Contracting, Exclusivity and the Formation of Supply Networks with Downstream Competition

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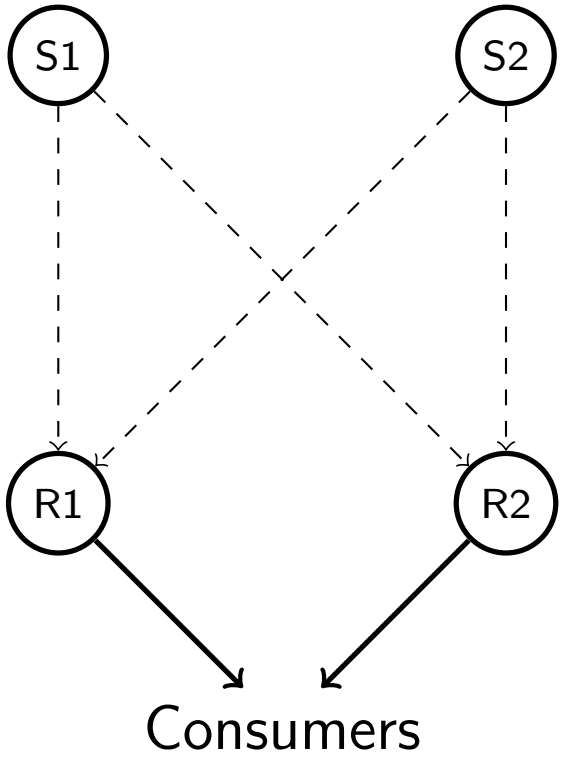
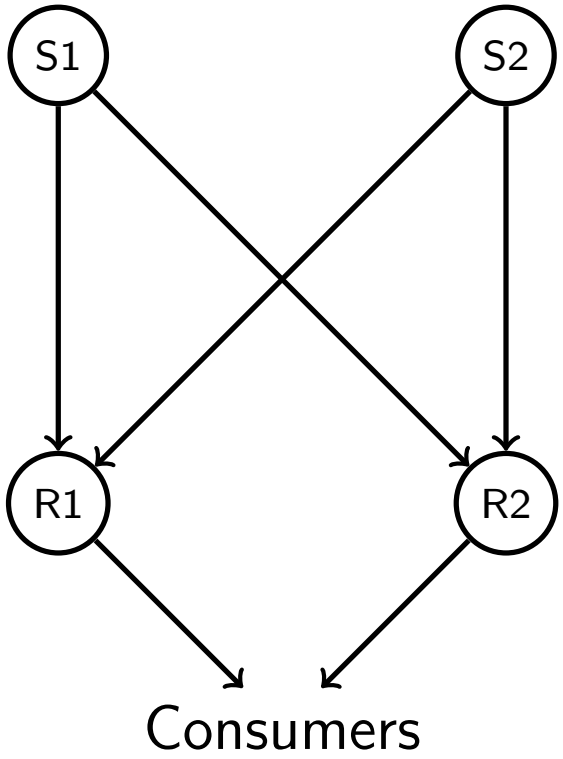
Many markets work approximately like this



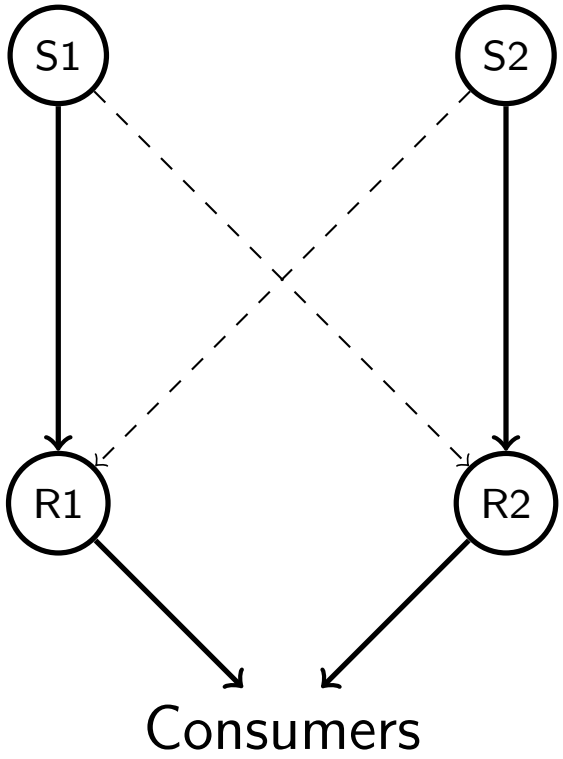
In some markets, all supply links are active



Examples:

Big-box stores (e.g., Best Buy, Target); online retailers (e.g., Amazon); online travel agents (e.g., Expedia, Travelocity)

In other markets, some degree of exclusivity



Examples:

Smartphones until a few years ago (e.g., iPhone - AT&T 2007-2011); sport events on pay TV; restricted networks in healthcare.

