Dual-Channel Supply Chain, Multilateral Contracting, and Vertical Foreclosure

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Background

- A dual-channel supply chain (DSC):
  An upstream manufacturer supplies DIRECTLY by herself, while INDIRECTLY through multiple downstream retailers.
  - Nike supplies various independent fashion shops while selling through the official online store;
  - In Japan, Mercedes-Benz sells though Yanase and Stern, while selling through its own direct store.
- There are also manufacturers using only the DIRECT channel:
  - Uniqlo never sells through independent retailers;
  - Volkswagen sells cars through only direct stores.

Secret contract problem

- In a DSC, it is difficult for a monopoly manufacturer to commit to offering a consistent contract to all the retailers.
  - The supplier can customize contracts to each retailer based on cost (a legal approach in Japan);
  - In a long-run, the manufacturer can also re-contract with a retailer without informing the others.
- But, the retailers are competing. They want to know the cost structure of the rival!
- The supplier's "secret contract" problem gives rise to the retailers' distrusts.
  - Will I be harmed in the competition with the others?
- The distrusts in turn dampen the manufacturer's market power.

My research questions and findings

- I consider a DSC with secret contracts. Which retailer to supply?

(1) A monopoly supplier chooses all the retailers who are more efficient than herself and forecloses all the less efficient ones.

- I endogenize the supply chain structure: will the manufacturer choose DSC or "Direct channel only"?

(2) A monopoly supplier will choose DSC if the inverse demand function is strictly concave ($P''(Q) < 0$) and the number of retailers is sufficiently small; she will not choose DSC if the inverse demand function is strictly convex ($P''(Q) > 0$).

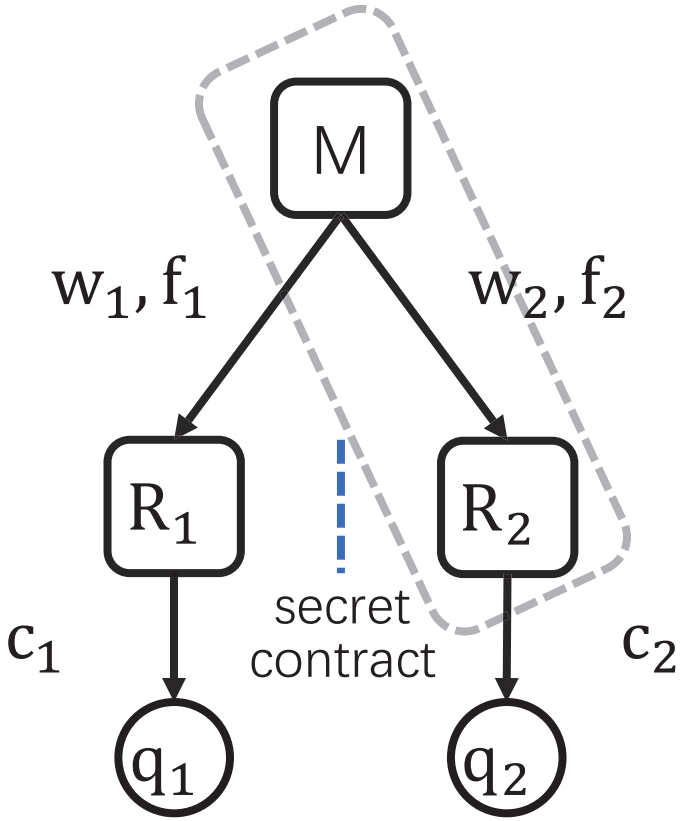
- Which structure generates the largest consumer surplus: Direct channel only? Indirect channel only? DSC?

(3) Indirect channel only!

Literature on secret contract

- When supplying multiple retailers, secret contract dampens a monopoly manufacturer's market power and results in oversupply (Hart&Tirole, 1990).
- Monopolist's attempts to solve this problem:
  - Nondiscrimination clauses (Marx&Shaffer, 2004):
    - if a retailer finds the manufacturer offers a more beneficial contract to the rival(s), the he asks for the same the contract;
  - Manufacturer firm's capacity constraint (Avenel, 2012):
    - the constraint acts as a commitment tool;
  - Vertically integrating with one retailer and foreclosing the others (Rey&Tirole, 2007; Reisinger&Tarantino, 2015).

