Cross-Platform Entry Effects of Commission Rate: Evidence from Mobile Applications in China

Jiayi Hou [†] Xuan Teng [*] Xuan Wang [†]

[†]Peking University

[*]University of Munich (LMU)

Economics of the DMA Workshop, JRC Brussels

September 2025

Commission Rate and Platform Regulation

- Apple's 30% App Store commission has been subject to global antitrust scrutiny.
  - Apple Inc. v. Pepper et al. (2019), Epic Games v. Apple (2020), Spotify and Rakuten's complaint to EU (2020).
  - Consumers pay higher app prices due to the fee.
  - Raise rivals' operating costs. Foreclose third-party developers, especially small ones who cannot survive the rate.
  - Showcase Apple's monopoly power.
- Recent legislation on platform regulations
  - Under the DMA, Apple shall allow third-party app stores.
  - The European Commission fines Apple $1.8 billion in 2024 for its "anti-steering" restrictions.
  - a U.S. federal judge rules that Apple must allow developers to offer external payment options in their U.S. apps in 2025.

Lack of Empirical Evidence and Open Questions

- Lack of variation in commission rates
  - Apple and Google Play Store charge the same 30% (or 15% for small businesses)
- *Magnitude*: How big is the negative entry effect on platform that increases commission rate?
- *Spillover*: Does one platform raising commission rate lead to fewer (or more) apps on the other platforms?
  - DOJ v. Apple (2024): "Most app developers do not view Android as a substitute for iOS or iOS as a substitute for Android"
  - Theories on platform fees: The existence and direction of cross-platform spillover determines whether platform competition can help address excessive commissions (Jeon and Rey, 2024; Teh and Wright, 2025).
- *Quality*: What is the effect of commission rate on the quality of new apps? What is the effect on the quality gap between platforms?

This Paper: China's App Industry Saw a Big Change

- In August 2014, several leading Android app stores increased commission rates on **games** from 30% to 50%.
  - This event leads to the current 50% commission rates on games in almost all Android app stores in China.
- Non-game apps' commission rates are not changed.
- Apple's App Store remains its 30% commission rate.
- Quasi-natural experiment to study the effect of commission rates on entry—on Android and iOS app stores, separately.
- Difference-in-Differences (DiD), comparing the difference in the *number* and *quality* of new apps between game markets and non-game markets, before and after August 2014, on Android and iOS app stores, separately.

China's App Industry

- Sizable, especially in Games: 2.58 million apps by the end of 2022. **41.79 billion USD** total revenue of mobile games in 2021. (China MIIT)
- Android as a Dominant Ecosystem: in 2014, Android smartphones account for about **79% shipment** of mobile phones in China. (IDC)
- App Stores in China:
  - iOS: Apple App Store.
  - Android: Google Play Store is *not* available.
    - First-Party Stores: Huawei, Xiaomi, Vivo, Oppo, etc.
    - Third-Party Stores: Tencent, Baidu, 360, etc.

(a) Huawei App Store

(b) Tencent App Store

The Mobile Hardcore Alliance (MHA)

- In **August 2014**, six Android phone makers established the Mobile Hardcore Alliance (MHA).
  - Huawei, OPPO, Vivo, Coolpad, Lenovo, and Gionee.
  - Three of the members' app stores together account for 81.22% monthly active Android app store users in China in 2022. (AppInChina)
- MHA coordinates members' policies on **mobile games**. No coordination or change in the non-game categories.
- An Immediate Policy on Games: increase the **commission rate** from 30% to 50%.
  - Conflicts between game developers and MHA: Huawei *versus* Mihoyo (2020) and Tencent (2021).
  - Ongoing debate: whether MHA violates China's antitrust law.

Other Policies and Other Android Stores

- MHA adopted some compensating policies in/after late 2015:
  - A common connection SDK to all member stores (only for games).
  - Monthly promotion program for the 2 most promising games.
  - Financial services available to game developers.
- Other Android app stores adopted the 50% commission rate on games *not* until late 2017.
- Apps may switch to other Android app stores during our sample period.
  - Alternative first-party stores: Xiaomi.
  - Third-party stores are tricky substitutes, as consumers will encounter security warnings when trying to install an app from third-party stores.
- Compared to Google Play Store raising commission rates in Europe, our policy change provides a **lower bound** on the effect of a higher Android commission rate.

A Dataset on New Apps

- Source: commercial (Qimai) + administrative.
- **Android Apps**: top 39,833 apps.
  - Do they join MHA or Non-MHA stores, or both? Approximate it with positive annual/accumulative downloads on each Android app store during 2017-2022. Check robustness to years.
- **iOS Apps**: top 49,999 apps.
- **Multi-Homing Apps**: 6,793 apps.
  - Small in number, large in downloads. ▸ visualization
- Their entry time ranges from 2008 to 2022. We focus on those released between **August 2013 and January 2016**, amounting to 10 quarters surrounding **August 2014**.
  - Very few entry before 2013.
  - Another big policy change in the game industry in May 2016.
- Measure **App Quality**: the accumulative average rating by the end of the 5-th year since entry. (stabilized quality) ▸ rating histogram

Game *versus* Non-Game Markets

- "Market": a category/quarter pair.
- **Android**: 24 categories. 10 are game. 14 are non-game.
  - MHA Stores: Huawei, Vivo, Oppo, Meizu.
  - Non-MHA Stores: Xiaomi, Tencent, Baidu, 360.
  - Approximate store entry with positive downloads.
- **iOS**: 35 categories. 14 are game. 21 are non-game.
- **Industry-wide**, we construct 24 joint categories.