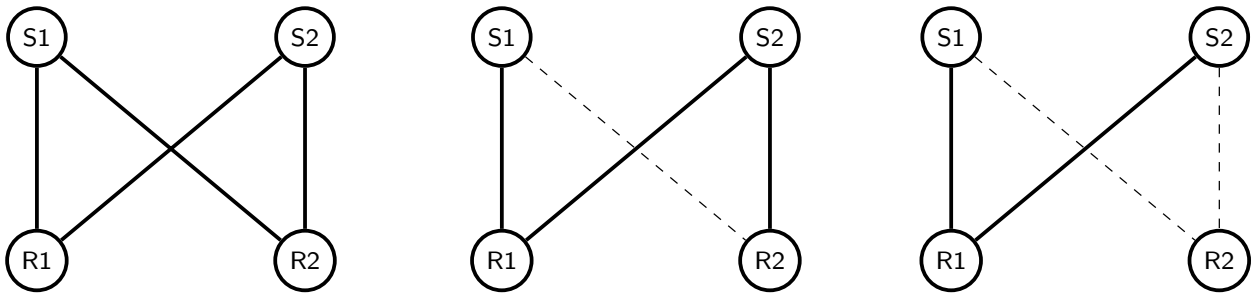
Automobile distribution in the U.S. (no contractual exclusivity)

Research questions

- What types of supply networks maximize industry profits and consumer welfare?
- What types of equilibrium supply networks arise from decentralized contracting?
- Model of bilateral contracting with transfers. Combines literatures on
  - Network formation with transfers (Bloch and Jackson, 2007)
  - Vertical contracting (O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994; Bernheim and Whinston, 1998)
- Factors affecting equilibrium structure of supply networks include
  - Degree of supplier and retailer differentiation
  - Mode of downstream competition
  - Availability of exclusive contracts
  - Firm's (in)ability to commit publicly to terms of contracts

Why not use "Nash-in-Nash" bargaining?

- Horn and Wolinsky (1988), Crawford and Yurukoglu (2012), Gowrisankaran, Nevo and Town (2015)
- Theory: Collard-Wexler, Gowrisankaran and Lee (2017)
- Focuses more on division of surplus than on structure of contracts and networks
- "Contract equilibrium" approach: firms modify only one contract at a time



- Assumes that each link in a (given) network yields gains from trade
  - Only possible equilibrium outcome has all links active
- Simplifies structure of vertical contracts
  - Only lump-sum payments or only linear prices

My approach

- Advantages over Nash-in-Nash
  - Allows firms to optimize across *all* their bilateral relations at the same time
  - Allows firms to use nonlinear contracts
  - Allows firms to enter into (and compete for) exclusives
  - Determines structure of supply networks endogenously
- Drawbacks relative to Nash-in-Nash
  - Yields less precise predictions about division of surplus

Model

- $S \geq 2$ suppliers (indexed by s) and $R \geq 2$ retailers (indexed by r)
  - $S \times R$ differentiated "products" with quantity q_{sr} and retail price p_{sr}
- Two stages
  - $t = 1$: Simultaneous contracting without public commitment
  - $t = 2$: Downstream competition (Bertrand or Cournot)
- At $t = 1$, each firm i submits a proposal $x_i^j = \left\langle t_i^j, w_i^j, \theta_i^j \right\rangle$ to each firm j
  - $t_i^j \gtreqless 0$ upfront transfer to be paid by retailer to supplier
  - $w_i^j \geq 0$ unit wholesale price
  - θ_i^j exclusivity clauses (if any)
- If proposals are consistent (i.e., $w_r^s = w_s^r$, $\theta_r^s = \theta_s^r$ and $t_r^s \geq t_s^r$), then s and r enter into a contract and a supply link is formed, $\ell_{sr} = 1$.

Equilibrium concept

- Vertical and horizontal coordination failures $\Rightarrow$ many Nash equilibria with different networks and wholesale prices
- Coalition-proof Nash equilibrium (Bernheim, Peleg and Whinston, 1987)
  - Nonbinding pre-play communication. Agreements must be incentive compatible (no enforceable collusion)
  - Equilibrium must be immune to deviations that leave all members of any feasible coalition better off
  - Deviations must themselves be immune to further deviations by any feasible subcoalition (i.e., must be self enforcing)
  - ... and so on ...

