

IM 7011: Information Economics (Fall 2014)

Incentives for Retailer Forecasting

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Road map

- ▶ **Introduction.**
- ▶ Model.
- ▶ Rebates contracts.
- ▶ Returns contracts.

Demand forecasting

- ▶ Supply-demand mismatch is costly.
- ▶ Firms try to do **forecasting** to obtain demand knowledge.
- ▶ In a supply chain, typically the retailer does forecasting.
 - ▶ The manufacturer may only **induce** the retailer to forecast.
 - ▶ It is also the retailer that incurs the forecasting cost.
 - ▶ We shall study how the **forecasting cost** affects the supply chain.
- ▶ Is it always beneficial to induce forecasting?
 - ▶ Forecasting allows the supply chain to reduce supply-demand mismatch.
 - ▶ It also places the manufacturer at an **informational disadvantage!**
- ▶ If inducing forecasting is beneficial, when? How?

Contract formats

- ▶ Whether inducing/encouraging forecasting is beneficial depends on how the system profit is split.
 - ▶ The **contract format** between the manufacturer and retailer matters.
- ▶ Two kinds of contracts alters the retailer's decision of forecasting.
- ▶ Under a **rebates** contract, the manufacturer pays a bonus to the retailer for each sold unit.
 - ▶ A rebates contract provides a **lottery** to the retailer.
 - ▶ It **encourages** the retailer to forecast.
- ▶ Under a **returns** contract, the manufacturer buys back unsold units.
 - ▶ A returns contract provides an **insurance** to the retailer.
 - ▶ It **discourages** the retailer to forecast.
- ▶ Which contract format is more beneficial for the manufacturer?
- ▶ Taylor and Xiao (2009) study this problem.¹

¹Taylor, T., W. Xiao. 2009. Incentives for Retailer Forecasting: Rebates vs. Returns. *Management Science* **55**(10) 1654–1669.

Demand forecasting

- ▶ A manufacturer (he) sells to a retailer (she), who faces uncertain consumer demands.
- ▶ The unit production cost is c and unit retail price is p .
- ▶ Without forecasting, firms believe that the random demand $D_N \sim F_N$.
- ▶ The retailer may **forecast** with a forecasting cost k .
- ▶ If she forecasts, she obtains a **private** demand **signal** $S \in \{H, L\}$.
- ▶ With probability λ , she observes a favorable signal:
 - ▶ $S = H$ makes the retailer **optimistic**.
 - ▶ She believes that the market is good and the updated demand $D_H \sim F_H$.
- ▶ With probability $1 - \lambda$, she observes an unfavorable signal:
 - ▶ $S = L$ makes the retailer **pessimistic**.
 - ▶ She believes that the market is bad and the updated demand $D_L \sim F_L$.
- ▶ We assume that $F_H(x) \leq F_L(x)$ and $F_N(x) = \lambda F_H(x) + (1 - \lambda)F_L(x)$ for all $x \geq 0$. We also assume that $F_S(\cdot)$ is strictly increasing.
- ▶ Let $\bar{F}_S(x) := 1 - F_S(x)$, $S \in \{H, L, N\}$.

An example for demand forecasting

- ▶ As an example, suppose that $D_L \sim \text{Uni}(0, 1)$ and $D_H \sim \text{Uni}(0, 2)$, i.e.,

$$F_L(x) = \begin{cases} x & \forall x \in [0, 1] \\ 1 & \forall x \in (1, 2] \end{cases} \quad \text{and} \quad F_H(x) = \frac{x}{2} \quad \forall x \in [0, 2].$$

- ▶ The market is either good or bad. If it is good, the demand is D_H . Otherwise, it is D_L .
- ▶ We may say that the demand $D(\theta) \sim \text{Uni}(0, \theta)$, where $\theta \in \{1, 2\}$.
- ▶ The firms both believe that $\Pr(\theta = 2) = \lambda = 1 - \Pr(\theta = 1)$.
- ▶ Without knowing θ , a firm can only believe that the demand is $D_N \sim F_N = \lambda F_H + (1 - \lambda) F_L$.

- ▶ If the retailer forecasts, she knows θ and thus whether it is D_H or D_L .

