Price Discrimination

Empirical Industrial Organization

Andras Niedermayer[1]

[1]Department of Economics (THEMA), Cergy Paris Université

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Definition

Three types of price discrimination:

- First-degree, or perfect price discrimination: each individual i pays a different price p_i that reflects its willingness to pay. In this case and under monopoly, all the consumer surplus is extracted by the firm. Under imperfect competition, not clear because competition for each consumer intensifies
- Second degree: firms offer menus of contract such that consumers self select. Typically, firms produce different versions of the product with different quality levels associated with different prices (p_V, q_V)

Definition

Three types of price discrimination:

- Third degree: firms observe some consumers characteristics that are correlated with their preferences and set prices conditional on these observables. Consumers are segmented in $d = 1, \ldots, n_D$ groups and firms set p_d. First-degree PD is a limit case of third-degree PD. Welfare impact of price discrimination unclear; typically winners and losers but depends on competition

First-degree price discrimination

When do we observe individualized prices?

- Business to business transactions
- When products are individualized: services (e.g catering)
- Individual discounts

But there are other price determination mechanisms that imply individual prices as outcome:

- Bargaining
- Quantity rebate

Second-degree price discrimination

- Most firms offer more than one version of their products (e.g. computer, cars, education,...)
- Each version of the product associated with different characteristics and a different price
- Second degree price discrimination when the price difference between two versions is not equal to the cost difference which amounts to test:

$$p_{jv} - c_{jv} = p_{jv'} - c_{jv'}$$

Third degree price discrimination

- A lot of examples
- Third degree PD can be explicit: half price for women, reduced-price for kids and seniors
- Or implicit: different prices in different cities, different prices for train or flight tickets depending on the purchase date, new consumer discounts, unobserved rebates...
- But, third degree PD typically limited by arbitrage opportunities (e.g driving to a cheaper city or country)

Questions of interest

- Detecting price discrimination: are price differences attributable to cost or markup differences?
- Welfare impacts of price discrimination: who benefits from price discrimination? Would uniform pricing be welfare-improving?
- Heterogeneous prices imply heterogeneous impacts of a merger, a policy

Literature

- **Testing for second degree price discrimination:** Borenstein & Rose (airline industry), Verboven (automobile)
- **Welfare analysis of second degree price discrimination using structural model** Crawford, Shcherbakov & Shum (cable TV), Leslie (Broadway play), Verboven (gasoline vs. diesel car), D'Haultfoeuille & Février (work contact) . . .
- **Structural models of second degree price discrimination, identification based on second degree price discrimination** Miravete & Röller (mobile phone), Luo, Perrigne & Vuong (mobile phone), Bontemps & Martimort (water utilities), Durrmeyer, Niedermayer & Schneyerov (automobile)

General model of non-linear pricing

- Based on Luo, Perrigne & Vuong Non-parametric identification of model with second degree price discrimination under monopoly and continuous distribution of types
- Theory: Mussa & Rosen, Maskin & Riley
- Non-parametric on utility and distribution of types, but parametric on the cost function
- Idea: use the FOC of consumer choice and the FOC of the monopolist to identify utilities and individual types

Framework

- Q as quality or quantity
- θ individual type, willingness to pay for quality $\theta \sim F(.)$
- Utility $U(Q, \theta) = \theta U_0(Q)$
- Firm is monopolist, has a cost $C(Q)$ set a price function (tariff) $T(Q)$
- Utility from consumption $\theta U_0(Q) - T(Q)$
- Primitives of the model (to identify) $[U_0(.), F(.), C(.)]$
- Individuals have an outside option which gives a utility $U_0(0)$

