The Effects of Customer Rebates and Retailer Incentives on Manufacturer Profitability and Sales

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Motivation

A Brief History of Incentives in Auto Industry

- Henry Ford promised rebates on Model Ts in 1912
- After the 1973 oil embargo, became more widespread
- American auto manufacturers: customer rebates, Japanese auto manufacturers: retailer incentives

To get the most benefit from promotions:

What kind of promotion?
Under which conditions?
Dealer Incentives and Cash Rebates in the Automotive Industry


Nov '01 change likely due to low financing promotions offered.

Customer Rebates as a Percentage of Vehicle Cost to Dealer

- American (Averages of 4 highest sales volume utility vehicles)
- Japanese (Averages of 3 highest sales volume utility vehicles)
Motivation: Dealer Incentives and Cash Rebates in the Automotive Industry

- Largely fixed production and labor costs
  - "The problem is that Detroit's costs are roughly the same whether a plant is churning out as many cars as it can or standing idle part of the time - so the Big Three [GM, Ford, Chrysler] produce more cars than their market share justifies, creating gluts that force them to offer large cash incentives to move the excess." Jakobson (2005)

Customer Rebate as a Percentage of Vehicle Cost to Dealer

Cross correlation=0.87
Motivation: Dealer Incentives and Cash Rebates in the Automotive Industry

- Largely fixed production and labor costs
  - “The problem is that Detroit's costs are roughly the same whether a plant is churning out as many cars as it can or standing idle part of the time - so the Big Three [GM, Ford, Chrysler] produce more cars than their market share justifies, creating gluts that force them to offer large cash incentives to move the excess.” Jakobson (2005)
- Competition. Every manufacturer offers some kind of incentive
  - “Ford's new rebate program could cause some manufacturers to increase their incentives programs on select models in response to Ford's actions,” Joseph Amaturo, analyst, Calyon Securities.
  - Incentives are becoming so ingrained that they're really counted into the price of the car to begin with.” Mark McCready, director, CarsDirect.com.

Relevant Work

- Gerstner, Hess, and Holthausen (1994)
  - Customer rebates
  - High and low customer segments, competing retailers
- Kim and Staelin (1999)
  - Manufacturer allowances (retailer incentives), pass-through rates
- Busse, Silva-Risso, and Zettelmeyer (1999)
  - Information asymmetries involved in incentives and rebates, pass-through rates
- Bruce, Desai, and Staelin (2005, 2006)
  - Promotions of durable goods manufacturers
Our Work

- Promotions analyzed:
  - Customer rebate: per unit payment to the end customer
  - Retailer incentive: lump sum payment to the retailer

- Settings: No Competition (Monopoly) and Competition in Automobile Industry with price-discriminating retailers

  - No Competition: (Baysar, C-Demirag, Keskinocak, and Swann (2006))
    - Which promotion is more effective (higher sales and revenues) for the manufacturer under which market conditions?
    - How is the dealer’s ordering decision affected by the manufacturer’s promotions?

  - Competition: (C-Demirag, Keskinocak, and Swann (2006))
    - What are the manufacturers’ wholesale price and promotion decisions when
      - manufacturers offer only customer rebates?
      - manufacturers offer only retailer incentives?
      - manufacturers offer different promotions?

Knowing the Unknowable

- Things we know
  - Differences among manufacturers
  - Dealers know more

- Things we don’t know
  - Causality
  - Customer behavior

- Things that Matter
  - Price discrimination with dealer margins
  - Decentralized systems
Model Characteristics

- 2-stage supply chain
- Manufacturers and retailers are risk neutral and maximize their own profits
- First-degree price discrimination by the dealers
  - Dealers price discriminate through car model, market-specific properties, and the type of purchase transaction such as first-time purchase and trade-in, Goldberg (1996).
- Constant wholesale price by the manufacturers
  - “…manufacturers rarely vary published retail and invoice prices of a particular model over the course of the model year.” Busse et al. (2006)
  - “…manufacturers hold wholesale prices constant even when capacity is scarce.” Cachon and Lariviere (1999)
- Stackelberg Game: Manufacturer leader, retailer follower
- (Competition) Cournot Game: Manufacturers move simultaneously followed by simultaneous move by dealers
- Backward Induction to find sub-game perfect Nash equilibrium

