

Collusion between supply chains under asymmetric information

Yaron Yehezkel
Tel-Aviv University

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Motivation

- Manufacturers engage in long-term interaction
 - ▶ Firms can engage in tacit collusion
- Manufacturers have long-term relationship with their retailers
 - ▶ Manufacturers can include their retailers in the collusive scheme
- Examples:
 - ▶ **Collusion involving retailers:** In 2021, Germany's competition authority fined two leading music instruments manufacturers **and their retailers** for limiting price competition
 - Manufacturers inspected the retailers' behavior as part of the collusive scheme
 - ▶ **Collusion without retailers:** In 2022, the federal appeals court in San Francisco ruled against two leading canned tuna manufacturers for alleged collusive scheme
 - Retailers (supermarkets and restaurants) sued their suppliers

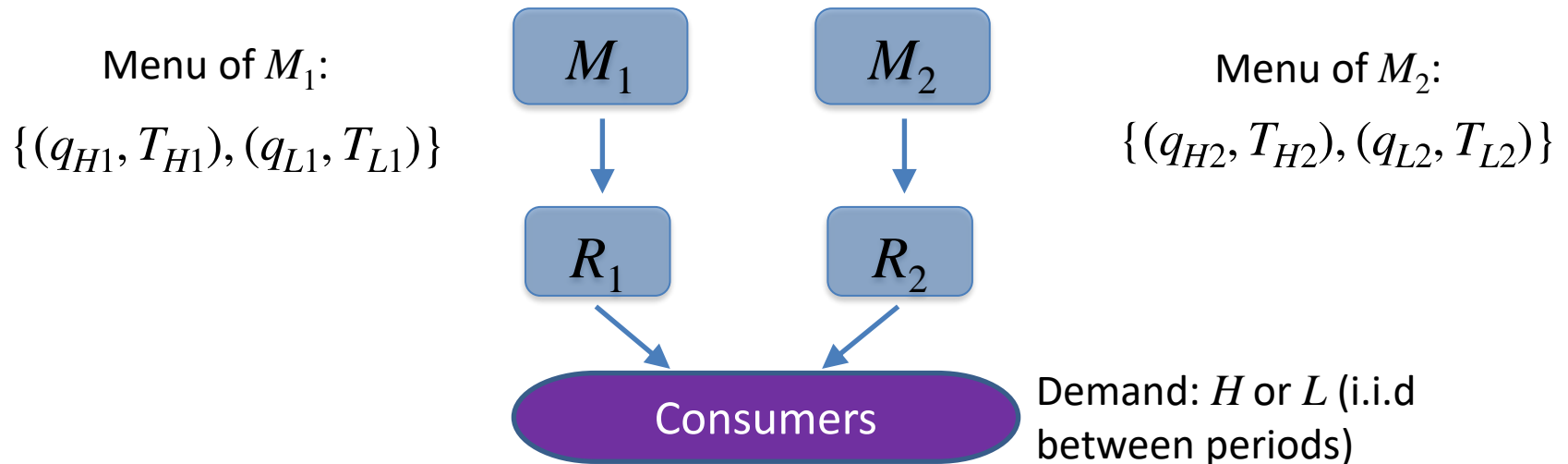
This paper

- Infinitely repeated game between two manufacturer – retailer supply chains
- Retailers have private information concerning the demand
 - ▶ Manufacturers “pay” retailers information rents
- Manufacturers can include retailers in the collusive scheme
- Research questions:
 1. How (and when) retailers facilitate collusion?
 2. What are the features of a collusion equilibrium that involves the retailers?
- Main results
 1. Retailers facilitate (hinder) collusion when asymmetric information between manufacturers and retailers is significant (weak)
 2. Manufacturers find it optimal to collude on a quantity above (below) the monopoly quantity in periods of high (low) demand

Literature

- Vertical relations when retailers have private information (static games):
Gal-Or (1991a) and (1991b), Caillaud, Jullien and Picard (1995), Martimort (1996), Yehezkel (2008), Acconcia, Martina and Piccolo (2008) and Yehezkel (2014)
- Repeated vertical relations and anti-competitive behavior:
Jullien and Rey (2007), Nocke and White (2007), Piccolo and Reisinger (2011), Reisinger and Thomes (2017), Calzolari and Spagnolo (2020), Gilo and Yehezkel (2020)
- **Contribution:** The role of privately informed retailers in facilitating collusion

The model



- Infinitely repeated game. Firms' discount factor: δ ($0 < \delta < 1$)

