# Multiproduct Intermediaries

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# Introduction

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- Many intermediaries carry multiple products and serve buyers with multiproduct demand
  - Retailers (e.g. supermarkets and department stores), shopping malls, cable TV companies, travel agencies, trade intermediaries

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- Related issue of which products to carry exclusively
  - Examples: Hotel Collection at Macy's, Martha Stewart at Home Depot
  - Around 40% of Macy's sales are from exclusive products
- Upstream suppliers can increasingly bypass traditional intermediaries via direct-to-consumer (DTC) sales
  - In 2016 more than 40% of US manufacturers estimated to sell direct
  - Big brands (e.g. Nike, P&G) develop their own DTC channels
  - Smaller brands do the same using marketplaces such as Amazon

# Introduction

- Our paper develops a new model of multiproduct intermediaries
  - Allows for cost and demand heterogeneities, and cross-product effects
- How does a multiproduct intermediary create value and make profit?
  - Offer a different rationale to standard efficiency arguments
- Which products should the intermediary carry (exclusively)?
  - Optimum trades off 'direct' profit and 'indirect' (endogenous) cross-product externalities
- Is the intermediary too big/small relative to the social optimum?
  - Does it qualitatively stock the 'right' products?
- Apply the model to understand the impact of DTC sales
  - How should an intermediary adjust its product range?

# Some related literature

- **Intermediaries**: Rubinstein and Wolinksy (1987), Gehrig (1993), Spulber (1996, 99), Shevchenko (2004); Biglaiser (1993), Lizzeri (1999), Biglaiser and Li (2018)
- **Bundling**: Stigler (1968), Adams and Yellen (1976), McAfee, McMillan and Whinston (1989), Chen and Riordan (2013); Rayo and Segal (2010, informational bundling)
- **Multiproduct search**: McAfee (1995), Shelegia (2012), Zhou (2014), Rhodes (2015), Kaplan, Menzio, Rudanko and Trachter (2017), Rhodes and Zhou (2017)
- **Vertical markets with search frictions**: Janssen and Shelegia (2015), Asker and Bar-Isaac (2017)
- **Product assortment** (OR and marketing): Kök, Fisher and Vaidyanathan (2015), Bronnenberg (2017)

# Outline of the talk

- **Model**
- A simple case
- The general case
- Applications and extensions
- Conclusion

# Model

Manufacturers

- A unit mass of single-product manufacturers, each indexed by $i$
- Each produces a different and independent product at marginal cost $c_i$
- Can sell direct to consumers e.g. via their own outlet, or an independent specialist

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Consumers

- A unit mass of consumers, interested in buying every product
- All consumers have the same downward-sloping demand $Q_i(p_i)$ for product $i$ when its price is $p_i$
- Different products have different demands (specified below)

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Intermediary

- The intermediary can buy from manufacturers and resell to consumers
  It has no resale cost, but faces a stocking constraint $\bar{m} \leq 1$
- Upstream contracts specify a two-part tariff $(\tau_i, T_i)$ and whether or not the intermediary has exclusive sales rights

# Model

Information and search frictions

- Consumers cannot observe a firm's price, or buy its product, without paying a search cost
- Consumers differ in their search cost, which is distributed on $(0, \overline{s}]$ with differentiable density $dF(s)$

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- Searching a mass $n$ of manufacturers costs $n \times s$

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- Searching a mass $n$ of manufacturers costs $n \times s$

- Searching an intermediary with mass $m$ products costs $h(m) \times s$
- We assume $h(0) \geq 0$ and $h'(m) \geq 0$
  - Larger stores located further out of town, or harder to navigate
  - Alternative 'instore search' foundation for $h'(m) > 0$
- Economies of search from visiting the intermediary iff $h(m) < m$

# Model

Move order

1. The intermediary simultaneously makes take-it-or-leave-it offers to each manufacturer, who simultaneously accept or reject

   [The intermediary publicly announces its stocking intentions]

2. All firms that sell to consumers set their (linear) prices

3. Consumers observe who sells what (but no contract terms or prices)

   They form beliefs about prices and search sequentially with free recall

# Preliminaries

- Let $p_i^m = \arg\max \; (p - c_i)\, Q_i\,(p)$ be the monopoly price of product $i$
- Monopoly per-consumer profit and consumer surplus are

$$\pi_i = (p_i^m - c_i)\, Q_i\,(p_i^m) \quad \text{and} \quad v_i = \int_{p_i^m} Q_i\,(p)\, dp$$

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Consider the case where product $i$ is only sold by its manufacturer:

- Using the standard hold-up argument, the manufacturer charges $p_i^m$
- Consumers search it if and only if $s \leq v_i$
- Hence the manufacturer's profit is just $\pi_i F(v_i)$

# Preliminaries

Same outcome even with the intermediary:

**Lemma**

*i) In any equilibrium with search, each seller of product $i$ charges $p_i^m$*
*ii) If product $i$ is stocked by the intermediary, it offers a two-part tariff $(\tau_i = c_i, T_i)$ such that the manufacturer's payoff is $\pi_i F(v_i)$*

Intuition

- The intermediary pushes manufacturer $i$ down to $\pi_i F(v_i)$
- Consequently it seeks to maximize joint profit on product $i$...
- ... which it does through offering a bilaterally efficient contract
- Monopoly pricing then follows:
  - from the standard hold-up argument, with exclusivity
  - from the Diamond paradox, with non-exclusivity

# Preliminaries

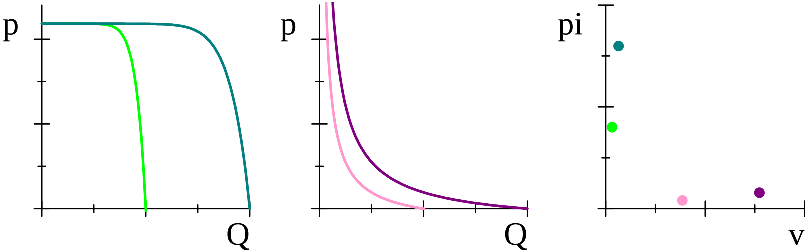
- It will turn out that $(\pi_i, v_i)$ is a "sufficient statistic" for product $i$
  - Our approach also works if the intermediary and manufacturer of $i$ charge the same (not necessarily monopoly) retail price

- Therefore we can represent products using $\Omega \subset \mathbb{R}^2_+$, a compact and convex product space $(\pi, v)$
- Notation: $v \in [\underline{v}, \overline{v}]$ and $\pi(v) \in [\underline{\pi}(v), \overline{\pi}(v)]$ for each $v$
- Avoid corner solutions by assuming $\overline{v} \leq \overline{s}$

- Probability measure space $(\Omega, \mathcal{F}, G)$
- $G$ also denotes the joint distribution over $(\pi, v)$
  Corresponding density $g$ is strictly positive and differentiable

# Preliminaries

- We can construct such a product space when products differ in the size and curvature (or elasticity) of their demand



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# A simple case

Today, mainly focus on the following simple case:

- The intermediary offers no economies of search i.e. $h(m) = m$
- The intermediary has no stocking constraint i.e. $\bar{m} = 1$
- Only exclusive contracts may be offered

# Analysis

- Let $q\left(\pi, v\right) \in \{0, 1\}$ denote if the intermediary stocks product $\left(\pi, v\right)$

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$$\int q(\pi, v)(v - s)\, dG \geq 0 \quad \iff \quad s \leq k \equiv \frac{\int q(\pi, v)\, v dG}{\int q(\pi, v)\, dG}$$

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- The intermediary offers contracts with $(\tau_i = c_i, T_i = \pi_i F(v_i))$
- Therefore the intermediary's profit can be written as

$$\underbrace{\int q(\pi, v)\, \pi F(k)\, dG}_{\text{Revenue}} - \underbrace{\int q(\pi, v)\, \pi F(v)\, dG}_{\text{Payments to manufacturers}}$$

- Remark: the intermediary makes positive profit on goods with $v < k$, but negative profit on goods with $v > k$

# Analysis

- The intermediary's problem is then to

$$\max_q \int q(\pi, v)\, \pi \left[F(k) - F(v)\right] dG$$

given that

$$\int q(\pi, v)(v - k)\, dG = 0$$

**Lemma**

*An optimal solution exists. The intermediary generates strictly positive profit and chooses* $\int q(\pi, v)\, dG \in (0, 1)$.

# Solution

- It is convenient to solve this problem using the Lagrangean method

$$\max_{q(\pi,v),k} \int q(\pi, v) \left[ \underbrace{\pi \left[F(k) - F(v)\right]}_{\text{Direct effect}} + \underbrace{\lambda (v - k)}_{\text{Indirect effect}} \right] dG$$

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- The intermediary's optimal product set is characterized as follows:

$$v < k \quad \text{and} \quad \pi \geq \lambda \frac{k-v}{F(k) - F(v)} \quad (\text{"profit generators"})$$

$$v > k \quad \text{and} \quad \pi \leq \lambda \frac{v-k}{F(v) - F(k)} \quad (\text{"loss makers"})$$