Model solved in two steps

- For any network g, find self-enforcing profile of wholesale prices $w(g)$
  - Without public commitment $\Rightarrow$ opportunism $\Rightarrow$ $w(g) = c$

- A network g is an equilibrium if $\exists$ transfers t^g such that $\nexists$ profitable and self-enforcing deviations to any network $h \neq g$

- Deviation from network g to network h is profitable for coalition Z iff

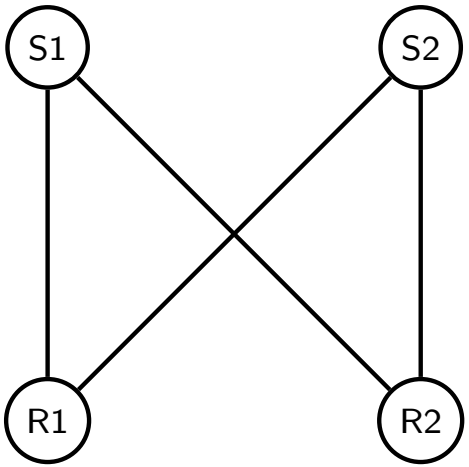
$$\underbrace{\sum_{r \in Z} \left[\Pi_r^h - \Pi_r^g \right]}_{\text{Gain in gross profits}} > \underbrace{\sum_{s \in Z} \sum_{r \notin Z} \left(\ell_{sr}^g - \ell_{sr}^h \right) t_{sr}^g}_{\text{Change in transfers received by suppliers}} - \underbrace{\sum_{r \in Z} \sum_{s \notin Z} \left(\ell_{sr}^g - \ell_{sr}^h \right) t_{sr}^g}_{\text{Change in transfers paid by retailers}}$$

- Algorithm to check whether profitable deviations are self enforcing

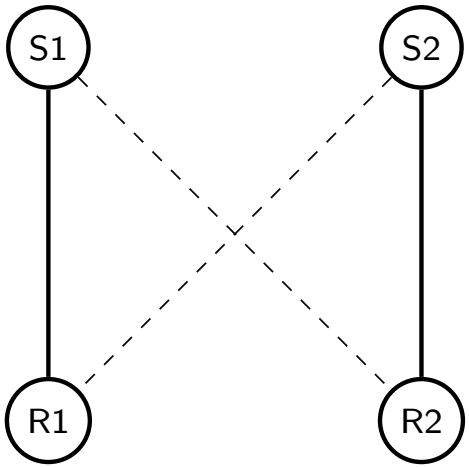
$$\langle g, t^g \rangle \rightarrow \langle h, t^h(t^g) \rangle \rightarrow \langle k, t^k(t^h(t^g)) \rangle \rightarrow \ldots$$

Bilateral duopoly with linear demand

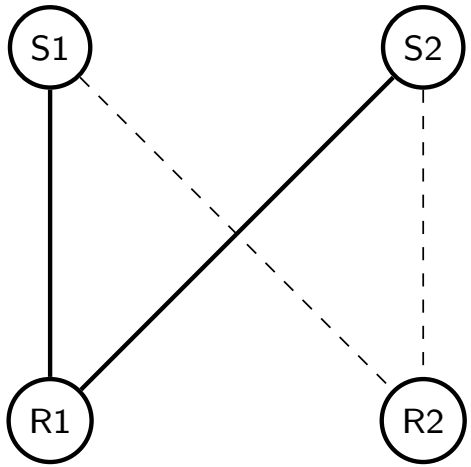
Possible supply networks in bilateral duopoly



