Oligopolistic Price Leadership and Mergers: The United States Beer Industry

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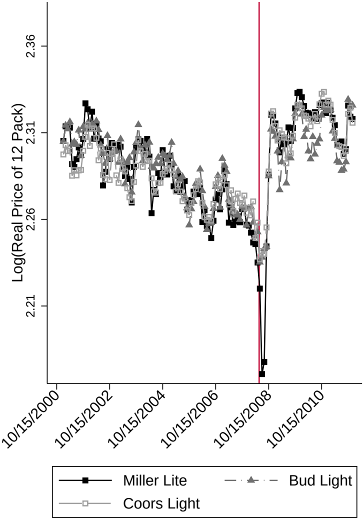
This research was primarily performed while Gloria Sheu was a staff economist at the U.S. Department of Justice. The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the Board research staff or the Board of Governors. Furthermore, the views expressed here should not be purported to reflect those of the U.S. Department of Justice.

Summer 2019

Price Leadership in Beer



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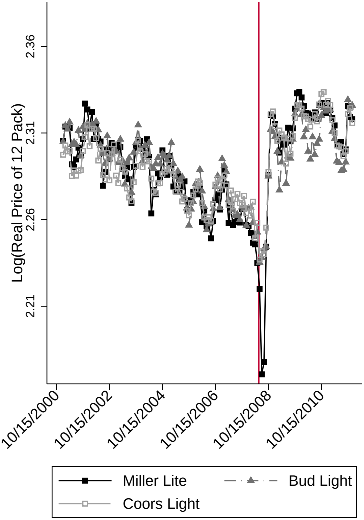

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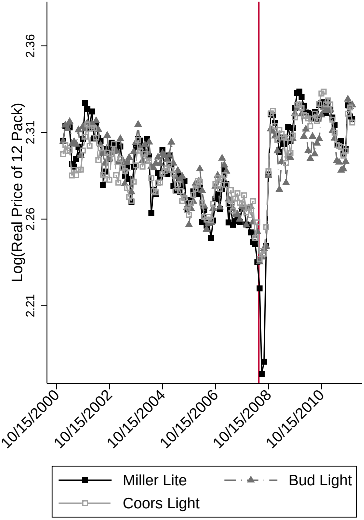

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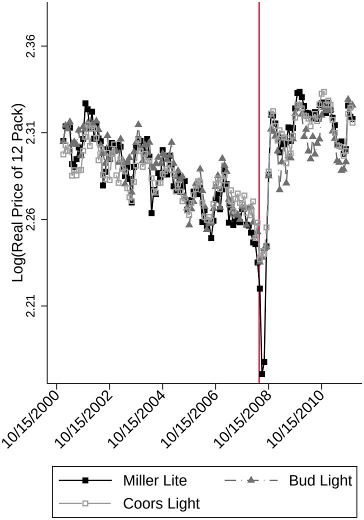

What explains the concurrent jump in prices?

- Common cost or demand changes?
- Price coordination?

Such patterns can be difficult to square with the typical static Nash-Bertrand assumption.

Price Leadership in Beer

From the DOJ Complaint in ABI/Modelo (2013):

> *ABI and MillerCoors typically announce annual price increases in late summer for execution in early fall.... ABI is the market share leader and issues its price announcement first, purposely making its price increases transparent to the market so its competitors will get in line.... MillerCoors has followed ABI's price increases to a significant degree.*

Contribution

Specify a repeated game of oligopolistic price leadership.

- Leader proposes a *supermarkup* above Nash-Bertrand prices to coalition of rivals. Maximizes leader's profit subject to IC constraints.
- Allow for asymmetric firms and partial coalitions.

Empirical application to the United States beer industry.

- Estimate the structural parameters of the supergame.
- Recover the supermarkup and quantify the welfare effects of price leadership.
- Examine the coordinated effects of the ABI/Modelo merger.

