Spring 3-2018

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Xiaoyun He
Auburn University at Montgomery, xhe@aum.edu

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Xiaoyun He
Auburn University at Montgomery
xhe@aum.edu

ABSTRACT

Recent years have witnessed unprecedented growth in the development and usage of mobile apps. While there are indications that mobile apps hold great potential in shaping a new ecosystem, research in this area is just burgeoning. In this study, we aim to better understand the relevant determinants and characteristics in the rapidly evolving mobile app markets by drawing upon the recent studies in mobile apps. In particular, we focus on the demand side and supply side as well as value creation of the emerging app markets. We also identify research gaps and suggest future research agenda.

Keywords

Mobile apps, app markets, demand and supply, determinants and characteristics, value creation

INTRODUCTION

With the phenomenal growth in the usage of mobile devices worldwide, we have seen the fast rise in the development and usage of mobile applications, known as mobile apps. Since Apple first launched its iPhone App Store in July 2008, the growth in the mobile app markets has been remarkable. As of March 2017, the two largest global platforms for app distribution are Google Play, which is the official app store for the Android OS, and Apple's App Store, which caters to iOS users. Android users are able to choose between 2.8 million apps, and Apple's App Store remains the second-largest app store with 2.2 million available apps (Statista, 2017). Mobile apps generate revenue in a number of different ways, such as charging users a small amount of money for the use of an app (an average of US$1.02 per app in the Apple Store), charging for access to premium features of an otherwise free app or simply selling ad space. Global consumer spending on mobile gaming apps is set to reach 105.2 billion U.S. dollars in 2021 (Statista, 2017).

Over time, the platform providers have lowered the cost of development and distribution of mobile apps. Few could have anticipated how drastically it would change the mobile software market. Meanwhile, stakeholders such as app developers and advertisers also play their respective role in pricing to influence the dynamics and equilibrium of the app ecosystem in terms of demand and supply. Understanding this app ecosystem and the potential opportunities is important for all stakeholders involved. Yet, academic research on the new markets of mobile apps has just begun burgeoning. Many interesting questions that would have relevant managerial and theoretical implication remain unanswered yet.

In particular, the emerging app markets together may have created a new ecosystem (Petsas, Papadogiannakis, Polychronakis, Markatos, and Karagiannis, 2017). On the one side of this ecosystem, app developers develop and provide a supply of apps in the various categories; on the other side, mobile users have different demands on the apps for diverse purposes. Mobile apps compete in a variety of markets: games, entertainment, content, Internet services, travel services, online advice, shopping, utilities and productivity, and messaging, etc. (Bresnahan, Davis, and Yin, 2014). Indeed, mobile apps in these categories are creating a fast growing market. The app markets are characterized by very low entry barriers and an extremely high degree of competition (Comino, Manenti, and Mariuzzo, 2016). Like any new markets that hold great promise, mobile apps have engendered attentions and conjectures about how it will play out from the perspective of supply, demand, and ultimately value creation. Specifically, what are the determinants of demand? What are the determinants of supply? What characterizes the value creation in mobile app markets?

The objective of this paper is to answer the aforementioned questions through reviewing and synthesizing the recent studies related to demand, supply, and value creation of emerging app markets. We also identify research inadequacies and provide a useful roadmap for future research in this area.

DETERMINANTS OF DEMAND AND SUPPLY IN MOBILE MARKETS

Demand Side

Several studies have looked into what factors may affect the demand side in app markets. For example, Ifrach and Johari (2014) suggest that a high position in the top-ranked list boosts the demand and such boosting effect is significant for the top 20 positions. Yet, the development of the killer apps, i.e., the apps appearing in the top-ranked list, can be influenced by market and app characteristics (Yin, Davis, and Muzyrya, 2014). For instance, game apps are more likely to be in the top-ranked list. While more updates help non-game apps, game apps with no updates are more likely to appear in the top list.

