Relationship between Screen Features of User's Mobile Terminals and Cellular Data Usage

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Keywords: screen size, mobile terminal, cellular data consumption, telecommunications company.

Abstract: The cell-phone has been standard equipment for almost everyone in modern society, and mobile data services have gradually become the major business for global telecommunications companies. This study aims to conduct research on the relationship between screen features of user's mobile terminals and their cellular data usage, we established an individual level regression model to explore the correlation relationship between screen features of user's mobile terminals and cellular data usage based on 50,000 records of consumers' cellular data consumption and their basic information provided by Telecommunications Corporation in China. During the study, we carried out regression analysis from four perspectives, which are all terminals, non-smart phones, smart phones and tablets. It is firstly observed that there is an overall positive and significant correlation between screen features of user's mobile terminals and cellular data usage over the entire range of screen sizes. Secondly, we also found that the effects of user's age on cellular data consumptions are always significantly negative for different terminal datasets, that is to say, the older the user is, the less cellular data the user use. This study has not only provided some suggestions for telecommunications companies, but also made reference recommendations for mobile terminal manufacturers.

1 INTRODUCTION

With the development of communication technology, people have entered the era of mobile Internet, in which the cell-phone has been standard equipment for almost everyone in modern society. Making a general observation of the global market, mobile data service has become one of the main services provided by global telecom operators for users (Olla et al.,2002, Lu et al.,2008). Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update: 2014–2019, issued by Cisco in February 3, 2015, indicated the facts that the global mobile data traffic had increased by 64% in 2014, it had increased from 1.5 exabytes per month in 2013 to 2.5 exabytes per month in 2014(Cisco,2015). Regarding different consumers using different mobile terminals with various screen sizes, there are also significant discrepancies on consumers' cellular data consumption. So, what is the relationship between screen features of users' mobile terminals and users' cellular data usage? This study aims to conduct research on the relationship between screen features of users' mobile terminals and their cellular data usage.

The changes of mobile terminal drive the development of Internet, the Mobile Internet is evolving, and the study of mobile terminals and Mobile Internet has become a new research direction. Adipat, Zhang, Zhou et al. studied the effects of browsing the web in the form of TreeView on handheld devices (Adipat et al.,2011). According to the influences of demonstration adaptation method, they proposed a mixed method to adjust the rending effects of web page, this method improves notably the Mobile Web experiences users perceived and the experiences of web browsing, an important factor considered in this study is the screen size of mobile terminal. Ghose et al. explored the changes of user's browsing behavior in mobile terminal and PC in the Internet era, their findings show that when the screen sizes of mobile terminal is small, the costs of user searching information will increase, and

Yihe N.
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DOI: 10.5220/0006443200310035
In *ISME 2016 - Information Science and Management Engineering IV (ISME 2016)*, pages 31-35
ISBN: 978-989-758-208-0

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users are more sensitive to the position of information in mobile terminal, users are more likely to click on the link at the top of the cellphone screen, so the effects of ranking are better in mobile terminal (Ghose et al.,2011, Ghose et al.,2013, Ghose et al.,2014). However, at this stage there is no direct the academic study indicates that different screen sizes will affect the usage of mobile data traffic, and we can conclude from the previous researches that the changes of mobile terminal can bring large impact on user's behaviors. Making research on the relationship between the screen features of user's mobile terminals and cellular data usage can fill the research gap.

Based on this background, this study aims to conduct research on the relationship between screen features of user's mobile terminals and their cellular data usage by utilizing the massive amounts of consumers' data provided by a telecommunications company. Specifically, we established an individual level regression model to explore the correlation relationship between screen features of user's mobile terminals and cellular data usage based on 50,000 records of consumers' cellular data consumption and their basic information provided by Telecommunications Corporation in China.

This study has great value on the terminal manufacturers and telecom operators, exploring the hidden relations has both theoretical and practical significance for users, terminal manufacturers and telecom operators. In theory, drawing on and using a large number of discipline research methods and findings in the study, exploring the relationship between the screen features of user's mobile terminals and their mobile data usage based on users data, have an important significance on data mining and data analysis in the context of big data. From a practical point of view, on one hand, this study provide practical cases of data analysis and application for the telecommunications industry who have huge amounts of user data, it can help telecom operators understand users' online behaviors better, and pricing products combined the properties of terminals offers a new perspective for telecom operators. On the other hand, for mobile terminal equipment manufacturers, this study can help mobile terminal equipment manufacturers choose more suitable screen sizes of mobile terminals, make the user experience better.

