Platform competition in the tablet market: The role of application quality

CCP 15th Annual Conference

Thanh Doan Fabio Manenti Franco Mariuzzo

Franco Mariuzzo
School of Economics &CCP
University of East Anglia

June 6, 2019

Introduction

Aim of the paper

- Study the role of app quality on the demand for tablets that run on two main operating systems: iOS or Android.

Introduction

Aim of the paper

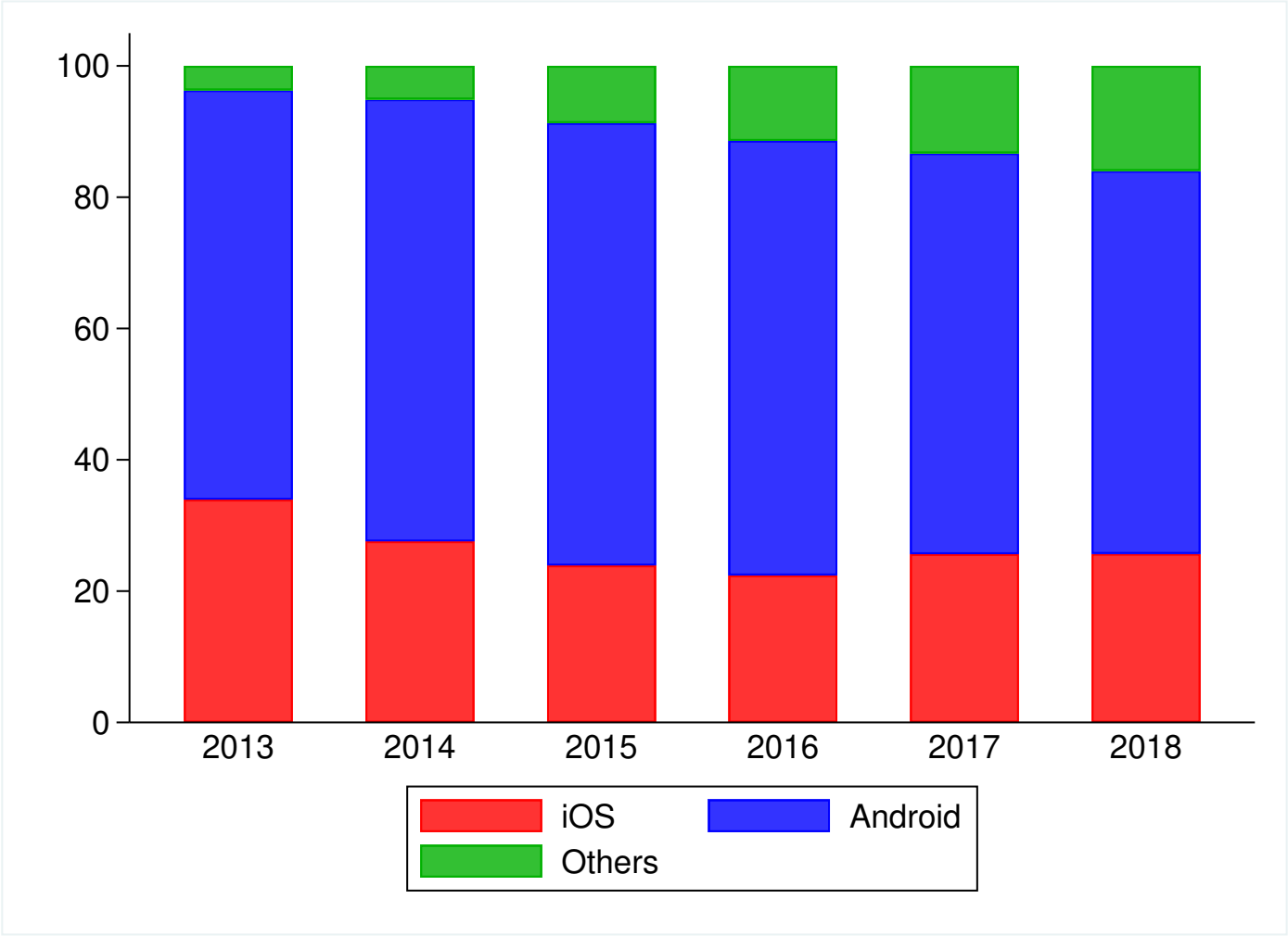
- Study the role of app quality on the demand for tablets that run on two main operating systems: iOS or Android.