	Android	iOS	Joint
Num of Markets	240	350	240
Num of New Apps	58.42	17.71	77.55
	[53.81]	[14.34]	[66.28]
Avg Quality of New Apps	4.00	4.04	3.98
	[0.36]	[0.43]	[0.31]
% Joining MHA	0.83		
	[0.20]		

▸ entry pattern ▸ choice pattern ▸ quality pattern

Difference-in-Differences

For a category c in quarter t,

$$y_{ct} = \beta \left(Game_c \times Post_t \right) + \gamma_c + \lambda_t + \epsilon_{ct} \tag{1}$$

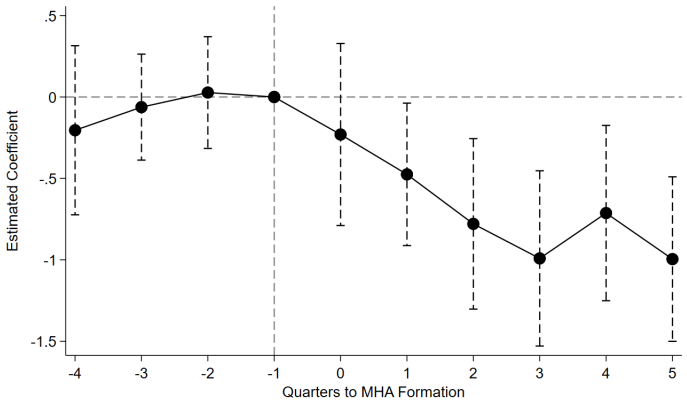
$$y_{ct} = \sum_{\tau \neq -1} \beta_\tau \left(Game_c \times 1\{t = \tau\} \right) + \gamma_c + \lambda_t + \epsilon_{ct} \tag{2}$$

- Include category FE (γ_c) and quarter FE (λ_t). Cluster standard errors at category level.
- Identification Assumption: in the absence of the MHA formation, the outcomes in game markets would evolve as those in non-game markets.

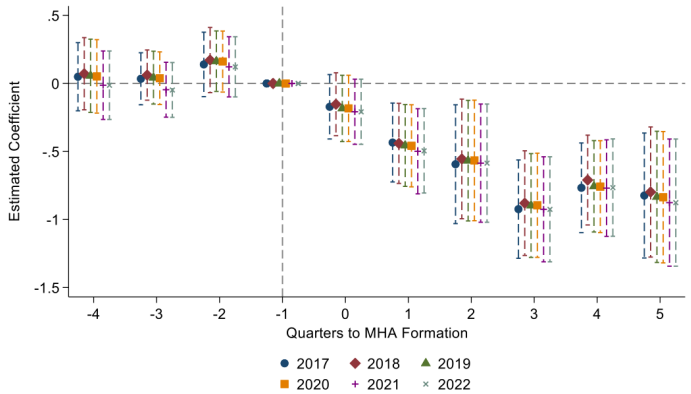
Result 1: The Entry Effects on Android and iOS

Negative Entry Effect on Android, especially on MHA.

Dep. Variable: log of the number of new apps.



(a) Android

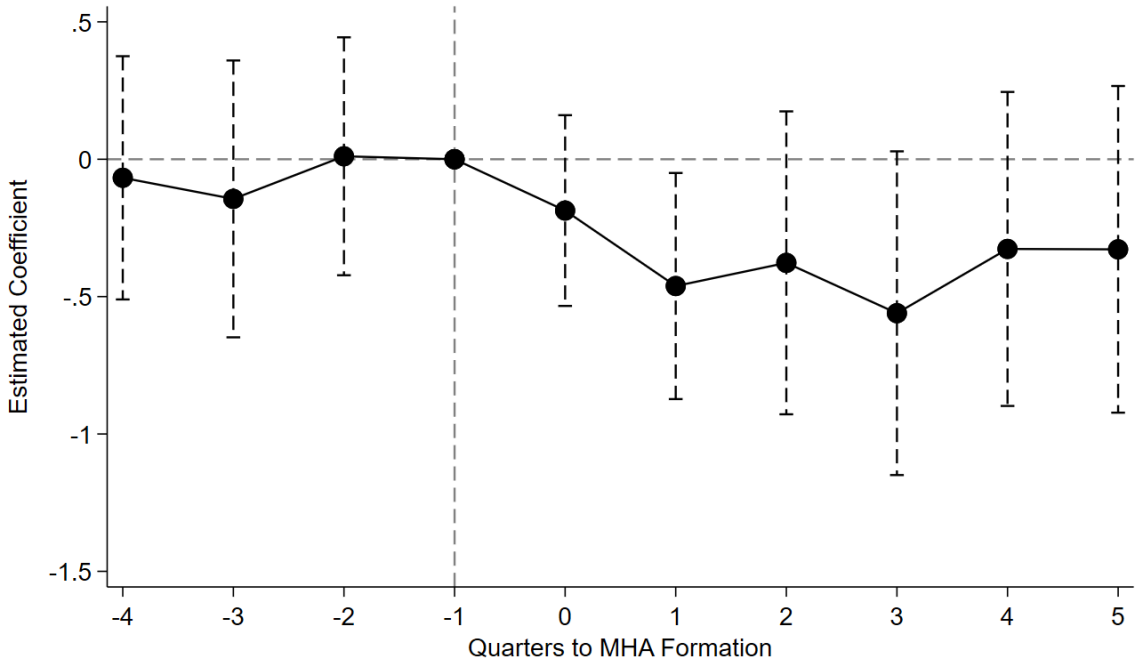


(b) MHA

	(a) Android	(b) MHA
ATE	-0.64*** (0.19)	-0.80*** (0.18)
in %	-47%	-55%

Spillover Effect to iOS

Dep. Variable: log of the number of new apps.



	(c) iOS
ATE	-0.32*** (0.11)
in %	-27%

A Conceptual Framework

- A general equation of the num. of entrants on an app store s:

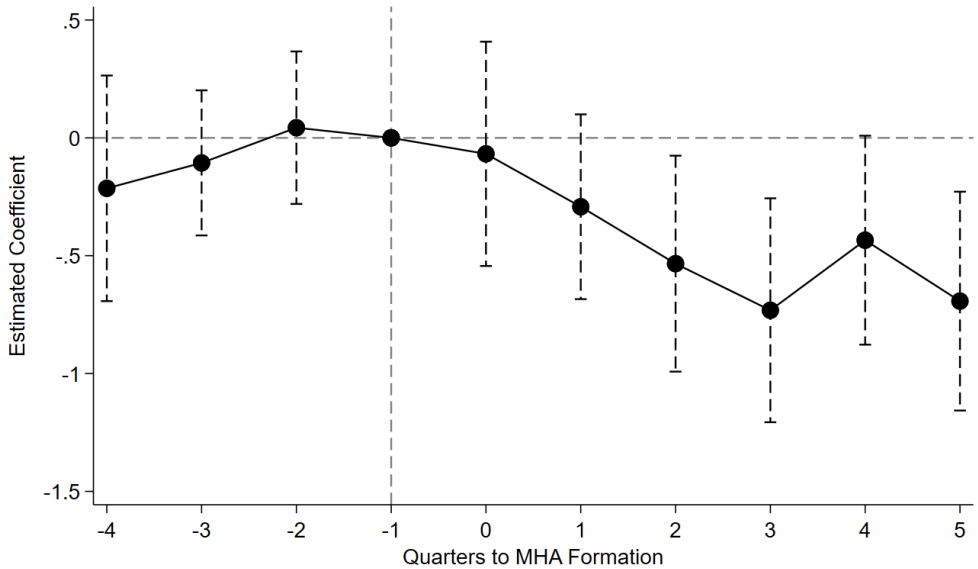
$$N_s = N \times Pr[Join\ s|Development] \tag{3}$$

