The Welfare Effects of Third-Degree Price Discrimination in a Differentiated Oligopoly

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1. Introduction

- **Examples of 3rd-Degree PD (final products):**
  - Movie Tickets (discounts to students, senior citizens)
  - Pharmaceutical Products (in the international market)
  - Computer Software ("academic discounts")
  - .....
- **Oligopolistic Competition**
- **Price Discrimination ← Price Control**
- **One Source: (Horizontal) Product Differentiation**

1. Introduction

■ Research Question:

- Welfare Consequences of 3rd-Degree PD
- Social Welfare under PD
  $>$ Social Welfare under UP (Uniform Pricing)?
- Under Oligopolistic Competition
- Horizontal Product Differentiation

1. Introduction

■ Main Results:

- PD can improve SW (especially) if firms' brands

  are *substitutes* in the "*strong*" market, and
  are *complements* in the "*weak*"market,

  but it never improves vice versa.

- Consumer surplus never improves by PD.

- "Prisoners' Dilemma" may arise if $\Delta Q < 0$ (conjecture)

- Competition due to strong substitutability
  → Bad for PD to improve SW

Road Map

- **2. Related Literature**
- **3. Model**
- **4. Welfare Analysis**

2. Related Literature

■ *Can 3rd-Degree PD Improve Social Welfare?*

• In the case of Monopoly, well understood:

- SW *never improves* if it doesn't increase aggregate output.
(Robinson ('33),..., Schmalensee ('81), Varian ('85)

(inefficiency from interconsumer misallocations should be offset)

- SW *may improve* even if it doesn't increase aggregate output
in the presence of consumption externalities. (Adachi ('02, '05))

• As Stole ('08, Handbook of IO) points out, less is known in the case of

Oligopoly,.....

2. Related Literature

■ Oligopoly

· Holmes ('89, AER)

Symmetry

Decomposition of Equilibrium Price Elasticities

· Corts ('98, RAND)

Asymmetry

Unambiguous cases of welfare improvement

· Dastidar ('06, Manchester)

Symmetry

Not necessarily $\Delta Q = 0$ even in the case of linear demands

2. Related Literature

■ Potential Sources in Efficiency

- 1. Aggregate output over all markets is too low if prices exceed marginal cost.

- 2. For a given level of aggregate output, PD typically generates interconsumer misallocations relative to uniform pricing.

  → Aggregate output is not efficiently distributed to the highest-value ends.

- 3. Additional interconsumer misallocations caused by strategic interaction

■ Our model allows a simple and natural result on 3.

Road Map

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3. Model

- Price-setting firms (not Qunatity-setting)

- Categorize:

$$\begin{cases} \text{“Strong” markets: } \{m | p^u < p_m\} \\ \\ \text{“Weak” markets: } \{m | p^u > p_m\} \end{cases}$$

- Restrict attention to the symmetric case:

  All firm agree in their ranking of strong markets & weak markets.

- Assume further symmetry across firms:

  Everything is symmetric across firms...

3. Model

■ Product Differentiation

- (Chamberlin-Robinson approach)
- Representative Consumer's Utility:

$$U_m(q_m^A, q_m^B) \equiv \alpha_m \cdot (q_m^A + q_m^B) - \frac{1}{2}\left(\beta_m [q_m^A]^2 + 2\gamma_m q_m^A q_m^B + \beta_m [q_m^B]^2\right)$$

- *Substitutes*: $\gamma_m > 0$
- *Complements*: $\gamma_m < 0$

3. Model

- Demand functions in market m:

$$\begin{cases} q_m^A(p_m^A, p_m^B) = \dfrac{\alpha_m}{\beta_m + \gamma_m} - \dfrac{\beta_m}{\beta_m^2 - \gamma_m^2} p_m^A + \dfrac{\gamma_m}{\beta_m^2 - \gamma_m^2} p_m^B \\ q_m^B(p_m^A, p_m^B) = \dfrac{\alpha_m}{\beta_m + \gamma_m} + \dfrac{\gamma_m}{\beta_m^2 - \gamma_m^2} p_m^A - \dfrac{\beta_m}{\beta_m^2 - \gamma_m^2} p_m^B \end{cases}$$

- Normalization: common constant marginal cost $= 0$

- $\alpha_s/\alpha_w \in (\underline{\alpha_s/\alpha_w}, \overline{\alpha_s/\alpha_w})$

  (Relative) size of the weak market should be sufficiently *small*
  for neither firm to have an incentive to deviate to closing the weak market,
  and be also sufficiently *large*
  for the weak market to be open under unifor pricing.