Facts

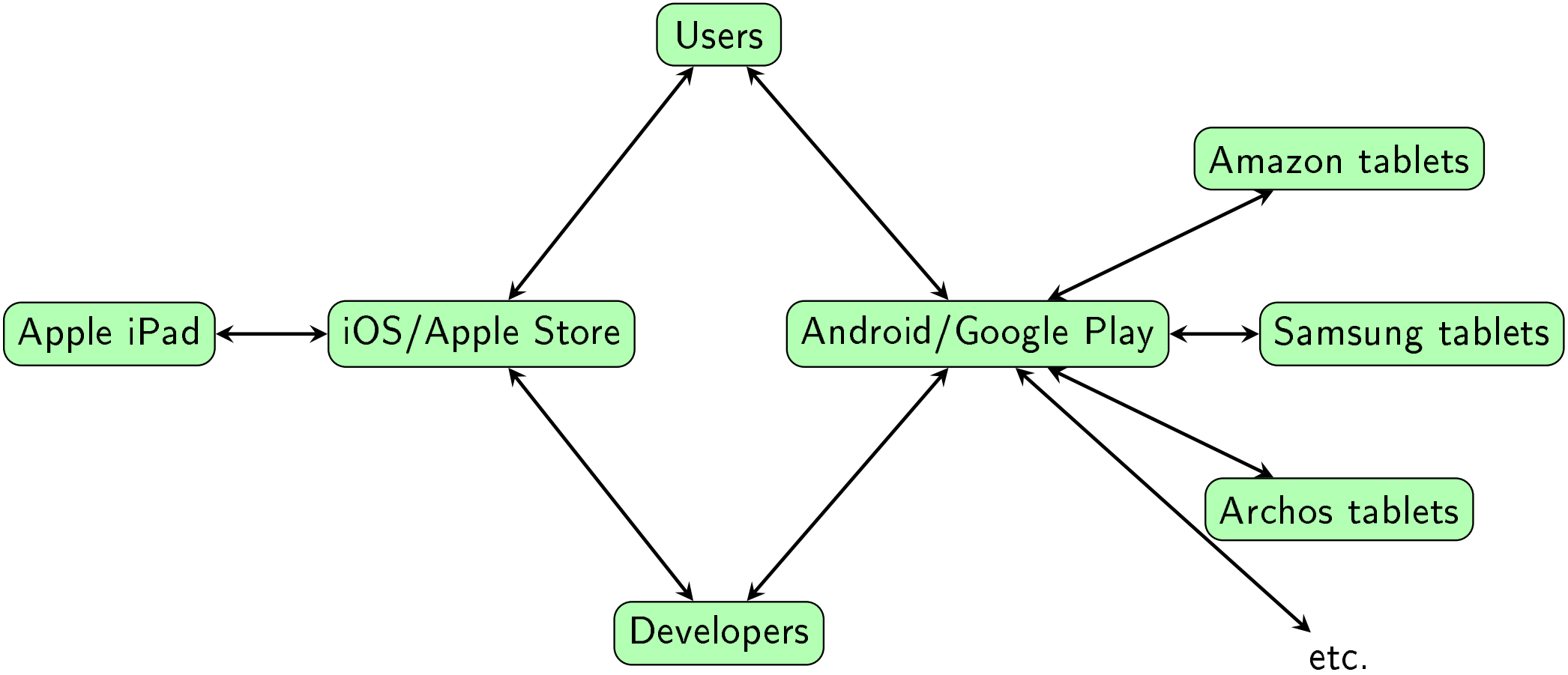
- Apple has developed iOS. It is a closed platform.
- Google has created Android. It is an open platform.

Market Overview (Source: Statista)

Figure: Global tablet market shares by operating system (OS)

