Efficiency and Foreclosure Effects of Vertical Rebates: Empirical Evidence

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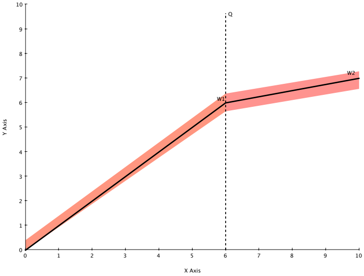
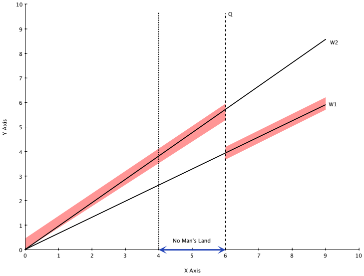
Vertical Rebates: All-Units Discounts

Vertical Rebates (All-Units Discounts) apply a linear discount retroactively to previous sales:



Standard Non-linear Pricing



All-Units Discounts

Efficiency vs. Foreclosure

At issue are the contracts' potential efficiency and foreclosure effects.

Efficiency effects include:

- Aligning incentives of upstream and downstream firms
- Incentivizing costly effort by downstream firms
- Eliminating double marginalization or downstream moral hazard.

Foreclosure effects include:

- Reducing competition from other manufacturers
- Reducing retail shelf-space or service levels on competitor's products
- Substituting brands that compete closely with brands that don't.
- Carrying underperforming brands by a rebating manufacturer.

Use of Vertical Rebates

- Used prominently in many vertically-separated industries
- A wide range of different settings:
  - Used by dominant/competitive upstream firm?
  - Does it reference rivals?
  - Are multiple products covered? (If so, facing requirements?)
  - Is there downstream price competition?
- A few recent anti-trust cases:
  - *LePages v. 3M (2004)*: rebates on branded and private-label tape products found to be exclusionary.
  - *Cascade Health Solutions v. PeaceHealth (2008)* and *Eisai v. Sanofi-Aventis (2014)*: hospital care/pharmaceutical rebates alleged to be exclusionary, allowed (price-cost test)
  - *Intel (2009)*: Marketshare-based rebates, found by the European Comission to be anticompetitive. ($1.4 billion fine.)
  - *Meritor v. Eaton (2012)*: rebates in heavy-duty truck transmission, found in violation of Sherman, Clayton Acts.

Challenges

- Tension between efficiency and foreclosure effects requires empirical analysis in order to resolve the relative contributions of a contract
  - But, vertical contracts are considered proprietary by firms, frustrating many empirical studies
  - And, measuring downstream effort can be difficult
- Our Approach:
  - Examine an AUD contract using detailed data from one retailer
  - Conduct a field experiment in product stocking to identify: substitution patterns, and the relative cost of downstream moral hazard for upstream firms.
  - Estimate models of demand and retailer re-stocking to identify impacts of retailer decisions, and effects of AUD.

A Partial Literature Review

Theoretical Views on Vertical Contracts: Efficiency vs. Foreclosure

- Chicago Critique: Bork (1978), Posner (1976)
- Game-theoretic response: Aghion & Bolton (1987), Bernheim & Whinston (1998), Fumagalli & Motta (2006)
- Efficiency effects: Telser (1960), Klein & Murphy (1988), Deneckere, Marvel & Peck (1996, 1997)
- Anti-competitive effects and exclusion: Shaffer (1991a/b), Rasmusen, Ramseyer & Wiley (1991), Segal & Whinston (2000), Inderst & Shaffer (2010), Asker & Bar-Isaac (2014)
- All-Units Discounts: Kolay, Shaffer, & Ordover (2004), O'Brien (2013), Chao & Tan (2013)

Empirical Work: Downstream Effort/Moral Hazard, Exclusive Contracts

- Vertical Integration: Lafontaine (1992), Baker and Hubbard (2003), Crawford, Lee, Whinston and Yurukoglu (2015)
- Exclusive contracts: Lee (2013), Sinkinson (2014)

The Application and Research Question

Vending Industry:

- $41 billion, vertically-separated industry
- Many small independent downstream operators
- No within-product (category) price variation
- Focus on confections (vending is about $1/3$ of sales in US).
- Concentrated upstream market (Mars, Hershey, Nestle).
- The largest firm, Mars, Inc., offers an AUD.
- Contracts that have never been litigated!

Research Question:

- What are the efficiency and foreclosure effects of an All-Units Discount used by Mars, Inc. in the confections industry?