Road Map

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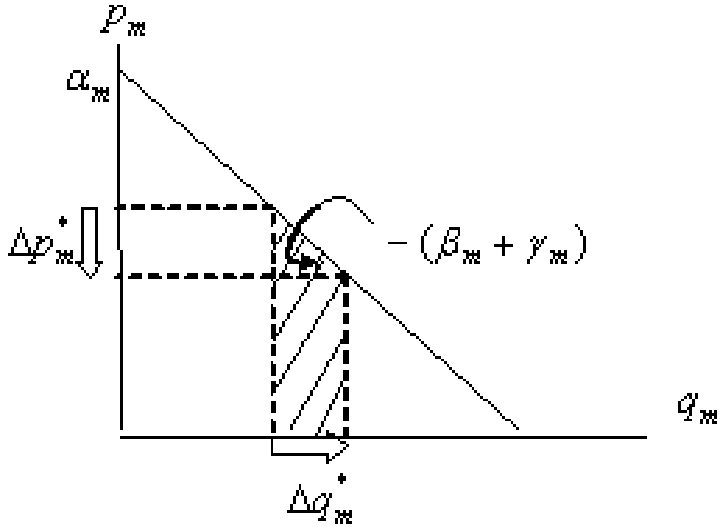
4. Welfare Analysis

■ Analytical Properties

Proposition 1. *Equilibrium differences in social welfare is given by*

$$\Delta SW^*(\boldsymbol{\gamma}, \boldsymbol{\alpha}, \boldsymbol{\beta}) = -\sum_{m \in \{s,w\}} \frac{\Delta p_m^*}{\beta_m + \gamma_m} \cdot (p_m^* + p^*)$$

where $\Delta p_m^* \equiv p_m^* + p^*$.



4. Welfare Analysis

Lemma 1. *Equilibrium price elasticity of demand in market m in equilibrium is given by*

$$\varepsilon_m(p_m^*) = \underbrace{1}_{\text{market elasticity}} + \underbrace{\left(-\frac{\gamma_m}{\beta_m}\right)}_{\text{cross-price elasticity}}.$$

- Special case of Holmes ('89)
- Product Differentiation $\rightarrow$ Strategic Interaction
- Cross-price elasticity: how much each firm "steals" from the other firm *in equilibrium*.
- $\varepsilon_m(p_m^*) \lesseqgtr 1$ if and only if $\gamma_m \gtreqless 0$.

4. Welfare Analysis

Proposition 2. $\Delta Q^* \leq 0 \Rightarrow \Delta SW^* < 0.$

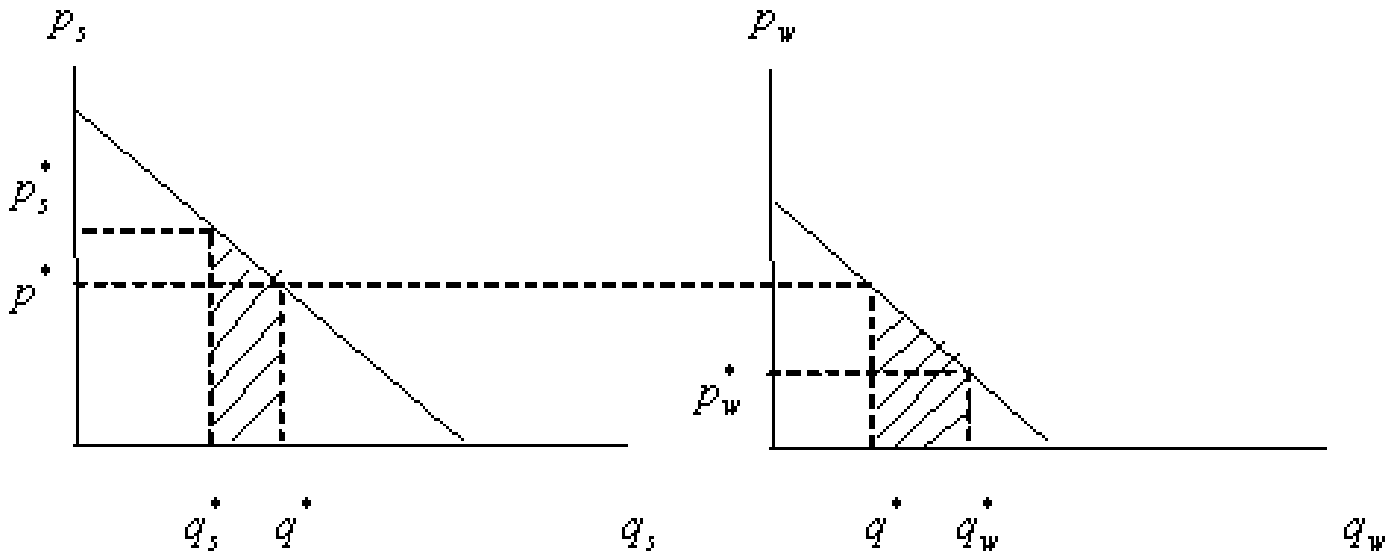
- Same as Monopoly
- $\Delta Q^* \gtreqless 0 \Leftrightarrow$ if and only if $\frac{\gamma_s}{\beta_s} \gtreqless \frac{\gamma_w}{\beta_w}$.
- Also, a special case of Holmes ('89)