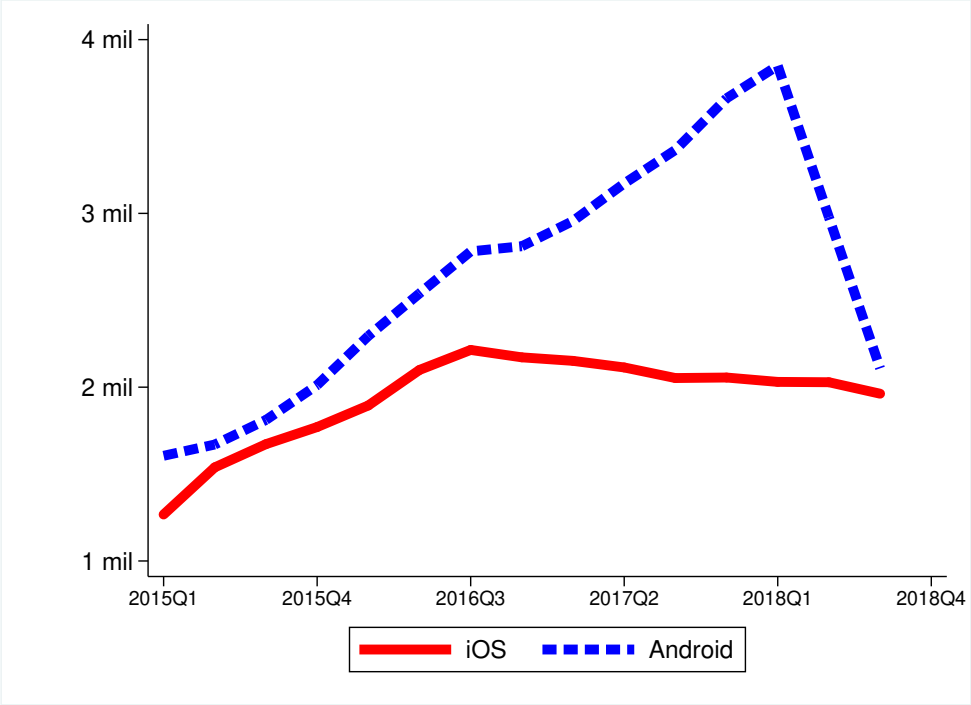


Two platforms with different strategies



Market overview (Source: Statista)

Figure: Number of applications available in the two largest application stores



App stores quality control

1. In 2016, Apple updated its app store review guidelines, focusing on reducing bad apps and spam apps.
2. In 2017, Google used machine learning algorithm to remove 700,000 bad apps and 100,000 developers from Google Play (and similarly the following year).

Research questions

Questions

- What is the impact of indirect network externalities induced by app quality on tablet demand?
- Is the impact of app quality on prices, market shares and profits the same on the two (asymmetric) platforms?
- Is the impact of income on prices, market shares and profits the same on the two (asymmetric) platforms?

Some related literature

Indirect network effects

1. Theory: Church and Gandal (1992).
2. Large number of empirical works on various industries:
    1. Reduced form and static models: Gandal et al. 2000 (CD Players), Nair and Dub 2004 (Personal Digital Assistants), Corts and Lederman 2009 (Video Games), Kim et al. 2014 (Gaming Industry).
    2. Structural and dynamic models: Lee (2013), Zhou (2017) (Video games).

Smartphone and application markets

- Kim (2012): estimates a structural model of smartphone demand and exploits heterogeneity in application demand.
- Sun (2013): measures the impact of cross-network externalities on the brand value of smartphones.
- Ghose and Han (2014): estimates demand for smartphones using a random coefficients nested logit model.
- Comino et al (2018): estimates heterogeneous impact of updates on the demand for apps controlled by Google and Apple and then studies the decision to update.

Contribution to the literature

- We exploit asymmetry between two competing platforms: Google (open platform) and Apple (closed platform) and:
  - Estimate a structural model of demand for tablets and quantify the indirect network externalities driven by application quality.
  - Test for a possibly asymmetric impact of indirect network externalities (generated by app quality) on important outcomes of tablet demand controlled by the two platforms.
  - Test for a possibly asymmetric impact of income on important outcomes of tablet demand controlled by the two platforms.

Key findings

- App quality has a significant impact on the demand for tablets.
- An increase in app quality leads to:

  Larger gains of demand from the outside market than from the other competitor.

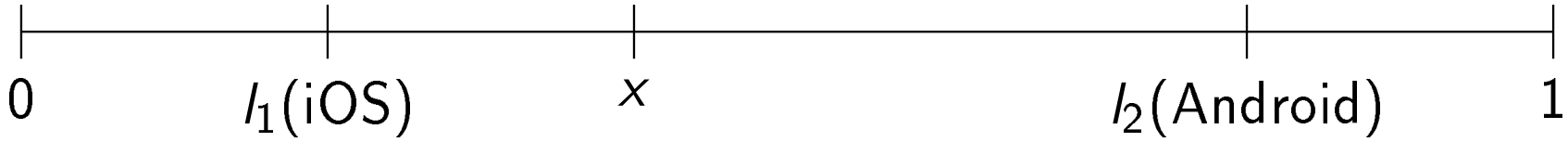
  Larger effect on market shares and profits on the closed platform (Apple) and no differential effect on prices.
- An increase in income for middle-class consumers leads to:

  Larger market shares and profits for the closed platform (Apple).

  Larger prices (mark-ups) for the open platform (Google).