Demand Characteristics

\[ P(Q) = a - bQ \]

- \( a \): market potential
- \( b \): price sensitivity
- \( m \): fixed margin
- \( w \): wholesale price
- \( c \): production cost
No Competition: Order of Decisions

Manufacturer learns demand state

- Manufacturer
- Dealer
- End Customers

- Wholesale price, \( w \)
- Incentive \( (K^h, K^l) \), Rebate \( (R^h, R^l) \) or none
- Order (sales) quantity, \( (Q^h, Q^l) \)

No Competition: Promotion Effects

- Total amount of rebate given to the customers \((ABCD)\)
- Amount of lump sum incentive used by the retailer to increase demand \((EFG)\)
Analysis:

1) **Deterministic Demand**
2) Uncertainty in Market Potential
3) Competition
   - For each model we analyze three cases:
     a) No promotion
     b) Retailer Incentive
     c) Customer Rebate
3) Data Analysis

Model 1: Deterministic
Model 1: Deterministic

Model 1a) Deterministic-No Promotion

- Sequence of decisions:
  - Manufacturer determines wholesale price
  - Retailer determines the order quantity

- Retailer’s Problem:
  \[
  \Pi^R = \max_{Q} \int_0^Q (a - bQ)\,dQ - cQ \\
  \text{s.t.} \quad 0 \leq Q \leq \frac{a - w - m}{b},
  \]
  \[
  Q^* = \max\{0, \frac{a - w - m}{b}\} = \left(\frac{a - w - m}{b}\right)^+
  \]

- Manufacturer’s Problem:
  \[
  \Pi^M = \max_{w} \left( w - c\right)\left(\frac{a - w - m}{b}\right) \\
  \text{s.t.} \quad c \leq w \leq a - m.
  \]

Equilibrium Solution

| \[w^*\] | \[\frac{a + m - c}{2}\] |
| \[Q^*\] | \[\frac{a - m - c}{2b}\] |
| \[\Pi^M\] | \[\frac{1}{b}\left(\frac{a - m - c}{2}\right)^2\] |
Model 1b) Deterministic-Retailer Incentive

- Retailer’s Problem:

\[ \Pi^R = \max_Q \int_0^Q (a-bQ)dQ - wQ + K \]
\[ \text{s.t. } \int_{a-bQ}^Q ((w+m) - (a-bQ))dQ \leq K \]
\[ 0 \leq Q \leq \frac{a}{b} \]

\[ \Pi^M = \max_{K \geq 0, w \geq 0} (w-e)(\min\left\{ \frac{a-w}{b}, \frac{a-w-m+\sqrt{2Kb}}{b} \right\}^+ - K \]

\[ Q^* = \max\{0, \min\left\{ \frac{a-w}{b}, \frac{a-w-m+\sqrt{2Kb}}{b} \right\}\} \]

\[ \Pi^M = \max_{K \geq 0, w \geq 0} (w-e)(\min\left\{ \frac{a-w}{b}, \frac{a-w-m+\sqrt{2Kb}}{b} \right\}^+ - K \]

(A specific K* can then result in different Q* values)
Model 1b Deterministic-Retailer Incentive

Each of the tree’s endpoints are associated with K and Q decisions and with profit outcomes.