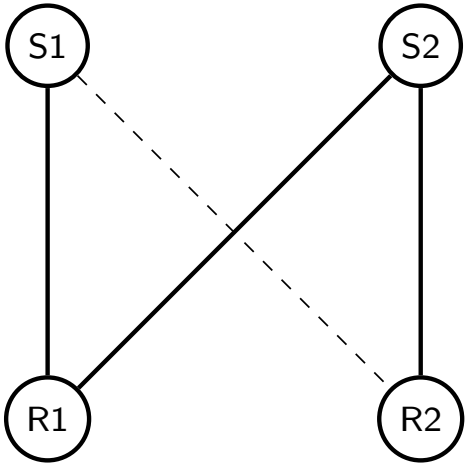
All links active



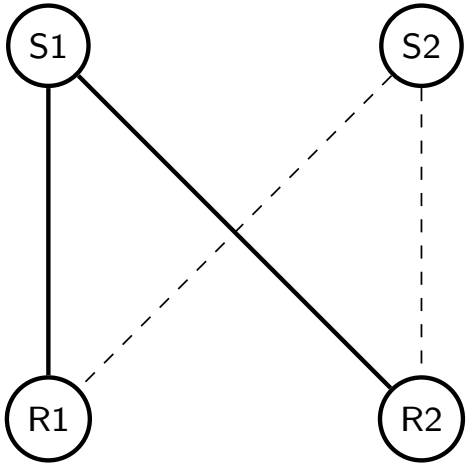
Pairwise exclusivity



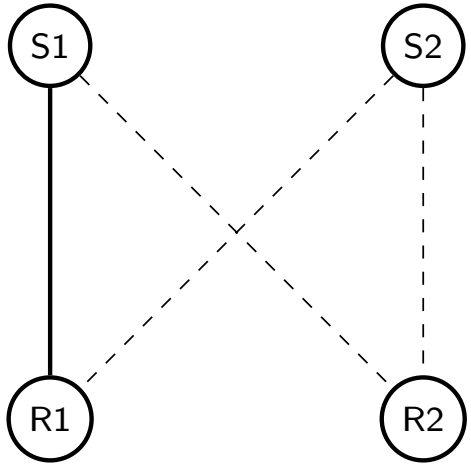
Downstream monopoly



Mixed network



Upstream monopoly



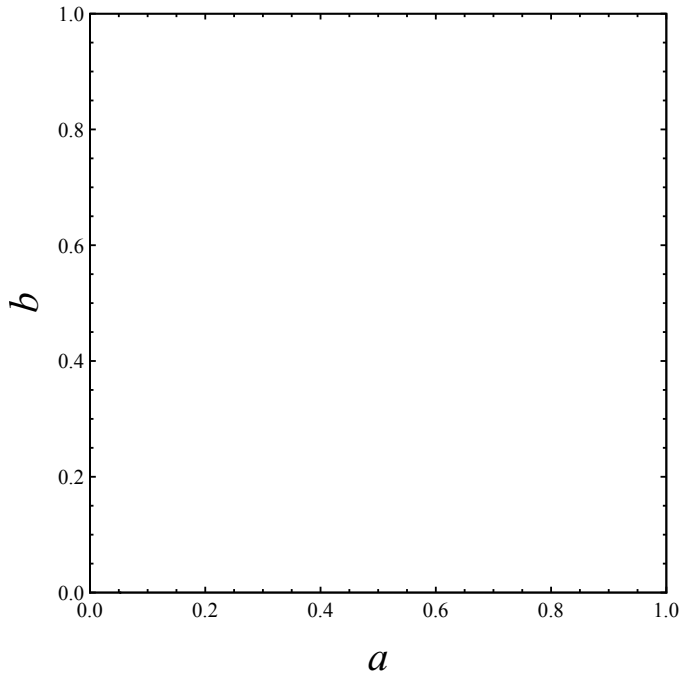
Bilateral monopoly

Consumer demand

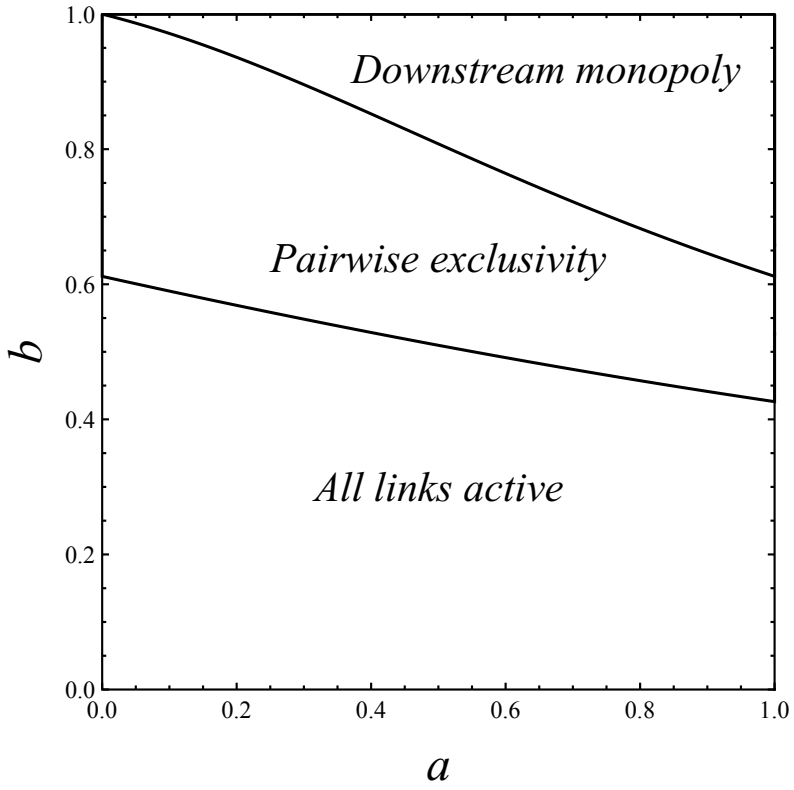
Inverse demand for product s at retailer r

