Empirical Work in Industrial Organization: Past Progress and Current Challenges.

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Backgound?

- Industrial Organization is the study of market responses to environmental and/or policy changes.
- In the 1980's theorists took up the challenge of analyzing responses to changes in institutions in "oligopolistic" markets – markets where each firm knew its actions affected all firms' payoffs. This provided a conceptual framework for analyzing imperfectly competitive markets; i.e. virtually all markets. What followed was a revolution in the way markets were analyzed.
- Different theory models used different assumptions and came to different conclusions. This generated an understanding of what could happen. But it was not clear which assumptions were appropriate for which situation.

Enter Empirical Industrial Organization.

- General Goal; build frameworks that let the data tie down the assumptions needed in order to use the theory to generate market responses to environmental change.
- Earlier attempts to merge empirical work with theory (e.g. Houthakker, 1955, for production and Gorman, unpublished circa 1960, on demand systems) were difficult to generalize in a useable way. The generality was needed to enable the data to determine the appropriate assumptions.
- What changed? The computer revolution; and the data, econometric techniques, and computational abilities that accompanied it.
- What I want to do here is quickly review both; (i) the issues that we have a pretty good handle on and (ii) recent developments that the lecturers will focus on – and point out some missing pieces that we have done relatively little on.

Static vs. Dynamic Analysis.

- I will start with the part of the literature that deals with competition among a known set of products with known cost functions where prices today do not have an independent effect on future profit opportunities. A part of the literature usually known as "static" analysis.
- A typical question to be analyzed is what is likely to happen to prices after a change in market conditions (e.g.'s, a merger, tariff, regulatory change ...)
- This analysis ignores the impact of the event on investment in physical assets and/or product development; a part of the literature we usually refer to as "dynamics". I return to dynamics below.

Primitives and Equilibrium Condition for Static Analysis

Primitives

1. A model for how much of these products would be purchased at various prices (a "demand" system)
2. A model for how much does it cost to produce those products (a "cost" or "production" function).

Equilibrium Conditions.

- If we were looking to analyze the impacts of, say a merger in a retail market, we need a model for how firms determine prices given demand and cost.
- The analysis would typically proceed by looking at Nash equilibrium conditions in prices before and after the event. This because Nash equilibrium is a "rest point": At equilibrium no agent has an incentive to change its price, and if we are not in a Nash equilibrium at least one agent can do better by changing its price.

Is Their Something Missing from the Analysis?

- Nobody believes the market will get to a rest point instantaneously.
- Unofortunately we know very little about what an appropriate adjustment model looks like.
- It is obvious that having an adjustment model, would let us investigate "transition dynamics": how long does it take to get to the new rest point, and how desirable is the transition path.
- But the need for a model of adjustment is deeper than that.
- The model has interacting agents, so there may be multiple equilibria, and the multiple equilibria possibility gets more likely with problems that involve sunk and/or fixed costs that we will come to next.
- A reasonably accurate empirical model of how firms' learn to adapt to a change would be one way of choosing between the alternatives, and we will need this when computing the likely result of a policy option.

Demand Systems and Equilibrium Assumptions.

Prior work on demand was in product space and was not useable in most of our applications.

1. The "too many parameter problem".
2. Predicting demand for new goods.

We changed to characteristic space i.e.

- Products are defined as bundles of characteristics.
- Individual preferences determined by the interaction of product characteristics with the individual's characteristics.

Berry, Levinsohn and Pakes (1995,2004); or BLP and fellow travellers.

This generated two computational problems.

- Aggregation. To figure out aggregate demand we had to sum up over the demands of many different individuals This is where computers and simulation techniques came in. (Prediction: McFadden and Travilte,1979; Estimation: Pakes, 1986)
- At least for retail products we need to allow for characteristics we could not condition on, and we had to be able to separate their effects from price effects (BLP).

How have we done with our demand and equilibrium assumptions in retail markets?

- In any given market this is easily checked.
- If we rely on
  - our demand system and
  - our equilibrium or "rest point" assumption,
- then price should equal cost plus a markup.
- The markup can be obtained separately from the estimates of the demand system and should have a coefficient of one in the pricing equation.

The Wollman (forthcoming *AER*) Excercise

- Had a separately estimated demand system for trucks.
- We regress price on the determinants of costs and the predicted markup calculated from the demand system.
- Then look at
  - fit
  - coefficient of markup
  - how well we fit changes in a products price over time.

We do pretty well.

- One of the best fitting equations in the social sciences.
- However hedonics alone works pretty well in the cross-section.
- Look to differences over time: still 50-60% fit, and it is pretty much all due to changes in markup (i.e. changes in the characteristics of competitors).

Table 1: Wollman & Pricing Equilibrium.

	Price	(S.E.)	Price	(S.E.)
Gross Weight	.36	(0.01)	.36	(.003)
Cab-over	.13	(0.01)	.13	(0.01)
Compact front	-.19	(0.04)	0.21	(0.03)
long cab	-.01	(0.04)	0.03	(0.03)
Wage	.08	(.003)	0.08	(.003)
$\hat{Markup}$	.92	(0.31)	1.12	(0.22)
Time dummies?	No	n.r.	Yes	n.r.
R^2	0.86	n.r.	0.94	n.r.

Note. There are 1,777 observations; 16 firms over the period 1992-2012. S.E.=Standard error.

Accordingly

- The demand framework is used in economic analysis outside of I.O. (Public Finance, Marketing, ...)
- The equilibrium framework is used in
  - much of academic economic research that analyzes market outcomes (health, environment, ...)
  - consultancies analyzing markets and to some extent both
  - government agencies and firms in their planning.

Extension 1: Markets where the cost function depends on the characteristics of the purchaser and conditions of sale.

- Relevance:
  - Insurance Markets (probability of sickness, accident....)
  - Loan Markets (probability of default).
- Extension: allow the cost function to depend on; (i) the characteristics of the purchaser (adverse selection) and (ii) conditions of sale (moral hazard).
- Implication: demand responses to price changes effect costs; generates new first order conditions for equilibrium.
- Relevant empirical literature: Einav and coauthors (Finkelstein, Levin,...); Chiappori and Salanie.

