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# Mobile Advertising: An Empirical Study of Advertising Response and Search Behavior

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# MOBILE ADVERTISING: AN EMPIRICAL STUDY OF ADVERTISING RESPONSE AND SEARCH BEHAVIOR

*Completed Research Paper*

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## Abstract

*Although businesses are increasing their mobile advertising budgets, its strategic value and effectiveness have not been investigated in depth. Using data from an automobile advertisement campaign, we focus on investigating the efficacy of mobile advertising in terms of consumers' response to sign up for a car test drive in relation to their search behavior. We propose and estimate an empirical model of advertising response and search behaviors based on a panel-level random-effects specification of simultaneous binary logit and Poisson count models. We find that users' reactions to the advertiser's target response are related to a) the depth and breadth of information search, b) contents viewed in each session, c) the number of return session visits and session durations. The sensitivities of advertising response to the numbers of informative and persuasive ad views, the numbers of images and characters viewed are higher during the campaign's focal event of a car show.*

**Keywords:** Mobile advertising, Advertising response, Information Search

# Introduction

Despite the importance of mobile technology as a new advertising media, the state of empirical research into the use of mobile technologies has lagged behind technological developments and the increasing use of integrated marketing communications[1] (IMC) with both online and offline media channels (Oh and Xu, 2003). The mobile communications platform, as an advertising media, provides distinct advantages over the conventional print, broadcast and Internet media in terms of targeted marketing. Compared to the Internet technology, mobile technology caters to more accurate and consistent tracking of site visitors through individuals' mobile phone numbers rather than Internet Protocol (IP) addresses which are non-static. Mobile technology also allows servers to accurately record the users' geographical location information and other mobile handset information from their Subscriber Identity Module (SIM) card without having to explicitly request users to send such information. Finally, unlike television or personal computers, mobile phones are portable and are likely to follow the movement of the individuals. In location-aware advertising contexts, advertisers benefit from increasing the relevance and targeting capability of advertisements delivered to consumers who are in the vicinity of advertisers' physical presence.

Most recent studies of advertising in e-commerce or online environments have focused on studying consumers' advertising response and information search behavior via the Internet media (Bakos 1997; Brynjolfsson and Smith 2000; Haubl and Trifts 2000). While there are research attempts on mobile device adoption and information privacy issues (Barwise and Strong 2000; Pedersen 2005), to the best of our knowledge, there has been no formal academic research study on a mobile platform disaggregate clickstream model of advertising response in relation to consumer search behavior. The objective of our research is thus to investigate the efficacy of mobile advertising, for a new product launch in a IMC campaign context, in terms of consumers' response to mobile advertising and their search behavior for information. We seek to answer the following research questions:

1) What are the factors that impact on consumers' decision to react to the advertisers' desired target response in mobile advertising?

2) What is the relationship between consumer information search behavior and advertising response in mobile advertising platforms?

Using a novel proprietary data set of an automobile advertisement campaign conducted by an advertising agency in an Asian country[2], we propose and validate a model of consumer advertising response and search behavior based on a panel-level random-effects model specification of simultaneous binary logit and Poisson count models. In this study, the novel nature of the advertising campaign also allows us to conduct a detailed analysis in terms of the location-aware effects by comparing the relationship between the model covariates and dependent variables across different campaign time periods and geographical regions.

Our findings showed that consumers' reaction to the mobile advertiser's target response is related to their depth and variety of information search and the contents they viewed in each session. Increased depth and breadth of information search were associated with higher propensities to respond to the advertisement in terms of registering for a car test drive. The breadth of search exhibited a diminishing marginal returns effect on the mobile advertising response. Advertising content viewed, in terms of the number of informative and persuasive ad pages viewed in a session, are found to have a downward-sloping, U-shaped relationship with advertising response. Interestingly, we also find that increased session durations and return visit sessions are associated with higher advertising response rates. Across different session visits, mobile phone users seem to be increasing the depth of information search but decreasing the breadth of information search in terms of the number of information categories searched. Consumers tend to search for more information before the focal campaign event of the car show, while the sensitivities of advertising response to the advertisement contents are higher during the car show.

