Pricing, Markups, and Misallocation

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This Paper

Focus: **Misallocation across firms with heterogeneous markups**

- **Predominant view: high-markup firms are under-producing**
  - High-markup firms **should be subsidized**
- We show this result relies on a strong assumption: **linear pricing** - $P(q_j) = p_j q_j$

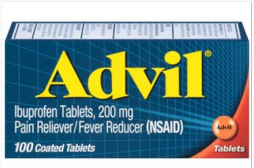
This paper: Allow firms to offer any **pricing schedule** they want

- **No misallocation** across firms despite markup dispersion
  - We **should not subsidize** high-markup firms
- Endogenous labor supply → **concentration is higher** with non-linear pricing
  - Market share of high-markup firms is **too large**

Non-Linear Pricing

$5.29 22.0¢ / ea.

$6.79 13.6¢ / ea.



$9.99 10.0¢ / ea.

$17.99 9.0¢ / ea.

New
iPhone 12 Pro
From $999

New
iPhone 12
From $699**

iPhone SE
From $399

iPhone 11
From $599

Allocative Efficiency with Linear Pricing

- **Linear pricing:** $P(q_j) = p_j q_j$
  - price = marginal cost $\times$ markup
  - **No misallocation** if **price** $=$ **marginal cost** for all firms
- Linear-pricing assumption $\Rightarrow$ **high-markup firms are under-producing**
  - Hsieh and Klenow (2009) - CES preferences
  - Edmond, Midrigan, and Xu (2019) - Kimball preferences, elastic labor supply
  - Dhingra and Morrow (2019) - VES preferences, endogenous varieties
  - Baqaee and Farhi (2020) - Non-parameteric characterization
  - Result holds for oligopolistic competition - Atkeson and Burstein (2008)

Breaking the Link Between Heterogeneous Markups and Misallocation

- Consider case of **perfect price discrimination**
  - Firm makes a take-it-or-leave-it offer → **extract full consumer surplus**
  - No deadweight losses → **allocation is first-best**
- But perfect price discrimination is not feasible
  - Firms may **not be able to identify consumer tastes**
  - Firms may be restricted to offer a **single *menu* to all consumers**
- We analyze the case of non-linear pricing (2^{nd}-degree price discrimination)
  - Firms know distribution of tastes in population
  - Can **offer a non-linear pricing schedule** - $\{p, q\}_j$

Literature

- **Misallocation with heterogeneous markups**
  - Hsieh and Klenow (2009), Edmond, Midrigan, and Xu (2019), Dhingra and Morrow (2019), Boar and Midrigan (2019) , Baqaee and Farhi (2020)

  Study misallocation with **non-linear pricing**

- **Theoretical literature on non-linear pricing**
  - Mussa and Rosen (1978), Maskin and Riley (1984), Wilson (1993), Stole (1995)

  Study allocative efficiency **across firms in general-equilibrium**

Model

Overview: A Static Model

- Preferences with variable elasticity of substitution
- Heterogeneous productivity across firms → **heterogeneous markups**
- **Heterogeneous tastes** across consumers - two types
- Study two pricing schemes
  1. Firms are restricted to **linear pricing**
  2. Firms can offer **non-linear pricing** schedule

Household Preferences

- Measure 1 of households: $i \in (0, 1)$
  - Supply one unit of labor inelastically
- Measure 1 of differentiated goods $j \in (0, 1)$
- **Idiosyncratic tastes** τ_{ij} (iid across i and j)
  - **2 types**: $\tau_{ij} \in \{1, \tau\}$ where $\tau > 1$
  - $\tau_{ij} = \tau$ with probability π

Preferences:

$$U_i = \int_0^1 \tau_{ij} u(q_{ij}) dj$$

Firms

Technology

- Each firm produces a single good ($j \in (0, 1)$)
- Linear production: c_j units of labor per unit of output
- Firms **differ in their marginal cost** c_j

