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Ziqing Yuan
City University of Hong Kong, zqyuan2-c@my.cityu.edu.hk

Hailiang Chen
City University of Hong Kong, hailchen@cityu.edu.hk

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Research-in-Progress

Ziqing Yuan
City University of Hong Kong
Kowloon, Hong Kong
zqyuan2-c@my.cityu.edu.hk

Hailiang Chen
City University of Hong Kong
Kowloon, Hong Kong
hailchen@cityu.edu.hk

Abstract

As smartphones and tablets are becoming ubiquitous, mobile ecommerce is also evolving rapidly. Consumers can shop on mobile devices in two ways; they either open a mobile browser and visit a retailer's website, or download the retailer's mobile app and shop within the app. However, it is unclear how retailers should manage these two emerging channels together. This proposed study aims to investigate the relationship between mobile web and mobile app channels by analyzing how a change to one channel affects the outcome in the other. To infer causality, we utilize an exogenous event in the mobile web channel to assess how it influences the demand of retailers' mobile apps. The results could reveal whether these two mobile channels complement or substitute each other. This study contributes to the literature of multi-channel management in mobile commerce and provides important managerial implications for retailers to better leverage the growing mobile channels.

Keywords: Mobile web, mobile app, retail, mobile friendliness, complementarity, substitution

Introduction

Shopping online has skyrocketed over the years and its total revenue reached $119 billion in 2017 (U.S. Census 2018). As online shopping increases, so does purchasing on mobile. Among customers surveyed by UPS (2016), one in four customers has made purchases more often on their mobile devices. Mobile commerce provides great new opportunities for retailers' business growth. In today's mobile commerce, mobile web and mobile app are the leading two types of mobile channels for retailers to engage with customers. Data from Criteo (Q4 2017) reveal that retailers' mobile apps are responsible for 44% of all e-commerce transactions, while the mobile web contributed 23% and desktop accounted for 33% in North America.

Mobile web (or mobile website; these two terms are used interchangeably afterward) is a website accessed via a mobile browser on smartphones and tablets. Different from desktop websites, a mobile website is designed for smaller handheld display and touch-screen interface, and a mobile-friendly website should be able to adjust its content and display according to the size of the browser viewing it. Mobile websites provide a broader customer reach for retailers. Customers can easily access a website through a browser without downloading anything. Besides, the development and maintenance of mobile websites are relatively easier and cheaper. Retailers could instantly update information in the websites, which is independent of operating systems. Therefore, mobile website, especially mobile-friendly website, could provide customers with a simple and convenient shopping experience.

The mobile app, however, is another channel that can be useful for retailers. A (native) mobile app is a software application that is specifically designed for smartphones and tablets; it can be downloaded

from app stores (e.g., Apple App Store and Google Play) and installed on mobile devices to run. A mobile app enables retailers to integrate all kinds of functionalities and capabilities (e.g., photo taking via camera, push notifications) that may not be viable in a mobile web. Besides, some certain functions or contents are available for use even without Internet access. All these factors may contribute to greater customer engagement and higher conversion rates (Criteo 2017). In addition, the user data of mobile apps are available for retailers to generate future marketing and sales strategies.

There have been discussions and debates in the industry about whether a retailer should invest in either mobile web or mobile app, or both (e.g., eMarketer 2015, Fishkin 2015, Kapur 2016, MIMS 2014). Several factors contribute to the complexity of this issue. First, the cost of investing in either mobile web or mobile app can be substantial, and building a mobile app is often more expensive (eMarketer 2015). Second, the behavior patterns of mobile users largely determine the role each channel plays. On one hand, smartphone users spent 87% of their mobile media time through mobile apps and only 13% through the mobile web in June 2017 (comScore 2017). Despite the high mobile app usage, consumers are very selective about the apps they download and use (RetailMeNot 2015). Consumers on average spend 61% of their time using only one app on smartphones (comScore 2016), which implies that the chance for an average retailer app to catch and keep consumers' attention is small. On the other hand, while in the store, 82% of smartphone shoppers use search engines to browse product information, and 65% prefer mobile websites to mobile apps (Google 2013). Third, the unique characteristics of each channel also require that a retailer should align the mobile channel choice with its business goals. It is suggested that mobile web can reach more customers who are primarily interested in finding information, while mobile apps can appeal to loyal customers who are enticed to specific unique features (e.g., Fishkin 2015, Kapur 2016). To maximize reach and revenue, a retailer thus should allocate their resources properly between mobile app and mobile web, given that developing and maintaining either a mobile web or a mobile app involves substantial costs.