In summary, this study contributes to the extant academic literature of advertising on mobile technology platforms in terms of (i) clarifying the relationship between consumer advertising response and information search behavior, (ii) documenting the relationship between advertisement content and consumer advertising response, and

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[1] Integrated marketing communications, according to the *American Marketing Association*, is a planning process designed to assure that all brand contacts received by a customer for a product or service are relevant to that person and consistent over time. It aims to ensure consistency of a marketing message and the complementary use of media.

[2] Due to confidentiality reasons, we cannot reveal the names of the advertiser, advertising agency, and certain contextual information of the mobile advertising campaign.

(iii) examining how consumer search behaviors and advertising response sensitivities may vary across different campaign time periods and focal promotion events in a IMC campaign context.

## Conceptual Foundations and Research Propositions

From our literature review, we identified two general classes of literature which are relevant to our research questions, namely from consumer information search behavior and advertising response behavior in terms of consumers' decision to purchase. Since we deem this research as an exploratory effort to uncovering potential relationships between advertising content, consumer search behavior and advertising response, we derive research propositions where appropriate and relevant, rather than formal hypotheses.

Mandel and Johnson (2002) pointed out that most studies of exploratory search and the measures used in them have ignored the content of the pages viewed. Additionally, it had been shown that consumers often construct their preferences during their online shopping session according to the page content encountered during the session. A previous study on information content in advertising found that non-informative advertising is likely less effective in persuading consumers to seek relevant product information and to purchase products that can show real benefits over existing alternatives (Resnik and Stern 1977). Ackerberg (2001) provided empirical evidence to show that inexperienced consumers are affected by advertisements and that consumer behavior was influenced by advertisements with informative contents but not persuasive contents. Bucklin and Sismeiro (2004) constructed measures of exposure to site design and structure that incorporate visitors' idiosyncratic experience at the site (i.e. the set of pages requested) and the page-specific characteristics. They suggested increasing advertising exposure for those visitors which display high level of search activity and personalizing the advertising content of the site for this group of visitors. Given these prior research findings above, we postulate that there are significant relationships between advertisement contents and (a) consumer information search behaviour as well as (b) advertising response in mobile advertising platforms (*Propositions P1(a) and P1(b)*).

There have been several studies (e.g., Bucklin and Sismeiro 2000; Novak, et al. 2000; Montgomery, et al. 2004) exploring online navigational behavior in terms of the effects of page-depth (the number of pages viewed in a shopping session). Huberman and colleagues (1998) had proposed a "law of surfing" which associated the number of pages requested by visitors with some assumptions of surfing behavior. However, they do not take into account the potential effect of covariates on page requests and how user behavior may change for returning visitors. Bucklin and Sismeiro (2003) found that the average page-request probabilities is positively associated with visit depth at the aggregate level, suggesting that as users browse more extensively on the site, the probability of additional page requests increases, a result of within-site "stickiness". While these prior results on the effects of website page browsing and exposure apply to the online context of using personal computers, we postulate that the underlying mechanisms determining consumer decision processes are similar in mobile platforms. As such, we propose that there exist significant relationships between advertising page view exposures, and (a) consumers' information search behaviour and (b) advertising response in mobile advertising platforms (*Propositions P2(a) and P2(b)*).