Main Findings

- Mars' AUD affects retailer assortment choice:
  - Favors Mars' products over Hershey's, foreclosing Hershey.
  - Consumers prefer 'all Mars' to 'all Hershey' assortment.
  - But consumers' most-preferred assortment is a Mars/Hershey mix, which is not supported by the AUD.
- Mars' AUD also leads to increased retailer effort:
  - Better service for Mars and consumers (faster re-stocking).
  - Hershey and Nestle lose (Mars products don't stock-out).
  - But efficiency effect alone cannot justify the contract.
- Observed contracts are close to optimal (given wholesale p)
- Upstream mergers may mitigate foreclosure incentives, but may also reduce retailer profit.

Theory: Foreclosure

Start with the following (simple) setup:

- A retailer R has two remaining places on the shelf.
- Two manufacturers are selling products: a "dominant" firm M and a rival H.
- Retailer can choose three assortments: $a \in \{(H,H),(H,M),(M,M)\}$.
- Retail prices are fixed, so that a is only choice.
- Can order the profits for each agent:

$$\begin{aligned} \text{Retailer: } \pi^R(H,H) > \quad & \pi^R(H,M) & > \pi^R(M,M) \\ \text{Rival, H: } \pi^H(H,H) > \quad & \pi^H(H,M) & > \pi^H(M,M) \\ \text{Dominant, M: } \pi^M(H,H) < \quad & \pi^M(H,M) & < \pi^M(M,M) \end{aligned}$$

- This closely parallels our empirical exercise.

Conditions for Full Foreclosure

First, temporarily ignore (H, M)

- Suppose M offers R a transfer T conditioned on foreclosing H
- Define $\Delta\pi^*$ as $\pi^*(M, M) - \pi^*(H, H)$ for agent *
  $\Delta\pi^R = \pi^R(M, M) - \pi^R(H, H)$, etc.
- Three Equilibrium Conditions for Full Foreclosure:

(A1) $\Delta\pi^R + T \geq 0$
Incentive Compatible: T induces R to switch (H,M)

(A2) $\Delta\pi^M - T \geq 0$
Individually Rational: M wants to offer T

(A3) $\Delta\pi^M + \Delta\pi^R + \Delta\pi^H \geq 0$
Efficiency: Foreclosure improves industry profits.
Or, $-\Delta\pi^H \leq \Delta\pi^M + \Delta\pi^R$ "Rival can't outbid."

Conditions for Partial Foreclosure

Next, temporarily ignore (M, M)

- Define $\Delta_H \pi^*$ as $\pi^*(H, M) - \pi^*(H, H)$ for agent *
- Consider paying transfer T_H to switch from (H, H) to (H, M)
- Three Equilibrium Conditions for Partial Foreclosure

(B1) $\Delta_H \pi^R + T_H \geq 0$

(B2) $\Delta_H \pi^M - T_H \geq 0$

(B3) $-\Delta_H \pi^H \leq \Delta_H \pi^M + \Delta_H \pi^R$

Moving from Partial to Full Foreclosure

Temporarily Ignore (H, H)

- Define $\Delta_M \pi^*$ as $\pi^*(M, M) - \pi^*(H, M)$ for agent *
- Consider paying transfer T_M to switch from (H, M) to (M, M)
- Three Conditions:

$$\text{(C1)} \quad \Delta_M \pi^R + T_M \geq 0$$
$$\text{(C2)} \quad \Delta_M \pi^M - T_M \geq 0$$

Either:

$$\text{(C3)} \quad -\Delta_M \pi^H \leq \Delta_M \pi^M + \Delta_M \pi^R$$

Rival can't outbid.

Or:

$$\text{(C4)} \quad -\Delta_M \pi^H > \Delta_M \pi^M + \Delta_M \pi^R \geq 0$$

Rival can outbid.

- C3 and C4 are mutually exclusive.

Equilibrium Foreclosure

Suppose that (A1)-(C3) hold.

- M pays R transfer T to switch from $(H, H) \to (M, M)$.
- (M, M) is the equilibrium outcome
- By (A3) and (C3), it maximizes industry profits.
- Foreclosure happens, but it improves welfare.

Equilibrium Foreclosure

Suppose that (A1)-(C3) hold.

- M pays R transfer T to switch from $(H, H) \to (M, M)$.
- (M, M) is the equilibrium outcome
- By (A3) and (C3), it maximizes industry profits.
- Foreclosure happens, but it improves welfare.

Suppose that (A1-C2)+(C4) holds instead.