Preview of Empirical Results

1. Supermarkups of about \$0.60 per 12-pack. Far short of joint profit maximization—coordination need not be perfect.
2. Higher supermarkups are more profitable for ABI (the leader), thus an IC constraint must bind. Ends up being the MillerCoors IC constraint.
3. The ABI/Modelo merger would have loosened the MillerCoors IC constraint and allowed for higher supermarkups.

Related Literature

Empirical:

1. Estimating repeated oligopoly games: **Igami and Sugaya (2019)**; Eizenberg and Shilian (2019)
2. Conduct parameters: Porter (1983); Ciliberto and Williams (2014); Igami (2015); Sullivan (2016); **Miller and Weinberg (2017)**; Michel and Weiergraeber (2018)
3. Price leadership: Byrne and de Roos (2019); Chilet (2017, 2018); Lemus and Luco (2018); Busse (2000); Kaufman and Wood (2007); Rojas (2008); Lewis (2012)

Theoretical:

1. Perfect information pricing games: **Rotemberg and Saloner (1986)**
2. Oligopolistic price leadership: **Rotemberg and Saloner (1990)**; Deneckere and Kovenock (1992), Marshall et al (2008); Mouraviev and Rey (2011)
3. Partial coalitions: d'Aspremont et al (1983), Donsimoni et al (1986), Bos and Harrington (2010)

Outline

1. **Model of Oligopolistic Price Leadership**
2. The Beer Industry
3. Supply-Side Estimation and Results
4. Coordinated Effects of the ABI/Modelo Merger
5. Conclusion

Motivating Price Leadership

In an infinitely repeated pricing game, oligopolists face an *incentive problem* and a *coordination problem* (Whinston (2006)).

- The *incentive problem*: Must account for firms' incentive to deviate.
- The *coordination problem*: There may be infinitely many equilibria.

Overview of the Model

Timing: Infinitely-repeated pricing game with F firms.

- Period 0: Leader proposes a coalition of firms, $\mathbb{C}$. Any firm not in the coalition is in the fringe.
- Periods $t = 1, 2, \ldots \infty$. Economic state, Ψ_t, realized, then:
  - Stage 1: Leader announces non-binding supermarkup, m_t, above Nash-Bertrand prices.
  - Stage 2: Coalition members and fringe firms set prices simultaneously, people buy beer.

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Information: Common knowledge of Ψ_t and past outcomes (no asymmetric information).

Transitions: Ψ_t is iid stochastic and unaffected by actions.

Equilibrium Concept: Subgame perfection.

The Pricing Stage

Define the price vectors:

- $p_t^{NB}(\Psi_t)$ is Nash-Bertrand.
- $p_{ft}^{PL}(m_t, \Psi_t) = \begin{cases} p_{ft}^{NB}(\Psi_t) + m_t & \text{coalition firms} \\ \text{solves static FOC} & \text{fringe firms} \end{cases}$
- $p_{ft}^{D,f}(m_t, \Psi_t)$ solves static FOC, given that $p_{-f,t} = p_{-f,t}^{PL}(m_t, \Psi_t)$.

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Assumption: All firms believe that any deviations from $p_{ft}^{PL}(m_t, \Psi_t)$ will be punished with infinite reversion to Bertrand pricing.

Assumption: All firms believe that any firm would deviate if its NPV of deviation exceeds its NPV of price leadership.

The Pricing Stage

Slack function of firm $f \in \mathbb{C}$ with infinite Nash reversion:

$$\begin{aligned} g_{ft}(m_t;\Psi_t) \quad &= \quad \overbrace{\frac{\delta}{1-\delta} \boldsymbol{E}_{\Psi}\left[\pi_f^{PL}(\Psi) - \boldsymbol{R}^*(\Psi) - \pi_f^{NB}(\Psi)\right]}^{\text{Expected Future Net Benefit of Price Leadership}} \\ &- \quad \underbrace{\left[\pi_{jt}\left(p_t^{D,f}(m_t,\Psi_t);\Psi_t\right) - \left(\pi_{jt}\left(p_t^{PL}(m_t,\Psi_t);\Psi_t\right) - \boldsymbol{R}(m_t)\right)\right]}_{\text{Immediate Net Benefit of Deviation}} \end{aligned}$$

- Slack functions allow for the analysis of incentive compatibility.
- If $g_{ft}(m_t;\Psi_t) \geq 0$ for all f then all firms accept supermarkup.
- If some $g_{ft}(m_t;\Psi_t) < 0$ then firm f prefers to deviate; all firms anticipate, and prices shift immediately to $p_t^{NB}(\Psi)$.