4. Welfare Analysis

■ Welfare-improving price discrimination

• Reduce the number of parameters: $\alpha_s = 1 > \alpha_w > 0$ (necessary for social welfare to improve)

• $\Delta SW^* > 0 \Leftrightarrow \Delta q_w^* \cdot (p^* + p_w^*) > \Delta q_s^* \cdot (p^* + p_s^*)$



4. Welfare Analysis

■ Case of Symmetric Product Differentiation ($\gamma_s/\beta_s = \gamma_w/\beta_w$)

Proposition 3. *In the case of symmetric product differentiation,*

$$\Delta SW^* < 0.$$

4. Welfare Analysis

■ Case of Asymmetric Product Differentiation ($\gamma_s/\beta_s \neq \gamma_w/\beta_w$)

- (1) γ_m is common: $\gamma \equiv \gamma_s = \gamma_w$
- (2) β_m is common: $\beta \equiv \beta_s = \beta_w$

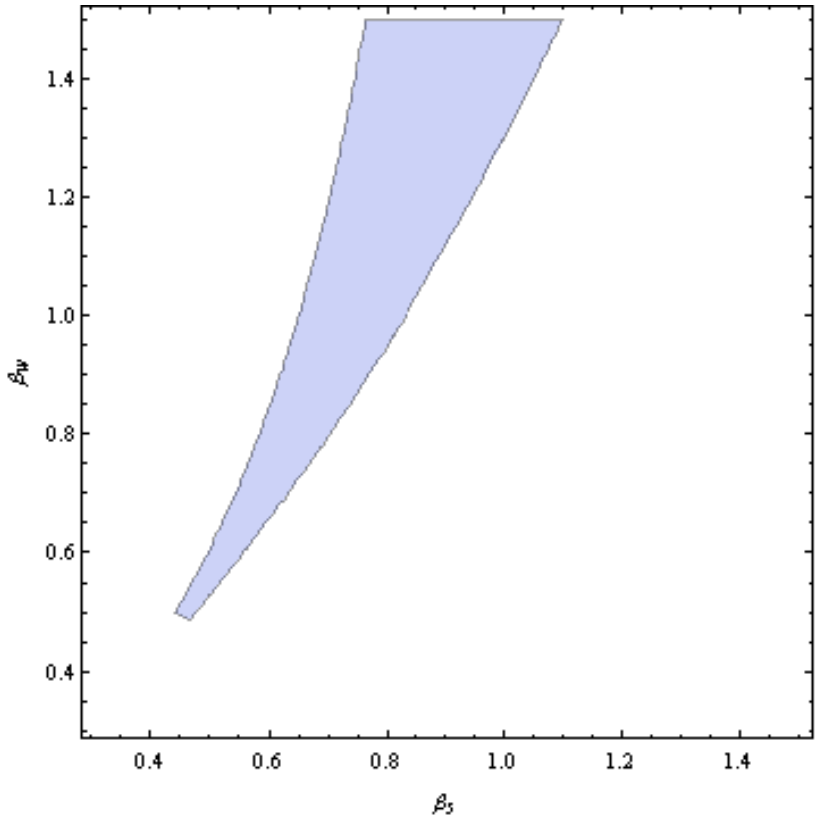
4. Welfare Analysis

■ (1) γ_m is common ($\alpha_w = 0.85$)