Research questions revisited

- ▶ Should the manufacturer induce the retailer to forecast?
- ▶ If so, how should the manufacturer design the offer?
- ▶ Which type of contracts, rebates or returns, is more beneficial?
- ▶ Efficiency? Inefficiency? Incentives? Information?

Road map

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- ▶ Rebates contracts.
- ▶ Returns contracts.

Contractual terms: rebates contracts

- ▶ By offering a rebates contract, the manufacturer specifies a three-tuple

$$(q, r, t).$$

- ▶ q is the order **quantity**.
- ▶ r is the sales **bonus** per unit sales.
- ▶ t is the **transfer** payment.
- ▶ If the retailer accepts the contract, she pays t to purchase q units and the rebate r .
- ▶ Note that the manufacturer is not restricted to sell the products at a wholesale price.
 - ▶ If this is the case, he will specify (q, r, w) where $t = wq$.
 - ▶ To find the optimal rebates contract, such a restriction should not exist.
 - ▶ t may depend on q and r in any format.

Contractual terms: returns contracts

- ▶ By offering a rebates contract, the manufacturer specifies a three-tuple

$$(q, b, t).$$

- ▶ q is the order **quantity**.
- ▶ b is the **buy-back price** per unit of unsold products.²
- ▶ t is the **transfer** payment.
- ▶ If the retailer accepts the contract, she pays t to purchase q units and the buy-back price b .
- ▶ The manufacturer is still not restricted to sell the products at a wholesale price.
 - ▶ t may depend on q and b in any format.

²Note that all unsold products can be returned. *Partial returns* are not discussed in this paper.

The manufacturer's contract design problem

- ▶ Note that we assume that the manufacturer can offer a **take-it-or-leave-it** contract.
 - ▶ The retailer cannot choose quantities at her disposal.
 - ▶ She can only **accept of reject** the contract.
 - ▶ Her information makes her accept-or-reject decision more accurate.
- ▶ If the retailer does not forecast, a single contract is enough.
 - ▶ There is no information asymmetry.
 - ▶ Enough flexibility is ensured by the flexibility on t .
- ▶ If the retailer has private information (signal S), a **menu of contracts** should be offered to induce truth-telling.
 - ▶ As S is binary, a menu of two contracts is optimal.
- ▶ We assume that the manufacturer **cannot mix** rebates and returns.
 - ▶ We will see that mixing does not make the manufacturer better off.
- ▶ The retailer determines whether to obtain private information. This is a problem with **endogenous adverse selection!**

Timing

- ▶ The sequence of events is as follows:
 1. The manufacturer offers a (menu of) rebates or returns contract(s).
 2. The retailer decides whether to forecast. If so, she privately observes the demand signal.
 3. The retailer chooses a contract or reject the offer based on her signal.
 4. Demand is realized and payments are made.
- ▶ The manufacturer **can induce** the retailer to or not to forecast.
 - ▶ Whether the retailer forecasts is also private. However, the manufacturer can anticipate this.
- ▶ Alternative timing (not discussed in this paper):
 - ▶ The retailer forecasts after choosing a contract ($1 \rightarrow 3 \rightarrow 2 \rightarrow 4$).
 - ▶ The retailer forecasts before getting the offer ($2 \rightarrow 1 \rightarrow 3 \rightarrow 4$).

Integrated system without forecasting

- ▶ As a benchmark, let's first analyze the first-best situation: integration.
 - ▶ The decisions: (1) forecasting or not and (2) production quantity.
 - ▶ These decisions will be compared to determine efficiency.
- ▶ Suppose the system chooses not to forecast, it solves

$$\Pi_N(q_N) := p\mathbb{E} \min(q_N, D_N) - cq_N.$$

The optimal quantity is $q_N^I = \bar{F}_N^{-1}(\frac{c}{p})$.

- ▶ The optimized expected system profit is $\Pi_N(q_N^I)$.