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The Pricing Stage

Antitrust risk, $R(m)$, is a fixed cost borne by coalition firms:

- Captures disinclination to coordinate: litigation costs in price-fixing suits, future mergers might receive more scrutiny.
- Creates theoretical possibility that PLE with $m > 0$ does not exist.
- We assume $R(0) = 0$ and $R'(m) \geq 0$.

The Announcement Stage

Leader ($f = 1$) solves a constrained maximization problem:

$$m_t^*(\Psi) \quad = \quad \arg\max_{m \geq 0} \left\{ \pi_{1t} \left(p_t^{PL}(m, \Psi_t); \Psi_t \right) - R(m) \right\}$$

$$s.t. \quad g_{ft}(m; \Psi_t) \geq 0 \quad \forall f \in \mathbb{C}$$

- We know that $g_{ft}(m; \Psi_t) = 0$ at $m = 0$, so solution always exists.
- Leader can adjust supermarkup to satisfy incentive compatibility, so adverse draws of Ψ_t do not generate reversion to Bertrand.

Price Leadership Equilibrium (PLE)

Definition: *The following strategies constitute the PLE:*

1. In $t = 0$, the leader proposes a coalition that maximizes the present value of its profit, taking as given subsequent equilibrium play.
2. In the announcement stages, the leader selects m_t to maximize its profit subject to the incentive compatibility of all coalition firms.
3. In the pricing stages, firms price according to $p_t^{PL}(m_t, \Psi_t)$ if:
   (a) Incentive compatibility holds for all coalition firms
   (b) All firms have priced according to $p_{t-s}^{PL}(m_{t-s}, \Psi_{t-s})$ for all s.

   Otherwise, firms punish with $p_t^{NB}(\Psi)$.

Outline

Revenue Shares and HHI

Year	ABI	MillerCoors	Miller	Coors	Modelo	Heineken	Total	HHI
2001	0.37	.	0.20	0.12	0.08	0.04	0.81	2,043
2003	0.39	.	0.19	0.11	0.08	0.05	0.82	2,092
2005	0.36	.	0.19	0.11	0.09	0.05	0.79	1,907
2007	0.35	.	0.18	0.11	0.10	0.06	0.80	1,853
2009	0.37	0.29	.	.	0.09	0.05	0.80	2,350
2011	0.35	0.28	.	.	0.09	0.07	0.79	2,162

- Retail scanner data from IRI Marketing for supermarkets
- ABI, MillerCoors are largest domestic brewers
- Leading firms account for about 80% revenue each year
- We estimate with 13 best-selling brands sold as 6-packs, 12-packs, and 24/30-packs, in 39 regions, with monthly observations over 2005-2011.
- Mergers: Miller/Coors (closed 2008), ABI/Modelo (closed with divestiture 2013)

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Identification of Costs

Proposition 3 (Identification of Marginal Costs). *Suppose we have knowledge of demand, the coalition firms in $\mathbb{C}$, and the supermarkup. Then marginal costs are identified.*

Consider the case in which all firms are in the coalition, then:

1. Obtain $p^{NB} = p - m$ for coalition firms.
2. Evaluate static FOCs at p^{NB} to infer MC (and MR) for coalition firms.

