Price Discrimination with Redistributive Concerns

Daniel M. A. Barreto — Sciences Po (soon University of Amsterdam)
Alexis Ghersengorin — Paris School of Economics (soon University of Oxford)
Victor Augias — Sciences Po (soon University of Bonn)

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Motivation: Consumers' Data Regulation

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- Very valuable for firms: tailored recommendations, targeted advertising, personalized pricing, etc.
    - Several cases: Amazon, targeted discount vouchers, etc.
- Subject of regulatory concerns.
    - e.g. General Data Protection Regulation in the EU and the Banning Surveillance Advertising Act in the U.S.

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3. Define how surplus is distributed among different consumers.
    - Maximizing total consumer surplus might disproportionately benefit richer consumers.
    - Prioritizing the surplus of poorer consumers might only be feasible while granting additional profits to the firm.

This Project

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Questions:

- How to optimally segment a market given a redistributive goal?
- When can the redistributive goal be met while still maximizing total consumer surplus?
    - When will a redistributive segmentation grant additional profits to the monopolist?

Outline of talk

Model

Consumer-optimal segmentations without redistributive concerns

Consumer-optimal segmentations with redistributive concerns

When does redistribution require additional profits to the monopolist?

Model

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- A monopolist sells a good to a continuum of mass one of buyers.
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- A market μ is a distribution over WTP. The set of possible markets is:

$$M \equiv \Delta(V) = \left\{ \mu \in \mathbb{R}^K \;\middle|\; \sum_{k=1}^{K} \mu_k = 1 \text{ and } \mu_k \geq 0 \text{ for all } k \in \{1, \dots, K\} \right\}.$$

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- An aggregate market is denoted $\mu^\star \in M$.

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- Formally, a segmentation σ is a probability distribution on M which averages to the aggregate market $\mu^\star$:

$$\Sigma(\mu^\star) \equiv \left\{ \sigma \in \Delta(M) \,\middle|\, \sum_{\mu \in \mathrm{supp}(\sigma)} \mu\,\sigma(\mu) = \mu^\star, |\mathrm{supp}(\sigma)| < \infty \right\}.$$

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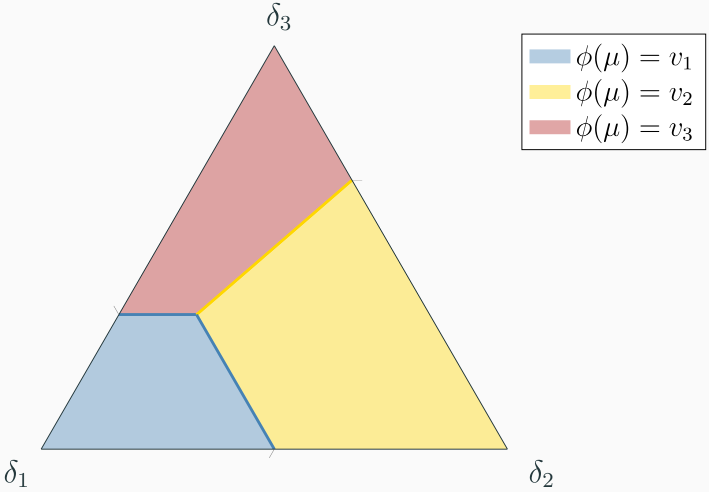
- Surplus of a consumer of type v_k at segment μ:

$$u_k(\mu) = \max \{0, v_k - \phi(\mu)\}.$$

Segmentations: Illustration



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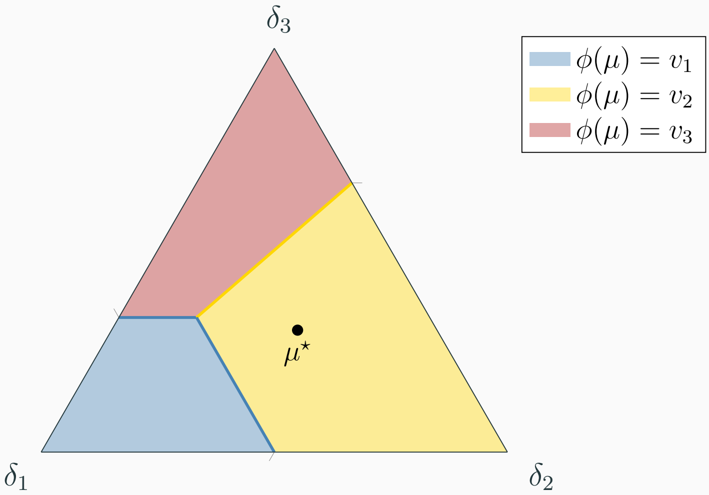