Model 1b Deterministic-Retailer Incentive

All Feasible Solutions for Deterministic Demand Model with Retailer Incentive

<table>
<thead>
<tr>
<th></th>
<th>K.1.a.1</th>
<th>K.1.b.2</th>
<th>K.1.a.1</th>
<th>K.1.b.2</th>
<th>K.2</th>
<th>K.3.a</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.R.</td>
<td>(\alpha \geq 2m + c)</td>
<td>(\alpha \geq m + c)</td>
<td>(\alpha \leq 2m + c)</td>
<td>(\alpha \geq 2m + c)</td>
<td>(\alpha \leq 2m + c)</td>
<td>(\alpha \geq m + c)</td>
</tr>
<tr>
<td>(u^*)</td>
<td>(\frac{a + \alpha}{\beta})</td>
<td>(\frac{\alpha - \alpha - \epsilon}{\beta})</td>
<td>(\frac{\alpha - \alpha - \epsilon}{\beta})</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(Q^*)</td>
<td>(\frac{\alpha^2}{3\beta^2})</td>
<td>(\frac{\beta - \beta - \epsilon}{\beta})</td>
<td>(\frac{\beta - \beta - \epsilon}{\beta})</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(K^*)</td>
<td>(\frac{\alpha^2}{2})</td>
<td>(\frac{\alpha - \alpha - \epsilon}{2\beta})</td>
<td>(\frac{\alpha - \alpha - \epsilon}{2\beta})</td>
<td>0</td>
<td>(\frac{\alpha}{2\beta})</td>
<td>0</td>
</tr>
<tr>
<td>(\Pi^m)</td>
<td>(\frac{\alpha^2 - 2m^2}{4\beta})</td>
<td>(\frac{\alpha^2 - 2m^2}{2\beta})</td>
<td>(\frac{\alpha^2 - 2m^2}{2\beta})</td>
<td>0</td>
<td>0</td>
<td>(\frac{\alpha}{2\beta})</td>
</tr>
</tbody>
</table>

The bottom row shows the dominating solution (based on profit functions and the feasible region where that solution occurs).
Model 1b) Deterministic-Retailer Incentive

- **Retailer’s Problem:**
  \[ \Pi^R = \max_Q \int_0^Q (a - bQ)dQ - wQ + K \]
  s.t. \[ \int_0^Q ((w + m) - (a - bQ))dQ \leq K \]
  \[ 0 \leq Q \leq \frac{a}{b} \]
  maximize profit
  satisfy margin
  nonnegative price

- **Manufacturer’s Problem:**
  \[ \Pi^M = \max_{K \geq 0, w \geq 0} (w - c)(\min \left\{ \frac{a - w}{b}, \frac{a - w - m + \sqrt{2Kb}}{b} \right\})^+ - K \]
  maximize profit

**Equilibrium Solutions**

| \( w^* \) | \( a - m \) | \( \frac{a + e}{2} \) |
| \( Q^* \) | \( \frac{a - m - e}{b} \) | \( \frac{a - e}{b} \) |
| \( K^* \) | \( \frac{a - m - e}{2b} \) | \( \frac{a}{2b} \) |
| \( \Pi^M \) | \( \frac{a - m - e}{2b} \) | \( \frac{a - e^2 - 2m}{18} \) |

Incentive \( K^* \) is never “pocketed” by retailer

Model 1c) Deterministic-Customer Rebate

- **Demand Function:**
  \[ P(Q) = \alpha + R - bQ. \]

- **Retailer’s Optimal Solution:**
  \[ Q^* = \left( \frac{a + R - w - m}{b} \right)^+ \]

- **Manufacturer’s Problem:**
  \[ \Pi^M = \max_{R, w} (w - c - R) \left( \frac{a + R - w - m}{b} \right) \]
  s.t. \( c \leq w \) \( R \leq m \) \( a \)

**Equilibrium Solution:**

| \( w^* - R^* \) | \( \frac{a + e - m}{2} \) |
| \( Q^* \) | \( \frac{a - m - e}{2b} \) |
| \( \Pi^M \) | \( \frac{1}{2} \left( \frac{a - m - e}{2} \right)^2 \) |
Model 1 (Deterministic Demand): Comparison of Promotions

- Offering customer rebate is identical to offering no promotion in terms of total sales and manufacturer profits.

- Manufacturer is always better off in terms of total sales and profits when she offers retailer incentive promotion.