Using data collected from Apple's App Store, Lee and Raghu (2014) find that app-level attributes such as offering free apps, higher initial popularity, investment in less-popular categories, continuous updates on app features and price, and higher user feedback on apps are positively associated with user demand and the longevity of apps. On the demand side, Li, Goh, and Cavusoglu (2014) assess the effects of popularity spillover between app developers' existing and new apps. They find that popular existing apps of an app developer can promote the popularity of new apps in the same category. New apps, in turn, drive demand for an app developer's existing apps both within and across categories.

Liu, Au, and Choi (2014) examine how freemium strategy may impact demand that is measured by sales volume and revenue of paid apps. Freemium, a combination of the words "free" and "premium", is a business model by which a service or a product is offered free of charge, but a premium is charged for advanced features, functionality, or related products and services. The authors find that higher sales rank and review rating of the free version of a mobile app both lead to higher sales rank of its paid version. However, only higher review rating of the free app contributes to higher revenue from the paid version.

In the app markets, new apps may be developed to imitate the design and appearance of innovative and original apps. These new ones are copycat apps. Using a combination of machine learning techniques, Li, Singh, and Wang (2014) detect two types of copycats: deceptive and non-deceptive. Their findings suggest that the copycat apps can be either friends or foes of the original apps. Specifically, high quality copycats tend to compete with the original app, especially if the copycat apps are non-deceptive. Interestingly, for low quality copycats, there is a significant and positive effect from the deceptive copycats on the original app downloads, suggesting a potential positive spillover effect.

Managing app updates (i.e., releasing new versions of an existing app) is critical to increase app visibility and to keep users engaged, disguising a hidden strategy to stimulate downloads (Comino, Manenti, and Mariuzzo, 2016). A quality update has a positive impact on App sales when consumers want better quality Apps and a price-promotion strategy is important when there is growing App demand along with increased device sales (Lee and Raghu, 2016). Also, producer-generated app descriptions have an effect on demand (Frank and Scholz, 2017).

Supply Side

With lowered cost of development and distribution of mobile apps that are facilitated by mobile platforms, there is the largest group of app developers, mostly entrepreneurs, ever to enter the app industry (Bresnahan, Davis, and Yin, 2014). To date, a large number of mobile apps have been developed by either entrepreneurial app developers or established firms. Yet, Bresnahan, Orsini, and Yin (2014) find that, at the current stage, the supply of mass market mobile apps is overwhelming from established firms, not from entrepreneurial app developers. Such difference is attributed to high marketing costs for new firms.

On the supply side, Ghose and Han (2014) show that app file size is a major cost driver in app development but that there are significant returns to scale in app development. Cost decreases with in-app purchase, in-app advertisement, app age, and age restrictions. Compared to lifestyle apps, games, social, and utility apps have higher marginal costs while media apps have lower marginal costs. Also, Li, Goh, and Cavusoglu (2014) examine the effect of app developers' app portfolio size and diversity on app quality. There is a negative impact of portfolio diversity on developers' app quality. However, this negative influence is mitigated by the increasing size of app portfolio. Lee and Raghu (2014) find that, by broadening their app offerings across multiple categories, app developers can improve their apps' sustainability in the top-ranked list.

CHARACTERISTICS OF VALUE CREATION IN MOBILE MARKETS

In the fast-growing app markets, the importance of value creation has been noted (e.g., Bresnahan, Davis, and Yin, 2014; Hyrynsalmia, Seppänenb, and Suominen, 2014). Value creation can be viewed from the perspective of demand side (i.e., end users) or supply side (i.e., developers of apps). Building on the concept of perceived customer value examined in the general context of Information and Communication Technology (ICT), a few studies have investigated the value of apps to consumers (e.g., Asche and Kreis, 2014; Wang, Liao, and Yang, 2013). Yet, research in relation to value creation of apps hitherto has primarily focused on the supply side.

Apps can achieve a variety of goals for app developers or publishers, though earning revenue is considered as the clear favorite (App Annie, 2015). In this regard, the following revenue models have been used for revenue generation: (1) Freemium - free download of apps with in-app purchases; (2) Paid – paid download with no in-app purchases; (3) Paidmium – paid download with in-app purchases; (4) In-app advertising – apps contain ads such as banner ads, video ads, etc. (5) Dynamic – business model shifts depending on certain factors. For instance, it can be shifted to an ad-supported model if the user does not make in-app purchases.

