Product Bundling and Quality Innovation in Network Industries

Yi-Ling Cheng
National Sun Yat-sen University

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Network externalities (NEs)

- **Direct externalities**
- **Indirect externalities**
- Both are important and common in digital markets.

Smartphones

Operating Systems

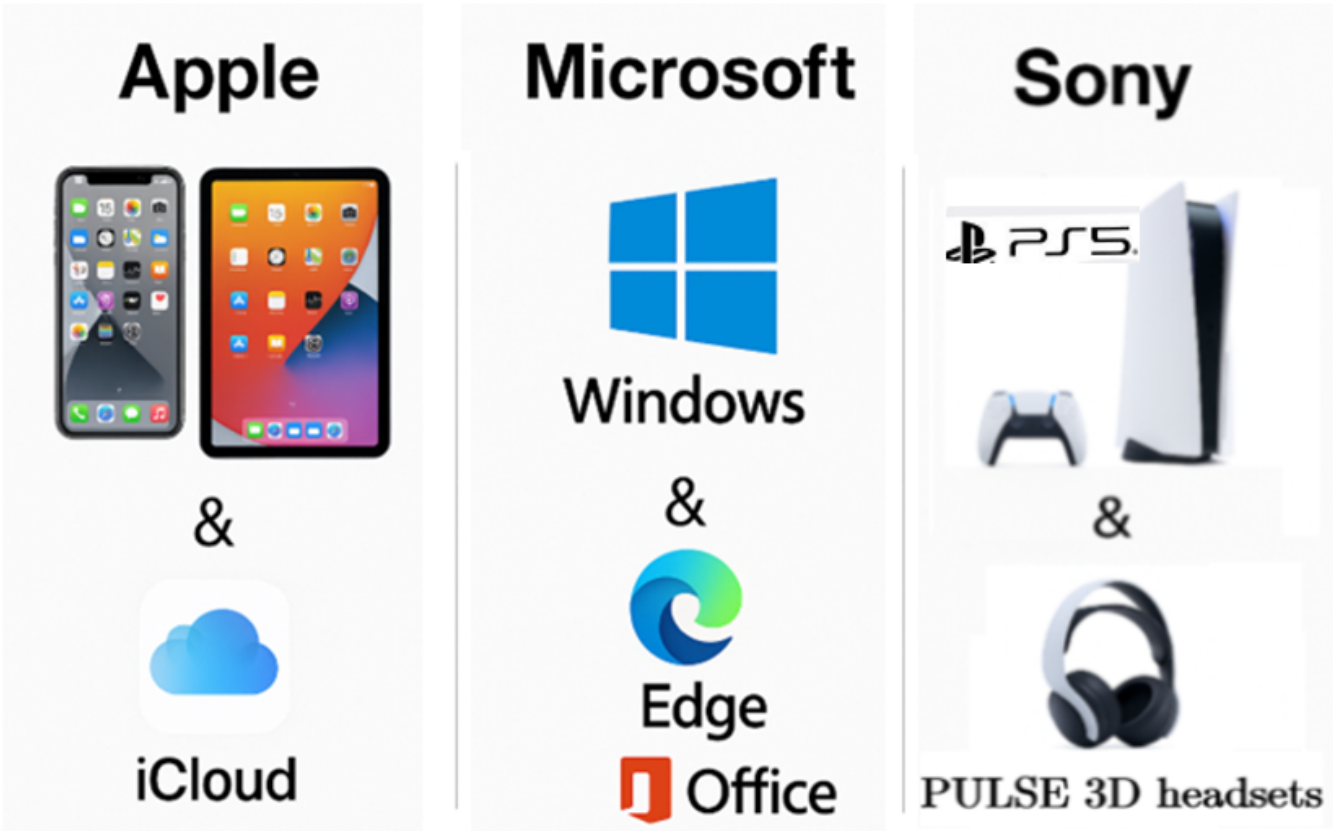
Windows

macOS

Online games

Digital markets: Network Effects+Bundling

- Dominant firms bundling products



Purpose

In these industries, **network size (NS)** and **quality innovation (QI)** are two key factors that determine a product's value and success. This paper studies:

- How bundling impacts on both of them in the primary (bundling) and secondary (bundled) products, as well as overall welfare.
- How NEs impact the firm's incentives to adopt bundling strategies.