GMM Objective Function

For each candidate $\widetilde{\theta} = (\widetilde{m}_t, \widetilde{\gamma}, \widetilde{\sigma}_j, \widetilde{\mu}_r, \widetilde{\tau}_t)$, we have:

$$\underbrace{\eta^*_{jrt}(\widetilde{\theta})}_{\text{Implied Residual Costs}} = \underbrace{mr_{jrt}\left(p^{NB}_{rt}(\widetilde{m}_t, \Psi_t), X_t, \Omega_t\right)}_{\text{Marginal Revenue at Nash Prices}} - \underbrace{\left[w'_t\widetilde{\gamma} + \widetilde{\sigma}_j + \widetilde{\mu}_r + \widetilde{\tau}_t\right]}_{\text{Parameterized Costs}}$$

GMM estimator:

$$\widehat{\theta} = \arg\min_{\theta} \eta^*(\theta; \Psi)' Z A Z' \eta^*(\theta; \Psi)$$

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- We use ABI×Post-Miller/Coors-Merger as the instrument.
- But m is a *choice variable*, not a structural parameter; any variation in Z suggests another m.
- Restriction: $m = 0$ before Miller/Coors merger.

Table 3: Baseline Supply Estimates

	Parameter	RCNL-1	RCNL-2	RCNL-3	RCNL-4
Estimation Results					
Supermarkup	m	0.643	0.596	0.738	0.709
		(0.025)	(0.027)	(0.034)	(0.033)
Miller×Post-Merger	γ_1	-0.540	-0.533	-0.583	-0.416
		(0.007)	(0.007)	(0.005)	(0.002)
Coors×Post-Merger	γ_2	-0.826	-0.831	-0.914	-0.666
		(0.009)	(0.009)	(0.006)	(0.004)
Distance	γ_3	0.168	0.164	0.172	0.153
		(0.001)	(0.001)	(0.001)	(0.001)
Supplementary Results					
Unconstrained Supermarkup		2.69	2.57	3.25	2.56
		[2.64,2.77]	[2.49, 2.66]	[3.18, 3.31]	[2.48,2.63]
Negative Marginal Costs		0.12%	0.09%	0.26%	0.03%
Welfare Effects of Price Leadership					
% Δ Profit		10.68	8.57	10.90	14.42
Δ Consumer Surplus / Δ Profit		3.73	3.93	3.90	3.88

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Calibrating the Slack Functions

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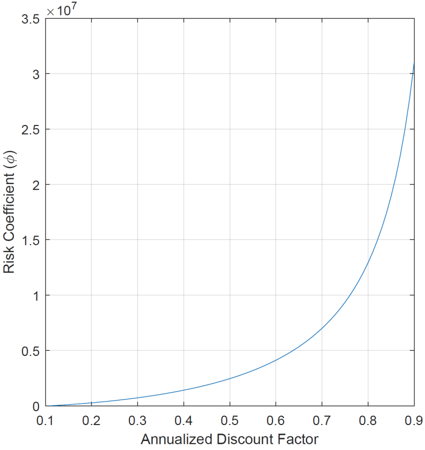
- We know an IC binds. Thus we have an *equality* that can be used for identification: $g_{ft}(m_t;\Psi_t) = 0$.
- Parameterize $R(m_t;\phi) = \phi m_t$, for risk coefficient ϕ. One equation, two unknowns: joint identification of (δ, ϕ).
- Reduced-form interpretation of δ: captures discount factor *and* duration of punishment (Rotemberg and Saloner (1986)).

Joint Identification of (δ, ϕ)