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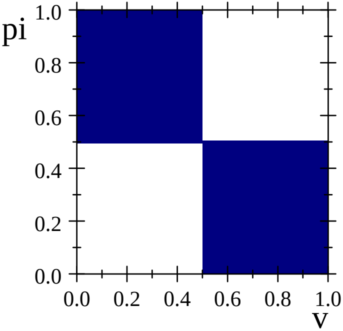
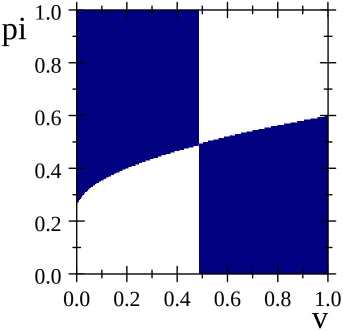
where $k$ and $\lambda$ jointly solve

$$\underbrace{k=\frac{\int q(\pi,v)\,vdG}{\int q(\pi,v)\,dG}}_{\text{Search constraint}} \quad \text{and} \quad \underbrace{\lambda=f(k)\frac{\int q(\pi,v)\,\pi dG}{\int q(\pi,v)\,dG}}_{\text{FOC with respect to } k}$$

# Examples



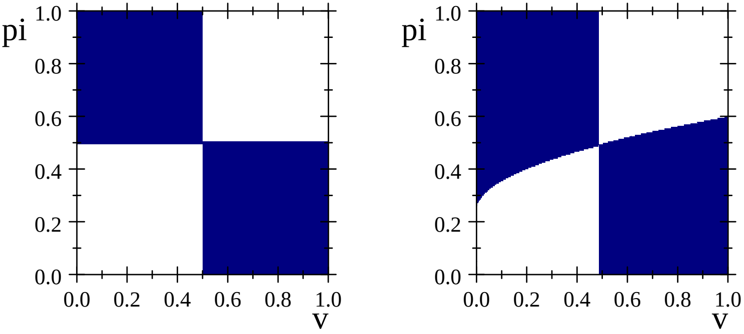

(a) $F(s) = s$




(b) $F(s) = \sqrt{s}$

Figure 1: The simple case with a uniform product space $[0, 1]^2$

# Examples




(a) $F(s) = s$ (b) $F(s) = \sqrt{s}$

Figure 1: The simple case with a uniform product space $[0, 1]^2$

- The intermediary increases industry profit by 12.5% and 10.8% respectively, and total welfare by 2.5% and 2.8% respectively

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# The general case

- The intermediary may now propose non-exclusive deals as well
- More general search technology, with $h(m) \geq 0$ and $h'(m) \geq 0$
- General stocking constraint $\bar{m} \leq 1$

# The general case

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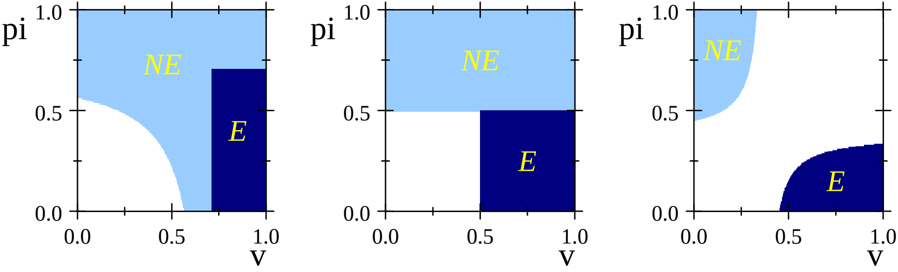
- More general search technology, with $h(m) \geq 0$ and $h'(m) \geq 0$
- General stocking constraint $\bar{m} \leq 1$

Some results:

- Search rule is more complicated, but is still a cut-off $k$
- Non-exclusive products with $v > k$ break even
  $\implies$ no aggregate demand expansion or contraction
- Sufficient conditions on $h(m)$ for the intermediary to be profitable

# The general case: examples

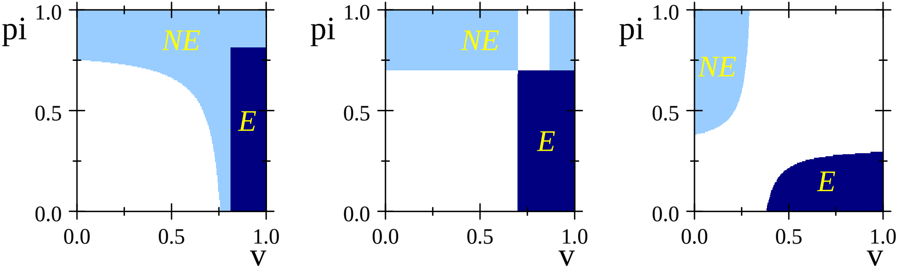



(a) $h(m) = 0.8m$ (b) $h(m) = m$ (c) $h(m) = 1.2m$

Figure 2: Uniform example with $\bar{m} = 1$

- As the intermediary's search efficiency decreases, it stocks fewer products but a larger proportion of them are exclusive