- Transfer T is still IC and IR for R and M.
- But losses to H exceed bilateral gains to R and M
- Either (H, M) or (M, M) is the equilibrium outcome.
- $\Delta_M \pi^M + \Delta_M \pi^R \geq 0$:
  (M, M) maximizes bilateral surplus to R and M.
- $-\Delta_M \pi^H > \Delta_M \pi^M + \Delta_M \pi^R$:
  (H, M) maximizes industry surplus.

Chicago Critique

If M can condition the transfer T on achieving (M, M), then (M, M) is the equilibrium outcome.

- Full foreclosure of H is not socially optimal.
- But it happens anyway.
- Partial foreclosure *is* optimal.
- By conditioning T on the (M, M) outcome, M effectively ties the products.

Theory: All Units Discounts

Introduce an All Units Discount

- If: R sells at least $\overline{q}_m$ units of M's products
- Then: R receives a discount d on all units.
- For constant marginal cost c_M and linear wholesale price w_M, the discount is a fraction of M's profit:

$$d \cdot q_M = \underbrace{\left(\frac{d}{w_M - c_M}\right)}_{\lambda} \cdot \pi^M$$

Payoffs governing the retailer's choice of product assortment in terms of M's profits are:

$$\begin{cases} \pi^R(a) + d \cdot q_M(a) & \text{if } q_M(a) \geq \overline{q_M} \\ \pi^R(a) & \text{if } q_M(a) < \overline{q_M} \end{cases} = \begin{cases} \pi^R(a) + \lambda \cdot \pi^M(a) & \text{if } \pi^M(a) \geq \overline{\pi^M} \\ \pi^R(a) & \text{if } \pi^M(a) < \overline{\pi^M} \end{cases}$$

Theory: All Units Discount Rebates

Result:

- AUD can be used to foreclose a rival (whether or not it maximizes industry profits).
- M just needs to choose threshold $\overline{\pi}^M$ appropriately: $\pi^M(H,H) < \pi^M(H,M) < \pi^M(M,M)$

$$\begin{cases} \pi^R(a) + \lambda \cdot \pi^M(a) & \text{if } \pi^M(a) \geq \overline{\pi^M} \\ \pi^R(a) & \text{if } \pi^M(a) < \overline{\pi^M} \end{cases}$$

Theory: Efficiency

- AUD contract also has potential efficiency benefits
- Suppose R must exert costly effort $c(e)$ to sell the good.
  - service, test-drives, lower retail price, restocking
- Temporarily hold fixed the assortment choice a

$$\begin{cases} \pi^R(e) - c(e) + \lambda \cdot \pi^M(e) & \text{if } \pi^M(e) \geq \overline{\pi^M} \\ \pi^R(e) - c(e) & \text{if } \pi^M(e) < \overline{\pi^M} \end{cases}$$

- Effort can be increased via both features of the contract:
  - a larger per unit discount increases λ and makes R consider the profits of M
  - $\pi^M(e)$ is increasing in effort, a larger choice of threshold $\overline{\pi^M}$ can be used to increase the retailer's effort.
- We quantify both channels in our application.

Theory: Solving For Effort

$$\begin{cases} \pi^R(e) - c(e) + \lambda \cdot \pi^M(e) & \text{if } \pi^M(e) \geq \overline{\pi^M} \\ \pi^R(e) - c(e) & \text{if } \pi^M(e) < \overline{\pi^M} \end{cases}$$

Retailer choice of effort has three potential solutions:

1. Interior Solution to bottom eq. (no rebate): e^{NR}
2. Interior Solution to top eq. (with rebate): e^R
3. Constraint binds (with rebate): e: $\pi^M(e) = \overline{\pi}^M$

We calculate these in our empirical exercise.

Theory: Solving For Effort

- We can characterize other solutions to the effort problem:
  - e^{VI} maximizes bilateral surplus between R and M
  - e^{SOC} maximizes social surplus (including consumers).

$$
\begin{aligned}
e^{NR} &= \arg\max_{e} \pi^{R}(e) - c(e) \\
e^{R} &= \arg\max_{e} \pi^{R}(e) - c(e) + \lambda \cdot \pi^{M}(e) \\
e^{VI} &= \arg\max_{e} \pi^{R}(e) - c(e) + \pi^{M}(e) \\
e^{IND} &= \arg\max_{e} \pi^{R}(e) - c(e) + \pi^{M}(e) + \pi^{H}(e) \\
e^{SOC} &= \arg\max_{e} \pi^{R}(e) - c(e) + \pi^{M}(e) + \pi^{H}(e) + \pi^{C}(e)
\end{aligned}
$$

Theory: Putting it together

- Retailer observes rebate λ, threshold $\overline{\pi}^M$ and chooses (a, e).
- No uncertainty about payoffs.

$$\max_{a,e} \begin{cases} \pi^R(a,e) - c(e) + \lambda \cdot \pi^M(a,e) & \text{if } \pi^M(a,e) \geq \overline{\pi^M} \\ \pi^R(a,e) - c(e) & \text{if } \pi^M(a,e) < \overline{\pi^M} \end{cases}$$

Questions:

- How does M choose $(\lambda, \overline{\pi}^M)$?
- Is H foreclosed? Does foreclosure maximize industry profits? Could H give up all profit to avoid foreclosure?
- Are gains to effort sufficient to overcome potential losses from foreclosure?