  - N: the number of newly developed apps
  - $Pr[Join\ s|Development]$: the likelihood that a newly developed app joining store s.

- Two countervailing effects of a higher commission rate on platform s on the entry on another platform $s\prime$:
  1. *Negative Profitability Effect*: the total expected revenue becomes less likely to cover the development cost. Fewer new apps in the first place. Smaller N.
  2. *Positive Substitution Effect*: when choosing platforms to join, new apps substitute away from platform s toward other platforms. Higher $Pr[Join\ s\prime|Development]$.

Why Negative Spillover to iOS? (1)

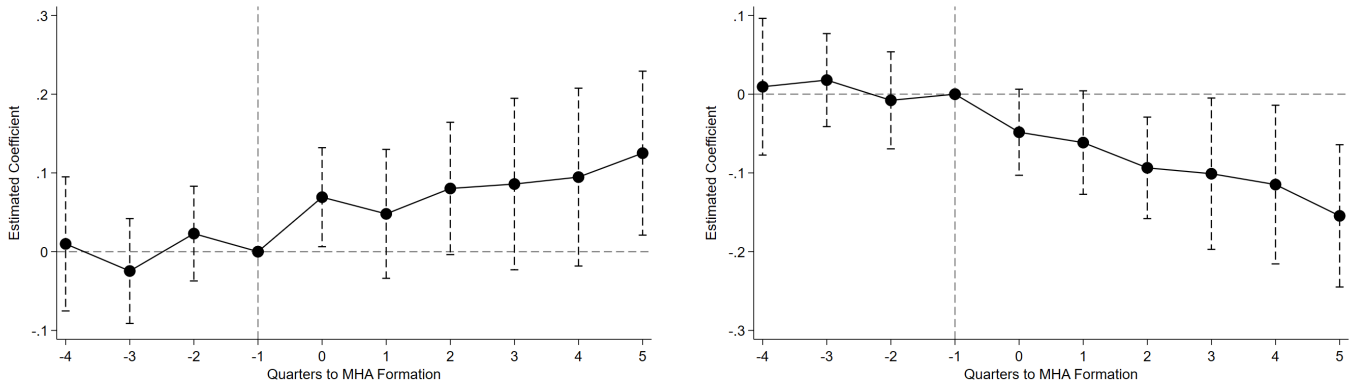
- Negative Profitability Effect: fewer games are developed in the first place.
- Dep. Var: log of the num of new apps in the joint markets.



	(d) Joint Markets
ATE	-0.39** (0.16)
in %	-32%

Why Negative Spillover to iOS? (2)

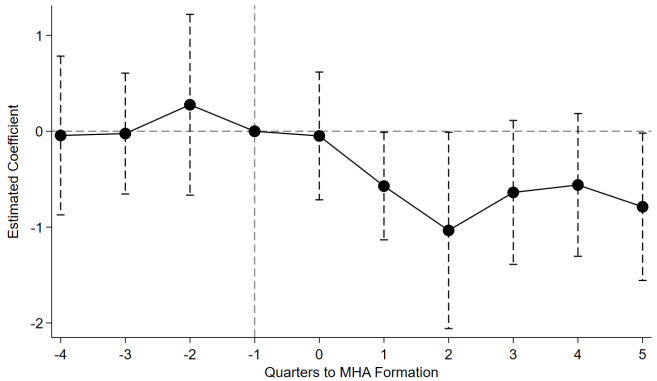
- Positive Substitution Effect: new games more strongly prefer to join iOS than Android.
- Dep. Variable: share of new apps joining iOS (Android).
- on iOS: Negative profitability effect $>$ Positive substitution effect

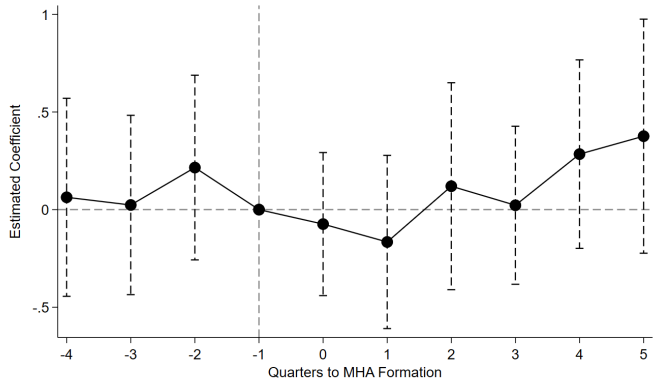


	(a) % iOS	(b) % Android
ATE	0.08**(0.03)	-0.10**(0.03)
Base Mean	0.15	0.82

The Decline in Multi-Homing Apps

- Why didn't developers continue to produce games and release them only on iOS?
- Some games are only profitable if they join both platforms.
- A decline in new multi-homing games should account for the negative entry effect on iOS, rather than a change in the entry of iOS-only games.



