アテンション・エコノミーにおける競争と「中毒」

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アテンション・エコノミー における競争

多くのデジタルプラットフォームは消費者の時間(attention)を収益化

アテンション獲得のためサービスの質を犠牲にする懸念 (Stigler Report)

例：動画表示アルゴリズム、通知機能、UI

“Addictive Platforms”
(with Byung-Cheol Kim)

消費者のアテンションをめぐる競争を理論的に分析

Pはサービスの「中毒性(addictiveness)」を選択

Addictive: 低品質だが長時間滞在したくなるサービス

競争はサービスの質をあげるか？

競争はサービスの質をあげるか？

プラットフォームの直面するトレードオフ:

1. サービスの質を上げてユーザーを獲得したい
VS
2. 「中毒性」を上げてアテンションを獲得したい

競争によって2が強まり、サービスの質が下がることも

政策的含意・収益モデルの果たす役割

関連文献

ソーシャルメディアがユーザーに与えうる負の影響(実証):
Allcott and Gentzkow 2017, Allcott et al. 2020, Mosquera et al. 2020

デジタルサービスの消費量は余剰に結びつかないという指摘:
Cremer et al., 2019, Scott Morton and Dinielli, 2020

↑「低品質だが滞在したくなるサービス」をモデル化↓

プラットフォーム間の競争(理論)
Rochet and Tirole 2003, Armstrong 2006など多数

Model

Platforms $1, \ldots, K$

A single consumer

No uncertainty or behavioral component

1. Each platform $k \in K$ sets addictiveness $d_k \in \mathbb{R}_+$
2. C joins platforms and allocates attention

Consumer Problem

C chooses $J \subset K$ and $(a_k)_{k \in J} \in \mathbb{R}^J_+$ to maximize

util. of allocating a_k to platform k with d_k

attention cost $C(\cdot) \geq 0$ (increasing and convex)

$$\sum_{k \in J} u(a_k, d_k) - C\left(\sum_{k \in J} a_k\right)$$

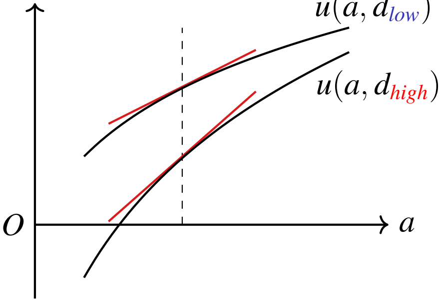
subject to the attention constraint $\sum_{k \in J} a_k \leq \overline{A}$

Platform k's payoff $= a_k$ (can be relaxed)

Assumption on $u(a, d)$

Assumption

1. *$u(a, d)$ is increasing and concave in a, and $u(0, 0) \geq 0$.*
2. *$u(a, d)$ is decreasing in d and negative for some d.*
3. *$\dfrac{\partial u}{\partial a}$ is increasing in d.*



Example 1: Data Collection

Platform collects data d for personalization

base value of service

$$u(a,d) = (1+d)v(a) - \ell \cdot d$$

personalization

privacy cost

$\ell > \sup v(\cdot) \Rightarrow u(a,d)$ decreasing but $\frac{\partial u}{\partial a}$ increasing in d

What is d?

d parametrizes the quality-attention trade-off

(Higher d: low contribution to utility but users will spend a lot of time)

Complex choices summarized as a shift of $\left(u, \frac{\partial u}{\partial a}\right)$

(cf. Armstrong and Vickers 2006)

Different from price or advertising intensity

Discussion on the Rational Consumer

The model does not capture "I spent too much time on Twitter"

Later, we derive $u(a, d)$ from rational addiction $+$ time inconsistency

Extension in which the consumer misperceives d

Solving the Model

1. Each platform chooses d_k to maximize attention
2. C joins platforms and allocates attention

First-Best

Social planner controls $d_1, .., d_K$ but not the consumer's choice

- CS is maximized by $d_k = 0$
- TS (the sum of everyone's payoff) may be maximized by $d_k > 0$

