Vertical Market Structure 1

Introduction and Theory

IO Fall 2013

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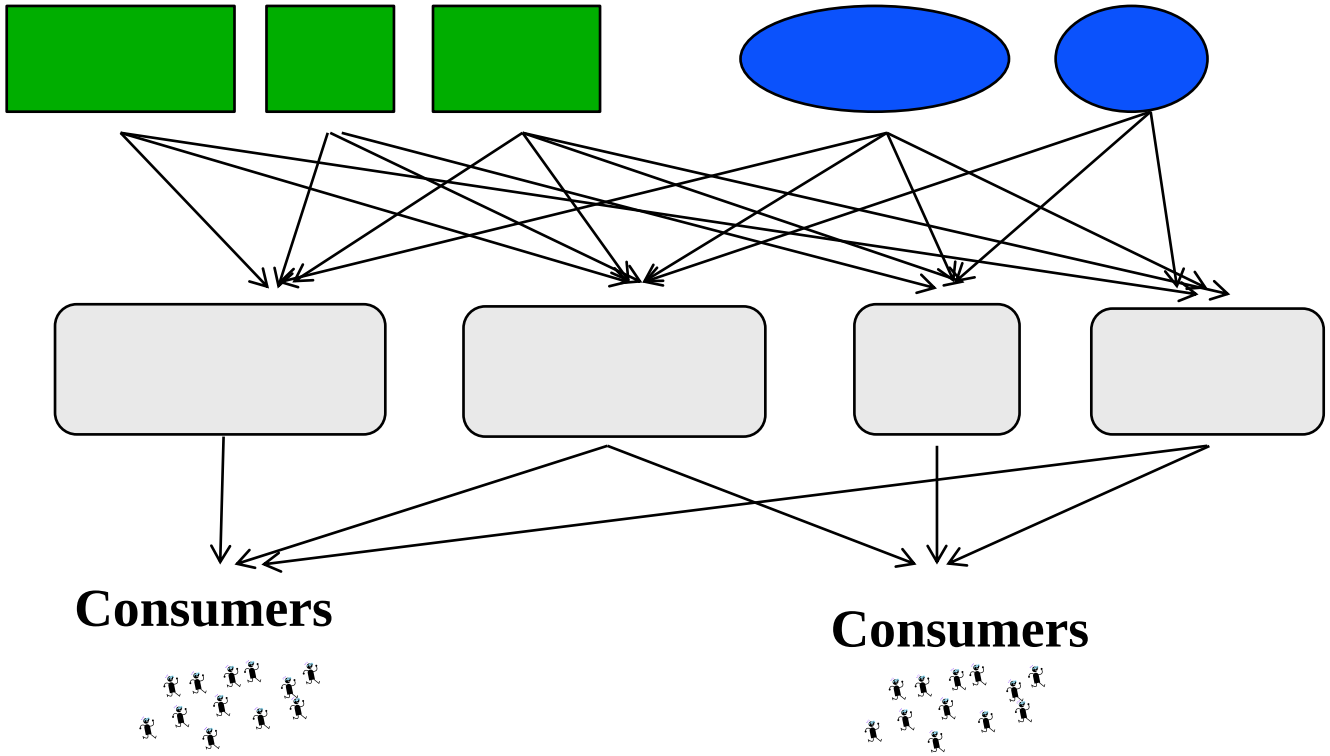
Vertical Market Structure Key Elements



Main ingredients: Buyers and sellers with market power, externalities between different groups, contracting

Vertical Markets in IO

- Consumer Packaged Goods: **Manufacturers:** Proctor and Gamble, Unilever, Colgate-Palmolive and **Retailers:** Walmart, Costco, Target, Safeway, CVS, Walgreens

- Cable and Satellite TV: **Content:** Viacom, News Corp, Time Warner, NBC-Universal and **Distribution:** Comcast, DirecTV, Dish, Time Warner Cable, Cablevision, Cox, Charter, Verizon, AT&T

- Automobiles: **Parts:** Denso, Bridgestone, Delphi… **Manufacturers:** Ford, Toyota, GM, Chrysler, Nissan, BMW… and **Dealer Groups**

- Health Care: **Equipment Manufacturers** (GE, Phillips) …, and **Hospitals**,… and **Insurers**

- Beer: **Brewers** (Anheuser Busch, Miller-Coors), **Distributors**, and **Retailers**