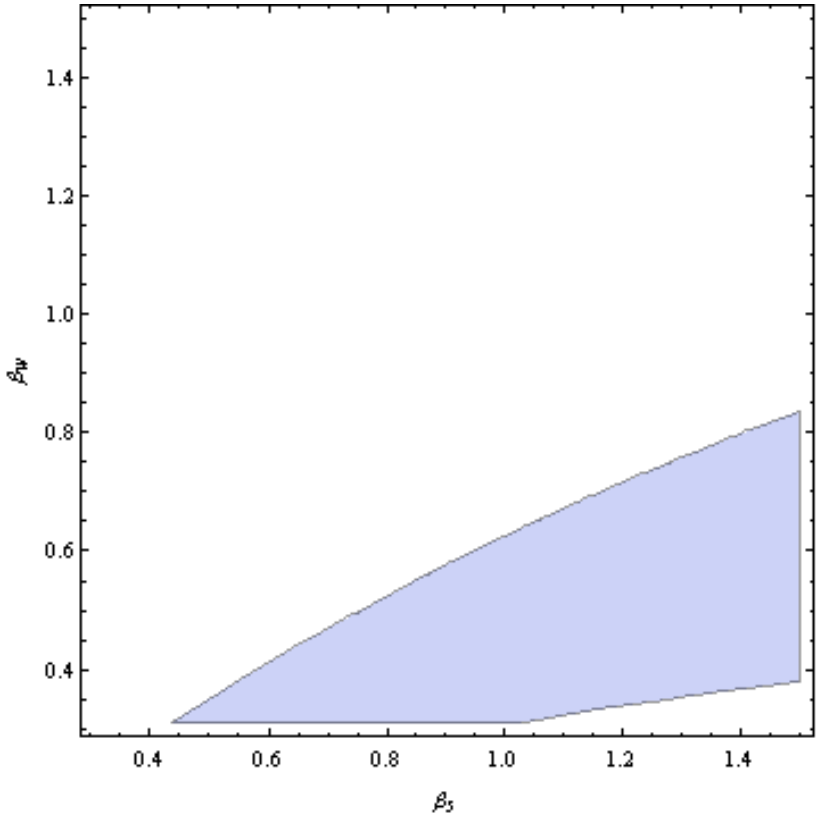
	$(\gamma, \beta_s, \beta_w) =$			
	$(0.3, 1.0, 0.75)$	$(0.3, 0.75, 1.0)$	$(-0.3, 1.0, 0.75)$	$(-0.3, 0.75, 1.0)$
p^*	0.3582	0.3644	0.5235	0.5423
p_s^* $(\Delta p_s^*/p^*)$	0.4118 (15%)	0.3750 (3%)	0.5652 (8%)	0.5833 (8%)
p_w^* $(\Delta p_w^*/p^*)$	0.3188 (−11%)	0.3500 (−4%)	0.4958 (−5%)	0.4804 (−11%)
Δq_s^* $(\Delta q_s^*/q_s^*(p^*))$	−0.9412 (−8%)	−0.0101 (−2%)	−0.0596 (−9%)	−0.0912 (−9%)
Δq_w^* $(\Delta q_w^*/q_w^*(p^*))$	0.0375 (8%)	0.0111 (3%)	0.0615 (8%)	0.0884 (20%)
ΔSW^*	−0.0063	0.0005	−0.0022	−0.0123
ΔCS_s^*	−0.0507	−0.0127	−0.0543	−0.0797
ΔCS_w^*	0.0384	0.0109	0.0419	0.0598
$\Delta\Pi^*$	0.0060	0.0023	0.0102	0.0076
ΔQ^*	−0.0037	0.0009	0.0019	−0.0028

4. Welfare Analysis

■ (1) γ_m is common ($\alpha_w = 0.85$)



