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

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Disclaimer:

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Many markets work approximately like this

![Diagram showing interactions between suppliers (S1, S2) and retailers (R1, R2) with consumers.](image)
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

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Why not use “Nash-in-Nash” bargaining?

- Focuses more on division of surplus than on structure of contracts and networks
- “Contract equilibrium” approach: firms modify only one contract at a time

![Diagram of contracts and networks]

- 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
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 \( x^i_j = \langle t^i_j, w^i_j, \theta^i_j \rangle \) to each firm \( j \)
  - \( t^i_j \leq 0 \) upfront transfer to be paid by retailer to supplier
  - \( w^i_j \geq 0 \) unit wholesale price
  - \( \theta^i_j \) exclusivity clauses (if any)

If proposals are consistent (i.e., \( w^s_i = w^r_i, \theta^s_i = \theta^r_i \) and \( t^s_i \geq t^r_i \)), then \( s \) and \( r \) enter into a contract and a supply link is formed, \( \ell_{sr} = 1 \).
Equilibrium concept

- Vertical and horizontal coordination failures ⇒ 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 $\not\exists$ profitable and self-enforcing deviations to any network $h \neq g$.

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

  \[
  \sum_{r \in Z} \left[ \Pi^h_r - \Pi^g_r \right] > \sum_{s \in Z} \sum_{r \notin Z} \left( \ell^g_{sr} - \ell^h_{sr} \right) t^g_{sr} - \sum_{r \in Z} \sum_{s \notin Z} \left( \ell^g_{sr} - \ell^h_{sr} \right) t^g_{sr}
  \]

  - Gain in gross profits
  - Change in transfers received by suppliers
  - Change in transfers paid by retailers

- Algorithm to check whether profitable deviations are self enforcing

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

$$p_{sr} = \nu - (q_{sr} + a q_{sr}') - b (q_{sr'} + a q_{sr'})$$

- $a \in [0, 1]$ product substitutability
- $b \in [0, 1]$ retailer substitutability
Networks that maximize industry profits

- Downstream monopoly
- Pairwise exclusivity
- All links active

Bertrand competition

Cournot competition
Equilibrium networks without exclusive contracts
Equilibrium networks without exclusive contracts: Cournot

All links active

Cournot competition
Equilibrium networks without exclusive contracts: Bertrand

Pairwise exclusivity

All links active

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

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Equilibrium networks with exclusive contracts

![Graph showing equilibrium networks with exclusive contracts](image)

- **Downstream monopoly**
- **Pairwise exclusivity**
- **No pure-strategy CPNE**
- **All links active**

Title: Bertrand competition

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Date: November 2, 2017
Equilibrium networks with exclusive contracts

- Downstream monopoly
- Pair. excl.
- No pure-strategy CPNE
- All links active

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

- $t^g \in [\underline{t^g}, \bar{t}^g]$  
  - $t^g$ 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

- 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)