Imperfect Platform Competition: A General Framework

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This Paper: Competition in Two-Sided Markets

Example: Apple and Microsoft's Operating Systems
- End Users
- Software Developers

More Broadly: *Consumption Externalities*
- Credit Cards
- Search Engines
- Internet Service Provision
- Newspapers

Consumption Externalities Drive Important Issues

For Instance:

- Network Neutrality
- Payment Cards Pricing
- Concentration in Network Industries

So far, literature has focused on stylized models

To inform policymaking, would like a richer model

This Paper's Contribution

Develops techniques to study platform competition
while relaxing restrictive assumptions

- Functional forms
- Symmetry of platforms
- "Homing"
- Consumer heterogeneity

General pricing formula demonstrating *Spence distortion*

"Embeds" ordinary differentiated Bertrand competition

Our Approach

1. Build a general model to illustrate two basic indeterminacies arising in such settings
2. Propose an economically-motivated solution concept:

Insulated Equilibrium

Exploits *Two Sources* of Multiplicity,
gives uniqueness

The Model

$m \geq 1$ platforms

Two "groups" or "sides" of consumers

$\mathcal{S} = \mathcal{A}, \mathcal{B}$

The Model

Demand:

Each consumer on side $\mathcal{S} = \mathcal{A}, \mathcal{B}$ has quasi-linear utility

$$v^{\mathcal{S}}\left(\mathfrak{X}, \mathbf{N}^{-\mathcal{S}}, \theta^{\mathcal{S}}\right) - y$$

The Model

Supply:

Platform j receives profits

$$\sum_{\mathcal{S}=\mathcal{A},\mathcal{B}} P^{\mathcal{S},j} N^{\mathcal{S},j} - C^{j}\left(N^{\mathcal{A},j}, N^{\mathcal{B},j}\right)$$

Timing and Strategies

1. Platforms announce price functions
2. Consumers decide which set of platforms to join

Platform Strategies

A price function for each side of the market

$$\sigma^{\mathcal{S},j} = \sigma^{\mathcal{S},j}\left(\mathbf{N}^{-\mathcal{S}}\right)$$

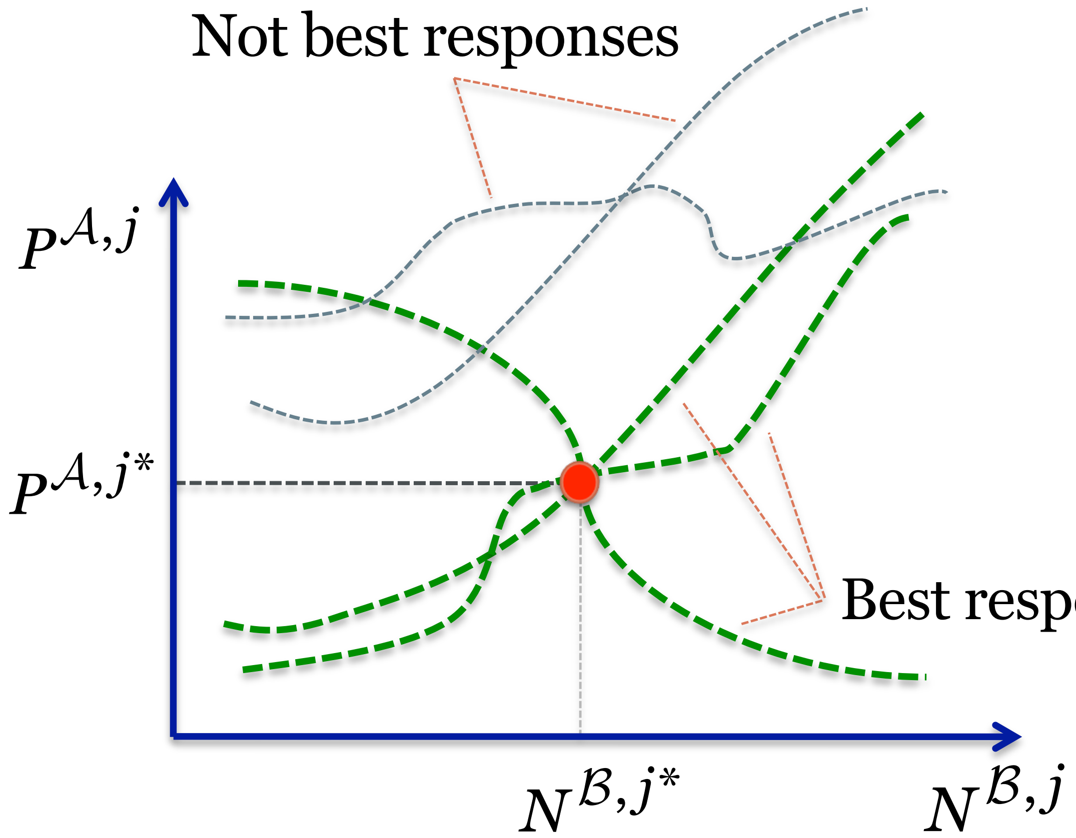
Note: $\sigma^{\mathcal{S},j}$ can depend on *entire* opposite-side "allocation"