Previous studies (e.g., Bucklin and Sismeiro 2000; Novak, Hoffman, and Yung 2000) have explored online navigational behavior in terms of session-duration (the amount of time spent during an online session). Johnson, Bellman, and Lohse (2003) also studied the duration of website sessions across multiple visits. Their study had shown that visitors spend less time per session with increasing returning visits to the same website. The researchers contended that visitors become more efficient as they return to the site. Bucklin and Sismeiro (2004) found that the more time and effort that visitors invest in the site, the more likely they are to eventually buy at the site. Similarly, Bucklin and Sismeiro (2003) had shown that repeat visits led to reduced page-view propensities, however, not to reduced page-view durations, hence suggesting visitors' time-saving strategies. This result corroborated the findings reported by Johnson, Bellman, and Lohse (2003), which showed that repeat visitation is associated with shorter total session durations. There had also been previous studies which suggest that people who shop frequently may be more likely to make a purchase (Bellenger, et al. 1978; Janiszewski 1998; Jarboe and McDaniel 1987; Roy 1994). Moe and Fader (2004) performed a clickstream analysis which provided strong confirming evidence that increase in visiting rates over time are more likely to purchase. People who experience increases in their visiting rates over time are more likely to purchase than those who are slowing down (Moe and Fader 2004). In sum, we postulate that there are significant relationships between consumers' session visitation characteristics and their (a) information search behavior as well as (b) advertising responses in mobile platforms (*Propositions P3(a) and P3(b)*).

The significant relationships between consumer search behavior, advertising response and decision to purchase have long been documented in the marketing consumer behaviour and advertising literature. In particular, past research have found that consumers' intensity of search has an inverted-U-shaped relationship with prior product experience and knowledge either from usage or advertisements, varies inversely with the effort cost of search, and is positively related to purchase behavior or intention (c.f., Moorthy, et al. 1997; Manchanda, et al. 2006; Bellenger, et al. 1978; Moe 2003; Punj and Staelin 1983; Moe and Fader 2004). Many past studies elaborated above found that consumer search behavior and advertising response in conventional online web-based environments are positively and linearly–dependent. However, information search behaviors on mobile platforms may be intrinsically different from those on desk-bound personal computer platforms due to a few reasons. First, mobile devices are typically much smaller in physical size and network bandwidth compared to desktop or notebook computers (Chan, et al. 2002). As such, textual and pictorial information conveyed on mobile devices are usually much constrained in layout design and content. Consequently, typical frequencies, types and categories of information sought by consumers using mobile devices can differ significantly compared to those using personal computers (Baeza-Yates, et al. 2007). Second, mobile phones are personal communication devices which typically can be in possession by an individual wherever he or she goes. As such, information sought by a consumer using mobile devices can be much varied and context-dependent depending on the location, place, time and activity the individual is in. Consequently, the consumer's information search behavior and decision process to respond to advertising offers can differ across mobile device platforms and deskbound personal computer platforms. As a result of potential threshold effects from limited physical size, network bandwidth and the context-sensitive nature of mobile advertising and marketing, we propose that there exist a potential significant non-linear relationship between consumer search behavior and advertising response in mobile platforms (*Proposition P4*).

