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Empirical Research on How Keyword Advertising Linked Item Characteristics Affect CTR

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Abstract

In this paper, search simulation system is established to collect user clicking behavior. Empirical method is employed to study characteristics of results page which affect the user's clicks. Rankings, product brand information, retailer information, whether including product images, keywords length and other characteristics of the user click behavior are analyzed. The empirical results show that ranking is not the only factors that determine the result of click; well-known branded keyword or well-known retailer specific can improve click-through rate. Non well-known companies and non-famous retailer should get the top-ranking position to improve their ad clicks. User usually choose moderate length keyword to search. The article also firstly study the impact on commodity picture click-through rate (CTR). These conclusions have important guiding significance for advertisers to better carry out keyword ad activities.

Keywords*: keyword advertising; click-through rate; linked item characteristics*

1. Introduction

Internet trading has become an important part of the current business. Online advertising therefore receives a great deal of attention. Among variety online advertising, keyword advertising has occupied a major position. Reports from iResearch show [1] that in Chinese network advertising market, keyword advertising revenues accounted for more than 30% in 2014, and became the most important contribution to the search engine. Search engine keyword advertising is therefore an important marketing tool for many company. Famous search engine providers such as Google, Yahoo!, Microsoft, Baidu, Sogou, Soso, Sina have carry out the advertising business for some time[2] [3].

With respect to the great success of the business model, theoretical study of keyword advertising has lagged behind, especially study of factors which affect advertising effectiveness from the advertiser perspective. In this paper, results page item properties are studied. We collect user's clicking data and used empirical methods to find out how characteristics of results page item affect clicking behavior. These characteristics include rank, brand, retailer, product image in descriptions and keyword length.

There are several main contributions of this work.

(1) We construct a searching simulation system to collect user behaviors data. This method can dig out more real searching and clicking behaviors than traditional method, in which data were collected through surveying by printing paper.

(2) This research reveal some novel results which are different from existent literature. For example, rank is not the only determining factor influencing CTR, including well-known brand or high market share company message in keywords can improve CTR significantly, non-famous company should occupy top ranking position.

(3) Research on factors that affect marketing efficiency in Chinese search engine platform is rarely reported. Our work is helpful to understand Chinese searching and consuming behavior.

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This paper is organized as follows. Section 2 provides briefly review the background knowledge of sponsored search and provide an overview on related work. Section 3 advances main hypothesis. We specify object and method in Section 4 and design experiments. Experimental results are discussed in Section 5. More than one factor which affect clicking behavior are studied separately in this section. Comprehensive analysis of rank, brand information and retailer information are carried out by constructing a user discrete choice model in Section 6.Finally, Section 7 concludes our study.

2. Literature Review

The development of keyword ad auction mechanism has gone through two stages [4] Generalized First-Price Auctions (GFP) and Generalized Second-Price Auctions (GSP). GFP was introduced by Overture firstly. However, the mechanism was unstable due to the fact that bidders could change their bids very frequently. The mechanism therefore encouraged inefficient investments in gaming the system, causing volatile prices and allocative inefficiencies. Google addressed these problems by introducing GSP, which was adopted by most search engine soon after that.

In general, there are two main lines of research on GSP auction. One focuses on designing bidding strategies for bidders. The other concentrates on designing optimal auction mechanisms (in terms of various criteria) for auctioneers. Edelman *et al*. [5] and Varian [6] establish theoretical models of the market and find that prices and allocations of positions are equivalent to those obtained from a static dominant-strategy Nash equilibrium of a multi-item Vickrey auction.

Through analyzing practical ranking data, Edelman and Ostrovsky [5] find that strategic bidding behavior exist in GSP auction. However, Edelman proves that GSP auction has no dominant strategy and that "truth-telling" is not always a Nash equilibrium. Thus, advertisers do not have simple yet effective strategies. Recently, Wilfred *et al*. [7] discuss a model of the first-page bid estimate (FPBE) mechanism. They show why and when the FPBE mechanism yields higher profits for the search engine compared with the traditional GSP.

