Lecture 2: Market equilibrium, market power and merger analysis

TSE, MRes

Outline

Motivation

So far, we considered just estimation of demand

Estimating demand is useful but does not allow to analyze market power

Supply model useful to predict price change under a counterfactual situation

Start with the standard supply model: oligopolistic market, firms compete in prices

Because products are differentiated, firms have market power

Supply model

Consider F firms on the market, firms are multiproduct

The objective is to maximize profits. Profit for firm f is:

$$\Pi_f = \sum_{j \in \mathcal{J}_f} (p_j - c_j) s_j M$$

where M is the number of potential consumers so that $s_j \times M$ represents the sales of product j

Optimal prices satisfy firms' first order conditions:

$$s_j + \sum_{k \in \mathcal{J}_f} (p_k - c_k) \frac{\partial s_k}{\partial p_j} = 0 \quad \forall j \in \mathcal{J}_f$$

System of first order conditions can be written with vectors and matrices for products of firm f:

$$S^f + \Omega^f (P^f - C^f) = 0$$

where $\Omega^f_{jk} = \frac{\partial s_k}{\partial p_j}$ for $j, k \in \mathcal{J}_f$

Supply model

P^f, S^f are observed and Ω^f can be expressed as function of demand parameters so we can back out the vector of marginal cost C^f:

$$C^f = P^f + \Omega^{f,-1} S^f$$

Note, we can back out the full vector of marginal cost as:

$$C = P + \tilde{\Omega}^{-1} S$$

where $\tilde{\Omega} = \Omega \odot O$ and O is the ownership matrix such that:

$$\begin{cases} O_{jk} = 1 \text{ if j and k belong to the same firm} \\ O_{jk} = 0 \text{ if j and k belong to different firms} \end{cases}$$

Remarks:

- $O_{jj} = 1$
- If firms are single-product, $O = I$ and we have $c_j = p_j + \frac{s_j}{\partial s_j / \partial p_j}$
- If firms are colluding and form a cartel $O_{jk} = 1 \; \forall j, k$

Supply model

We may want to specify the marginal cost as function of cost shifters W

$$c_j = \mathbf{w}_j'\gamma + \omega_j$$

We can use ω_j to construct supply moment conditions based on $\mathbb{E}(\boldsymbol{\omega}' Z) = 0$

Why?

- Gain precision on the estimation of demand parameters
- Useful to specify the marginal cost to predict change in marginal costs shifters or predict the marginal costs of new products
- Necessary if marginal costs depend on the total quantity produced

Counterfactual simulations

Use demand and supply models to predict a counterfactual market equilibrium

Examples: change in ownership structure (mergers, divestitures...), new tax/subsidy (e.g. carbon tax, sugar tax, change in VAT), introduction of new products or exit of products, minimum quality standard

Market equilibrium under counterfactual environment: $(\tilde{\mathbf{p}}, \tilde{\mathbf{s}})$ s.t

$$\begin{cases} \tilde{\mathbf{s}} = s(\tilde{\mathbf{p}}, \theta) \\ \tilde{\mathbf{p}} = \mathbf{c} - \Omega(\tilde{\mathbf{p}})^{-1}\tilde{\mathbf{s}} \end{cases}$$

Need to solve a non-linear system of equations ($J \times 2$ unknowns)

Equivalently, substitute and solve in $\tilde{\mathbf{p}}$ (J unknowns):

$$\Omega(\tilde{\mathbf{p}})\left(\tilde{\mathbf{p}} - \mathbf{c}\right) + \tilde{\mathbf{s}}(\tilde{\mathbf{p}}) = 0$$

Counterfactual simulations

How to solve for $\tilde{\mathbf{p}}$?