$$p_{sr} = v - \left(q_{sr} + aq_{s'r}\right) - b\left(q_{sr'} + aq_{s'r'}\right)$$

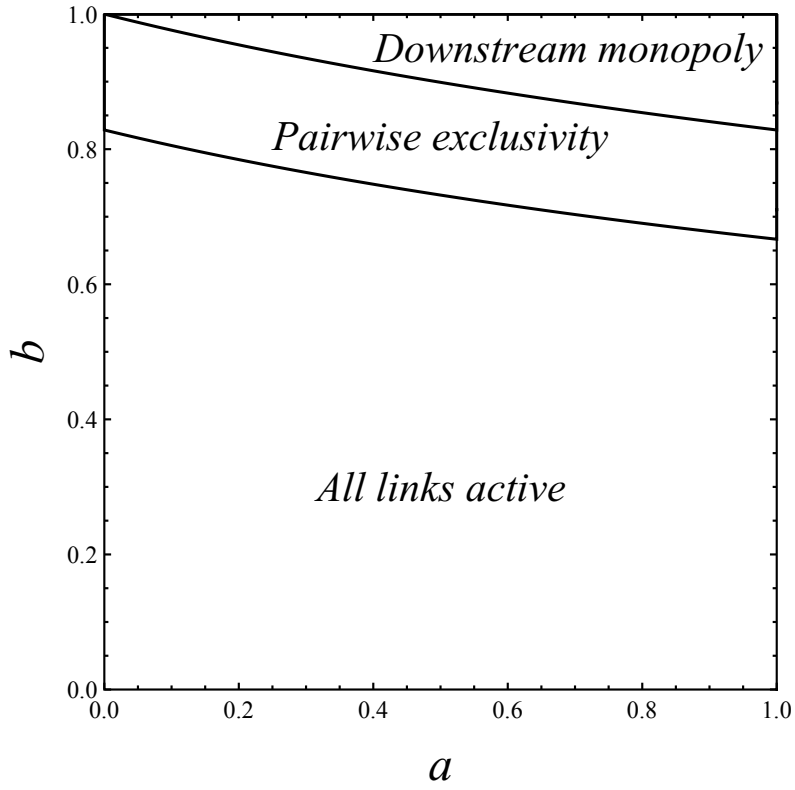
- $a \in [0, 1]$ product substitutability
- $b \in [0, 1]$ retailer substitutability