Despite the importance of this issue in the evolving mobile commerce, no prior study has empirically examined the interaction between the mobile app and mobile web channels for retailers. An important research question to ask now is, how do mobile web and mobile app interact with each other, or does mobile web complement or substitute mobile app for retailers? The answer to this question would provide implications for how retailers should manage the mobile web and mobile app channels together.

Literature Review

This study is related with the broad literature of multi-channel management in the information systems and marketing fields. The complementarity and substitution between online and offline channels have been extensively studied by prior studies in various contexts (e.g., Avery et al. 2012, Deleersnyder et al. 2002, Forman et al. 2009, to name a few). Deleersnyder et al. (2002) find that the introduction of online channel reduces the newspaper sales on the offline channel. Avery et al. (2012) extend the literature by studying how the introduction of an offline channel (a retail store for selling high-end apparel, accessories, and home furnishings) affects the online channel. Their findings suggest that the introduction of an offline channel decreases the sales of catalog channel in the short run, but increases sales in both catalog and Internet channels in the long run. Other studies have investigated how the emerging digital distribution channels affect the sales of physical products (e.g., Chen et al. 2018, Danaher et al. 2010, among many others). In terms of marketing channels, prior studies have investigated how television, print, search engine, and social media interact with each other (e.g., Goldfarb and Tucker 2011, Naik and Raman 2003, Yu et al. 2016, among many others). In addition, a few studies have examined the effects of the mobile channel addition on the existing online channel. Jung and Lee (2011) find that the mobile channel complements the Internet channel in banking services, and Xu et al. (2017) document that the tablet channel substitutes the PC channel but complements the smartphone channel.

Although the literature of research on mobile apps and the mobile Internet is growing fast (e.g., Garg and Telang 2013, Ghose and Han 2011, Ghose et al. 2013, Ghose and Han 2014, Lee and Raghu 2014, Han et al. 2016, to name a few), the topic on the relationship between mobile web and mobile app channels has received limited attention by previous research. To our knowledge, there is only one study

that addresses this research question but in a different industry. Xu et al. (2014) examine how the launch of the Fox News app in early 2010 affects users' visits to the Fox News mobile website. Their main findings suggest that mobile app and mobile web are complements for news consumption. This study differs from Xu et al. (2014) in at least four aspects: (1) we focus on the two-way interaction between mobile website channel and mobile app channel. Xu et al. (2014) only examine the effects of mobile app introduction on the mobile website traffic. In addition to examining the effects of mobile app launch and updates on mobile website traffic, we also investigate how making a website optimized for mobile affects the demand for the same retailer's mobile app. (2) We employ an exogenous event, Google's use of the mobile friendliness as a ranking signal in its search algorithm, to address potential endogeneity concerns (e.g., the decision of making a website mobile friendly or launching a mobile app may be endogenous). (3) Instead of focusing on only one company, we study the relationship between these two channels across many retailers (see details in the Data section below). (4) The research context is different (retail vs. news media industry).

Data

We acquire our datasets for this study from multiple sources. The mobile web/app traffic data (at monthly/website or monthly/app level) starting from July 2014 to June 2017 are purchased from comScore Inc. It includes traffic measures such as the number of total visits, number of unique visitors, and number of page views. All the firms within the retail category in comScore Mobile Metrix are included in our initial sample. For each retailer in the sample, we select the most representative shopping website and its corresponding mobile app. Our initial sample consists of 189 retailers present in both mobile web and mobile app channels. As the official website URLs and mobile app names are provided for all retailers in the comScore database, we rely on the website URLs to obtain the exact website optimization date on CompetitorScreenshots.com, which is the date when the website is optimized for users on mobile devices. We use the mobile app names to identify the app release date and version update history on the AppleAnnie.com. After combing data from these sources, the final sample consists of 129 e-commerce companies that are present in both mobile web and mobile app channels.

Mobile Website Friendliness

One difficulty in constructing the necessary data is to identify when a retailer website became optimized for mobile. To obtain this historical information, we rely on a website called CompetitorScreenshots.com. It takes daily screenshots of the homepage of various websites on both desktops and mobile devices. If a website is not optimized for mobile, it would look much like the same website viewed on desktops. By comparing the screenshots of a retailer website on mobile devices across different days, the exact date when the website became optimized for mobile can be identified.