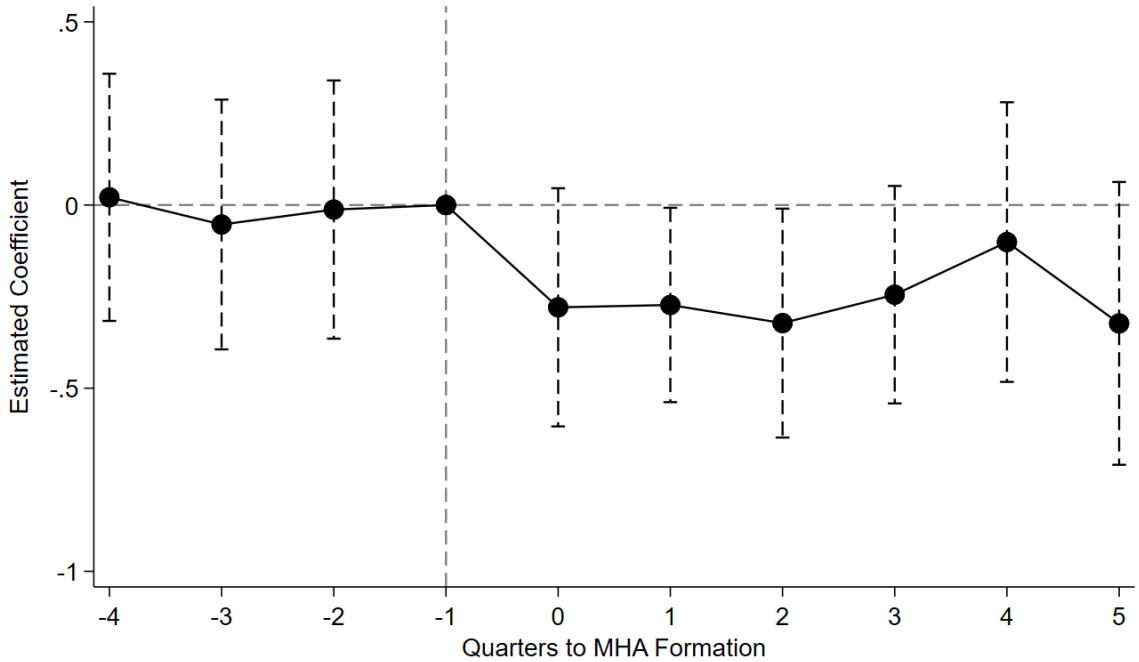


	(a) # multi-homing	(b) # iOS-only
ATE	-0.63***(0.21)	0.03 (0.10)
in %	-47%	3%

Result 2: Industry-Wide Quality Effect

Lower Entrant Quality with Higher Commission Rate

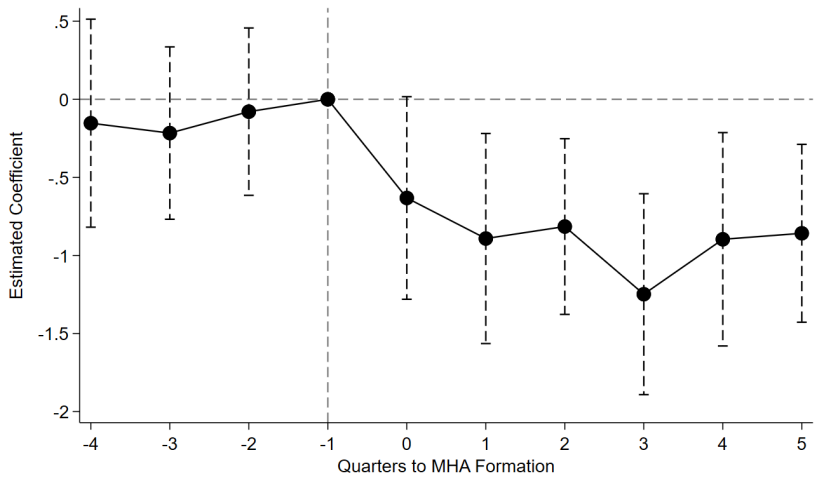
Dep. Var: Average quality of new apps in the joint markets.



	(a) Average Quality
ATE	-0.25*** (0.08)
Base Mean	3.98

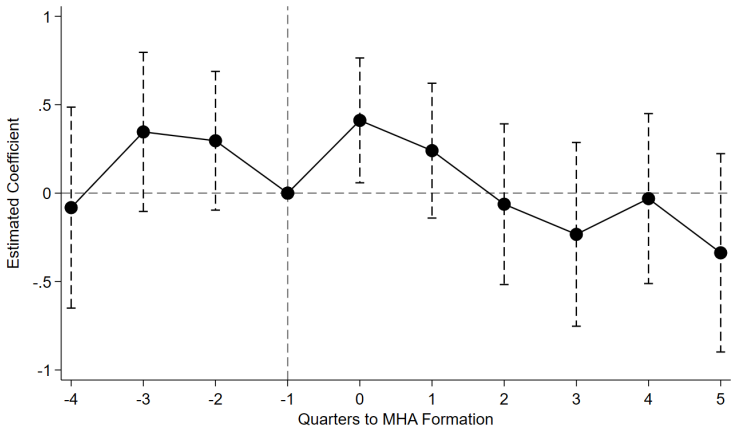
The Lost Generation of High-Quality Games

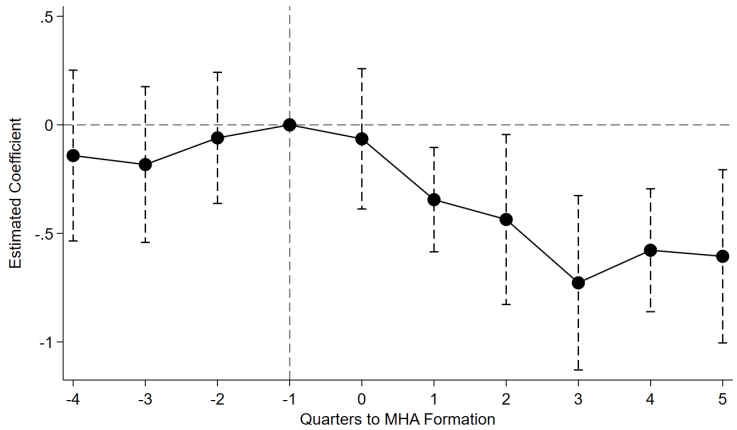
- We construct within-category quality bins, with cutoffs at the 33th- and 67th- percentiles. ▸ ratings histogram
- Dep. Vars: The Number of New Apps in High-, Medium-, and Low-Quality Bins.