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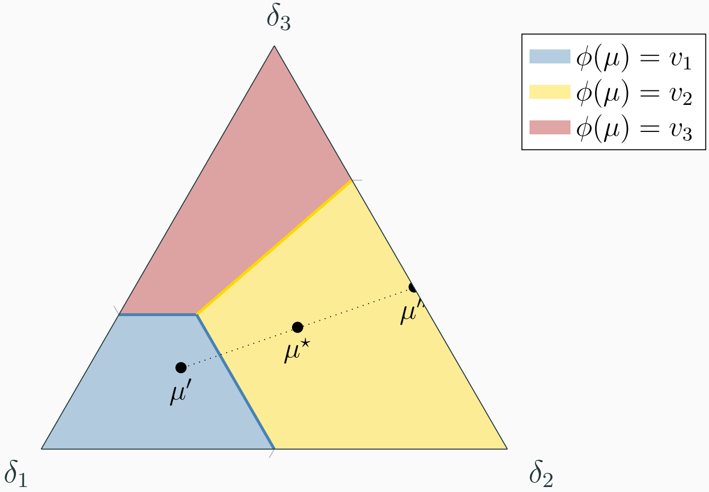

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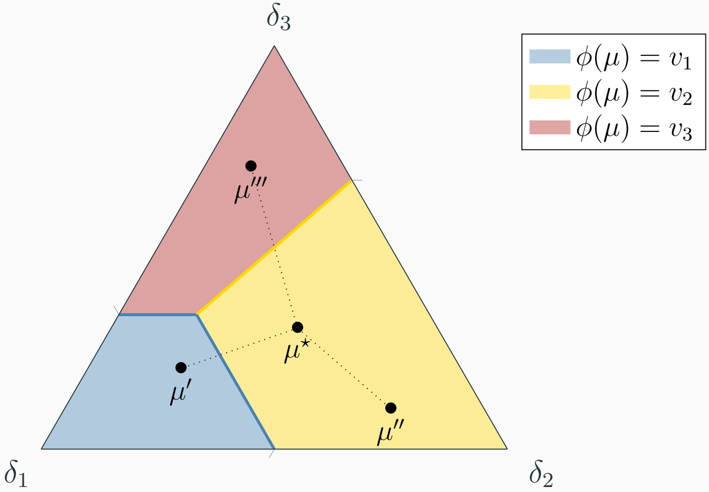

Redistributive Preferences

- Social planner's objective is to maximize a weighted sum of consumers' surplus, with social weights $\boldsymbol{\lambda} = (\lambda_1, \lambda_2, \ldots, \lambda_K)$.
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- Given aggregate market $\mu^\star$, social planner's objective is given by:

$$V(\mu^\star) = \max_{\sigma \in \Sigma(\mu^*)} \sum_{\mu \in \mathrm{supp}(\sigma)} \sigma(\mu) W(\mu) \qquad \text{(WCS)}$$

Preliminary results

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- We can focus on direct segmentations.
- A segment μ is efficient if all consumers in μ buy the good:
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- A segmentation σ is efficient if it is only supported on efficient segments.

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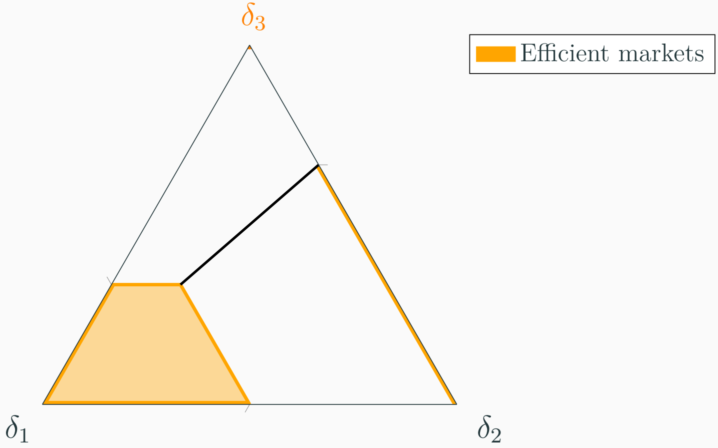
Proposition 1: Optimality implies Efficiency

If $\lambda_K > 0$, any optimal segmentation is efficient.