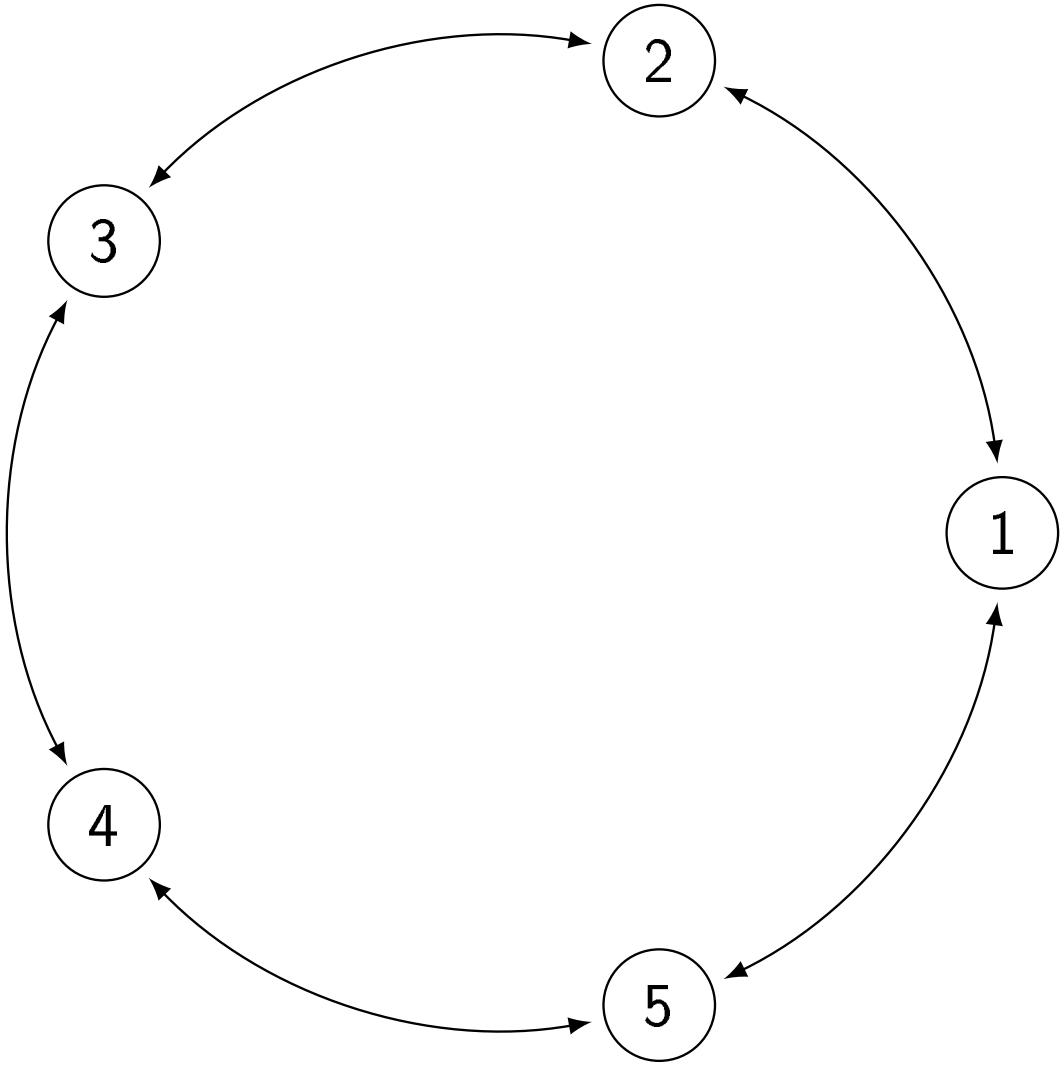
Simple theoretical model: a two-stage game

1. Stage 1: Inter-platform tablet competition à la Hotelling.



- Consumers are of two types: a proportion μ is high income (inelastic) and $1-\mu$ is low income (elastic).
- Consumers gain utility from tablet quality (z_h) and expected app quality ($\overline{z}_s$). Without loss of generality, we interact the two sources of quality ($z_h\overline{z}_s$).

Figure: Salop circular model (example with n=5)



Predictions from the theoretical model

Prediction 1: Effect of app quality

The impact of app quality on tablet demands and profits tends to be larger on the closed platform (Apple).

Prediction 2: Effect on demand of income rise for middle-class consumers

When middle-class consumers become richer, market shares of both platforms increase and if $c_1 > \frac{5}{3} c_2$, the impact of such a change is stronger on the closed platform (Apple).