Integrated system with forecasting

- ▶ Suppose the system chooses to forecast, it solves

$$\begin{aligned}\Pi_F(q_H, q_L) := & \lambda \left[p \mathbb{E} \min(q_H, D_H) - cq_H \right] \\ & + (1 - \lambda) \left[p \mathbb{E} \min(q_L, D_L) - cq_L \right].\end{aligned}$$

The optimal quantities are $q_S^I = \bar{F}_S^{-1}(\frac{c}{p})$, $S \in \{H, L\}$.

- ▶ By observing different signals, the quantity can be **adjusted** accordingly.
- ▶ If no adjustment, i.e., $q_H = q_L = q$, then forecasting brings **no benefit**:

$$\Pi_F(q, q) = \Pi_N(q) \quad \forall q \geq 0.$$

- ▶ The optimized expected system profit is $\Pi_F(q_H^I, q_L^I)$.

Integrated system: forecasting or not?

- ▶ If forecasting is free, the system should **always forecast**:

$$\Pi_F(q_H^I, q_L^I) \geq \Pi_F(q_N^I, q_N^I) = \Pi_N(q_N^I).$$

- ▶ However, forecasting requires a cost k .
 - ▶ Whether the system should forecast depends on the value of k .
- ▶ The **performance gap** $k^I := \Pi_F(q_H^I, q_L^I) - \Pi_N(q_N^I)$ is the threshold.

Proposition 1

If $k < k^I$, the system should forecast and produce q_H^I (q_L^I) upon observing signal H (L). Otherwise, the system should not forecast and should produce q_N^I .

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- ▶ Returns contracts.

Rebates contracts

- ▶ Here we study the manufacturer's optimal strategy for offering **rebates contracts**.
- ▶ He has two options:
 - ▶ Inducing the retailer to forecast.
 - ▶ Inducing the retailer not to forecast.
- ▶ We will first find the optimal contracts in either case. Then we make comparisons to obtain the manufacturer's optimal strategy.
- ▶ In all equilibria, the retailer will accept a contract. Let

$$R^r(S, C) := (p + r_C)\mathbb{E} \min(q_C, D_S) - t_C,$$

be the retailer's expected profit when:

- ▶ she observes **signal** $S \in \{N, H, L\}$ (N for no forecasting) and
- ▶ she chooses **contract** (q_C, r_C, t_C) , $C \in \{N, H, L\}$.

No forecasting

- ▶ Suppose the manufacturer wants to drive the retailer not to forecast.
 - ▶ He will offer a single contract (q_N, r_N, t_N) .
- ▶ Among rebates contracts that induce no forecasting, which is optimal?
- ▶ By accepting (q_N, r_N, t_N) with no forecasting, the retailer earns

$$R^r(N, N) := (p + r_N)\mathbb{E} \min(q_N, D_N) - t_N.$$

- ▶ However, she may choose to forecast and then accept or reject the offer **based on her signal**. If she forecasts, the retailer earns

$$\lambda \max\{R^r(H, N), 0\} + (1 - \lambda) \max\{R^r(L, N), 0\} - k.$$

- ▶ With probability λ she will observe $S = H$. She then determine whether to accept (and earn $R^r(H, N)$) or reject (and earn 0).
- ▶ With probability $1 - \lambda$ she will observe $S = L$.
- ▶ In both cases, she pays k for forecasting.

No forecasting: formulation

- ▶ To optimally induce no forecasting, the manufacturer solves

$$\begin{aligned} \max_{q_N, r_N, t_N} \quad & t_N - cq_N - r_N E \min\{q_N, D_N\} \\ \text{s.t.} \quad & R^r(N, N) \geq \lambda \max\{R^r(H, N), 0\} \\ & \quad \quad \quad + (1 - \lambda) \max\{R^r(L, N), 0\} - k \\ & R^r(N, N) \geq 0. \end{aligned}$$

- ▶ The first constraint ensures that the retailer prefers no forecasting.
- ▶ The second constraint ensures that the retailer will participate.
- ▶ **Incentives** are provided through contracts.
- ▶ Technical assumptions:
 - ▶ Naturally, $q_N \geq 0$ and $r_N \geq 0$ though not explicitly specified.
 - ▶ It is assumed that $t_N \in \mathbb{R}$. Money may transfer in **either direction**!