Data

Detailed data from Mark Vend

- A mid-sized vending operator in the Chicago area
- Retail and wholesale prices, quantities, rebate payments.
- Enterprise-wide data, over a 38-month period:
  January 2006 - February 2009.

Prices

- At Mark Vend, retail prices are fixed at the category level.
- All confections are sold for 75 cents.
- We observe wholesale prices paid and terms of Mark Vend's AUD rebate program. We cannot disclose those directly.
- Other manufacturers do not offer rebates (or 'rebate' without a quantity threshold).
- Mars leaked a copy of very similar rebate terms in 2010.

Mars Rebate Program

Mars Rebate Program

2010 Vend Operator Program

Platinum Rebate Level

- Receive a great Every Day Low Cost from your Authorized Vend Product Distributor
- Purchase brand level targets for 6 singles or king size items
  - Reduction from 7 must-stock items in 2009!
  - You pick the six items!
  - Will consolidate item variants to qualify (by brand, excluding SNICKERS ® Bar and M&M's ® Peanut Candies)
- No Growth Requirement
- PLUS a Rebate Payment

Low Cost PLUS Rebate:

Item	Rebate %	Rebate $ Per Bar (singles)
All Items	8%	4.0¢

MARS chocolate north america

Mark Vend's Assortment

Comparison of National Availability and Shares with Mark Vend

Manu-facturer	Product	National: Rank	National: Avail-ability	National: Share	Mark Vend: Avail-ability	Mark Vend: Share
Mars	Snickers	1	89	12.0	96	22.0
Mars	Peanut M&M	2	88	10.7	96	23.0
Mars	Twix Bar	3	67	7.7	79	13.0
Hershey	Reeses Peanut Butter Cups	4	72	5.5	29	3.7
Mars	Three Musketeers	5	57	4.3	34	4.3
Mars	Plain M&M	6	65	4.2	47	6.4
Mars	Starburst	7	38	3.9	16	1.0
Mars	Skittles	8	43	3.9	77	6.5
Nestle	Butterfinger	9	52	3.2	33	2.7
Hershey	Hershey with Almond	10	39	3.0	0	0
Nestle	Raisinets	>45	N/R	N/R	78	8.9

Notes: National Rank, Availability and Share refers to total US sales for the 12 weeks ending May 14, 2000, reported by Management Science Associates, Inc., at http://www.allaboutvending.com/studies/study2.htm, accessed on June 18, 2014. National figures not reported for Raisinets because they are outside of the 45 top-ranked products. By manufacturer, the national shares of the top 45 products (from the same source) are: Mars 52.0%, and Hershey 20.5%. For Mark Vend, shares are: Mars 80.0%, Hershey 8.5% (calculations by authors). Mark Vend averages 6.86 confection facings per machine.

Response to Threshold: Assortment

Quarter	Index %	Total Vends	Mars Share	Mars	Hershey	Nestle
5	109.16	1,000.00	20.20	6.61	1.13	1.58
6	106.29	1,087.45	19.77	6.24	1.44	1.17
7	100.81	1,008.57	20.94	6.21	1.63	1.08
8	105.23	1,092.49	19.97	6.26	1.73	1.03
9	106.27	1,103.42	19.45	5.98	2.08	0.97
10	97.20	1,057.32	19.77	5.57	2.29	0.93
11	91.88	1,014.13	19.14	5.37	2.29	0.91
12	87.02	1,048.26	18.11	5.48	2.19	0.89
13	87.03	1,058.54	17.65	5.32	1.99	0.83

Right three columns report facings per machine by manufacturer.