From the perspective of app developers, much of the research attention to date has been directed to app profitability. The dramatic differences in app profitability are observed by developer type (e.g., entrepreneurial app developers vs. established firms) and app type (e.g., game vs. non-game) (Bresnahan, Orsini, and Yin, 2014). In order to increase overall profitability, app developers may resort to optimal price cycles, where they alternate between a high price to boost revenue and a low one to enhance visibility (Ifrach and Johari, 2014). Lee and Raghu (2014) suggest that, by utilizing the natural segmentation in consumer tastes offered by different categories of apps, app developers may be able to improve sales performance of their apps. Petsas et al. (2013) show how free apps with an ad-based revenue strategy may result in higher financial benefits than paid apps. Prices of paid apps strongly depend on the platform where the apps are marketed. Specifically, the Apple's App Store is associated with lower prices for paid apps than Google Play (Roma, Zambuto, and Perrone, 2016). App-bundle's uniqueness is the determining factor behind consumer's motivation to purchase given that the price is acceptable to the consumer. All other factors that address customer's utilitarian and hedonic needs can have both upward and downward influence on a consumer's purchase (Wan, Zhao, Lu, and Gupta, 2017).

Using a two-sided market model with two separate agents - a platform owner and an app developer, Hao, Guo, and Easley (2013) reveal the market conditions that dictate when the platform owner can profit by subsidizing the app developer and when an app developer can benefit from the growth of the advertising market. Hao, Li, Tan, and Xu (2011) explore the fundamental influence of consumer rating behavior on mobile app market. Specifically, by incorporating bidirectional rating-utility conversion process into the utility function, the authors examine the market equilibrium and show how change in consumer rating attitude, such as being severer in offering ratings or being less critical in accepting ratings, would affect the developers' optimal choices of app price and app quality level as well as the platform owner's optimal revenue sharing policy.

In addition, Lee, Lee, and Whinston (2014) aim to evaluate the effectiveness of cross promotion that is defined as advertising a mobile app in another established app. On average, cross promotion is suboptimal as compared with display ads. By modeling the ad placement in cross promotions as a matching problem, the authors suggest that app similarity, measured by topic models from apps' text descriptions, is a significant factor that increases the user engagement in cross promotions. Zinck Stagno (2012) focuses on how start-ups may create business value with mobile apps.

Lastly, what are the sources of value creation in mobile app ecosystems from an app developer's point-of-view? To address this question, Hyrynsalmia, Seppänenb, and Suominen (2014) apply the framework of identifying sources of value creation in e-business to the context of app ecosystem. Among the four identified sources - efficiency, complementarities, lock-in, and novelty (Amit and Zott, 2001), they find that efficiency is the main value driver while lock-in and novelty are found to be used only occasionally, and the lack of the use of complementary offerings is remarkable.

The determinants of demand and supply as well as the characteristics of value creation in mobile markets are summarized in Figure 1.