Networks that maximize industry profits



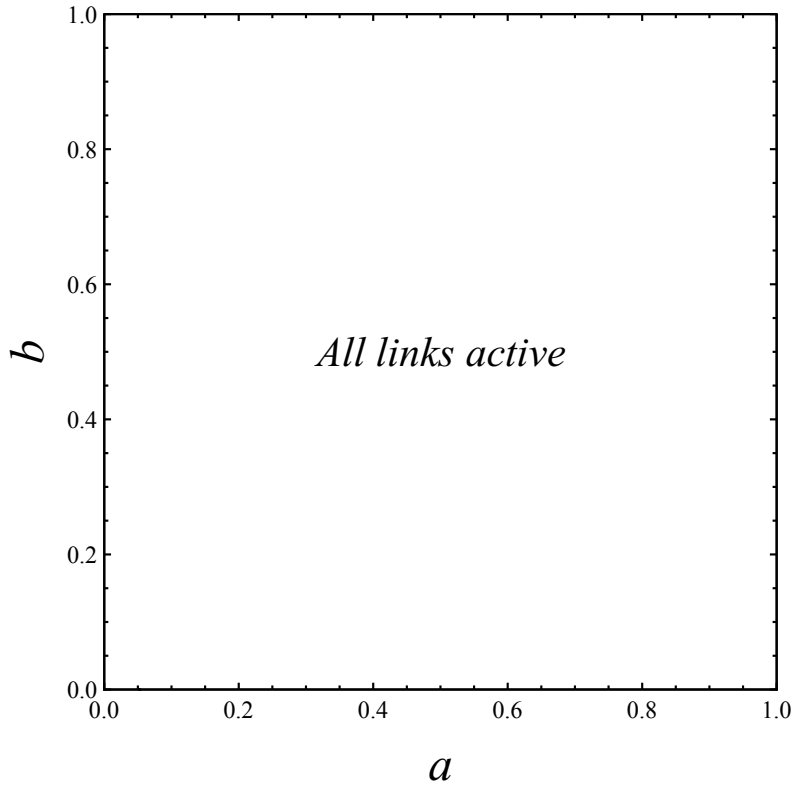
Bertrand competition



Cournot competition

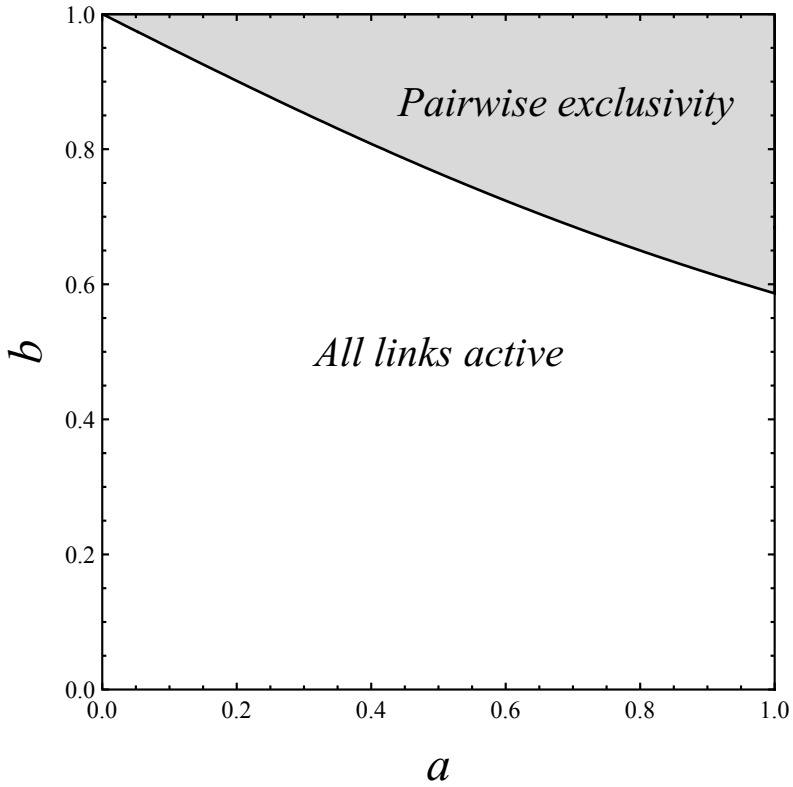
Equilibrium networks without exclusive contracts