Use non-linear equation solver, "fsolve" in Matlab

Or by iteration, e.g. apply Newton-Raphson to
$F_j(\tilde{\mathbf{p}}) = \left[\Omega(\tilde{\mathbf{p}})\left(\tilde{\mathbf{p}} - \mathbf{c}\right)\right]_j + \tilde{\mathbf{s}}_j(\tilde{\mathbf{p}})$

$$\mathbf{p}^{t+1} = \mathbf{p}^t + \mathbf{J}_F^{-1} F(\mathbf{p}^t)$$

with $\mathbf{J}_F$ the Jacobian of F

My algorithm: approximate $\mathbf{J}_F$ by

$$\tilde{\mathbf{J}}_F = \Omega(\mathbf{p}^t) + \mathbf{J}_s(\mathbf{p}^t)$$

Where $\mathbf{J}_s$ is the Jacobian of s, the market share function; note that it is different from Ω since $\Omega_{j,k} = 0$ when j and k belong to different firms

Counterfactual simulations

Morrow & Skerlos (2011) suggests the "ζ-markup" algorithm:

$$\mathbf{p} = \mathbf{c} + \boldsymbol{\zeta}(\mathbf{p})$$

with

$$\boldsymbol{\zeta}(\mathbf{p}) = \boldsymbol{\Lambda}(\mathbf{p})^{-1}\tilde{\boldsymbol{\Gamma}}(\mathbf{p})(\mathbf{p}-\mathbf{c}) - \boldsymbol{\Lambda}(\mathbf{p})^{-1}\mathbf{s}(\mathbf{p})$$

and

$$\boldsymbol{\Lambda}(\mathbf{p}) = \int \alpha \begin{pmatrix} s_1(\alpha,\mathbf{p}) & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & s_J(\alpha,\mathbf{p}) \end{pmatrix} dF(\alpha)$$

$$\tilde{\boldsymbol{\Gamma}}(\mathbf{p}) = -\boldsymbol{\Gamma}(\mathbf{p}) = \int \alpha \begin{pmatrix} s_1(\alpha,\mathbf{p})^2 & \cdots & s_1(\alpha,\mathbf{p})s_J(\alpha,\mathbf{p}) \\ \vdots & \ddots & \vdots \\ s_1(\alpha,\mathbf{p})s_J(\alpha,\mathbf{p}) & \cdots & s_J(\alpha,\mathbf{p})^2 \end{pmatrix} dF(\alpha)$$

such that: $\boldsymbol{\Omega} = \boldsymbol{\Lambda} + \boldsymbol{\Gamma}$

Counterfactual simulations

Sketch of proof (for simplicity we omit the argument "$(\mathbf{p})$"):

1. Start with $\mathbf{p} = \mathbf{c} - \Omega^{-1}\mathbf{s}$
2. Show that $\Omega^{-1} = (\Lambda + \Gamma)^{-1} = (\mathbf{I} + \Lambda^{-1}\Gamma)^{-1}\Lambda^{-1}$
3. Show that $(\mathbf{I} + \Lambda^{-1}\Gamma)^{-1} = \mathbf{I} - \Lambda^{-1}\Gamma(I + \Lambda^{-1}\Gamma)^{-1}$
4. From 2 & 3, we get: $(\Lambda + \Gamma)^{-1} = \Lambda^{-1} - \Lambda^{-1}\Gamma(\Lambda + \Gamma)^{-1}$
5. Replace Ω^{-1} by the expression above:

$$\mathbf{p} = \mathbf{c} - \left[\Lambda^{-1} - \Lambda^{-1}\Gamma(\Lambda + \Gamma)^{-1}\right]\mathbf{s}$$

$$\mathbf{p} = \mathbf{c} - \Lambda^{-1}\mathbf{s} + \Lambda^{-1}\Gamma\underbrace{(\Lambda + \Gamma)^{-1}\mathbf{s}}_{-(\mathbf{p}-\mathbf{c})}$$

$$\mathbf{p} = \mathbf{c} - \Lambda^{-1}\mathbf{s}\underbrace{-\Lambda^{-1}\Gamma(\mathbf{p} - \mathbf{c})}_{\Lambda^{-1}\tilde{\Gamma}(\mathbf{p}-\mathbf{c})}$$

Price equilibrium

Is there always a unique equilibrium in $\mathbf{p}$?

- With single product firms and RC demand: Caplin & Nalbuff (1991)
- With multiproduct firms and logit demand: Nocke & Schutz (2016)
- With multiproduct firms and RC demand:? probably multiple equilibria
- Under multiple equilibria, is there one that is more relevant than another?
- Importance of "relevant" starting values

Counterfactual simulations

With the counterfactual market equilibrium, what are the outcomes of interest?