Multiplicity in Stage 2:

Well known: *Consumer Coordination*

Multiplicity in Stage 1: *Armstrong's Paradox*

Candidate strategies $\sigma^{\mathcal{A},j}$ for platform j on side $\mathcal{A}$



Our Solution Concept – We Posit That:

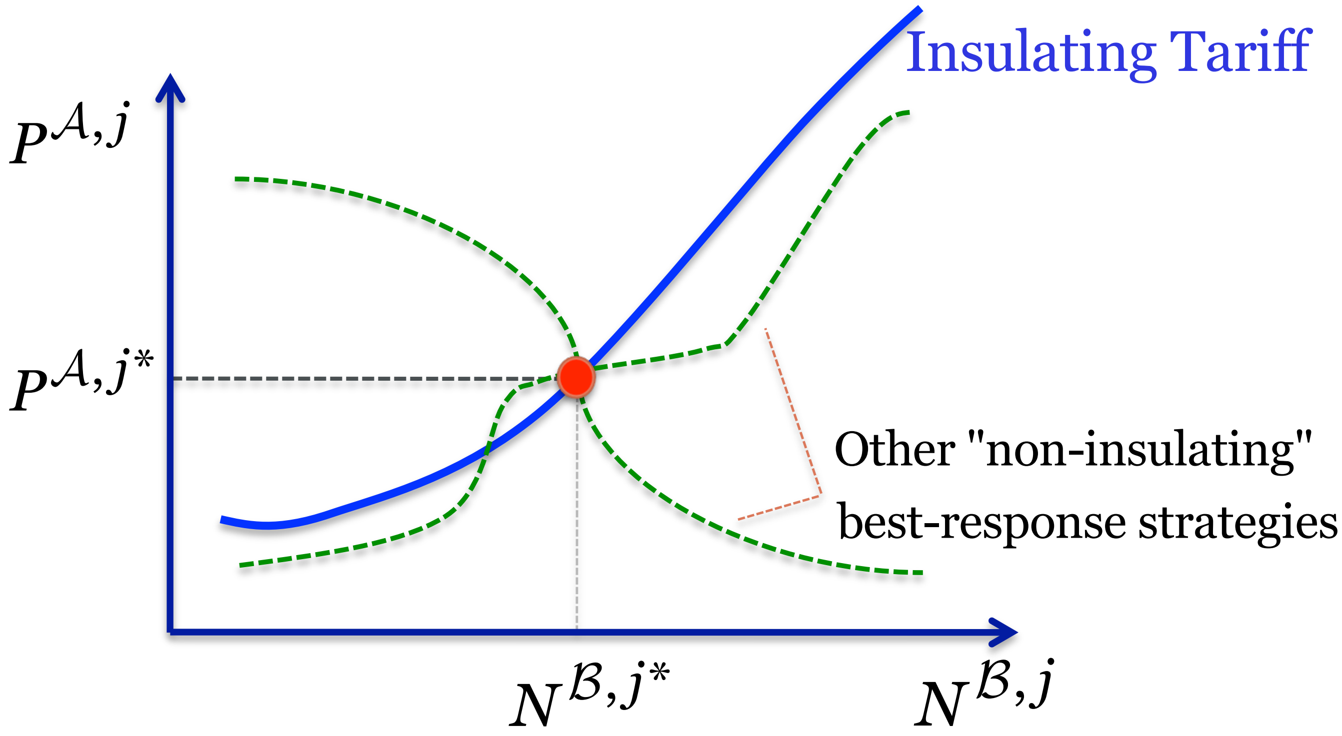
1. Holding fixed the strategies of all other platforms, each platform identifies its optimal feasible allocation on each side of the market.

2. From among the many price functions that weakly implement this desired allocation, each platform selects *Residual Insulating Tariffs*, which are special in that they remove any scope for problems of Consumer Coordination, thus guaranteeing that the chosen allocation will be realized.

When all platforms do this as a best response to one another, it is an Insulated Equilibrium.