Data

- Tablet data:

  Product-level information on tablet characteristics of 775 models produced by 45 vendors (12,337 observations).
  Five European countries: France, Germany, Italy, Spain and the UK over 15 quarters from 2010q3 to 2014q1.
  An observation is a model with a certain connectivity (wifi vs. 3G or 4G) and screen size (example, Huawei MediaPad WiFi 8GB - 7").

- App data:

  Six monthly panels of top 1,000 most downloaded apps in Google Play and App Store, respectively.
  Same five European countries from September 2013 to February 2014.

- Income data: country surveys from Eurostat.

Summary statistics key variables (n=3750)

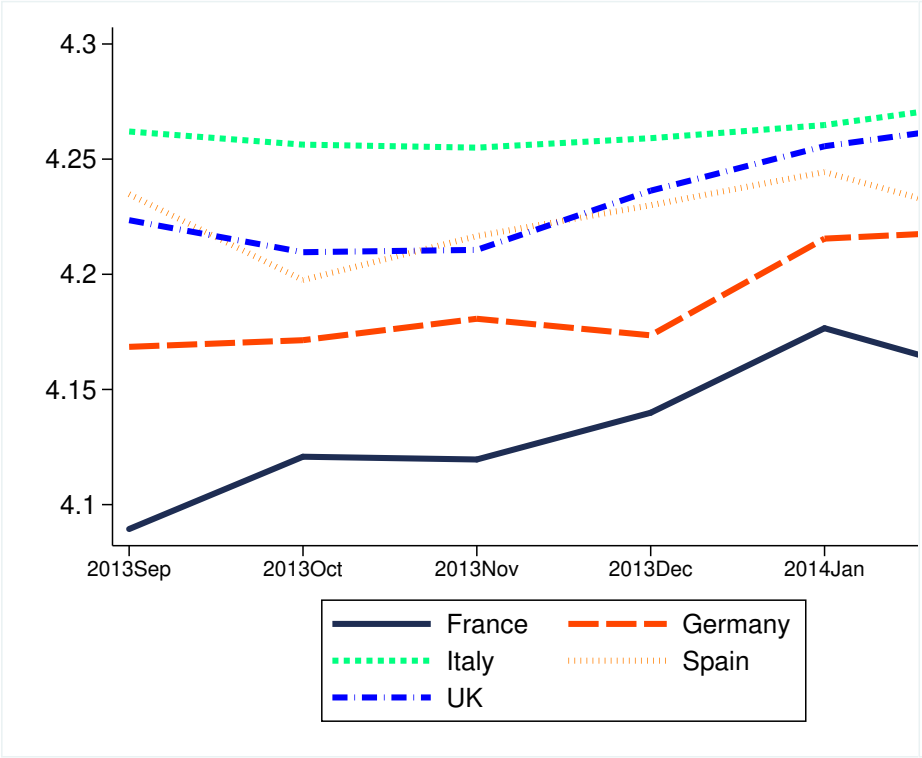
Variables	Mean	Std.dev	Min	Max
market share (s)	0.004	0.007	1.77E-06	0.08
price (p)	261.1	170.12	37.74	1050
screen size	8.65	1.37	7	13.3
storage	20.95	20.02	0.51	250
log screen resolution	13.83	0.66	12.86	15.226
# models	139.93	15.80	112	160
app rating	4.13	0.068	4.03	4.28

What is app rating?

