Research on Profit Model of Public Transport Mobile Payment

Zhengdong Zuo
Faculty of Finance, Anhui University of Finance and Economics, Bengbu, 233000, China

Abstract: This paper will evaluate the problem of bus mobile payment from four angles. By means of fuzzy impairment clustering, the number of categories and clustering centers are preliminarily established to describe the payment characteristics of riders, and the characteristic values are accurately extracted by using fuzzy C mean clustering, and the characteristics of Cox-stuart trend test are used to judge the development trend of the characteristics. Assuming that the platform income comes entirely from the precipitation capital income and service fee income, through the decision mode of precipitation capital income and fee income, the two-party profit expression is obtained, the two sides will be added to the total profit, and the factors affecting the total profit are obtained. Using the bilateral market theory, the Hotelling model is introduced, the profit situation is further analyzed quantitatively, and the suggestions for the innovation of profit model are put forward accordingly.

Keywords: Fuzzy C mean clustering analysis; Cox-Stuart trend test; Bilateral market; Hotelling model

1. Introduction

In recent years, the rapid development of mobile payment, the growth of public transport mobile payment services has reduced the problem of deposits for public transport, reduced the operating costs of public transport companies, and better provided services to the public; at the same time, in the big data, cloud computing Contemporaryally, mobile payment can better collect and analyze data in the public transportation field, and better provide data samples for bus companies to better serve the citizens. This promotes the development of public transportation, encourages people to travel by public transportation, and relieves travel pressure. Has a positive impact.

2. Sources of Research Data and Model Assumptions

The data in this paper comes from the local statistical bureau and public transport company information data. In the process of establishing model analysis problems, the following assumptions are made: Ignoring the influence of seasonal factors on user payment behavior; the full source of revenue from third-party payment platforms. The deposit funds of the payment method are all from the user's recharge, and each user's recharged funds are used in the same month; The service fee income is all from the bus company registration. Fees and service fees charged to the bus company; Users who use third-party payments are an increasing function of their utility.

3. Research Data Preprocessing

3.1. Research data meaning

ID represents the ID of the rider; LASTTIME represents the last ride time; UPTIME represents the ride time; PAYTYPE represents the payment method; METRONUM represents the number of subway rides in the current month; BUSNUM represents the number of buses in the current month; BUSMETRONUM represents the bus subway of the current month The total number of rides.

3.2. Data processing

For the 0001-1-1 last ride time, the passengers who did not have the ride time were excluded from the abnormal value. Sort the three times for each person (ID) by the number of subways this month, the number of times the bus is used, and the total number of times, and remove the data of people who are too few times because these people may It is an occasional business trip, not a person in this city, the data can be removed. Sort the interval of the entire month, and remove the data that is too long, because such personnel can only be removed once in a bus or subway. Payment method: 0 means bus mobile payment, 1 means bus card payment, and other payment methods are excluded.

3.3. Normalization of data

Since the passenger ID, the travel time, the number of rides, and the payment type data have different dimensional units, the size of the data varies greatly, and the range of the data is also different. Larger differences will increase the impact of certain variables on the prediction results, and will also reduce the impact of certain variables on the prediction model. Therefore, it is necessary to perform passenger ID, travel time, number of rides, and payment type data after the abnormal value is removed. Normalized. Converting all the data into a number between [0, 1] can eliminate the deviation of the data due to different sizes, and finally reverse-normalize the prediction results. There are many methods for normalizing data. In this paper, the maximum and minimum methods are used for normalization. The formula for normalizing passenger ID, travel time, number of rides, and payment type is as follows.

$$x_i^{'} = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \tag{1}$$

Where x_i and $x_i^{'}$ are the passenger ID, ride time, ride number, and payment type data before and after normalization, and x min and x max refer to the passenger ID, ride time, ride number, and minimum value of payment type data, respectively. And the maximum.

4. Analysis of Passengers' Payment Characteristics Through Cox-Stuart Trend

4.1. Path of research

Firstly, the data is cleaned and filtered by the preprocessing of the data. Through the fuzzy impaired clustering, the number of categories and the cluster center are preliminarily established, and the payment characteristics of the occupants are described in different categories. Based on the fuzzy impaired clustering, further fuzzy c-means clustering is carried out, and the eigenvalues are extracted accurately to determine the characteristic development trend of Cox-Stuart trend test.

4.2. Research methods

4.2.1. Subtractive clustering method

Because the data in February is more than the data of METRONUM, BUSNUM, and BUSMETRONUM compared with May, August, and November, and the influence of seasonal factors on the payment behavior of users is negligible, and the data bad rate in February It is only 0.127%, so the information from February is selected as a sample.