Monopoly Equilibrium

P chooses d to maximize attention a

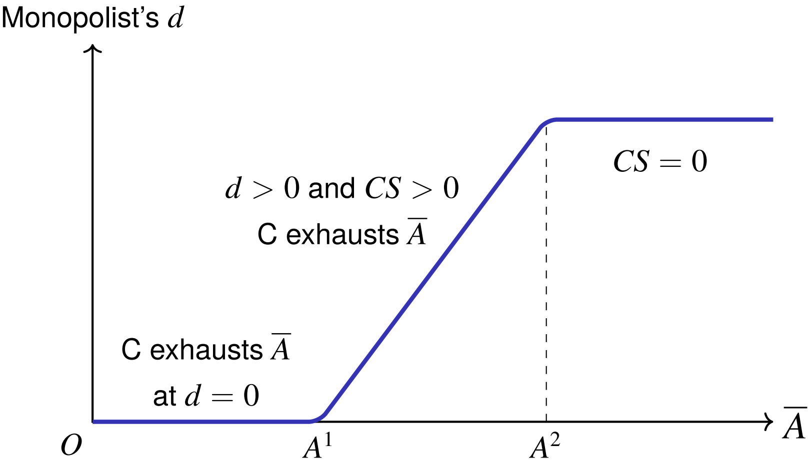
Conditional on joining:

- C maximizes $u(a, d) - C(a)$ s.t. $0 \leq a \leq \overline{A}$
- Attention increases in d

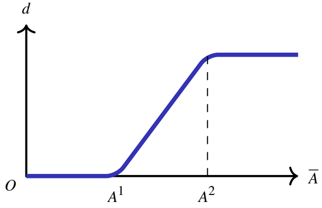
Participation constraint bounds d

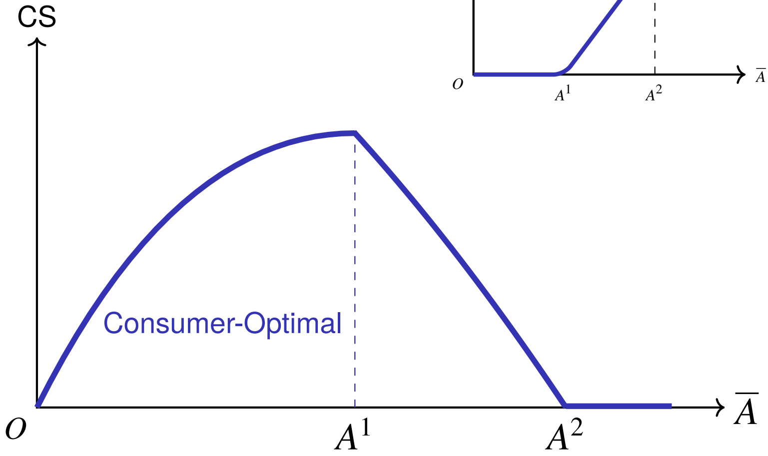
Monopoly

P maximizes attention subject to participation constraint



Consumer Surplus Under Monopoly





Competition ($K \geq 2$)

Each P maximizes attention subject to participation constraint

Increase d so long as C joins

Proposition

In the unique eqm, all platforms choose $d^* > 0$ that makes the consumer indifferent between joining K and $K-1$ platforms. The consumer joins all platforms and allocates attention equally.

$d = 0$ ensures participation

Business stealing incentive $\rightarrow$ $d^* > 0$ even for a small $\overline{A}$

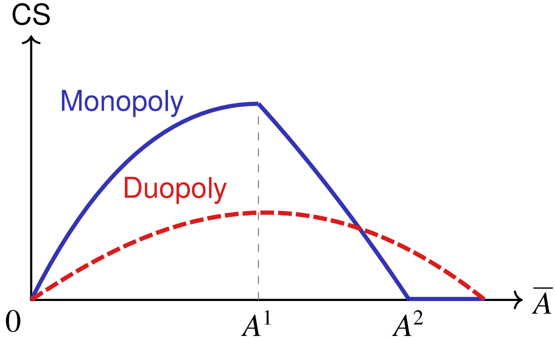
Monopoly vs. Duopoly

Proposition

If $\overline{A} < A^1$, the consumer is strictly better off under monopoly.