No forecasting: solution

Proposition 2

The optimal rebates contract inducing no forecasting is

k	q_N^*	r_N^*	t_N^*
$k \leq \Gamma(q_L^I)$	q_L^I	0	$pE \min(q_L^I, D_N) - \frac{\Gamma(q_L^I) - k}{1 - \lambda}$
$k \in (\Gamma(q_L^I), \Gamma(q_N^I))$	$\Gamma^{-1}(k)$	0	$pE \min(\Gamma^{-1}(k), D_N)$
$k \geq \Gamma(q_N^I)$	q_N^I	0	$pE \min(q_N^I, D_N)$

where $\Gamma(q) := (1 - \lambda)p \int_0^q [\bar{F}_N(x) - \bar{F}_L(x)] dx$ is strictly increasing in $q \in (q_L^I, q_N^I)$ and thus $\Gamma^{-1}(\cdot)$ is well-defined over $[\Gamma(q_L^I), \Gamma(q_N^I)]$.

- ▶ The optimal contract depends on k .
- ▶ It is ugly, but it can be found.

No forecasting: intuitions

k	q_N^*	r_N^*	t_N^*
$k \leq \Gamma(q_L^I)$	q_L^I	0	$pE \min(q_L^I, D_N) - \frac{\Gamma(q_L^I) - k}{1 - \lambda}$
$k \in (\Gamma(q_L^I), \Gamma(q_N^I))$	$\Gamma^{-1}(k)$	0	$pE \min(\Gamma^{-1}(k), D_N)$
$k \geq \Gamma(q_N^I)$	q_N^I	0	$pE \min(q_N^I, D_N)$

- ▶ A rebate encourages forecasting so **no rebate** should be offered.
- ▶ A large quantity encourages forecasting so **q increases in k** .
 - ▶ When k is large, it is easy to induce no forecasting.
 - ▶ The manufacturer can implement the **efficient quantity** (q_N^I) and capture all the surplus by the transfer.
 - ▶ When k is moderate, it is not too hard to induce no forecasting.
 - ▶ The manufacturer captures all the surplus with a **reduced quantity**.
 - ▶ When k is small, it is hard to induce no forecasting.
 - ▶ The manufacturer must **leave some rents** to the retailer by reducing t .

No forecasting: intuitions

- ▶ The retailer is “advantageous” when k is small. Does that make sense?
- ▶ The retailer gets rents though she does not have private information.
 - ▶ The **threat** of obtaining private information can generate rents!
- ▶ The power of threat depends on k :
 - ▶ When k is large, the threat is **weak** (noncredible). The manufacturer can be mean to the retailer (and use the transfer to extract everything).
 - ▶ When k is small, the threat is **strong** (credible). The manufacturer must be generous to the retailer.
- ▶ We may verify that the manufacturer’s expected profit increases in k .
 - ▶ This is true if, and only if, he is required to induce no forecasting.

Forecasting

- ▶ Suppose the manufacturer wants to induce forecasting.
 - ▶ The retailer will have the private demand signal.
 - ▶ A **menu** of two contracts $\{(q_H, r_H, t_H), (q_L, r_L, t_L)\}$ will be offered.
- ▶ Now the manufacturer must ensure four things:
 - ▶ Once the retailer forecasts, she will select the intended contract.
 - ▶ Selecting the intended contract leaves the retailer a nonnegative profit.
 - ▶ The retailer must prefer forecasting to no forecasting.
 - ▶ Forecasting leaves the retailer a nonnegative profit.

Forecasting: formulation

- ▶ To optimally induce forecasting, the manufacturer solves

$$\begin{aligned}
 & \max_{\substack{(q_H, r_H, t_H) \\ (q_L, r_L, t_L)}} && \lambda \left[t_H - cq_H - r_H E \min\{q_H, D_H\} \right] \\
 & && + (1 - \lambda) \left[t_L - cq_L - r_L E \min\{q_L, D_L\} \right] \\
 \text{s.t.} && R^r(H, H) \geq R^r(H, L), \quad R^r(L, L) \geq R^r(L, H) \\
 && R^r(H, H) \geq 0, \quad R^r(L, L) \geq 0 \\
 && \lambda R^r(H, H) + (1 - \lambda) R^r(L, L) - k \geq R^r(N, H) \\
 && \lambda R^r(H, H) + (1 - \lambda) R^r(L, L) - k \geq R^r(N, L) \\
 && \lambda R^r(H, H) + (1 - \lambda) R^r(L, L) - k \geq 0
 \end{aligned}$$

- ▶ The first two IC constraints ensure truth-telling after forecasting.
- ▶ The next two IR constraints ensure participation after forecasting.
- ▶ The last three IC and IR constraints ensure forecasting.

