Entry and Market Structure

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Entry and Market Structure

- So far we've focused on "short run" competition, mainly price competition, taking the number and identity of firms as fixed.
- We now take up competition and industry evolution over the medium and long run: in particular, how market structure is determined by decisions about entry and exit, how to invest, where to locate in geographic or product space, and whether to vertically integrate production.
- Many of these decisions are inherently dynamic: they depend on expectations about future competition, rival's responses and so forth. Nevertheless, we'll start by looking at abstractions that are close to static in nature — e.g. entry models that focus on long-run market configurations.

Market Structure Questions

- Why are some industries concentrated? Is it increasing returns, barriers to entry, or efficiency differences?
- What is the result of industry concentration? For example, how many firms are necessary for a market to become "competitive"?
- Should we be worried by concentration?
  - Maybe no ... if efficient firms enter and invest aggressively to maintain market leadership, if markets are contestable, or if rents are necessary to recover investment in valuable new technology.
  - Maybe yes ... if incumbents can create barriers to entry and generate monopolistic rents, if concentrated industries are prone to collusion and inefficiently high prices, or if market dominance slows the pace of innovation.
- Economic theory has lots to say about these questions, but nothing definitive — ultimately a question of identifying what types of effects are most important, when and why.

Background: Back to Structure-Conduct-Performance

- Bain (1951, 1957): "one-way" chain of causation
  - Structure (concentration) affects conduction (competition)
  - Competition determines profitability.
  - But why don't high profits lead to entry ... must be barriers.
- Bain originally focused on technological scale economies
  - But lots of industries are concentrated without scale economies.
  - Instead, R&D and advertising seem to be the explanation.
  - But these are choice variables! => reverse causality?
- SCP models tried to write systems of equations
  - Profits depend on R&D, R&D depends on profits...
  - But how to identify these regressions ... literature runs aground..

- Theory as guidance? Many theories of market structure....
  - Free entry models, entry deterrence models, predation models.
  - Different kinds of competition, investment, etc.
- How can we take the insights from these models to data?
  - Pick a model that captures essence of a particular industry
  - Look for broad predictions that seem "robust" across models.
- We'll set up a fairly simple framework that captures basic ideas about how entry and competition are co-determined in the long run, and then apply it.

"Static" Models of Market Structure

- Two stage game:
  - First stage: M potential entrants simultaneously choose whether to enter or not. If a firm enters, it incurs a sunk cost F.
  - Second stage: entrants compete (e.g. in prices or quantities).
- Assume second stage competition gives rise to firm profits $\pi_i(n)$ that are a function of the number of firms in the industry — simplest case has symmetry $\pi(n)$.
  - Examples: Cournot competition, Homogeneous goods Bertrand competition, Differentiated Bertrand competition (e.g. on the Salop circle).

"Static" Models of Market Structure, cont..

- First stage equilibria: Pure Strategies
  - In equilibrium, n^* firms enter where:

$$\pi(n^*) - F \geq 0 > \pi(n^* + 1) - F.$$

  - Identity of the entrants is not determined; also the equilibrium requires some coordination or sequencing of decisions.
- First stage equilibria: Mixed Strategies
  - Each potential entrant enters with probability p such that expected value of entry is F :

$$\sum_{n=1}^{N} \binom{N-1}{n-1} p^{n-1} (1-p)^{N-n} \pi(n) - F = 0$$

  - Outcome may not be an *ex post equilibrium*, so hard to interpret as a long-run outcome.

Entry and Efficiency

- What is the relationship between free entry equilibrium and the socially optimal number of firms in a market?
- First best: one firm and $p = mc$. But what if second period competition is taken as given?
- Compare the free-entry equilibrium (the solution to $\pi(N) = F$) with the social planner's (second best) optimal number of firms:

$$n^* = \arg\max_n \left[n \left(\pi(n) - F \right) + CS(n) \right]$$

- In general, two forces work in opposite directions:
  - The *business stealing effect* creates a negative externality of an additional entrant, leading to excessive entry.
  - The *consumer surplus effect* creates a positive externality of an additional entrant, leading to too little entry.
- Which wins out is in general ambiguous, depending on product differentiations, nature of price competition, elasticity of demand and so forth, but some cases have clear prediction.

Mankiw and Whinston (1986) Example

- Symmetric homogeneous goods: if n enter, price $p(n) = p\left(nq\left(n\right)\right)$
- Marginal private return to entry

$$\pi\left(n\right) - F = p\left(n\right)q\left(n\right) - c\left(q\left(n\right)\right) - F$$

- Social planner's problem:

$$S(n) = \max_{n} \int_{0}^{nq(n)} p\left(x\right)dx - nc\left(q\left(n\right)\right) - nF$$

- Marginal social return to entry:

$$S'\left(n\right) = p\left(n\right)\left[q\left(n\right) + nq'\left(n\right)\right] - c\left(q\left(n\right)\right) - nc'\left(q\left(n\right)\right)q'\left(n\right) - F$$

- Re-arranging yields

$$S'(n) = \pi\left(n\right) - F + nq'\left(n\right)\left[p\left(n\right) - c'\left(q\left(n\right)\right)\right] \geq \pi\left(n\right) - F$$

Social return is below the private return => excess entry!

Sutton (1991): Entry and Market Structure

- Models of entry and price competition yield all sorts of predictions that appear to be sensitive to the exact modeling specification. Are any of these predictions *robust*?
- Idea: focus on whether large markets can support a fragmented market structure - rely on useful distinction between "exogenous" and "endogenous" sunk costs.
- Exogenous sunk costs: fixed size investments or investments that can only increase consumer utility for the product in a limited way: e.g. start-up costs, plant of minimum efficient scale, acquiring industry know-how.
- Endogenous sunk costs: variable size investments the returns to which increase with market size, e.g. advertising & R&D investments that proportionally increase demand.

Exogenous Sunk Costs

- Entry costs are fixed, so this is the model from above ($\pi(n) = F$).
- Predictions for n depend on nature of competition:
  - Bertrand: always have single entrant, monopoly price.
  - Cournot: have $p(n) \rightarrow mc$ and $n \rightarrow \infty$ in large markets.
  - Horizontal (circle): also $n \rightarrow \infty$ and $C_1 \rightarrow 0$ in large markets.
- Generally...?
  - "Tougher" competition associated with higher concentration.
  - "Anything can happen" in terms of concentration: in a large market, concentration (as measured by C1) can be arbitrarily low.

