# Merger Analysis in the App Economy:
## An Empirical Model of Ad-Sponsored media

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# Motivation

- Antitrust/regulation issues in the app economy:
  - Google's acquisition of YouTube;
  - Facebook's acquisition of WhatsApp;
  - FTC v. Facebook;
  - Epic Games v. Apple/Google.
- Challenge: **co-existence of multiple business models**
  - Paid apps;
  - Free ad-sponsored apps;
  - Combination of paid/ad monetization.
- Difficulty in traditional (=price-based) antitrust analysis
  $\rightarrow$ rooms for misguided policies.

# Research question

- How can we estimate demand/supply parameters of an imperfect competition of ad-sponsored media where multiple monetization policies co-exist?
- How can we conduct the usual merger analysis including relevant market definition and merger simulation?
- How can we analyze issues such as the effect of changing transaction fee imposed by the marketplace on welfare?

# Method and materials

- Develop an empirical model of ad-sponsored media:
  - Consider consumers with budget and time constraints.
  - App developers compete in utility through price and advertisement setting.
  - Introduce well-defined notion of consumer's "cost" for using an app.
- Establish an estimator based on available data about Google Play in Japan.
- Using the estimated model, conduct an SSNIC test, run merger simulation, and study the effect of transaction fee.

# Results

- Estimates:
  - Disutility from ads is 5-6% of the app's advertising revenue.
  - Game apps are more segmented by categories than non-game apps.

- Market definition:
  - Some game categories constitute relevant market.

  ex Action, Puzzle, and Role Playing games.

- Merger simulation:
  - Only the mergers within relevant markets have large impact on welfare.

- Transaction fees:
  - Reduction in fees can *increase* prices and reduce ads, especially for non-game apps.

# Setting

- For each market $t$:
  - A set of apps $j$.
  - A set of app developers $d$.
  - A mass of consumers.
- A developer of app $j$:
  - sets the download price $F_j$, and
  - advertising intensity $a_j$.
- Consumer $i$:
  - downloads at most one app $j$, and
  - choose the usage time $q_j$ of downloaded app.
- Consider a static pure-strategy Nash equilibrium.

# Consumer's problem

- The indirect utility from downloading app $j$:

$$u_{ij} := S_j + \beta'_{di} X_{dj} - \alpha_y F_j + \xi_{dj} + \underbrace{\varepsilon_{ij}}_{\text{TIEV}}$$

- The usage surplus is:

$$S_j = \max_{q_j} v_j,$$

where

$$v_j := \kappa \left[ \left( \beta'_{uj} X_{uj} - \alpha_a a_j - \alpha_y w + \xi_{uj} \right) q_j - \frac{\eta}{2} q_j^2 \right].$$

- With this specification,
  - usage time $q_j$ and
  - download share $s_j$

  are analytically solved.

# App developer's problem

- The per-app profit:

$$\pi_j := s_j \times \left\{ (1-\rho)F_j + q_j(a_j r - \lambda) - \epsilon_j \right\}$$

- The total profit of app developer $d$:

$$\Pi_d := \sum_{j \in \{d\text{'s apps}\}} \pi_j .$$

- Each developer chooses $(a_j, F_j)$ of the owned apps to maximizes the total profit, *with non-negativity constraints* $a_j \geq 0$, $F_j \geq 0$.

- The *free apps* and *ad-free* apps are captured by a corner solution.

# Competition in utility

- The mean utility is sufficient statistics of price and advertisement for consumers.
- The assumption of no random coefficient in price and the usage-related utility is crucial for this.
- The per-app profit can be expressed as

$$\pi_j(\delta) := s_j(\delta) \times \bar{\pi}_j(\delta_j),$$

  - $\delta_j$ is mean utility from app $j$;
  - $\bar{\pi}_j(\delta_j)$ is maximal per-consumer profit to achieve $\delta_j$.