Forecasting: solution

Proposition 3

The optimal rebates contract inducing forecasting is

$$q_L^* = \operatorname{argmax}_{q \geq 0} \left\{ p \int_0^q [\bar{F}_L(x) - \lambda \bar{F}_H(x)] dx - (1 - \lambda) cq \right\}$$

$$r_L^* = 0$$

$$t_L^* = pE \min(q_L^*, D_L)$$

$$q_H^* = q_H^I$$

$$r_H^* = \frac{k}{\lambda(1 - \lambda)\Delta(q_H^I)}$$

$$t_H^* = (p + r_H^*)E \min(q_H^*, D_H) - p\Delta(q_L^*) - \frac{k}{\lambda}$$

where $\Delta(q) := \mathbb{E} \left[\min(q, D_H) - \min(q, D_L) \right]$.

Forecasting: intuition

- ▶ Whenever we want to differentiate agents through contract design, we need to provide incentives for them to tell the truth.
- ▶ Who has the incentive to lie?
 - ▶ A retailer always **tends to claim** that the market is **bad** to get generous contracts.
 - ▶ The high-type retailer wants to pretend to be the low-type one.
- ▶ That is why we have $r_H^* > r_L^* = 0$ and $q_H^I = q_H^* > q_L^*$.
 - ▶ An optimistic retailer likes rebates and high quantity.
 - ▶ To prevent her from mimicking the low type, the manufacturer **cuts down** r_L^* and q_L^* .
 - ▶ **Efficiency at top**: $q_H^I = q_H^*$.
 - ▶ **Monotonicity**: $q_H^* > q_L^*$.
 - ▶ **No rent at bottom** can also be verified.
 - ▶ $r_L^* = 0$: There is no point to offer a rebate to the low-type retailer.

Inducing forecasting or not

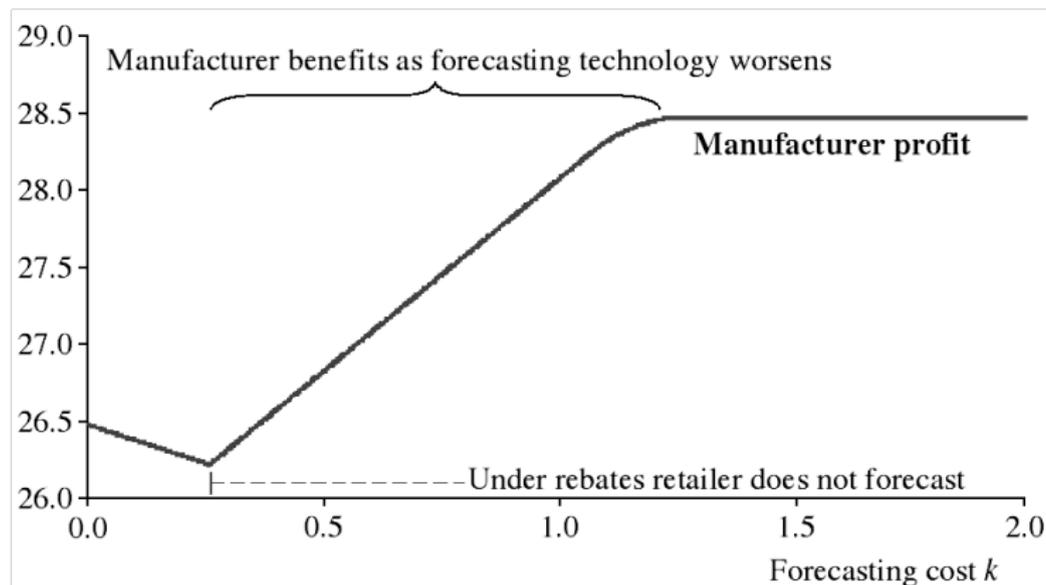
- ▶ We can find $\mathcal{M}_F^r(k)$ and $\mathcal{M}_N^r(k)$, the manufacturer's expected profit, as a function of k , when the retailer is induced to or not to forecast.
- ▶ Forecasting should be induced if and only if $\mathcal{M}_F^r(k) > \mathcal{M}_N^r(k)$.
- ▶ It can be verified that:
 - ▶ When $k = 0$, $\mathcal{M}_F^r(0) \geq \mathcal{M}_N^r(0)$: Inducing no forecasting is too costly when forecasting is free.
 - ▶ When k goes up, $\mathcal{M}_F^r(k)$ decreases (inducing forecasting becomes more costly) and $\mathcal{M}_N^r(k)$ increases (inducing no forecasting becomes easier).
- ▶ Therefore, there exists **a unique threshold** $k^r \geq 0$ such that