Equilibrium networks without exclusive contracts: Cournot



Cournot competition

Equilibrium networks without exclusive contracts: Bertrand



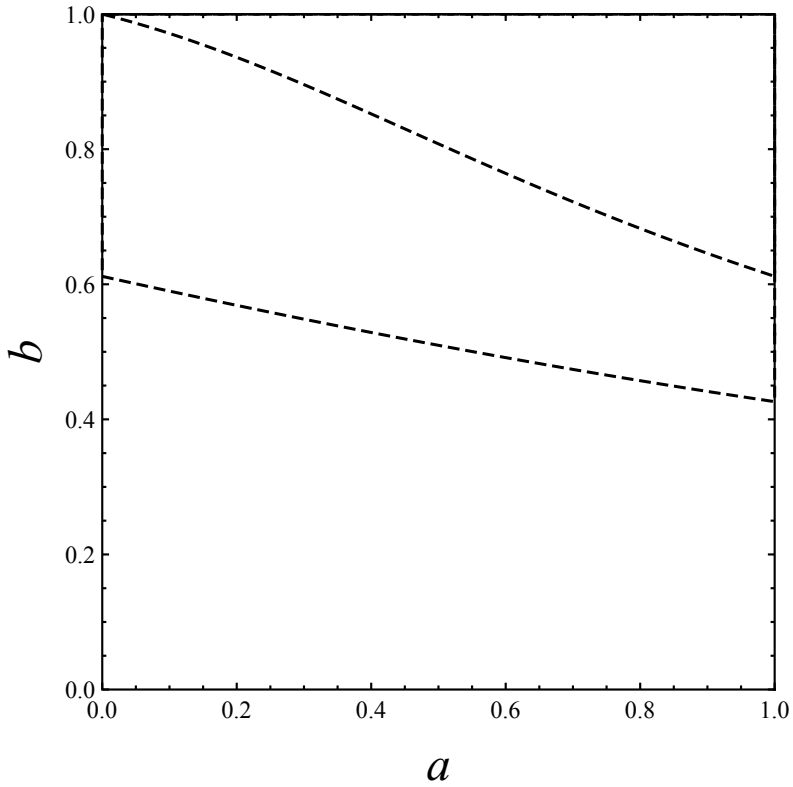
Bertrand competition

Equilibrium networks with exclusive contracts

Adapting the framework to exclusive contracts

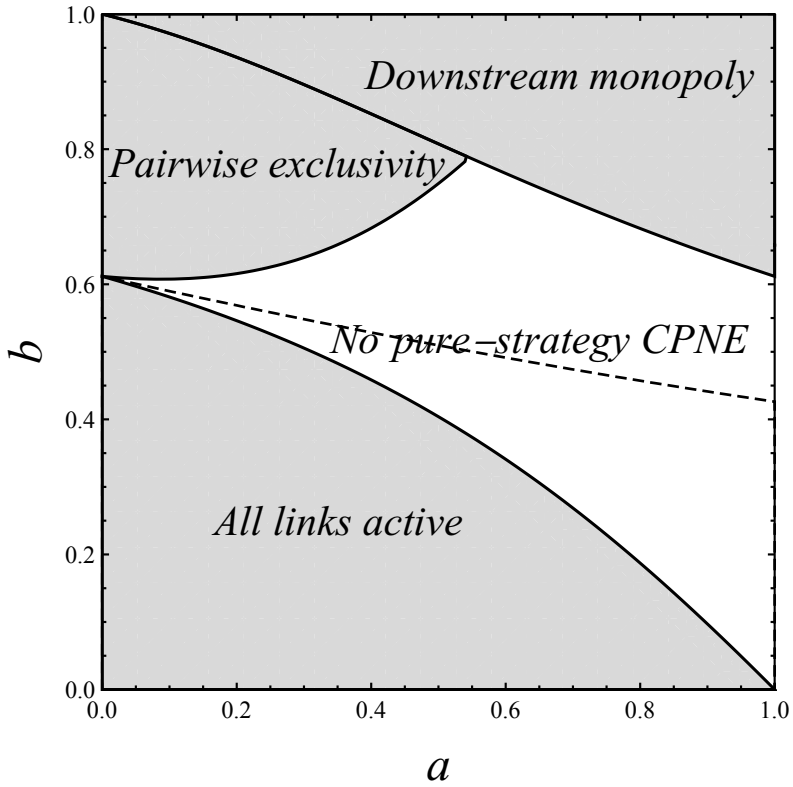
- A given network can be implemented with or without exclusive contracts
- However, exclusive contracts change feasibility/profitability of deviations
  - Force firms that want to add a link to renegotiate their existing exclusive contracts (or drop those contracts altogether)
- Assumption: Equilibrium networks are implemented by the most restrictive combination of exclusive contracts compatible with that network.
  - No assumption is necessary for deviations
- Assumption to rule out the exclusion of firms through "bait-and-switch" strategies