If $\overline{A} > A^2$, the consumer is better off under duopoly.

Example:



General Competition Analysis

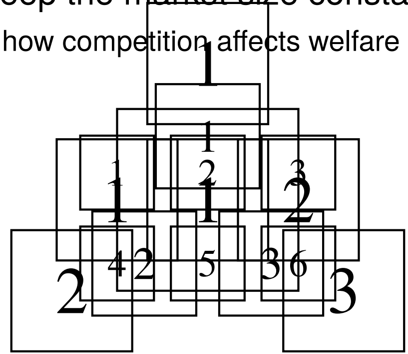
Can monopoly dominate more competitive markets?

Does high degree of competition attain $d \to 0$?

General Competition Analysis

Keep the market size constant

focus on how competition affects welfare through d



Constant Market Size

Market 1, 2, $\ldots$, same size but growingly competitive

Market 1 has a monopolist with utility $u(a, d)$

Market K has K platforms with $u^K(a, d) := \frac{1}{K} u\left(Ka, d\right)$

Total utility of allocating $\frac{A}{K}$ to each platform $= u\left(A, d\right)$

$C(\cdot)$ and $\overline{A}$ common across all markets

Limit Economy

$$A(d) := \arg \max_{A \in [0, \overline{A}]} u(A, d) - C(A)$$

Proposition

For $K \geq 2$, the equilibrium addictiveness is decreasing in K.

It converges to $d^\infty > 0$ that uniquely solves

$$u\left(A(d^\infty), d^\infty\right) = A\left(d^\infty\right) \cdot \frac{\partial u}{\partial a}\left(A(d^\infty), d^\infty\right)$$

Loss of not joining

Benefit of reallocating attention

Competition with Fixed Market Size

Paper: analytically solve the limit eqm for special cases

Today: comparison of CS between monopoly and limit

Quadratic Attention Cost

$$C(a) = \frac{ca^2}{2}$$

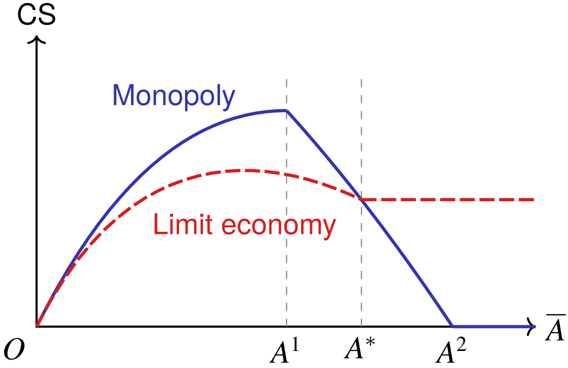
$$u(a,d) = 1 - e^{-\rho(a-d)} \quad \text{with} \quad \rho > c$$

Quadratic Attention Cost

Proposition

CS is greater under monopoly than the limit economy if and only if

$$\overline{A} \leq A^* := \frac{-c + \sqrt{c^2 + 4c\rho^2}}{2c\rho}.$$



Linear Attention Cost

$$C(a) = ca, \quad c > 0$$

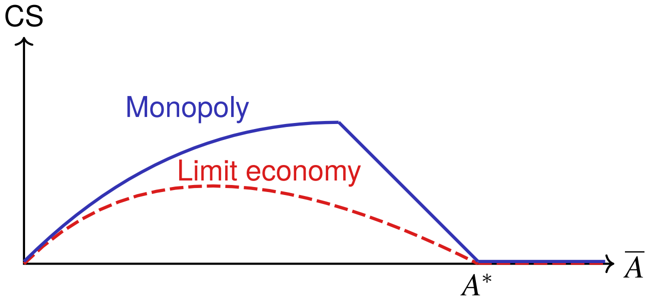
$u(a, d) = v(a - d)$ for an increasing concave $v(\cdot)$ with $v'(0) > c$