Plan for Next Four Lectures

- Analyze a combination of theory and empirical models of vertical markets in IO
- *Lecture 1, Basic Theory*: Hart and Tirole, McAfee and Schwartz, Nash, Rubinstein, Horn and Wolinsky, Cramton
- *Lecture 2, Contractual Terms and Vertical Restraints*: Exclusive dealing and refusal to deal, wholesale bundling, wholesale price discrimination, most favored nation clauses (mix of theory and empirics)
- *Lecture 3, Estimating Bargaining Models of Vertical Markets*: Commercial supply contracts from cable and electricity, Crawford and Yurukoglu
- *Lecture 4, Vertical Merger Analysis*: Efficiency vs foreclosure incentives, investment incentives, empirical analysis

Basic Theory

- Ariel and I were at anti-trust conference a few weeks ago.
- Mike Whinston to Ariel: *"From now on, all new static vertical theory models should be banned"* (paraphrasing)
- I will go through what have been the most useful models for myself in organizing my thinking and modeling empirical questions in cable, electricity, pharmaceuticals, and hospitals-health insurance.
- It will become clear there are a lot of loose ends, unknowns, extreme sensitivity to model assumptions, and so forth.

TIOLI Offers

- We start with take-it-or-leave-it (TIOLI) offers by the upstream firms to the downstream firms.

- The equilibrium notion is like Nash-in-prices with the main difference being upstream firms can target their price to each buyer.
  - We will have to account for informational considerations.

- When we get to bargaining later, we will see TIOLI endows, by assumption, all the "bargaining power" (to be defined) to the firms making the offers.

TIOLI Offers

- The focus on TIOLI is because the game theory is somewhat tractable.

- Hope that theoretical forces that emerge in TIOLI carry through to bargaining, but the conditions when this is true or not haven't been worked out.

Undergraduate Vertical Relationships

- One upstream firm (U) and one downstream firm (D).
- U needs to sell through D to reach consumers.
- D needs U's input to have a product.
- U has cost c. D's marginal cost is the unit price it pays U (call it τ).
- Under linear fee contracts, there is double marginalization (double mark-up).
- Under two-part tariffs, U and D maximize their surplus (but still not great for social welfare: monopoly price).

Hart and Tirole (1990)

- This is a Brookings paper whose goal is to analyze vertical integration.
- We will come back to vertical integration issues in a few lectures.
- We will focus for now on the theory of vertical relationships that is embedded in their larger model.
- Specifically, focus on the issue of **out-of-equilibrium beliefs**.

Hart and Tirole (1990) and Passive Beliefs

- One upstream firm U (they have multiple)
- Two downstream firms D1 and D2

- U sells an input that the D's transform at zero cost to sell to consumers.
- U's marginal cost is 0

- D1 and D2 compete for consumers (Cournot or differentiated Bertrand).

- D_i marginal cost is its contract's linear price from U.

Hart and Tirole (1990) and Passive Beliefs

- Contract offers are secret.
- Timing is U simultaneously makes contract offers (F_i, τ_i) to each D_i.
- D's accept or reject, then produce in competition with each other.
- Because contracts are secret, equilibrium prescription must deal with information.

Hart and Tirole (1990) and Passive Beliefs

- To recap game:

- The players are U, D1, and D2.

- Strategy space for U consists of contract offers.
- Strategy space for D_i are functions mapping their own contract offers and beliefs about the other contract offer into whether they accept or reject contract and their downstream price.

- Payoffs: $\Pi_U = F_1 + F_2 + c_1 Q_1(\vec{p}) + c_2 Q_2(\vec{p})$

$$\Pi_{D_i} = -F_i + (p_i - c_i) Q_i(\vec{p})$$

Hart and Tirole (1990) and Passive Beliefs

- Equilibrium consists of

- Strategy for U: (F_i, τ_i)
- Strategy for each D_i:
  - $Accept_i$: (F_i, τ_i) x $\mu_i(F_i, \tau_i)$ -> {0,1}
  - q_i: (F_i, τ_i) x $\mu_i(F_i, \tau_i)$ -> R
- Beliefs for each D_i: $\mu_i(F_i, \tau_i)$ - Probability distribution over offers to D_{-i}

- Bayesian Perfect Equilibrium:
  - Strategies must be optimal given other strategies and beliefs.
  - Beliefs must be derived (via Bayes rule) from U's equilibrium strategy, **when possible**.
  - We're looking at pure strategies, so D_i believes for sure D_{-i} is getting the offer prescribed by the equilibrium when D_i itself is getting the offer prescribed by the equilibrium.

