ECO 2901
EMPIRICAL INDUSTRIAL ORGANIZATION
Lecture 3:
Estimating conduct with differentiated products

Victor Aguirregabiria (University of Toronto)

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Today's Lecture (Topic 3)

Estimating conduct parameters with differentiated products

1. **Inference on conduct parameters in the cereal industry**
   Michel & Weiergraeber (2018)

2. **Inference on conduct parameters in the airline industry**
   Ciliberto & Williams (RAND, 2014)

1. Conduct parameters
in the Cereal industry

Conduct in cereal industry: Michel & Weiergraeber (2018)

- Paper studies competition in the US cereal industry during 1991-96. Two important events during this period:
    - (1) Merger of Post & Nabisco in 1993;
    - (2) massive wholesale price reduction in 1996.

- Paper emphasizes importance of allowing **conduct "parameters" to vary over time and across firms** in the same industry.

- The authors are also particularly concern with finding **powerful instruments** to separately identify conduct and marginal costs.

- The authors propose novel instruments that exploit information on **firms' promotional activities**.

Data

- Consumer level scanner data from the Dominick's Finer Food (DFF).

- 58 **supermarket stores** located in the Chicago metropolitan area.

- Sample Period: February 1991 to October 1996. Data aggregated at the monthly level (69 months)

- Focus on **26 brands** of cereals from the **6 nationwide manufacturers**: Kellogg's, General Mills, Post, Nabisco, Quaker Oats, and Ralston Purina.

- Brands classified in 3 groups: adult, family, and kids.

- Importantly: dataset contains information on **wholesale prices** (not only retail prices), and **in-store promotional activities**.

Descriptive evidence: Market shares

- Very concentrated industry: $CR1 \simeq 45\%$; $CR2 \simeq 75\%$.

- Firms market shares are more or less stable over the sample period, though with some changes after 1993 merger.

Descriptive evidence: Market shares [2]

Table 4: Market share evolution

	GMI	KEL	POS	NAB	QUA	RAL
1991	32.4	46.1	7.9	3.1	7.2	3.4
1992	30.0	46.3	10.1	3.9	6.6	3.1
1993	28.9	47.0	11.6	0.0	8.9	3.6
1994	25.8	48.3	12.3	0.0	10.4	3.3
1995	31.9	43.8	14.4	0.0	6.8	3.1
1996	27.5	48.1	13.5	0.0	8.1	2.7

Notes: The table summarizes the firm-specific volume-based market shares (in percent) across all stores in our data set for each year. From 1993 onwards, Post's market shares include those of Nabisco. GMI stands for General Mills, KEL for Kellogg's, POS for Post, NAB for Nabisco, QUA for Quaker, and RAL for Ralston.

Descriptive evidence: 1993 Merger

- Post & Nabisco merger is 1993.

- Main concern of antitrust authority was the strong substitutability in the adult cereal segment between Post's and Nabisco's products (price increase after merger).

- The merger did not lead to any product entry or exit or any changes in existing products.

- Following the merger, Post+Nabisco increased significantly its prices, and this price increased was followed by the other firms.

- In principle, this could be explained under Bertrand-Nash competition, without any change in conduct.

Descriptive evidence: 1996 reduction wholesale prices

- April 1996: Post decreased its wholesale prices by 20%.

- This was followed, a few weeks later, by significant price cuts by the other firms.

- Average decrease in the wholesale price between April and October 1996 of **9.66**% (and 7.5% in retail price).

