Platform Oligopoly with Endogenous Homing: Applications to Mergers and Free Entry

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Motivation/Summary

- It looks like a platform merger would be **less harmful** if **multi-homing** is prevalent.
  - Because substitution between platforms is already low.
- We point out **one adverse effect**—reduction in output (customer base)—in a new framework that embeds consumer multi-homing in a two-sided market:
  - **Standard Cournot oligopoly** + **Incremental-Value Principle**
  - Apply it to (1) platform mergers and (2) free entry

Literature

- Jeitschko and Tremblay (2020, IER)
  - Bertrand price competition
- Bakos and Halaburda (2020, Management Sci)
  - Duopolistic Hotelling price competition
- Correia-da-Silva, Jullien, Lefouili, and Pinho (2019, JEMS)
  - Cournot competition, but with single-homing on both sides
- Liu, Teh, Wright, and Zhou (2021, working paper)
  - Homing patterns are exogenously given

- Our advantage:
  - Unlike much of the previous literature, we can investigate **how changes in N impact welfare** as in the traditional Cournot setting in consideration of **endogenous multi-homing**.

A Two-Sided Market with Multi-Homing

Platforms

- Profits for platform X, $X = 1, 2, ..., N$, are given by:

$$\Pi^X = \underbrace{[p_C^X - c^X] \cdot n_C^X}_{\text{Consumers}} + \underbrace{p_S^X \cdot n_S^X}_{\text{Sellers}},$$

  where $c^X \geq 0$ denotes MC for an additional consumer.

- Each platform competes for the customer base, choosing q^X.
  - Consumer prices p_C^X are so determined that they are consistent with $n_C^X = q^X$ for all X.
- Each platform also chooses the prices for sellers p_S^X.
  - Sellers choose the portfolio of the platforms to join.

Consumers (heterogenous)

- Consumer type: $\tau \in [0, \overline{\tau}]$ (distributed uniformly)
- Type τ's utility from joining platform $X = 1, 2, ..., N$ is:

$$u_C^X(\tau) = \alpha_C(\tau) n_S^X - p_C^X,$$

  where
  - $\alpha_C(\cdot)$: indirect network benefits for consumers (decreasing)
  - n_S^X: number of sellers on platform X
  - p_C^X: consumer price of platform X
- Outside option (from joining no platform) has zero value for all consumers.

Sellers (homogeneous)

- The utility from joining platform X for a seller is given by:

$$U_S^X = \pi \cdot n_C^X - p_S^X,$$

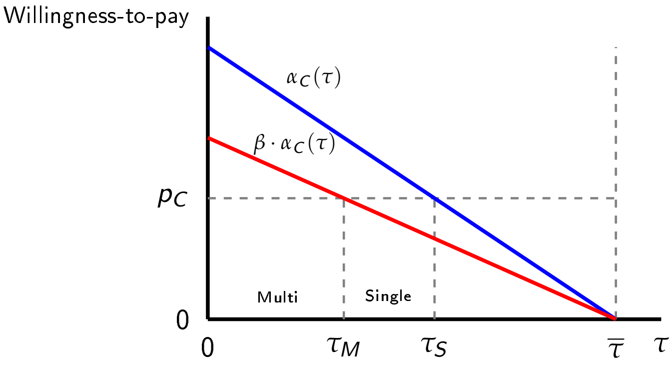
  where
  - $\pi > 0$: network externality parameter for sellers
  - n_C^X: number of consumers on platform X
  - p_S^X: seller price of platform X
- Outside option has zero value for all sellers.

Multi-homing: β and δ

- Consumers derive a fraction $\beta \in [0, 1]$ **of network benefits when they meet with the second seller**.
  - They do not derive extra network benefits from the third, fourth, ... transactions.
  - In this way, consumers have no incentives to join more than two platforms.
- Sellers derive **additional network benefits** $\delta\pi$, where $\delta \in [0, 1]$, by **multi-homing on two platforms**.
  - No extra network benefits accrue if they multi-home more than two platforms.

Demand for Platforms

Multi-Homing and Single-Homing Decisions



- Each platform has $\frac{2}{N}\tau_M$ multi-homing consumers because the τ_M consumers join **two** platforms randomly.

Consumer Price, p_C

- Market clearing price must satisfy the **single-homing margin**:

$$p_C = \alpha_C(\tau_S),$$

given that all sellers multi-home (i.e., $n_S^X = 1$ for any X).