Reisinger&Tarantino (2015)'s findings

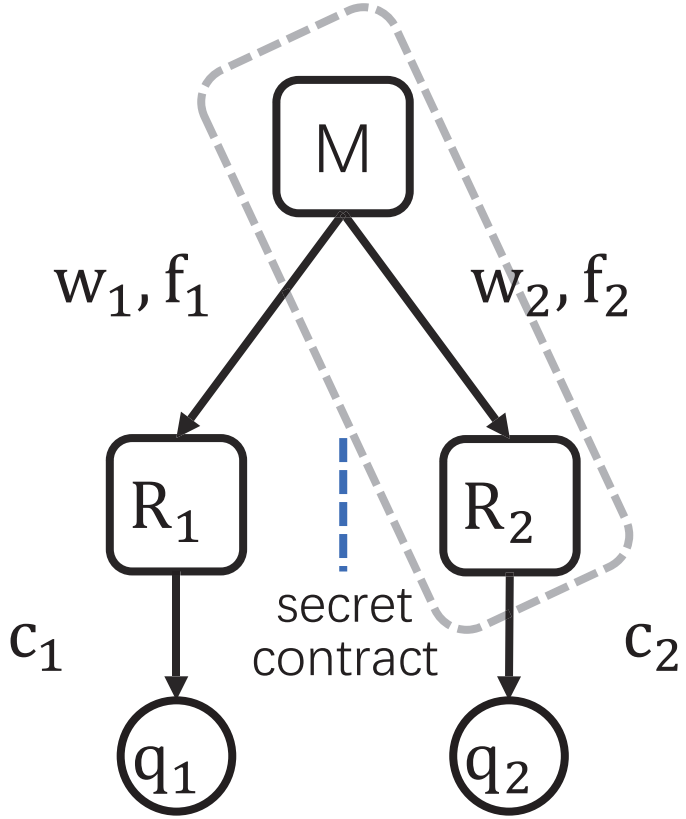


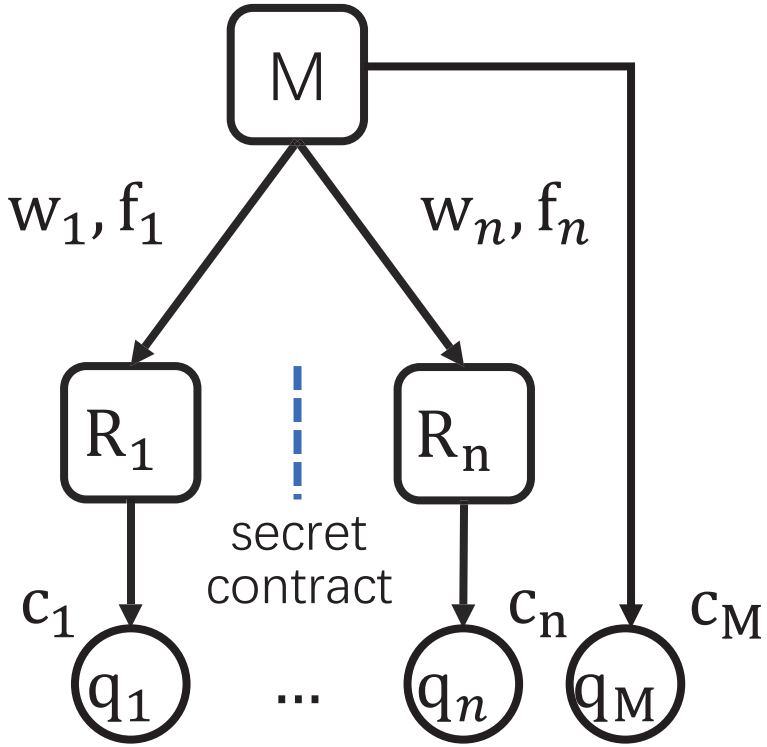
If M integrates with R_2:

1. R_1 will not be foreclosed iff $c_1 < c_2 \Rightarrow$ DSC.
2. R_1 will be foreclosed iff $c_1 \geq c_2 \Rightarrow$ Direct channel only.
   - The marginal cost is the only determinant.

- Key assumptions:
  1. The vertically integrated firm (M and R_2) faces only one rival. 2. No secret contract in the DSC.