Since urban users have their own personalized payment characteristics, in order to carry out classification research, a clustering method is adopted to classify the user information of the city. Since there is no prior information for the user classification number, fuzzy subtractive clustering is used to determine the corresponding Classification number and cluster center. Each data point is taken as a possible data center, and the probability of the point as a cluster center is calculated based on the data point density around each data point. If there is the highest data point density around a data point, you can select it as the cluster center. After selecting the first cluster center, continue to use the same method from the remaining points that may be cluster centers. Select the next cluster center. The process continues until the likelihood that all remaining data points are clustered centers below a certain threshold.

In the mat lab, the subclust function is used for calculation. Since $0 < \mathrm{RADII} < 1$, and the smaller the RADII value, the larger the capacity of the cluster center. Considering the selection of 1750 samples in February, the sample size is too large, so take $\mathrm{RADII} = 0.3$, first calculate the density of each data point to get the density index.

$$M(v_i) = \sum_{k-1}^{n} e^{-a\,d(x_k, v_i)}, \alpha = \frac{4}{t_1^2} \tag{2}$$

Find the data with the highest density index as the first cluster center V^*_{k-1}, then remove the density of this point, and then calculate the density index of the point.

$$M_k(v_i) = M_{k-1}(v_i) - M^*_{k-1} e^{-b\,d\left(v^*_{k-1}, v_i\right)}, \beta = \frac{4}{t_1^2} \tag{3}$$

On this basis, find the largest density indicator and use this as the clustering center. Cycle through until:

$$\frac{M^*_{k-1}}{M^*_1} < d \tag{4}$$

Finally, we can get the number of clusters as 2, the cluster center is as shown in the following table (from left to right: "the number of bus rides in the month", "the number of subway rides in the current month", "the last trade time and The interval between the rides is "the dimensionless value of the three variables".

Table 1. Fuzzy impairment cluster center table

Project	Zbusnum	Zmetronum	Ztime
Cluster center value	-0.3126	-0.1728	-0.0273
	1.1281	-0.1728	-0.049

According to the calculation results, the first type of users in the table have more bus rides in the month, and the interval between the last transaction time and the current travel time is shorter, which is an active user; and the second type of user travels by bus in the current month. The number of times is small, and the interval between the last transaction time and the current travel time is long, which is an underactive user. For the two types of cluster centers in the current month, the cluster centers overlap, which shows that the difference between the two categories is not significant.

The cluster 3D map is drawn using mat lab as follows. Each scatter represents a user's payment-related behavior, with black circles representing cluster centers.

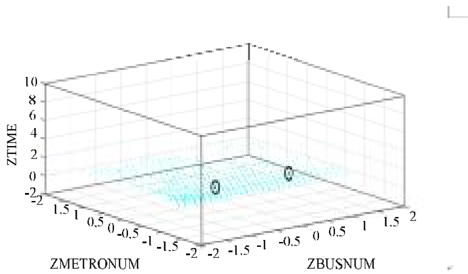

Figure 1. User payment behavior scatter clustering diagram

4.2.2. Fuzzy c-means clustering

Based on the fuzzy subtractive clustering, we obtained the cluster number 1, and the initial clustering center. Using Mat lab for iterative and fuzzy c-cluster, the users were clustered in February.

4.2.3. Cox-Stuart trend test

For the data in Annex I, the trend of mobile payment is calculated and plotted as follows.