$$\mathcal{M}_F^r(k) > \mathcal{M}_N^r(k) \quad \Leftrightarrow \quad k < k^r.$$

- ▶ Induce forecasting if and only if the **forecasting cost is low**.

Impact of the forecasting cost

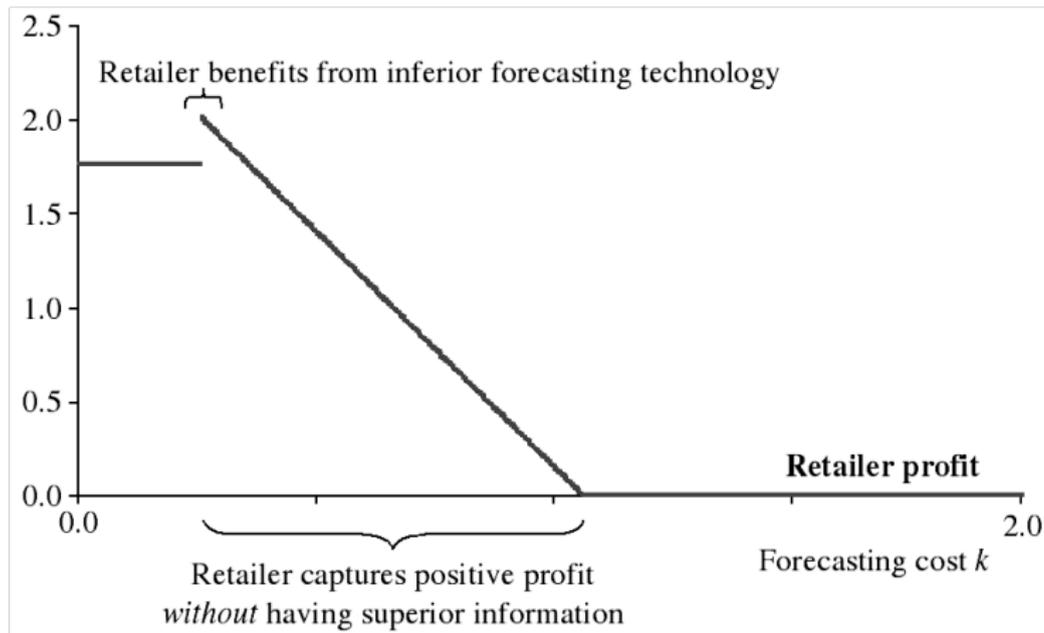
- ▶ The manufacturer may **prefer** a retailer with a **high** forecasting cost.