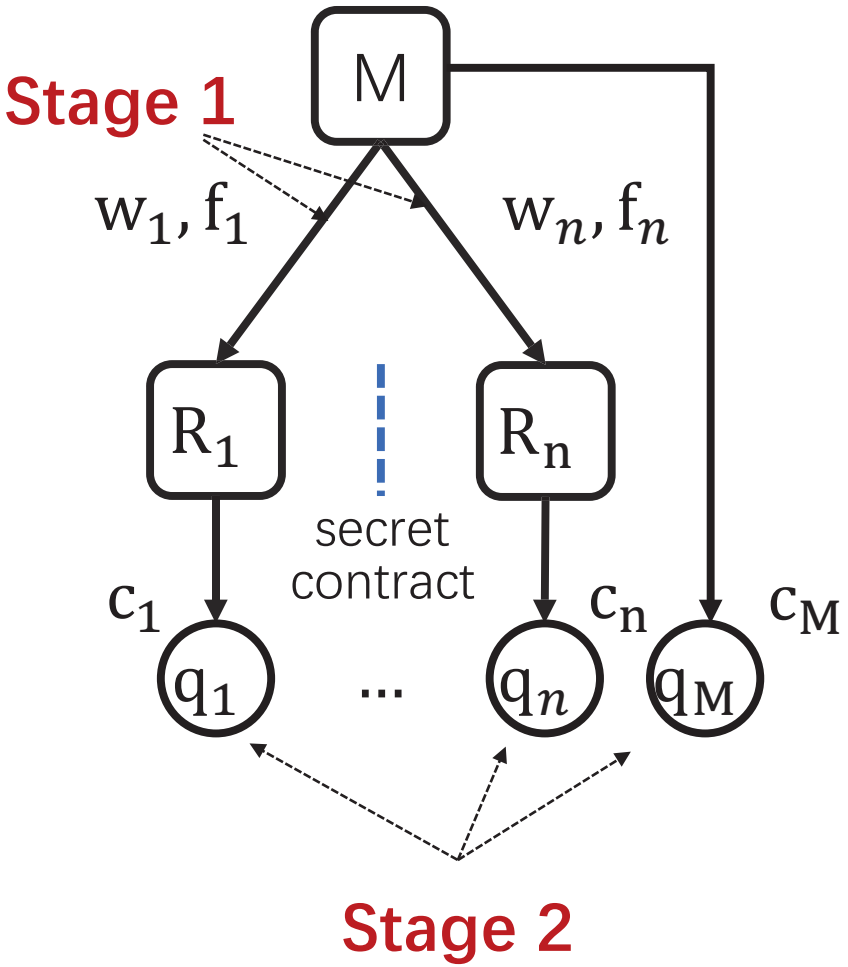
Difference of Pan (2019)





- M supplies n retailers; M can sell directly; M can decide to whom to supply, and whether to sell directly.
- Novelties: 1. Retailers compete in the indirect channel. 2. Secret contracts always exist in the DSC.

Settings and equilibrium concept



- Players: M and R_i, $i \in N$.

S.1 M decides whether to supply R_i; if yes, SECRETLY offering $\{w_i, f_i\}$;

S.2 Quantity decisions.

- *Contract equilibrium*: given others' contracts, $\{w_i, f_i\}$ maximizes the bilateral joint profit of M and R_i.
- Weak perfect Bayesian equilibrium.

Demand assumptions

- Homogeneous products. $P(Q)$: continuous, nonnegative, strictly decreasing, and third-order differentiable, choke price.

Assumption 1

$\epsilon(Q) \equiv \frac{P''(Q)Q}{P'(Q)} > -1 \Longleftrightarrow P'(Q) + P''(Q)Q \leq 0$ (Vives, 1999).

- Ass. 1 is for the concavity of profit function and a well defined equilibrium.

Assumption 2

$\epsilon(Q) \geq \alpha(Q)$, where $\alpha(Q) \equiv \frac{P'''(Q)Q}{P''(Q)}$ (Ara&Ghosh, 2016).

- Demand curvature is larger than the slope curvature, or equivalently, $\epsilon'(Q)Q/\epsilon \leq 1$ (not necessarily needed).
- Any $P(Q)$ with constant price elasticity can satisfy.