Endogenous Sunk Costs

- Three-period model: first decide whether to enter or not, then choose F, then compete.
  - Investments F have proportional increase on demand.
  - Marginal revenue from extra F is higher, the larger is the market.
  - Condition for equilibrium, anticipating $F(n)$, free entry leads to $\pi(n, F(n)) = F(n)$ (up to integer constraints), where $F(n)$ is decreasing in n and $\pi(n, F)$ is decreasing in n but increasing in F.
- As market size increases, the investment in F increases, but the number of firms is bounded above and concentration does not go to zero (see Sutton chapter 3 for exact conditions and a derivation).

Sutton: Empirical Application

- Twenty food and drink industries
- Six "independent" markets: US, Japan, France, Germany, Italy, UK.
- Data on market shares and market size for each industry-market.
- Construct (fairly crude) proxy of ratio of set-up cost of m.e.s. plant (σ) to market size (S).
- Distinguish industries based on their advertising intensities.
  - High ad/sales: Beer, RTE Cereals, Margarine, Soft Drinks, Pet Food.
  - Low ad/sales: Salt, Sugar, Flour, Bread, Processed Meat, Frozen Food.
- Empirical exercise: plot concentration (C_4) against market size (S/σ). Interest is in what happens to the lower bound as market size gets large relative to set-up costs.

Sutton: Empirical Evidence

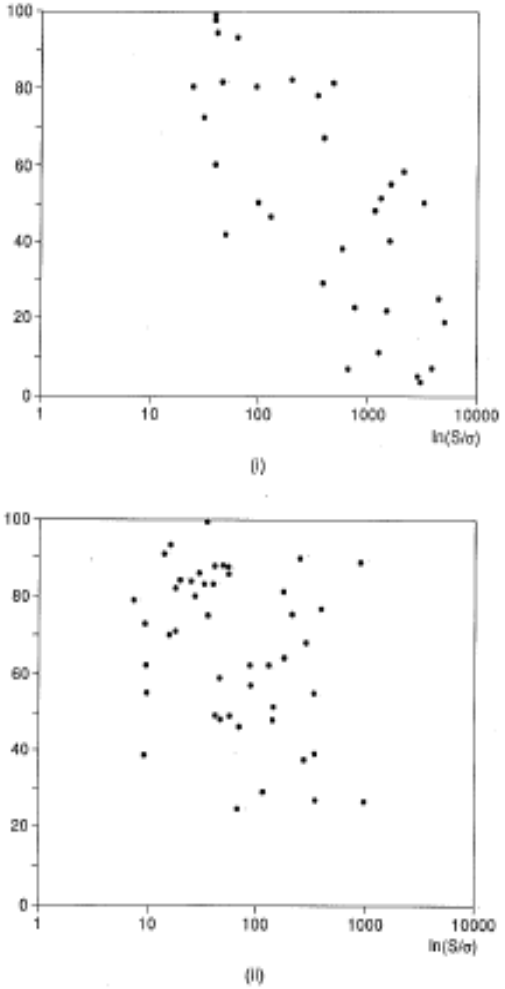


Figure 5.2
Scatter diagrams of the four-firm concentration ratio C_4 versus the market size to setup cost ratio S/σ (log scale) for (i) homogeneous goods industries and (ii) advertising-intensive industries.

Sutton: Empirical Evidence

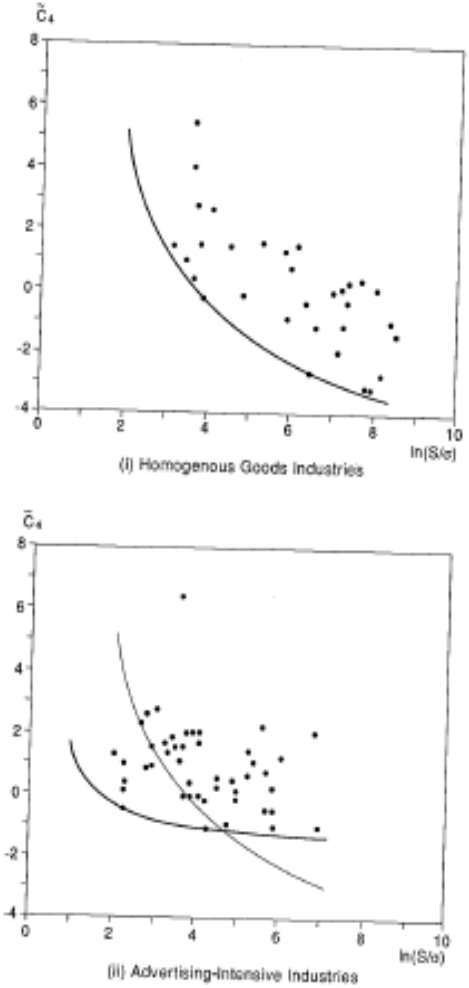


Figure 5.4
Scatter diagrams of the logit transformation of C_4 against $\ln S/\sigma$ for (i) homogeneous goods industries and (ii) advertising-intensive industries. The fitted bounds are (i) $\tilde{C}_4 = -6.08 + 22.3/(\ln S/\sigma)$; (ii) $\tilde{C}_4 = -1.83 + 3.08/(\ln S/\sigma)$. The estimated bound (i) is shown also for comparison in panel (ii). The outlier in panel (ii) is the Japanese beer industry (see chapter 13).