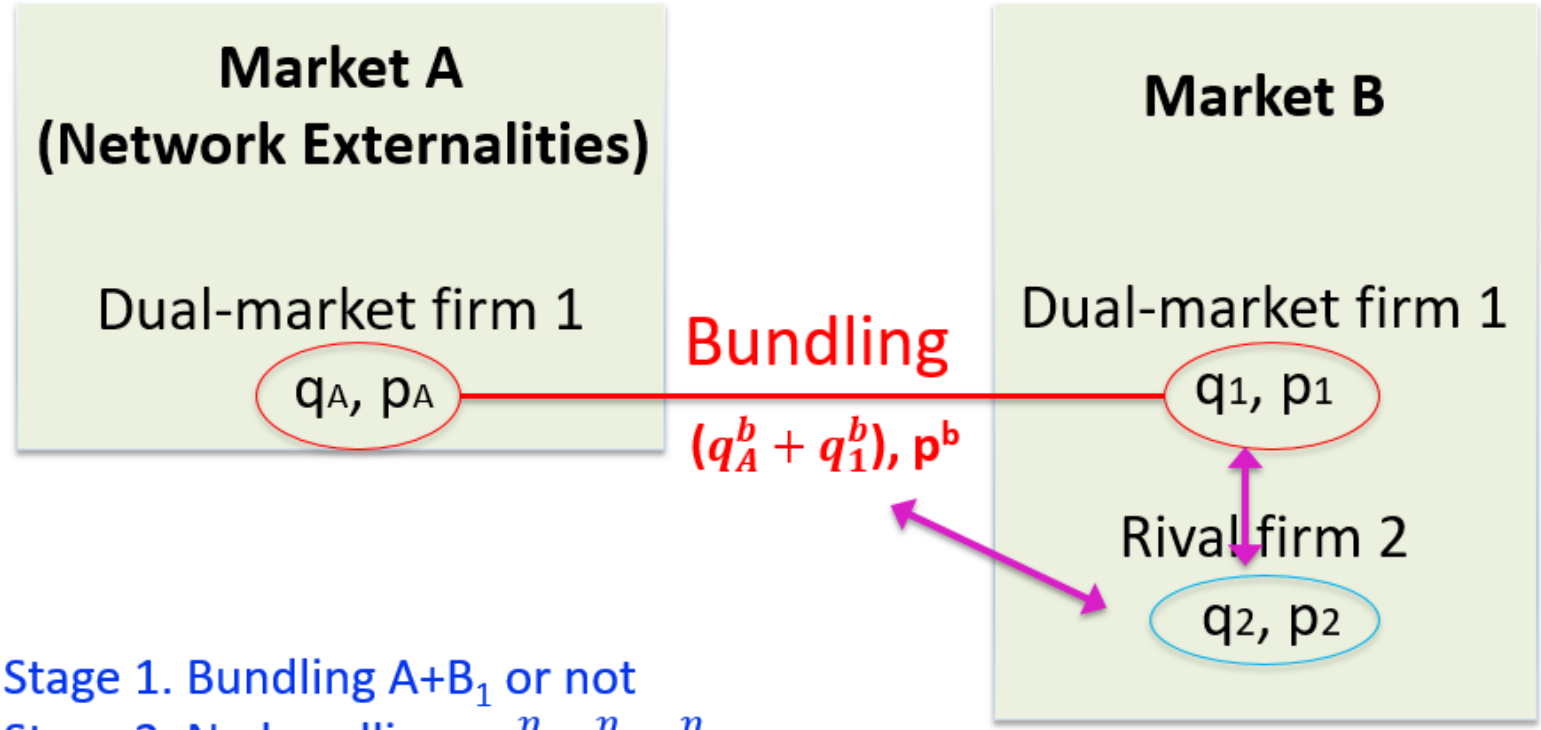
Literature Review

There is a large literature on bundling (e.g., Gilbert and Riordan, 2007; Avenali et al., 2013), but most studies do not consider network effects.