Issues that arise

- Market unravelling (Ackerloff). More generally: existence and computational issues.
- Regulatory issues.
  - Asymmetric Information and "fairness" of contracts. There is a DOI in most states to review rates and characteristics of insurance products.
  - Externalities: difference between cost to individual and cost to society (moral hazard).
- Impacts through "social norms".
  - Contractarian society: a citizen who fulfills society's duties has a right to a minimal level of goods and services often including *health insurance*. Leads to public involvement in market.
  - **Objective of Intervention.** Insure the provision of these services at minimal cost (*not* to maximize welfare). Questions of the market design which accomplish this.

Extension 2: Vertical Markets. Topic of both first (Lee and Whinston) and second (Asker, Eisenberg, Yurukoglu) set of lectures.

Applied analysis of environmental changes requires consideration of both upstream and downstream markets.

- "Upstream" market: Producers of goods or services sell to intermediaries.
- Intermediaries typically either buy from or contract with many firms and re-market bundles of goods to consumers.
- Downstream market; often a retail market where intermediaries set "take it or leave it" prices to consumers.
- If both the upstream firms and the intermediary are large they bargain for the price the intermediary pays the upstream firm for its goods or services.
- Initial empirical framework; Crawford and Yurukoglu, 2012

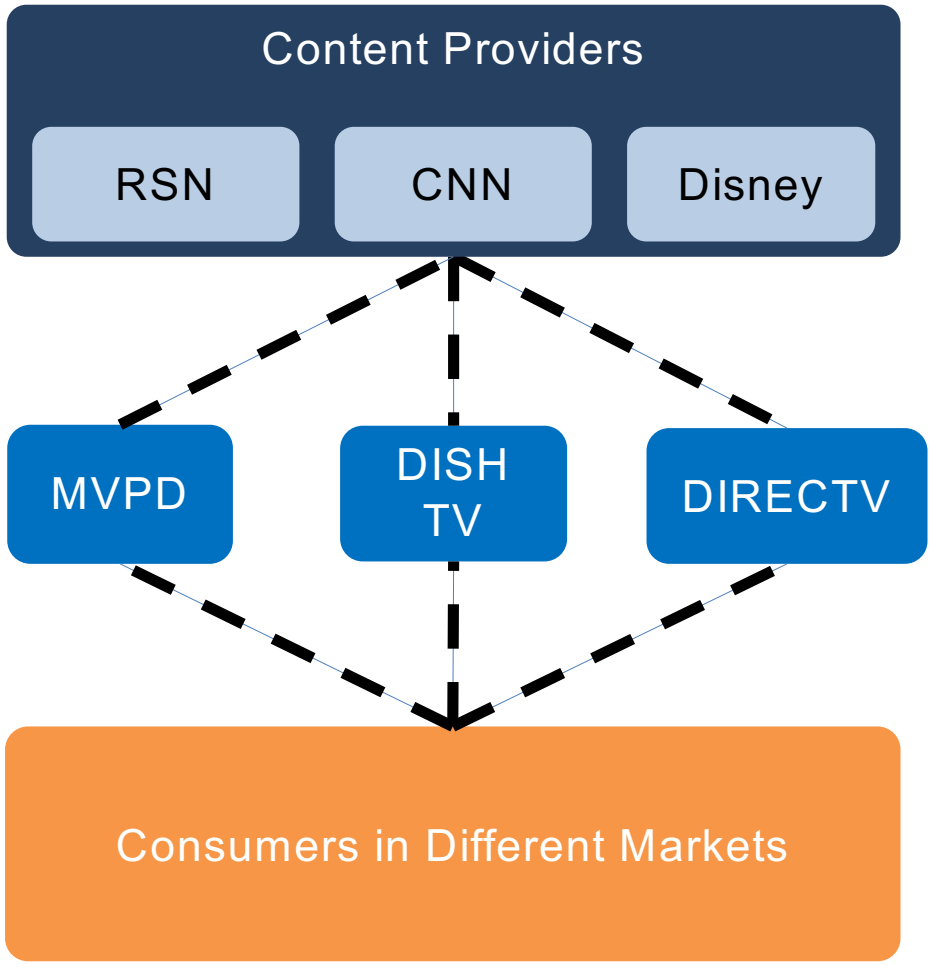
Examples; TV (content providers and cable channels), health (service providers and health insurers), manufacturer and and large retail outlets.