2 METHOD

2.1 Multiple Linear Regression

In this study, we employ a multiple linear regression model to explore the relationship between the screen size of mobile terminal and the mobile data traffic from the user level. We can find from the descriptive statistics that the screen size of mobile terminal does have influence on user's Cellular data usage, and user's personal characteristics, such as user's age, gender and rank, also have a certain influence on user's Cellular data usage, so we also include the personal characteristics of user into the variables that affect user's cellular data usage. Taking into account the brand of mobile terminal will also affect the way customer use the cellphone, and further affect user's Cellular data usage, so we choose the personal characteristics of user, the screen size of mobile terminal and the brand of mobile terminal as the independent variables, the Cellular data usage user used as the dependent variable. The screen size is the primary factor, and user's personal characteristics and the terminal brand as the control variables, the employed regressive model as be expressed as follows:

$$y = Screen_i + Sex_i + Age_i + Diamond_i + Gold_i + Silver_i + Brand + \varepsilon \quad (1)$$

where y is the dependent variable, represents the cellular data traffic, and its unit is MB; i represent the user, $Screen_i$ is the screen size of the mobile terminal that ith user own; Sex_i is the gender of ith user, 1 represents female and 0 represents male; Age_i the age of ith user; $Diamond_i$, $Gold_i$, $Silver_i$ are three dummy variables representing user rank, each user only belongs to one rank of these three ranks; Brand is the dummy variable of brand, it can be used to evaluate the influences of the mainstream cell-phone brands on cellular data usage. The error term ε is used to adjust error brought by the prediction model.

2.2 Data

The data used in our study is provided by a telecom company in China, which record 50,000 consumers' information including cellular data consumption and their basic information in April 2014. The raw data provided by the operator only records the terminal model, through crawler technology obtaining the attribute information of terminals, and then relating it to the screen size customers used, we acquired our final data. In our dataset, the total data recordings amount to 48890 items, including the tablets

recordings 1191 items, the fields is listed as follows ： 1)user_id, unique identification for identifying each user; 2)sex, representing the gender of user,M is male and F is female; 3) age, which is calculated based on user’s birthday; 4) gprs_stream, representing the consumption of cellular data, it records the total amount of cellular data user used in April 2014, and its unit is MB; 5) screen, recording the screen size of mobile terminal; 6) VIP Class, there are three user ranks, Silver, Gold, Diamond, each user belongs to one and only one rank; 7) brand, which is a dummy variable and represents the effects of terminal brand, main brands of terminal equipment contain Apple, Samsung, Nokia, Xiaomi, Huawei and so on.

According to the terminal type, we divide the users into phone group and tablet group, and we conducted a descriptive statistical analysis. In the phone group, 19.86% of total users are female, and male accounts for 80.14%. The average screen size of user’s mobile phone is 4.2 inches, and the average age of user is 31 year old, in addition, the average cellular data consumption of user is 264.52 MB in current month. In the tablets group, female accounts for 20.74% while the proportion of male is 79.26%. The average screen size of user’s tablet is 8.7 inches, and the average age of user is 36 years old, which is slightly older than the average age of phone group. Besides, the average cellular data consumption of user is 595.75 MB in current month. By crossing analysis, we found that the screen size of user’s terminal, personal characteristics and brands have an impact on user’s cellular data consumption.

3 EMPIRICAL RESULTS

In this paper, we carry on linear regressive analysis based on the overall sample data, mobile terminal sample data and tablet computer sample data respectively, and the empirical results are shown in Table 1. This study carried on regressive analysis from the user personal level and equipment level, as is shown in Table 1, the first column is the dependent variables in the model, and the first row is the terminal equipment. From the equipment level, we divide terminal into overall terminals (that is, cell-phone & tablet computer), cell-phone under 3 inches, cell-phone above 3 inches and tablet computer. We make 3 inches as a cut-off point for the screen size of cell-phone, since the screen size of smart-phone is all above 3 inches, and that of most non smart-phones is less than 3 inches. Non smart-phone can only access to the Internet in textual way and consumes little cellular data, so the smart-phone is the focus of our research.

The second column in Table 1 presents the regression results for all equipment. It can be found that for the overall terminals including cell-phone and tablet computer, screen size, sex, age, user rank and brand are all significant to user’s cellular data usage at the 5% level. The effect of screen size on cellular data usage is positive, and its standard error is quite small. With respect to user’s personal characteristics, the effects of two factors, sex and age, is negative. That is to say, women’s cellular data usages are less than men, and the bigger user’s age is, the more cellular data he consumed. User rank also affects the cellular data usage significantly, and the effect is positive, but the standard error is large (65.647 for the SE of Diamond rank). There is a significantly positive correlation between terminal brand and cellular data usage.