(Figure 1a in Taylor and Xiao (2009))

Impact of the forecasting cost

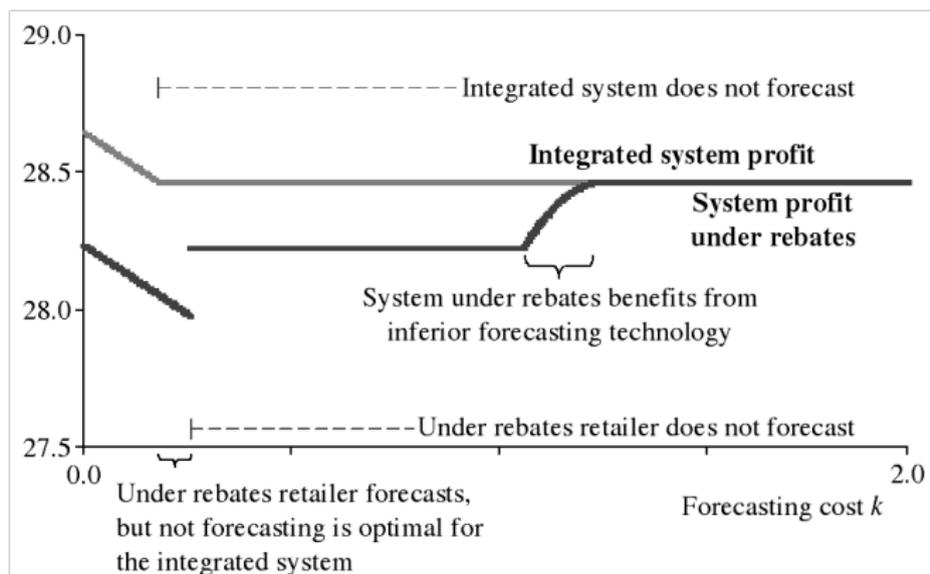
- ▶ The retailer may also **benefit** from a **high** forecasting cost.



(Figure 1b in Taylor and Xiao (2009))

Impact of the forecasting cost

- ▶ Rebates contracts **may not coordinate** the supply chain ($k^I \neq k^r$).
- ▶ The system may **benefit** from a **high** forecasting cost.



(Figure 1c in Taylor and Xiao (2009))

Summary for rebates contracts

- ▶ Manufacturers should not blindly seek out retailers with low forecasting cost.
 - ▶ It is easier for a better-forecasting retailer to get information advantage.
- ▶ Retailers should not blindly reduce the forecasting cost.
 - ▶ Especially if the reduction crosses the threshold k^r .
- ▶ In practice, a manufacturer may reduce a retailer's forecasting cost.
 - ▶ He should do that only when the retailer is already good at forecasting.
- ▶ Note that all these conclusions are made when the manufacturer is restricted to rebates contracts.
 - ▶ How about returns contracts?
 - ▶ How about optimal contracts?

Road map

- ▶ Introduction.
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Returns contracts

- ▶ Here we study the manufacturer's optimal strategy for offering **returns contracts**.
- ▶ He may still chooses to induce the retailer to or not to forecast.
- ▶ In all equilibria, the retailer will accept a contract. Let

$$R^b(S, C) := p\mathbb{E} \min(q_C, D_S) + b_C\mathbb{E} \max(q_C - D_S, 0) - t_C,$$

be the retailer's expected profit when she observes signal $S \in \{N, H, L\}$ and chooses contract (q_C, b_C, t_C) , $C \in \{N, H, L\}$.

No forecasting

- ▶ Suppose the manufacturer wants to drive the retailer not to forecast.
 - ▶ He will offer a single contract (q_N, b_N, t_N) .
- ▶ Among returns contracts that induce no forecasting, which is optimal?
- ▶ Inducing the retailer not to forecast is surprisingly simple. Just provide a **full insurance!**
 - ▶ A contract satisfying $(q, b, t) = (q, p, pq)$ is a **full-returns** contract.³
 - ▶ Under a full-returns contract, the retailer has **no incentive to forecast**.
- ▶ The retailer **earns nothing** under a full-return contract.
- ▶ If the manufacturer offers the efficient quantity q^I , the manufacturer's expected profit is maximized to the expected system profit.
- ▶ The optimal returns contract is (q_N^I, p, pq_N^I) .

³In Pasternack (1985), this is called a *full-credit* return contract.