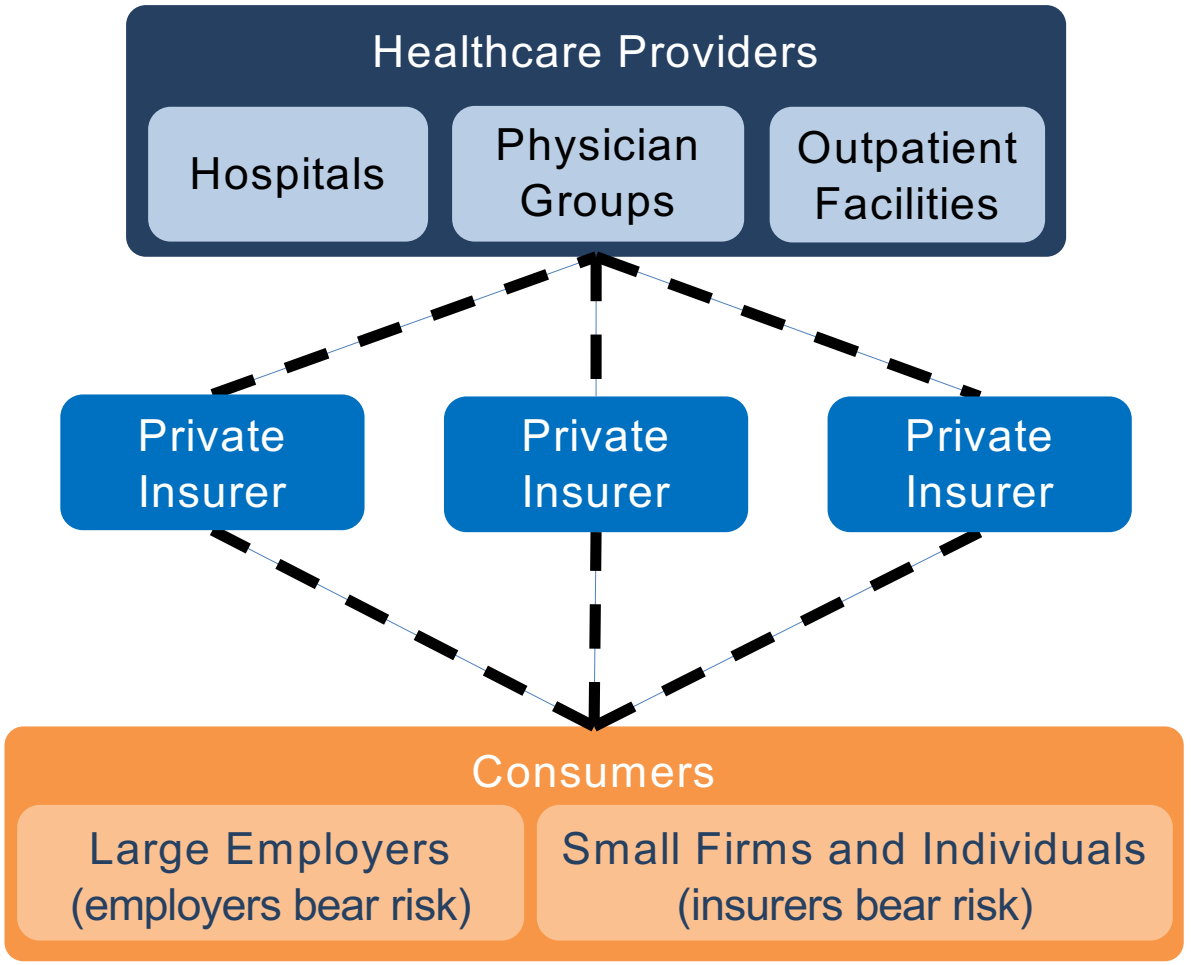
- This is bargaining with externalities; i.e. whether upstream firm A contracts with intermediary B, and the terms of that contract, effects the profits to other upstream and downstream firms.
- The total profits generated by a contract between A & B are the revenues the downstream firm generates minus the costs of production of the upstream firm.
- The bargaining generates contracts which splits those profits between the intermediaries and the producers of the goods.
- There is no generally accepted notion of a rest point for these models. Much depends on what we consider to be a relevant deviation.

Example: what happens when you ignore the Intermediary.

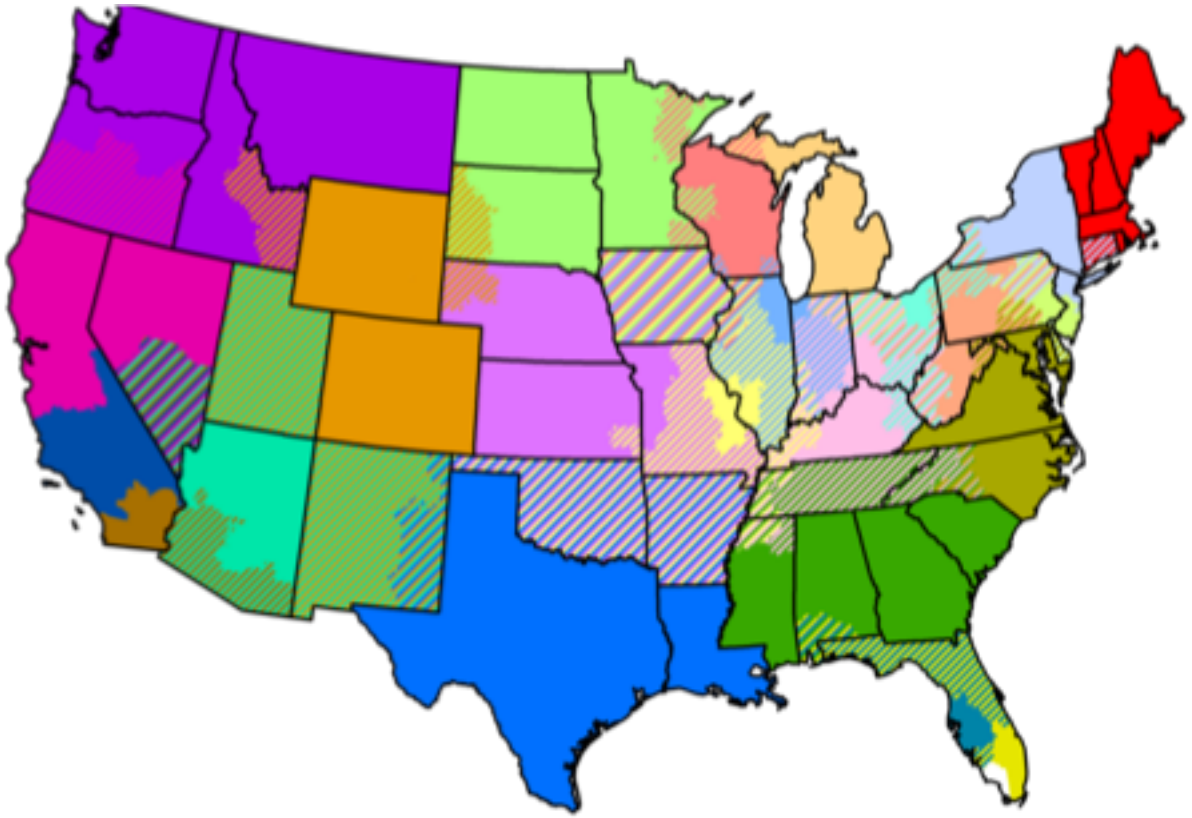
Pictures; MLB and Television rights. Slides from "expert forum" by Cornerstone