In each period:

- Retailers privately observe the demand: H (L) with probability p ($1 - p$)
 - ▶ Total profit of chain $M_i - R_i$: $\pi_{Hi}(q_i, q_j) > \pi_{Li}(q_i, q_j)$ (q_i : quantity of R_i)
- Manufacturers offer secret menus: $\{(q_{Hi}, T_{Hi}), (q_{Li}, T_{Li})\}$
- Each retailer "reports" the state by choosing a contract
- At the end of the period, information becomes common knowledge
 - ▶ Manufacturers observe the true state of demand

Benchmark: competitive (static) game

- Two binding constraints on the contracts:

$$IR_L^S : \underbrace{\pi_{Li}(q_{Li}, q_{Lj}) - T_{Li}}_{R_i \text{ accepts contract } L \text{ in state } L} \geq \underbrace{0}_{R_i \text{ rejects the menu}}$$

$$IC_H^S : \underbrace{\pi_{Hi}(q_{Hi}, q_{Hj}) - T_{Hi}}_{R_i \text{ chooses contract } H \text{ in state } H} \geq \underbrace{\pi_{Hi}(q_{L1}, q_{Hj}) - T_{Li}}_{R_i \text{ chooses contract } L \text{ in state } H}$$

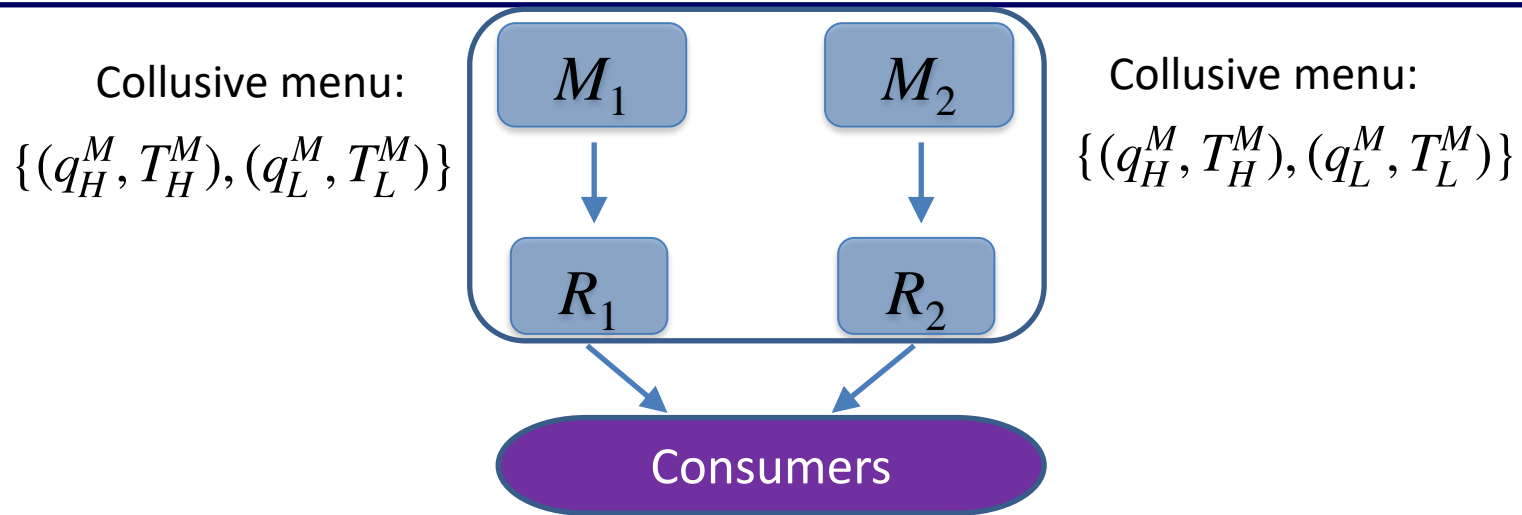
- M_i earns: $pT_{H1} + (1 - p)T_{L1} =$

$$= \underbrace{p\pi_{Hi}(q_{Hi}, q_{Hj}) + (1 - p)\pi_{Li}(q_{Li}, q_{Lj})}_{\text{Expected joint profit of } M_i - R_i} - \underbrace{p[\pi_{Hi}(q_{Li}, q_{Hj}) - \pi_{Li}(q_{Li}, q_{Lj})]}_{R_i\text{'s competitive "information rents"}}$$