- Developer's problem is then to choose $\{\delta_j\}$ to maximize

$$\Pi_d := \sum_{j \in \{d\text{'s apps}\}} \pi_j(\delta)$$

# Notion of cost

- Define the *cost* for using an app $j$

$$c_j := \delta_j^0 - \delta_j,$$

  - $\delta_j^0$: mean utility achieved by zero price/ads.
  - $\delta_j$: actual mean utility.

- Under price competition, $c_j = \alpha_y F_j$.
- Thus, the notion of cost generalizes the notion of price.
- This notion is used for market definition.

# Covered apps

- Platform: Google Play.
- Selection of apps:
  - For game/non-game apps and each business model (free/ad, paid/ad-free, paid/ad).
  - Select apps based on the # of times that ranked above a certain threshold on the download and usage ranking.
- Period: March 2015 to January 2017.

# Mobile app industry

Shares of business models for each product category (Application)

| Category | N | Paid/Ad sponsored | Paid/Ad free | Free/Ad sponsored |
|---|---|---|---|---|
| Comics | 1171 | 0.693 | 0.081 | 0.225 |
| Communication | 1296 | 0.255 | 0.275 | 0.470 |
| Education | 1988 | 0.082 | 0.508 | 0.409 |
| Entertainment | 1375 | 0.255 | 0.131 | 0.615 |
| Lifestyle | 1113 | 0.092 | 0.081 | 0.827 |
| Music and Audio | 3238 | 0.148 | 0.311 | 0.540 |
| News and Magazines | 4191 | 0.026 | 0.072 | 0.902 |
| Personalization | 646 | 0.173 | 0.115 | 0.712 |
| Photography | 1853 | 0.131 | 0.107 | 0.761 |
| Productivity | 1204 | 0.098 | 0.425 | 0.477 |
| Social | 1649 | 0.534 | 0.136 | 0.329 |
| Tools | 2241 | 0.124 | 0.007 | 0.869 |
| Video Players | 1612 | 0.093 | 0.223 | 0.684 |
| Total | 23577 | 0.175 | 0.188 | 0.637 |

# Key identification assumption

- We do not observe ad intensity $a_j$.
- Usually, we identify marginal costs from the (i) observed price and (ii) price optimality condition.
- In this paper, we elicit equilibrium advertising from the advertising optimality condition:
  - under the assumption that the marginal cost for showing advertising is zero.
- Justification: ad-technology.
  - cf. newspapers, TVs.

# Key identification assumption

- Price optimality condition cannot point-identify marginal costs of *free apps*
- Some extrapolation is necessary.
- We try to identify the distribution of the costs of free apps by assuming that free/paid versions of a pair of sibling apps has the same marginal costs.
- Some bias may exist because the apps that have free/paid version may not represent free apps.

# Estimation result:

Table: Estimation results of demand non-linear parameters

| Parameter | Application | Game |
|---|---|---|
| $\alpha_y$ | 0.0194 | 0.000856 |
| $\alpha_a$ | 0.479 | 0.0233 |
| $\eta$ | 0.01 | 0.0105 |
| $\kappa$ | 7.94 | 52.5 |

Table: Implied advertisement disutility

| Application | Game |
|---|---|
| 24.7 | 27.2 |

# SSNIC test

- Market definition uses SSNIP test:
  - **S**mall but
  - **S**ignificant and
  - **N**on-transitory
  - **I**ncrease in
  - **price**

- SSNIP test considers how the profit of a hypothetical monopolist that owns a set of apps changes after 5% increase in prices.

- The set of apps forms the market if the profit increases.

- Because we cannot use a SSNIP test for free apps, we use SSNI**C** test.