Assortment Detail: Facings Per Machine

	Mars products:		Hershey products:	
Quarter	Milkyway	3 Musketeer	Reese's PB	Payday
1	0.26	0.50	0.19	0.08
2	0.26	0.49	0.15	0.03
3	0.29	0.56	0.03	0.01
4	0.31	0.55	0.01	0.04
5	0.32	0.56	0.00	0.08
6	0.31	0.53	0.00	0.18
7	0.29	0.54	0.01	0.21
8	0.30	0.51	0.15	0.20
9	0.38	0.29	0.51	0.19
10	0.43	0.03	0.66	0.21
11	0.41	0.00	0.63	0.23
12	0.40	0.01	0.62	0.24
13	0.37	0.01	0.62	0.23

Response to Threshold: Effort

Table: Effort Response to Changes in the Threshold

	Vends Per Visit	Elapsed Days Per Visit
Lower Threshold	8.262***	0.857***
	(0.410)	(0.0690)
Observations	117,428	117,428
R-squared	0.361	0.154
Machine FE	YES	YES
Week of Year FE	YES	YES

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Exogenous Product Removals

In addition to the detailed data on p, q, and rebate payments, Mark Vend ran a field experiment for us:

- Exogenously remove Snickers, Peanut M&Ms, or both.
- Simulates impact of re-stocking effort; identifies substitution.

Experimental Setting:

- 66 snack machines in office buildings in downtown Chicago
- For each run, remove product(s) for 2.5-3 weeks from all machines at each site.
- Interventions run during May - October, 2007 and 2008.
- For details, see our other papers.

Profit/Revenue Impacts of the Product Removals

Downstream Profit

		Before Rebate			After Rebate		
		Difference In:		T-Stat	Difference In:		T-Stat
Removal	Vends	Margin	Profit	of Diff	Margin	Profit	of Diff
Snickers	-216.82	0.39	-56.75	-2.87	0.24	-73.26	-4.33
Peanut M&Ms	-197.58	0.78	-10.74	-0.58	0.51	-39.37	-2.48
Joint	-282.66	1.67	-4.54	-0.27	1.01	-54.87	-3.72

Note: Rebate is a direct transfer from Mars to Retailer.

Upstream Revenue

	Pre-Rebate Impact of Removal on:				Cost Born by Mars	
Removal	Mars	Hershey	Nestle	Other	% Before	% After
Snickers	-26.37	5.89	19.32	-20.26	31.7%	11.9%
Peanut M&Ms	-68.38	32.76	11.78	-9.36	86.4%	50.2%
Joint	-130.81	61.43	20.22	37.10	96.7%	59.5%

Note: Revenues to manufacturer are calculated as the wholesale cost paid by Mark Vend to the manufacturer.

Consumer Choice

Discrete Choice Random Utility Maximization:

$$u_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt}. \tag{1}$$

$\delta_{jt} = d_j + \xi_t$ captures mean utility for product j in market t:
includes 73 product, and 15,256 market (machine-visit) fixed effects

Random Coefficients:

Let $\mu_{ijt} \sim f(\mu_{ijt}|\theta)$, where $\mu_{ijt} = \sum_l \sigma_l \nu_{ilt} x_{jl}$ where $\nu_{ilt} \sim N(0,1)$.
Choice probabilities are:

$$p_{jt}(\delta, \theta, a_t) = \int \frac{e^{\delta_{jt} + \sum_l \sigma_l \nu_{ilt} x_{jl}}}{1 + \sum_{k \in a_t} e^{\delta_{kt} + \sum_l \sigma_l \nu_{ilt} x_{kl}}} f(v_{ilt}|\theta) \tag{2}$$

Three continuous product characteristics:

- salt, sugar, and nut content

Estimates

Supply Side

Overview:

- Three manufacturers: (H)ershey, (N)estle, and (M)ars. Only Mars offers an AUD.
- Take manufacturer terms as given: $w_H, w_N, w_M, \lambda, \overline{\pi_M}$
- Model retailer choice of assortment, a, and effort, e.

Retailer Choice of Assortment:

- Assortment choice is discrete over a small number of alternatives. Compute it directly.

Supply Side, cont.

Retailer Choice of Effort:

- Mark Vend chooses an enterprise-level restocking policy at the beginning of each quarter.
  - Translates the effort policy to a restocking schedule for each machine using machine-specific arrival rates.
  - Once set, the schedule is broken into driver routes.
  - In order to reduce the number of consumers between visits, Mark Vend requires additional routes, which increases his cost.
- Retailer chooses restocking frequency: Rust, but 'in reverse.'
  - Use data on cost of restocking; compute the optimal wait time.
- Motivated by earlier evidence that re-stocking effort varies with threshold, but schedules are fixed within a quarter.

Dynamic Model of Re-stocking

- The retailer's value function is:

$$V(x) = \max\{u(x) - FC + \beta V(0), \beta E_{x'}[V(x'|x)]\} \qquad (3)$$

where x is the number of potential consumers (a scalar).