Benchmark: no direct selling

S.2: R_i's belief about others' wholesale prices: $\bar{\mathbf{w}}_{-i} \equiv \{\bar{w}_j\}_{j\in N\setminus\{i\}}$.
R_i's quantity: $q_i(w_i, \mathbf{c}) \equiv q_i(w_i, \bar{\mathbf{w}}_{-i}, \mathbf{c})$, $\mathbf{c} \equiv \{c_1, ..., c_M\}$.

- R_i's belief on others' quantities: $\bar{\mathbf{q}}_{-i}(\mathbf{c}) \equiv \{q_j(\bar{w}_j, \mathbf{c})\}_{j\in N\setminus\{i\}}$.

S.1: M sets $f_i = (P(q_i(w_i, \mathbf{c}), \bar{\mathbf{q}}_{-i})(\mathbf{c}) - w_i)q_i(w_i)$, and solves

$$\max_{\mathbf{w}} \Pi^I \equiv \sum_i (P(q_i(w_i, \mathbf{c}), \bar{\mathbf{q}}_{-i}(\mathbf{c})) - c_i)q_i(w_i, \mathbf{c}).$$

- The optimal w_i only maximizes M and R_i's **bilateral** profit.
- FOC: $\frac{\partial q_i(w_i,\mathbf{c})}{\partial w_i}(P'(q_i, \mathbf{q}_{-i})q_i + P(q_i, \bar{\mathbf{q}}_{-i}) - c_i) = 0$.
  The equilibrium quantity is an oligopoly level.
- M must supply all the retailers, although she is an upstream monopolist.

Commitment problem in DSC

S.2: R_i forms his belief about others' wholesale prices $(\bar{\mathbf{w}}_{-i})$. R_i's quantity: $q_i(w_i, \mathbf{c}) \equiv q_i(w_i, \bar{\mathbf{w}}_{-i}, \mathbf{c})$, $\mathbf{c} \equiv \{c_1, ..., c_M\}$.

- R_i's belief on others' quantities: $\bar{\mathbf{q}}_{-i}(\mathbf{c}) \equiv \{q_j(\bar{w}_j, \mathbf{c})\}_{j \in N \setminus \{i\}}$.
- M can observe all contracts, hence choosing $q_M(\mathbf{q}_R(\mathbf{w}, \mathbf{c}), c_M) \equiv q_M(q_1(w_1, \mathbf{c}), ..., q_n(w_n, \mathbf{c}), c_M)$.

S.1: M solves $\max_{\mathbf{w}} \Pi^{DSC} \equiv$

$$\sum_{i=1}^{n} \left(P(q_i(w_i, \mathbf{c}), \bar{\mathbf{q}}_{-i}(\mathbf{c}), q_M(q_i(w_i, \mathbf{c}), \bar{\mathbf{q}}_{-i}(\mathbf{c}), c_M)) - c_i\right) q_i(w_i, \mathbf{c})$$

$$+ \left(P(\mathbf{q_R}(\mathbf{w}, \mathbf{c}), q_M(\mathbf{q_R}(\mathbf{w}, \mathbf{c}), c_M)) - c_M\right) q_M(\mathbf{q_R}(\mathbf{w}, \mathbf{c}), c_M).$$

$*$ w_i ONLY maximizes M and R_i's **bilateral** joint profit; the impact on the rivals $\mathbf{R}_{-i}$ are neglected.

Reduced-form game

- The FOC in the contracting stage:

$$\frac{\partial q_i(w_i, \mathbf{c})}{\partial w_i} \times \left(P'(Q) \left(1 + \frac{dq_M(q_i, \bar{\mathbf{q}}_{-i})}{dq_i} \right) q_i + c_M - c_i \right) = 0.$$

  (Assumption 3 for SOC: $P'''(Q)$ sufficiently small).
- Notice: each retailer's equilibrium quantity is decided in Stage 1.
- The contracting secrecy makes the retailers the Stackelberg leaders, and M the follower.
- Solving n FOCs, we have $\{q_1^*(\mathbf{c}), ..., q_n^*(\mathbf{c})\}$. Then,

$$Q_R^*(\mathbf{c}) = \sum_{i=1}^{n} q_i^*(\mathbf{c}, c_M); \;\; q_M^*(\mathbf{c}) = q_M(Q_R^*(\mathbf{c}), c_M).$$

Proposition 1: whom to supply in DSC?