- Two exceptions: Carlton and Waldman (2002), Choi et al. (2023), but they both assume that network externalities arise in the secondary (bundled) market and do not study innovation.
- However, we often see strong NEs in primary product markets, usually dominated by large, innovative firms, like the Windows of Microsoft.
- Thus, I consider the externalities are tied to a primary product rather than a secondary one, and the market is dominated by a large firm.

Model

- Two product markets: A is a network product provided by a monopoly. Market B is a duopoly.



Stage 1. Bundling A+B_1 or not
Stage 2. No bundling: $q_A^n, q_1^n; q_2^n$
Bundling: $(q_A^b + q_1^b); q_2^b$
Stage 3. No bundling: $p_A^n, p_1^n; p_2^n$
Bundling : $(p^b), p_2^b$

Findings: Effects of bundling

1. The package combines the two qualities and NB spillover from A. Its overall quality is higher than the standalone product.
   $\Rightarrow$ in B, Firm 1's competitiveness $\uparrow$ & VPD$\uparrow$ (Competition$\downarrow$)
   $\Rightarrow$ Overall QI by Firm 1 decreases
2. After bundling, A needs to compete with the rival
   $\Rightarrow$ A from monopoly to duopoly$\Rightarrow$ competition $\uparrow\Rightarrow$ **A's users**$\uparrow$
3. Bundling forces consumers to buy B with A
   $\Rightarrow$**A's users** $\downarrow\Rightarrow$lower network value$\Rightarrow$**A's users** $\downarrow$
   (Higher NEs: the feedback loop is stronger, leading to more user loss.)

- **Low** NEs: A's user base$\uparrow$, A's QI $\uparrow$, rival's QI $\uparrow$; CS $\uparrow$, Welfare $\uparrow$.
- **High** NEs: A's user base$\downarrow$, A's QI $\downarrow$, rival's QI $\downarrow$; CS $\downarrow$, Welfare $\downarrow$.

Findings: firm's Incentives for bundling

- In B, the two firms are symmetric — either can become the high-quality provider geting higher profits.
- Bundling is not just creating a more attractive package; it enables Firm 1 to provide the high-quality B.
- If the firm starts with a **low-quality B** $q_1 < q_2$, bundling helps it to reverse the quality order and take over the high-quality spot.
- Thus, for a low-quality firm, it's always profitable to bundle.
- Bundling's effect by a low-quality firm.
  - Low NEs: A's user base ↑, A's QI ↑, rival's QI ↑; CS ↑, Welfare ↑.
  - High NEs: A's user base ↓, A's QI ↓, rival's QI ↓; CS ↓, Welfare ↓.

Findings: firm's Incentives for bundling

- If Firm 1 already offers the **high-quality** B ($q_1 > q_2$), it's profitable for it to bundle under **intermediate** NEs.
  - Low NEs: competition$\uparrow \Rightarrow$ profits$\downarrow$.
  - High NEs: user loss$\Rightarrow$ profits$\downarrow$.
- At this range of NEs, the high-quality firm adopts bundling
  - A's user base$\downarrow$, CS$\downarrow$, and W$\downarrow$.
- Regualtion on bundling may be necessary. We've seen real cases
  - In 2004, European Commission required Microsoft to unbundle *Windows Media Player* from *Windows*, arguing that the default bundling limited choice and harmed CS.
  - In 1998, Microsoft bundled *Internet Explorer* with *Windows*, breaching antitrust laws.