Pricing

- Firms must offer single pricing schedule to all consumers
- **Linear pricing**: choose p_j, commit to sell any quantity at that price
- **Non-linear pricing**: offer bundles of $\{p, q\}_j$

Assumptions on Utility Function

- Assume utility function satisfies

$$(u')^{-1}(x) = \beta_0 - \beta_1 \frac{x^{\beta_2 - 1} - 1}{\beta_2 - 1}$$

  - Large class of utility functions: CES, linear demand (Melitz-Ottaviano), CARA, HARA

- Elasticity of demand decreasing in quantity consumed

$$\epsilon'(q) < 0, \quad \text{where } \epsilon(q) = -\frac{u'(q)}{qu''(q)}$$

  - **High-productivity firms charge higher markup** with linear pricing

- Preferences are aligned (Dhingra and Morrow (2019))

$$\psi'(q) > 0, \quad \text{where } \psi(q) = \frac{u(q)}{qu'(q)}$$

  - **Social markups are aligned with private markups**

Linear Pricing

Firm's problem:

$$\max_{\{p_j, q_{j\tau}, q_{j1}\}} \pi p_j q_{j\tau} + (1-\pi) p_j q_{j1} - c_j(\pi q_{j\tau} + (1-\pi) q_{j1})$$

$$\text{s.t.} \quad u'(q_{j1}) = \frac{p_j}{P}$$

$$\tau u'(q_{j\tau}) = \frac{p_j}{P}$$

Markup Heterogeneity: Higher productivity firms charge a higher markup

Misallocation across firms: High-markup firms are **too small**

Misallocation within firms: No misallocation within firms

Firm's Problem with Non-Linear Pricing

$$\max_{\{p_{j\tau}, p_{j1}, q_{j\tau}, q_{j1}\}} \quad \pi p_{j\tau} q_{j\tau} + (1-\pi) p_{j1} q_{j1} - c_j(\pi q_{j\tau} + (1-\pi) q_{j1})$$

$$\text{s.t.} \quad u(q_{j1}) \geqslant \frac{p_{j1} q_{j1}}{P} \qquad [IR_1]$$

$$\tau u(q_{j\tau}) \geqslant \frac{p_{j\tau} q_{j\tau}}{P} \qquad [IR_\tau]$$

$$u(q_{j1}) - \frac{p_{j1} q_{j1}}{P} \geqslant u(q_{j\tau}) - \frac{p_{j\tau} q_{j\tau}}{P} \qquad [IC_1]$$

$$\tau u(q_{j\tau}) - \frac{p_{j\tau} q_{j\tau}}{P} \geqslant \tau u(q_{j1}) - \frac{p_{j1} q_{j1}}{P} \qquad [IC_\tau]$$

Firm's Problem with Non-Linear Pricing

$$\max_{\{p_{j\tau}, p_{j1}, q_{j\tau}, q_{j1}\}} \quad \pi p_{j\tau} q_{j\tau} + (1-\pi) p_{j1} q_{j1} - c_j(\pi q_{j\tau} + (1-\pi) q_{j1})$$

$$\text{s.t.} \quad u(q_{j1}) = \frac{p_{j1} q_{j1}}{P} \qquad [IR_1]$$

$$\tau u(q_{j\tau}) > \frac{p_{j\tau} q_{j\tau}}{P} \qquad [\cancel{IR_\tau}]$$

$$u(q_{j1}) - \frac{p_{j1} q_{j1}}{P} > u(q_{j\tau}) - \frac{p_{j\tau} q_{j\tau}}{P} \qquad [\cancel{IC_1}]$$

$$\tau u(q_{j\tau}) - \frac{p_{j\tau} q_{j\tau}}{P} = \tau u(q_{j1}) - \frac{p_{j1} q_{j1}}{P} \qquad [IC_\tau]$$

Constraints in equilibrium:

- Two are slack: individual rationality of high type and incentive compatibility of low type
- Two are binding: individual rationality of low type and incentive compatibility of high type

