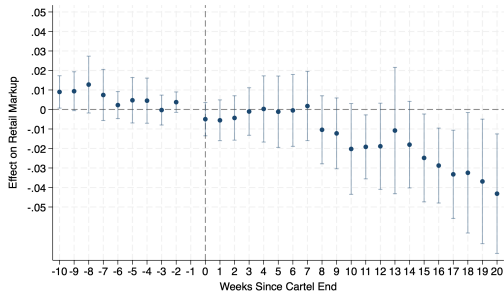
City-Level Event Study Estimates: Retail Outcomes

[◀ Back to results](#)[Wholesale outcome](#)

log(Retail Price)

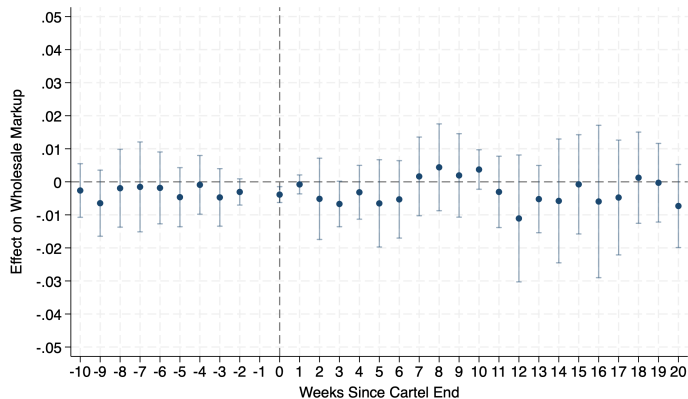


Retail Markup



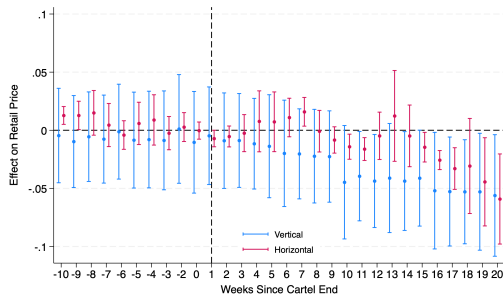
Dots: event-time coefficients from TWFE model. Bars: 95% CI. Pre-trend p -values: 0.79, 0.91, 0.99. Standard Errors are clustered at the case-week level.

City-Level Event Study Estimates: Wholesale Markup

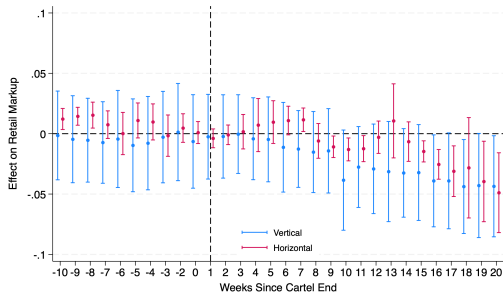
[◀ Back to results](#)[Retail outcomes](#)

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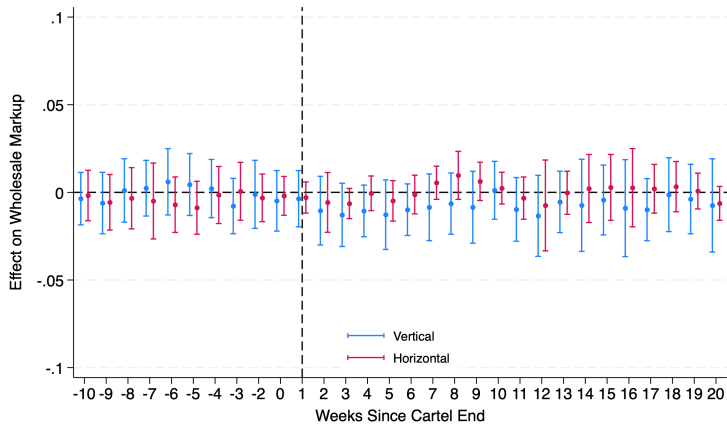
Log(Retail Price)



Retail Markup



Event Studies Robustness - Heterogeneous: Wholesale Markup

[◀ Back to results](#)[Retail outcomes](#)

Procedure

- Keep the number of vertical cases fixed at four.
- Reassign the vertical label across the eight cases:

$$\binom{8}{4} = 70$$

possible assignments.

- Re-estimate the city-level specification for each assignment.
- Compare the actual $\hat{\beta}_2$ to the placebo distribution.

