

Digital Business Models and Innovation

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Telecom Paris, CREST

CRESSE Conference, June-July 23

Motivation

- ▶ Innovation is the main driver of benefits brought to users in digital markets, as well as an important dimension of competition
- ▶ We observe a variety of business models in digital markets
 - ▶ Subscription-based, ad-funded, data monetization,...

Research questions:

- ▶ How are incentives to innovate shaped by platforms' business model, as well as their competitors? What business models will be selected ?
- ▶ What is the influence of homing type and nature of competition ?

The Model

We consider 2 competing platforms, 1 and 2.

They operate on a 2-sided market: Users & Advertisers

Platforms.

They provide services and ad-space with zero marginal cost.

Platforms can invest in quality enhancing innovation at a quadratic cost $c(q) = \frac{q^2}{2}$

They can have between two different business models:

Device-funded (D):

- $f_i \geq 0$: device (or membership) fee

Profit:

$$\Pi_i = f_i n_i^C - c(q_i)$$

Ad-funded (A):

- $p_i \geq 0$: price per ad-campaign

Profit:

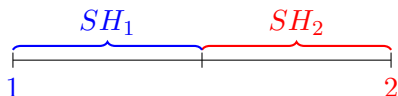
$$\Pi_i = p_i n_i^A - c(q_i)$$

The Model

Advertisers. There is a mass 1 of homogeneous advertisers

- $\sigma > 0$: value of an impression

Users. There is a mass 1 of single-homing users uniformly distributed along an Hotelling line.



A user who joins PF i gets utility:

$$v + q_i - td_i - f_i$$

- $v > 0$: intrinsic utility from joining
- $t > 0$: differentiation parameter
- $d_i \in [0, 1]$: distance to PF

Timing

- ▶ Business model decision stage
- ▶ Innovation effort decision stage
- ▶ Pricing decision stage
- ▶ Users homing decision stage

Users and Advertisers' decision

Let us first consider the business models as given

Users. The market is covered, a single-homing user joins the platform that offers her the higher surplus. Users demands are:

$$n_i^C = \frac{1}{2} + \frac{q_i - q_j}{2t} - \frac{f_i - f_j}{2t}$$

Advertisers. Multi-homing advertisers join every platform that offers them positive utility. Hence, they join *ad-funded* platform i if

$$\sigma n_i^C - p_i \geq 0$$

Profit maximizing price will be

$$p_i = \sigma n_i^C \text{ and } n_i^A = 1$$

The 3 settings

There are three possible settings:

- ▶ *Device-funded vs. device-funded* (DD)
- ▶ *Ad-funded vs. ad-funded* (AA)
- ▶ *Device-funded vs. ad-funded* (DA)

Device-funded vs. device-funded - Subgame eq.

Equilibrium.

$$n_{DD}^C = \frac{1}{2}$$

$$q_{DD} = \frac{1}{3}$$

$$f_{DD} = t$$

$$\Pi_{DD} = \frac{1}{2} \left(t - \frac{1}{9} \right)$$

- ▶ Profits are increasing in t

Ad-funded vs. ad-funded - Subgame eq.

Equilibrium.

$$n_{AA}^C = \frac{1}{2}$$

$$q_{AA} = \frac{\sigma}{2t}$$

$$p_{AA} = \frac{\sigma}{2}$$

$$\Pi_{AA} = \frac{\sigma}{8t^2} (4t^2 - \sigma)$$

- ▶ Profits are increasing in t
- ▶ Profits are concave in σ :
 - For low σ , $\Pi_{AA} \nearrow$ in σ
 - For high σ , $\Pi_{AA} \searrow$ in σ

Comparison of the symmetric settings

Innovation effort. We can now compare the innovation efforts exerted by the platforms in the two symmetric settings, (AA) and (DD):

Proposition

Innovation effort is higher when both platforms are ad-funded than when they are both device-funded ($q_{DD} \leq q_{AA}$), iff $\sigma \geq \frac{2t}{3}$

The ability to monetize innovation is the main driver for platforms' effort

Comparison of the symmetric settings

Consumer surplus. Let us compare the user surplus in the two setting:

$$\begin{aligned}CS_{DD} \leq CS_{AA} &\Leftrightarrow v + q_{DD} - f_{DD} - T_{DD} \leq v + q_{AA} - T_{AA} \\ &\Leftrightarrow q_{DD} - f_{DD} \leq q_{AA}\end{aligned}$$

Proposition

- (a) For $t > \frac{1}{3}$, the user surplus is always higher when platforms are both ad-funded ($CS_{DD} < CS_{AA}$)
- (b) For $t \leq \frac{1}{3}$, the user surplus is higher when platforms are both ad-funded iff $\sigma \geq \frac{2t}{3} (1 - 3t)$

Device-funded vs. ad-funded - Subgame eq.