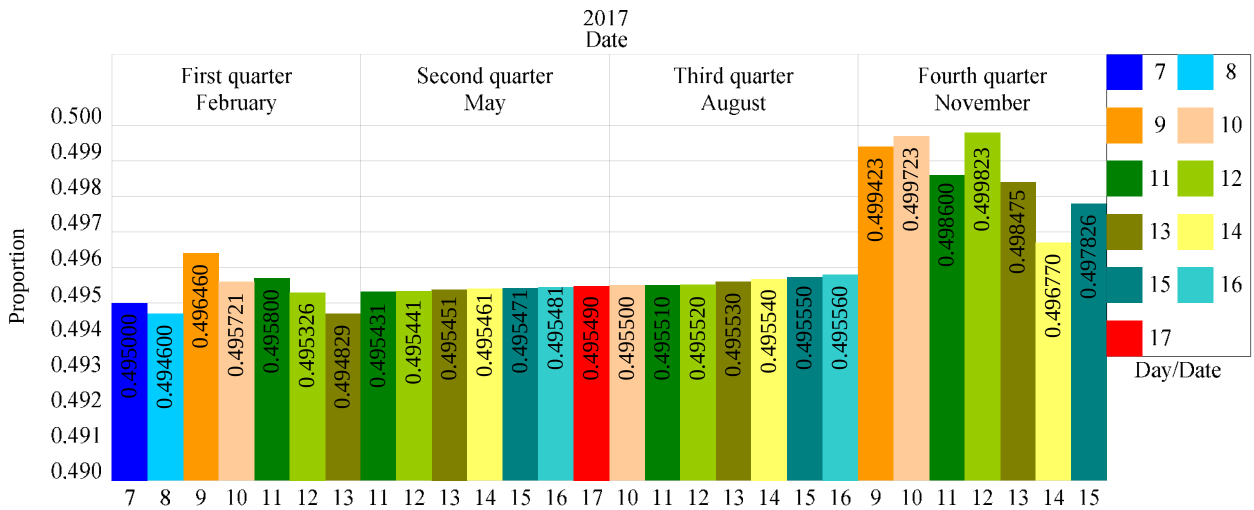

Figure 2. Trends in the proportion of public transport payments

As can be seen from Figure 2, the overall trend of bus mobile payment ratio seems to show an increasing trend, but it does not always increase. The Cox-Stuart trend test is a method for quickly judging whether there is a trend that does not depend on the trend structure. The theoretical basis for the Cox-Stuart trend existence test is the symbol test. Its test idea is: directly consider the trend of data, if the data has an upward trend, then the value of the data that is listed later is significantly larger than the value of the data that precedes it. Conversely, if the data has a downward trend, then the row In the latter data, the value of the data is significantly smaller than the value of the data in the front, and the difference between the data of the two periods before and after is used to judge the total trend of the data. So the team used the Cox-Stuart method to further analyze the data.

A hypothesis can be established:

H0: no growth trend.

H1: There is a growing trend.

Step: The amount of time $n = 28$ is even, so $c = n/2 = 14$ pairs. Compare each observation to another observation separated by 14. So there are 14 pairs. Then look at the growth pair and the reduced pair to determine the total trend. Take and form a pair. So the pair in this example is:

$(X_{1,}\ X_{15}),(X_2,X_{16}),(X_3,X_{17}),(X_4,X_{18}),(X_5,X_{19}),(X_6,X_{20}),(X_7,X_{21}),$
$(X_8,X_{22}),(X_9,X_{23}),(X_{10},X_{24}),(X_{11},X_{25}),(X_{12},X_{26}),(X_{13},X_{27}),(X_{14},X_{28})$

That is: (0.494999938 ,0.495500455), (0.494600,0.495510414),(0.496460334,0.495520373) , (0.495720911,0.495530332),(0.495800,0.495540290), (0.495326499,0.495550249), (0.494828666,0.495560208), (0.495430742,0.499423401),(0.495440701,0.499784754) ,(0.495450660,0.498600), (0.495460619 ,0.499822871), (0.495470578,0.498475075),(0.495480537,0.496770448) ,(0.495490496 ,0.497825751)。

Use the sign of the difference between the two elements of each pair $D_i = x_i - x_{i+c}$ to measure the increase or decrease. Let S^+ be the number of positive D_i and S^- as the number of negative D_i.

As can be seen from Table 2, $S^{+}=3$, $S^{-}=11$ 。 Obviously S^{+} is far less than S^{-}, so the proportion of bus mobile payment has a growing trend.

Since the statistic should obey the binomial distribution $b(n',0.5)$ under the null hypothesis without trend, $a=0.05$. Obtained statistical observations $k=S^{+}=3$, Use Excel software to calculate the formula.

$$P(K \le k)=P(K \le 1)=\frac{1}{2^{14}}\sum_{i=0}^{1}\binom{14}{i} \tag{5}$$

$p<a$ $(a=0.05)$, Can reject the null hypothesis H0.

Therefore, based on the results of the data analysis, it is concluded that there is a growing trend in the proportion of bus mobile payment in the city. It also shows that the use of bus mobile payment in the city has been expanding in 2017.

5. Analysis of The Profitability of Third-Party Payment Platforms by Establishing Quantitative Models

5.1. Research ideas

We use the sedimentary capital income and service fee income as the two main sources of profit. Based on the Hotelling model, we use the user network efficiency to reduce the network cost, obtain the user utility, and use the partiality of utility to calculate the equilibrium formula under the maximum profit.