# The general case: examples




(a) $\bar{m} = 0.5$ (b) $\bar{m} = 0.46$ (c) $\bar{m} = 0.3$

Figure 3: Uniform example with $h(m) = 0.4$

- As the intermediary's stocking constraint tightens, a larger proportion of its products are exclusive

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# Application: shopping malls

Reinterpret the model:

- A shopping mall contracts with multiple stores
- Each store can join the mall exclusively or non-exclusively...
  ... exclusivity means not having another store in the vicinity
- The mall is a platform: it charges rent but does not set prices

# Application: shopping malls

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Our earlier analysis applies

- Stores with $v < k$ pay a rent $\pi[F(k) - F(v)]$
  Stores with $v > k$ either pay zero or are paid $\pi[F(v) - F(k)]$
- If interpret those with $v > k$ as "anchor stores", consistent with e.g. Gould et al (2005)'s finding that 73% of anchor stores pay zero rent, and that the mall subsidizes maintenance and other costs
- Consumer search rule is the same as earlier, as is the mall's profit and hence so is the store selection

# Extensions

- Interpreting the $(\pi, v)$ space details
  - Link points in $(\pi, v)$ space to demand size, curvature and elasticity
- The effect of direct-to-consumer (DTC) sales details
  - DTC benefits consumers and manufacturers, harms the intermediary
  - Intermediary may need to greatly change stocking policy to survive
- Social planner's problem
  - Welfare- and intermediary-optimal stocking policies are similar
  - However the former tends to involve fewer (exclusive) products
- Upstream competition
  - Intermediary's stocking policy is qualitatively the same
  - However now even exclusive products can generate profit

# Conclusions

- A tractable framework to study multiproduct intermediaries
- Existence of intermediary without the usual efficiency rationale
- Optimal product selection reflects cross-product externalities
  - The $(\pi, v)$ approach allows for a simple characterization
- The intermediary stocks high-$v$ and low-$\pi$ products exclusively to increase search, then profits by selling low-$v$ and high-$\pi$ products
- Stocking policy and exclusivity can be linked to underlying demand
- The intermediary can improve welfare by distorting search
  However it tends to stock too many (exclusive) products
- Adjusting product range is crucial to survive DTC sales

- Other possible applications: TV platforms, trade intermediaries

Thank you!

# Interpretation: Demand curvature

- Suppose that demands lie within the constant curvature class

$$Q_i(p_i) = \alpha_i \left(1 - \frac{1-\sigma_i}{2-\sigma_i}\frac{p_i - \mu_i}{\beta_i}\right)^{\frac{1}{1-\sigma_i}}$$

  where $\alpha_i, \beta_i > 0$, and $\sigma_i < 2$ is demand curvature
- This implies that in the standard monopoly problem with $c_i = 0$

$$\pi_i = \alpha_i \left(\frac{1}{(2-\sigma_i)\beta_i}\right)^{\frac{1}{1-\sigma_i}} \left(\beta_i + \mu_i \frac{1-\sigma_i}{2-\sigma_i}\right)^{\frac{2-\sigma_i}{1-\sigma_i}} \quad , \quad \pi_i = v_i(2-\sigma_i)$$

- Varying $(\alpha_i, \beta_i, \mu_i, \sigma_i)$ traces out various combinations of $(\pi_i, v_i)$
- Convex demand (high $\sigma_i$) $\implies$ relatively low $\pi_i / v_i$
- Concave demand (low $\sigma_i$) $\implies$ relatively high $\pi_i / v_i$
- Large demand (high $\alpha_i$) $\implies$ relatively high $v_i, \pi_i$

back

# Interpretation: Demand elasticity

- Suppose that demands have the form

$$Q_i(p_i) = \alpha_i \left(1 - p_i^{\sigma_i}\right)$$

  where $\alpha_i, \sigma_i, c_i > 0$
- A higher $\sigma_i$ indicates a lower demand elasticity
- A higher $\sigma_i$ also produces a higher $\pi_i / v_i \, (> 1)$ ratio

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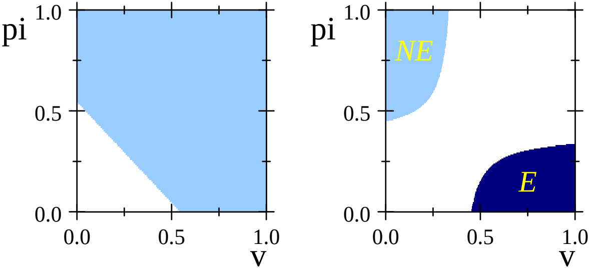
# The impact of DTC sales




(a) No DTC sales (b) With DTC sales

Figure 4: Uniform example with $h(m) = 1.2m$ and $\bar{m} = 1$

- If the intermediary carries the same products (exclusively) as in (a), its profit will be $-0.027$
- Adjusting product selection is necessary to survive DTC sales

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