- Symmetric equilibrium: $\{(q_H^S, T_H^S), (q_L^S, T_L^S)\}$

- As p (the probability of state H) increases, manufacturers have a stronger incentive to decrease the retailers' competitive information rents

Collusion on the monopoly quantities



- Infinitely repeated game
- In each period, manufacturers offer a collusive menu: $\{(q_H^M, T_H^M), (q_L^M, T_L^M)\}$
- Deviation triggers the competitive (static) menu: $\{(q_H^S, T_H^S), (q_L^S, T_L^S)\}$
- The retailers' role in the collusive scheme:
 1. **Including retailers in the collusive scheme:** if a retailer deviates, collusion stops in all future periods
 2. **Excluding retailers from the collusive scheme:** manufacturers ignore a retailer's out-of-equilibrium deviation

Binding constraints with active retailers

$$IR_L^M : \pi_L(q_L^M, q_L^M) - T_L^M + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_H^M, q_H^M) - T_H^M) + (1 - p)(\pi_L(q_L^M, q_L^M) - T_L^M) \right]$$

Retailer's expected collusive information rents

$$\geq 0 + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_L^S, q_H^S) - \pi_L(q_L^S, q_L^S)) \right]$$

Collusion stops
(competitive information rents)

$$IC_H^M : \pi_H(q_H^M, q_H^M) - T_H^M + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_H^M, q_H^M) - T_H^M) + (1 - p)(\pi_L(q_L^M, q_L^M) - T_L^M) \right]$$

Retailer's expected collusive information rents

$$\geq \pi_H(q_L^M, q_H^M) - T_L^M + \frac{\delta}{1 - \delta} \left[p((\pi_H(q_L^S, q_H^S) - \pi_L(q_L^S, q_L^S))) \right]$$

Collusion stops
(competitive information rents)

Binding constraints with passive retailers

$$IR_L^M : \pi_L(q_L^M, q_L^M) - T_L^M + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_H^M, q_H^M) - T_H^M) + (1 - p)(\pi_L(q_L^M, q_L^M) - T_L^M) \right]$$

Collusion continues in future periods

$$\geq 0 + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_H^M, q_H^M) - T_H^M) + (1 - p)(\pi_L(q_L^M, q_L^M) - T_L^M) \right]$$

Collusion continues in future periods

$$IC_H^M : \pi_H(q_H^M, q_H^M) - T_H^M + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_H^M, q_H^M) - T_H^M) + (1 - p)(\pi_L(q_L^M, q_L^M) - T_L^M) \right]$$

Collusion continues in future periods

$$\geq \pi_H(q_L^M, q_H^M) - T_L^M + \frac{\delta}{1 - \delta} \left[p(\pi_H(q_H^M, q_H^M) - T_H^M) + (1 - p)(\pi_L(q_L^M, q_L^M) - T_L^M) \right]$$