3-Type Case: Efficient Markets

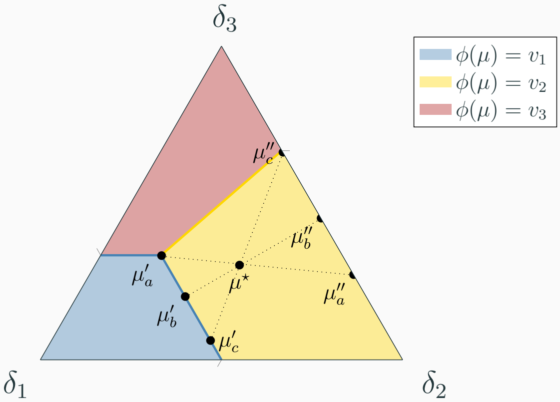


Consumer-optimal segmentations without redistributive concerns

Unweighted-optimal Segmentations

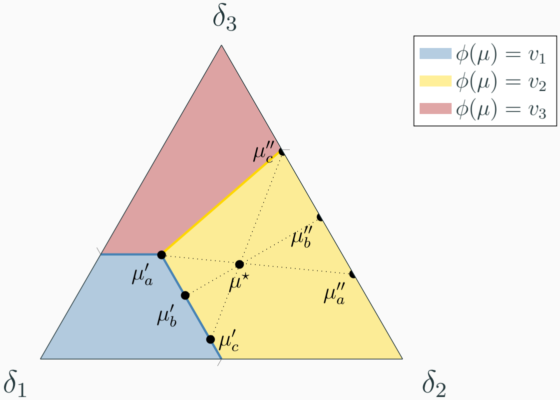
- When $\lambda_1 = \lambda_2 = \cdots = \lambda_{K-1} = \lambda_K$, we have many optimal segmentations.
    - We'll refer to these segmentations as unweighted-optimal.
- As shown in Bergemann, Brooks and Morris (2015), a segmentation is unweighted-optimal if:
    1. It is efficient.
    2. It does not give any additional profits to the monopolist relative to the unsegmented market.

3-Type Case: Unweighted-Optimal Segmentations



- These three segmentations are unweighted-optimal: they maximize total consumer surplus.

3-Type Case: Unweighted-Optimal Segmentations



- However, they do not allocate surplus the same way.
- Under decreasing weights, σ_c is preferred over the other unweighted-optimal segmentations.

Consumer-optimal segmentations with redistributive concerns

Strongly Redistributive Preferences

- We'll study the case where $\boldsymbol{\lambda}$ strongly prioritize lower types.

Definition

Social weights $\boldsymbol{\lambda}$ are κ-strongly redistributive if, for any $k < k' \leq K - 1$, $\frac{\lambda_k}{\lambda_{k'}} \geq \kappa$.

- Preferences are κ-strongly redistributive if the social weight of any type k is at least κ times greater than the social weight of any higher type k'.

Strongly Redistributive Preferences

Proposition 2: Optimal Segmentation under SRP

For any aggregate market $\mu^\star$ in the interior of M, there exists $\underline{\kappa}$ such that if $\boldsymbol{\lambda}$ is $\underline{\kappa}$-strongly redistributive, then any optimal direct segmentation generates segments that divide the type space into overlapping intervals, with the intersection in the support of any two segments being comprised of at most one type.

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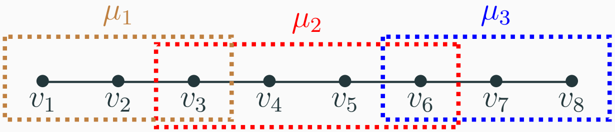
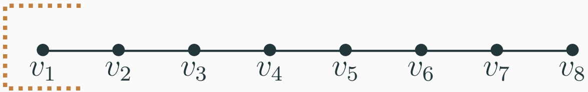


How to Construct Strongly Redistributive Optimal Segmentations



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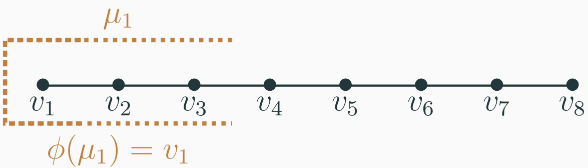

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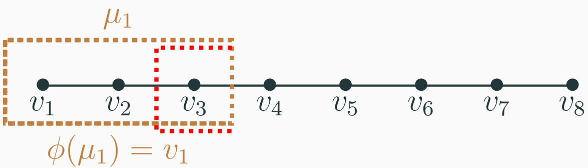