By searching for the URL of each website on CompetitorScreenshots.com, we collect the historical daily screenshots for the retailers in our sample. Most retailers' screenshots are available since January 1, 2014. After going through all screenshots for each retailer, the date when a website became optimized for mobile is manually identified. We find that 52 out of 136 retailers became optimized for mobile before July 2014 and 3 websites are still showing desktop website versions for mobile devices by June 2017.

Mobile App Release and Updates

The release date and version updates information of each app are collected from App Annie (https://www.appannie.com/). App Annie provides the app data for different App stores, such as Apple App Store, Google Play, and other Android App platforms. We primarily use the app information on the Apple App Store for this study. When an app is unavailable on the Apple App store, we use the app information on the Google Play store. 24 out of 130 apps were launched during our study period (July 2014 to June 2017).

Methodology

To investigate the relationship between mobile web and mobile app channels, we investigate how a change to one channel affects itself (if applicable) and the other channel. We primarily focus on three types of events. The first event is when a retailer website becomes mobile friendly (or optimized for mobile). We study how it affects its own website traffic coming from mobile devices (Model 1) and how it affects the number of downloads for the same retailer's mobile app if there is one at the time of the event (Model 2). The second event is when a retailer launches a new mobile app. We study how it affects the traffic to the same retailer's mobile website (Model 3). To address potential endogeneity concerns, we further utilize an exogenous event, Google's use of the mobile friendliness as a ranking signal in its search algorithm, to evaluate how such an event affects mobile app downloads and how the effect varies between mobile-friendly retailers and non-mobile-friendly retailers, thereby inferring whether mobile web complements or substitutes mobile app for retailers (Model 4).

Below we describe the model specifications for these models in more detail. The four regression models can be estimated using either fixed or random effects estimators to control for those variations among retailers. Besides, time dummies (e.g., year-month dummies) would also be included in the model to control for any time effects such as weather, vacation, holidays or other seasonal variations. Moreover, other control variables would be used to increase the reliability of our results, such as the retailers' marketing strategies. Standard errors are clustered by retailer to account for the residual correlation across different observations related with the same retailer.

Model 1: how does mobile friendliness affect mobile web traffic?

When a website becomes mobile friendly, its traffic from mobile devices is expected to increase, holding everything else equal. This is because a mobile-friendly website can provide a better user experience for mobile users, so they are more likely to visit it.. Thus, we construct a retailer-month panel and specify the following regression model to test this hypothesis.

$$WebTraffic_{it} = MobileWebFriendly_{it} + MobileApp_{it} + MobileAppUpdate_{it} + \varepsilon_{it} \quad (1)$$

The dependent variable $WebTraffic_{it}$ in Equation (1) could be different website traffic measures, such as $TotalVisit_{it}$, $UniqueVisitor_{it}$, or $PageView_{it}$, where *i* denotes a retailer and *t* denotes a month. The main variable of interest is $MobileWebFriendly_{it}$, which is 1 if retailer *i*'s website is mobile friendly in month *t* and 0 otherwise. $MobileApp_{it}$ is 1 if retailer *i* has a mobile app in month *t* and 0 otherwise. $MobileAppUpdate_{it}$ is the number of updates the retailer *i*'s mobile app has in month *t*.

Model 2: how does mobile friendliness affect mobile app traffic?

When a website becomes mobile friendly, how it affects the demand for the same retailer's app is not straightforward. In the short term, as the mobile website becomes easier to use, it is possible that consumers would stick to the mobile web channel and be less likely to download the app from the same retailer. This would imply that mobile web and mobile app channels substitute each other. In the long term, however, as consumers become more loyal to the brand through interactions on the mobile web, consumers may be more likely to download the mobile app for its convenience and other unique features. This would imply that mobile web and mobile app channels complement each other. To test the relationship between these two channels in the both short and long terms, we construct a retailer-day panel and specify the following regression model to conduct analyses.

$$AppTraffic_{it} = MobileWebFriendly_{it} + MonthsSinceWebFriendly_{it} + MobileAppUpdate_{it} + \varepsilon_{it} \quad (2)$$

The dependent variable in Equation (2), $AppTraffic_{it}$, is any one of those app traffic variables (e.g., the number of total unique visitors etc.) for retailer *i*'s mobile app on month *t*. Among the independent variables, the main variable of interest, $MobileWebFriendly_{it}$ is 1 if retailer *i*'s website is mobile friendly in month *t* and 0 otherwise; $MonthsSinceWebFriendly_{it}$ is the number of months since retailer *i*

optimized its mobile website for mobile users. All other variables are defined as the same in Equation (1).