Collusion continues in future periods

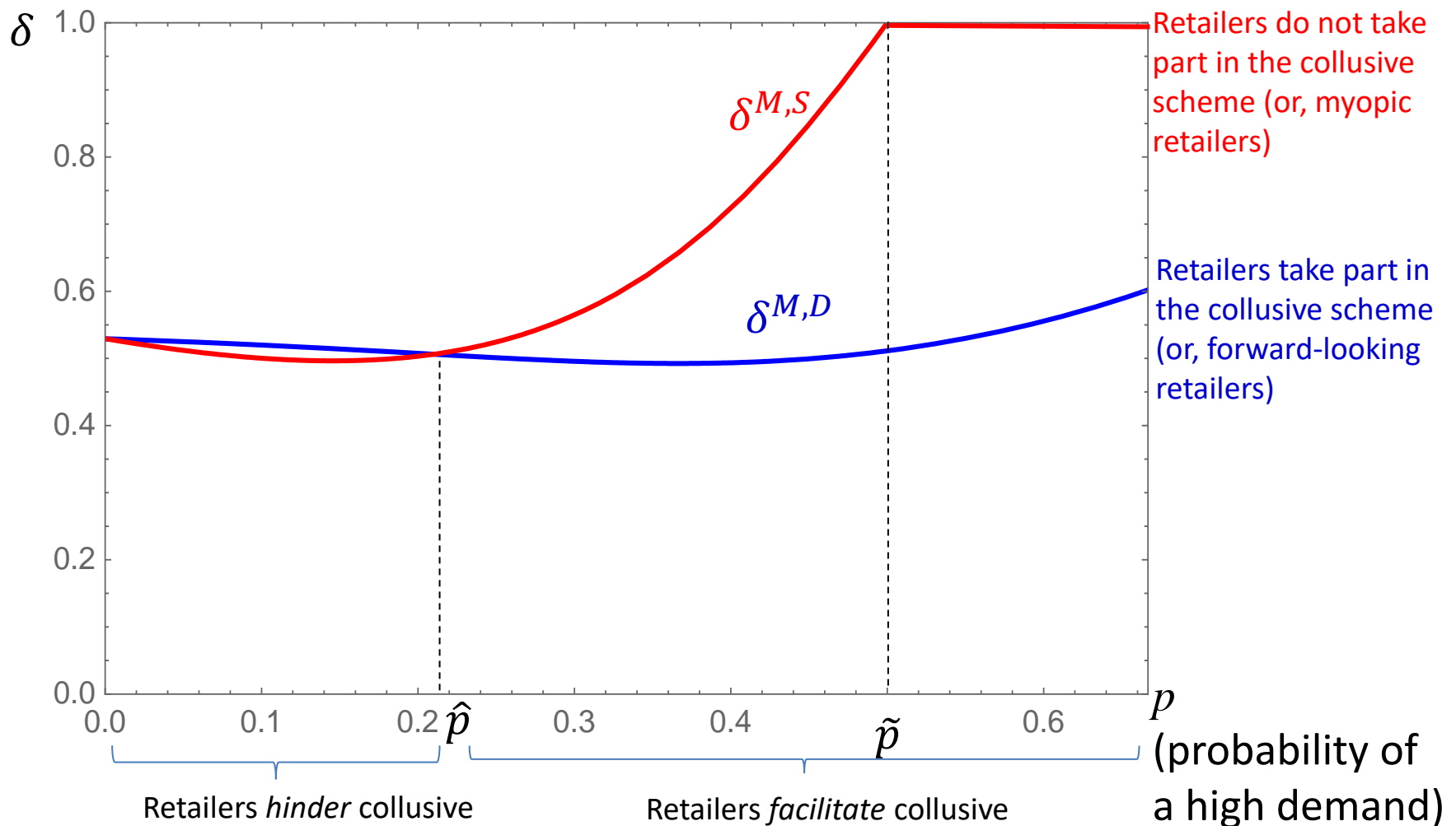
Existence of a collusive equilibrium

$$\underbrace{\frac{pT_H^M + (1-p)T_L^M}{1-\delta}}_{M_i\text{'s collusive profits}} \geq \underbrace{\Pi_{M1}^S(q_{H1}^S(q_H^M), q_{L1}^S(q_H^M, q_L^M), q_H^M, q_L^M)}_{M_i \text{ deviates to the static best response}} + \frac{\delta}{1-\delta} \underbrace{(pT_H^S + (1-p)T_L^S)}_{\text{Collusion stops (competitive equilibrium)}}$$

Results:

- There is a collusive equilibrium on the monopoly quantities that **involves** the retailers if: $\delta > \delta^{M,D}$
- There is a collusive equilibrium on the monopoly quantities that **does not involve** the retailers if: $\delta > \delta^{M,S}$

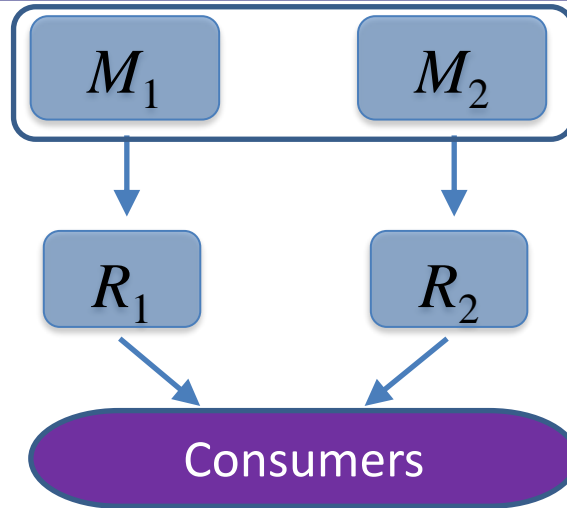
When do retailers facilitate collusion?