- On the other hand, the **multi-homing margin** implies that $\beta\alpha_C(\tau_M) - \alpha_C(\tau_S) = 0$ as well, or

$$p_C = \beta \cdot \alpha_C(\tau_M),$$

which gives the multi-homing type τ_M as a function of τ_S,

$$\tau_M = \tau_M(\tau_S).$$

Consumer Price, p_C (cont'd)

- **Total customer base**, $Q = \sum_{X=1}^{N} q^X$, is equal to

$$2\tau_M + (\tau_S - \tau_M)$$

  - because it consists of τ_M consumers who join two platforms and $\tau_S - \tau_M$ consumers who join one platform.

- The single-homing margin is a function of Q, $\tau_S = \tau_S(Q)$, given implicitly by:

$$Q = \underbrace{2\tau_M}_{\text{multi-homing}} + \underbrace{(\tau_S - \tau_M)}_{\text{single-homing}} = \tau_M(\tau_S) + \tau_S.$$

Seller Price, p_S^X: Incremental-Value Pricing Principle

- Incremental value of a platform for the seller:

$$\underbrace{\tilde{\pi}_S^N - \tilde{\pi}_S^{N-1}}_{\text{Marginal gross profit change}} = \pi \cdot \left[q^X - \frac{2(1-\delta)}{N} \tau^M \right] \quad (3)$$

Lemma 1

For any given profile $(q^X)_{X=1,\ldots,N}$, all sellers multi-home and each platform sets a seller price, p_S^x, given by the RHS of Equation (3).

The Cournot Platform Equilibrium

Preliminaries

- Given the demand structure described above, platform X chooses its own customer base, q_X, to maximize its profit,

$$\Pi^X = [\alpha_C(\tau_S) - c^X]q^X + \pi\left[q^X - \frac{2}{N}(1-\delta)\tau_M(\tau_S)\right].$$

- The equilibrium total customer base, Q^*, is obtained by:

$$\frac{p_C}{\epsilon(Q)} + Np_C - \sum_{X=1}^{N} c^X + N\pi\left(1 - \frac{2(1-\delta)}{N}\frac{1}{\frac{1}{\tau'_M[\tau_S(Q)]}+1}\right) = 0,$$

where $p_C = \alpha_C[\tau_S(Q)]$, and $\epsilon = \frac{dQ}{dp_C}\cdot\frac{p_C}{Q}$ is the elasticity of consumer demand.

Characterization

Proposition 1

If $c^X = c$ for all X, then the symmetric equilibrium pricing strategy for each platform is implicitly given by

$$p_C^* = c + \underbrace{\frac{1}{N} \cdot \frac{p_C^*}{-\epsilon}}_{\text{markup}} - \underbrace{\pi \cdot \left[1 - \frac{2(1-\delta)}{N} \frac{1}{\frac{1}{\tau_M'(\tau_S(Q^*))} + 1}\right]}_{\text{markdown}}.$$

Characterization (cont'd)

- On the consumer side, the equilibrium price, p_C^*, induced by Cournot platform competition resemble a combination of both:
  1. the traditional Cournot pricing, where $p^* = c + \frac{1}{N} \cdot \frac{p^*}{-\epsilon}$
  2. the monopoly platform pricing, where $p_C = c + \frac{p_C}{-\epsilon} - \pi n_S$.
- The **markdown term** gets larger in absolute terms as N increases.
  1. This stems from the incremental pricing strategy.
  2. More platforms will increase competition on the seller side.
     - Each platform attempts to attract more consumers through a larger consumer markdown.

Applications

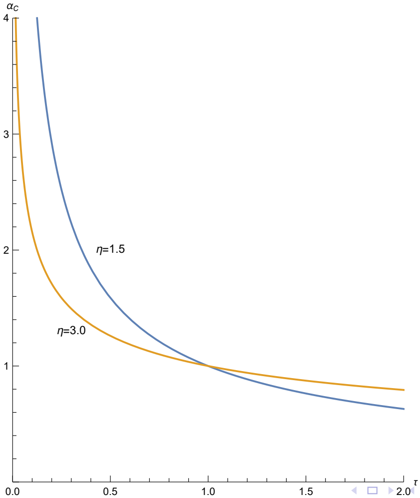
Simplification

- Constant-elasticity demand specification:

$$\alpha_C(\tau) = \tau^{-\frac{1}{\eta}},$$

where $\eta > 1$ is the elasticity of demand.

Simplification (cont'd)



Simplification (cont'd)

- As a result, Q^* is explicitly given by

$$Q^* = (1+\beta^\eta)\left(\frac{\sum_{X=1}^{N} c^X - \pi\left[N - 2(1-\delta)\theta_M\right]}{-\frac{1}{\eta} + N}\right)^{-\eta},$$

where $\theta_M \equiv \frac{\tau_M}{Q} = \frac{\beta^\eta}{1+\beta^\eta}$ is the fraction of multi-homing consumers relative to total output.