FUTURE RESEARCH DIRECTIONS

With the rapid growth of mobile apps in the market that we have seen to date, the emerging stream of research in mobile apps has investigated some of the interesting research questions pertinent to demand and supply of mobile apps as well as value creation. Yet, we believe that the era of mobile market is yet to come. Based on the literature synthesis while recognizing the fact that the research of mobile apps is still at its early stage, we identify several research deficiencies and propose prospective research directions accordingly.
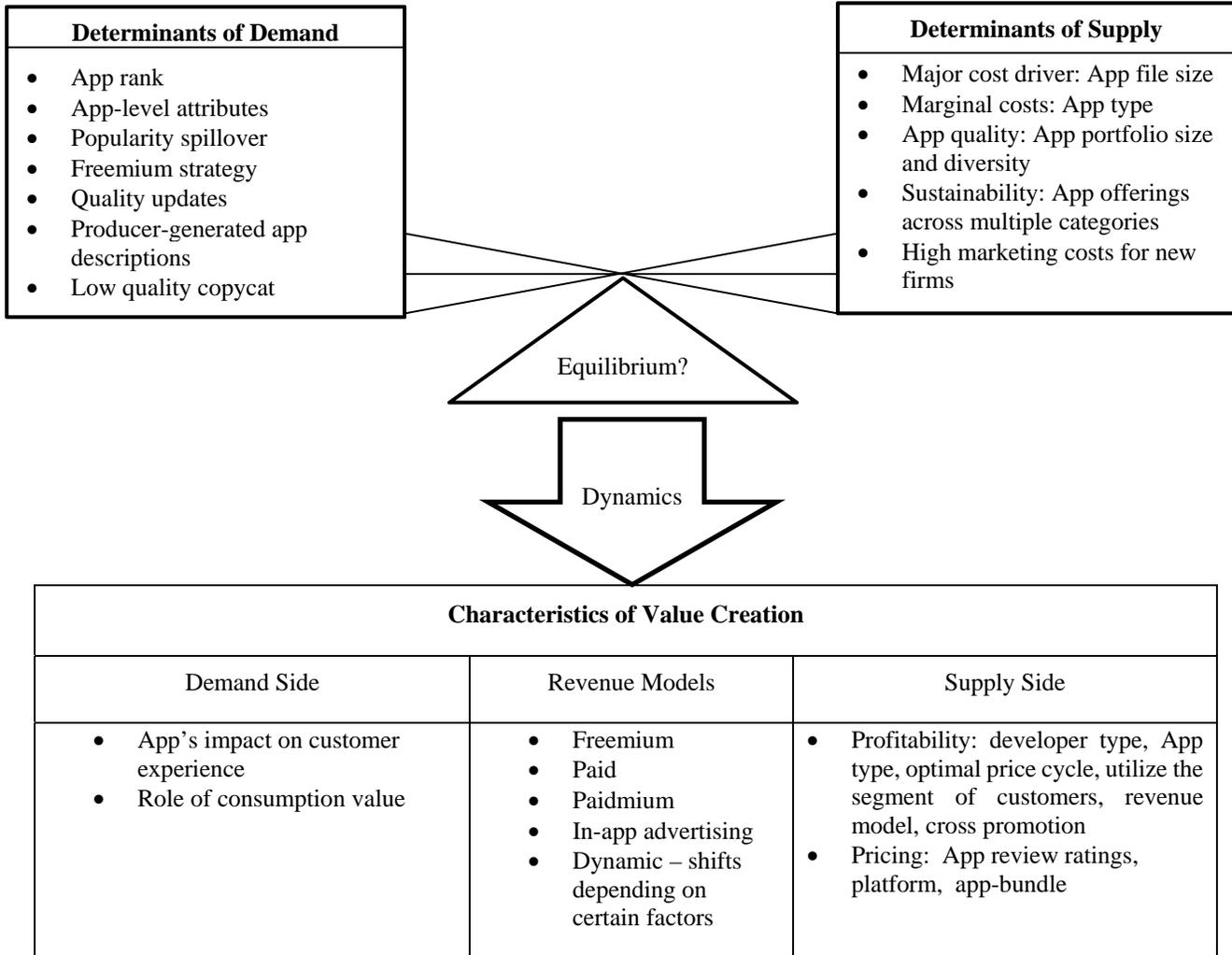
Determinants of Demand			Determinants of Supply

- App rank
- App-level attributes
- Popularity spillover
- Freemium strategy
- Quality updates
- Producer-generated app descriptions
- Low quality copycat

- Major cost driver: App file size
- Marginal costs: App type
- App quality: App portfolio size and diversity
- Sustainability: App offerings across multiple categories
- High marketing costs for new firms

Equilibrium?