Model 3: how does a mobile app launch affect mobile web traffic?

Another way to assess the relationship between mobile web and mobile app channels is to examine how mobile web traffic changes after a retailer launches a new mobile app. As mobile apps are more likely to appeal to loyal customers, they may visit the corresponding mobile websites less, at least in the short term. For new customers, the event of a new mobile app launch may not matter much. The net effect of a mobile app launch on mobile web traffic in the short term should thus be negative. In other words, these two channels would substitute each other in the short term. However, it is unclear whether a mobile app launch would positively or negatively affect mobile web traffic in the long term.

To test the effect of a mobile app launch in the both short and long terms, we modify Equation (1) by adding an interaction term. The panel is at the retailer/month level because mobile web traffic data is available at the monthly level. The new regression model is as follows.

$$WebTraffic_{it} = MobileApp_{it} + MonthsSinceAppLaunch_{it} + MobileWebFriendly_{it} + MobileAppUpdate_{it} + \varepsilon_{it} \quad (3)$$

The new variable, $MonthsSinceAppLaunch_{it}$, in Equation (3) is the number of months since retailer *i*'s mobile app launch. All other variables are defined as the same in prior models. The main variables of interest are $MobileApp_{it}$ *and* $MonthsSinceAppLaunch_{it}$.

Model 4: mobile friendliness as a ranking signal in Google search

The analyses outlined so far could potentially suffer from endogeneity issues. Specifically, the events of the mobile friendliness and mobile app launch can be endogenous. A retailer may decide to launch a new mobile app because its business is growing fast. The mobile web traffic might increase regardless of whether the retailer launches a mobile app or not. Without accounting for this, one may infer that mobile web and mobile app complement each other. Alternatively, a retailer may decide to make its website optimized for mobile because its customer base is shrinking, so the retailer hopes that a mobile-friendly site may help improve the situation. In that case, the number of mobile app downloads might decrease regardless of whether the retailer makes its website optimized for mobile or not. One may thus incorrectly infer that mobile web and mobile app substitute each other.

To address these concerns, we utilize an exogenous event that is uncorrelated with any retailer's specific situation. On February 26, 2015, Google announces that it will include mobile friendliness as a ranking signal in its search algorithm for mobile devices starting April 21, 2015 (Google 2015). This change implies that mobile-friendly search results will appear on the top so that a mobile-friendly website's traffic would increase but a non-mobile-friendly website's traffic would decrease. Thus, if the mobile website channel complements (or substitutes) the mobile app channel, the mobile app traffic would increase (or decrease). Therefore, by investigating the effects of this exogenous event on the mobile app demand for retailers who have both channels, we can assess whether these two channels complement or substitute each other. For this purpose, we specify the following regression model.

$$AppTraffic_{it} = MobileWebFriendly_{it} + GoogleChange_{it} + MobieWebFriendly_{it} \times GoogleChange_{it} + MobileAppUpdate_{it} + \varepsilon_{it} \quad (4)$$

The new variable, $GoogleChange_{it,}$ is 1 if day *t* is on or after April 21, 2015 and 0 otherwise. The main variables of interest are $GoogleChange_{it,}$ and $MobieWebFriendly_{it} \times GoogleChange_{it}$. All other variables are defined as the same in prior models. The estimation can be performed on the sample of retailers that had a mobile app prior to February 26, 2015. We also drop two retailers whose website became mobile friendly between February 26 and April 21, 2015 from the analyses in case their mobile website transition was responding to Google's announcement. The study period can be three months, six months, or one year before and after April 21, 2015.

Potential Results

The coefficient estimate on $MobileWebFriendly_{it}$ in model 1 represents the relationship between mobile friendliness and mobile web traffics. If the estimate is positive and statistically significant, then the results are consistent with the hypothesis that mobile friendliness increases mobile website traffic.