- Let $\underline{c} \equiv \min\{c_1, ..., c_n\}$; $\bar{c} \equiv \max\{c_1, ..., c_n\}$.

Proposition 1

Suppose Assumption 1, 2 and 3 hold. In a DSC, M forecloses all the retailers if M is weakly more efficient than all retailers ($c_M \leq \underline{c}$); if otherwise, M supplies all those who are more efficient than herself.

- Proof: $P'(Q)\left(1 + \frac{dq_M(q_i, \bar{\mathbf{q}}_{-i})}{dq_i}\right) q_i + c_M - c_i = 0.$
- Intuitions: despite of contracting secrecy, $\mathbf{c}$ is known to all. Given any off-equilibrium-path beliefs $\bar{\mathbf{q}}_{-i}$, R_i with $c_i \geq c_M$ is foreclosed by a strong Stackelberg follower.
- $*$ It is best for M to supply R_i with $c_i = \underline{c} \leq c_M$ and foreclose all the others. But she cannot, because of lacking commitment.

DSC vs. Direct channel only ("D")

- Direct channel only: $\Pi^D = (P(q_M^{**}) - c_M)q_M^{**}$.
- DSC: At $c_M = \underline{c}$, $Q_R^* = 0$, so $\Pi^{DSC} = \Pi^D$.
- $\dfrac{d\Pi^D}{dc_M} = -q_M^{**}$; $\dfrac{d\Pi^{DSC}}{dc_M} = -\left((n-1)Q_R^{*\prime}(c) + \dfrac{n}{P'(Q)}\right)c_M - q_M^*$.
- The condition for $\Pi^{DSC} > \Pi^D$: $\dfrac{d\Pi^D}{dc_M} < \dfrac{d\Pi^{DSC}}{dc_M}$

DSC vs. Direct channel only ("D")

$$\frac{d\Pi^D}{dc_M} < \frac{d\Pi^{DSC}}{dc_M}$$

$$\Longleftrightarrow \underbrace{\left((n-1)\frac{dQ_R^*(\mathbf{c})}{dc_M} + \frac{n}{P'(Q)}\right) c_M}_{output-shifting\ \ effect} < \underbrace{q_M^{**} - q_M^*}_{self-response\ \ effect} .$$

- If M chooses DSC, two requirements need to be satisfied: (1) An increase in c_M does not shift too much output to $Q_R^*(\mathbf{c})$; (2) M can effectively reduce q_M in her direct channel.

Proposition 2: the condition of DSC

- Let $\delta_M = \frac{q_M^*}{q_M^* + Q_R^*}$.

Proposition 2

Suppose Assumption 1, 2, 3 hold. Suppose $\bar{c} \leq c_M$ and $num\{i \in N \mid c_i = \underline{c}\} \geq 2$. Then, for any $\delta_M \in (0,1)$,

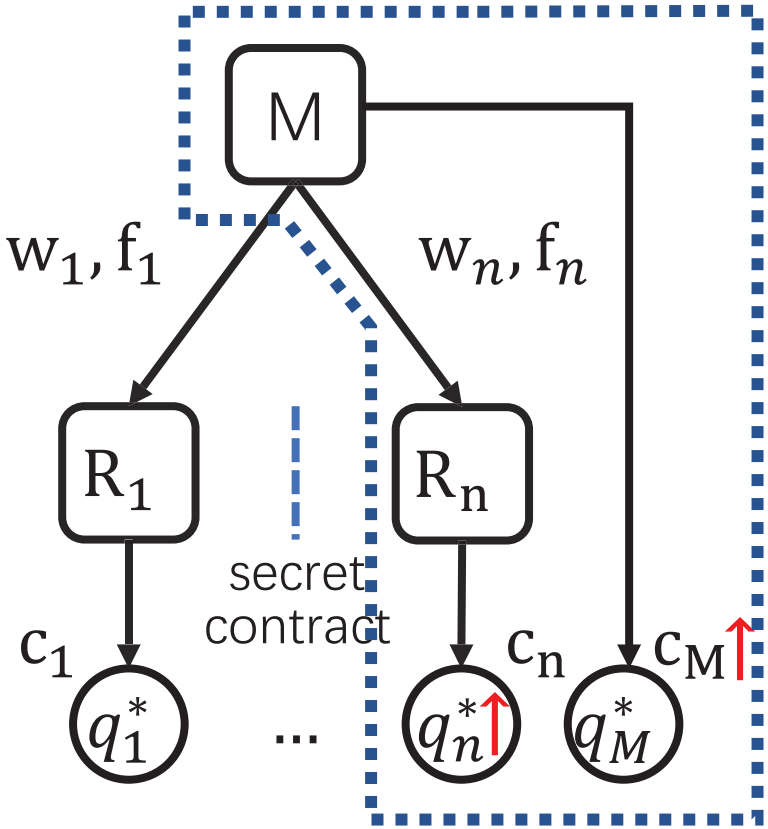
(i) M chooses DSC in equilibrium if $\frac{dQ_R^*/dc_M}{Q_R^*/c_M} < 1/(n-1)$, i.e., $P''(Q) < 0$ and n is smaller than a cutoff, $\hat{n}(\alpha(Q), \epsilon(Q))$;