Descriptive evidence: Wholesale prices

Evolution of RTE cereal prices (wholesale)
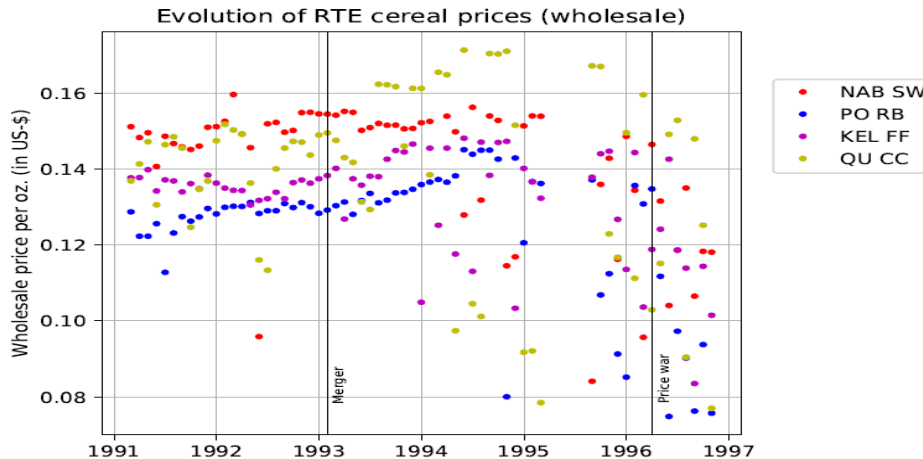
Reduced form regressions for wholesale prices

$$\log(p_{jst}^w) = PROMO_{jst}\ \beta + \delta_1\ AFTMER_t + \delta_2\ Y96_t + \alpha_j^{(1)} + \alpha_s^{(2)} + \varepsilon_{jst}$$

- 96,512 observations. Rich controls for promotions variables, and store-level aggregate demand.

- Estimated effects:

Variable	Estimate	s.e.
After merger	0.0609	(0.0023)
After merger	-0.0983	(0.0015)

Structural model

- **Demand:** Random coefficients nested logit model.

- **Supply side:** Flexible conduct parameter framework that specifies the **degree of cooperation** by a matrix of parameters that capture the degree to which firms internalize their rivals' profits.

Structural model: Demand

- Random coefficients logit model discrete choice demand model.

$$u_{ijt} = x_j \ \beta_i + \beta_i^{PRO} \ PRO_{jt} + \alpha_i \ p_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

- PRO_{jt} total (aggregated over stores and type of promotion) in-store promotions of product j during month t.

- Similar to Nevo (2001) but, very importantly, including in-store promotional variables.

Estimates of demand parameters

- BLP-Instruments: Characteristics of other products.

- The authors exploit the substantial amount of sample variation in Promotion variables.

- **Results:**
  - Price coefficient is highly negative.
  - High-income consumers are less price-sensitive.
  - Promotions have a significant positive effect.

Estimates of demand parameters [2]

Table 1: RCNL Demand Estimates: Main Specification

	Mean	Children	Income
Constant	−2.1043***		
	(0.0066)		
Price	−9.4674***		0.7491***
	(0.0967)		(0.1825)
Sogginess	0.2202***		
	(0.0018)		
Sugar	−1.0145***	3.1400***	
	(0.0048)	(0.1456)	
Fiber	−0.0383***		−0.1074***
	(0.0022)		(0.0299)
Promotions	0.2662***		
	(0.0146)		
Nesting parameter	0.4758***		
	(0.0859)		

Notes: The estimation includes product- and month-year fixed effects and a linear-quadratic time trend. Standard errors are in parentheses. Number of observations: 96512.

Structural model: Supply

- **Manufacturers' marginal costs:** Constant:

$$MC_{jt} = W_{jt} \ \gamma + \omega_{jt}$$

  and ω_{jt} follows AR(1) process.

- **Conduct parameters:** Firms indexed by f.

$$\lambda_{ff't} \ \in \ [0,1] \text{ represents the degree to which}$$
$$\text{firm } f \text{ internalizes the profits of firm } f'$$
$$\text{when setting its whole sale price in month } t$$

Structural model: Conduct parameters

- **Example.** Three firms and a merger for firms 1 and 2.
- Pre-merger:

$$\Lambda^{PRE} = \begin{pmatrix} 1 & \lambda_{12}^{PRE} & \lambda_{13}^{PRE} \\ \lambda_{21}^{PRE} & 1 & \lambda_{23}^{PRE} \\ \lambda_{31}^{PRE} & \lambda_{32}^{PRE} & 1 \end{pmatrix}$$

- Post-merger:

$$\Lambda^{POS} = \begin{pmatrix} 1 & 1 & \lambda_{13}^{POS} \\ 1 & 1 & \lambda_{13}^{POS} \\ \lambda_{31}^{POS} & \lambda_{31}^{POS} & 1 \end{pmatrix}$$