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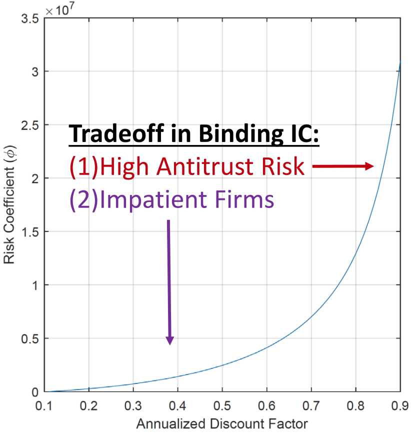
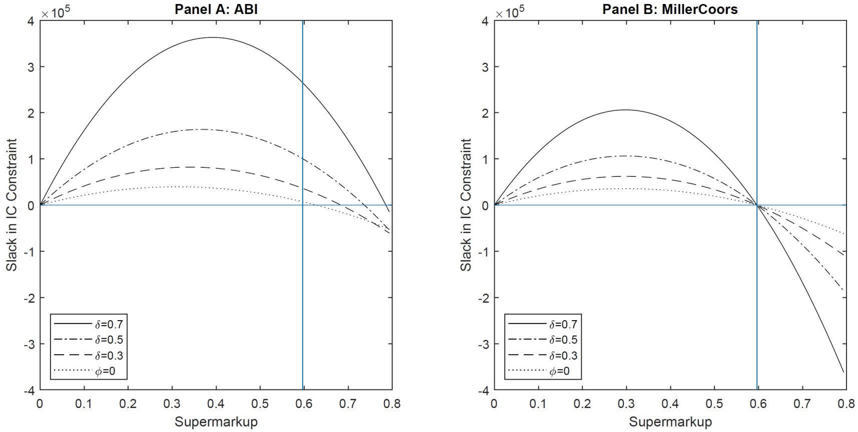
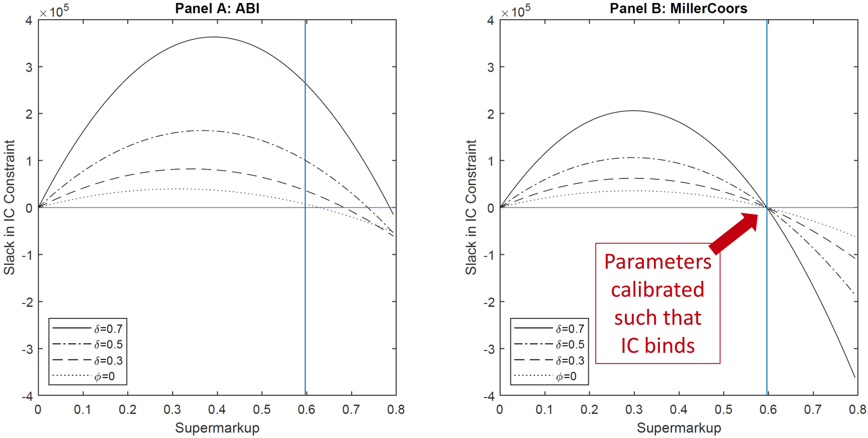


Notes: The figure shows the combinations risk coefficients and annualized discount factors for which the MillerCoors IC constraint binds.

Slack Functions with Calibrated Parameters



Slack Functions with Calibrated Parameters



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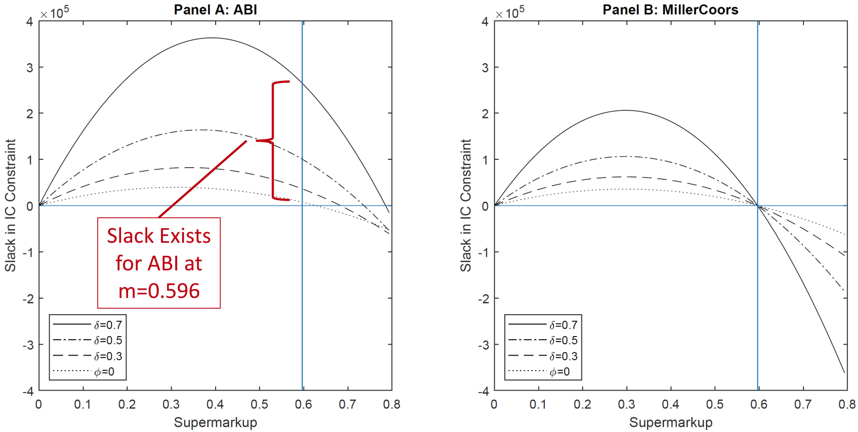


Outline

1. Model of Oligopolistic Price Leadership
2. The Beer Industry
3. Supply-Side Estimation and Results
4. **Coordinated Effects of the ABI/Modelo Merger**
5. Conclusion