	(a) High-Quality
ATE	-0.78*** (0.20)
in %	-54%

Also, Fewer Low-Quality New Games





	(b) Medium-Quality	(c) Low-Quality
ATE	-0.14 (0.19)	-0.35*** (0.08)
in %	-13%	-30%

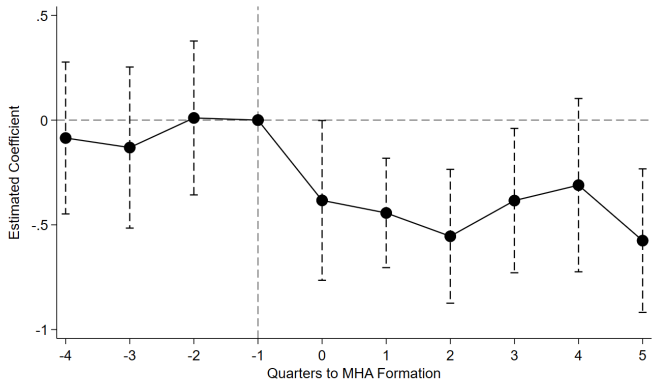
Why Fewer High-Quality New Games?

1. Quality is unpredictable before entry (Aguiar and Waldfogel, 2018; Janssen et al. 2022; Waldfogel, 2025).
   - Indeed find that apps' quality is imperfectly predictable before release: variables known before entry explain 13.6% variations in the realized app quality. ▸ predict quality
   - However, the variability of residual quality is significantly higher among middle-quality apps than high-quality apps. ▸ variability
2. Higher commission rate flattens the revenue curve of app quality, discouraging high-quality choice.
   - We build a simple two-stage quality choice model that can explain the decline in both the low-quality and high-quality apps under regular assumptions. ▸ model ▸ incumbents version age
   - Entry selection on the efficiency of quality provision screens out developers that would choose low quality after entry.
   - Empirically, we find that incumbent Android games postpone update significantly by 20% after the commission change.

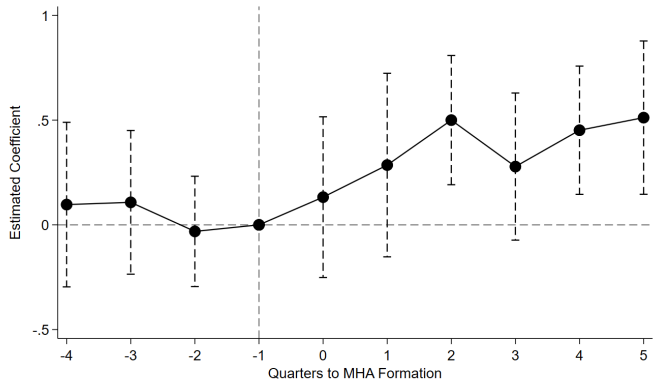
Result 3: The Effect on the Quality Gap between Platforms

Widened Quality Gap

Dep. Variables: the average quality of new apps on Android (iOS).



(a) Android Entrant Quality



(b) iOS Entrant Quality

ATE	-0.39*** (0.07)	0.32** (0.11)
Base Mean	3.91	4.13

Why: Profitability *versus* Substitution Effects within quality bins (Android)

$$N_s^b = N^b \times Pr[Join\ s | Development, b], \forall b = high\text{-}, medium\text{-}, low\text{-}quality.$$

Quality bin	(1) Industry-wide entry	(2) %Android | entry	(3) Entry on Android
High	-0.78***	-0.19**	-1.17***
	(0.20)	(0.07)	(0.24)
Medium	-0.14	-0.03	-0.29
	(0.19)	(0.04)	(0.22)
Low	-0.35***	0.05	-0.42***
	(0.08)	(0.04)	(0.15)

Table: ATEs within Quality Bins to Explain Declined Quality of New Games on Android

Why: Profitability *versus* Substitution Effects within quality bins (iOS)

The increased quality of new games on iOS is driven by the loss of low-quality new iOS games. Neither platform saw significantly more high-quality new games!

	(1)	(2)	(3)
Quality bin	Industry-wide entry	% iOS | entry	Entry on iOS
High	-0.78***	0.16**	0.03
	(0.20)	(0.05)	(0.14)
Medium	-0.14	0.04	-0.11
	(0.19)	(0.03)	(0.16)
Low	-0.35***	0.01	-0.71***
	(0.08)	(0.03)	(0.25)

Table: ATEs within Quality Bins to Explain Increased Quality of New Games on iOS

Summary of Results

As the Android game commission rate increased from 30% to 50%, we find:

- **Direct Negative Entry Effect**: A 47% decline in the number of new games on Android.
- **Negative Spillover Effect**: A 27% decline in the number of new games on iOS. (platform complementarity)
  - Driven by the decline of multi-homing games.
- **The Lost Generation of High-Quality Games**: A 6% decrease in the average quality of new games, driven by a 54% decline in the number of high-quality new games.
- **Widened Quality Gap**: The gap between an average Android new game and an average iOS new game increased by 0.7 stars from a baseline of 0.2 stars.

Concluding Remarks

- We document the effects of a higher Android commission rate on the number and quality of new apps across platforms.
- (i) Negative spillover effect to iOS. (ii) The lost generation of high-quality apps.
- The impact of gatekeepers' conducts goes beyond their owned platforms and beyond small suppliers.
- Fewer apps and worse apps. Consumers lose welfare in the app markets. Compensation in the smartphone market?
- Empirics meet theories, and the Economics of DMA.
  - Platform competition alone may not help address the underlying distortions.
  - Regulations shall account for the spillovers among platforms. Worse/Better entry condition on one can hurt/help another.

Related Literature

- Theories on Platform Fees
  - Cross-platform spillover (Teh and Wright, 2025) and platform complementarity (Jeon and Rey, 2024). We additionally examine how commission rates affect quality.
  - Armstrong (2006), Wang and Wright (2017, 2018), Karle, Peitz and Reisinger (2020), Ronayne (2021), Ronayne and Taylor (2022), Etro (2023), Teh et al. (2023), Wang and Wright (2025), Anderson and Bedre-Defolie (2025).
- Empirics on Platform Fees:
  - Conti and Santaló (2023) study entry and quality effects of the small business program. We uniquely examine complementarity and substitutability between platforms, as well as document significant effects on high-quality apps.
  - Choi and Mela (2019), Sullivan (2023).
- Entrant Quality
  - Ershov (2020): lower discovery costs lead to more entry and lower entrant quality.
  - Janssen et al. (2022): the loss of innovative apps after GDPR. More generally, (un)predictability of quality (Aguiar and Waldfogel, 2018; Waldfogel, 2025).