Non-Linear Pricing: Equilibrium Offers

Firm-level optimality conditions

- ***No distortion* at the top**: $\tau u'(q_{j\tau}) = \frac{c_j}{P}$
- **Quantity rationing at the bottom**: $u'(q_{j1}) = \frac{c_j}{P} + \underbrace{\pi\tau\left(u'(q_{j1}) - u'(q_{j\tau})\right)}_{\text{incentive to misreport type}} = \frac{1-\pi}{1-\tau\pi}\frac{c_j}{P}$

Misallocation within firms

$$\frac{u'(q_{j1})}{\tau u'(q_{j\tau})} = \frac{1-\pi}{1-\tau\pi}$$

- In GE: **high-taste consumer allocation is also distorted**

Non-Linear Pricing: Misallocation Across Firms

For each taste, relative quantities across firms are not distorted

- Efficient allocation: $\frac{u'(q_{h\tau})}{u'(q_{l\tau})} = \frac{u'(q_{h1})}{u'(q_{l1})} = \frac{c_h}{c_l}$
- **Identical under non-linear pricing**

Firm-level quantities same as first-best

Firm-level production quantities under non-linear pricing are **identical to their production in the first-best allocation**

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No misallocation across firms

The planner's **optimal firm-level taxes/subsidies are equal to zero**

Non-Linear Pricing: Markup Dispersion

Firm-level optimal markups

- **Incentive to raise markups for low-taste consumer**: $\mu_{j1} = \frac{1-\pi}{1-\tau\pi}\psi(q_{j1})$
- **Incentive to lower markup for high-taste consumer**: $\mu_{j\tau} = \psi(q_{j\tau}) - (\tau - 1)\mu_{j1}$

Firm-level markup definition: $\mu_j \equiv \frac{\text{Sales}}{\text{Costs}} = \frac{\pi p_{j\tau} q_{j\tau} + (1-\pi) p_{j1} q_{j1}}{c_j(\pi q_{j\tau} + (1-\pi) q_{j1})}$

$$\frac{1}{\mu_j} = \alpha \frac{1}{\psi(q_{j1})} + (1-\alpha)\frac{1}{\psi(q_{j\tau})}, \quad \alpha = \frac{\pi\tau u(q_{j1})}{\pi\tau u(q_{j1}) + (1-\pi\tau)u(q_{j\tau})}$$

- Aligned preferences → **high-productivity firms charge a higher markup**

Summary: Linear vs. Non-Linear Pricing

	Linear Pricing	Non-Linear Pricing
High-productivity firms:		
charge high markups	✓	✓
under-produce	✓	✗
should be subsidized	✓	✗
High-taste consumers:		
over-consume	✗	✓

Endogenous Labor Supply

Endogenous Labor Supply

- So far: aggregate labor supply independent of P
- Now: **linear disutility of labor**

$$U_i = \varphi(1 - l_i) + \int_0^1 \tau_{ij} u(q_{ij}) dj$$

- Standard result applies
  - No quantity distortion to the high type
  - Too little sold to the low type: $u'(q_{j1}) = \frac{1-\pi}{1-\tau\pi} \frac{c_j}{P}$

Concentration is Higher With Non-Linear Pricing

Non-linear pricing raises market concentration

There exists a productivity threshold $\frac{1}{\tilde{c}}$ such that under non-linear pricing, relative to first-best

- Market share of firms with **higher levels of productivity is higher**
- Market share of firms with **lower levels of productivity is lower**

- Corollary: **concentration measures are higher under non-linear pricing**
- Nonetheless, optimal subsidy is **uniform across firms**