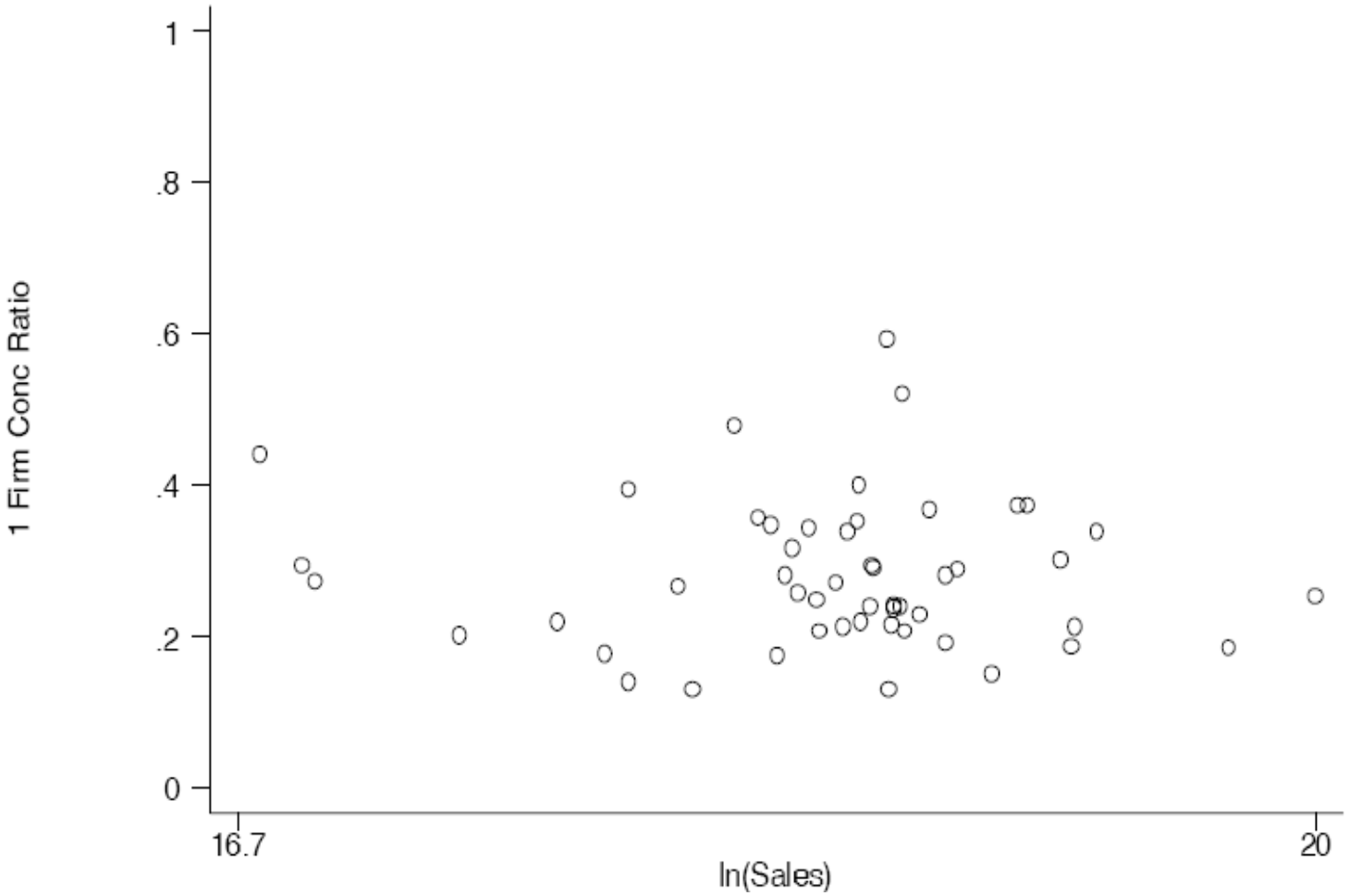
Sutton: Additional Questions

- What questions does the analysis raise
  - Why did only some industries end up advertising-intensive?
  - What's going on above the lower bound?
  - What are the sources of cross-market heterogeneity?
- Sutton provides detailed case studies to shed light on these questions, with many interesting institutional details and stories.
- More generally, we might ask whether his results are likely to extend to other industries, e.g. retailing, manufacturing, services, etc.?

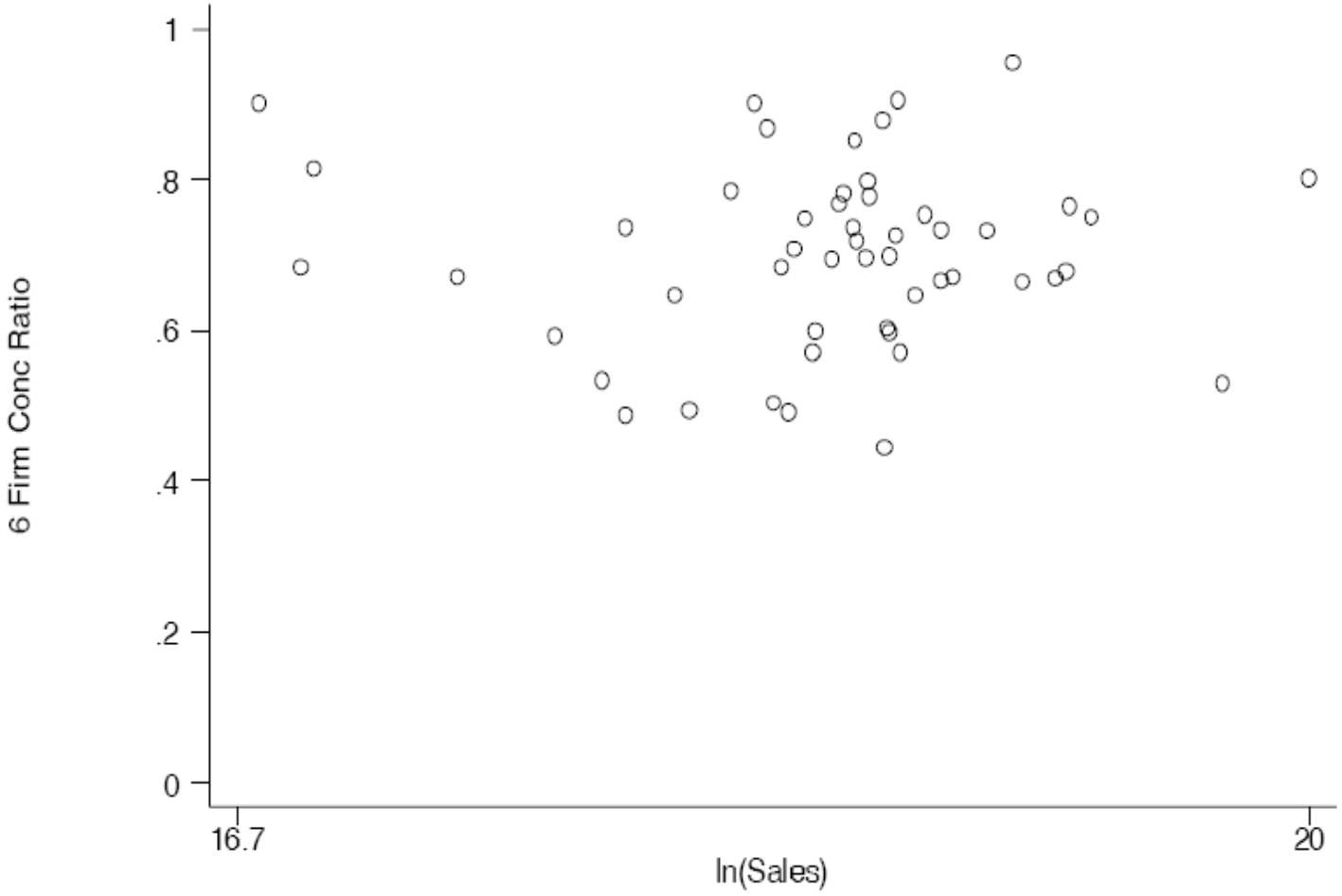
Recent Applications: Ellickson (Rand, 2007)

- Supermarket industry across 50 distinct geographic markets.
- Uses store-level data.
- Findings:
  - Remarkably similar market structure across cities of different sizes
  - Wwe do not see one big firm in small markets and many firms in bigger market.
  - Bigger markets just have a larger fringe of small firms.
- Compares to barbershops and beauty salons — he thinks of this as a "pure horizontal" exogenous sunk cost industry.