Change in profits (only variable profits), mark ups (measure of market power)

Individual consumer surplus:

$$\begin{aligned} CS_i &= \max_j \mathbb{E}U_{ij} \\ &= \frac{\ln\left(\sum_{j=0}^{J} \exp(\delta_j + \mu_{ij})\right)}{\alpha_i} \end{aligned}$$

So the total consumer surplus is:

$$CS = M \int CS_i(\boldsymbol{\theta}) dF(\boldsymbol{\theta})$$

Outline

Motivation

Model of market equilibrium useful to analyze horizontal mergers

Horizontal mergers = between competing firms

Unilateral effects = price increase due to the relax of competing pressure

Merger simulation allow to quantify unilateral effects

Unilateral effects typically compensated by cost synergies

Cost synergies difficult to predict but we can compute the efficiency gains necessary to compensate the unilateral effects and see whether the magnitudes are credible

Formalization

A merger is simply a change in the ownership matrix: $O \rightarrow \tilde{O}$ so

$$\tilde{\mathbf{p}} = \mathbf{c} - \tilde{\Omega}(\tilde{\mathbf{p}})^{-1}\mathbf{s}(\tilde{\mathbf{p}})$$

with $\tilde{\Omega} = \Omega(\tilde{\mathbf{p}}) \odot \tilde{O}$

Remark: what is not modeled

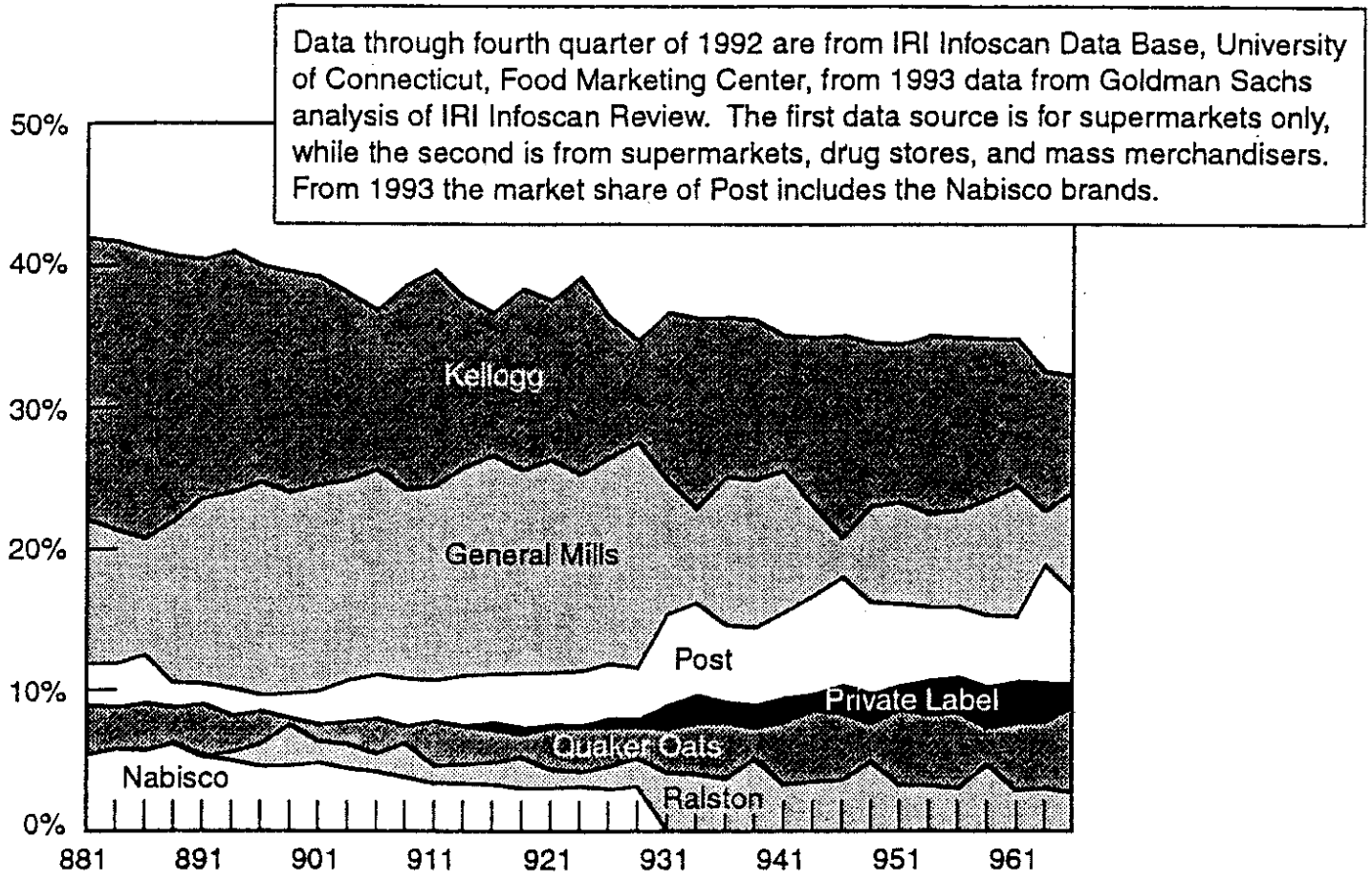
- Change in advertising, product characteristics: observed and unobserved product characteristics are assumed to remain identical
- No exit/entry of new products
- Coordinated effects (i.e. change in likelihood of collusion)
- Future merger (merger waves)
- Forclosure