Evidence from Retail Pricing

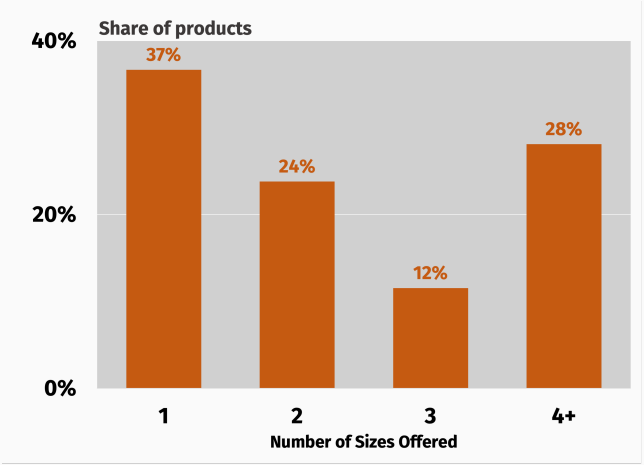
Data: Nielsen

Retail Scanner Dataset

- Covers all products in a sample of stores between 2004-2017
- Weekly data on **price** and quantity sold at the UPC-store level
- Product characteristics:
  - Product type, category, and department
  - **Brand**
  - Product characteristics: **size**, flavor, packaging, organic, etc.

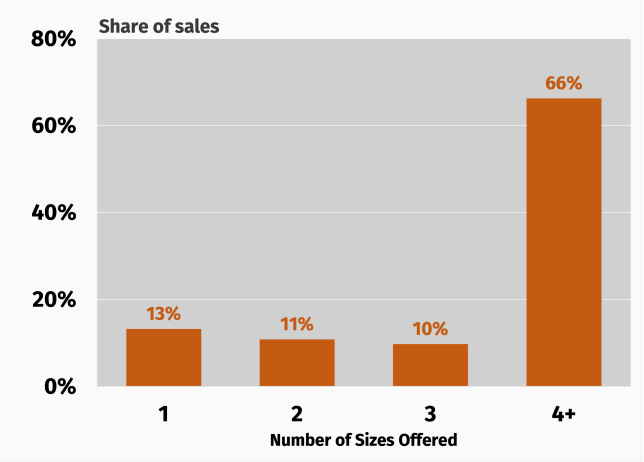
Today: Proof of concept → focus on **potato chips**

Quantity Dispersion



Notes: Each bar represents the share of products which are offered in x different sizes

Quantity Dispersion



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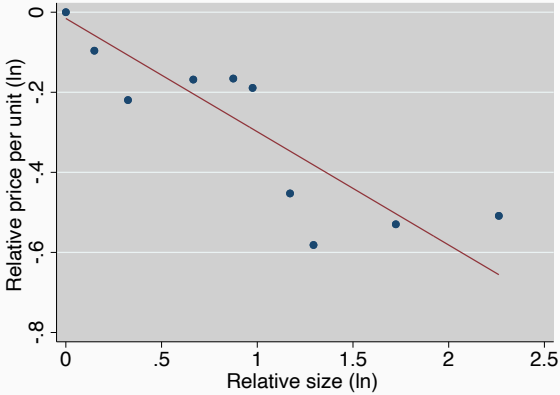
Price-Per-Unit Declining with Package Size



Notes: The figure presents a binscatter of the product size and its price-per-unit relative to the price and size of the smallest product offered

Price-Per-Unit Declining with Package Size

Outcome =	ln(price)	
	(1)	(2)
ln(size)	0.695***	0.673***
	(0.0004)	(0.0004)
Product FE	✓	✓
Store FE		✓
Obs.	1,440,822	1,440,835
R2	0.85	0.88

Notes: Each regression includes brand and store fixed effects. Product is defined as a collection of UPCs who share the same brand as well as share all product characteristics.

Conclusion

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- Macro and firm-dynamics literature assume **linear pricing**
  - *Robust* result: high-markup firms **under**-produce
- This paper: relax the linear pricing assumption
  - Non-linear pricing → **no misallocation across firms**
  - Endogenous labor supply → **concentration levels are higher**

Is the market share of superstar firms too small?

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Is the market share of superstar firms too small?
It is plausible that the answer is no.