# Research Methodology

## *Research Model*

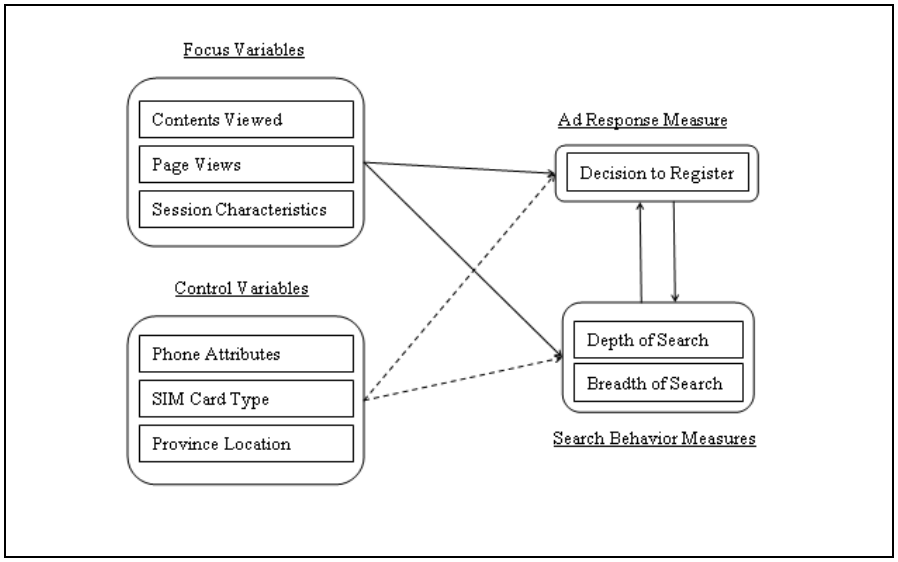


**Figure 1 – Research Model**

Figure 1 presents our proposed research model with an illustration of the relationships between the model constructs. Using our proposed research model, we seek to gain a holistic understanding of consumer responses towards mobile advertising, in part based on past documented research results and findings of consumer response towards online Internet advertising. To have a more parsimonious model, we limited the scope of this study to analyze the relationship between consumers' information search and advertising response behavior, in terms of the level of their search activity and their decision to register for a free product trial (i.e., car test drive) respectively.

The various constructs of our research model were gathered from the outcome of our literature review and from the information which was available to us in our mobile advertising clickstream data. We postulated different

main groups of constructs to be measured, namely advertising content attributes, page view exposure attributes, session visitation attributes, search behavior measures, advertising response measures, and control variables such as phone attributes and demographic proxies. Specifically, we chose the depth of search and the breadth (or variety) of search as measures of consumer search behavior. We used mobile phone users' decision to register as a proxy for their final purchase decision due to data limitations from the advertising agency – users' purchase information were not available from the agency. Nonetheless, we find that similar decision proxies were used for estimating user behaviors in other marketing research studies related to automobile transactions (Zettelmeyer, et al. 2006). The constructs of consumer's decision to respond, depth and breadth of search are the dependent variables in our research model. Based on our literature review in the previous section, we presented 4 research propositions relating the constructs studied in our research model presented in Figure 1.

### *Location-Aware Contexts – A Post-hoc Analysis*

In this study, we also perform a more detailed analysis into comparing the relationship between the model covariates and the dependent variables across different time periods and geographical regions of the mobile advertising campaign. Time period is measured relative to the period before and during an industry-level car exhibition show, during which the product subject of the advertising campaign was formally introduced in a location-aware IMC campaign context. Geographical region is measured relative to the mobile phone users' proximity to the car exhibition show which was held in the capital city of the country. We classify users into those who are located at cities in the same province as the capital city into one group and users who are located at cities outside this province into another group. We then focus on observing differences in the users' advertising response and information search behavior before and during the car show, as well as differences between users who are located in the nation's capital province and those who are located outside the capital province.

### *The Mobile Advertising Campaign*

The context of our study is a mobile advertising campaign which takes advantage of a mobile WAP[3] site to promote new car models from an automobile manufacturer. These new car models were slated for launch in an industry-level car exhibition show held in the capital city of an Asian country from 18th to 27th November 2006.

#### Before the Show

As a pre-campaign initial activity, the automobile company placed banner and text advertisement hyperlinks on the mobile operator's WAP portal site 3 days before the car show. By taking advantage of the huge visitor traffic volume of the portal, the automobile company increased the chances of driving user traffic to its campaign WAP site. The company had also inserted text advertisements in dedicated content channels of the portal, the News and Finance channels, where its target audience would likely visit. Users would be brought to the homepage of the automobile company's campaign WAP site upon clicking on the advertisement hyperlinks. In addition, the automobile company inserted print advertisements in the local capital city's newspapers with a tagline prompting readers to send a SMS[4] to a short code[5] for more information. Readers who sent a SMS would receive a response from the mobile operator in the form of a WAP PUSH[6] which contains a hyperlink to the campaign WAP site. Upon entering the homepage of the campaign WAP site, the visitor had a number of options. Visitors would be able to browse for more information about the car exhibition show, the new and existing car models, download wallpaper images of the car models, participate in lucky draws to win tickets to the car exhibition show, and choose to register for a free car test drive.