Hart and Tirole (1990) and Passive Beliefs

- The issue of beliefs is:
- What does a D_i believe about (F_i, τ_i) when it sees a contract offer that is **not the one prescribed by the equilibrium.**
- "Out of equilibrium" beliefs. Lots of possibilities.
- These beliefs are never invoked in equilibrium, but they are necessary to logically define the equilibrium.
- They are needed for considering deviations by U.
- Often refer to out-of-equilibrium belief choice as "supporting" a strategy profile.

Hart and Tirole (1990) and Passive Beliefs

- Hart and Tirole consider an equilibrium supported by **passive beliefs**.

- When a D_i sees an out of equilibrium offer, it believes that U is still offering D_{-i} the offer prescribed by the equilibrium.

- The language is "passive" because D_i always has the same beliefs about D_{-i}'s offer no matter what it sees from U.

Passive Beliefs Equilibrium

- Let's play this out with Cournot competition.
- Check whether an intuitive outcome is an equilibrium or not.
- Possibility: Vertically Integrated Monopoly Profit:
- U is a monopolist. Can it obtain the integrated monopoly profit?
- Key notion: under passive beliefs, equilibrium contracts must be **pairwise-stable**.

Passive Beliefs Equilibrium

- Follow the intuition from undergraduate vertical relationships.

- Obtain monopoly profit by setting the linear part of the contract to induce the downstream firms to price at the monopoly price, then take it all by the fixed fees.

- Is it an equilibrium? **No.**

- U is collecting fixed fees from everyone regardless of whether they sell anything.
- Holding everyone else fixed, it can deviate with any one retailer, lowering their τ and increasing their F, and still collect the F's from the other retailers.

Passive Beliefs Equilibrium

- Equilibrium consists of U charging **marginal cost to downstream firms and collecting all the profits via fixed fee.**

- **U has a commitment problem.**

- It would like to commit to contracts that induce vertically integrated monopoly profit, but since they are unobservable, it can not.

- Similar to durable goods monopolist.

McAfee and Schwarz (1994)

- This is in the AER in 1994.
- It is short and sweet. There are some benchmark results and a lot of food for thought.
- Key points of this paper:
- Introduce notion of **wary beliefs**.
- Show that **non-discrimination clauses do not solve the commitment problem**.

McAfee and Schwarz (1994)

- **Wary beliefs** says that when a D_i sees an out of equilibrium offer, it considers that U's offer to D_{-i} changed to the contract that maximizes U's profit assuming both were to take U's new offers.

- Doesn't change allocation for Cournot with secret offers.

- Series of papers looking at other settings (Rey and Verge), which show that wary beliefs are more stable and tend to exacerbate commitment problem.

McAfee and Schwarz (1994)

- Somewhat surprising the non-discrimination clause does not solve commitment problem.
- What else could a firm do to solve commitment problem?
- They suggest vertical integration, exclusive dealing, establishing a reputation for transparency and uniformity in contracts.
- Using only linear contracts another possibility (I conjecture).

H&T and M&S

- The point of going through these are to show some of the informational issues that arise.
- Results are sensitive to seemingly minor changes in timing or informational assumptions.
- There is a cottage industry of papers.

Buyer Power and Bargaining

- We now move to models where the upstream firms don't just dictate the terms of trade to downstream firms.
- Coca Cola doesn't go to Walmart and say here is our price, take it or leave it.
- Walmart itself might tell a small manufacturer: "We'll carry your product for price x, take it or leave it"
- Equilibrium will satisfy pairwise stability, but mostly sweeps modeling of informational issues under the rug.

Bargaining

- Start by reviewing bargaining theory.
- A bargaining problem is when two agents can create a surplus together, but they disagree over how to split the surplus.
- Simplest case is I have a product to sell to you. The surplus is the difference in our values.
- I would like to charge your full valuation. You would like to pay just my reservation value.
- Any price weakly between these two is better than not transacting. So what price gets chosen?