Merger on the breakfast cereals market

- Nevo (2000, Rand): investigates actual and hypothetical mergers on the breakfast cereal market
- In 1992, General Mills (2nd largest on the market) announced its intention to buy Nabisco (6th largest)
- Merger was not approved because of antitrust concerns
- Two weeks after, Kraft-Post (3rd largest) announced its intention to buy Nabisco, accepted by federal authorities but challenged by the state of New-York
- The concerns were about “Shredded Wheat” (Nabisco brand) and ”Grape Nuts” (Post brand) which were the two main competing products on a small segment (“healthy”)
- Merging parties argued that there was enough competition from private labels

Merger on the breakfast cereals market

VOLUME MARKET SHARES



Merger on the breakfast cereals market

Data used:

- UConn Infoscan data base.
- Time period: Q1 1988 - Q4 1992.
- 65 US cities.
- Prices and market shares in city-quarter pairs, brand characteristics, advertising and demographic information.

Model:

- Allow for unobserved individual heterogeneity in preferences
- Allow for unobserved individual heterogeneity that is a function of individuals' demographic characteristics: age, log(income), log(income)^2, and the presence of a child in the household
- Control for advertising expenses

Importance of having heterogeneity in preferences to have substitution across products with similar characteristics

Results

TABLE 2 Results from Mixed Logit Model

Variable	Means (β's)	Standard Deviations (σ's)	Interactions with Demographic Variables: log(Income)	log(Income)^2	Age	Child
Price	−43.039 (11.015)	.339 (2.119)	761.747 (214.241)	−41.637 (11.799)	—	−3.053 (4.181)
Advertising	.030 (.009)	—	—	—	—	—
Constant	−2.685[a] (.135)	.095 (.649)	2.331 (2.601)	—	.4586 (.650)	—
Cal from fat	1.661[a] (.261)	3.396 (2.713)	—	—	—	—
Sugar	18.540[a] (.994)	.845 (6.337)	−45.439 (14.616)	—	7.302 (3.978)	—
Mushy	.938[a] (.268)	.348 (.922)	11.322 (2.435)	—	1.193 (.824)	—
Fiber	−2.898[a] (.445)	2.036 (4.520)	—	—	—	−14.685 (5.866)
All-family	1.237[a] (.134)	.216 (1.496)	—	—	—	
Kids	−2.539[a] (.276)	1.739 (.740)	—	—	—	
Adults	3.788[a] (.441)	1.959 (.862)	—	—	—	

Results

- Cross price elasticities:

  % change in market share of brand i with a one percent change in price of j (i row, j column)