Despite the emerging theory work, little empirical work exists in online search advertising. Empirical research on search advertising, on the other hand, has focused on exploring the impact of search advertising on advertisers' click-through and conversion rates. Rutz and Bucklin [8] studied hotel marketing keywords to analyze the profitability of different campaign management strategies. Ghose and Yang [9] modeled the relationship between click-through rates, conversion rates, CPC, and ad ranks using a simultaneous equations model. Rutz and Bucklin [10] examined potential spillover effects between generic and branded keywords and found that generic keyword searches affect branded keyword searches, but the reverse effect is not significant. Yao and Mela [11] developed a dynamic model of advertisers' bidding strategy. Based on online data of South Korea, Kim *et al*.[12]investigates the effects of impressions, click-through rate, conversion rate, the number of competitors and the quantity of online customer reviews on the performance of individual keywords and. Lo *et al*.[13] conducted a laboratory experimental method to study the behavior of clicking and eye movement on keyword advertising.

To our knowledge, little empirical work exists in online search advertising. This is primarily because of the difficulty researchers have in obtaining such advertiser-level data. Research on factors that affect marketing efficiency in Chinese search engine platform is rarely reported. How to select search keywords for online advertising. Which keyword specific characteristics advertising can benefit advertisers most? And how the characteristic of result page item affect user behavior? All these questions have yet to be studied.

3. Hypotheses

Previous studies show that top position can receive more attention. However, weather high attention lead to higher click-through rate? We then give Hypothesis 1-5：

Hypothesis 1. The higher rank, the higher probability of a linked item is clicked.

Hypothesis 2. Linked item with the presence of a brand name can increase CTR.

Hypothesis 3a. Linked item with well-known retailer can increase CTR.

Hypothesis 3b. Linked item with non-well-known retailer can't increase CTR significantly.

Hypothesis 4. Containing product image in linked item's description can increase CTR.

Hypothesis 5. Keyword length don't effect on CTR significantly.

4. Research Design

4.1. Subject and Method of Investigation

Statistical bulletin of 2014 communications industry, which was issued by the Ministry of Industry and Information Technology of China, shows that the total number of mobile phone subscribers reached 1.286 billion in China, and penetration rate reached 94.5 mobile phone per person[1]. Smart phones have become an indispensable part of daily life. Therefore, smart phone was chosen as study subject in this paper. We conduct an investigation to collect user's data of searching behavior when they are presumed to purchase a smart phone. Guangxi University junior undergraduates and graduates were selected for the survey. Further, we limited the respondents to those with at least one online shopping experience in the past two months. In recent years, undergraduate and graduate students have become an important force of online shopping, and they are common to smart phones. Therefore, the sample is universal.

We choose 'smart phones' and the related recommendation keywords for searching on Baidu.com such as ' phones ','vivo smart phones ', 'smart phones Andro 4.1','hot smart phones', 'best cost smart phones ', 'which smart phones is better', 'going jd.com to buy smart phones ','latest top smart phones ' and 'TMALL.com smart phones big sale', as shown in Figure 1. A searching simulation system was constructed based on Baidu.com searching results page of one day in May 2013. The first page of simulation system contains 'smart phones' and other ten keywords recommended previously.

The simulation system runs in a network environment. Respondents select one of ten previous keywords to search. In results page, linked item link to real online advertising page, which come from Baidu.com. The whole simulation system is identical to the real search environment as Baidu.com besides the index page. Respondents can complete real search and buying process in the system, though real purchase are not required. Respondents are asked to complete experiments in accordance with the flow in Figure 2.