Investment decision. When choosing their innovation effort, the platforms expect the following demands:

$$D_1 = \frac{1}{4} + \frac{q_1 - q_2}{4t}$$

$$D_2 = \frac{3}{4} - \frac{q_1 - q_2}{4t}$$

The profit maximizing innovation effort are as follows:

$$q_1 = \frac{t - \sigma/4t}{4t - 1}$$

$$q_2 = \frac{\sigma}{4t}$$

Comparison of the three settings

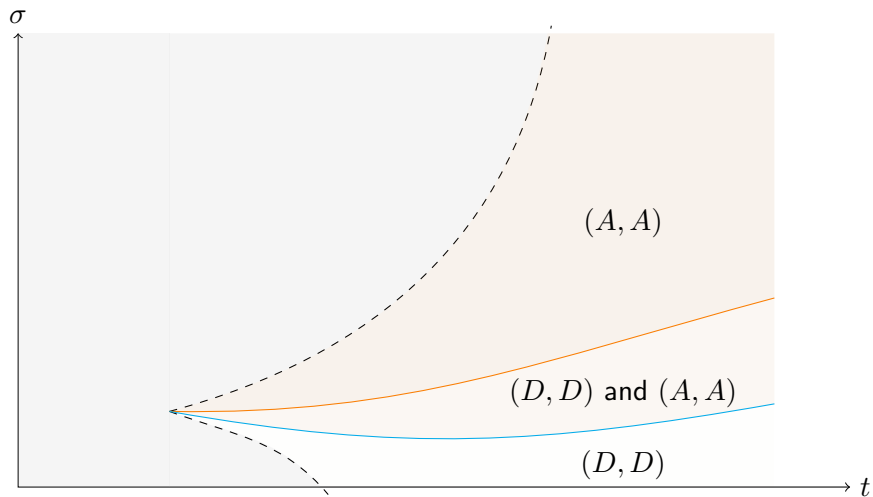
Innovation effort. Let us now compare the innovation effort exerted by platforms depending on their opponents business model:

Proposition

- (a) *An ad-funded platform always provides a lower quality when facing a device-funded platform*
- (b) *A device-funded platform provides a lower quality when facing an ad-funded platform whenever $t \leq 1$. When $t > 1$, it provides a lower quality when facing an ad-funded platform iff $\sigma > \frac{4t}{3}(t - 1)$*

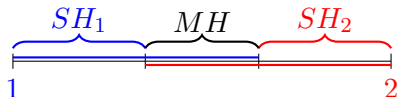
Consumer surplus. We have that $CS_{AA} \geq CS_{DA} \geq CS_{DD}$

Business model decision



Ad-nuisance and endogenous multi-homing -Set up

Users. There is a mass 1 of heterogeneous multi-homing users uniformly distributed along an Hotelling line.



- r_i^e : rational expectation of ad-level
- $\gamma \geq 0$: ad-nuisance parameter

Utility from joining platform i :

if *Device-funded*:

$$v + q_i - td_i - f_i$$

if *Ad-funded*:

$$v + q_i - td_i - \gamma r_i^e$$

Ad-nuisance and endogenous multi-homing -Set up

Advertisers. There is a mass 1 of homogeneous advertisers:

- $\sigma \geq 0$: value from reaching a user once
- $\sigma + \sigma\beta$ with $\beta \leq 1$: value from reaching a user twice

Platforms. Same as before, but now platforms also set their ad-level $0 \leq r_i \leq 1$

Timing

- ▶ Innovation effort decision stage
- ▶ Pricing and ad-level decision stage
- ▶ Users homing decision stage

Device-funded vs. device-funded

Profit is:

$$\Pi_i = f_i SH_{DD} + f_i MH_{DD} - c(q_i)$$

Equilibrium.

$$n_{DD}^C = \frac{v + q_{DD} - f_{DD}}{t}$$

$$f_{DD} = tv$$

$$q_{DD} = \frac{v}{2t - 1}$$

Hedonic price: $f_{DD} - q_{DD}$

Ad-funded vs. ad-funded

Pricing. (Incremental Pricing) In eq. advertising price is:

$$\sigma SH_{AA} + \beta\sigma MH_{AA}$$

and max ad-level $r_i = 1 = r_i^e$ (rationally anticipated)

Profit is:

$$\Pi_i = \sigma SH_{AA} + \beta\sigma MH_{AA} - c(q_i)$$

Equilibrium.

$$n_{AA}^C = \frac{v + q_{AA} - \gamma}{t} \qquad q_{AA} = \beta \frac{\sigma}{t}$$

Hedonic price: $\gamma - q_{AA}$

Device-funded vs. ad-funded

Decisions are **unchanged** for the *device-funded platform*

Pricing. In eq. advertising price is:

$$\sigma SH_{AD} + \sigma MH_{DA}$$

and max ad-level $r_i = 1 = r_i^e$ (rationally anticipated)

Profit is:

$$\Pi_i = \sigma SH_{AD} + \sigma MH_{DA} - c(q_i)$$

Equilibrium.

$$n_{AD}^C = \frac{v + q_{AD} - \gamma}{t} \qquad q_{AD} = \frac{\sigma}{t}$$

Hedonic price: $\gamma - q_{AD}$

Effects of asymmetry differ

In the single-homing setting, business model differentiation fosters less innovation...

...but in the multi-homing setting:

Proposition

An ad-funded platform always exerts higher innovation effort when facing a device-funded platform ($q_{AD} \geq q_{AA}$)

Conclusion

- ▶ Business model plays a role in firms' innovation effort

In a single-homing setting:

- ▶ Business model differentiation fosters less innovation (but not necessarily lower surplus)
- ▶ Only symmetric eq. arise, sometimes maximizing CS and innovation efforts

However, considering multi-homing and changing the nature of competition, we find that:

- ▶ Business model differentiation fosters more innovation from *ad-funded* platforms, as competition for advertisers is softened
- ▶ Cannot conclude on CS and BM decision...

Thank you for your attention !

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Related literature

Platforms business models: Calvano and Polo (2021)
Casadesus-Masanell and Zhu (2010); Caffarra (2019) ...

Digital markets and innovation: Etro (2021); Cunningham,
Ederer and Ma (2021); Moraga-González and Motchenkova
(2021)...