Structure of Health Care and Telecasting Industries



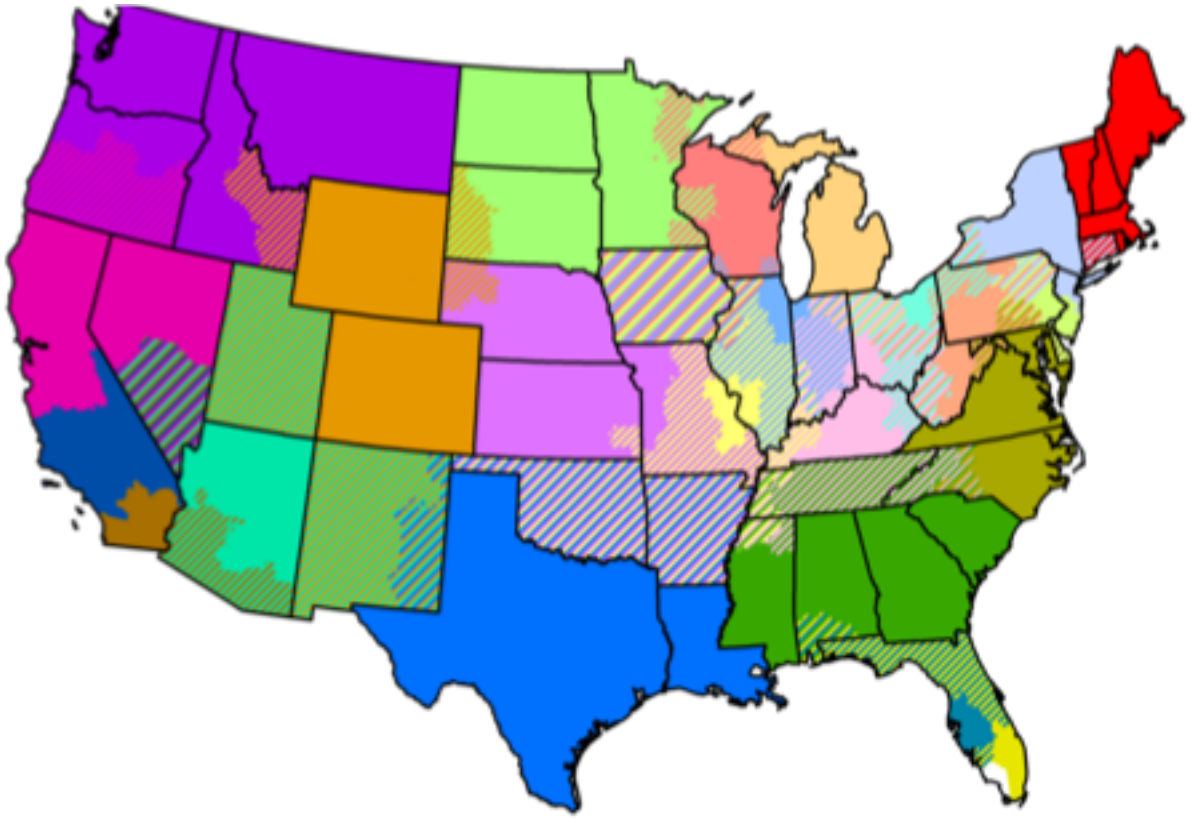


MLB Home Television Territories



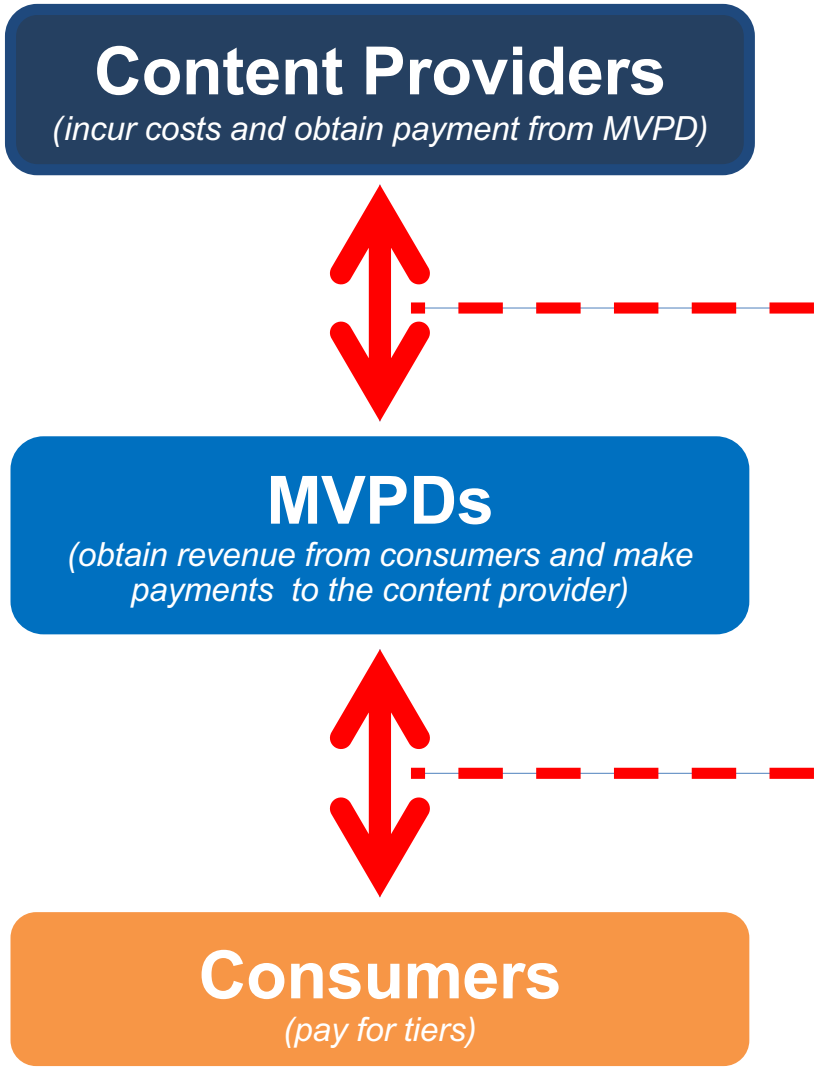
- League defines each team's "home television territory."
- In-market telecast rights are assigned to the teams.
- Out-of-market ("OOM") telecast rights are held by the League.
- OOM telecasts are sold as part of an OOM Bundle ("OMB").