Thank you! All Comments are Welcome!

xuan.teng@econ.lmu.de

Appendix: The Popularity of Multi-Homing Apps on iOS

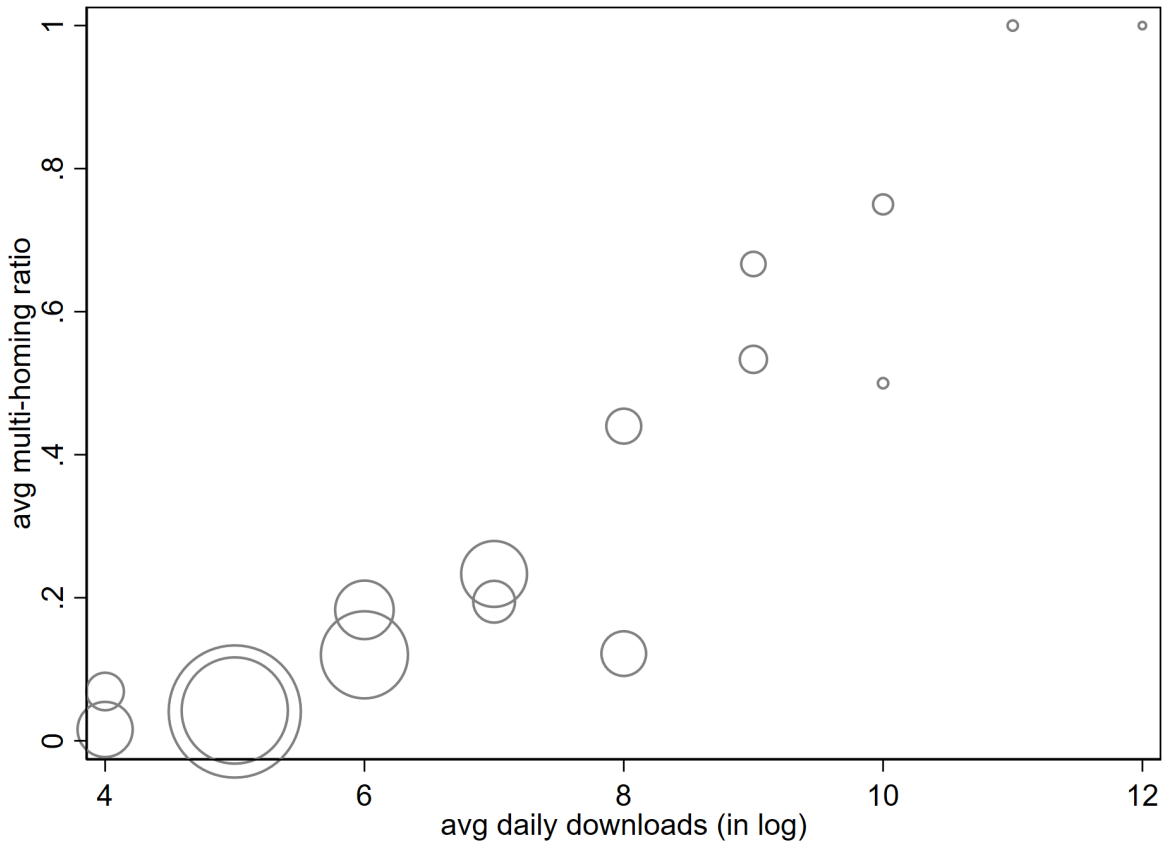
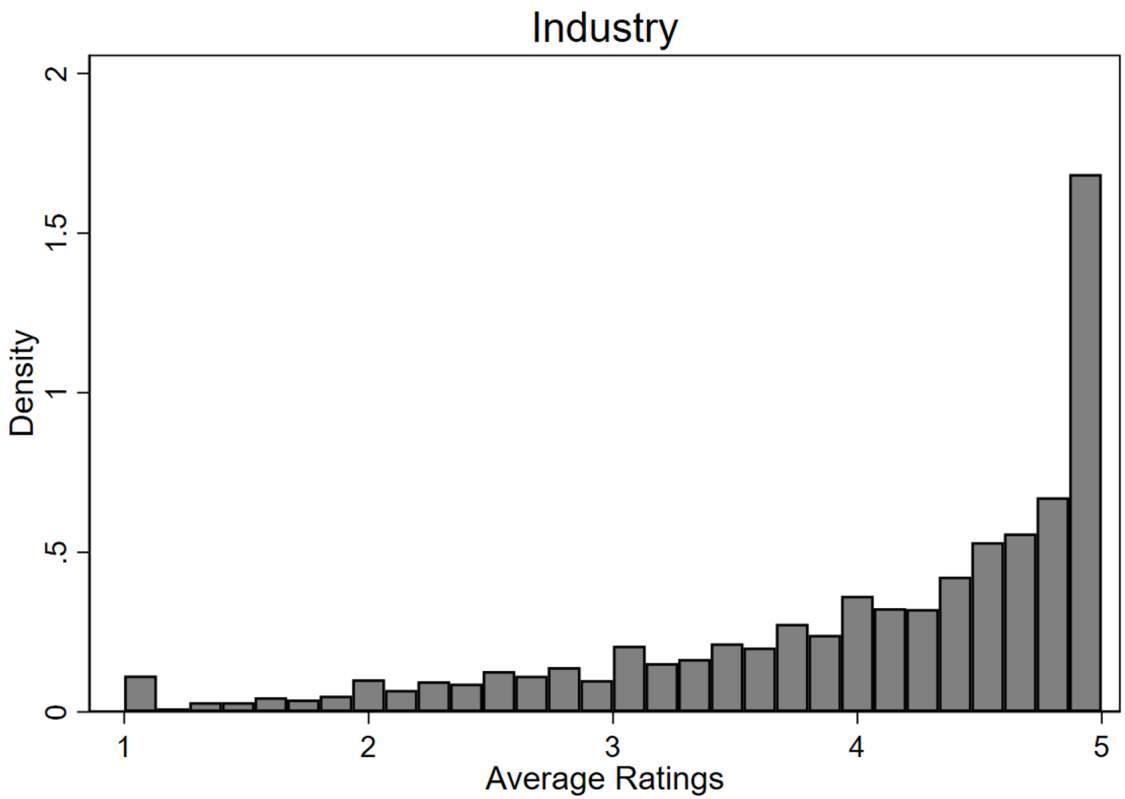


Figure: The ratio of multi-homing apps in each log-downloads bin. Circle size denotes the number of apps in each bin.