**Question:** Why do manufacturers give customer rebates?

Analysis:

1) Deterministic Demand
2) **Uncertainty in Market Potential**
3) Competition
   - For each model we analyze three cases:
     a) No promotion
     b) Retailer Incentive
     c) Customer Rebate
3) Data Analysis
Model 2: Uncertainty in Market Potential

- Retailer’s problem: same problem as in deterministic case solved for both high and low demand states
- Manufacturer’s problem:
  - same problems as in deterministic case for determining $R$ and $K$ (high and low)
  - for determination of $w$, profit of the manufacturer:
    $$\Pi^M = \beta\Pi^{M_h} + (1 - \beta)\Pi^{M_l}$$

Model 2a) Uncertainty in Market Potential-No Promotion

- The solution is such that the manufacturer switches to a different decision based on a threshold (defined as $\beta^*$ here). The decision is either driven by expected demand or high demand.
Model 2b) Retailer Incentive

Several equilibrium solutions are found depending on the system parameters. Different $\beta$ threshold values exist.

$w = \frac{a + c}{2}$

$w$ depends on expectation

$w = \frac{a}{2} + \frac{c}{2}$

As $(a^h - a^l) \uparrow \beta^*$

Model 2c) Uncertainty in Market Potential-Customer Rebate

Equilibrium Solution

$w^* = R^*$

$\frac{a^j + c - m}{2}; j = l, h$

$Q_j^*$

$\frac{a^j - m - c}{2b}; j = l, h$

$\Pi^M$

$\frac{b(a^h - m - c)^2 + (1 - \beta)(a^l - m - c)^2}{2b}$

Same as determining wholesale price after demand is realized.
Model 2: Uncertainty in Market Potential - Comparison of Promotions

✓ Manufacturer is always better off in terms of total sales and profits when she offers retailer incentive or customer rebate rather than offering no promotion.

✓ The dominance between the retailer incentive and customer rebate promotions depends on system parameters.

Model 2: Retailer Incentive vs. Customer Rebate

✓ When $(\alpha^h - \alpha^l)$ is small, uncertainty is small, behaves as if in the deterministic case
✓ When $(\alpha^h - \alpha^l)$ is larger
  ✓ $\beta$ small or large, deterministic case decision
  ✓ for some $\beta$ range in the middle, uncertainty is max., rebate is better because rebate can adjust the wholesale price
Combined Promotions (Retailer Incentive and Customer Rebate):

- Model 1 (Deterministic), Model 3 (Uncertain b): The manufacturer is indifferent between offering combined promotions and offering only retailer incentive.

- Model 2 (Uncertain a): The manufacturer is better off if she offers both promotions at the same time rather than offering any of them individually.

Model 2: Combined Promotions vs. Individual

- As \((a^h - a^l)\) increases the benefit from combined promotions decreases
- (The benefit from combined promotions decreases as \((a^h - a^l)\) increases
Model 4: Rebate Dependent Demand

✓ Manufacturer selects $\alpha$ and $R$ to increase demand intercept $(1+\alpha)a + R$, which has a cost of $e\alpha^2$
✓ Customer rebate is more profitable and generates more sales than retailer incentive when $e \cdot e^*$

Analysis:

1) Deterministic Demand
2) Uncertainty in Market Potential
3) **Competition**
   - For each model we analyze three cases:
     a) No promotion
     b) Retailer Incentive
     c) Customer Rebate
3) Data Analysis
Model Setting

- No Competition

- Competition

Demand Characteristics

\[ P(Q) = a - bQ \]

\[ P_1(Q_1, Q_2) \]

- Monopoly
- Competition

\[ m : \text{fixed margin} \]
\[ w : \text{wholesale price} \]
\[ c : \text{production cost} \]
Competition: No Promotion

- Manufacturers’ problems:
  \[ \pi^M_i = \max_{w_i, c_i} (w_i - c_i)Q_i, \; i = 1, 2 \]
  
  **Maximize profit**

- Dealers’ problems:
  \[ \pi^D = \max_{Q_2 \geq 0} \int_0^{Q_1} (a - (b_{1o} + b_{1c})Q_1)dQ_1 - \pi_1 \]
  
  **Maximize profit**

\[ s.t. \]
\[ Q_1 \leq \frac{\pi_1 - \pi_2}{b_{1o} + b_{1c}} \]
\[ Q_1 \leq Q_2 \]

\[ \pi^D = \max_{Q_2 \geq 0} \int_0^{Q_1} (a - (b_{2o} + b_{2c})Q_2)dQ_2 + \int_0^{Q_2} (a - (b_{2o}Q_2 - b_{2c}Q_1))dQ_2 - \pi_2 \]

\[ s.t. \]
\[ Q_2 \leq \frac{\pi_1 - \pi_2}{b_{2o}} \]
\[ Q_2 \geq Q_1 \]

Unique equilibrium exists when manufacturers are significantly different.