# SSNIC test

Table: SSNIC test for categories

| Category | Profit change (%) |
|---|---|
| Comics | -6.192 |
| Communication | -12.957 |
| Education | -0.618 |
| Entertainment | -4.131 |
| Lifestyle | -0.105 |
| Music and Audio | -0.168 |
| News and Magazines | -0.438 |
| Personalization | -0.743 |
| Photography | -0.177 |
| Productivity | -0.2 |
| Social | -2.18 |
| Tools | 0.01 |
| Video Players | -0.188 |

(a) Application

| Category | Profit change (%) |
|---|---|
| Action | 8.496 |
| Adventure | -0.031 |
| Card | -0.046 |
| Casino | 0.103 |
| Casual | 0.346 |
| Puzzle | 2.944 |
| Role Playing | 10.869 |
| Simulation | 0.276 |
| Sports | -1.806 |
| Strategy | -0.012 |

(b) Game

# Merger analysis

- Welfare effects of mergers are large only for categories that form relevant markets.

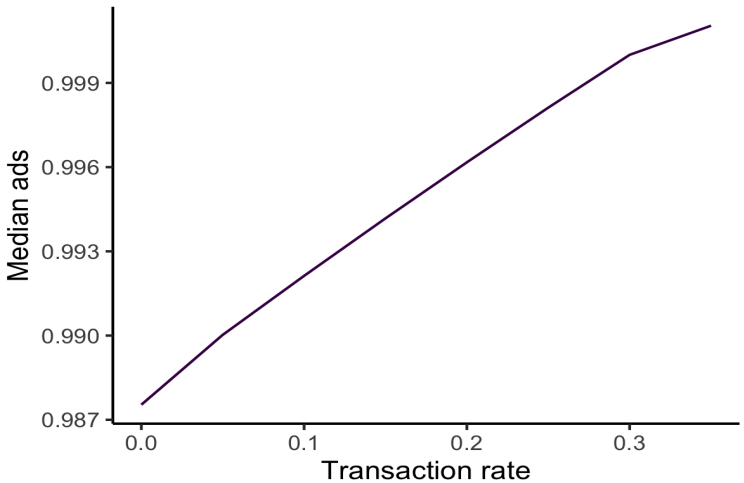
| Category | Consumer surplus | Profit app | Profit platform | Total surplus |
|---|---|---|---|---|
| Action | 0.971 | 1.16 | 1.06 | 0.99 |
| Adventure | 1 | 1 | 1 | 1 |
| Card | 1 | 1 | 1 | 1 |
| Casino | 1 | 1 | 1 | 1 |
| Casual | 0.999 | 1.01 | 1.01 | 1 |
| Others | 1 | 1 | 1 | 1 |
| Puzzle | 0.95 | 1.23 | 1.12 | 0.98 |
| Role Playing | 0.916 | 1.42 | 1.24 | 0.971 |
| Simulation | 0.999 | 1.01 | 1.01 | 1 |
| Sports | 1 | 1 | 0.999 | 1 |
| Strategy | 1 | 1 | 1 | 1 |

(c) Game

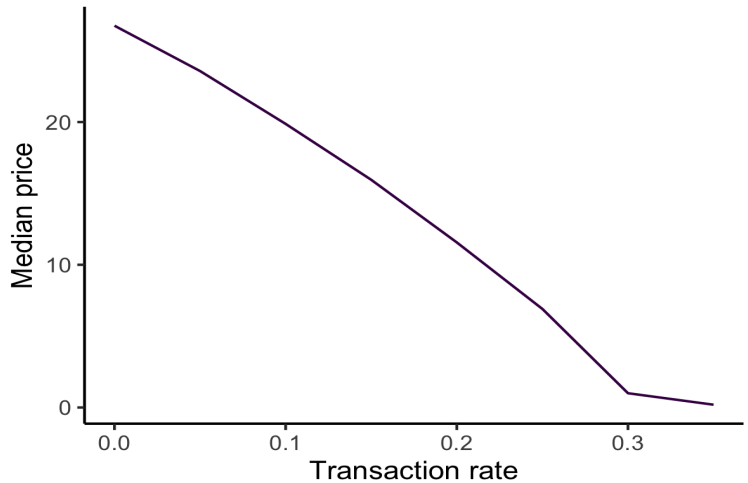
# Impact of transaction fees

- What happens if the transaction fee is reduced?
- Price may *increase* through 2 channels.
  1. Shift from ad revenue to price revenue.
  2. Special feature of proportional fee.
- Therefore, the impact of transaction fees on prices is theoretically ambiguous.