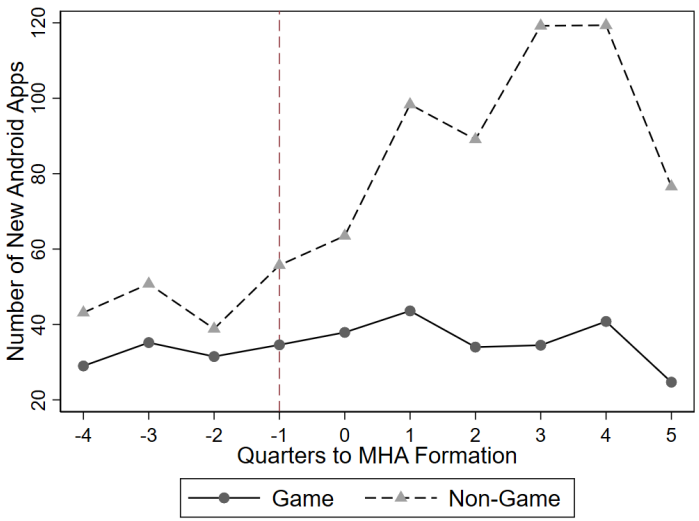
back

Appendix: Histogram of App Quality, Measured by Average Ratings

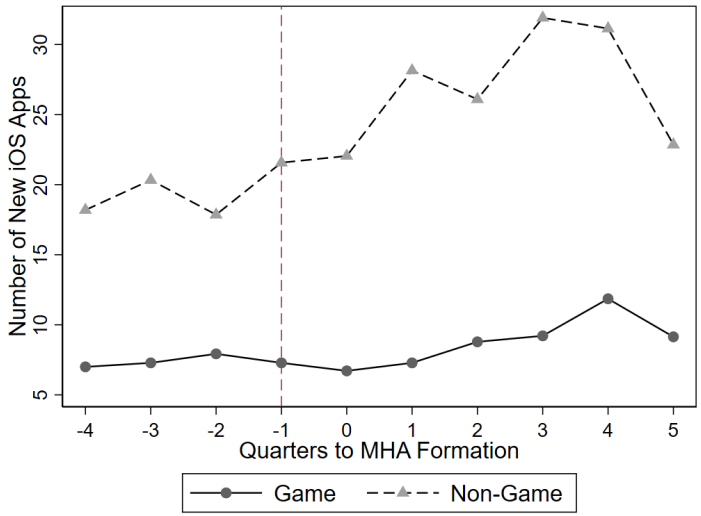


back

Appendix: Game vs. Non-Game Markets: Number of New Apps



(a) Android

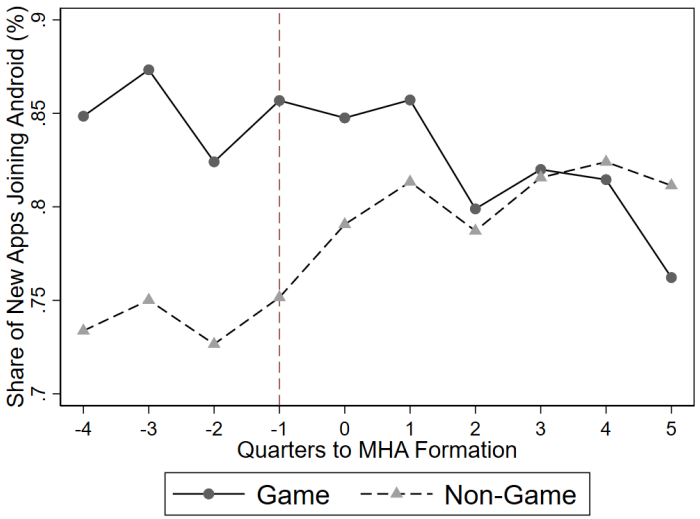


(b) iOS

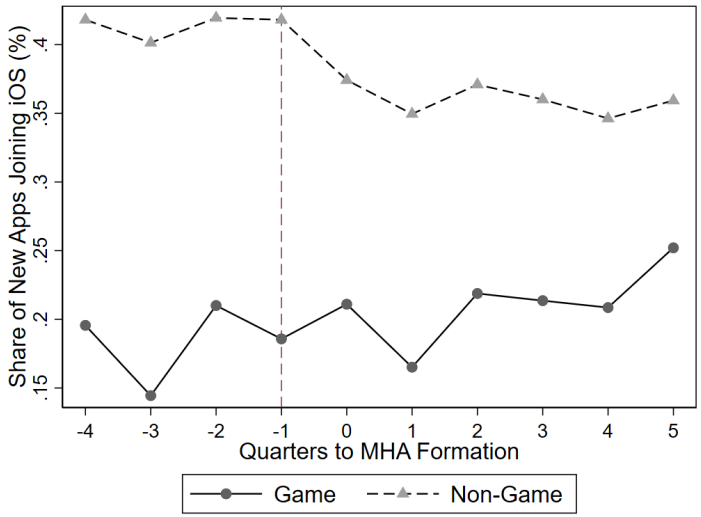
Figure: Number of New Apps Per Category on Android (iOS), by Game and Non-Game Categories.