Garber v. MLB et al.



- Plaintiffs characterize the rights arrangements as a conspiracy to divide the "MLB Video Distribution Market."
- Plaintiffs claim this conspiracy harmed all consumers that purchased the OMB.

Vertical Interactions



Upstream

- Total profit is MVPD revenue from consumers minus costs of content providers.
- A bargaining process sets a contract which splits these profits between these two.

Downstream

- MVPDs do not bargain with single consumers. Instead consumers given a “take it or leave it” price.
- A “Bertrand” or Nash equilibrium determines prices.

Dr. Noll's Assumptions Ignore the MPVDs

	Dr. Noll's Assumptions	Market Reality
Cost to Marketer	Cost = telecast costs	RSN/MVPD negotiation sets cost Cost = telecast cost + RSN markup
Who Sets Prices	Each RSN sets the price to consumers for its own product	MVPDs set prices to consumers for all products it markets (includes all RSN's)
Pricing Incentives	Each RSN sets its price independently to maximize its own revenue minus the telecast cost	An MVPD sets prices to maximize revenue from all products it markets minus the sum of their fees

Assumptions vs. Likely Reality

- Dr. Noll's BFW pricing assumptions.
  - MVPDs face higher cost than Dr. Noll assumes.
  - MVPDs prices multiple products, but Dr. Noll assumes RSNs set prices "independently."

  Implication: Consumers face higher prices than Dr. Noll assumes.

- Dr. Noll did not check equilibrium conditions.
  - Dr. Noll assumes there still exists an OMB including all teams. However, the Yankees would make more money if they drop out and increase price.

  Implication: Both Yankee and OMB consumers lose.

Extension 3: Non-price centralized allocation frameworks. Topic of fourth set of Lectures; Agarwal and Pathak.

Applied work; medical residency, school assignment, kidneys match (Roth, Pathak, Sonmez).

- Framework: Deferred Acceptance Algorithm, Top trading cycles (Gale, Shapley).
- Theory Issues
  - Impact of deviations from model's assumptions: incomplete application lists, ties in ordering , interdependent preferences (couples or siblings), institutional constraints (walk zones). More generally ordering of mechanisms by manipulability.
  - Equity issues; sophisticated and unsophisticated users

Empirical work (Agarwal, Ahslagi, Pathak, Somaini)

- Evaluation of outcomes.
  - For medical and school match requires estimates of utility functions. Data: for schools from ordered lists submitted by participants. For medical match only final allocations and characteristics of the participants on the two sides has been made available.
  - To compare to prior mechanisms; requires an ability to estimate preferences when lists are, and are not, truthful (incentive incompatibility)
  - To formulate a new allocation mechanism: what aspects of allocation mechanisms are central to good performance?
- The kidney match is more complex as applicants offered a kidney can reject it in the hope of getting a "better" kidney later on. This leads to a need to study
  - dynamic choices by individuals when the appearance of kidneys is random; and there are match specific complementarities that must be incorporated in the model

Production Functions and Productivity.

Productivity is defined as the ratio of outputs to inputs. Interested because

- Regulation (monopolies and/or mergers). The relationship between market structure and the efficiency of the allocation of output among firms.
- Evaluate policies for; infrastructure, public R&D, intellectual property laws, ...

Estimation of the index of inputs or the "production function".

- Productivity is the "residual", the output differences that inputs do not account for.
- Environmental changes change relative productivities; leads to entry, exit, and changes in size of continuing establishments. $\Rightarrow$ estimation needs to
  1. correct for entry and exit (large and small firms exit at different productivity levels)
  2. a way of separating out input growth from productivity growth (since input choices depend on productivity) .

Analysis.

- Economic theory provides the relationship between input demand and exit decisions to productivity (Maskin and Tirole, 1987; Ericson and Pakes, 1995).
- Olley and Pakes (1996) use this to correct for the relationship between productivity and i) input demands, ii) exit in their analysis of the breakup of A.T. &T.

The breakup of A.T. & T (1982-84)

- Had been a legally protected monopolist in telephone services, and only purchased equipment from its wholly owned subsiduary, Western Electric.
- Judge Green. Breaks it into 7 Regional Bell Operating Companies and makes it illegal for any of them to operate an equipment manufacturer.
- Huge change in structure of industry; immediate entry by Ericson, Northern Telecom, Hitachi,...)

- Question: how did deregulation impact productivity, welfare....

Correcting for exit and simultanaeity in production function estimates

- Note the difference between the balanced panel estimates and the full sample. in sample size
- Full sample Total and Kernel columns correct for the input and exit decisions; Note the difference in capital and labor coefficients.

Productivity growth

- Analysis finds productivity growth after deregulation.
- Prior analysis of productivity just had aggregate data.
- With micro data can we delve deeper into the causes of productivity growth?

Table VI
Alternative Estimates of Production Function Parameters[a]
(Standard Errors in Parentheses)

Sample:	Balanced Panel		Full Sample[c,d]			
						Nonparametric F_ω
	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Procedure	Total	Within	Total	Within	OLS	Kernal
Labor	.851	.728	.693	.629	.628	.608
	(.039)	(.049)	(.019)	(.026)	(.020)	(.027)
Capital	.173	.067	.304	.150	.219	.355
	(.034)	(.049)	(.018)	(.026)	(.018)	(.058)
Age	.002	-.006	-.0046	-.008	-.001	.010
	(.003)	(.016)	(.0026)	(.017)	(.002)	(.013)
Time	.024	.042	.016	.026	.012	.020
	(.006)	(.017)	(.004)	(.017)	(.004)	(.046)
Investment	—	—	—	—	.13	—
					(.01)	—
Other Variables	—	—	—	—	—	Kernel in P and h
# Obs.[b]	896	896	2592	2592	2592	1758

a. The dependent variable is the log of value added.