Dynamics

Characteristics of Value Creation

Demand Side	Revenue Models	Supply Side
• App's impact on customer experience • Role of consumption value	• Freemium • Paid • Paidmium • In-app advertising • Dynamic – shifts depending on certain factors	• Profitability: developer type, App type, optimal price cycle, utilize the segment of customers, revenue model, cross promotion • Pricing: App review ratings, platform, app-bundle

Figure 1. Determinants of Demand and Supply and Characteristics of Value Creation

First, much of the research to date has focused on either the demand side or supply side of the app ecosystem. However, there is a lack of integrative view of both sides. In particular, with entry barriers appearing to be low (Comino, Manenti, and Mariuzzo, 2016), new apps are introduced at a rapid rate. Meanwhile, the fast growth of user base suggests that the distribution for demand for apps can be volatile. The subsequent questions include but are not limited to the following: how should app developers advertise their apps to the right users? How can consumers search the right apps that fit their needs? The search problem for a particular consumer is difficult. The current solution offered by app platformers is of a "top list" form. This form does not appear to be very effective at matching demanders to desired apps (Bresnahan, Davis, and Yin, 2014). The lack of effective matching users to apps may slow the rate of innovation in mobile application. Therefore, new mechanisms in matching demand with supply needs to be developed.

Second, despite the recent efforts on studying app markets, there are many relevant questions remain unanswered yet. The growth of app market provides a great opportunity to examine the important questions around software innovation, app pricing and promotion, app design, platform leadership, and externality (Garg and Telang, 2012; Ghose and Han, 2014). Especially with the large volume of apps related data continuously flowing in in a real time fashion, data-driven mobile analytics could be a means to provide solutions to some of the questions. In this direction, data analytics based on interdisciplinary approaches such as data mining, machine learning, and predictive analytics may help to uncover new insights on app markets.

In addition, distribution assumptions on the app data have been made in the extant research, e.g., assuming that the distributions of app sales is governed by Pareto distribution (Carare, 2010), and that the relationship between the rank of an app and the number of downloads follows a Pareto distribution (Garg and Telang, 2012). Meanwhile, Petsas et al. (2013) find that the app

popularity distribution exhibits a clustering effect, deviating from commonly observed Zipf-like models. It is observed that there is a strong temporal affinity of user downloads to app categories. Also, paid apps follow a different popularity distribution than free apps. As more apps related data are generated and available, it may require that researchers judge whether the assumptions are reasonable and whether they should be reviewed at certain stage. This is especially important, given that the validity of any conclusion drawn from a statistical inference depends on the validity of the assumptions made. Along this line, validating statistical models for emergent app data can be a direction to pursue. It can be coupled with the leveraging of techniques in data mining.

Third, in order to increase app revenue and profitability, how should app developers craft their successful monetization strategies? The app marketplace is constantly in flux. The vast majority of consumers stop using apps within 30 days after downloading them; on the other hand those who stay active spend more money -- or drive more traffic to the ads that generate revenue. Trust and satisfaction have been considered as two stepping stones for the success in the traditional e-commerce environment. Yet, it remains unclear whether the same would apply for the emerging app markets.

Fourth, as discussed earlier, with lowered cost of development and distribution of mobile apps, there is the largest group of app developers, mostly entrepreneurs, ever to enter the app industry (Bresnahan, Davis, and Yin, 2014). Thus, app markets may have the potential of generating new wealth, mostly through entrepreneurial start-ups and corporate ventures. It is transforming the rules of competition for established businesses in unprecedented ways. The advent of app economy presents a strong case for the confluence of the entrepreneurship and strategy research streams, as advocated by Hitt and Ireland (2000). Yet, the literature to date has neither articulated the central issues related to this new phenomenon, nor has it developed theory that captures the unique features of app markets. We believe that such inadequacies may be addressed by drawing on the received entrepreneurship and strategic management literatures. For example, how is value created within strategic network theory and transaction costs economics? Then, the applicability of these theories in the context of the emergence of app markets shall be discussed.

CONCLUSION

As the usage of mobile devices and apps continues to grow at a fast pace worldwide, we aim to better understand the essential elements and the implications from both demand and supply sides as well as value creation in the rapidly evolving app markets. In particular, we identify the determinants of demand and supply as well as the characteristics of value creation in the app markets by drawing upon the extant research. We also identify research gaps and propose future research agenda. This paper contributes to the emerging stream of literature on the emerging ecosystem of mobile apps.

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