	Corn Flakes	Grape Nuts	Shredded Wheat
K Corn Flakes	-3.69	0.00	0.001
P Grape Nuts	0.001	-2.096	0.070
N Shredded Wheat	0.002	0.115	-2.27

Results

Price cost margins: (p-mc)/p

Rice Krispies (Kellogs): 85.8%, Cheerios (General Mills): 63.9%, Grape Nuts (Post): 43.8%, Shredded Wheat (Nabisco): 39.2%

Price variation post merger:

	Cheerios	Shred. Wheat	Grape Nuts	R. Crispies
GM/ Nabisco	0.7%	7.5%	0.1%	0.1%
Post/Nabisco	0%	3.1%	1.5%	0%

Efficiency gains such that Δp=0:

	Cheerios	Shred. Wheat	Grape Nuts	R. Crispies
GM/ Nabisco	2.1%	10.4%	0%	0%
Post/Nabisco	0%	5.1%	2.6%	0%

Mergers and coordinated effects

Miller & Weinberg (2017, Econometrica) investigate the MillerCoors joint venture in the retail beer market

Use data on before and after the merger between Miller & Coors

Provide evidence that the price increase after merger is not only due to unilateral effects but to facilitated price coordination

Study prices in 39 geographic regions over 2001-2011, merger occurred in 2008

Test whether there was collusion between ABI and MillerCoors post-merger

Findings: ABI & MillerCoors internalize 26% of their pricing externalities; post-merger prices are 6-8% higher than under competition; but cost reductions are large enough that the merger increases total surplus

Industry background

Miller & Coors were the 2nd and 3rd largest firms in the U.S. brewing industry

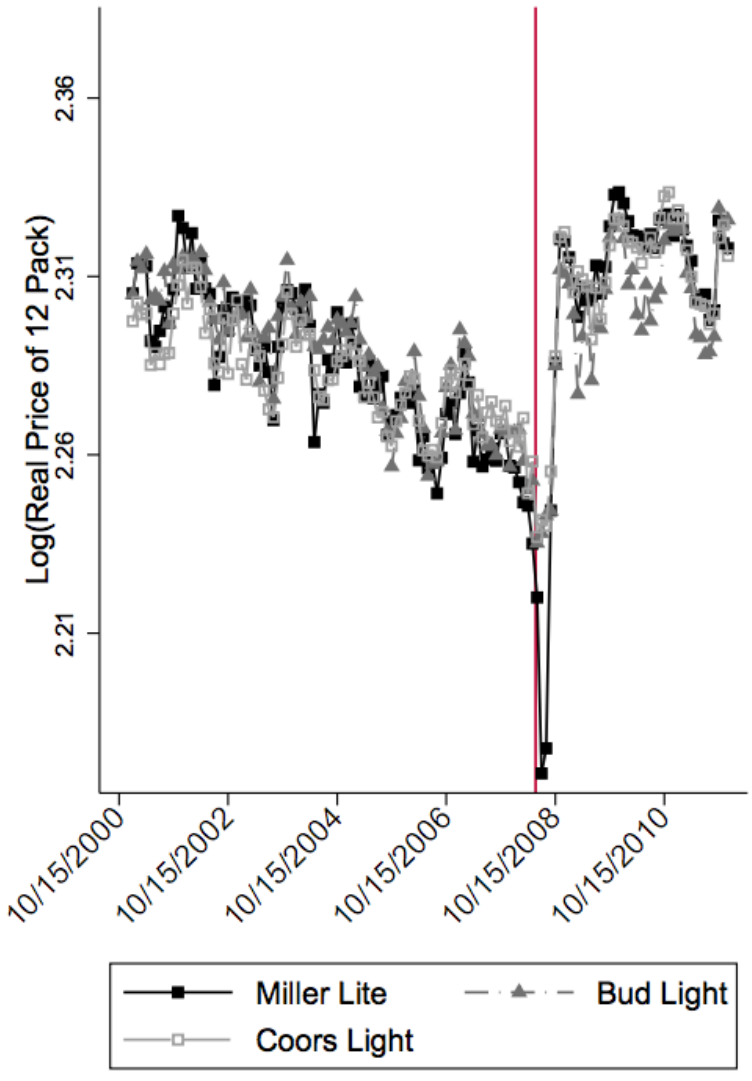
Merger approved by the DOJ on July 2008 because of expected large cost-reduction after the merger