Decomposing Productivity Growth

- If $p_{i,t}$ is measured productivity p_t is aggregate productivity for the industry, $s_{i,t}$ is the share of the plant in industry sales, and $\overline{p}_t$ is the (unweighted) average productivity among plants

$$p_{i,t} = \sum_i s_{i,t} p_{i,t} \quad \Rightarrow \quad p_t = \overline{p}_t + \sum_i \Delta s_{i,t} \Delta p_{i,t},$$

  where $\Delta p_{i,t} = p_{i,t} - \overline{p}_t$, etc.

- This divides productivity changes into

  1. allocation of output effect,

  2. general productivity improvement.

- The productivity improvements we see after 1984 are totally in the distribution of output among plants (Table 11)

- What is clear is that the covariance of capital and productivity is improving. Under regulation the capital allocation seems inefficient and de-regulation improves it.

Table XI
Decomposition of Productivity[a]
(Equation (16))

Year	p_i	$\overline{p}_i$	$\Sigma_i \Delta s_{it} \Delta p_{it}$	$\rho(p_t, k_t)$
1975	0.72	0.66	0.06	-0.11
1976	0.77	0.69	0.07	-0.12
1977	0.75	0.72	0.03	-0.09
1978	0.92	0.80	0.12	-0.05
1979	0.95	0.84	0.12	-0.05
1980	1.12	0.84	0.28	-0.02
1981	1.11	0.76	0.35	0.02
1982	1.08	0.77	0.31	-0.01
1983	0.84	0.76	0.08	-0.07
1984	0.90	0.83	0.07	-0.09
1985	0.99	0.72	0.26	0.02
1986	0.92	0.72	0.20	0.03
1987	0.97	0.66	0.32	0.10

[a] See text for details.

Needed Extensions.

This is an area of research just beginning and if there were one more set of lectures, it would be on this topic.

- Most data sets (including this one) have revenue, but not quantity. For many issues it will be important to separate them out; if revenue goes up because price goes up, it need not be a good thing.
- New work by De Loecker and co-authors (E.g. De Loecker, Goldberg, Khanderwal, Pavnick 2015): makes progress in separating revenue from output productivity.
  - Puts more structure input decisions; cost minimization plus a "perfectly" variable input generate markup=price/marginal cost.

Related Issues

1. Analytic framework for multi-product firms.
   - Data limitations make it hard to estimate a cost function; $\Rightarrow$ we need a production possibility frontier (allow for common costs).
   - Regulatory issues: economies of scope, vertical integration,...
2. Impact of R&D on productivity and of market structure on R&D is at the heart of
   - many merger cases (recently Dow/Dupont; Monsanto/Bayer),
   - the current debate on the impacts of increases in concentration.

The latter point pushes us toward dynamic analysis.

A Start on Product Development: Product Repositioning and Merger Analysis.

Background: Horizontal merger analysis.

- Focuses on predicting price changes resulting from the merger holding the set of products and their characteristics constant. If their are no "cost synergies" the merger will increase price.
- However this does not take into account product repositioning: a change in the characteristics of the products marketed by an incumbent firm.
- Recent work: shows that in a number of industries an analysis that does not take repositioning into account is likely to be misleading, even in the very short run.

The product repositioning literature

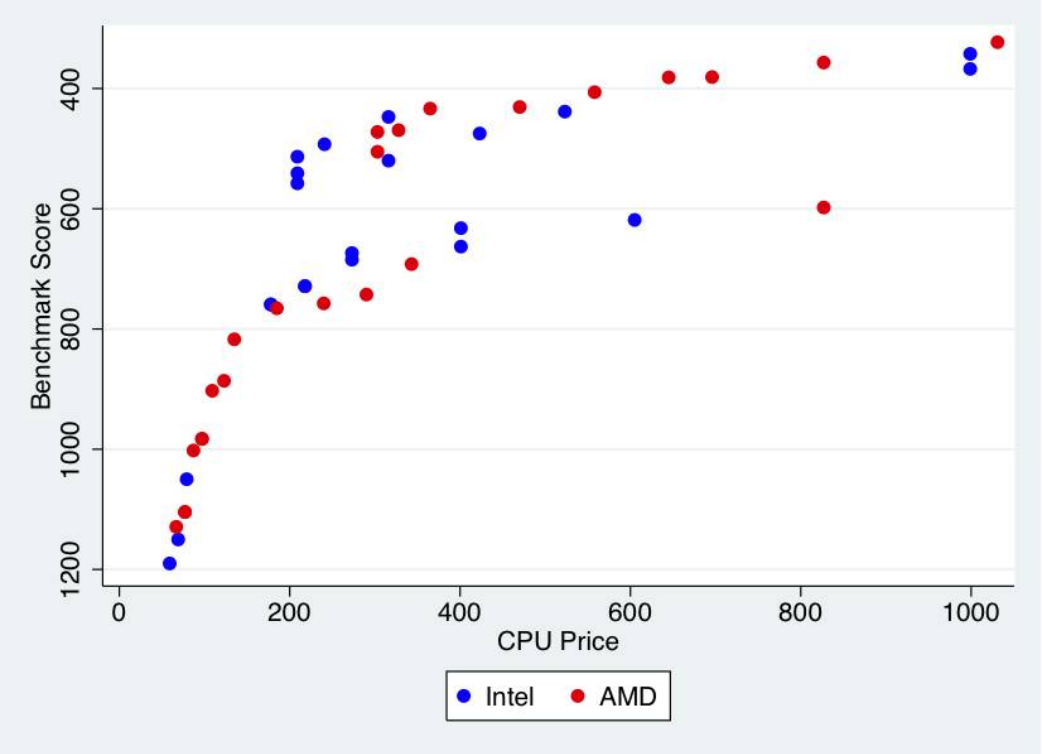
- In addition to demand systems and pricing equations it requires estimates of the fixed cost of marketing a new variant of a product.