- Given a policy, compute post-decision transition-probability-matrix $\tilde{P}$ and utility $\tilde{u}$ given by:

$$\tilde{u}(x, x^*) = \begin{cases} 0 & \text{if } x < x^* \\ u(x) - FC & \text{if } x \geq x^* \end{cases}$$

- which solves the value function at all states in a single step:

$$V(x, x^*) = (I - \beta\tilde{P}(x^*))^{-1}\tilde{u}(x, x^*) \qquad (4)$$

Dynamic Restocking Procedure

- Of interest: a stationary long-run policy, $e \equiv x^*$ and $V(x, x^*)$.
- We can evaluate the pay-off of R, M, H, N, or any combination (VI, IND, SOC) given a fixed policy, $x.^*$
- Equivalent to "pre-committing" to effort level before realizing sales, or setting an "average service level."
- No demand uncertainty, many machines, so we can focus on the ergodic distribution of profits. (Makes the game static).

Dynamic Restocking Procedure, cont.

Given demand parameters $\hat{\theta}$:

1. Forward simulate sales for a machine with choice set a, from full to completely empty, as a function of x.
2. Choose an effort policy $e = x$.*
3. Given $(w_H, w_N, w_M, \lambda, \overline{\pi^M})$, compute pay-offs for all agents.

Details:

- Use a fixed cost of re-stocking of \$10.
  - Approximates the per-machine restocking cost using driver's wage and average number of machines serviced per day.
  - Robust to reasonable alternative estimates.
- Vending machines allow 7 confections products. Restrict attention to assortments that are not dominated.

Dynamic Restocking Procedure, cont.

- Non-dominated assortments include five base products:
  - Four Mars: Snickers, Peanut M&M, Plain M&M, and Twix.
  - One Nestle: Raisinets.
- Simulate results for 15 assortments: 5 base products and $\binom{6}{2}$ options for the final two slots.
- Provide results for three assortments that are relevant: $(H, H), (H, M)$, and (M, M).
  - (H, H): Reese's PB Cup, Payday
  - (H, M): Reese's PB Cup, Three Musketeers
  - (M, M): Three Musketeers, MilkyWay

Details(1) Details(2)

Assortment Decisions with Effort Policy e^R

Table: Agent Profits

	(H,H)	(H,M)	(M,M)
e^R	257	261	259
π^R	36,656	36,394	36,086
$\lambda\pi^M$	1,617	1,882	2,096
π^M	10,106	11,763	13,101
π^H	2,167	1,299	0
$\pi^R + \pi^M$	46,762	48,157	49,187
$\pi^R + \pi^M + \pi^H$	48,929	49,456	49,187

Assortment Decisions with Effort Policy e^R, cont.

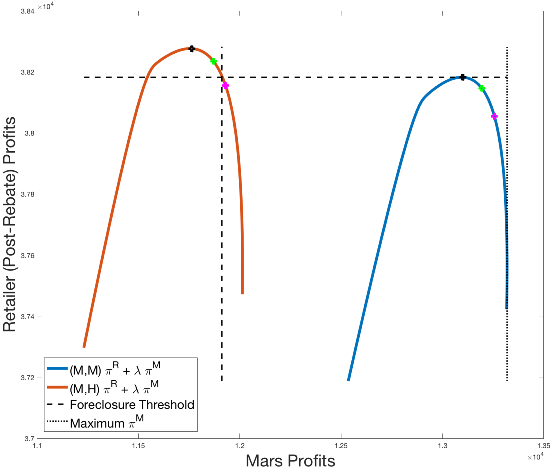
Table: Changes in Profit

from to	(H,H) (H,M)	(H,M) (M,M)	(H,H) (M,M)
$\Delta\pi^R$	-262	-308	-570
$\Delta\pi^M$	1,657	1,338	2,995
$\Delta\pi^{M+R}$	1,395	1,030	2,425
$\Delta\pi^H$	-868	-1,299	-2,167

Table: Changes in Producer and Consumer Surplus

Feasible Observed	262-1,657 1,882	308-1,338 214	570-2,995 2,096
ΔPS	501	-272	229
ΔCS	261	-110	150
ΔSS	762	-383	379

Impact of AUD Quantity Threshold on Retail Assortment



Notes: Figure reports retailer profit under two assortment choices ((H,M) on the left and (M,M) on the right), against sales of Mars products. For a threshold $\overline{\pi}^M \geq 11,912$ (noted by the vertical dashed line), the retailer prefers to switch his assortment from (H,M) to (M,M).