Linear Attention Cost

Proposition

There is a unique cutoff A^* such that:

1. *If $\overline{A} < A^*$, CS is strictly higher under monopoly than the limit.*
2. *If $\overline{A} \geq A^*$, CS is zero in all markets.*



Costly Investment in Addictive Technology

Stigler report: "platforms make investments to extract data, encourage stickiness and addiction, and promote ever-greater use"

Assumption

- *Each platform incurs a cost of* $\frac{\gamma d^2}{2}$ *with* $\gamma > 0$ *(generalizable)*
- $u(a, d) = v(a - d)$

Costly Investment in Addictive Technology

Unique equilibrium

Compare the eqm to the "collusive outcome"

- Platforms choose $(d_1, \ldots, d_K)$ to maximize joint surplus
- Consumer chooses between joining all or nothing

Capture weaker competition without changing the # of platforms

Costly Investment in Addictive Technology

Cost: $\dfrac{\gamma d^2}{2}$

Proposition

C is worse off under the equilibrium than the collusive outcome
$\iff \gamma$ *is above some* γ^*

Consistent with previous results: for a low $\overline{A}$, $\gamma^* = 0$

High γ: C's attention allocation determines d
$\rightarrow$ business stealing incentive increases d

So Far

The quality-attention trade-off

A platform balances:

ensuring participation $(+)$ vs. capturing more attention $(-)$

When one dominates the other?

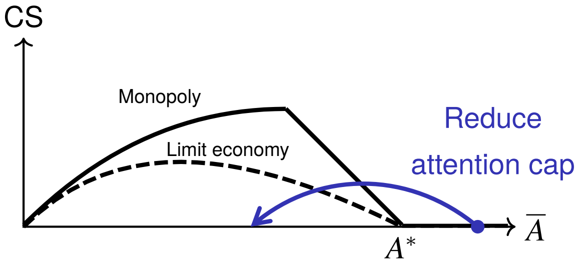
Depend on the attention cap $\overline{A}$ and the cost of increasing d

Competing platforms typically choose $d > 0$

Digital Curfew

Digital curfew

- Shutdown law in South Korea
- "Social Media Addiction Reduction Technology" act in the US



Role of Revenue Models

Price competition:

1. Platform k sets participation fee p_k
2. No revenue from attention, only from price

Equilibrium:

- $d = 0$ and $p^* > 0$ solving the indifference condition
- Monopoly worst for the consumer

Price vs. Attention

Consider the normalized market K.

Proposition

If K is sufficiently large, CS is higher under attention competition than price competition.

Intuition for the Limit Economy

Attention competition:

$$u(A(d^\infty), d^\infty) = A(d^\infty)\frac{\partial u}{\partial a}(A(d^\infty), d^\infty)$$

Price competition:

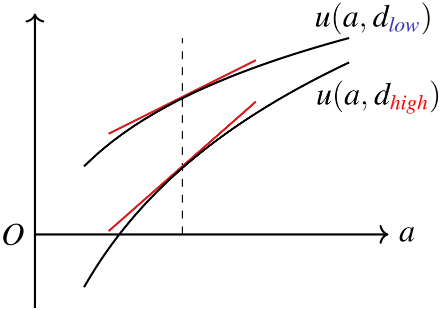
$$u(A(0), 0) - p^* = A(0)\frac{\partial u}{\partial a}(A(0), 0)$$

Attention comp $\rightarrow$ higher marginal util $\rightarrow$ higher outside option