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[3] WAP, Wireless Application Protocol, is an open international standard for applications that use wireless communication. Its principal application is to enable access to the Internet from a mobile device.
[4] SMS, Short Message Service.
[5] Short codes are special telephone numbers, significantly shorter than full telephone numbers, which can also be used to address SMS and MMS messages from mobile phones or fixed phones.
[6] WAP PUSH is a text message service which contains a hyperlink to a mobile WAP site.


**Figure 2 – Entry Points on Mobile Operator's WAP Portal**

### During the Show

During the show, the automobile company deployed new mobile technologies to attract visitors to its exhibition booth and to its campaign WAP site. Visitors who visit the campaign company's booth would receive a brochure which enables them to enter the WAP site on their mobile phones using QR[7] codes. Visitors would capture the QR code using their phone camera to automatically load the mobile web browser and the campaign WAP site. At the same time, the banner and text advertisements on the mobile operator WAP portal continued to run and draw site visitors who may or may not be physically present at the car exhibition show in the capital city. Lucky draw promotions on the WAP site ended upon the start of the show, and winners were announced on the site. All other contents of the WAP site remained the same during the show.


**Figure 3 – Screen Shots from Campaign WAP site**

### After the Show

After the exhibition show had ended, text link advertisements on the mobile operator's WAP portal continued to run for another day till 28th November 2006. Subsequently, users were only able to return to the campaign WAP site through their own bookmarks, saved WAP PUSH, or saved brochure QR code. All other contents of the WAP site remained the same after the car show and visitors can continue to register themselves for the free car test drive. Registrants of the free car test drives were contacted by dealers in their own nearest city to be scheduled a test drive appointment time.

## *Data Collection*

Data collection for this advertising campaign was undertaken by the mobile marketing and advertising agency which was engaged by the automobile company for the purpose of this mobile advertising campaign. The computer servers which hosted the campaign WAP site were able to capture user information from the requesting mobile user's SIM card upon each user's page request, in order to track user behavior on the campaign WAP site. This user information is sent together with the page request information (URL[8] requested) to the servers. These data were then stored in a local database. However, data pertaining to the entry points from which the user arrived at the

[7] QR codes, Quick Response codes, are two-dimensional barcodes that allow contents to be decoded at high speeds.
[8] URL, Uniform Resource Locator.

campaign WAP site could not be captured by the servers. Users' personal particulars, such as name, age and gender, were not sent to servers due to the mobile phone service operator's user privacy policies.

### *Data Summary*

The research data used in this study spanned 8 weeks from 7th November 2006 to 31st December 2006. During this time period, 505,841 user visit sessions were made by 411,500 unique visitors from across 31 different provinces in the country. This constituted 1,246,157 page view data observations. We aggregated this page view level data to the session level using measures which we would describe in the next section. These measures were used to describe the nature of the page views within each session. We identify a new visitor session whenever consecutive page requests by the same visitor are more than 20 minutes apart[9] or when it is the first time a visitor makes a page request. Of these 505,844 sessions, only 3,081 (2,965 unique visitors) were accompanied by a registration for the free test drive. This thus resulted in an average 0.6% conversion rate which falls into the range of that for online Internet advertising[10]. The average visit contained 2.7 page views lasting for a total of 44 seconds.

### *Variables and Measures*

Our variables of research focus were selected based on literature reviews of past related work in the marketing and information systems disciplines (e.g., Bucklin and Sismeiro 2000; Novak, et al. 2000). Control variables such as mobile phone number endings, SIM card types and province locations were used to control for potential wealth, income and spatial location effects. As the goal of our research model is not to map out page-to-page decisions of the visitor, we thus use the page-to-page information to develop session-level measures that characterize mobile user behaviors in relation to the constructs and variables in our research model. Table 1 below provides a summary of the measures for all variables used in this study.