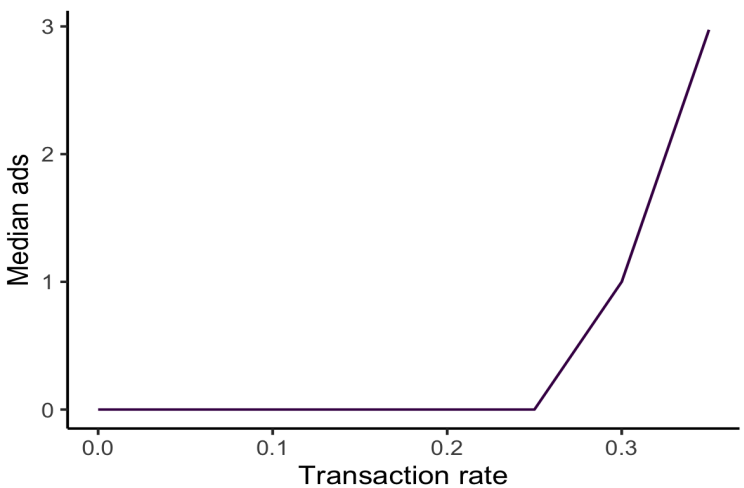
# Transaction fees: endogenous variables



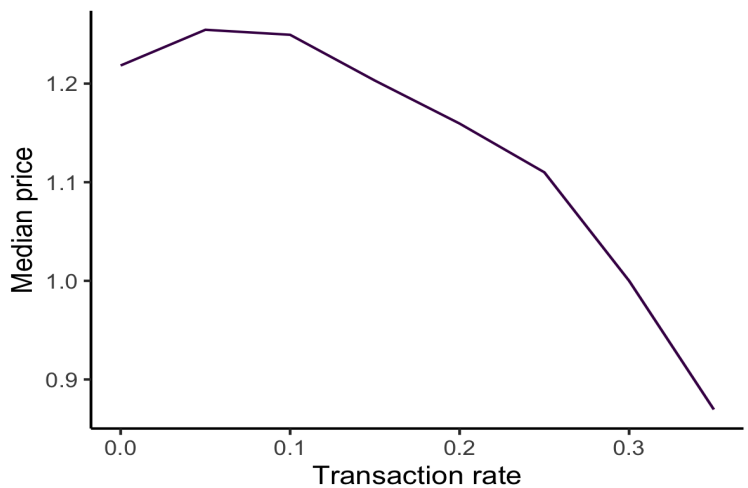

(a) Ad: Application




(b) Price: Application

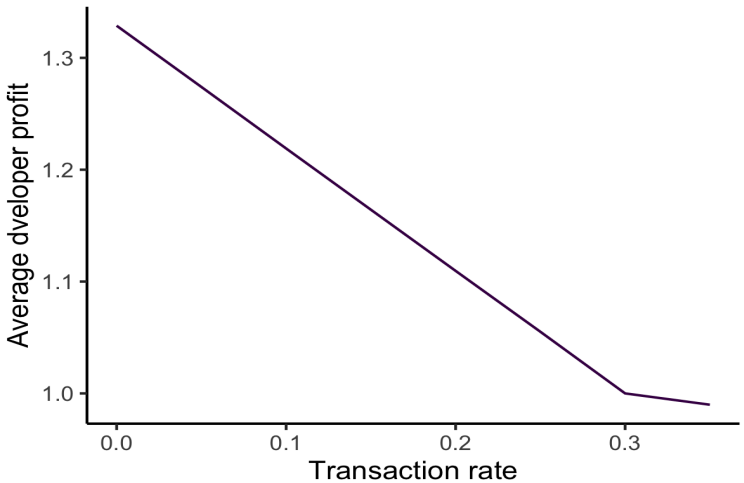



(c) Ad: Game

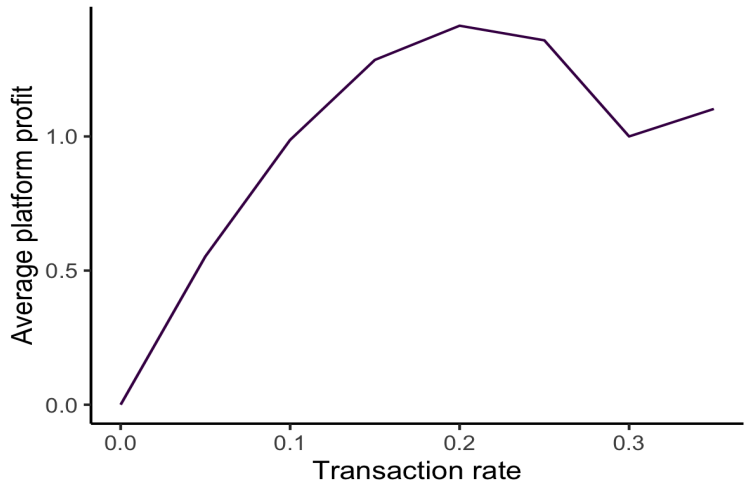



(d) Price: Game

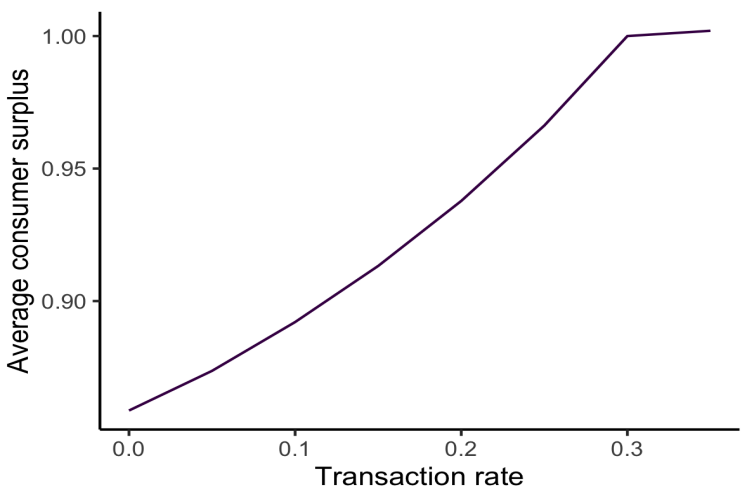
# Transaction fees: surplus/application



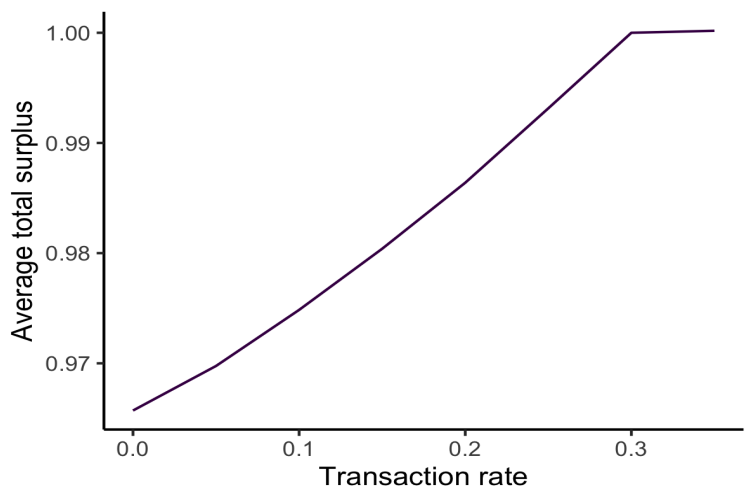

(e) App profit




(f) Platform profit

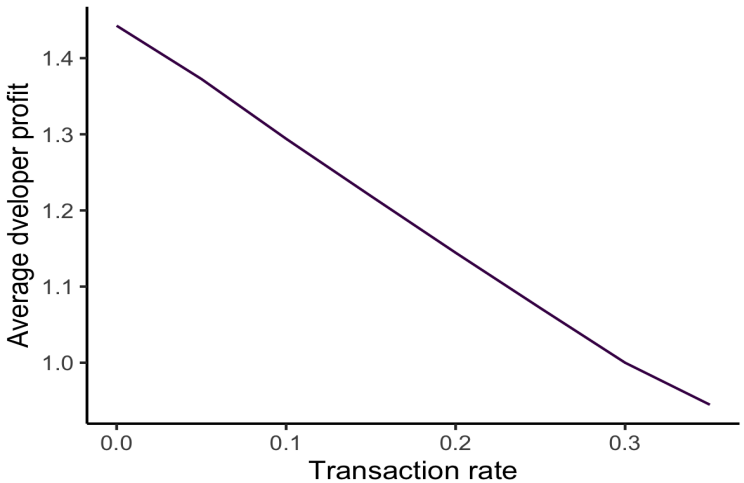



(g) Consumer surplus

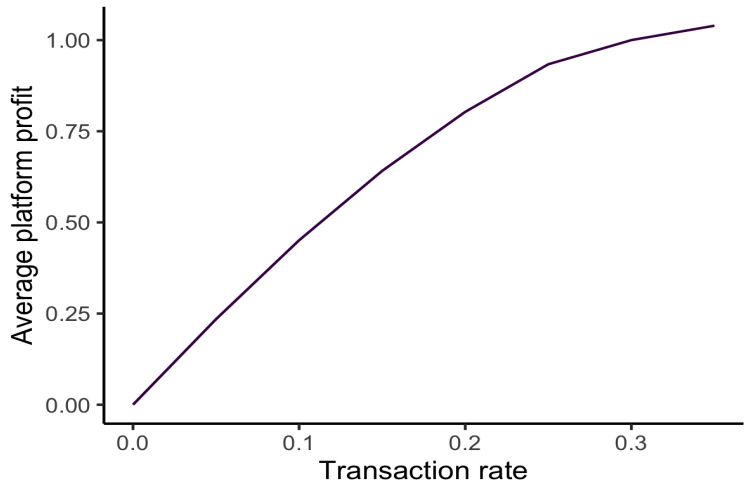



(h) Total surplus

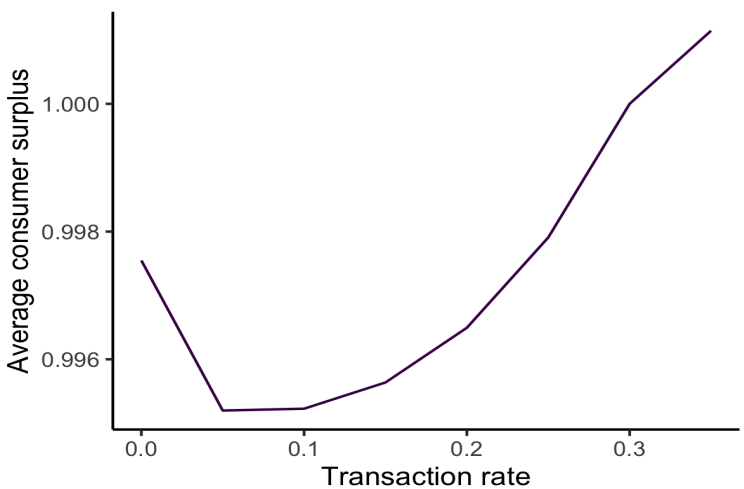
# Transaction fees: surplus/game



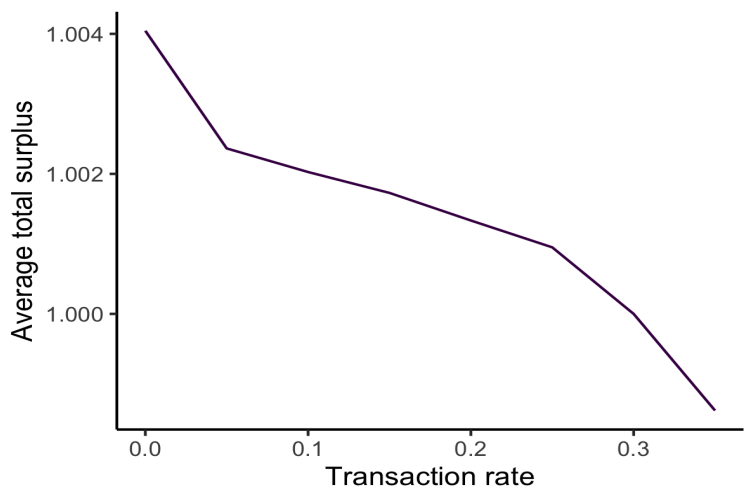

(i) App profit




(j) Platform profit




(k) Consumer surplus




(l) Total surplus

# Conclusion

- Our model allows for co-existence of business models and enables the usual merger analysis including market definition and merger simulation.