Figure 1. Index Page of Searching

[1] http://finance.chinanews.com/it/2015/01-21/6991924.shtml

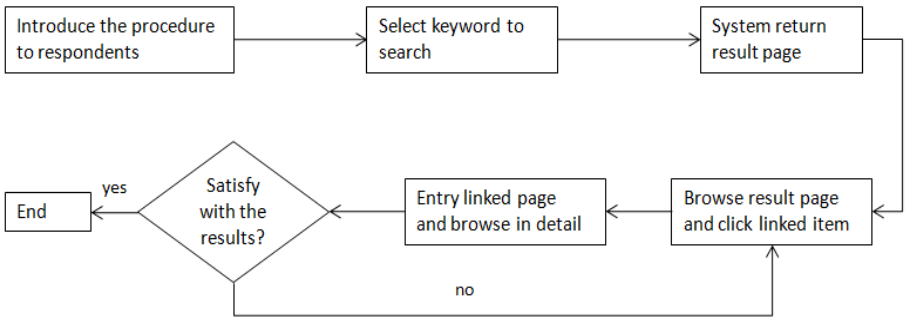

Figure 2. Process of Experiments

4.2. Experimental Design

For five hypothesis of this paper, five different returned page are designed to study the impact of various factors on CTR. Among these five returned page, page A is the basic searching results page with keyword 'smart phone'. Other four Pages are variant of page A by altering characteristics of linked item. Existence research show that most of the clicks occurred on the first page, so the investigation of this paper focus only on the first returned page. According to the above criteria, we chose 250 respondents. Each page are practiced among 50 respondents. Respondents are told to complete an information searching tasks before the procurement, which aim at a smart phones online shopping.

4.3. Validity and Reliability

The validity of this study is mainly ensured from the following aspects:

(1) Each respondent is familiar with smart phone and has the experience of using it.

(2) Each respondent is familiar with the electronic trading environment, and has online shopping experience.

(3) Before conducted, the purpose and process of experiment are explained in detail to ensure that experimenter can search and choose according to their usual habits.

5. Results and Analysis

Page A is the first returned page in Baidu.com with keyword ' smart phone ' on May 22 in 2013. To exclude the interference of other factors, the remaining four pages are derived from changing some message on page A individual. We have five comparative sample groups to practice each page in simulation system. Each group has 50 respondents respectively.

5.1. Impact of Ranking Position on CTR

Exchanging the first linked item with the seventh linked item in page A, the second linked item with the eighth linked item, we then get page B. In other words, to obtain page B, the position of four linked item in page A are altered. Neither the first and seventh item contains brand message or retailer message. Both the second and eighth item contain retailer information. Fifty respondents practice page A and other fifty respondents practice page B in the simulation system respectively. Their browsing and clicking behavior are recorded by a special program.

Data are collected from above through a special program and analyzed. Total clicks on page A are 70. The average CTR reach 0.14, as CTR is defined as click number divided by show number. The top linked item's CTR reach 0.18. CTR from the second position to

the fourth position is 0.6, 0.32 and 0.14. The remaining items' CTR is relatively low. When it comes to page B, total clicks and average CTR reach 76 and 0.16 respectively. CTR of items which position have been changed on page A are shown in Table 2.

Table 1. Statistics of click on page A

Ranking position	1	2	3	4	5	6	7	8	9	10
Click number	9	30	16	7	0	0	1	3	2	2

Table 2. Comparison items click on page A and page B

Item	L1		L2		L3		L4	
Page	Rank	CTR	Rank	CTR	Rank	CTR	Rank	CTR
A	1	0.18	7	0.02	2	0.6	8	0.06
B	7	0.04	1	0.16	8	0.4	2	0.22

Seen from Table 2, when position of a linked item is changed with the other conditions unchanged, CTR has significant fluctuation. For item L1, when we alter its position from top on page A to seventh on page B, its CTR is decreased by nearly 77 percent. When linked item L2 rise from seventh position on page A to top position on page B, it CTR increased by 7 times. Similar phenomenon occurs on linked item L3 and L4. However, fluctuations of CTR of linked items L3 and L4 are not so obviously due to famous retailer information. For the same linked item has different clicks on different position, there are two possible reasons: the varying rank or random factor. To find out which reason plays the main role in this fluctuation, Person's chi-square test is conducted on page A and B, as shown in Table 6. As can be seen, P value equal to 0.000, test result is significant. This shows that the fluctuation is caused by position changing. Therefore, hypothesis 1 is correct.