- Consumer price is given by

$$p_C = \alpha_C[\tau(Q)] = \left(\frac{Q}{1+\beta^\eta}\right)^{-\frac{1}{\eta}}$$

Simplification (cont'd)

- Consumer surplus, CS, is given as a function of Q by

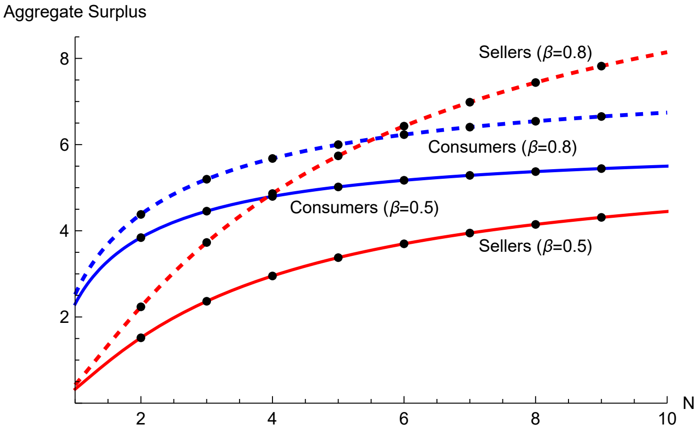
$$CS = \frac{(1+\beta^{\eta})^{\frac{1}{\eta}}}{\eta - 1} Q^{\frac{\eta-1}{\eta}}.$$

- Seller surplus, SS, is also given as a function of Q by

$$SS = \frac{(2-\delta)\beta^{\eta}}{1+\beta^{\eta}} Q.$$

Simplification (cont'd)

- $\delta = 0.5$, $\pi = 1.0$, $\eta = 1.5$, and $c = 1.2$ for all $X = 1, 2, ..., N$



A Merger Analysis

Setup

- There are **a few studies of platform mergers under consumer multi-homing**.
  - Except for the studies that focus solely on media mergers such as Ambrus, Calvano, and Reisinger (2016) and Anderson, Foros, and Kind (2019)
- It suffices to examine **whether a merger increases** Q to evaluate whether $\Delta CS > 0$.
  - Farrell and Shapiro (1990); Nocke and Whinston (2010)

Setup (cont'd)

- Let $c^M \equiv \min\{c^X, c^Y\}$ be the cost without synergies.
- Let $\Delta c^M \equiv c^M - \hat{c}^M$ be the size of synergy required to the merger to improve consumer surplus.
- Then, it is verified that

$$\begin{aligned}\Delta c^M &= \frac{p_C}{\eta}\left[s^M - \max\{s^X, s^Y\}\right] + 2(1-\delta)\theta_M \pi\left(\frac{1}{N-1} - \frac{1}{N}\right) \\ &= \frac{(1+\beta^\eta)^{\frac{1}{\eta}} Q^{-\frac{1}{\eta}}}{\eta}\left[s^M - \max\{s^X, s^Y\}\right] \\ &\quad + 2(1-\delta)\frac{\beta^\eta}{1+\beta^\eta}\pi\left(\frac{1}{N-1} - \frac{1}{N}\right).\end{aligned}$$

Result

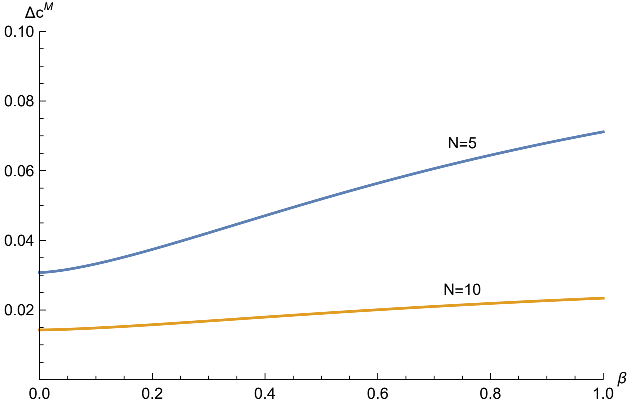
Proposition 2

The level of merger-specific synergy that is required for CS to increase, Δc^M,

- ***increases** with the level of consumer multi-homing β*
- ***decreases** with the level of seller multi-homing δ.*

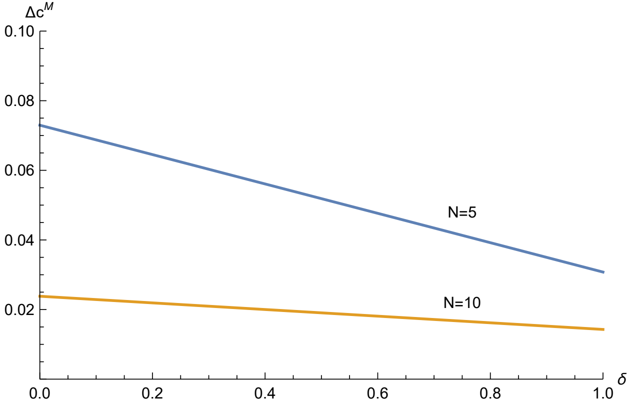
$\Delta c^M(\beta, \overline{\delta})$

- $\delta = 0.5$, $\pi = 1.0$, $\eta = 1.5$, and $c = 1.2$ for all $X = 1, 2, ..., N$