Critical Thresholds and Foreclosure at Observed λ

Table: Critical Thresholds

$\overline{\pi}_M^{MIN}$	$\overline{\pi}_M^{MAX}$	Assortment	Effort
0	11,763	(H,M)	$e^R(H, M)$
11,763	11,912	(H,M)	$e(\overline{\pi}_M(H, M))$
11,912	13,101	(M,M)	$e^R(M, M)$
13,101	13,319	(M,M)	$e(\overline{\pi}_M(M, M))$
13,320	∞	(H,H)	$e^{NR}(H, H)$

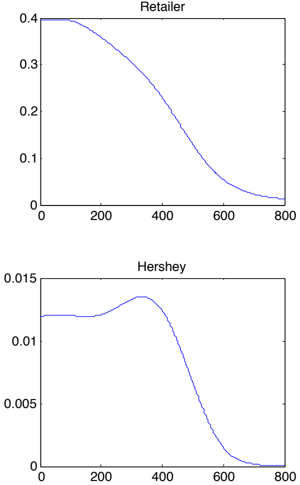
Optimal Effort Policies

Table: Restock after how many customers?

	(H,H)	(H,M)	(M,M)
e^{NR}	263	267	264
e^{R}	257	261	259
e^{VI}	237	244	243
e^{IND}	241	247	244
$e^{SOC}(\epsilon = -4)$	233	238	235
$e^{SOC}(\epsilon = -2)$	227	232	229
$e^{SOC}(\epsilon = -1)$	220	224	222

Notes: Social optimum effort levels reported for different calibrated median own price elasticities of demand. For further details, see Appendix A.4.

Profits Per Consumer, Varying the Restocking Policy



Notes: Reports the profits of the retailer, Mars, Hershey and Nestle as a function of the retailer's restocking policy, using the product assortment in which the retailer stocks 3 Musketeers (Mars) and Reese's Peanut Butter Cups (Hershey) in the final two slots. Specifically, the vertical axes report variable profit per consumer for each of the four firms, and the horizontal axes report the number of expected sales between restocking visits.

Potential Gains from Effort

	Vertically Integrated			Socially Optimal		
	(H,H)	(H,M)	(M,M)	(H,H)	(H,M)	(M,M)
$\%\Delta(e^{NR}, e^{Opt})$	9.89	8.61	7.95	13.69	13.11	13.26
$\%\Delta(e^{R}, e^{Opt})$	7.78	6.51	6.18	11.67	11.11	11.58
$\Delta\pi^R$	-83	-63	-55	-163	-152	-157
$\Delta\pi^M$	195	152	128	251	211	190
ΔPS	76	65	63	39	24	17
$\Delta CS(\epsilon = -2)$	228	210	192	289	290	284
ΔSS	304	275	255	329	313	301

Notes: Percentage change in policy is calculated as increase required from baseline policy e^{NR} to vertically integrated or socially optimal policy. Social optimum assumes α corresponding to a median own price elasticity of demand of $\epsilon = -2$. For robustness, see Appendix A.4.

Net Effect of Efficiency and Foreclosure

Base: to (M,M) and	(H,M) and e^{NR} e^{R}	e^{VI}	e^{SOC}	(H,H) and e^{NR} e^{R}	e^{VI}	e^{SOC}
$\Delta\pi^{R}$	-312	-364	-466	-575	-626	-728
$\Delta\pi^{M}$	1,382	1,476	1,538	3,045	3,140	3,201
ΔPS	-239	-203	-250	267	302	255
ΔCS $(\epsilon=-2)$	-49	92	185	211	352	444
ΔSS	-287	-111	-65	477	654	700

Notes: Consumer Surplus calibrates α to median own price elasticity of $\epsilon=-2$. Calibration only affects the scale of consumer surplus calculations, not the ranking of various options. For more details see Appendix A.4.

Potential Upstream Deviations

Base: to (M, M) and	(H, M) and e^{NR} e^{R}	e^{VI}	e^{SOC}	(H, H) and e^{NR} e^{R}	e^{VI}	e^{SOC}
$\Delta\pi^{R}$	-312	-364	-466	-575	-626	-728
$\Delta\pi^{M}$	1,382	1,476	1,538	3,045	3,140	3,201
$\Delta\pi^{H}$	-1,302	-1,302	-1,302	-2,173	-2,173	-2,173
$\lambda\pi^{M}$	2,096	2,111	2,120	2,096	2,111	2,121
w_h to avoid Foreclosure	-15.83	-14.61	-11.59	12.83	13.54	15.35
Reduction in λ $(w_h = 0.15)$	44.79%	42.72%	38.18%	5.27%	3.53%	-0.84%