Back to Modeling Assumption

Assumption

1. *$u(a, d)$ is increasing and concave in a, and $u(0, 0) \geq 0$.*
2. *$u(a, d)$ is decreasing in d and negative for some d.*
3. *$\dfrac{\partial u}{\partial a}$ is increasing in d.*



Back to Example 2: Rational Addiction

Derive $u(a, d)$ from rational addiction $+$ time inconsistency

Linear habit formation (cf. Rosen 2010): util $= u(a_t - const \cdot a_{t-1})$

Dual-self model (Thaler and Shefrin 1981, Fudenberg and Levine 2006):
DM consisting of myopic “doer” and forward-looking “planner”

Back to Example 2: Rational Addiction

Pick any platform with addictiveness d

Long-run	Myopic	
Participation	Pre-addiction period	Post-addiction period
utility $u_0 + u(a - da_0) := u(a, d)$	attention a_0, utility u_0 (indep. of d)	endogenous attention, utility $u(a - da_0)$

- C anticipates "addiction" and may avoid joining platforms

Extension: Naive Consumers

Platforms choose $(d_1, \ldots, d_K)$

C makes participation decision based on sd_k for $s \in (0, 1]$
(smaller $s \to$ severer misperception)

C allocates attention according to d

Participation decision less sensitive to $d \to$ higher d, lower CS

Main results robust

Naivete favors price competition

Literature (not exhaustive!)

Negative impact of digital services

Allcott and Gentzkow 2017, Allcott et al. 2020, Mosquera et al. 2020, Alter 2017, Scott Morton et al. 2019, Newport 2019, Rosenquist et al. 2020,...

"Addictive" service discussed in $\uparrow$ but not very much in $\downarrow$

Competition for attention & platform competition

Rochet and Tirole 2003, Anderson and Coate 2005, Armstrong 2006, Bordalo et al. 2016, Anderson and De Palma 2012, Wu 2017, Evans 2017 & 2019, Prat and Valletti 2019, de Corniere and Taylor 2020, Choi and Jeon 2020,...

Recap

Mozilla website:

The Attention Economy to the Addiction Economy

Heather West | July 27, 2018 | 56 responses

*M*uch has been said about the attention economy.

Gamification. Tech addiction. But what happens when those things combine and form an addiction economy online?

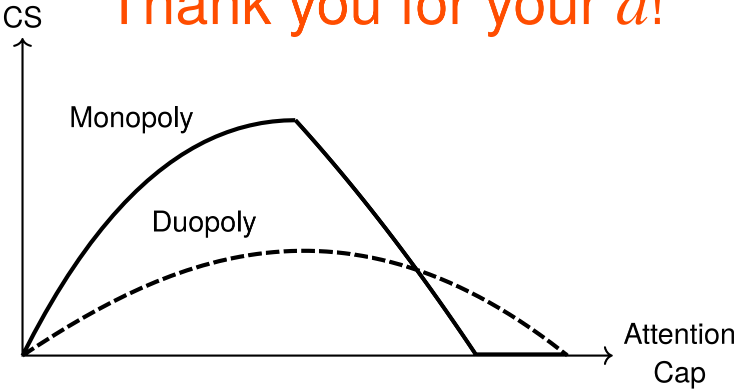
Recap

A strategic variable capturing the quality-attention trade-off

Competition harms consumers when attention is scarce

“Digital curfew” could mitigate the problem

Thank you for your a!



Digital Curfew

Social Media Addiction Reduction Technology ("SMART") act in the US (proposed bill)

> *. . . automatically limits the amount of time that a user may spend on those platforms across all devices to 30 minutes a day unless the user elects to adjust or remove the time limit. . .*

Gaming curfew for China, Korea, and Thailand

E.g., Games under 18 will be restricted to 90 minutes of gaming on weekdays and three hours on weekends and holidays.