Table 1 – Summary of Measures

| ***Construct*** | ***Variable*** | ***Measure*** |
|---|---|---|
| Decision to register | REG | Test drive registration decision (0/1 indicator) |
| Depth of search | DEPTH | Maximum depth of pages traversed |
| Breadth of search | INFOCAT | Number of information categories[11] searched |
| Contents viewed | INFOAD | Number of informative ads viewed |
| | PERSAD | Number of persuasive ads viewed |
| | IMGVIEW | Number of images viewed |
| | CHARVIEW | Number of characters viewed |
| Page views | URLUNQ | Number of unique URLs viewed |
| | PGVIEW | Number of page view or exposure counts per URL |
| | PGFAIL | Number of page counts which failed to load per URL |
| Session characteristics | SESSDUR | Total session duration (in seconds) |
| | SESSFIRST | Indicator for first visit if there are returning visits |
| | SESSRETN | Indicator for returning visit (at least one day apart) |
| | SESSFREQ | Cumulative number of sessions for user |
| Mobile phone attributes | ID8, 28, 88, 168, 518, 888 | Indicators for last digit(s) of mobile phone number: 8, 28, 88, 168, 518 and 888[12] |
| SIM card type | SIM | Mobile phone service subscription plan (pre/post-paid) |
| Province location | PROV | Province which mobile phone user is located in |

[9] We reference this benchmark for defining a new session by referring to previous studies on online purchase behavior, which had also used the 20 minute benchmark (for e.g., Montgomery 2002).
[10] Forrester Research reported that over 70% of e-commerce websites have less than 2% conversion rates.
[11] We classified information on the campaign WAP site into 5 categories: home page information, car model information, car show information, image downloads, and customer response to ads.
[12] In this country, these mobile numbers are also known as auspicious golden numbers, which can be purchased from the service providers or be bidded in the open market.

## Data Analyses and Results

In this section, we describe our approaches in analyzing our data set of mobile advertising responses and information search behaviors. Prior to specifying an individual-level model of advertising response and search behaviors, we undertake a model-free, aggregate-level analysis of summary statistics associated with our campaign measures across different provinces and dates in which the mobile advertising campaign was conducted. Insights from this aggregate-level analysis subsequently provided us with pointers and guidance in specifying, estimating and comparing the individual-level model estimation results across different data samples.

### *Aggregate-Level Statistics and Analyses*

Table 2 – Descriptive Statistics of Measures

| *Variable* | *Obs* | *Mean* | *Std. Dev.* | *Min* | *Max* |
|---|---|---|---|---|---|
| REG | 505841 | 0.006 | 0.078 | 0 | 1 |
| DEPTH | 505841 | 1.341 | 0.642 | 1 | 4 |
| INFOCAT | 505841 | 1.317 | 0.628 | 1 | 5 |
| INFOAD | 505841 | 1.490 | 1.418 | 0 | 48 |
| PERSAD | 505841 | 0.171 | 0.798 | 0 | 38 |
| IMGVIEW | 505841 | 5.469 | 4.467 | 0 | 180 |
| CHARVIEW | 505841 | 229.348 | 297.469 | 40 | 11234 |
| URLUNQ | 505841 | 1.478 | 1.178 | 1 | 25 |
| PGVIEW | 505841 | 1.644 | 1.417 | 1 | 169 |
| PGFAIL | 505841 | 0.575 | 1.380 | 0 | 168 |
| SESSDUR | 505841 | 43.922 | 157.380 | 0 | 5573 |
| SESSFIRST | 505841 | 0.057 | 0.232 | 0 | 1 |
| SESSRETN | 505841 | 0.090 | 0.287 | 0 | 1 |
| SESSFREQ | 505841 | 1.369 | 1.303 | 1 | 63 |