Networks that maximize industry profits



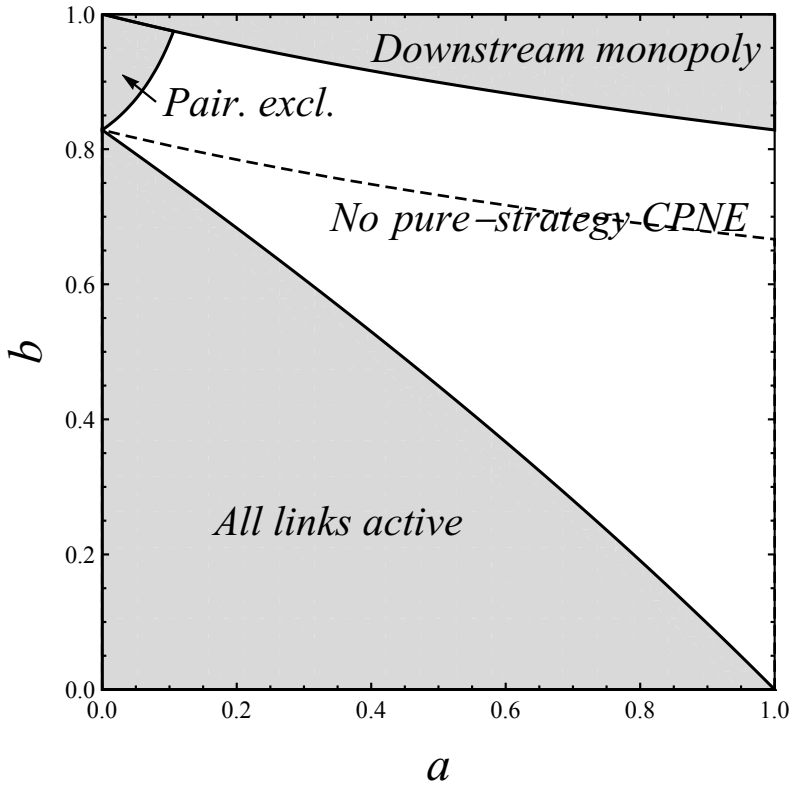
Bertrand competition

Equilibrium networks with exclusive contracts



Bertrand competition

Equilibrium networks with exclusive contracts



Cournot competition

Exclusive contracts reduce welfare

Whenever exclusive contracts are adopted and affect equilibrium supply networks, they reduce consumer and overall welfare

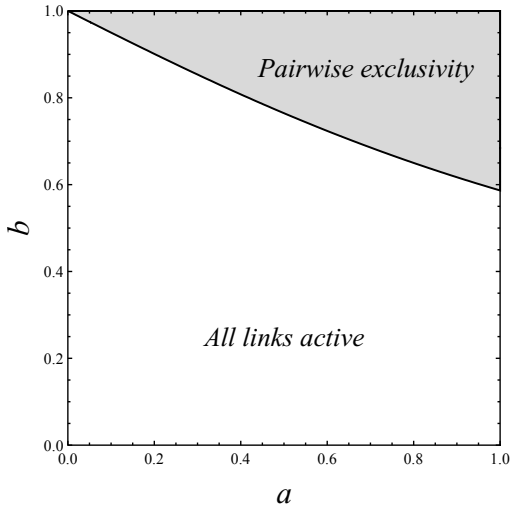
- Less variety
- Higher prices

Exclusive contracts affect distribution of profits

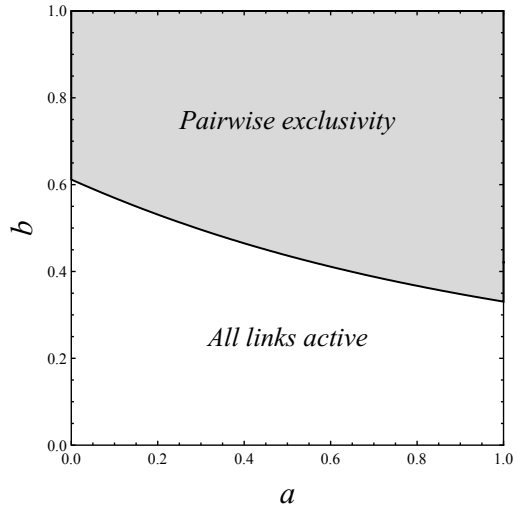
- $t^g \in [\underline{t}^g, \bar{t}^g]$
  - $\underline{t}^g$ increasing in outside options (i.e., credible deviations) of suppliers
  - $\bar{t}^g$ decreasing in outside options (i.e., credible deviations) of retailers
- Exclusive contracts change outside options $\rightarrow$ affect $[\underline{t}^g, \bar{t}^g]$ even when not adopted in equilibrium
  - Improve suppliers' outside options by more than retailers' outside options
  - Make suppliers unambiguously better off and retailers unambiguously worse off
- Mechanism:
  - Similar to Bernheim and Whinston (1998)
  - Different from Ho and Lee (2017) and Liebman (2016)

Ex-post bargaining and hold-up yield narrower networks

- Lee and Fong (2013) and Rey and Vergé (2016)
  - Firms first form links (without transfers), then (Nash) bargain over terms
  - Bargaining takes place under hold-up
- Hold-up reduces profitability of adding links $\rightarrow$ networks tend to be narrower



No hold-up



Hold-up

- Limitations of ex-post bargaining approach
  - Less realistic in markets with large firms (e.g., iPhone deal)
  - Not well suited to studying exclusive contracts.

Conclusion

- New way of looking at contracting in bilateral oligopoly
- Identifies some important factors affecting structure of supply networks
- Focuses more on structure of contracts and networks than division of surplus
- Possible next steps
  - More work on division of surplus, possibly with empirical implementations
  - Study markets with some public commitment (ongoing)