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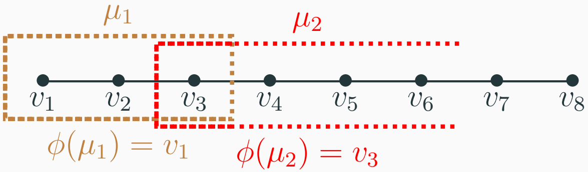

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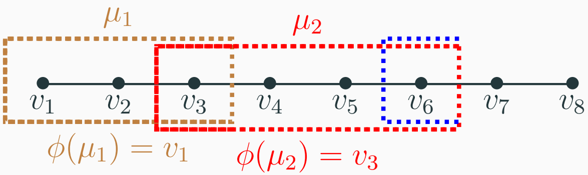

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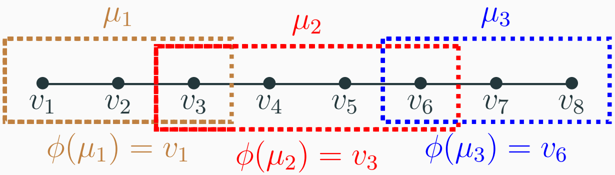
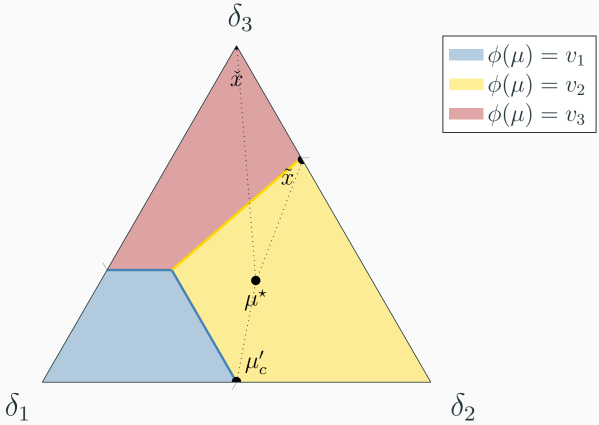


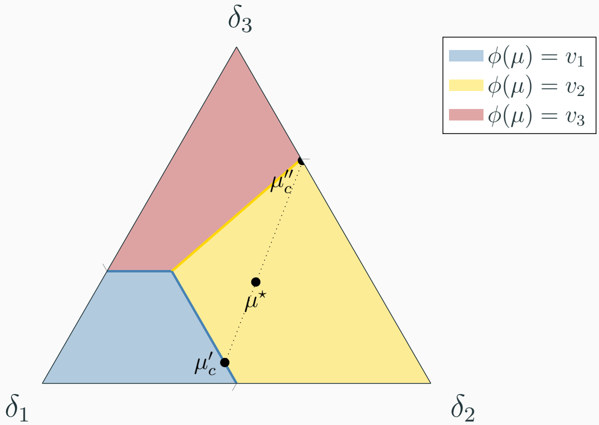
Illustration: 3-Type Case - Optimal Segmentation

- For $\frac{\lambda_2}{\lambda_3} > \frac{v_3+v_2-v_1}{v_2-v_1}$ (i.e. when redistributive motive is strong), the optimal segmentation is the one below.
- Monopolist gets some additional profits relative to the unsegmented market.



3-Type Case: Optimal Segmentation

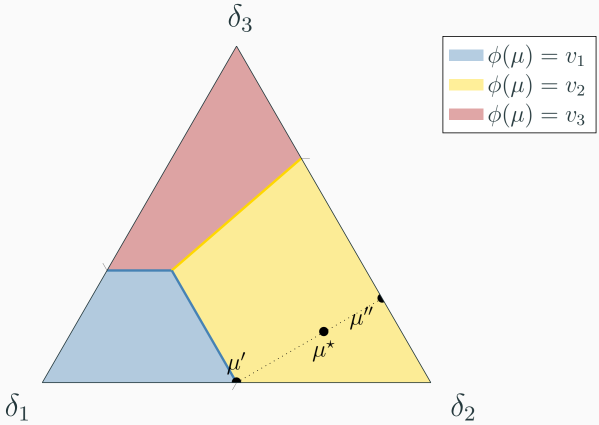
- For $\frac{\lambda_2}{\lambda_3} < \frac{v_3+v_2-v_1}{v_2-v_1}$ (i.e. when redistributive motive is not very strong), the optimal segmentation is the one below.
- Monopolist does not get any additional profits, total consumer surplus is maximized.