- Use the literature on profit inequalities (Pakes, Porter, Ho, and Ishii, 2012). Requires different econometric tools: would be a topic if summer school were not theory and applied work but econometrics and applied work.
- Since prior work enables us to calculate profits from a counterfactual, we can calculate
  - the incremental profits a firm makes from marketing a product which are expected to be greater than the fixed cost; generates a lower bound to fixed costs and
  - if a firm could have marketed a product but decided not to, the change in profits that it expected to earn from marketing the new product must be less than the fixed costs.; generates an upper bound.

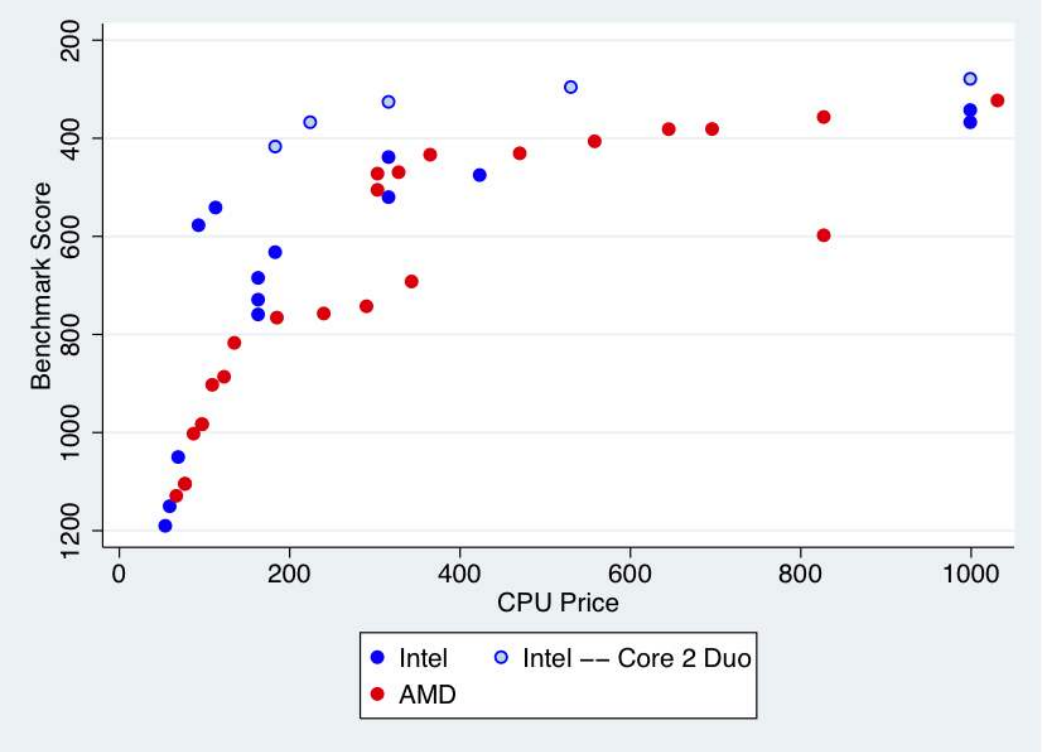
Example: Nosko: Intels' Introduction of The Core 2 Duo Generation in Desktops.

Figures: benchmark scores and prices for the products offered at different times.

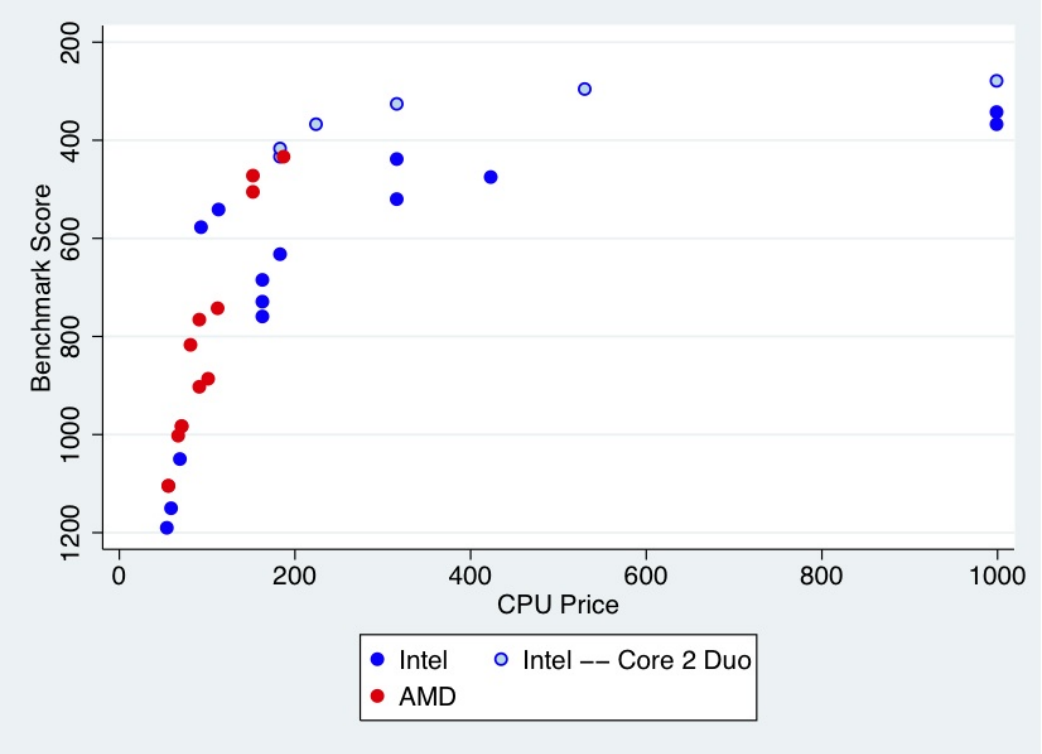
- June 2006: just prior to the introduction of the Core 2 Duo. The red and blue dots represent AMD's and Intel's offerings. Intense competition for high performance chips with AMD selling the highest priced product at just over $1000: seven sold at prices between $1000 and $600.
- Core 2 Duo introduced in July. By October; (i) AMD no longer markets any high priced chips (ii) there are no chips offered between $1000 and $600 dollars.
- November 2006: Only Core 2 Duo's at the high end.
- Nosko goes on to explain
  - that the returns from the research that went into the Core 2 Duo came primarily from the markups Intel was able to earn as a result of emptying out the space of middle priced chips and dominating the high priced end of the spectrum.
  - how a similar phenomena would likely occur if AMD were to merge with Intel. So one would get the wrong results if one ignored product repositioning in analyzing the potential merger.