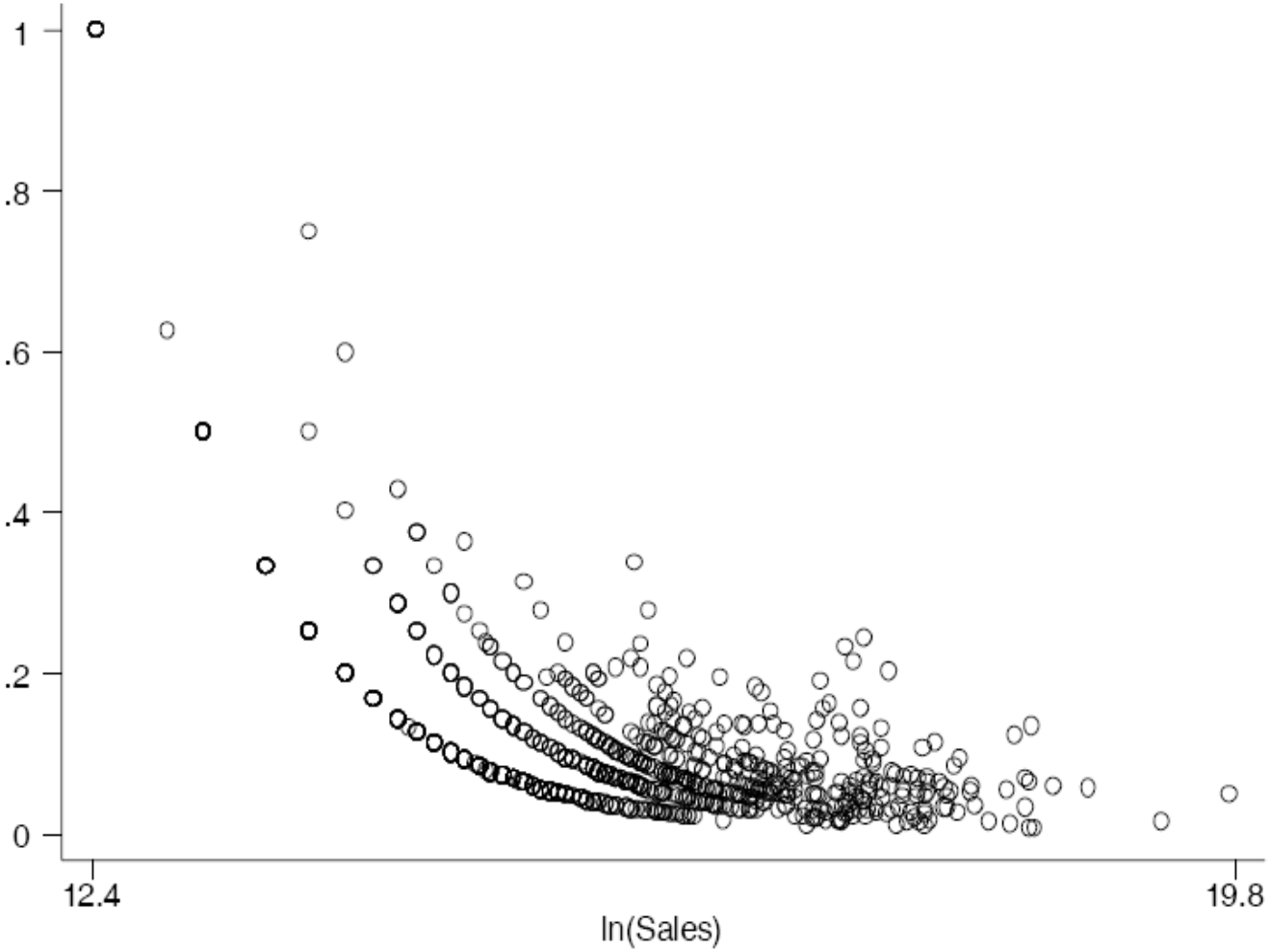
Ellickson: Supermarkets (Figure 3)



Ellickson: Supermarkets (Figure 3)



Ellickson: Barbers and Beauty Salons (Figure 5)



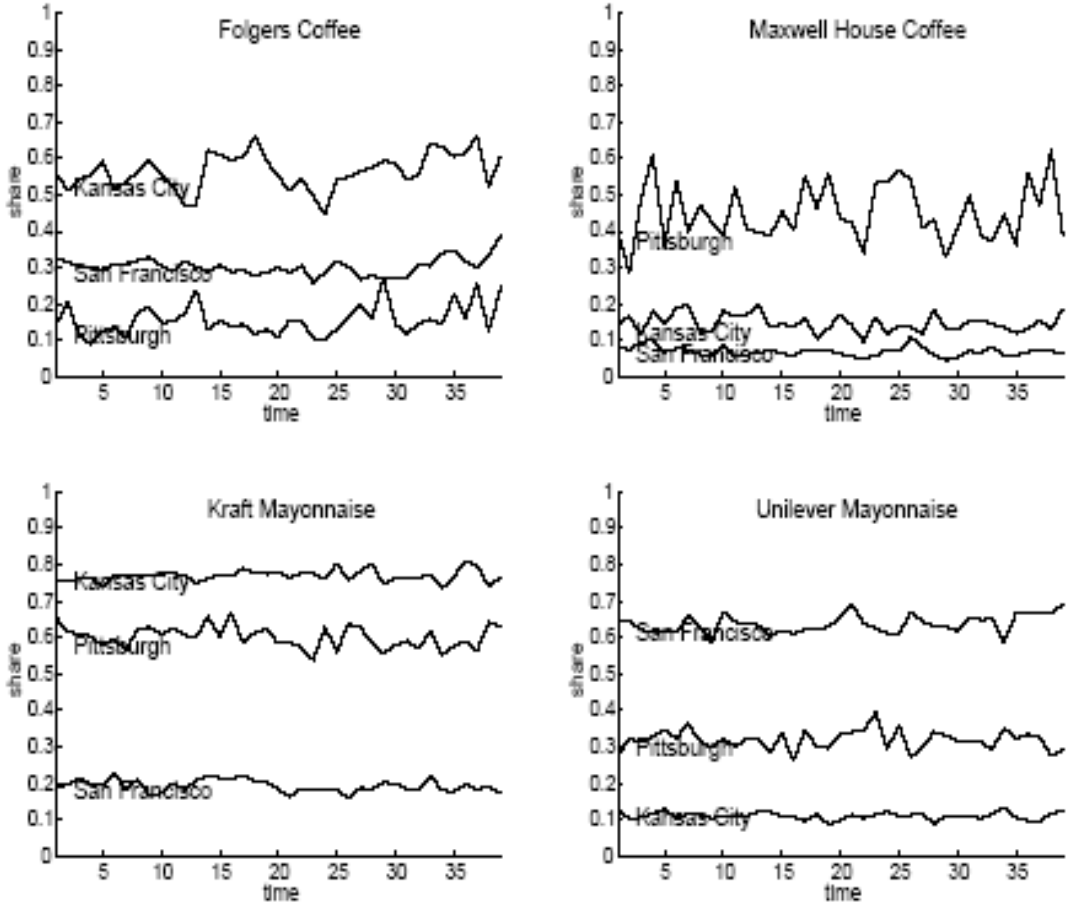
Bronnenberg, Dhar, and Dube (JPE, 2009)