ABI/Modelo Merger

From the DOJ Complaint (2013):

> *As the two largest brewers, ABI and MillerCoors often find it more profitable to follow each other's prices than to compete aggressively.... In contrast, Modelo has resisted ABI-led price hikes.... If ABI were to acquire the remainder of Modelo, this competitive constraint on ABI's and MillerCoors' ability to raise their prices would be eliminated.*

Slack Functions with ABI/Modelo

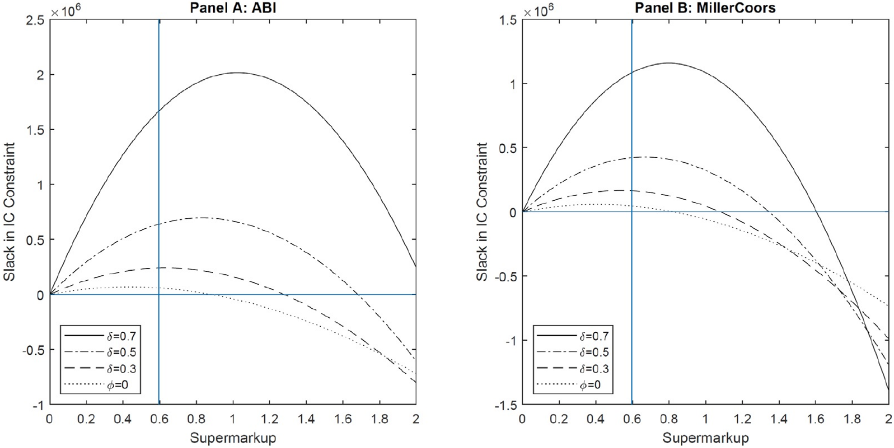
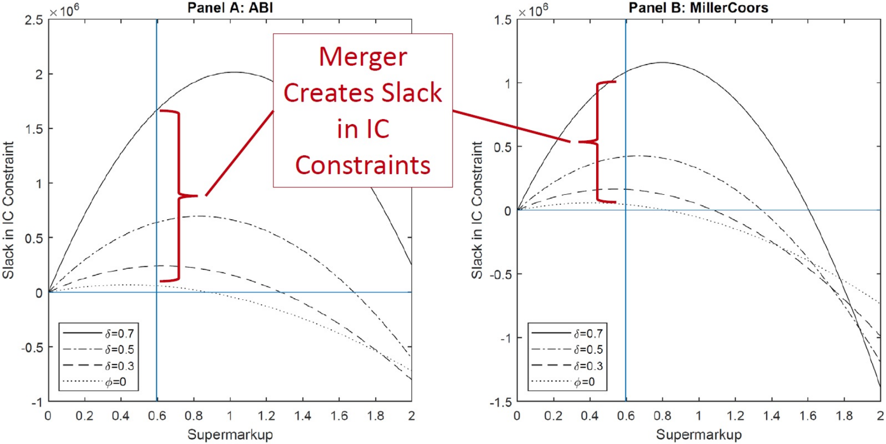


Figure: Slack Functions with an ABI/Modelo Merger

Slack Functions with ABI/Modelo



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Slack Functions with ABI/Modelo