In model 2, when $MonthsSinceWebFriendly_{it}$ is not included in the regression, the coefficient estimate on $MobileWebFriendly_{it}$ represents the average effect of mobile friendliness on the mobile app demand over time. If the coefficient estimate is positive and statistically significant, then the traffic of the corresponding mobile app increases after a retailer's website becomes mobile friendly. This would suggest that on average mobile web and mobile app complement each other. If the coefficient estimate is statistically negative, then the traffic of the corresponding mobile app decreases after a retailer's website becomes mobile friendly. This would suggest that on average mobile web and mobile app substitute each other. However, if the coefficient estimate is statistically insignificant, then mobile friendliness does not have any significant effect. When $MonthsSinceWebFriendly_{it}$ is included in model 2, we could evaluate how the effect of the mobile friendliness on mobile app demand differ over time via the coefficient estimate on $MonthsSinceWebFriendly_{it}$. If the coefficient estimate is positive and statistically significant, then the effect of mobile friendliness on the traffic of the corresponding mobile app increases over time. This would suggest that mobile web and mobile app complement each other in the long term. If the coefficient estimate is statistically negative, then the effect of mobile friendliness on the traffic of the corresponding mobile app decreases over time. This would suggest that mobile web and mobile app substitute each other in the long term. However, if the coefficient estimate is statistically insignificant, then the effect of mobile friendliness does not depend on time.

Similarly, the results in model 3 could reveal the effect of a mobile app launch in both the short and long terms. When $MonthsSinceAppLaunch_{it}$ is not included in the regression, the coefficient estimate on $MobileApp_{it}$ represents the average effect of mobile app release on the mobile web traffic. If the coefficient estimate is positive and statistically significant, then the traffic of the mobile web increases after the corresponding mobile app release. This would suggest that on average mobile web and mobile app complement each other. If the coefficient estimate is statistically negative, then the traffic of mobile web decreases after the corresponding mobile app release. This would suggest that on average mobile web and mobile app substitute each other. However, if the coefficient estimate is statistically insignificant, then mobile app release does not have any significant effect. When $MonthsSinceAppLaunch_{it}$ is included in the regression, the coefficient estimate on $MonthsSinceAppLaunc_{it}$ represents the effect of mobile app launch on mobile web traffic over time. If the coefficient estimate is positive and statistically significant, then the effect of mobile app launch on mobile web traffic increases over time. This would suggest that mobile web and mobile app complement each other in the long term. If the coefficient estimate is statistically negative, then the effect of mobile app launch on mobile web traffic decreases over time. This would suggest that mobile web and mobile app substitute each other in the long term. However, if the coefficient estimate is statistically insignificant, then the effect of mobile app launch does not depend on time.

In model 4, the key results lie in the main effect of $GoogleChange_{it}$ and its interaction effect with $MobileWebFriendly_{it}$. When the interaction term, $GoogleChange_{it} \times MobileWebFriendly_{it}$, is not included in the regression, the coefficient estimate on $GoogleChange_{it}$ represents the average effect of Google's use of mobile friendliness as a ranking signal on the mobile app demand. If the coefficient is positive and statistically significant, then the number of mobile app downloads increases after this change in Google's search algorithm that makes the mobile web channel easier to use. It would suggest that on average mobile web and mobile app complement each other. If the coefficient estimate is statistically negative, then the number of mobile app downloads decreases after the improvement in the mobile web channel. It would suggest that on average mobile web and mobile app substitute each other. If the coefficient estimate is statistically insignificant, then there is no interaction between these two channels. When the interaction term, $GoogleChange_{it} \times MobileFriendly_{it}$, is included in the regression, we can investigate how the effect of this exogenous improvement in the mobile web channel might differ between mobile-friendly and non-mobile-friendly websites. If the coefficient estimate on $GoogleChange_{it} \times MobileFriendly_{it}$ is positive and statistically significant, then the effect of the Google

event on mobile app demand is more positive for retailers with a mobile-friendly website. It would suggest that the relationship between mobile web and mobile app are more likely to be complementary for retailers with a mobile-friendly website. If the coefficient estimate is statistically insignificant, then the effect of the Google event does not vary between different types of mobile websites. If the coefficient estimate is statistically negative, then the effect of the Google event on mobile app demand is more negative for retailers with a mobile-friendly website. It would suggest that the relationship between mobile web and mobile app are more likely to be substitution for retailers with a mobile-friendly website.

Conclusion

This paper aims to examine the relationship between mobile web and mobile app channels for retailers and attempts to infer a causal relationship through a natural experiment. We utilize three events to access how a change to one channel affects itself (if applicable) and the other channel: mobile web friendliness, mobile app release, and Google's use of the mobile friendliness as a ranking signal in its mobile search algorithm. The findings of this research would provide important managerial implications for retailers to better leverage the growing mobile channels.

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