back

Appendix: Game vs. Non-Game Markets: Platform Choice



(a) %Android

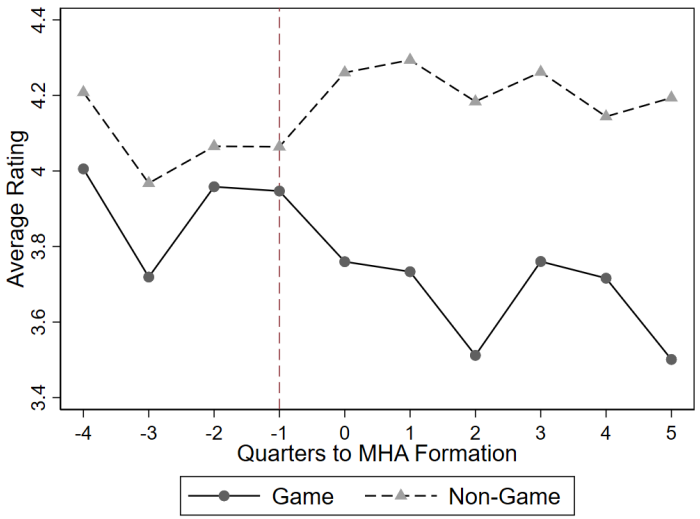


(b) %iOS

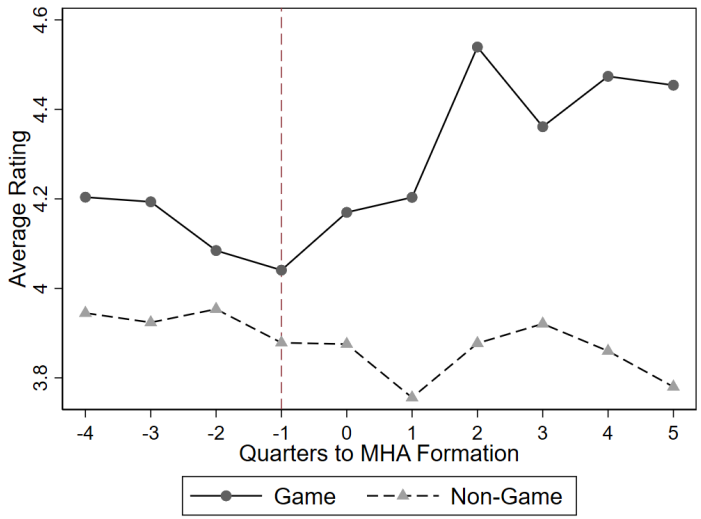
Figure: Share of New Apps Joining Android (iOS) Per Category, by Game and Non-Game Categories.

back

Appendix: Game vs. Non-Game Markets: Entrant Quality



(a) Android Rating



(b) iOS Rating

Figure: Average Quality of New Apps Per Category on Android (iOS), by Game and Non-Game Categories.

back

Appendix: Quality Predictability before Entry

	(1) Quality	(2) σ	(3) Quality	(4) σ
Developer prior ratings	0.340***		-0.710***	
	(0.023)		(0.063)	
Missing developer prior ratings	1.577***		-2.858***	
	(0.098)		(0.278)	
Log employee size at registration	0.071***		0.082***	
	(0.005)		(0.007)	
Missing employee size at registration	0.219***		0.273***	
	(0.027)		(0.035)	
Log team size before release	0.617***		0.642***	
	(0.167)		(0.186)	
Missing team size before release	3.014***		2.644***	
	(0.672)		(0.750)	
Predicted quality		-0.242***		-0.247***
		(0.025)		(0.012)
Observations	11,197	11,197	10,303	10,303
Adj. R-squared	0.054	0.009	0.136	0.039
Category-Quarter FE	no		yes	
Multi-app developer FE	no		yes	

Appendix: Variability of Un-Predictability of Quality

	(1) Quality	(2) σ	(3) Quality	(4) σ
SD of Resid. in Low quality bin	1.005		0.948	
SD of Resid. in Medium quality bin	0.559		0.500	
SD of Resid. in High quality bin	0.233		0.321	

back

Appendix: A Quality Choice Model

- A simple two-stage game:

$$\pi_i = (1 - r)R(u_i) - F_i(u_i) - C$$

  - Entry: incur entry cost C, endowed with quality provision technology $F_i(\cdot)$. An example:

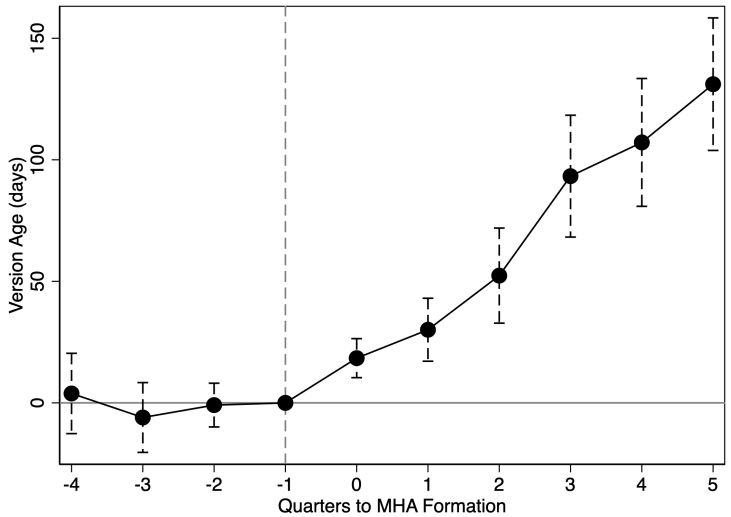
$$F_i(u) = F_{0i}u^{\beta}, u \geq 1 \text{ (minimum quality 1 with cost } F_{0i})$$

  - Quality Choice: incur the cost $F_i(u_i)$ to provide quality u_i.
- Characterization: $(\overline{F_{0i}} = T(r, C), \{u_i^*(r, F_{0i}) : F_{0i} \leq \overline{F_{0i}}\})$
- Endogenous quality threshold: $L(r, C) = u_i^*(r, T(r, C))$
- Under regular conditions, we prove that, a higher commission rate r leads to:
  - lower chosen qualities among infra-marginal entrants: $\frac{\partial u_i^*(r,F_{0i})}{\partial r} < 0, \forall F_{0i} < L(r, C)$.
  - a higher (endogenous) quality threshold of the marginal entrants: $\frac{\partial L(r,C)}{\partial r} > 0$.

back

Appendix: The Effect on Incumbent Android Apps' Version Age

- Incumbent: apps released before the first month in the sample period (August 2013).
- Two-way FE: app FE, quarter FE. Cluster se at category level.



	Incumbents Version Age (Days)
ATE	72.83*** (10.17)
Base Mean	374

back