When does redistribution require additional profits to the monopolist?

Rent Region: 3-Type Case

- For some aggregate markets an informational rent is never needed to achieve the redistributive goal:



When does redistribution require rents?

Definition: Rent Region

An aggregate market $\mu^\star$ belongs to the rent region if there exists some $\underline{\kappa}$ such that if the social planner has $\underline{\kappa}$-strongly redistributive preferences, the optimal segmentation leaves a rent for the monopolist.

- Conversely, a $\mu^\star$ such that no optimal segmentation ever leaves a rent to the monopolist belongs to the no-rent region.

When does redistribution require rents?

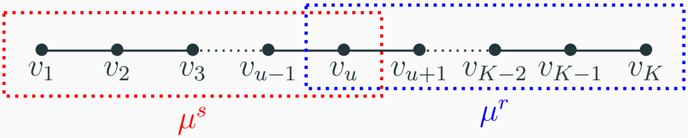
Definition: σ^{NR}

Let μ^* be an aggregate market with uniform price v_u. Call σ^{NR} the segmentation that splits $\mu^\star$ into two segments μ^s and μ^r, with:

$$\mu^s = \left(\frac{\mu_1^*}{\sigma}, \frac{\mu_2^*}{\sigma}, \ldots, \mu_u^s, 0, \ldots, 0\right),$$
$$\mu^r = \left(0, 0, \ldots, \mu_u^r, \frac{\mu_{u+1}^*}{1-\sigma}, \ldots, \frac{\mu_K^*}{1-\sigma}\right),$$

where $\mu_u^s = \frac{v_1}{v_u}$, $\mu_u^r = \frac{\mu_u^\star - \sigma\mu_u^s}{1-\sigma}$ and $\sigma = \frac{v_u \sum_{i=1}^{u-1} \mu_i^\star}{v_u - v_1}$.

- σ^{NR} creates only two segments:



When does redistribution require rents?

Proposition 3: No-Rent Region

Let μ^* be an aggregate market with uniform price v_u. $\mu^\star$ belongs to the no-rent region if and only if σ^{NR} is an unweighted-optimal segmentation of $\mu^\star$.

- No-rent region $\iff$ σ^{NR} maximizes total consumer surplus.

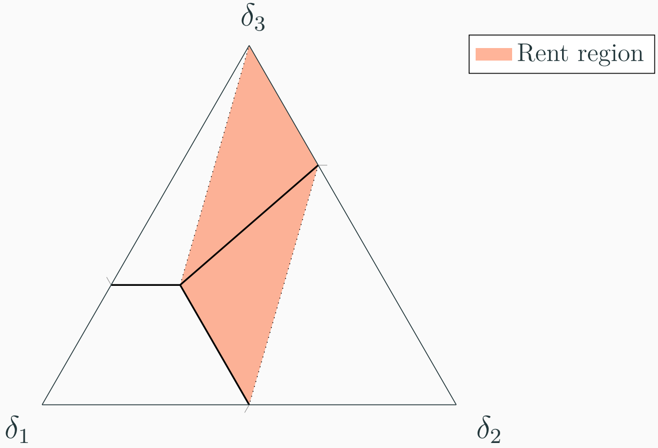
When does redistribution require rents?

Corollary: Rent Region

Let μ^* be an aggregate market with uniform price v_u. If σ^{NR} is not an unweighted-optimal segmentation of $\mu^\star$, then there exists $\underline{\kappa}$ such that under $\underline{\kappa}$-strongly redistributive preferences, the optimal segmentation leaves a rent for the monopolist.

Rent Region: 3-Type Case

- For any aggregate market in the shaded region, informational rents to the monopolist are needed whenever the redistributive motive is sufficiently strong.



Optimal Segmentation: No-rent markets

Corollary: Optimal Segmentation for No-Rent Markets

If a market $\mu^\star$ belongs to the no-rent region, σ^{NR} is its optimal segmentation.

- So for no-rent markets, optimal segmentations only generate two segments.
  - One discount segment with price v_1, pooling types from v_1 to v_u.
  - One uniform price segment with price v_u, pooling types from v_u to v_K.
- This segmentation is optimal for any (weakly) decreasing social weights.

Takeaways

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- Depending on how it's done, different consumers will reap the benefits.
- If we want poorer consumers to benefit, segments of the market in which they are pooled together must be created.
    - This comes at the expense of richer consumers.
- Depending on the composition of the market, this may be at the expense of total consumer surplus: informational rents to the seller might be needed to meet the redistributive goal.