Nash

- Nash formalized this problem as follows:
  - Set of feasible allocations: X
  - Two players with utility functions on X: $u_i(x)$
  - Disagreement values for each player d_i
  - Bargaining parameters b_i

- Simplest case: X is (x_1, x_2) / $x1+x_2 = 1$
- $u_i(x) = x_i$ and $d_i=0$ (Splitting a dollar)

- Nash bargaining solution:

$$\max_{x_1}(u(x_1) - u(d_1))^b(u(x_2) - u(d_2))^{(1-b)}$$

$$\max_{x_1}(x_1)^b(1 - x_1)^{(1-b)}$$

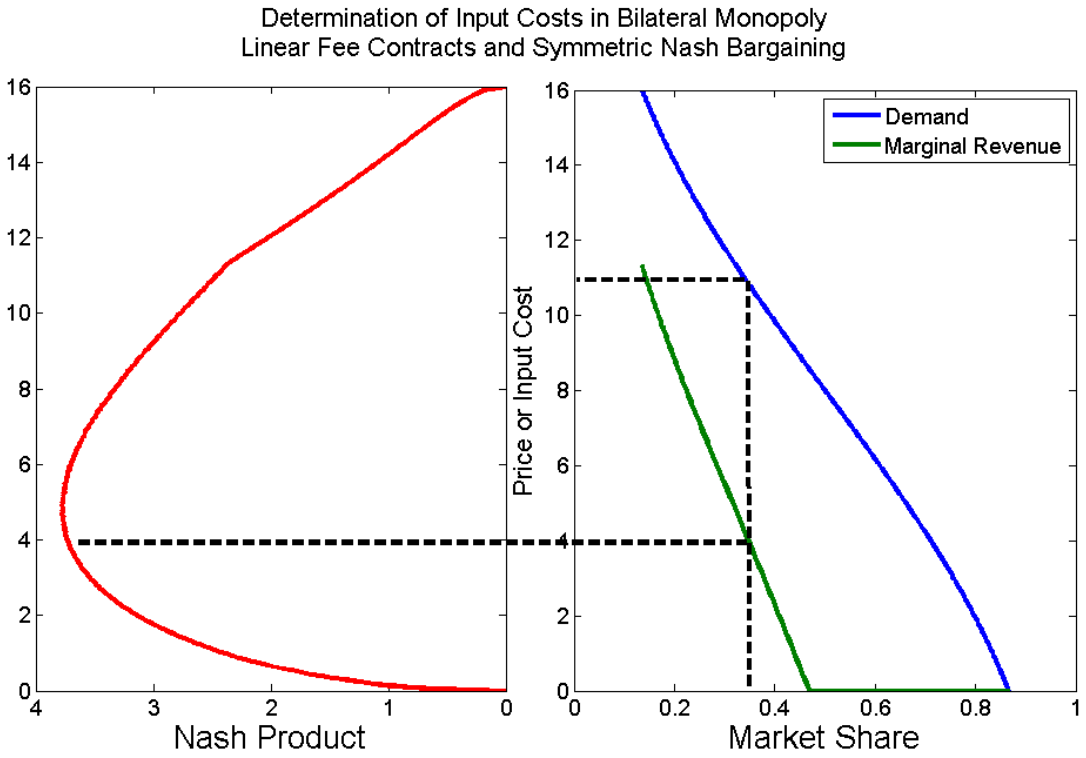
- Solution satisfies IIA and efficiency axioms.

Nash and Undergraduate Vertical Relationships

$$\max_{\tau}((p^* - \tau)D(p^*))^b((\tau - c)D(p^*))^{(1-b)}$$

Pay off to downstream firm

Pay off to upstream firm



Estimation

$$\max_{\tau}((p^* - \tau)D(p^*))^b((\tau - c)D(p^*))^{(1-b)}$$

Pay off to downstream firm

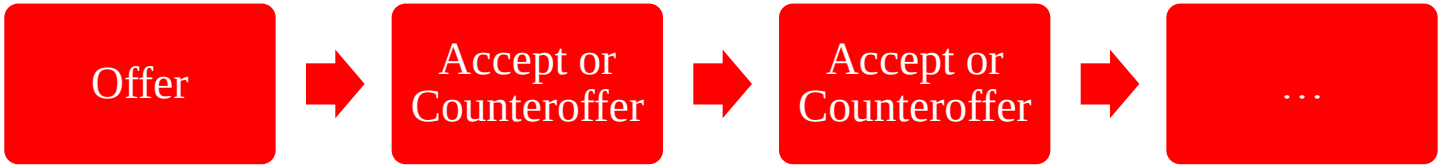
Pay off to upstream firm

- Assume demand system is estimated. Invert to get τ.
- c and b are unknown.
- In general, these are not separately identified.
- Might know c (for example in cable content, it is zero)
- Then estimate b to deliver τ in equilibrium.
- Otherwise, need more assumptions or more data.