Conclusion

- Choi et al. (2023): NEs are in the **secondary market**
  - Bundling **expands the user base of the secondary product**
  - **Higher NEs: larger user expansion⇒ NB ↑⇒ profits ↑, CS↑, W ↑.**
- Our study: NEs are in the **primary market** & **QI is involved**.
  ⇒It's always profitable for a **low-quality firm** to adopt bundling.
  - Low NEs: A's user base↑, innovation↑, CS↑, welfare↑.
  - **High NEs: A's user base↓, innovation↓, CS↓, welfare↓.**

  ⇒A **high-quality firm** adopts bundling only under intermediate NEs
  - **A's user base↓, CS↓, welfare↓.**

Thank you

Extensions

- In this paper,we focus on the **technological bundling** in the **early stage of product design**. Bundling in the **later marketing stage**.
- If the two products of the dual-market firm are **complementary**, bundling becomes a more attractive strategy. How does it affect quality innovation?
- We can also explore **mixed bundling**—selling products both individually and as a package.
- **Competition in the network market**: Bundling could become more appealing because the firm no longer needs to protect monopoly profits there.

Consumers

- Consumers can buy at most one unit per market.
- They have heterogeneous WTP for quality $\theta \in U\ [0,1]$:

$$U(\theta) = \begin{cases} \theta q_A + \alpha x_A q_A - p_A \text{ from buying } A \text{ with price } p_a \\ \theta q_i - p_i \text{ from buying } B_i \text{ with } p_i,\ i = H, L. \\ \theta(q_A + q_H) + \alpha x q_A - p \text{ from package } (A + B_H) \text{ with } p \end{cases}$$

  - $\alpha > 0$: the level of externalities in A, and $\alpha < 1/2$ ensure $x_A < 1$.
  - **NS and QI** are complementary for network benefit.
- From the utility, we may derive the demand (x_A, x_i, x) for the products A, Bi and the package.

Profits with and without Bundling

- Quality innovation costs are associated with fixed costs, identical for A, $B1$, and $B1$, and expressed as $q_i^2/2$.
- Without bundling, firms' profit are:

$$\pi_1^n = p_A^n x_A^n + p_1^n x_1^n - \frac{(q_A^n)^2}{2} - \frac{(q_1^n)^2}{2}$$

$$\pi_2^n = p_2^n x_2^n - \frac{(q_2^n)^2}{2}$$

- Under bundling $(A + B1)$, firms' profit are:

$$\pi_1^b = p^b x^b - \frac{(q_a^b)^2}{2} - \frac{(q_1^b)^2}{2}$$

$$\pi_2^b = p_2^b x_2^b - \frac{(q_2^b)^2}{2}$$

Findings: Effects of NEs

- **No Bundling:** $\alpha \uparrow \Longrightarrow q_A^n \uparrow x_A^n \uparrow \pi_1^n \uparrow$
  - The quality and output of products in Market B are not affected.
- **Bundling:** $\alpha \uparrow \Rightarrow q_A^b \uparrow q_1^b \downarrow q_2^b \downarrow; x^b \uparrow x_2^b \downarrow; \pi_1^b \uparrow \pi_2^b \downarrow$
  - **QI Reallocation:** Firm 1 raises network product 's quality ($q_A^b \uparrow$) but reduces the quality $B1$ ($q_1^b \downarrow$).
  - **Firm 1's Gains**: Due to stronger NB from A, the demand for the package ($A + B1$) increases, which raises firm 1's profit. ($x^b \uparrow \pi_1^b \uparrow$)
  - **Firm 2's Losses:** demand for B_L decreases, which reduces the $B2$'s QI and the rival's profit. ($x_2^b \downarrow q_2^b \downarrow \pi_2^b \downarrow$)

Findings: Effects of Bundling

- The firm uses $(A + B1)$ to compete with $B2$ rather than $B1$. The package combines two product's quality.
  $\Rightarrow (q_A^b + q_H^b) < (q_A^n + q_H^n)$.