- Nielsen scanner data
  - 31 consumer packaged goods (CPG) industries
  - 50 largest Nielsen markets
  - Data from four week intervals: June 1992-May 1995.
- Additional data
  - Market demographics
  - Nielsen advertising intensity per market.
  - Date of entry and some plant location data.

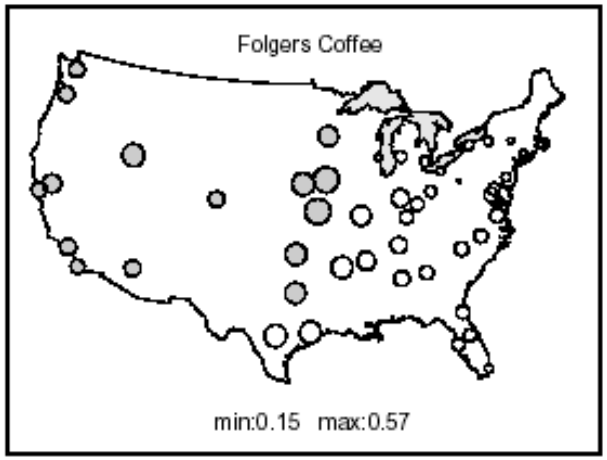
Bronnenberg, Dhar, and Dube (JPE, 2009)

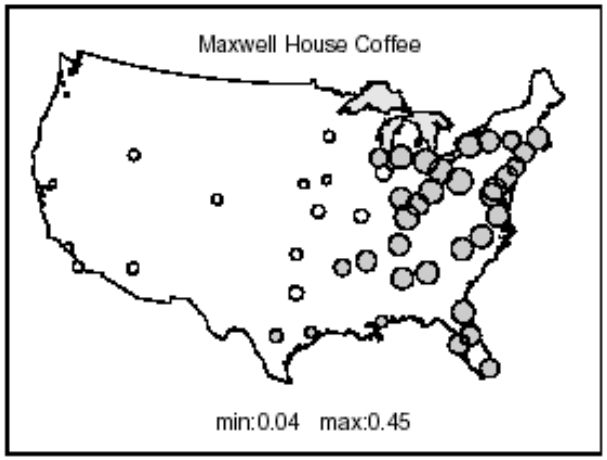
- Basic observations
  - For a given brand, market share varies much more across markets than across time.
  - For a given industry, there is substantial variation in market share and leadership across markets, but strong "spatial dependence".
  - Spatial variation can be linked to first-mover advantage.

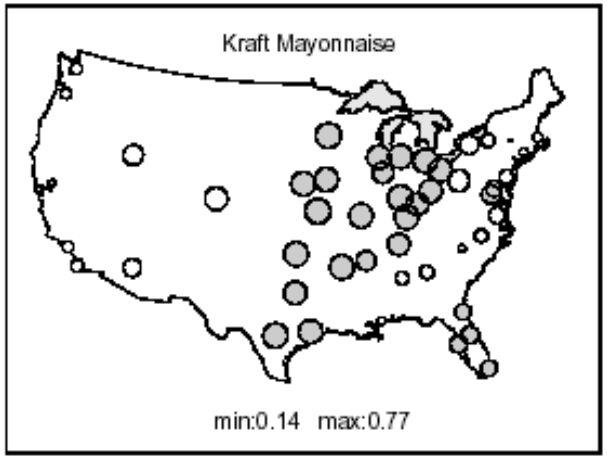
Bronnenberg, Dhar, Dube, cont.

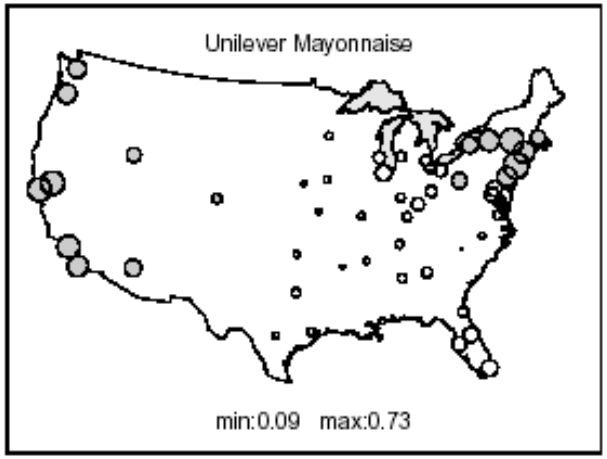


Bronnenberg, Dhar, Dube, cont.