Table 2 shows the different summary statistics associated with variables in our entire data set of 505,841 observations across all provinces and time periods. Table 3 shows the pair-wise Pearson correlation values between the variable measures. The overall average advertising response rate in terms of test drive registration rate REG amounted to about 0.6% across all provinces and across the entire duration of the campaign. Further analyses revealed that registration rates in the capital city province averaged about 4.4% before the car show and about 1% during the car show. The advertising response rates in our data set seem to match up with those reported in Lee, et al. (2006) where response rates ranged from 0.12% to 12.58% for the case of Korea.

Summary statistics associated with the information search behavior variables of DEPTH and INFOCAT show that on average in a user session, mobile phone users typically traversed to a maximum URL page depth level of 1.34 (out of a total of 4 levels), while users accessed about 1.32 information categories on average (out of a total of 5 categories). In terms of content-related variables, phone users viewed on average about 1.49 informative advertisement pages, while they also accessed about 0.17 persuasive advertisement pages in a session. Therefore, it seems that mobile phone users were primarily interested in accessing advertising content of an informative nature.

On average in a user session, about 5.47 images were viewed by the user while about 229 characters on the WAP pages were accessed. The variability of the number of characters viewed on the user's phone is higher than that of the number of images viewed since the standard deviation of CHARVIEW is higher than its mean, while the standard deviation of IMGVIEW is lower than its mean. Users also viewed on average, about 1.48 unique URLs and 1.64 pages per URL in a session, while an average of 0.58 pages failed to load properly for each URL in a session.

In terms of session characteristics, each user session lasted on average about 43.9 seconds while the mean frequency or number of user sessions in the campaign averaged 1.37 across the campaign duration period. Of all user sessions in our data set, about 5.7% were first-time visit sessions (conditional upon a return visit on another day). Similarly, about 9% of all sessions were return visit sessions (relative to the last visit on another prior day).

Table 3 – Correlation Matrix

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | REG | 1.00 | | | | | | | | | | | | | |
| **2** | DEPTH | 0.21 | 1.00 | | | | | | | | | | | | |
| **3** | INFOCAT | 0.22 | 0.88 | 1.00 | | | | | | | | | | | |
| **4** | INFOAD | 0.14 | 0.66 | 0.75 | 1.00 | | | | | | | | | | |
| **5** | PERSAD | 0.10 | 0.54 | 0.50 | 0.36 | 1.00 | | | | | | | | | |
| **6** | IMGVIEW | 0.16 | 0.69 | 0.75 | 0.89 | 0.70 | 1.00 | | | | | | | | |
| **7** | CHARVIEW | 0.22 | 0.71 | 0.78 | 0.97 | 0.46 | 0.88 | 1.00 | | | | | | | |
| **8** | URLUNQ | 0.32 | 0.84 | 0.88 | 0.83 | 0.60 | 0.84 | 0.90 | 1.00 | | | | | | |
| **9** | PGVIEW | -0.01 | 0.00 | 0.01 | 0.10 | 0.05 | 0.11 | 0.08 | 0.00 | 1.00 | | | | | |
| **10** | PGFAIL | -0.03 | -0.09 | -0.08 | -0.02 | -0.04 | -0.02 | -0.04 | -0.08 | 0.98 | 1.00 | | | | |
| **11** | SESSDUR | 0.16 | 0.54 | 0.58 | 0.63 | 0.43 | 0.66 | 0.65 | 0.61 | 0.12 | 0.02 | 1.00 | | | |
| **12** | SESSFIRST | 0.03 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.05 | 0.00 | -0.01 | 0.04 | 1.00 | | |
| **13** | SESSRETN | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | -0.01 | -0.01 | 0.00 | -0.08 | 1.00 | |
| **14** | SESSFREQ | -0.01 | -0.03 | -0.04 | -0.03 | -0.02 | -0.03 | -0.02 | -0.04 | -0.01 | -0.01 | -0.01 | -0.07 | 0.38 | 1.00 |

Since the advertising campaign was conducted in conjunction with the car exhibition show located in the capital city province, it is thus intuitive to compare the advertising response rates and information search behaviors of phone users in the capital city province against those in other provinces.