- Some categories of game apps form a relevant market, whereas none of non-game categories form relevant markets.

- Merger simulation shows that a merger in a app category has a large welfare impact only when it forms a relevant market.

- A reduction in transaction fees can increase the price, especially for non-game apps.

# FAQ

- Why the profit function can be translated into a function of delta. What's intuition? Which assumptions are crucial for this to work?
  - In the model, the mean utility of delta is sufficient statistics for a consumer. Therefore, the interaction with consumers and competitors works only through delta.
  - We can calculate the optimal combination of price and advertisement given a value of delta, and consider a game in which the action is to choose delta and the payoff is the profit evaluated at the optimal price and advertisement given the value of delta.
  - The assumption of no random coefficient in the usage-related utility is crucial for this.

# FAQ

- What is the special feature of proportional fee?
  - Proportional fee inflates the scale of marginal costs relative to price. Therefore, when marginal costs are positive, proportional fees increase prices. However, when firms obtain ad revenues, the perceived marginal costs of apps can be negative. In this case, the scale of negative marginal costs increases with proportional fees, and price can decrease with proportional fees.

# FAQ

- What if you allow for the market power on the advertiser side?
  - Theoretically, we would expect that new "sea-saw" effects would arise. When mergers hurt consumers by increasing advertisements, they tend to benefit advertisers by lowering advertising prices.
- Can you incorporate a versioning strategy such as IAP and freemium?
  - Our current setting does not allow to incorporate consumer heterogeneity in usage-related utilities. Theoretically, the competition-in-utility approach becomes infeasible. Empirically, we need to jointly elicit usage-related unobserved fixed effects and download-related fixed effects, which is hard. Moreover, to identify consumer heterogeneity at this level, consumer-level data will be required.

# FAQ

- Can you consider the Google-play's other strategies such as anti-steering clauses?
  - No, because we do not observe the app's activities outside Android.
- Aren't there other strategic variables of app developers such as data collection?
  - Of course yes, but currently we do not observe the data on app's data collection. Thus, we gave up analyzing these strategies. If the revenue from such a strategy exists, they will be captured as a negative marginal cost.
- Shouldn't you take quality choices such as upgrade into account?
  - Of course yes. Our setting should be viewed as a static benchmark.