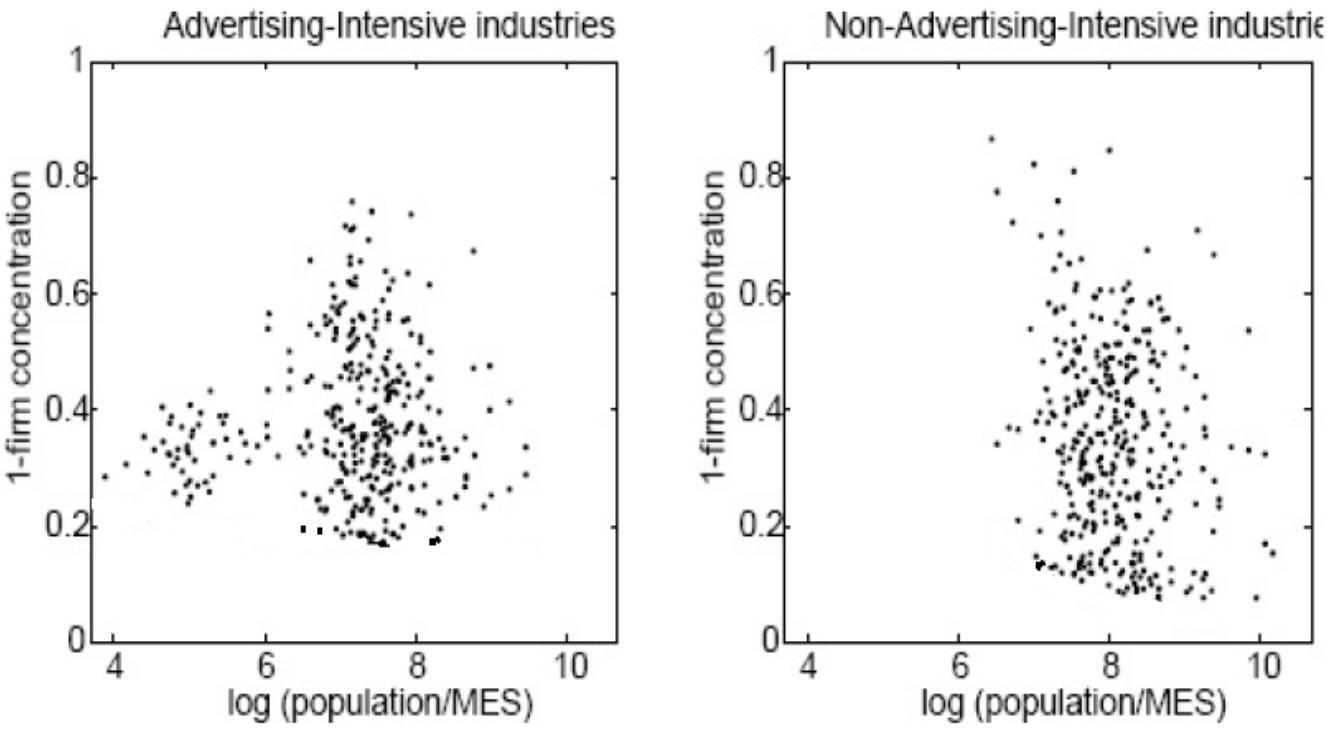








Bronnenberg, Dhar, Dube, cont.



Bresnahan/Reiss (1991, JPE): Empirical Models of Entry

- Can we infer something about competition from observing the number of firms in the market?
  - Consider homogeneous firms, $\pi(n)$ decreasing, sunk cost f.
  - Observe n firms in market means: $\pi(n) > f > \pi(n+1)$.
- BR (1991, JPE) empirical model: n firms enter as long as:

$$S_m \left(X_m \beta - \sum_{i=1}^{n} \alpha_i \right) - W_m \gamma + \epsilon_m > 0$$

  - S_m is the size of market m,
  - $X_m \beta - \sum_{i=1}^{n} \alpha_i$ is profit per capita
  - $W_m \gamma - \varepsilon_m$ is sunk costs of entry.
- This can be estimated using ordered probit (or ordered logit).

Bresnahan/Reiss (1991, JPE)

- BR introduce the useful idea of entry thresholds:

$$s_n = \frac{\overline{f}}{\overline{X}\beta - \sum_{i=1}^{n} \alpha_i},$$

- Here s_n is the market size needed to support n firms at average entry costs.
- Empirical application and data
  - 202 local isolated markets (small towns)
  - Five industries: doctors, druggists, dentists, plumbers and tire dealers.
  - Firms identified using telephone books and trade information, also visits (!).
  - Some covariates on towns, but main variable is population and population growth.
- Finding: entry thresholds converge quite fast, already after the second entrant - in other words, once we get to three or four firms, an additional entrant doesn't much affect competition.

Bresnahan & Reisss (1991)

995

TABLE 5

A. Entry Threshold Estimates

Profession	Entry Thresholds (000's) S_1	S_2	S_3	S_4	S_5	Per Firm Entry Threshold Ratios s_2/s_1	s_3/s_2	s_4/s_3	s_5/s_4
Doctors	.88	3.49	5.78	7.72	9.14	1.98	1.10	1.00	.95
Dentists	.71	2.54	4.18	5.43	6.41	1.78	.79	.97	.94
Druggists	.53	2.12	5.04	7.67	9.39	1.99	1.58	1.14	.98
Plumbers	1.43	3.02	4.53	6.20	7.47	1.06	1.00	1.02	.96
Tire dealers	.49	1.78	3.41	4.74	6.10	1.81	1.28	1.04	1.03

B. Likelihood Ratio Tests for Threshold Proportionality

Profession	Test for $s_4 = s_5$	Test for $s_3 = s_4 = s_5$	Test for $s_2 = s_3 = s_4 = s_5$	Test for $s_1 = s_2 = s_3 = s_4 = s_5$
Doctors	1.12 (1)	6.20 (3)	8.33 (4)	45.06* (6)
Dentists	1.59 (1)	12.30* (2)	19.13* (4)	36.67* (5)
Druggists	.43 (2)	7.13 (4)	65.28* (6)	113.92* (8)
Plumbers	1.99 (2)	4.01 (4)	12.07 (6)	15.62* (7)
Tire dealers	3.59 (2)	4.24 (3)	14.52* (5)	20.89* (7)

Note.—Estimates are based on the coefficient estimates in table 4. Numbers in parentheses in pt. B are degrees of freedom.
* Significant at the 5 percent level.

Bresnahan and Reiss (1991)