Illustration of Residual Insulating Tariff

Best-response strategies for platform j on side $\mathcal{A}$



Pricing

Pricing at Social Optimum: Pigouvian

$$P^{\mathcal{S},j} = C^j_{\mathcal{S}} \quad - \quad N^{-\mathcal{S},j}\,\overline{v_{\mathcal{S}}^{-\mathcal{S},j}}$$

Average "interaction value"
of platform *j*'s consumers on side $-\mathcal{S}$

Pricing at Insulated Equilibrium

$$P^{\mathcal{S},j} = C_{\mathcal{S}}^{j} + \mu^{\mathcal{S},j} \quad - \quad N^{-\mathcal{S},j} \left[\frac{\partial \overline{\mathbf{P}^{-\mathcal{S}}}}{\partial \mathbf{N}^{\mathcal{S}}} \right]_{j,\cdot} \left[-\mathbf{D}^{\mathcal{S}} \right]_{\cdot,j}$$

Same as in one-sided market

Impact on profits from opposite side

Shape of the Insulating Tariff System

$$\mathrm{O}_{m\times m} = \left[\frac{\partial \mathbf{N}^{-\mathcal{S}}}{\partial \mathbf{N}^{\mathcal{S}}}\right] + \left[\frac{\partial \mathbf{N}^{-\mathcal{S}}}{\partial \overline{\mathbf{P}^{-\mathcal{S}}}}\right]\left[\frac{\partial \overline{\mathbf{P}^{-\mathcal{S}}}}{\partial \mathbf{N}^{\mathcal{S}}}\right]$$

$$\Leftrightarrow$$

$$\left[\frac{\partial \overline{\mathbf{P}^{-\mathcal{S}}}}{\partial \mathbf{N}^{\mathcal{S}}}\right] = \left[-\frac{\partial \mathbf{N}^{-\mathcal{S}}}{\partial \overline{\mathbf{P}^{-\mathcal{S}}}}\right]^{-1}\left[\frac{\partial \mathbf{N}^{-\mathcal{S}}}{\partial \mathbf{N}^{\mathcal{S}}}\right]$$

$$\frac{\partial N^{-\mathcal{S},k}}{\partial \overline{P^{-\mathcal{S},j}}}$$

mass of marginal consumers

$$\frac{\partial N^{-\mathcal{S},k}}{\partial N^{\mathcal{S},j}}$$

mass of marginal consumers

×

their average “interaction value”

Pricing

Pricing at Social Optimum: Pigouvian

$$P^{\mathcal{S},j} = C^{j}_{\mathcal{S}} \quad - \quad N^{-\mathcal{S},j}\,\overline{v^{-\mathcal{S},j}_{\mathcal{S}}}$$

Pricing at Insulated Equilibrium

$$P^{\mathcal{S},j} = C^{j}_{\mathcal{S}} + \mu^{\mathcal{S},j} \quad - \quad N^{-\mathcal{S},j}\underbrace{\left[-\frac{\partial \mathbf{N}^{-\mathcal{S}}}{\partial \overline{\mathbf{P}}^{-\mathcal{S}}}\right]^{-1}\left[\frac{\partial \mathbf{N}^{-\mathcal{S}}}{\partial \mathbf{N}^{\mathcal{S}}}\right]_{j,\cdot}\left[-\mathbf{D}^{\mathcal{S}}\right]_{\cdot,j}}$$

Spence Distortion

Example: Media Pricing

- 2 newspapers
- Readers buy only their favorite paper
- For advertisers, decision to buy ads in one paper is independent of the other paper

Example: Media Pricing

Readers' (Side $\mathcal{R}$) Price

$$P^{\mathcal{R},j} = C^{j}_{\mathcal{R}} + \mu^{\mathcal{R},j} \quad - \quad N^{\mathcal{A},j}\,\widetilde{v^{\mathcal{A},j}_{\mathcal{R}}}$$

Average valuation among paper j's marginal advertisers for an additional reader

- Anderson & Coate (2005)
- Weyl (2010)