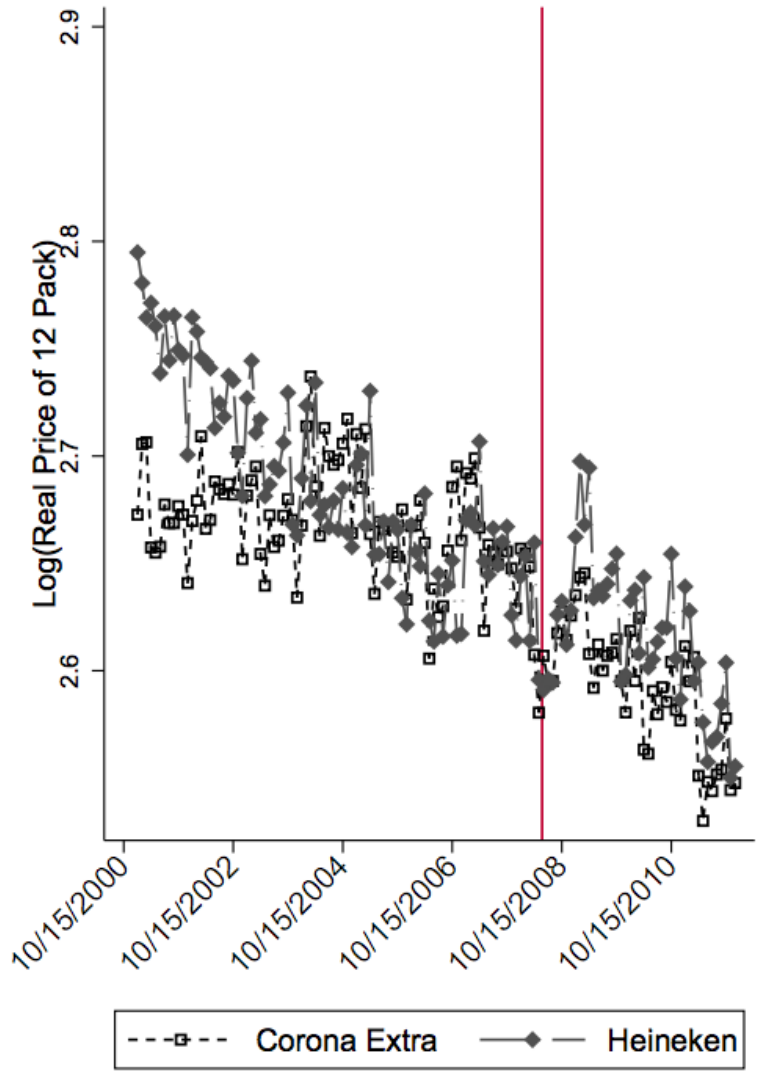
Closest competitor is ABI (domestic), other competitors are Modelo and Heineken (import beer) (they together account for 80% of total retail revenue)

Focus on 13 flagship brands: Bud Light, Budweiser, Michelob, Michelob Light, Miller Lite, Miller Genuine Draft, Miller High Life, Coors Light, Coors, Corona Extra, Corona Extra Light, Heineken, and Heineken Light

Consider 3 different pack sizes (6, 12, or 24/30)

Prices


Log(Real Price of 12 Pack)
2.21
2.26
2.31
2.36
10/15/2000
10/15/2002
10/15/2004
10/15/2006
10/15/2008
10/15/2010
Miller Lite
Bud Light
Coors Light


Log(Real Price of 12 Pack)
2.6
2.7
2.8
2.9
10/15/2000
10/15/2002
10/15/2004
10/15/2006
10/15/2008
10/15/2010
Corona Extra
Heineken

Model

They introduce a new parameter κ in the model: the degree of internalization of other brand's profit after the merger, or degree of collusion.