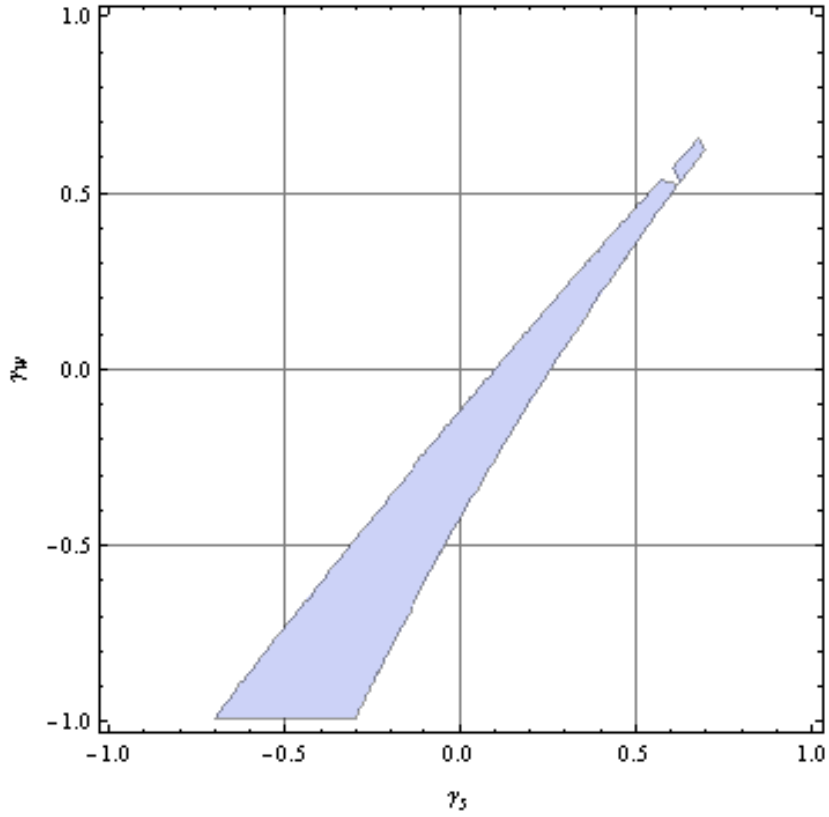
Substitutability ($\gamma = 0.3$)



Complementarity ($\gamma = -0.3$)

4. Welfare Analysis

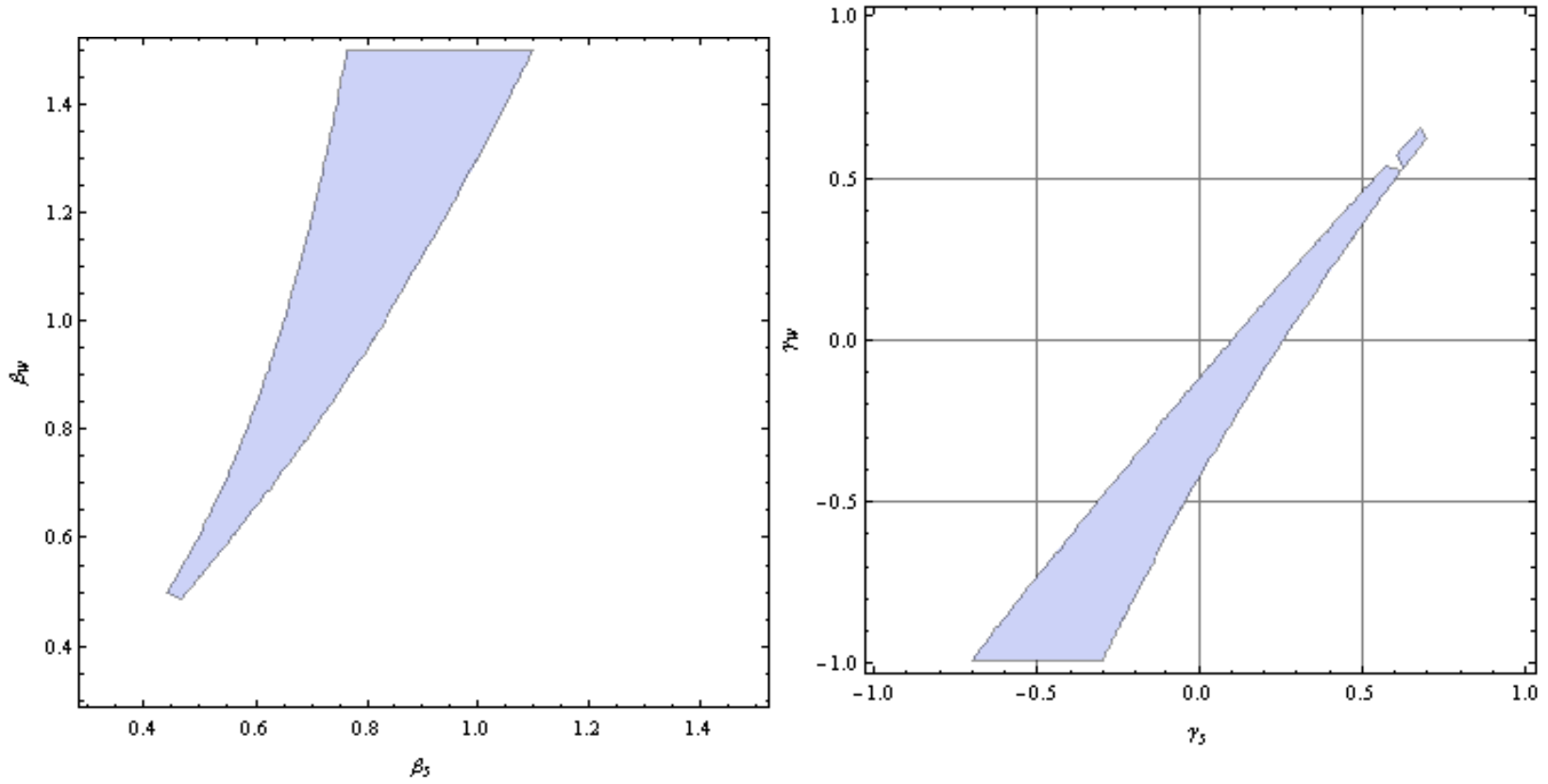
■ (2) β_m is common ($\alpha_w = 0.85$ and $\beta = 1.0$)