Intuition: why retailers may facilitate collusion

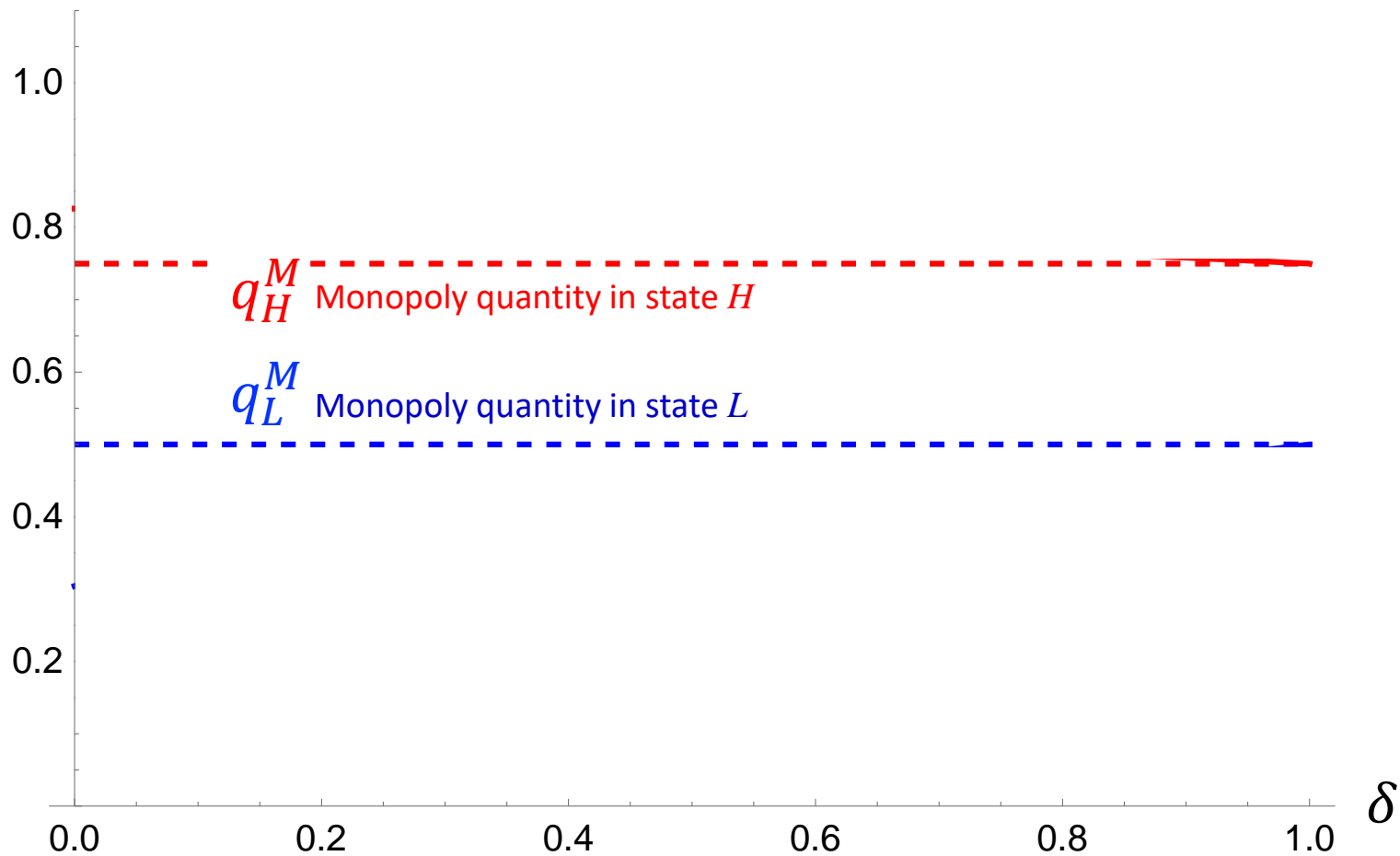
- Retailers facilitate collusion when they earn higher information rents given the monopoly quantities than given the competitive quantities
- Low p \Rightarrow in the punishment stage, manufacturers have a weak incentive to decrease the competitive information rents \Rightarrow information rents are higher in the competitive game than given the monopoly quantities \Rightarrow retailers hinder collusion
- As p increases, in the punishment stage, manufacturers have a stronger incentive to decrease the competitive information rents
- High p \Rightarrow information rents are higher given the monopoly quantities than in the competitive game \Rightarrow retailers facilitate collusion