They consider a variant of the ownership matrix $\mathbf{O}(\kappa)$ such that $\mathbf{O}_{jk} = \kappa$ if product j and k are produced by MillerCoors and ABI and if the period is after the merger; and consider the modified FOC after merger:

$$p_j = c_j + \left[\Omega \odot \mathbf{O}(\kappa)\right]^{-1} s(\mathbf{p}, \theta)$$

If $\kappa = 0$ then competition, no coordinated effects after the merger while if $\kappa = 1$, joint profit maximization

Model

Identification of κ? Specify a marginal cost equation

$$c_{jrt} = \mathbf{w}'_{jrt}\boldsymbol{\gamma} + \sigma_j^S + \tau_t^s + \mu_r^S + \eta_{jrt}$$

Since $\mathbf{c} = \mathbf{p} - \left[\Omega \odot \mathbf{O}(\kappa)\right]^{-1} s(\mathbf{p}, \theta)$, they estimate:

$$p_{jrt} = \left[\left[\Omega \odot \mathbf{O}(\kappa)\right]^{-1} s(\mathbf{p}, \theta)\right]_{jrt} + \mathbf{w}'_{jrt}\boldsymbol{\gamma} + \sigma_j^S + \tau_t^s + \mu_r^S + \eta_{jrt}$$

Use GMM since κ is a non-linear parameter

Since margin depends on prices, it is correlated with the cost shock η_{jrt}

Instrument: indicator that equals to 1 for ABI and MillerCoors in the post-merger periods

Results: estimates of κ

Table VI: Baseline Supply Estimates

Demand Model:		NL-1	RCNL-1	RCNL-2	RCNL-3	RCNL-4
Data Frequency:		Monthly	Monthly	Quarterly	Monthly	Quarterly
Variable	Parameter	(i)	(ii)	(iii)	(iv)	(v)
Post-Merger Internalization of Coalition Pricing Externalities	κ	0.374	0.264	0.249	0.286	0.342
		(0.034)	(0.073)	(0.087)	(0.042)	(0.054)
Marginal Cost Parameters						
MillerCoors×PostMerger	γ_1	-0.608	-0.654	-0.649	-0.722	-0.526
		(0.039)	(0.050)	(0.060)	(0.042)	(0.040)
Distance	γ_2	0.142	0.168	0.163	0.169	0.148
		(0.046)	(0.059)	(0.059)	(0.060)	(0.049)

Notes: This table shows the baseline supply results. We use the method of moments for estimation. There are 94,656 observations at the brand–size–region–month–year level in columns (i), (ii), and (iv) and 31,784 observations at the brand–size–region–year–quarter level in columns (iii) and (v). The samples exclude the months/quarters between June 2008 and May 2009. All regressions include product (brand×size), period (month or quarter), and region fixed effects. Standard errors clustered by region and shown in parentheses.

Results: understanding the merger

Simulate market equilibrium under hypothetical scenarios:

- Without the merger
- With the merger and efficiencies but without coordinated effects
- Merger without efficiencies and without coordinated effects
- Merger without efficiencies and with coordinated effects

Results: understanding the merger

Table X: Results from Counterfactual Analysis

Coordinated Effects:	yes	yes	no	no	no
Unilateral Effects:	yes	yes	yes	yes	no
Efficiencies:	yes	no	yes	no	no
	(i)	(ii)	(iii)	(iv)	(v)
			Retail Prices		
ABI	10.03	10.14	9.38	9.55	9.43
Miller	8.94	9.37	8.28	8.72	8.19
Coors	10.18	10.85	9.56	10.22	9.26
			Brewer Markups		
ABI	4.45	4.56	3.81	3.97	3.84
Miller	4.52	4.32	3.83	3.63	3.05
Coors	4.25	4.06	3.61	3.41	2.68
			Welfare Statistics		
Producer Surplus	22.1%	19.1%	10.3%	8.2%	·
ABI	10.3%	19.8%	-0.08%	9.3%	·
Miller	37.8%	20.2%	24.6%	9.1%	·
Coors	47.8%	12.9%	34.7%	3.5%	·
Consumer Surplus	-3.7%	-5.3%	-0.2%	-2.1%	·
Total Surplus	1.3%	-0.6%	1.8%	-0.1%	·