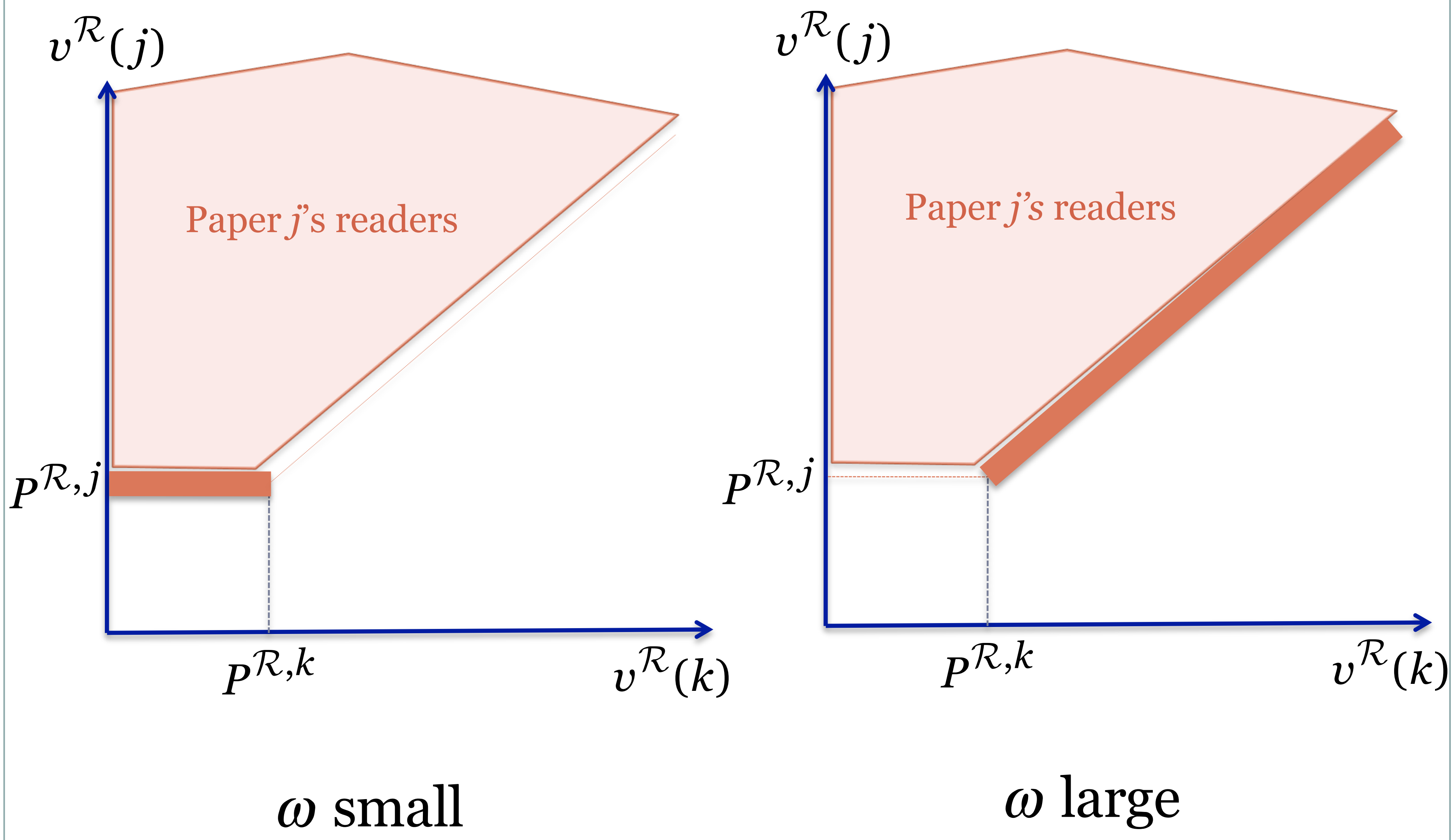
Example: Media Pricing

Advertisers' (Side $\mathcal{A}$) Price

$$P^{\mathcal{A},j} = C^{j}_{\mathcal{A}} + \mu^{\mathcal{A},j} - N^{\mathcal{R},j}\underbrace{\left(\omega\widetilde{v^{j,k}} + (1-\omega)\widetilde{v^{j,\varnothing}}\right)}$$

- Weighted average of paper *j*'s marginal readers' distaste for an additional ad
- Weight $\omega = \dfrac{1}{2 + \dfrac{f_{j,\varnothing}}{f_{j,k}}}$
- $f_{j,\varnothing}$ and $f_{j,k}$ are marginal masses of readers

Effect of Competition on Spence Distortion



Extensions and Discussion

- Generalization to many sides, within-side externalities
- First-order analysis of platforms mergers
- Empirical application in a discrete choice setting

Conclusion

Paper aspires to make 3 contributions

1. Develops a general model of competition incorporating consumption externalities; illustrates indeterminacies of this class of model
    - Consumer Coordination
    - Armstrong's Paradox
2. Proposes solution concept of Insulated Equilibrium
3. Identifies Spence distortion (in addition to market power) and provides framework for analyzing effects of competition