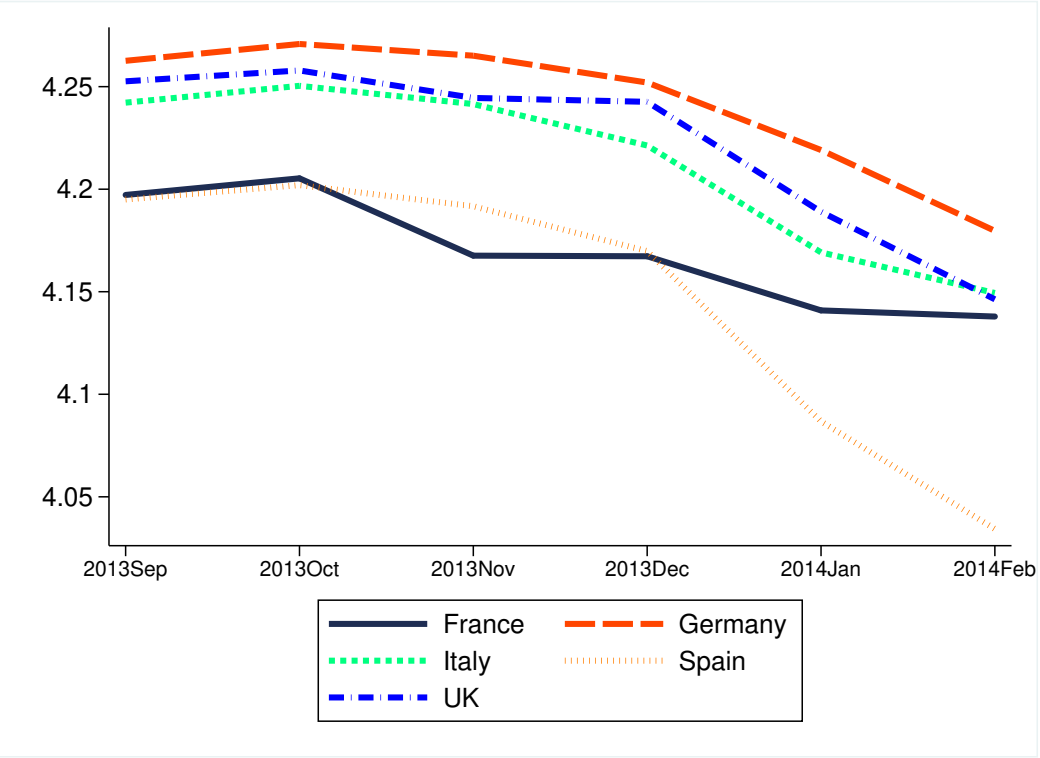
- Ratings and reviews influence how the app ranks in search results, and can affect whether someone downloads the app.
- Users can rate an app on a scale of 1 to 5.
- We only observe top 1,000 apps per period-country.

Average app rating by country and app store

(a) Apple

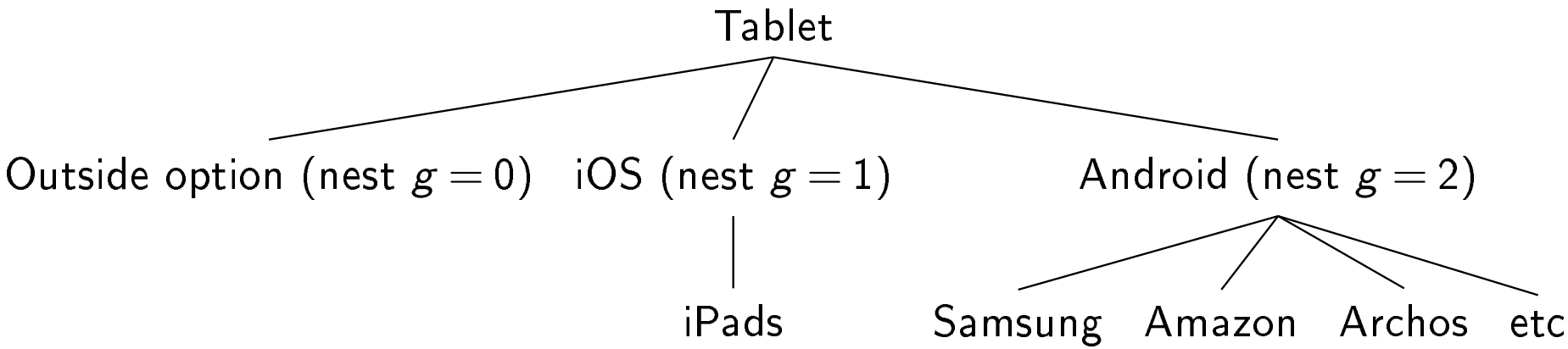


(b) Google Play



Econometrics: nested structure tablet market

Nested structure of the choice:



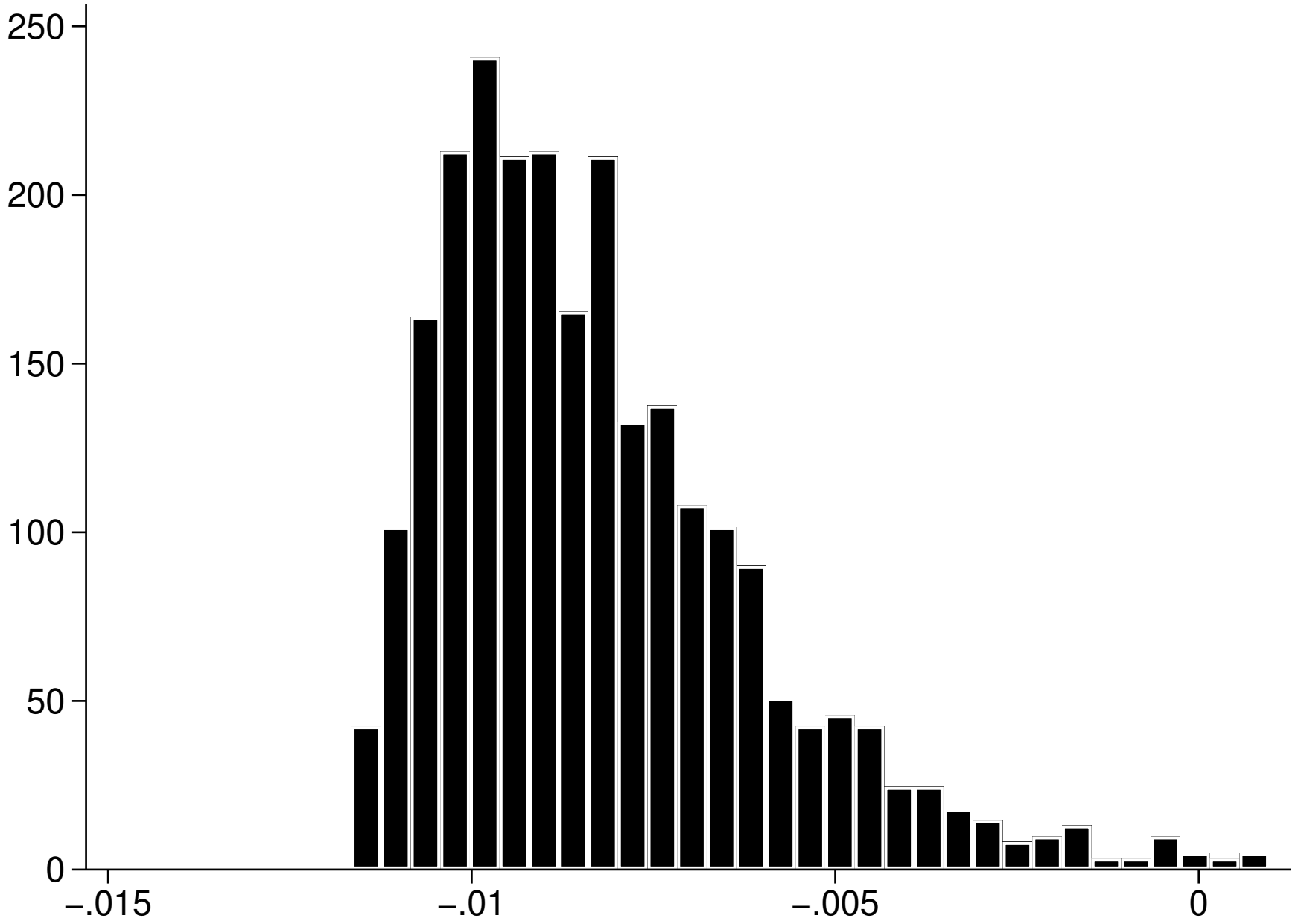
Econometric model (in words)

- Estimate jointly demand and pricing equations under various logit specifications.
- Allow for random coefficients on income and app quality.
- Use BLP instruments to deal with price endogeneity.

Table: Demand-Supply Estimation Results

	Logit		Nested Logit		RC Nested Logit		RC Nested Logit*	
	Parameter	SE	Parameter	SE	Parameter	SE	Parameter	SE
Demand Side								
Mean valuation (β)								
Constant	-30.614	3.452	-21.677	4.285	-26.981	0.605	-25.717	1.740
Storage	-0.001	0.008	0.005	0.033	-0.006	0.002	-0.006	0.001
Screen resolution	0.121	0.030	0.064	0.054	0.693	0.067	0.652	0.047
Screen size	0.030	0.057	0.045	0.038	0.033	0.002	0.021	0.015
Price	-0.012	0.004	-0.006	0.008	-0.013	0.028	-0.012	0.000
Apprating	1.302	0.381	1.862	0.409	2.509	0.744	2.412	0.375
Standard Deviation (σ)								
Price	NA		NA		0.004	0.034	0.005	0.002
Apprating	NA		NA		0.001	2.455	0.001	1.096
Interaction with D								
Price*Income	NA		NA		0.014	0.005	0.012	0.000
Apprating*Income	NA		NA		-0.025	0.010	-0.033	0.063
Nesting Parameter								
ρ	NA		0.652	0.182	0.285	0.091	0.350	0.019
Supply Side								
Constant	-11.25	0.445	-11.122	0.762	-1.949	3.963	-3.079	1.608
Storage	0.022	0.000	0.023	0.000	0.004	0.004	0.006	0.002
Screen resolution	0.082	0.003	0.076	0.003	0.309	0.157	0.363	0.118
Screen size	0.158	0.014	0.206	0.009	0.251	0.233	0.281	0.050
Model Statistics								
N	3750		3750		3750		3750	
R2D	0.361		0.881		0.600		0.564	
R2S	0.851		0.801		0.587		0.636	
N. mc < 0	333		11		172		255	