5.2. Precipitation capital gains

The third-party payment settlement fund refers to the collection of the transaction price of the transaction between the buyer and the seller that stays in the third-party payment platform account. Due to the large amount of delays in the payment and deferred liquidation of the buyers and sellers in the third-party payment platform, a large amount of funds accumulated in the platform and not participating in the circulation will be deposited. In the process, the third-party payment platform has the temporary right to use the deposited funds, and the liquidity benefit can be obtained (the interest rate is treated in the model according to the current deposit interest rate).

In order to ensure the validity of the model, we make the following rationalization hypothesis: the revenue of the third-party payment platform is all derived from the settlement of capital income and service fee income; the settlement funds of the payment method are all from the user's recharge, and each user each time The recharge funds are consumed on average within a month.

Indicates the user's monthly average recharge amount; tm indicates the time of one month (30 days); R0 indicates the current deposit interest rate.

Due to the existence of liquidity risk, credit risk and exchange rate risk, the above risks are weighted according to 30%, 60% and 10%. Finally, the risk of loss of deposit funds is 10%.

Then the formula for depositing capital gains is as follows:

$$\begin{aligned} L_1 &= 90\% \frac{R_0}{360}\sum_{i=1}^{n} F_i t_i, i=1,2\ldots\ldots,n \\ &= 90\% \frac{R_0}{360} * n_1 * \bar{F} * \frac{t_m}{2} \\ &= \frac{3r_h}{80} * \bar{F} * n \end{aligned} \tag{6}$$

5.3. Procedure service fee income

For third-party payment platforms, the fee for the service fee is all derived from the registration fee of the bus company and the service fee charged to the bus company. The third-party payment platform does not charge the passengers a handling fee.

Then the formula for depositing capital gains is as follows:

$$\begin{aligned} L_2 &= (r_2 - r_1)\sum_{i=1}^{n_1} Pm_i + P_r * n_2 \\ &= (r_2 - r_1) n_1 * P * \overline{m} + P_r * n_2 \\ L &= L_1 + L_2 \\ &= 90\% \frac{R_0}{360}\sum_{i=1}^{n} F_i t_i + (r_2 - r_1)\sum_{i=1}^{n} Pm_i + \mathrm{P_r} * n_2 \\ &= \frac{3r_{活}}{80} * \bar{F} + (r_2 - r_1) * P * \bar{m}] n_1 + P_r * n_2 \end{aligned} \tag{7}$$

From the above formula, under the assumptions, the third-party payment platform is profitable with the average passenger recharge, the number of passengers and bus companies paid by the third party, the passenger price and the number of passengers, and the registration charged by the third-party payment platform to the bus company. Fee related. Now, this article starts from the hotel market of the bilateral market theory and conducts a more in-depth analysis.

5.4. Net profit function based on Hotelling model pricing

The third-party payment platform market has multiple economic networks of independent user groups that provide network revenues. It is a platform that allows end-user transactions, and allows passengers, bus companies, etc. to remain on the payment platform by appropriately charging fees from all parties. . Then according to the bilateral market theory, the third-party payment platform market is a typical bilateral market.

Based on the Hotelling model, price pricing and corporate pricing strategies and investment decisions can be made based on customer spending behavior. Then, under the Hotelling model, when the optimal equilibrium point is reached, the current maximum profit can be obtained.

Since users who use third-party payments are an increasing function of their utility, the profit function is as follows:

$$
\begin{aligned}
&L=\frac{3r_h}{80}*\bar{F}+(r_2-r_1)*P*\bar{m}]n_1+P_r*n_2\\
&n_1=\varnothing(u_1),n_2=\varnothing(u_2)\\
&u_1=q_1(a_1n_2+e_1n_1)\\
&u_2=q_2(a_2n_1+e_2n_2)-\frac{n_1*r_2*P*\bar{m}}{n_2}P_r
\end{aligned}
\tag{8}
$$

$\frac{\partial L}{\partial u_1}=0,\frac{\partial L}{\partial u_2}=0$, The resulting p and p_r make the profit L the largest.

5.5. Model adaptation under dynamic factors

5.5.1. Fixed cost or variable cost increase

According to the dynamic pricing in the Hotlling model, the platform increases the user's handling fee and the merchant's registration fee to ensure the realization of platform profit. At the same time, because the third-party payment platform has a negative correlation between the two-part fee, that is, the registration fee and the handling fee, the platform reduces the handling fee charged by the merchant to attract the registration and continuous operation of the merchant.