Demand

- Consumer's FOC associated to a choice of quality (IC): 1

$$\theta \frac{\partial U}{\partial Q} = \frac{\partial T}{\partial Q}$$

- Optimal quality such that marginal utility is equal to the marginal price increase from quality
- Consumer chooses to buy the good if utility is higher than the utility of the outside option (IR):

$$\theta U_0(Q(\theta)) - T(Q(\theta)) \geq \theta U_0(\theta)$$

Supply

- Problem of the firm:

$$\max_{\theta^*, Q(.), T(.)} \int_{\theta^*}^{\bar{\theta}} [T(Q(\theta)) - C(Q(\theta))] f(\theta) d\theta$$

s.t (IC), (IR) satisfied $\forall \theta \geq \theta^*$

- FOC for $\theta > \theta^*$

$$\theta \frac{\partial U}{\partial Q}(Q(\theta)) = \frac{\partial C}{\partial Q}(Q(\theta)) + \underbrace{\frac{1 - F(\theta)}{f(\theta)} \frac{\partial U}{\partial Q}(Q(\theta))}_{\text{informational rent}}$$

- And θ^* is such that:

$$\theta^* U(Q(\theta^*)) - C(Q(\theta^*)) - \frac{1 - F(\theta^*)}{f(\theta^*)} U(Q(\theta^*)) = 0$$

Identification

- Assume $T(Q)$ is observed
- Identification of the model primitives from observed quantities G^{Q^*} and tariff $T(Q)$
- Assumption $C(Q) = \kappa + \gamma Q$
- Evaluate the FOC of firm at $\bar{\theta}$: no distortion at the top, marginal price increase is equal to marginal cost increase so:

$$\frac{\partial C}{\partial Q}(\bar{Q}) = \kappa = \frac{\partial \bar{T}}{\partial Q}(\bar{Q})$$

Identification

- Identification of distribution of types and utility exploits monotonicity of equilibrium qualities in θ, observed choice of quality reveals the type
- $\theta(\alpha)$ and $Q(\alpha)$ the α-quantile of the truncated distribution F^* over $\left[\theta^*, \bar{\theta}\right]$ (distribution of types, conditional on purchasing)

$$F^*(.) = \frac{F(.) - F(\theta^*)}{1 - F(\theta^*)}$$

- Note that the distribution of chosen qualities G^{Q^*} is by definition truncated

Identification

- Evaluate the firm and consumer FOC at $Q(\alpha)$ the quality such that a fraction α of the population choose a quality lower or equal to $Q(\alpha)$:

$$\theta(\alpha)\frac{\partial U}{\partial Q}(Q(\alpha)) = \gamma + \frac{1-\alpha}{f^*(\theta(\alpha))}\frac{\partial U}{\partial Q}(Q(\alpha))$$
$$\frac{\partial T}{\partial Q}(Q(\alpha)) = \theta(\alpha)\frac{\partial U}{\partial Q}(Q(\alpha))$$

- $F^*_\theta(\theta(\alpha)) = \alpha$ so that $\theta(\alpha) = F^{*-1}_\theta(\alpha)$ and $\frac{1}{f^*(\theta)} = \frac{\partial\theta}{\partial\alpha}$ so we get the density of θ : $f^*(\theta) = \frac{\partial\theta}{\partial\alpha}$

Identification

- Replacing the second equation in the first gives:

$$\frac{\partial\theta/\partial\alpha}{\theta(\alpha)} = \frac{\partial T/\partial Q(Q(\alpha)) - \gamma}{(1-\alpha)\partial T/\partial Q(Q(\alpha))}$$

- Integrate the equation above from 0 to α using $\theta(0) = \theta^*$:

$$\log\frac{\theta(\alpha)}{\theta^*} = \int_0^\alpha \frac{1}{1-u}\left[1 - \frac{\gamma}{\partial T/\partial Q(Q(u))}\right] du$$

- We need a normalization of θ^*, typically $\theta^* = 1$ and we get directly the quantiles of θ as function of the marginal tariffs

Identification

- Once the distribution of type is recovered, the utility function is identified from:

$$\frac{\partial U}{\partial Q} = \frac{\partial T / \partial Q(Q(\alpha))}{\theta(\alpha)}$$