Figure: **Frequency distribution of price sensitivity**



Elasticities

Store	Product-level			Segment-level	
	Own-price elasticities	Cross-price elasticities		Cross-price elasticities	
		Same segment	Different segment	Same segment	Different segment
Logit					
Apple	-5.25	0.01	0.01	0.11	0.09
Android	-2.68	0.01	0.01	0.09	0.12
Nested logit					
Apple	-8.01	0.18	0.01	4.57	0.05
Android	-4.16	0.01	0.01	2.19	0.06
RC nested logit					
Apple	-3.19	0.04	0.01	0.87	0.05
Android	-2.25	0.01	0.01	0.62	0.07

Table: Counterfactual 1: Increasing app rating

		France	Germany	Italy	Spain	UK
Increasing iOS apprating by 1 s.d						
Apple	Price changes (%)	0.06*(R)	0.13(F)	0.13(F)	-0.06(F)	-0.54(F)
	Market share changes (%)	14.60*(F)	13.70*(F)	14.83*(R)	14.71*(R)	14.92*(R)
	Profit changes (%)	14.77*(R)	13.83*(R)	14.69*(R)	14.54*(R)	13.22*(F)
Android	Price changes (%)	-0.02*	0.05*	-0.08*	-0.43*	-0.47*
	Market share changes (%)	-0.18*	-2.10*	-0.15*	-1.33*	-1.24*
	Profit changes (%)	-0.74*	-1.93*	-0.32*	-1.74*	-1.99*
Increasing GP apprating by 1 s.d						
Apple	Price changes (%)	-0.05*(R)	0.04(F)	-0.17*(R)	-0.21(R)	-0.26(R)
	Market share changes (%)	-0.61*(R)	-0.99(R)	-0.30*(R)	-0.42(R)	-0.78(R)
	Profit changes (%)	-0.23*(R)	-1.04* (R)	-0.72*(R)	-0.85*(R)	-1.51*(R)
Android	Price changes (%)	-0.01*	0.11*	0.11*	-0.49*	-0.33*
	Market share changes (%)	14.55*	13.49*	14.66*	13.19*	13.62*
	Profit changes (%)	14.53*	13.53*	14.48*	12.64*	13.10*

$p<0.05$: *. We perform K-Smirnov test for Counterfactual 1. The H0 is that changes for iOS and Android tablets are equally distributed. (R) = Reject at 5%; (F) : Fail to reject at 5%. The changes are in terms of own-effects (increasing application quality in that OS) and cross-effects (increasing application quality in the other OS).

Table: Counterfactual 2: Increasing income for middle-class

		France	Germany	Italy	Spain	UK
Apple	Price changes(%)	0.17*(R)	0.37(F)	-0.52(R)	-0.85(R)	-0.11(R)
	Market share changes (%)	6.05*(R)	8.46*(F)	10.39*(R)	8.00*(R)	12.03*(R)
	Profit changes(%)	6.38*(R)	7.78*(F)	8.65*(R)	5.34*(F)	10.52*(R)
Android	Price changes(%)	1.23*	1.67*	1.36*	1.31*	2.11*
	Market share changes(%)	2.66*	5.65*	4.71*	3.91*	5.14*
	Profit changes(%)	4.52*	6.66*	6.30*	5.00*	8.02*

$p<0.05$: *. Middle-class is defined by 25^{th} and 75^{th} population in the income distribution. We perform the K-Smirnov test for the Counterfactual 2 which the H0 is that the changes for iOS and Android tablets are equally distributed. R: Reject at 5%, F: Fail to reject at 5%.

Conclusions

- There are significant indirect network externalities from the application market to users in the tablet PC market.
- An increase in application quality leads to a larger increase in Apple than Android in terms of market shares and profits.
- Apple would gain more market shares and profits and Android would gain more mark-ups when the income of middle-income users increases.

Limitations and further extensions

- Limitations

  We do not use variety (number) of applications as a source of network effects like in previous literature.

  We have not exploited the application estimation to examine the network effects from users to developers.

- Extensions

  Investigate the role of network effects in developer decisions of publishing a paid or free application.

  Adjust for possible self-selection in app-rating by store, by using information on multihomed apps.

THANK YOU FOR YOUR ATTENTION!