The third column in Table 1 presents the regression results for cell-phone under 3 inches which is non smart-phone. Because there is no Diamond rank user among users who use cell-phone under 3 inches, so the corresponding term is vacant. As is shown in the table, for non-smart phone, screen size, age and user rank of Silver are significant to user’s cellular data usage at the 5% level, but the effects of user’s sex, brand and user rank of Gold are not significant. The effect of screen size on cellular data usage is negative significantly, which means that for non smart-phone users, the bigger the screen size of mobile phone is, the less the cellular data they consume. There is also a significantly negative correlation between user’s age and cellular data usage, as users grow older, their cellular data usage have reduced. The effect of Silver rank on cellular data usage is significantly positive, but the error is large.The fourth column in Table 1 presents the regression results for cell-phone more 3 inches which is smart-phone. Because there is no Gold and Silver rank user among users who use cell-phone above 3 inches, so the corresponding terms are vacant. As is shown in the table, for smart-phone, screen size, age, brand and user rank of Diamond are significant to user’s cellular data usage at the 5% level, but the effect of sex is not significant. The effect of screen size on cellular data usage is significantly positive, and its error is quite small, which means for smart-phone users, the bigger the screen size of mobile phone is, the more the cellular data they consume. There is a significantly negative correlation between user’s age and cellular data usage, as users grow older, their cellular data usage have reduced. The effects of

brand and user rank on cellular data usage is significantly positive, but the error of Silver rank is large.

Table 1: Results of the multiple linear regression model

	cell-phone & tablet computer	cell-phone under 3 inches	cell-phone above 3 inches	tablet computer
$Screen_i$	43.710***	-72.500**	5.724***	84.926***
	（2.868）	（31.038）	（4.463）	（28.253）
Sex_i	-29.285***	35.583	-30.318	-26.293
	（7.287）	（33.652）	（7.484）	（76.261）
Age_i	-8.319***	-5.509***	-6.749***	-7.449**
	（0.360）	（1.302）	（0.373）	（3.521）
$Diamond_i$	753.577***	—	705.466***	-493.115
	（65.647）		（66.122）	（1057.303）
$Gold_i$	608.986***	61.563	—	-166.980
	（25.031）	（321.781）		（611.609）
$Silver_i$	325.944***	120.547**	—	231.253
	（9.479）	（55.400）		（180.202）
Brand	88.294***	-21.662	128.233***	324.476
	（7.853）	（32.855）	（7.688）	（435.124）
R^2	0.049	0.023	0.015	0.012

*Notes: *: p-value<0.1, **: p-value<0.05, ***: p-value<0.01.*

The fifth column in Table 1 presents the regression results for tablet computer. As is shown in the table, for tablet computer, screen size, age are significant to user's cellular data usage at the 5% level, but the effects of sex, user rank, and terminal brand are not significant. The effect of screen size on cellular data usage is significantly positive, which means for tablet computer users, the bigger the screen size of mobile phone is, the more the cellular data they consume. There is a significantly negative correlation between user's age and cellular data usage, as users grow older, their cellular data usage have reduced.

As a whole, no matter how to categorize equipment, the effects of screen size on user's cellular data usage are always significant, especially for smart-phone and tablet computer, of which the screen size effect is positive. And the effects of user's age are always significantly negative for different terminal datasets, that is to say, the older the user is, the less cellular data the user use. As for other variables, the effects and significance are various for different datasets.

4 CONCLUSIONS

In the paper, we carried out regression analysis to explore the relationship between screen features of user's mobile terminals and their cellular data usage by utilizing the massive amounts of consumers' data provided by Telecommunications Corporation in China. The study is conducted from four perspectives, which are all terminals, non-smart phones, smart phones and tablets. Several conclusions can be drawn from the empirical results, firstly, there is an overall positive and significant correlation between screen features of user's mobile terminals and cellular data usage over the entire range of screen sizes. Secondly, we also found that the effects of user's age on cellular data consumptions are always significantly negative for different terminal datasets, that is to say, the older the user is, the less cellular data the user use.

According to the results of this study, we propose some recommendations for products and pricing strategies of telecommunications companies. First, telecommunication enterprises can establish a more flexible pricing standards for cellular data, and provide a stepped pricing method, which can stimulate customers to consume more cellular data. Second, telecommunication enterprises can strengthen competition advantage via adopting differentiation strategies, which can set different prices for different groups of consumers. For consumers aged from 20 to 40 years old, telecom firms should design a postage service package, which contains a wealth of cellular data and a low price, to better meet the needs of this part of the young and middle-aged population. Third, telecom firms can optimize package services configuration and charge combined the screen size of consumer's terminal. For terminals with different screen sizes, they can offer different contract-phone with corresponding data program, which can better cater

to the market and meet the needs of consumers, obtaining steady high-value users eventually.

Our study found consumers preferred screen sizes of mobile device through an in-depth research based on consumers’ data, which is valuable for mobile terminal manufacturers. According to the results of our study, we present useful proposals for terminal manufacturers. First, mobile terminal manufacturers should meet the needs of majority group in the design of terminal’s screen sizes, and screen size should not be too big or too small. Second, the tablet device manufacturers can use current user's choice on screen size as reference, setting tablet screen size at 7.9 inches or 9.7 inches which consumers prefer. Third, the terminal manufacturers should cooperate with telecommunication companies to design contract mobile phones to attract consumers that contains medium screen size and high cellular data, reaching a win-win result in the future.

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