(ii) M chooses "direct channel only" in equilibrium if $\frac{dQ_R^*/dc_M}{Q_R^*/c_M} > 1/(n-1)$, i.e., $P''(Q) > 0$.

- Part (ii) holds even for $\delta_M \to 0$ or $n = 2$.
- Interpretations: (1) DSC will not be chosen even if the retailers have a sufficiently large cost advantage; (2) the minimum level of competition may harm M.

Intuitions of Proposition 2: output-shifting effect

- When c_M increases:



$$(P(q_n^*\uparrow, \boldsymbol{q}_{-n}^*) - c_1)q_1^*$$

- M makes R_n to sell more through w_i: $q_n^*\uparrow$.
- Due to the secret contracts, R_n neglects the **negative** impacts on other retailers: e.g., $(P(q_n^*\uparrow, q_{-n}^*) - c_1)q_1^*$.
- In all, there is an **excessive output-shifting** to Q_R^*.

Intuitions of Proposition 2: self-response effect

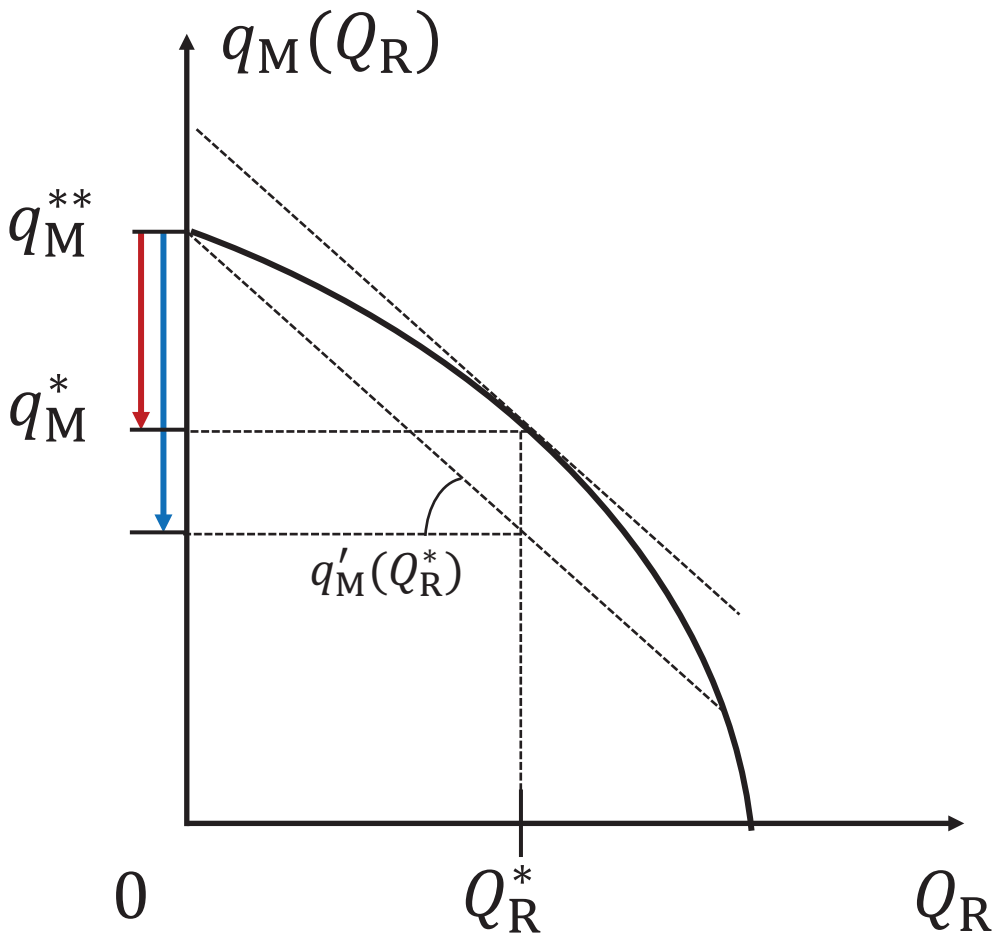
- How about q_M? Can M effectively reduce her quantity to alleviate the excessive output-shifting on Q_R^*?
- We see how the **Self-response effect** works.
- Properties on M's best response function $q_M(Q_R)$:

Lemma 1

Suppose Assumption 1, 2, 3 hold. $q_M''(Q_R) \geq 0$ iff $P''(Q) < 0$, and $q_M''(Q_R) \leq 0$ iff $P''(Q) > 0$.

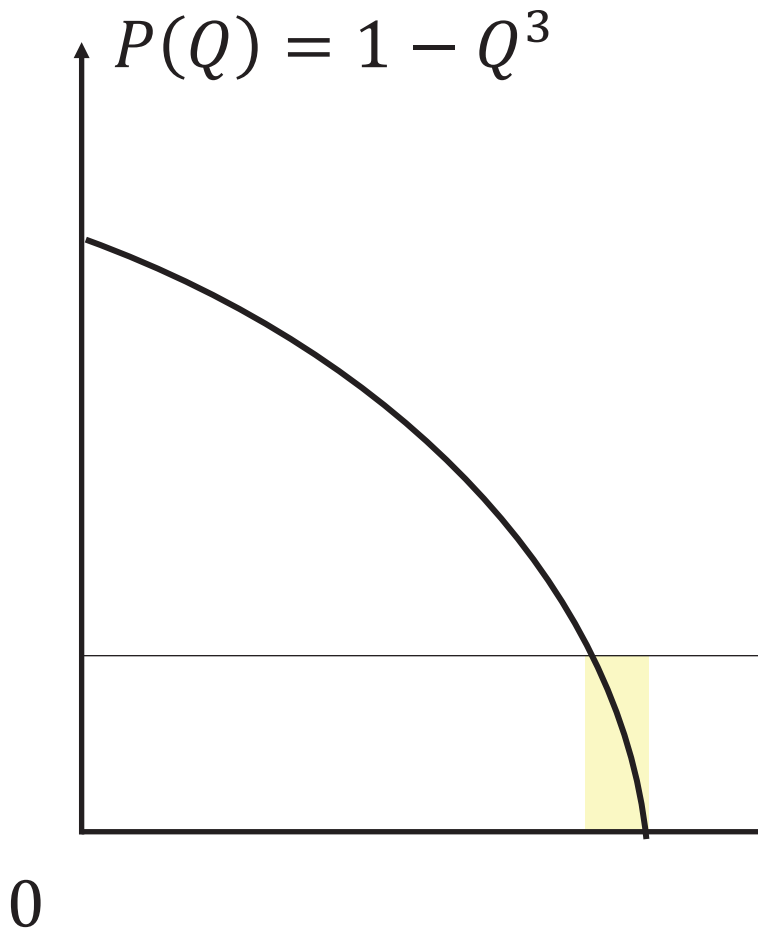
Self-response effect

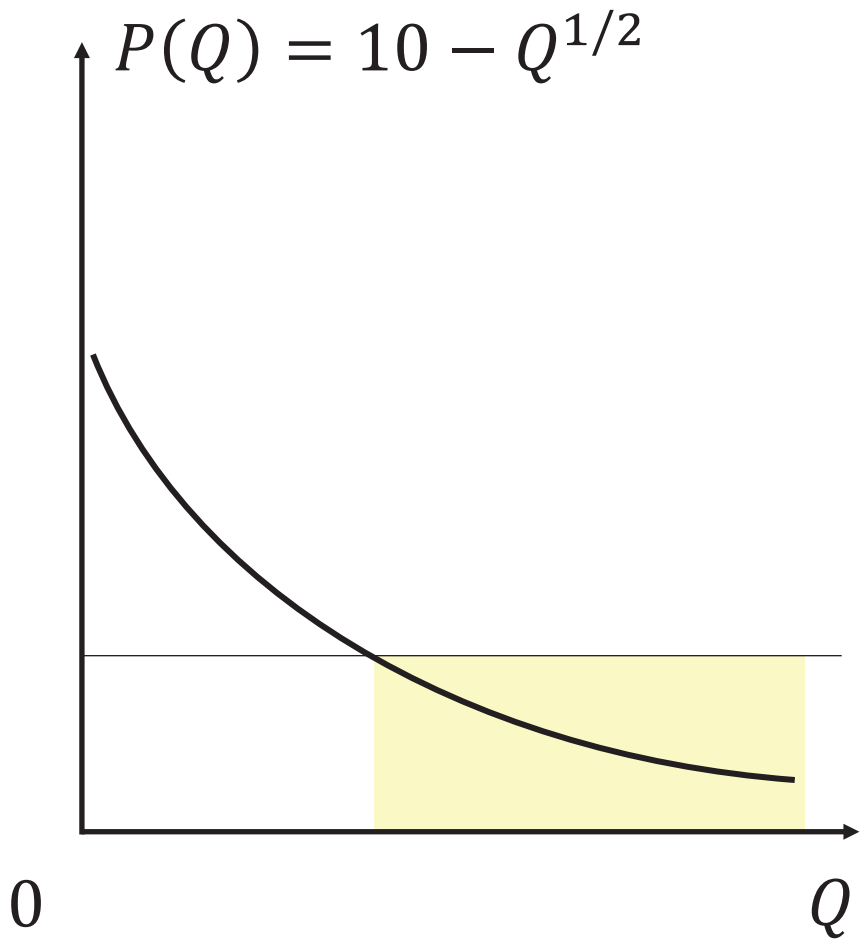
- When $P''(Q) > 0$, $q_M(Q_R)$ is concave.



- M's instantaneous reaction is to reduce q_M by $|q_M'(Q_R^*)|Q_R^*$.
- Since $q_M''(Q_R) < 0$, $q_M^{**} - q_M^* < |q_M'(Q_R^*)|Q_R^*$.
- M cannot effectively response to the excessive output-shifting.
- DSC is not chosen because: 1. output shifting effect is **too strong**; 2. self-response effect is **too weak**.

Convex demand function with a long tail area





Implications

- With a convex demand function, M prefers monopoly because
  - In DCS, the retailers are easily fall into "head-to-head" competition to capture the low-end consumers' demands.
  - The retail price becomes too low such that the manufacturer loses control of the downstream market.
- With a concave demand function, a monopoly manufacturer prefers DCS because
  - The retailers refrain from intense competition because consumers' willingness to pay is high.
  - The manufacturer can take advantage of the retailers' cost advantage and realize market power.
- We can estimate whether a DCS or a monopoly will be chosen based on demand characteristics rather that cost information.
  - Demand data is more accessible than cost data.