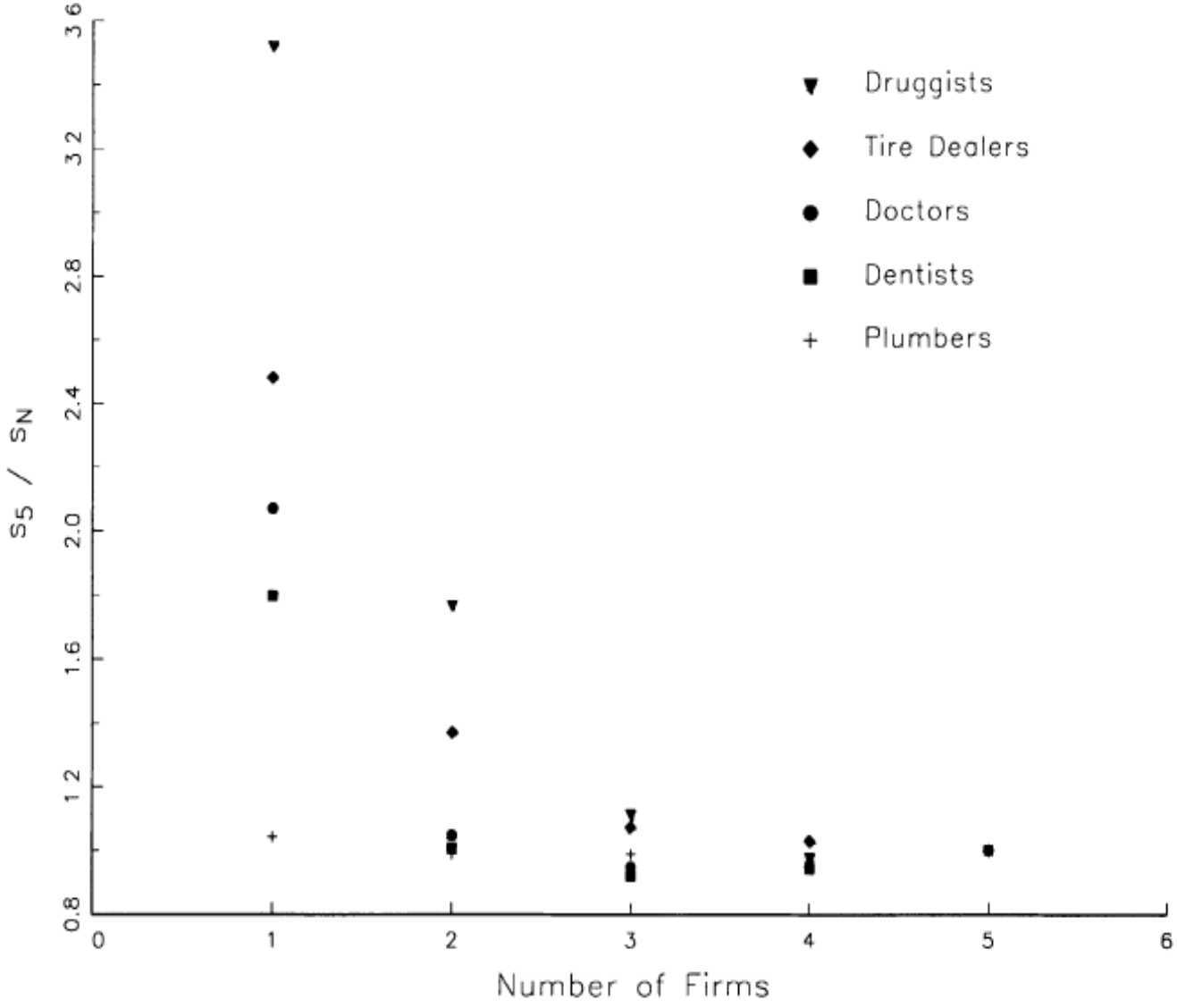


FIG. 4.—Industry ratios of s_5 to s_N by N

Bresnahan and Reiss (1991)

TABLE 10

TIRE PRICE SAMPLE DESCRIPTIVE STATISTICS

	Number of Tire Dealers in the Market						
	1	2	3	4	5	1.5	Urban
Candidate phone listings	39	66	48	64	75	*	200+
Surveyed by us	36	22	19	28	21	20	19
At listed number	32	19	19	24	21	17	18
Would respond	28	19	19	23	20	14	17
Total prices quoted	76	52	50	64	49	36	62
Usable price quotations	42	31	40	57	45	17	59
	Sample Means						
Price	54.9	55.7	54.4	51.6	52.0	53.8	45.6
Tire mileage rating (000)	44.5	47.0	47.7	45.4	43.8	43.0	45.3
	Sample Medians						
Price	53.9	55.0	52.9	50.9	49.8	51.7	43.2
Tire mileage rating (000)	45	45	50	40	40	40	45

* Unknown.

Bresnahan and Reiss (1991, J. Econometrics)

- Generalizes the theory somewhat to allow firms to vary in their entry costs.
  - Returns to entry $\Delta^1, \Delta^2, \ldots$ depends on number of entrants.
  - Costs of entry $\varepsilon_1, \varepsilon_2, \ldots$ can vary across potential entrants.
- Consider the two entrant case: there is no unique mapping from $(\varepsilon_1, \varepsilon_2)$ to (I_1, I_2): absent a rule for equilibrium selection, the model is "incomplete" — i.e. we cannot write down uniquely defined likelihood function because we cannot assign separate probabilities to $(0, 1)$ and to $(1, 0)$.
- Relatedly, the "structural parameters" Δ and distribution of the ε's often are underidentified from entry data (see, Berry and Tamer, 2007).

Bresnahan and Reiss, cont.