Forecasting: formulation

- ▶ If the manufacturer wants to induce forecasting, he should offer a menu of two contracts $\{(q_H, b_H, t_H), (q_L, b_L, t_L)\}$.
- ▶ To optimally induce forecasting, the manufacturer solves

$$\begin{aligned}
 & \max_{\substack{(q_H, b_H, t_H) \\ (q_L, b_L, t_L)}} && \lambda \left[t_H - cq_H - b_H E \max\{q_H - D_H, 0\} \right] \\
 & && + (1 - \lambda) \left[t_L - cq_L - b_L E \max\{q_L - D_L, 0\} \right] \\
 \text{s.t.} && R^b(H, H) \geq R^b(H, L), \quad R^b(L, L) \geq R^b(L, H) \\
 && R^b(H, H) \geq 0, \quad R^b(L, L) \geq 0 \\
 && \lambda R^b(H, H) + (1 - \lambda) R^b(L, L) - k \geq R^b(N, H) \\
 && \lambda R^b(H, H) + (1 - \lambda) R^b(L, L) - k \geq R^b(N, L) \\
 && \lambda R^b(H, H) + (1 - \lambda) R^b(L, L) - k \geq 0
 \end{aligned}$$

Forecasting: solution

- ▶ The optimal returns contract inducing forecasting is

$$q_L^* = q_L^I$$

$$b_L^* = p$$

$$t_L^* = pq_L^I$$

$$q_H^* = \max\{q_H^I, \Gamma^{-1}(k)\}$$

$$b_H^* = 0$$

$$t_H^* = pE \min \left\{ \max\{q_H^I, \Gamma^{-1}(k)\}, D_H \right\} - k/\lambda$$

- ▶ The manufacturer should offer a **no-returns** (**full-returns**) contract for the optimistic (pessimistic) retailer.
- ▶ **Efficiency at bottom**, not at top!
- ▶ We need to prevent the retailer from doing no forecast but selecting (q_H^*, b_H^*, t_H^*) . Upwards distorting q_H is effective: A retailer select a high-quantity contract only if she is optimistic enough.

Forecasting: surplus extraction

- ▶ It can be shown that the retailer still **earns nothing** when the manufacturer wants to induce forecasting.
- ▶ Why?
- ▶ The retailer may earn rents because she can **mimic** the low type when she is actually of the high type.
 - ▶ However, the full-returns contract leaves the retailer no surplus **regardless of her type**.
 - ▶ The manufacturer thus does not need to worry about the mimicking.
 - ▶ The retailer **has no informational advantage** even though she has private information!

Inducing forecasting or not

- ▶ Again, there is a unique threshold that determines whether the manufacturer should induce the retailer to forecast.
- ▶ (Most) surprisingly, the threshold is **always** identical to k^I , the threshold for the integrated system!

Proposition 4 (Proposition 6 in Taylor and Xiao (2009))

By offering a returns contract, manufacturer should induce forecasting if and only if $k < k^I$.

- ▶ *If $k \geq k^I$, a single full-returns contract is offered.*
- ▶ *If $k < k^I$, a full-returns contract and a no-returns contract are offered.*

In either case, the manufacturer's expected profit is the integrated system expected profit.

Inducing forecasting or not: intuition

- ▶ Full-returns contracts are too powerful!
- ▶ The manufacturer adopts the following strategy:
 - ▶ Always offer a full-returns contract to extract all the surplus from a type- N or type- L retailer.
 - ▶ Then the type- H also **loses her informational advantage**.
 - ▶ All I need to worry about is to induce forecasting when I should.
 - ▶ Offering a risky no-return contract with a large quantity encourages the retailer to forecast.
- ▶ **Screening** is not a problem. Inducing **information acquisition** is.
- ▶ However:
 - ▶ The retailer's threat of forecasting is credible only if k is small.
 - ▶ But when k is small, the manufacturer prefers the retailer to forecast.
 - ▶ The threat is strong only when the manufacturer does not care about it.
- ▶ The key difference between rebates and returns is that **screening is a problem** when using rebates contracts.

Conclusions

- ▶ A supply chain in which the retailer may forecast or not is studied.
- ▶ Two types of contracts, rebates contracts and returns contracts, are analyzed and compared.
- ▶ From the manufacturer's perspective, returns contracts are better.
- ▶ In fact, returns contracts are optimal and coordinating.