E.g., Tencent limits "game time to one hour per day for users under 12 and to two hours per day for users between 12 and 18. "

Recap: Assumption

Assumption

1. *$u(a, d)$ is increasing and concave in a, and $u(0, 0) \geq 0$.*
2. *$u(a, d)$ is decreasing in d and negative for some d.*
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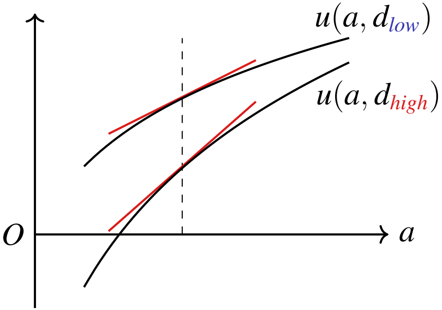
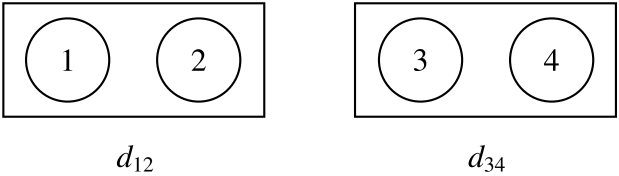


Merger

Before merger:

After merger:



- Merged services are tied
- Merger $=$ partition $\{\{1,2\}\,\{3,4\}\}$

Post-Merger Game (attention competition)

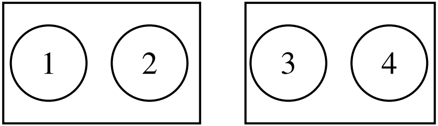
A merger partitions $\{1, \ldots, K\}$ into $\{P_1, \ldots, P_M\}$

1. Each platform $m \in M$ sets d_m
2. Consumer joins platforms $M' \subset \{1, \ldots, M\}$
3. Consumer allocates attention:

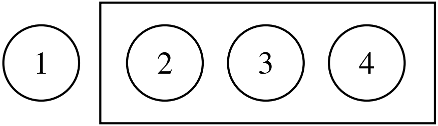
$$\max_{(a_k)_{k \in \bigcup_{m \in M'} P_m}} \sum_{m \in M'} \sum_{k \in P_m} u(a_k, d_m) \quad \text{s.t.} \quad \sum_{m \in M'} \sum_{k \in P_m} a_k \leq A.$$

- Merged services are tied
- Price comp similarly defined

Two Types of Merger



An all-but-one merger



Exclude, e.g., merger of 2 out of 5 platforms

Merger

Symmetric or all-but-one merger

Proposition

- *Attention comp: merger decreases CS and TS.*
- *Price comp: merger decreases CS but does not change TS.*

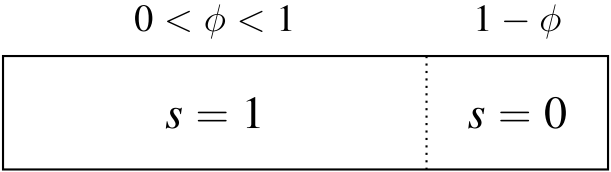
Intuition:

- Merged platforms set higher addictiveness or prices
- Price does not distort service quality
  (partly relies on perfect info)

Back

Heterogeneous Consumers

A unit mass of consumers

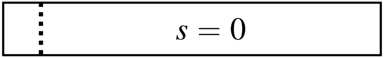


Heterogeneous Consumers

High but finite bound on addictiveness $\bar{d} < \infty$

- If $\phi > 1 - \frac{1}{K}$, same equilibrium as $\phi = 1$

- Small ϕ: $d_k = \bar{d}$, and $s = 1$ excluded



- Middle ϕ, there can be an asymmetric eqm

  $\rightarrow$ highly addictive platforms only acquire $s = 0$

Back

What is special about digital addiction?

- Need more evidence!
- Ability to experiment, personalize, and design user interfaces

Hsieh et al. (2020)

> *For example, variable reward schedules that have long been shown to lead to addictive behavior in mice and other animals, appear to drive identical behavioral patterns in humans who check social media with ever-increasing regularity for "likes" and other forms of engagement titrated from platforms.*