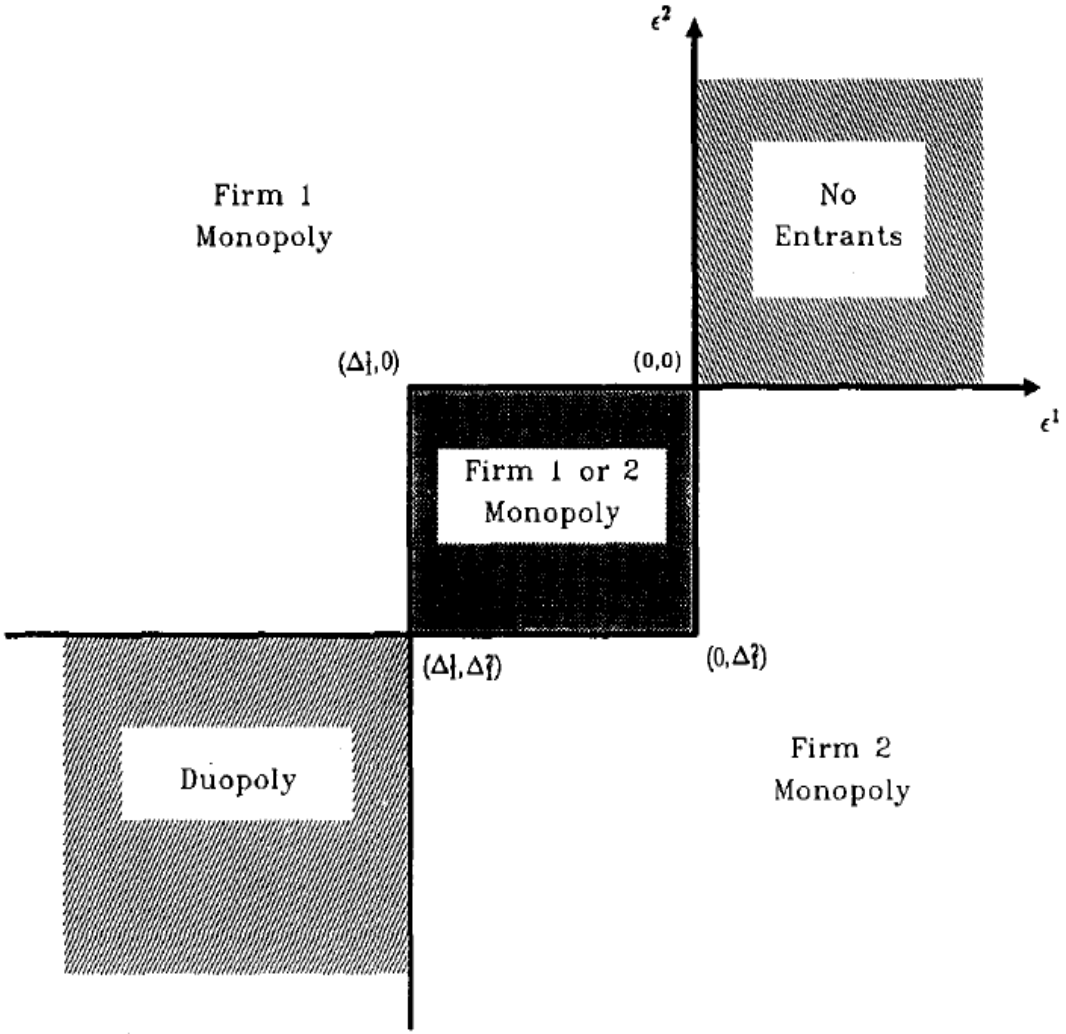


Fig. 1. The simultaneous-move entry game with costly entry (i.e., $\Delta_1^1 < 0$ and $\Delta_1^2 < 0$).

Bresnahan and Reiss, cont.

- How can we deal with this?
  - (i) Find a coarser unique prediction: e.g. in the above context sacrifice efficiency and condition only on the number of entrants but not on their identity: this is useful in a symmetric world, but won't necessarily work in every situation.
  - (ii) Complete the model by assuming an equilibrium selection rule (deterministic or probabilistic), or impose more/different structure on the game to obtain a unique equilibrium (e.g. sequential moves, etc.)
  - (iii) Sacrifice point estimates and only find bounds on the parameters.
- This problem (particularly ii & iii) has attracted a lot of interest in recent years, particularly in econometrics - Tamer (2009) provides a nice overview on partial identification.

Bresnahan and Reiss (1990, RES)

- Compare estimates that result from various models of the entry game, e.g.
  - Identical entry costs and profit functions
  - Correlated but not identical entry costs
  - Correlated but not identical monopoly/duopoly "errors"
  - Sequential move as opposed to simultaneous.
- Empirical application: data on number of car dealerships in small isolated markets.

Bresnahan and Reiss

TABLE 2

Distribution of town population by the number of dealers in town

	No entrants	Monopoly	Duopoly	Three or more entrants
Number of markets	34	42	40	33
Sample percentile				
25th	488	970	1248	1814
30th	545	1052	1417	2016
35th	600	1070	1573	2115
Sample mean	817	1514	2282	2977
65th	824	1492	2579	3130
70th	896	1657	2949	3387
75th	924	1752	3154	3616

Notes. The town population data come from the *1980 Census of Population and Housing* and Rand McNally's *Commercial Atlas and Marketing Guide.* Dealer counts come from R. L. Polk's dealer mailing lists. See the text for sample definitions and counting rules.

Bresnahan and Reiss

TABLE 8

Estimated breakeven monopoly and duopoly market sizes

Specification	Table	S^M	S^D	S^M/S^D	V^D/V^M	F^M/F^D
Model 1						
(1)	5	575	1820	0·316	0·752	0·419
		(188)	(166)	(0·095)	(0·180)	(0·183)
(2)	5	596	1486	0·401	0·590	0·680
		(133)	(178)	(0·070)	(0·139)	(0·194)
(3)	5	663	1518	0·437	0·642	0·680
		(135)	(171)	(0·070)	(0·143)	(0·184)
(4)	5	664	1538	0·432	0·619	0·698
		(135)	(173)	(0·068)	(0·135)	(0·184)
(5)	6	759	1433	0·530	0·640	0·828
		(103)	(141)	(0·057)	(0·111)	(0·163)
Model 2						
(6)	6	662	1538	0·431	0·624	0·691
		(166)	(175)	(0·069)	(0·141)	(0·192)
Model 3						
(7)	6	674	1893	0·356	0·656	0·542
		(115)	(251)	(0·067)	(0·106)	(0·122)
Sequential move						
(8)	7					
	GM	608	1595	0·381	0·709	0·538
		(180)	(220)	(0·170)	(0·158)	(0·196)
	FORD	671	1480	0·453	0·753	0·602
		(175)	(184)	(0·077)	(0·143)	(0·151)

Note. Asymptotic standard errors in parentheses. We evaluated the breakeven market sizes and standard errors at the means of the sample data. The breakeven market sizes have units equal to the number central town residents in 1980.

Brief Overview of Applications/Advances

- Berry (1992): airline markets — a famous paper.
  - Develops approach based on the number of total entrants. He shows that this is uniquely determined.
  - Econometric challenge: region of integration needed to calculate likelihood is complex — he makes early use of simulation methods.
- Mazzeo (2002): highway motels
  - Extends Berry's method for two (and three) types of products, somewhat relaxing the symmetry restriction.
  - Makes an assumption on equilibrium selection to partly resolve indeterminacy. Higher-profit motels move first: (H, L) is an equilibrium iff the standard condition apply and $\pi_L > \pi_H$ at $(L-1, H)$ and $\pi_L < \pi_H$ at $(L, H-1)$.

Brief Survey of Applications/Advances

- Seim (2006): video rental outlets
  - A different approach – assumes the ϵ's are private information and looks for the symmetric Bayesian Nash Equilibrium of the entry game. (Why does this help?)
  - She still restricts everyone to be symmetric (up to a small set of "types"), and cannot prove uniqueness of equilibrium in general).
  - Does this model seem reasonable? Why or why not?
- Toivanen-Waterson (2005): fast food outlets
  - Condition on the actual order of play, and solve for the simpler decision problem of the second entrant. This allows them to use a much richer specification for payoffs.
  - In their case the actual timing of entry solves the need to deal with the inter-dependencies between the decision. They are back into individuals choice. The history/data helps to resolve the multiplicity problem here.

Recent applications/advances, cont.

- Einav (2009): Movie studio decisions about release dates. Models "entry" as a sequential game with private information — equilibrium is unique for any specification of the value function (does not require symmetry).
- Athey, Levin and Seira (2008): Entry into auctions. Use bidding data to estimate profits conditional on entry, then use mixed strategy equilibrium model of entry to back out entry costs.
- Ciliberto and Tamer (2009): Entry into airline markets. Derive bounds on profit function using necessary conditions for equilibrium. Very elegant — but why not use prices and quantities?

Comments

- Recall the original BR question: how fast does competition kick in as number of firms in the market increases?
- There would seem to be an "obvious" way to study this
  - Identify exogenous entry events.
  - Measure prices (or revenues, etc.) before and after.
- Instead, literature has gone in a somewhat odd direction: more and more elaborate ways to infer something about $\pi(n)$ (or $\pi_i(\mathbf{n})$) from 0,1 data on market presence.