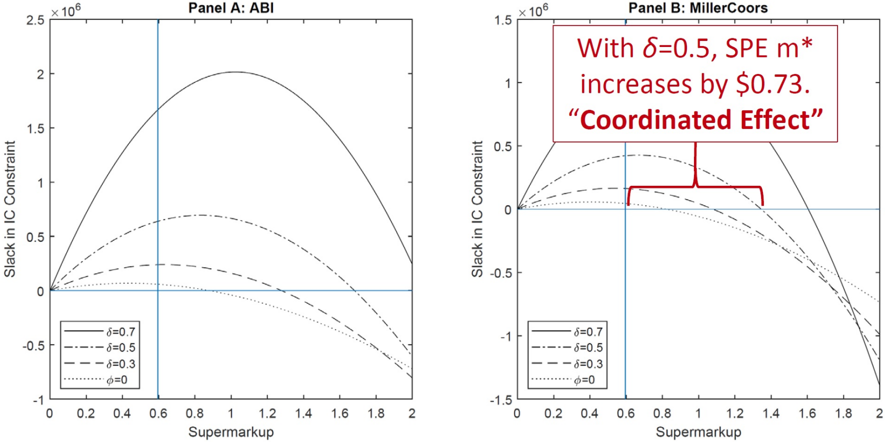

Figure: Slack Functions with an ABI/Modelo Merger

Table: Effects of ABI/Modelo on Prices and Quantities

	ABI	MillerCoors	Modelo	Heineken
Δ Bertrand Prices	0.29	0.11	1.76	0.01
Δ Supermarkup				
$\delta = 0.7$	1.01	1.01	1.60	0.00
$\delta = 0.5$	0.73	0.73	1.33	0.00
$\delta = 0.3$	0.47	0.47	1.07	0.00
$\phi = 0.0$	0.21	0.21	0.81	0.00
Total Δ Price				
$\delta = 0.7$	1.30	1.12	3.36	-0.08
$\delta = 0.5$	1.02	0.85	3.09	-0.07
$\delta = 0.3$	0.77	0.59	2.83	-0.06
$\phi = 0.0$	0.51	0.33	2.58	-0.04
% Δ Market Share				
$\delta = 0.7$	-10.03	-4.17	-53.66	47.01
$\delta = 0.5$	-7.66	-1.59	-52.63	35.81
$\delta = 0.3$	-5.46	-0.82	-51.68	26.12
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Incorporating Efficiencies

Consider three scenarios:

1. "None": No marginal cost efficiencies.
2. "Minor" efficiencies: Modelo's cost decrease by $0.50.
3. "Major" efficiencies: Exactly offset price increases if evaluated under Bertrand (Werden (1996)). ABI's costs decrease $0.51 on average, Modelo's by $1.72 on average.

Pass-through of these cost reductions is very different under Bertrand and PLE.

Table: Efficiencies under Price Leadership and Bertrand

Equilibrium Assumption:	Bertrand			PLE with $\delta = 0.7$		
Efficiencies:	None (i)	Minor (ii)	Major (iii)	None (iv)	Minor (v)	Major (vi)
Δ Bertrand Price						
ABI	0.34	0.36	0.00	0.29	0.31	-0.06
MillerCoors	0.13	0.12	0.00	0.11	0.10	-0.01
Modelo	1.70	1.15	0.00	1.76	1.21	0.06
Heineken	0.01	0.00	0.00	0.01	0.00	0.01
Δ Supermarkup	-	-	-	1.01	1.01	1.03
% Δ Profit						
ABI	5.63	4.23	14.51	16.23	14.91	25.87
MillerCoors	8.56	7.55	0.00	20.01	19.27	12.70
Modelo	-0.53	13.76	46.58	0.46	14.79	45.79
Heineken	13.3	10.91	0.00	44.32	41.95	28.91
% Δ Consumer Surplus	-1.64	-1.36	0.00	-5.38	-5.12	-3.88
% Δ Total Surplus	-1.25	-0.99	0.52	-4.14	-3.88	-2.48

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Outline

1. The Beer Industry
2. Theory of Oligopolistic Price Leadership
3. Supply-Side Estimation and Results
4. Coordinated Effects of the ABI/Modelo Merger
5. **Conclusion**

Conclusion

Project is an (early) attempt to apply structural methods to oligopoly supergames.

- Show how to estimate the parameters of the game with commonly available data.
- Estimate supermarkup for ABI and MillerCoors around $0.60. Increases profit about 10%, decreases consumer surplus by four times that amount.
- Study the coordinated effects of ABI/Modelo merger. Interesting results regarding marginal cost efficiencies.
- Demonstrate that market structure matters for the economic effects of oligopolistic price leadership.

Thank You!