Outcome	$\hat{\beta}_2$	Rank	Exact p
Retail price	-0.032	3/70	0.043
Retail markup	-0.015	6/70	0.086
Wholesale markup	-0.021	14/70	0.200

For a wholesale cartel with N_w symmetric wholesalers:

$$\frac{1}{1-\delta} \frac{\Pi_w^{WC}}{N_w} \geq \Pi_w^{WC}.$$

Therefore,

$$\delta \geq 1 - \frac{1}{N_w}.$$

Takeaway

Upstream collusion becomes harder to sustain as the number of wholesalers rises.

Following Bos and Harrington (2010), a stable cartel has a cutoff structure:

$$i \in \Gamma \iff k_i \geq \bar{k}.$$

- Larger retailers participate in the cartel.
- Smaller retailers remain outside and form the competitive fringe.

Stability requires two marginal participation conditions:

1. The **smallest insider** prefers to remain inside:

$$\pi_{\underline{i}}^{in}(\Gamma) \geq \pi_{\underline{i}}^{out}(\Gamma \setminus \{\underline{i}\}).$$

2. The **largest outsider** prefers to remain outside:

$$\pi_{\bar{j}}^{out}(\Gamma) \geq \pi_{\bar{j}}^{in}(\Gamma \cup \{\bar{j}\}).$$

With proportional sharing, the insider no-deviation constraint implies

$$D(p_r) \geq K - \theta K_{\Gamma}.$$

Given p_w and K_Γ , the cartel chooses

$$p_r^{RH}(p_w) = \min \{p^*(p_w, K_\Gamma), \bar{p}(K_\Gamma)\}.$$

The unconstrained residual-monopoly price satisfies

$$D(p^*) - (K - K_\Gamma) + (p^* - p_w)D'(p^*) = 0,$$

while the sustainability constraint imposes the price cap

$$\bar{p}(K_\Gamma) = D^{-1}(K - \theta K_\Gamma).$$

If fringe capacity is sufficiently large,

$$\underbrace{K - K_\Gamma}_{\text{fringe capacity}} \geq (p_w^{RH} - c) [-D'(p^M)],$$

then

$$p_r^{RH} \leq p^M.$$

With full downstream participation, vertical monopoly pricing is sustainable only if

$$D(p^M(c)) \geq (1 - \theta)K,$$

or equivalently

$$\theta \geq 1 - \frac{D(p^M(c))}{K}.$$

Takeaway

Full participation does not remove dynamic discipline; retailers still need to be sufficiently patient.

Vertical Cartel: Full Bargaining Problem

[◀ Back to bargaining](#)[Formation](#)

The insider wholesale price p_w^I solves

$$\max_{p_w^I} [D(p^M)(p_w^I - c) - \Pi_w^0]^{1-\lambda} [D(p^M)(p^M - p_w^I) - \Pi_r^0]^\lambda$$

subject to the downstream incentive constraints

$$\theta \geq \max \left\{ 1 - \frac{D(p^M)}{K}, \frac{\Pi_r^D(p_w^I) - \Pi_r^V}{\Pi_r^D(p_w^I) - \Pi_r^0} \right\},$$

and the upstream incentive constraints

$$\delta \geq \max \left\{ 1 - \frac{1}{N_w}, \frac{\Pi^M - \Pi_w^V}{\Pi^M - \Pi_w^0} \right\}.$$

- Vertical coordination is selected for low and intermediate elasticities
- As demand becomes more elastic, monopoly pricing entails larger quantity losses
- The model can switch from vertical coordination to retail-horizontal collusion

Takeaway

The model is not hardwired to choose vertical cartels. Market primitives determine which cartel structure is attractive.

Calibration and interpretation

Not structural estimation. The exercise asks whether the model can reproduce the qualitative ranking in the data.

Demand

$$D(p) = A - Bp, \quad p_0 = Q_0 = 1.$$

$$\varepsilon_0 = -0.399.$$

Market structure

- Empirical station capacity distribution
- Aggregate capacity $K = 1.10Q_0$
- $N_w = 3$
- $\delta = \theta = 0.95$

Takeaway

The calibration disciplines the mechanism with observed market primitives, not by targeting treatment effects.

Calibration result: vertical cartels reproduce the empirical ranking

[◀ Back to predictions](#)[Setup](#)

	Wholesale only	Retail only	Double horiz.	Vertical
Retail-cartel capacity share	–	29.9	74.6	100.0
Wholesale profit change	33.3	24.5	-2.5	25.4
Retail profit share of benchmark PS	0.0	0.1	4.6	7.9
Total producer profit change	33.3	24.6	2.1	33.3

Takeaway

Retail-horizontal collusion is limited by incomplete participation. Vertical coordination induces full participation and raises joint surplus.