Rubinstein

- Ariel Rubinstein applied dynamic game theory to the bargaining problem in a classic paper (related earlier results by Stahl).

- Considered a game of offers and counteroffers between parties.



- Game ends when an a deal is reached.
- Impetus not to hold out forever is time discounting.

Rubinstein

- The result in Rubinstein is that (1) there is a unique subgame perfect equilibrium of the alternating offer game (which is also stationary).

- (2) Take the limit of these equilibria as time periods get shorter. Limit is the Nash bargaining solution for appropriately chosen bargaining parameters.

- First offer is accepted, no delays and no actual negotiation.

- Appropriate bargaining parameters functions of differences in patience. Relatively more patience means greater fraction of surplus.
- Other variations: risk of total breakdown and risk aversion, risk of total breakdown and probability of being a proposer.

Rubinstein

- So far, perfect information (we'll come back to this).
- No externalities, just one bargaining game in isolation.
- Issue of TU vs NTU (transferable utility vs non-transferable utility).
- Rubinstein is in terms of TU.
- Linear contract games are NTU. The only way to transfer utility is by changing the linear fee, but this also changes the surplus to be split because of double marginalization.
- Having a fixed fee makes the game TU.

Horn and Wolinsky

- Application to vertical relationships.
- Horn and Wolinsky model a vertical market as a group of interrelated Nash bargains.
- Equilibrium notion is going to be a Nash equilibrium between Nash bargaining situations.
- Similar to pairwise stability.
- No pair can re-negotiate their contract to make themselves better off.

Horn and Wolinsky

Players:

- N upstream firms, n=1…N
- M downstream firms, m=1…M
- Distribution of consumers, F(i)

Technology:

- Upstream firms produce inputs
- Downstream firms procure inputs and produce final goods for sale to consumers

Payoffs and Strategies:

- Simplest treatment is to assume Bertrand competition in linear prices upstream and downstream.
- Can of course assume Bertrand competition in non-linear prices, upstream or downstream
- **Bargaining in linear prices and Bertrand competition downstream**
- Bargaining over complex contracts and Bertrand competition downstream

Horn and Wolinsky

Bargaining in linear prices and Bertrand competition downstream

Each upstream firm m and each downstream firm n negotiate a linear input fee τ_{mn} (could be a vector for multi product firms).

$$\max_{\tau_{mn}} (\Pi_n(\tau_{mn}, \tau_{-mn}) - \Pi_n(\emptyset, \tau_{-mn}))^{b_{mn}} (\Pi_m(\tau_{mn}, \tau_{-mn}) - \Pi_m(\emptyset, \tau_{-mn}))^{(1-b_{mn})}$$

$$(p_n^* - \sum_{m=1}^{M} \tau_{mn}) D_n(\vec{\tau}) \qquad \sum_{n=1}^{N} \tau_{mn} D_n(\vec{\tau})$$

Disagreement values: Horn and Wolinsky (Nash-in-Nash) hold all other contracts fixed

Horn and Wolinsky

- Solve numerically like any other static game (system of FOC's, best response dynamics).
- **The players are the negotiating pairs.**
- **The strategies are the contractual terms.**
- **The payoffs are the Nash products.**
- Simultaneous move Nash equilibrium to this game.

Horn and Wolinsky

- What are bargaining parameters? Appeal to Rubinstein, and argue they represent relative differences in time discounting.
- In practice, they are going to pick up factors which are un-modeled.
- In the purest case, it could just be discounting differences between firms.
- But so much goes un-modeled that one has to be a bit of simpleton to argue that in IO applications, at this point.
- Examples: possibility of backwards or forwards integration, possibility of another entrant entering one side or the other, negotiating skill, repeated bargaining, asymmetric information on primitives

Horn and Wolinsky

- One can also do the following assumption on disagreement payoffs:
- Disagreement payoffs are determined by re-negotiating all other contracts conditional on the disagreeing pair not having a contract.
- Associated with Stole and Zweibel who do this type of assumption for labor contracts within a firm.
- Has flavor of Shapley value from cooperative game theory.
- Solution is by solving Horn and Wolinsky for all possible configurations, starting from minimal configurations, and building up to an equilibrium using solutions of smaller coalitions as disagreement points.