Identification of MCs and Conduct

- Consider the case of two single-product firms. Their pricing equations are:

$$p_1 = MC_1 + \left(\frac{\partial s_1}{\partial p_1}\right)^{-1} \left[s_1 + \lambda_{12} \ (p_2 - MC_2) \ \frac{\partial s_2}{\partial p_1}\right]$$

$$p_2 = MC_2 + \left(\frac{\partial s_2}{\partial p_2}\right)^{-1} \left[s_2 + \lambda_{21} \ (p_1 - MC_1) \ \frac{\partial s_1}{\partial p_2}\right]$$

- Or similarly,

$$p_1 - \left(\frac{\partial s_1}{\partial p_1}\right)^{-1} s_1 = MC_1 + \lambda_{12} \ (p_2 - MC_2) \ \left(\frac{\partial s_1}{\partial p_1}\right)^{-1} \frac{\partial s_2}{\partial p_1}$$

$$p_2 - \left(\frac{\partial s_2}{\partial p_2}\right)^{-1} s_2 = MC_2 + \lambda_{21} \ (p_1 - MC_1) \ \left(\frac{\partial s_2}{\partial p_2}\right)^{-1} \frac{\partial s_1}{\partial p_2}$$

Identification of MCs and Conduct [2]

- We need instruments. The number of instruments needed increases with the number of firms, because we have more λ parameters.

- "BLP instruments" = characteristics of other products. Two issues with this type of instruments:

    (1) often are weak instruments;

    (2) if product characteristics do not vary across markets or time, these instruments are collinear with brand fixed effects.

- Instead the authors use promotional variables of other products as instruments:

    - Demand elasticities are significantly affected by these variables.

    - They have substantial variation across products, over time, and markets.

Identification of MCs and Conduct [3]

- Still, there is the concern that promotional variables are endogenous, i.e., correlated with the unobservable component of the marginal cost.

- Promotions are chosen by firms: it is more profitable to make promotions when marginal costs are low.

- To deal with this endogeneity, the authors make the following assumptions on the **error structure** and the **timing of promotion decisions**.

Identification of MCs and Conduct [4]

- **Error structure:** Fixed effects (product, store and seasonal) and AR(1) shock: $\omega_{jt} = \rho \ \omega_{jt-1} + v_{jt}$. . The model is estimated using quasi-differences:

$$(y_{jt} - \rho \ y_{jt-1}) = (x_{jt} - \rho \ x_{jt-1}) \beta + v_{jt}$$

- **Timing assumption:** Promotions are negotiated between manufacturers and retailers at least one month in advanced. Therefore, $PROMO_{jt}$ is not correlated with the i.i.d. shock v_{jt}.

Empirical results

- Strong evidence for coordination between 1991-1992.

- On average the conduct parameter is 0.277: i.e., a firm values $1 of its rivals' profits as much as $0.277 of its own profits.

- Because this coordination, pre-merger price-cost margins are **25.6% higher** than under multiproduct Bertrand-Nash pricing.

- After the Post + Nabisco merger in 1993, the degree of coordination increased significantly, on average to 0.454.

- Towards year 1996, the degree of coordination becomes close to 0, consistent with multiproduct Bertrand-Nash pricing.

Empirical results [2]

Table 2: Conduct Estimates: Model Comparison

	Small Model			Large Model		
	Pre-merger	Post-merger	Price War	Pre-merger	Post-merger	Price War
All Firms	0.2766***	0.4535***	0.0001			
	(0.0316)	(0.0101)	(0.0012)			
Large Firms				0.1269*	0.3094***	0.0038
				(0.0648)	(0.0633)	(0.0107)
Small Firms				0.4043***	0.6236***	0.0192
				(0.0208)	(0.0403)	(0.0358)

Notes: The table entries reflect the conduct estimates for both the small and the large conduct specification. Standard errors are in parentheses and account for two-step estimation. Number of observations: 96512.

Empirical results   [3]

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Notes: The table entries reflect the conduct estimates for both the small and the large conduct specification. Standard errors are in parentheses and account for two-step estimation. Number of observations: 96512.

