When Does a Platform Create Value by Limiting Choice?

Direct v. Indirect Network Effects

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PLATFORMS (GAME CONSOLES)

- two sides: users and developers

- preference for variety
  - the more games/applications the better (for users)
  - the more users the better (for developers)
  - indirect network effects
THE QUESTION

- Why would a platform limit the number of applications?
  - eg.: Nintendo, iPhone

- explanations:
  - quality control (Zhao)
  - competition on the same side (Halaburda-Piskorski)
  - more choice is bad: distaste for excessive choice (psychology), or cost of evaluating alternatives
This paper

Why would a platform limit the number of applications?

- **direct network effects**
  - the utility of consuming an application increases as other users consume the same application
    - eg. gamers like to play the same games as their friends
  - the model incorporates both indirect and direct network effects

(only the user’s side is modeled)
PREVIEW OF THE RESULTS

EQUILIBRIUM PROBLEMS

- **commons** problem: socially efficient consumption may not be an equilibrium
- **equilibrium selection** problem: multiple equilibria of different efficiency
- **coordination** problem: difficulty to consume the same applications if users lack perfect foresight

The platform can alleviate these problems by limiting the number of applications available
THE MODEL

- standard preference for variety (Dixit Stiglitz, 1979)

\[ u = \left( \sum_{a \in A} (x_{ka})^{1/R} \right)^R \]

- \( u \) consumption utility
- \( a \in A \) an application from the set of all \( A \) applications
- \( x_{ka} \) consumption of application \( a \) by user \( k \) (time)
- \( 1 \leq R < 2 \) preference for variety (\( R = 1 \) no preference for variety)
THE MODEL: introducing direct network effects

- consumption complementarity via $\alpha$

$$u = \left( \sum_{a \in A} (x^k_a)^{1/R} \right)^R + \alpha \sum_{a \in A} \left( x^k_a \sum_{l \neq k} x^l_a \right)$$
THE MODEL: introducing direct network effects

- consumption utility

\[ u = \left( \sum_{a \in A} (x_k^a)^{1/R} \right)^R + \alpha \sum_{a \in A} \left( x_k^a \sum_{l \neq k} x_l^a \right) \]

- net utility

\[ U = \left( \sum_{a \in A} (x_k^a)^{1/R} \right)^R + \alpha \sum_{a \in A} \left( x_k^a \sum_{l \neq k} x_l^a \right) - p \cdot \sum_{a \in A} 1(x_k^a) \]

\[ \sum_{a \in A} x_k^a \leq X \]

- \( p \) price per application
- \( X \) time budget
THE GAME

\[ U = \left( \sum_{a \in A} (x^k_a)^{1/R} \right)^R + \alpha \sum_{a \in A} \left( x^k_a \sum_{l \neq k} x^l_a \right) - p \cdot \sum_{a \in A} 1(x^k_a) \]

- \( N \) users simultaneously choose how much to consume each of the \( A \) applications supplied, \( x^k_a \) for \( k = 1, \ldots, N \) and \( a = 1, \ldots, A \) (\( A \) is “large”) \( \implies \) two stage game
  - users decide (simultaneously) which applications to purchase at price \( p \)
  - users decide (simultaneously) how to allocate their time budget \( X \) across the allocations they have purchased

- we look for SPNE in pure strategies
- everything exogenous, except for consumption levels

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Indirect v. Direct Network Effects
EQUILIBRIA: pure direct network effects

- consumption complementarity only: $R = 1$ and $\alpha > 0$

$$U = \sum_{a \in A} x_a^k + \alpha \sum_{a \in A} \left( x_a^k \sum_{l \neq k} x_a^l \right) - p \cdot \sum_{a \in A} 1(x_a^k)$$

**Proposition**

*In any equilibrium only one application is consumed in the market.*

*I.e., every user consumes one application, and all users consume the same application.*
EQUILIBRIA: pure indirect network effects

- preference for variety only: \( R > 1 \) and \( \alpha = 0 \)

\[
U = \left( \sum_{a \in A} \left( x^k_a \right)^{1/R} \right)^R - p \cdot \sum_{a \in A} 1(x^k_a)
\]

- whatever number of games the user purchases in equilibrium, he will consume equal amount of each of them \( \Rightarrow \) balanced equilibria

Proposition

Let \( p > 0 \). There is a finite number \( Q_I = \left( \frac{(R-1)X}{p} \right)^{\frac{1}{2-R}} \), such that a user does not want to consume more applications than \( Q_I \).

- for non-trivial results, consider \( Q_I > 1 \)

- for \( p = 0 \), the number of applications consumed is bounded only by \( A \)
in any equilibrium all users consume the same applications, due to consumption complementarity (direct network effect)

we focus on balanced equilibria

net utility of a user if $Q$ applications were consumed in a balanced equilibrium (hypothetically)

$$V(Q) = Q^{R-1}X + \alpha \frac{X^2}{Q}(N - 1) - pQ$$
BALANCED EQUILIBRIA: indirect and direct network effects

\[ V(Q) = Q^{R-1}X + \alpha \frac{X^2}{Q}(N - 1) - pQ \]

- shape of \( V(Q) \) is driven by the tradeoff between two forces
  - the benefit from product variety (\( R \))
  - the benefit from using the same applications as other users (\( \alpha \))
PROPERTY OF $V(Q)$

- let $\hat{Q} = \max \left\{ 1, Q \text{ such that } \frac{dV}{dQ} = 0 \right\}$

**Remark**

$\hat{Q} < Q_I$
**Proposition**

*There always exist balanced equilibria with $Q_{DI} = Q_I$. Moreover, there is $Q^o < Q_I$ such that any $Q \in [Q^o, Q_I]$ characterizes balanced equilibria.*

**Proposition**

*There exist parameter values such that $Q_{DI} = 1.*
EQUILIBRIA

**Proposition**

*When there exist multiple balanced equilibria with different values of $Q_{DI}$, equilibria with a smaller $Q_{DI}$ Pareto dominate equilibria with larger $Q_{DI}$.*
PROBLEMS WITH EQUILIBRIA

1. **commons** problem: when \( \hat{Q} > 1 \) is socially optimal, it is not equilibrium

2. **equilibrium selection** problem: multiple equilibria of different efficiency

- Let \( Q^{**} = \arg \max V(Q) \), socially optimal \( Q \)
- \( Q^{**} < Q_I \)

**Proposition**

The platform creates value by limiting \( A \) below \( Q_I \) and above \( Q^{**} \).
CONCLUSIONS

Why would a platform limit the number of applications?

- eg.: Nintendo, iPhone

EQUILIBRIUM PROBLEMS

- perfect foresight, under both direct and indirect network effects
  - commons problem
  - equilibrium selection problem
- no foresight, under direct network effects
  - coordination problem

The platform can alleviate these problems by limiting the number of applications available.