  - This model is potentially testable by empirical methods.

Proposition 3: welfare detrimental direct selling

- Welfare comparison between three systems: indirectly channel only (n firms compete), direct channel only (monopoly), DCS ($n+1$ firms compete):

Proposition 3

"Direct channel only" generates the lowest consumer surplus;
"Indirect channel only" generates the highest consumer surplus.

- $*$ Comparison between "indirect channel only" and DCS: one more firm but lower price. Why?

Intuition of Proposition 3

Indirect channel only:

- Due to secret contract, M cannot control the retailers' competition.

DCS:

- The direct channel acts as a strategic tool because M acts as a Stakelberg follower:

1. each retailer supplies less;
2. M recaptures her control of the supply chain, meaning a stronger market power.

- Policy implication: a seemingly pro-competitive market entry without vertical foreclosure can be anti-competitive.

Summary

What I did:

- I incorporated retailers' competition in to the DSC with secret contracts.
- The model can simultaneously capture "distribution imperfection" and "contracting imperfection."

What I found:

- A simple way to predict whether DSC will be chosen is to focus on $\frac{dQ_R^*/dc_M}{Q_R^*/c_M}$ and n;
- Market characteristics like $P''(Q)$ plays a decisive role.
- Market entry without vertical foreclosure can be anti-competitive.