Linear Pricing vs. AUD (Assortment is (M,M))

	e^R	e^{VI}	Linear Pricing
$\overline{\pi}^M$	$\in [11912, 13101]$	$=$13,195	$=$0
e	259	243	257
$\pi^R + \lambda\pi^M$	38,182	38,146	39,103
$(1-\lambda)\pi^M$	11,005	11,084	10,094
PS	50,441	50,476	50,450
CS $(\epsilon = -2)$	24,812	24,953	24,832

Notes: The optimal wholesale price under linear pricing is estimated to be 41.36 cents per unit. Hershey is excluded in the (M,M) assortment for all three arrangements, and earns zero profit. The changes in producer surplus include small changes in Nestle's profits due to the effect of changes in the retailer's choice of restocking policy on the sales of Raisinets.

Comparison under Alternate Ownership Structures

	No Merger	M-H Merger	M-N Merger	H-N Merger
AUD Ass.	$e^{VI}(M,M)$	$e^{VI}(H,M)$	$e^{VI}(M,M)$	$e^{VI}(M,M)$
Alt. Ass.	$e^{NR}(H,H)$	$e^{NR}(N,N)$	$e^{NR}(H,H)$	$e^{NR}(H,H)$
$\Delta\pi^R$	-626	-254	-621	-626
$\Delta\pi^M$	3,140	2,962	3,095	3,140
$\lambda\pi^M$	2,111	2,105	2,310	2,111
$\Delta\pi^{Rival}$	-2,173	-1,458	-2,173	-2,212
P^*	13.54	-11.31	9.52	13.79
$\%\Delta T^{**}$	3.53%	43.42%	12.67%	3.01%
ΔPS	302	1,251	302	302
ΔCS	444	2,473	436	444

Notes: Table compares the welfare impacts of an exclusive Mars stocking policy under alternative ownership structures. This assumes threshold is set at the vertically-integrated level in order to maximize efficiency gains. *Price to avoid foreclosure. **Assumes a marginal cost $c = 0.15$.

Conclusion

- We find both efficiency and foreclosure effects of an AUD.
- The AUD functions in a way that is analogous to tying.
- Hershey is foreclosed; the AUD fails to attain the socially-optimal assortment.
- True efficiency effects of more frequent restocking are small.
- Rivals are hurt by increased retailer effort.
- Nevertheless, total profits and consumer welfare are higher compared to a 'retailer optimal' outcome without a rebate.

Parameters of Consumer Choice Model

Random Coefficients:	Parameter Estimates	
σ_{Salt}	0.506	0.458
	[.006]	[.010]
σ_{Sugar}	0.673	0.645
	[.005]	[.012]
σ_{Peanut}	1.263	1.640
	[.037]	[.028]
# Fixed Effects ξ_t	15,256	2,710
LL	-4,372,750	-4,411,184
BIC	8,973,960	8,863,881
AIC	8,776,165	8,827,939

Both specifications include 73 product fixed effects. Total sales are 2,960,315. Back

Details, Re-stocking Model

Similar to Rust (1987): estimate the retailer's optimal wait until the next re-stocking visit (as a function of expected sales).

- Start from a 'full machine' with assortment a.
- Estimate the consumer choice model; specify an arrival process of 'likely consumers' $f(x'|x)$.
  - Use arrival rate at 'higher than average volume' machines.
- Simulate arrivals; after each consumer choice, update product-level inventories and adjust set of available products.
- Average over 100,000 simulated chains to construct expected profit after x consumers have arrived.
- Fit a smooth Chebyshev polynomial; use this to approximate profits of each agent.

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Simulating the Payoff of a Re-stocking policy

- For R, with assortment a and effort policy e, the net present value of the long-run average profit of a typical machine is:

$$\pi^R(a,e) = \Gamma(\tilde{P}(e)) \cdot (I - \beta\tilde{P}(e))^{-1} \cdot \hat{u}^R(x,a). \qquad (5)$$

- The ergodic distribution of x as a function of the restocking policy is given by the solution Γ to $\Gamma = \Gamma\tilde{P}(e)$.
- Both $\Gamma(\tilde{P}(e))$ and $(I - \beta\tilde{P}(e))^{-1}$ depend on effort only through the post-decision transition matrix $\tilde{P}(e)$).
- $\hat{u}^R(x,a)$ is the simulated cumulative payoff function, which depends only on a (and the state variable x).
- To evaluate profits for different agents, replace $\hat{u}^R(x,a)$ with $\hat{u}^M(x,a)$; evaluate at the same policy e.

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