5.2. Impact of brand on CTR

The third linked item on page A contains brand message, which is well-known in the electronics industry in China. While the seventh linked item does not contain any brand message. Exchanging the third and the seventh linked item on page A, we get page C. A new group of fifty respondents practice page C in the simulation system. Total clicks on page C are 75. The average CTR reach 0.15. CTR of the third and seventh linked item are 0.06 and 0.3. In this experiment, item's rank with the presence of a famous brand drops down while its CTR does not change almost. While item without any brand message raises in rank, its CTR also does not change significantly. As shown in Table 6, test results are significant. It can be concluded that: linked item contained well-known brand can bring higher CTR. Therefore, hypothesis 2 is correct.

Table 3. Comparison Items Click On Page and Page C

The third position		The seventh position	
Page	CTR	Page	CTR
A (with brand)	0.32	A (without brand)	0.02
C（without brand）	0.06	C（with brand）	0.3

5.3. Impact of Retailer on CTR

The second linked item on page A contains retailer message, which is well-known in China. While the sixth linked item does not contain any retailer message. Exchanging the second and the sixth linked item on page A, we get page D. Another new group of fifty

respondents practice page D in the simulation system. Total clicks on page D are 79. The average CTR reach 0.16. CTR of exchanged item are shown in Table 4. In this experiment, item containing famous retailer message declines in the ranking. Its CTR decreases slightly, however, is still in a high level. In contrast, item without retailer message rises from bottom to top position, only minor changes occurs in its CTR. We then reach the following conclusion: linked item containing well-known retailer message can bring higher CTR. Therefore, hypothesis 3a is correct.

Table 4. Comparison items click on page A and page D

The second position		The sixth position	
Page	CTR	Page	CTR
A (with retailer)	0.6	A(without retailer)	0
D (without retailer)	0.16	D(with retailer)	0.46

The retailer discussed above are very famous, it can lead to more clicks obviously. If the retailer is not famous, how it influence on CTR? In all above experiments, the fifth linked item, containing an unknown retailer message 'Baidu microbuying', receive zero click at most time. It is somewhat unusual in this position. ' Baidu microbuying ' is a new shopping platform released few months ago and few respondents have heard about it before. Unknowing much about a new website, respondents have suspicion when shopping and won't browse it. This phenomenon also shows that security of website is very important when shopping. Consumers doubt unfamiliar website and be reluctant to spend any time to explore it. Consumers are inert. They tend to click on those familiar links or links contained familiar information. Therefore, hypothesis 3b is correct.

5.4. Impact of Product Image on CTR

Intuitively, linked item with presence of commodity image in its description should be able to attract more consumers' attention. But whether image can bring more CTR remains unknown. In page A, both the second and fifth linked items' description contain product image. Deleting that image message in the second rank's description, page E is obtained. Also, another independent sample group of fifty respondents practice page E in the simulation system, as shown in Table 5. Table 5 shows that, in addition to the second item, CTR of other positions float slightly. The second item on page E does not contain any image message, its CTR is higher than that of page A. The reason, as we believe, is that consumers are very familiar with the search target and they have strong brand awareness. Image itself does not support the transfer of consumers who loyal to brand. Results of chi-square test also confirm that there are not significantly different between A and E. Therefore, hypothesis 4 is not correct.

Table 5. CTR on Page A and E

Rank	1	2	3	4	5	6	7	8	9	10
CTR on page A	0.18	0.6	0.32	0.1	0	0	0.02	0.06	0.04	0.04
CTR on page E	0.2	0.74	0.22	0.1	0	0.04	0.08	0.1	0.06	0.02

Table 6. Chi-Square Test

Returned page	B			C		
	Value	df	Sig.	Value	df	Sig.
Pearson chi-square	29.554a	8	.000	27.685a	7	.000
Likelihood ratio	32.249	8	.000	31.227	7	.000