$\Delta c^M(\overline{\beta}, \delta))$

- $\beta = 0.5$, $\pi = 1.0$, $\eta = 1.5$, and $c = 1.2$ for all $X = 1, 2, ..., N$



Intuition

- When multi-homing consumers are dispersed to N platforms, the overlap in consumers between platforms becomes small as N increases.
- Hence, a reduction in N *increases* this overlap.
  - Platforms have **weaker** incentives to expand customer base to obtain revenue from sellers.
    - This adverse effect becomes stronger **as the fraction of multi-homing consumers increases**, requiring greater synergies.
- On the contrary, Δc^M **decreases with** δ.
  - This is because the adverse effect above becomes **weaker** as the sellers' willingness to pay for interaction with overlapped consumers increases.

Social (In)efficiency of Entry

Setup

- Consider the case where there is an infinite number of potential entrant platforms with marginal cost c and entry cost $K > 0$.
- In this scenario, platforms first choose whether to enter the market and upon entry, they play a Cournot platform competition.
- Recall that we consider the case where $\alpha_C(\tau) = \tau^{-\frac{1}{\eta}}$.
- Furthermore, assume that all the platforms are symmetric so that $c^X = c$ for all X.

Setup (cont'd)

- Thus, the equilibrium total output given the number of platforms N is

$$Q^*(N) = (1+\beta^\eta)\left(\frac{Nc - \pi[N - 2(1-\delta)\theta_M]}{-\frac{1}{\eta} + N}\right)^{-\eta}.$$

- The equilibrium profit of each platform given the number of platforms N is

$$\Pi^*(N) = \frac{Q^*(N)}{N}[p_C - c + \pi - 2(1-\delta)\theta_M \pi] - K.$$

- Therefore, in the free-entry equilibrium, the number of platforms N^E is given by $\Pi^*(N^E) = 0$.

Analysis

- Social welfare W, defined as the sum of consumer surplus, seller surplus, and platform profits, is given by

$$\begin{aligned} W(N) =& CS + SS + N \cdot \Pi^*(N) \\ =& \frac{\eta}{\eta - 1}(1 + \beta^\eta)^{\frac{1}{\eta}} [Q^*(N)]^{\frac{\eta - 1}{\eta}} \\ & - [c - \pi (1 + \theta_M \delta)] Q^*(N) - NK \end{aligned}$$

- Equilibrium number of platform is insufficient (resp. excessive) if $W'(N^E) > 0$ (resp. $W'(N^E) < 0$).

Result: Inefficient Entry

Proposition 3

- *If* $c \in \left((1 - \frac{2(1-\delta)}{N}\theta_M)\pi, \pi \right]$, *then the equilibrium number of platforms is* ***always insufficient*** *in terms of social welfare.*
- *If* $c > \pi$, *then there exists* $\hat{\omega}(N^E) > 0$ *such that the equilibrium number of platforms is* ***insufficient if and only if***

$$\frac{\theta_M \pi}{c - \pi} > \hat{\omega}(N^E).$$

Comments

- Insufficient entry takes place only if $\theta_M = \frac{\beta^\eta}{1+\beta^\eta} > 0$ and $\pi > 0$ holds.
  - Thus, both the presence of consumer multi-homing and indirect network externalities are **necessary** for the insufficient entry result.
- Furthermore, the higher θ_M and π are, the more likely it is that insufficient entry takes place.

Intuition

- This property is driven by the fact that, when consumers multi-home, platforms cannot extract the surplus from sellers because the presence of overlapping membership **lowers** the incremental value of each platform for the sellers.
- As a result, the profit each platform obtains from sellers becomes **lower** than the surplus that sellers obtain from platform entry. This creates the source of insufficient entry.

Comments (cont'd)

- Proposition 3 suggests that contrary to the standard excessive entry result under Cournot competition of Mankiw and Whinston (1986) and Suzumura and Kiyono (1986), the presence of consumer multi-homing in two-sided markets tends the platform entry **insufficient**.
- This results provides the following policy implication.
  - There is a popular discussion that consumer multi-homing lowers the entry of new platforms, so the entry barriers are of less importance.
  - However, our insufficient entry result suggests that from the welfare perspective, policymakers should be more cautious about the insufficient entry when consumer multi-homing become important.