Collusion on upstream profits

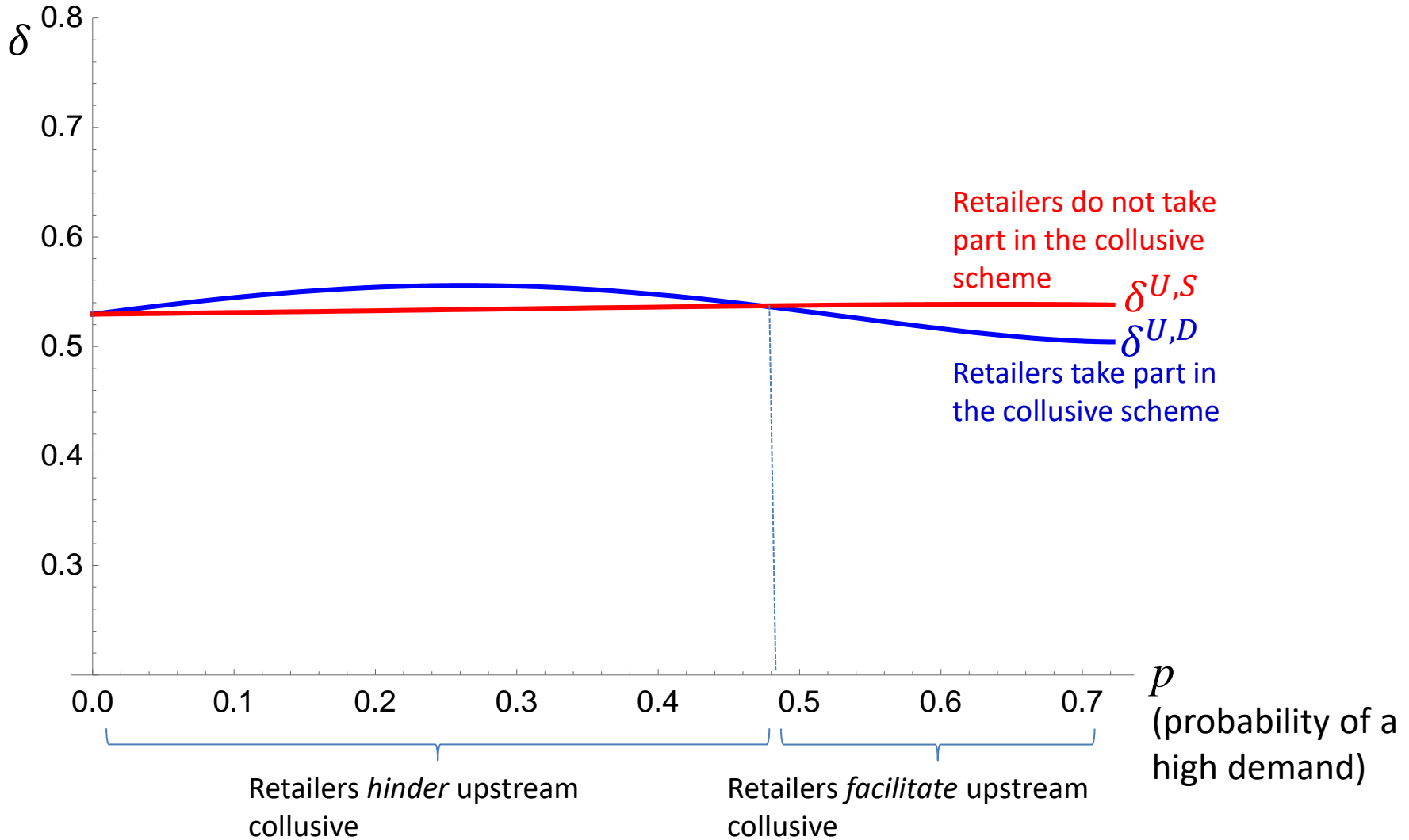


- Manufacturers can collude on maximizing the joint profits of $M_1 + M_2$
- In setting the quantities, manufacturers have two conflicting incentives:
 1. Relax competition
 - ▶ Set the monopoly quantities
 2. Reduce the retailers' information rents
 - ▶ Increase the gap between the quantities in states H and L (makes it less attractive to misrepresent H as L)

Quantities that maximize upstream profits



When retailers facilitate collusion on upstream profits?



Conclusion

- Repeated competition between two supply chains
 - ▶ Retailers have private information concerning the demand in each period
- Retailers may facilitate collusion
 - ▶ When detecting upstream collusion, competition authorities should also look at the retailers' role in facilitating collusion
- Manufacturers find it optimal to collude on a quantity below (above) the monopoly quantity in periods of low (high) demand
 - ▶ A substantial gap between outputs in periods of high and low demand may indicate the possibility of collusion

Thank you