Linear -by- linear association	22.397	1	.000	14.348	1	.000
valid cases	146			145		
Return page	D			E		
	Value	df	Sig.	Value	df	Sig.
Pearson chi-square	49.369a	9	.000	7.360a	9	.600
Likelihood ratio	61.322	9	.000	8.640	9	.471
Linear -by- linear association	24.513	1	.000	.345	1	.557
valid cases	149			149		

5.5. Impact of Keyword Length on CTR

A keyword may consist of one or more 'words'. Keyword length, defined as the number of words included in a keyword, are from 2 to 12 in above experiment. Keywords length and clicks are counted in Table 7. Visible, consumers accustom to choose 4 to 6 characters to search, which account for 45 percent of clicks. Both too many and too few characters lead to fewer clicks. Too few characters cannot express user intention accurately, while using too many characters is like to lose a lot of useful information in search. But there is an exception in this experiment. Keyword "best cost-effective smart phone", with 10 Chinese characters, receives 20 percent of clicks. It indicates that users are more concerned about the commodity price and performance in search. We also notice that the keyword "Which smart phone is good?" CTR is only 5%, which indicate that interrogative keyword isn't applicable to product marketing. Therefore, hypothesis 5 is correct.

Table 7. Keyword length and its CTR

Character number (in Chinese)	CTR	Character number (in Chinese)	CTR
2	0.09	8	0.06
4	0.24	9	0.03
6	0.21	10	0.20
7	0.05	12	0.12

6. Multi-Factor Analysis

More than one factor which affect clicking behavior have been studied in previous. The analysis shows that rank, brand information and retailer information significantly affect the user's clicking behavior, while product image do not have an impact. However, these factors were studied separately. How do these factors influence user's clicking behavior simultaneously is still unknown. Next, comprehensive analysis of rank, brand information and retailer information will be carried out by constructing a user discrete choice model.

6.1. Discrete Choice Model

The probability that user clicks on a particular linked item can be described as follow:

$$P_{click} = \frac{e^{u}}{1+e^{u}}$$

Error! Reference source not found.Error! Reference source not found.

Here *u***Error! Reference source not found.** is consumer utility. We then get following logistic formula:

$$\ln(\frac{P_{click}}{1-P_{click}}) = u = \beta_0 + \beta_1 Rank + \beta_2 Brand1 + \beta_3 Brand2 + \beta_4 \mathrm{Re}tailer1 + \beta_5 \mathrm{Re}tailer2 + \varepsilon \quad (1)$$

Where β is the parameter to be estimated and **Error! Reference source not found.** is error term. The value of r**Error! Reference source not found.**ank is defined between 1 and 10. The smaller the value, the higher rank. As there are much difference among consumers in the recognition of different brands and retailers, this article generalize these differences to be well-known or non-famous. Brand1 means linked item contain well-known brand information while it value is 1, otherwise it value is 0. Brand2 means linked item contain non-famous brand information while it value is 1, otherwise it value is 0. **Error! Reference source not found.** means linked item contain well-known retailer information while it value is 1, otherwise it value is 0. As before,**Error! Reference source not found.** means linked item contain non-famous retailer information while it value is 1, otherwise it value is 0. In the mobile phone industry, consumers are easy to reach a consensus about well-known brand and non-famous brand. For example, Apple and Samsung are well-known brands currently. Also, jd.com mall is considered as well-known retailer and micro purchase of Baidu.com is non-famous retailer. Features of each items on page A is shown in Table 8：

Table 8. Features of Each Items on Page A

Rank	Brand1	Brand2	Retailer1	Retailer2
1	0	0	0	0
2	0	0	1	0
3	1	0	0	0
4	0	0	1	0
5	0	0	0	0
6	0	0	0	1
7	0	0	0	0
8	0	0	0	1
9	0	1	0	0
10	0	1	0	0

6.2. Result Analysis

Each of sample groups previous is independent. Comprehensive analysis is carried out based on collected data. Collected data are shown inTable 9 and Table 10.