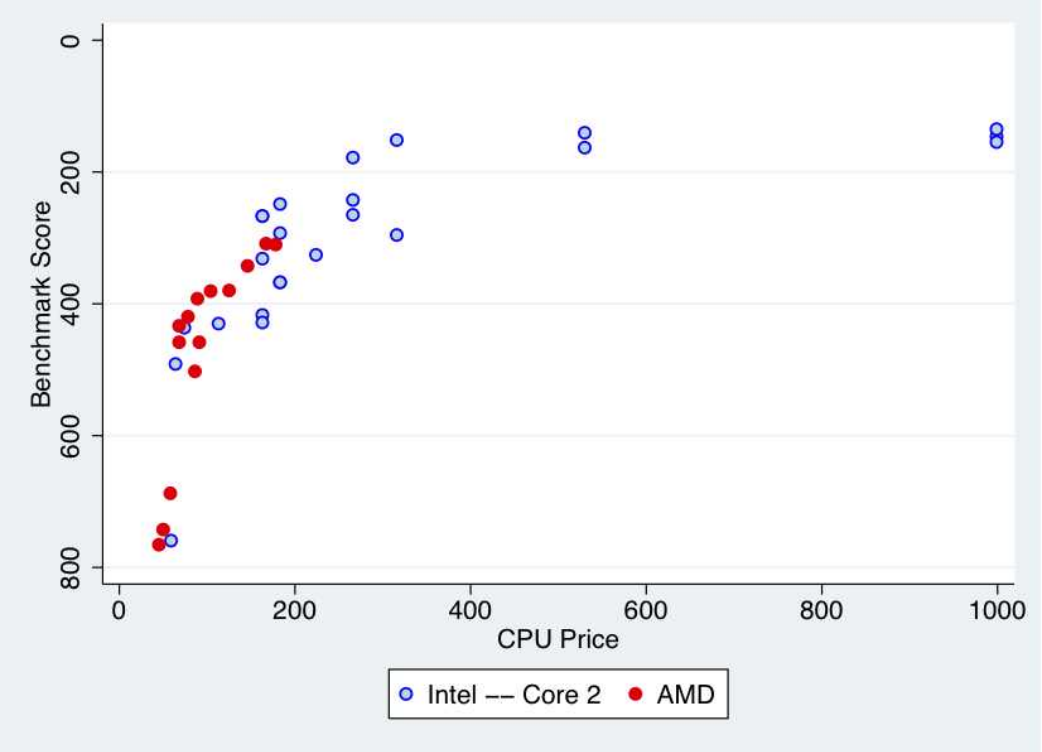
Price/Performance – June 2006



Price/Performance – July 2006



Price/Performance – Oct 2006



Price/Performance – January 2008

Dynamics.

Topic of third set of lectures (Kalouptsidi, Maskin, Pakes.)

- We still need an empirically useable model for investments in physical assets and in product development.
- We started with Markov Perfect models (Maskin and Tirole, 1987, for the theory and Ericson and Pakes, 1995, for the applied framework). These models are based on two behavioral assumptions;
  - firms make choices to maximize their perceptions of the expected discounted value of future net cash flows, and
  - their perceptions are consistent with both the play of competitors and the processes generating any exogenous factors that affect profits.
- The basic model lead to computational explorations of theoretical issues learning by doing (Besanko et. al.), collusion (Fershtman and Pakes), mergers (Gowrisankaran) & some empirical work (Benkard, Goettler and Gordon).

What seemed like realistic assumptions lead to the need for

- large state space, and/or
- asymmetric information.

Once we took either into account the cognitive and memory requirements to formulating policies for these models were such that it was difficult

- for the researcher to use these models (computation, estimation...), and
- to believe management made decisions in this way.

So though many thought that these models were the best models available, it seemed worth investigating assumptions that might both

- better approximate firm behavior, and
- be easier for the empirical researcher to use.

Attempts to do so

1. Based on approximating equilibria. Benkard, Weintraub, and Van Roy, (2008) operationalized a computational technique based on a limiting (or invariant) distribution over states in "Oblivious Equilibrium" .
   (Related work includes the "mean field" literature in Operations Research and the anonymous sequential games literature in economic theory.)
2. A behavioral approach to simplifying the problem was developed by Fershtman and Pakes, (2012) and labelled "Experience Based Equilibrium". It assumes that given their information sets, firms do not err on average. With appropriate information sets it nests Oblivious Equilibrium
   (For related work in the theory literature see Fudenberg and Levine, 1993, on "self-confirming equilibrium".)
3. Empirical work is just beginning. Perhaps the most striking example is on the bulk shipping industry where Kalouptsidi et. al. combine the above approaches in a setting with search, and endogenously determine trade costs, how they would change with particular environmental changes, and the impact of those changes on trade.

We go over much of this in the third set of lectures. However

- though computational and data constraints are less than they used to be, they are typically still a problem, and
- there is a need for work on transitions to equilibrium behavior as distinct from equilibrium behavior per se.

Like most prior problems in applied work, these are likely to be solved in the context of actually doing empirical work on particular industries.