4. Welfare Analysis

■ (2) β_m is common ($\alpha_w = 0.85$ and $\beta = 1.0$)

- Closer to Perfect Substitutes...



4. Welfare Analysis

■ (2) β_m is common ($\alpha_w = 0.85$ and $\beta = 1.0$)

	$(\gamma_s, \gamma_w) =$	
	$(0.1, -0.1)$	$(-0.1, 0.1)$
p^*	0.4588	0.4663
p_s^* $(\Delta p_s^*/p^*)$	0.4737 (3%)	0.5238 (12%)
p_w^* $(\Delta p_w^*/p^*)$	0.4452 (−3%)	0.4026 (−14%)
Δq_s^* $(\Delta q_s^*/q_s^*(p^*))$	−0.0615 (−3%)	−0.0640 (−11%)
Δq_w^* $(\Delta q_w^*/q_w^*(p^*))$	0.0150 (3%)	0.0578 (17%)
ΔSW^*	0.0009	−0.0131
ΔCS_s^*	−0.0145	−0.0646
ΔCS_w^*	0.0120	0.0481
$\Delta \Pi^*$	0.0034	0.0034
ΔQ^*	0.0014	−0.0061

5. Summary

- PD can improve SW (especially) if firms' brands

  are *substitutes* in the "*strong*" market, and
  are *complements* in the "*weak*"market,

  but it never improves vice versa.

- Consumer surplus never improves by PD.

- "Prisoners' Dilemma" may arise if $\Delta Q < 0$ (conjecture)

- Competition due to strong substitutability
  → Bad for PD to improve SW

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(1. Introduction)

■ What is Price Discrimination?

• *Price Discrimination* is present when two or more identical units of the same products or services are sold at *different* prices, either to the same buyer or to different buyers. (Adachi ('07, Encyclopedia))

• It's a marketing technique for a seller to generate higher profits (by extracting some of the consumer surplus).

(1. Introduction)

■ What is Price Discrimination? (cont'd)

- Taxonomy (Pigou ('20); Dupuit (1849) & Tirole ('89))

  - 1st-Degree PD: Each consumer pays her WTP
  - 2nd-Degree PD: Each consumer self-selects into a different price schedule
  - 3rd-Degree PD: Consumers are segmented into groups by unambiguous traits

- This talk concentrates on 3rd-Degree PD.

(1. Introduction)

■ Two conditions for PD to be introduced

- Imperfect competition
  (firms must have some control power over the price)
- No arbitrage
  (no immediate resale among consumers)

(1. Introduction)

■ Methodological Issues

- Evaluation Criteria:
  - Alfred Marshall's Concept of Surplus
  - *Social Welfare* = Profit (of firms) + Surplus (of consumers)
- Restrict Attention:
  - Theoretical Analysis
  - Partial Equilibrium Analysis (small income effects)
  - No Uncertainty, No Asymmetric Information
  - Final Products
  - Static Analysis
  - No Enty, No Exit