Horn and Wolinsky

- Empirical implementation in my JMP. We will go through in 3rd lecture.
- Estimation is fairly straightforward in cable (because marginal cost of production is commonly known to be zero).
- Some follow on work applied to different industries (device manufacturers and hospitals, coffee manufacturers and grocery, hospitals and insurance)
- We will examine the various assumptions or new data these papers bring to the table.

Asymmetric Information in Bargaining

- Started lecture with focus on informational issues.
- Horn and Wolinsky doesn't model information, but uses notion of pairwise stability which is a feature of equilibrium in models with secret contracts.
- 1v1 bargaining with asymmetric information is itself quite difficult.
- But it is important: strikes, wars, and negotiation impasses.
- Impasses rare, but regular occurrence in both hospital-insurance negotiations and content – distribution negotiations.

Asymmetric Information in Bargaining

Anthem declares **impasse** with Exeter **Hospital** | SeacoastOnline.com
www.seacoastonline.com/articles/20101213-NEWS-101219932
Dec 13, 2010 - **...** have declared an **impasse** in their **negotiations** with Exeter **Hospital** **...** the **insurance** provider will terminate its contract with the **hospital** at the **...**

Middlesex **Hospital**, UnitedHealthCare at Contract **Impasse ...** - Patch

www.patch.com/articles/middlesex-**hospital**-united-health-care
by cassandra day
Mar 5, 2012 - "Despite good faith efforts by both parties to **negotiate** a new contract **...** says Oxford HealthCare commercial **insurance** clients are also affected.

Hospitals Fail To **Negotiate** With **Insurance** Carrier - Hamptons.com
www.hamptons.com/.../**Hospitals**-Fail-To-**Negotiate**-With-**Insurance**.html
Aug 3, 2009 - **...** an **impasse** on Saturday, resulting in Southampton **Hospital**, Peconic **...** If we don't successfully **negotiate**, other **insurance** payers will point to **...**

East End **hospitals**, BlueCross at **impasse** on payouts - Newsday
www.newsday.com › Long Island
Aug 3, 2009 - **...** **hospitals** has been credited with **negotiating** better deals from **insurance** companies. **...** East End **hospitals**, BlueCross at **impasse** on payouts.

Hospital, Independence Blue Cross at **impasse** over reimbursement **...**
articles.mcall.com/2001-07.../3375157_1_grand-view-**hospital**-blue-cros...
Jul 10, 2001 - In recent years, many area **hospitals** have encountered similar difficulties **negotiating** new contracts with large **insurance** providers. In March **...**

Asymmetric Information in Bargaining

- This is another theory literature which gets complicated quickly (not surprisingly also issue of out-of-equilibrium beliefs).
- The simplest case: one uninformed party who makes offers (not TIOLI, but close). Screening equilibrium.
- When informed party can do stuff, like make counter-offers or sit on offers, then there is also signaling.
- For example, one can sit on an offer for some time to signal their type to the other side.

Asymmetric Information in Bargaining

- When both sides have private information and both sides can make offers, there are potentially many equilibria that again depend on how one specifies beliefs.

- I am not an expert on all the results, though I've been working on an empirical project where the goal is to prior variances from length of strike duration in cable.

- There are papers which construct an equilibrium in this setting.

- The cleanest one I've come across is by Cramton.

Asymmetric Information in Bargaining

- Equilibrium is described by stages.
- Start with no one making offers for an endogenous period of time.
- Then one side fully reveals its type via an endogenous offer.
- The other party sits on the offer for an endogenous period of time, then fully reveals its type with an endogenous counter-offer which is accepted if there are gains from trade.
- Only waste is due to delay. If parties should trade, then they do.

Asymmetric Information in Bargaining

- Take the union of the papers on passive beliefs, wary beliefs, and so on with the papers on asymmetric information offer-counteroffer bargaining.

- Unknown.

- Empirical work started by assuming TIOLI offers with passive beliefs.
  - But unrealistic in many scenarios to endow one side to take the whole marginal surplus.

- Estimate Horn and Wolinsky inspired model.
  - Identification issues in general (though not in cable).

Conclusion

- These are the core group of theory papers I have in my mind when I am doing empirical research on vertical relationships.
- Develop appreciation for informational issues and bargaining.
- We so far assumed a very limited contractual space: linear contracts or two part tariffs.
- Next class expands contract space, mostly in terms of TIOLI offers and theory. We'll look at some empirical papers. Then estimation of Horn and Wolinsky type model. Then vertical merger analysis.