No Promotion: Observations

- Two SPNE: SPNE 1: \( Q_1^* \leq Q_2^* \)
  SPNE 2: \( Q_1^* \geq Q_2^* \)

- Unique equilibrium exists when manufacturers are “significantly” different.
Competition: Retailer Incentives

- Dealers’ problems

\[ \pi_{D_1} = \max \int_0^{Q_{K_1}^K} (a - (b_{1o} + b_{1e})Q_{K_1}^K) dQ_{K_1}^K - w_1Q_1 + K_1 \]

s.t.
\[ \int_0^{Q_{K_1}^K} (w_1 + m_1 - (a - (b_{1o} + b_{1e})Q_{K_1}^K)) dQ_{K_1}^K \leq K_1 \]

Incentives' effect on sales

Similar problem for Dealer 2

- Manufacturers’ problems

\[ \pi_{M_i} = \max_{w_i \geq c_i, K_i \geq 0} (w_i - c_i)Q_{i}^K - K_i, \quad i = 1, 2 \]

Maximize profit

Retailer Incentives: Observations

- Incentives offered by Manufacturer 2 reduces sales of Manufacturer 1

- Incentives’ effect on sales smaller when the competitor is also offering an incentive

- Pocketing by Dealer 1 for K1>6 reduces Manufacturer 1 profits

\[ a = 60, b_{1o} = 3, b_{1e} = 2, b_{2o} = 2.5, b_{2e} = 1, \]
\[ c_1 = 12, c_2 = 10, m_1 = 6, m_2 = 8 \]
\[ e_1 = 20, e_2 = 35 \]
Observations: Retailer Incentives

- A: (Unique) Equilibrium with no-promotion
- B: (Unique) Equilibrium with retailer incentives
- Dealers can be worse off with incentives than no-promotion when market potential is high.
- Retailer incentives usually increase manufacturers’ profits.

\[
\begin{align*}
\Pi^D_1 & = 37.3 \\
\Pi^D_2 & = 33.3 \\
\Pi^M_1 & = 41.6 \\
\Pi^M_2 & = 52.8
\end{align*}
\]

\[
\begin{align*}
\text{a) } a = 25 & \\
\text{b) } a = 75
\end{align*}
\]

\[
b_{1a} = 3, b_{1c} = 2, b_{2a} = 1.5, b_{2c} = 1, \\
c_1 = 8, c_2 = 5, m_1 = 5, m_2 = 3
\]

Competition: Customer Rebates

- Demand

\[
P_1(Q_1, Q_2, R_1, R_2) = \begin{cases} 
(a + R_1 - \delta_2 R_2) - (b_{1o} + b_{1c})Q_1 & \text{if } Q_1 \leq Q_2 \\
(a + R_1 - \delta_2 R_2) - b_{1o}Q_1 - b_{1c}Q_2 & \text{otherwise.}
\end{cases}
\]

- Manufacturers’ problems

\[
\Pi^M_i = \max_{w_i, R_i} (w_i - R_i - c_i)Q_i, \ i = 1, 2
\]
Customer Rebates: Observations

Continuum of SPNE:

- Competitor’s profit is driven to zero

Summary of Observations

- No promotion
  - Unique equilibrium exists when manufacturers “significantly” differ in their business characteristics (retailer’s margin, cost and price sensitivities)

- Retailer incentives
  - Incentives offered by the competitor reduces the market leader’s sales and profits
  - Incentives can reduce the retailers’ profits when market potential is high because of manufacturers’ high wholesale prices
  - Incentives usually increase the manufacturers’ sales and profits

- Customer rebates are effective (can drive the competitor’s profits to zero)