Estimation of Marginal Costs

Evolution of manufacturer marginal cost over time (12-month MA
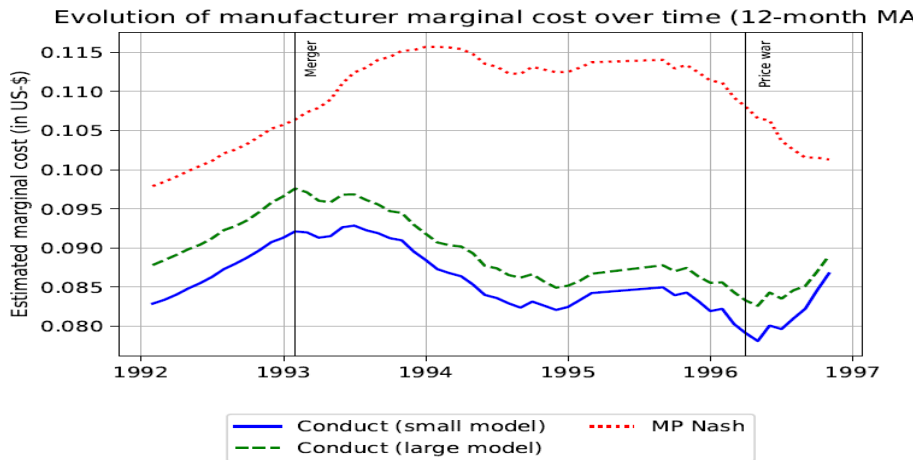
Actual evolution of input prices

Evolution of input prices over time (12 months-MA)
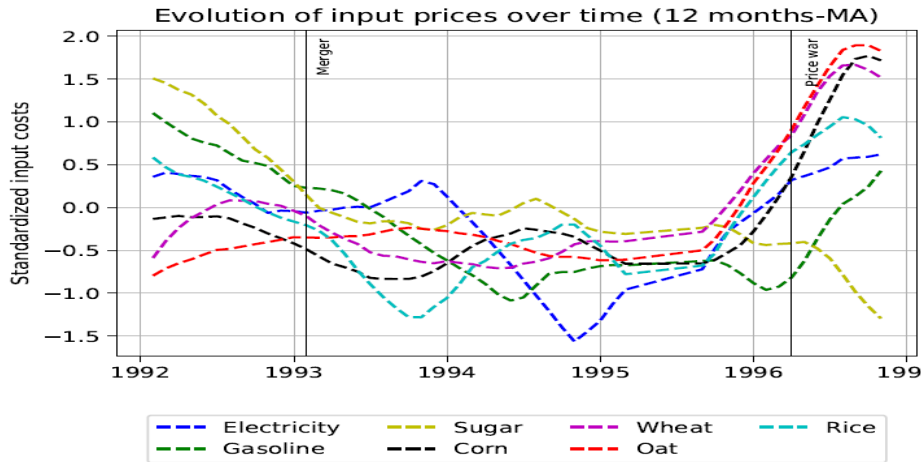
Counterfactual experiments

- Counterfactuals: if firms had competed ala Bertrand-Nash before 1996:

  - Consumer welfare would have increased by between $1.6 - $2.0 million per year;

  - Median wholesale prices would have been 9.5% and 16.3% lower during the pre-merger and post-merger periods.

Counterfactual experiments   [2]

Table 3: Counterfactual Simulation 1: Change to multiproduct Bertrand-Nash pricing

	Small Model		Large Model	
	Pre-merger	Post-merger	Pre-merger	Post-merge
Δ consumer surplus (in US-\$ mio.)	2.3	5.3	3.2	6.3
Δprice All Firms (in %)	-9.5	-15.7	-9.4	-16.9
Δprice GM (in %)	-8.5	-15.3	-7.6	-14.8
Δprice RAL (in %)	-10.8	-16.8	-25.4	-25.7
Δprice KEL (in %)	-8.3	-13.5	-8.3	-13.8
Δprice POSNAB (in %)	-13.7	-18.6	-27.6	-27.4
Δprice QUA (in %)	-13.5	-22.8	-30.9	-34.1

Notes: The table entries reflect the results from the counterfactual simulations for both the small and the large conduct specification. The simulations compute the changes in consumer surplus and wholesale prices before the price war period when all firms play according to multiproduct Nash pricing instead of the estimated conduct.

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2.   Conduct parameters

in the Airline industry

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