5.5.2. Increase in the number of transactions and enhancements from network externalities

User fees and merchant registration fees will be reduced. In order to ensure profit, the platform will increase the merchant's handling fee, and at the same time reduce the user's handling fee and the merchant's registration fee to attract more users and merchants, further increase the number of transactions, but ultimately tend to charge the merchants more fees to carry out the cost. subsidy.

5.5.3. Changes in platform preferences between users and merchants

The platform will change the pricing of users and merchants at the same time. Any increase in the user's or merchant's preference for the platform will cause the platform to shift to increase the handling fee charged to the merchant, and reduce the user's handling fee and the merchant's registration fee.

5.5.4. Cross-network externalities become larger or the number of platform users increases

The user fee in the model and the registration fee of the merchant will be reduced. At this time, the merchant's charging fee parameter in the model will fluctuate upward.

6. Profit Forecasting Through Profit Estimates Derived from Quantitative Models

6.1. Research ideas

According to the quantitative third-party payment platform profit model formula, through the data processing and empirical analysis of the actual value into the formula, the quantitative profit estimate is obtained.

6.2. Model establishment and results

According to the conclusion of the third-party payment platform profit model analysis, the final profit formula we obtained is as follows:

$$
L=L_1+L_2=\frac{3R_0}{80}\times\sum_{i=1}^{n}F_i+(r_2-r_1)\times\sum_{i=1}^{n}p_{mi}+p_r n_2 \tag{9}
$$

Contact the real economic environment:

$R_0=0.35\%$, $r_2=0.35\%$, $r_1=0.2$, $p=1$.

According to the processing of Annexes 1 and 2:

$\overline{m}_i=4\times14=56$;

$\sum_{i=1}^{n}pm_i=p\sum_{i=1}^{n}m_i=np\overline{m}_i=1048576\times1\times56=58720256$,

Assumed registration fee $p_r=10000$, The city has bus company $n_2=5$ Finally calculated $L\approx11030823$.

7. Business Feasibility Analysis

7.1. Research ideas

The team conducts analysis and demonstration through technical feasibility, economic feasibility and market feasibility, and gives specific suggestions.

7.2. Feasibility analysis of public transport payment

7.2.1. Technical feasibility

The popularity of mobile phones and the proportion of coverage of third-party payments by public transport in the future have provided technical support for their future development. According to statistics released by the People's Bank of China for the second consecutive year of the "Overall Situation of Payment System Operation", China's electronic payment business is quite large, and its mobile payment business has maintained a super-fast growth trend.

7.2.2. Economic feasibility

From the perspective of resource allocation, it is worthwhile to measure the value of public transportation third-party mobile payment projects, which is conducive to the realization of regional economic development goals, effective allocation of economic resources, increased supply, and improvement of people's lives.

7.2.3. Market feasibility

According to the Cox-Stuart trend test, we know that the proportion of public transport payments is getting bigger and bigger, and its penetration rate is increasing, showing an upward trend. Secondly, the public transportation payment of the residents has the characteristics of high frequency, and the incremental space for mobile payment use is relatively large.

7.3. Innovation in profit model

This paper follows the profit model synergy matching principle to make the profit source, profit generation and profit realization of the third-party electronic payment platform as the system context of researching the profit model, with emphasis on its market characteristics, pricing behavior and collaborative governance. The main way to formulate and improve the profit model is to implement differentiated pricing for users within the third-party electronic payment platform based on platform positioning and user scale, reflecting the mutual dependence of the transaction scales of the two sides, so as to obtain the maximum profit in the third-party electronic payment platform. Externally, the first is to coordinate the relationship with the bank, realize the investment income of the deposited funds, reduce the profit forecast, and realize the reasonable distribution of benefits. Second, establish the reputation mechanism of the third-party electronic payment platform, maintain its long-term development and finally coordinate internally and externally. Under, gain profitability.

8. Conclusion

According to the fuzzy C-means clustering analysis, we can classify user types into two types: active users and underactive users. For the two types of cluster centers in the current month, the cluster centers overlap, which shows that the difference between the two categories is not significant. Based on the results of the data analysis, the Cox-Stuar method is used to conclude that the population of mobile payment in the city has a growing trend. In 2017, the use of bus mobile payment in the city has been expanding. Then, based on the profit model of the third-party payment platform, the formula for calculating the net profit of public transport payment is derived, thereby predicting the full implementation of the profitability of public transport and the feasibility report, and further innovating the profit model.

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