Table 9. Clicks on each Page

Page	Rank									
	1	2	3	4	5	6	7	8	9	10
A	9	30	16	7	0	0	1	3	2	2
B	8	11	11	10	0	1	2	20	3	10
C	7	23	3	9	0	0	15	10	3	5
D	7	4	16	8	1	23	2	9	3	6
E	10	37	11	5	1	2	4	5	3	1

Parameter R is used to test the fitness of model. Test results show that R2 is 0.88, adjusted R2 is 0.82, F is 17.948 and P is 0.000, which mean that the model fits the data better and model test is significantly.

Table 10. CTR on Each Rank

Rank	1	2	3	4	5	6	7	8	9	10
CTR	0.103	0.227	0.153	0.113	0.003	0.080	0.067	0.140	0.037	0.077

Table 11. Analysis of Variance

Model	Squares	df	Mean squares	F	Sig.
Regress	36.706	5	7.341	17.948	.000[a]
Residuals	31.403	34	.924	-	-
Total	68.109	39	-	-	-

Rank, brand information and retailer information significantly affect CTR, as can be seen from Table 12. Among these three factors, rank has negative effects on click-through. Ratio of click $\frac{P_{click}}{1-P_{click}}$ is reduced to 0.840 times of the original when rank decreasing by one. Test result is significantly. Therefore, hypothesis 1 holds. Whether containing brand information also significantly affect clicks. Famous brand information can improve click rate by 8.406 times. While non-famous brand improve click rate by 3.022 times. This shows that users prefer to focus on well-known brand products. Hypothesis 2 holds. Containing famous retailer information increase the ratio by 9.096 times. Also, Test result is significantly, hypothesis 3a holds. There is no statistical significance when containing non-famous retailer information. Hypothesis 3b holds.

Table 12. Regression Coefficient Test

Model	Non-standardized coefficients		Standardized coefficients	t	Sig.
	B	Standard error	Beta		
Constant	-2.884	.417		-6.922	.000
Rank	-.174	.078	-.382	-2.235	.002
Brand1	2.129	.555	.490	3.837	.001
Brand2	1.106	.512	.492	2.623	.003
Retailer1	2.208	.439	.677	5.028	.000
Retailer2	.567	.459	.174	1.234	.226

Comprehensive analysis of regression results show that rank, brand information and retailer information have a great impact on clicks. Top in rank, containing famous brand and well-known retailer information can improve CTR. Lists by their weights according the contribution to CTR are as follow: famous retailer information, famous brand information, non-famous brand information and rank.

7. Conclusion

In this paper, experimental system is set up to simulate real searching and shopping environment. Respondents searching and clicking activities' data are collected and analyzed. Following conclusions are reached:

(1) Top position ad is likely to bring more clicks. But rank is not the only determining factor.

(2) Different company have different strategy on deciding whether to contain brand information in the linked item. Our research shows that well-known brand or high market share company should include their brand message to improve CTR significantly. Rather than the well-known brand, non-famous company should occupy top ranking position. Also, containing well-known retailer information can significantly improve CTR.

(3) One may think intuitively that containing image of good in linked item should attract more attention of consumers and bring more clicks. This study prove that this view

is incorrect in smart phone industry. Because the brand awareness in current smart phone industry is very high, image itself does not support the transfer of brand loyalty.

(4) User accustom to choose a moderate length of keyword to search, too long or too short keyword bring less CTR.

One highlight of this paper is to built an experimental system which almost is identical to the real environment. Users can search in this system with a real returned result page, which came from Baidu.com in a certain period. Users can click on an item into the real linked page to browse commodities, and even can order commodities if they want. The method used herein is more truly representative of the real searching and clicking behavior than traditional method, in which data were collected through surveying. Another highlight of this paper is to study product image impact on CTR firstly.

User's searching and clicking behavior is a complex decision-making procedure, which involve social science knowledge environment, age level, education level and economic conditions. How these factors are taken into account is still unknown. To maximize advertising effectiveness, how the relationship between CTR and conversion rate and which factors will ultimately affect the conversion rate worth further depth study.

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