Figure 4 shows substantial variations in the advertising response rates (REG), depths (DEPTH) and breadths (INFOCAT) of search across the 31 different provinces of the country. Specifically in terms of test drive registration rates across the entire campaign duration, the capital city province (see province #2 in Figure 4) averaged close to about 3%, which is 2 to 5 times higher compared to the rest of other provinces. Therefore, advertising response to this specific campaign by users in the capital city province seems structurally different compared to users in other provinces. Accordingly, in our individual-level model estimation and analysis reported below, we would also compare our individual-level model parameter estimates across users in the capital city province and other provinces.

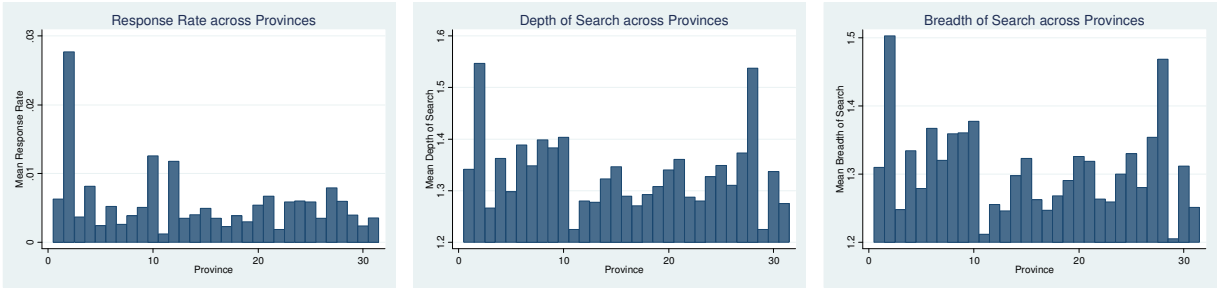


**Figure 4 – Ad Response Rate, Depth and Breadth of Search across Provinces**

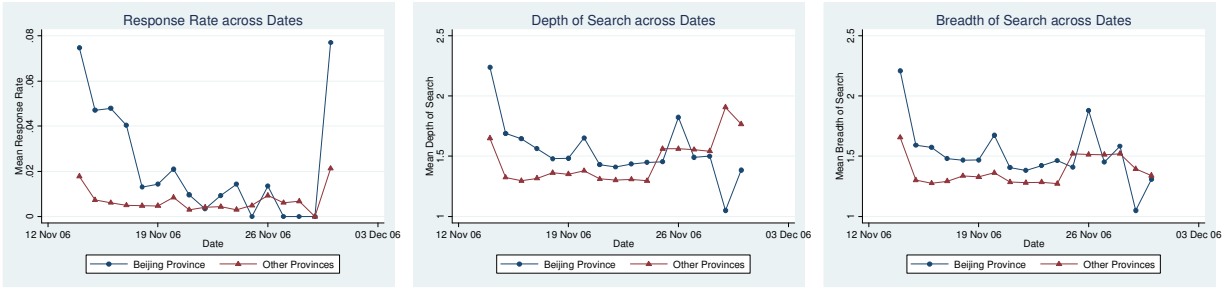


**Figure 5 – Ad Response Rate, Depth and Breadth of Search across Dates**

Across different time periods or dates of the advertising campaign, Figure 5 also shows significant variations in the advertising response rates (REG), depths (DEPTH) and breadths (INFOCAT) of search. Prior to the

opening of the car show in the capital city on 19th November 2006, advertising response rates and information search behaviors seem to decline progressively from 5 days prior to the car show opening. For phone users in the capital city province, their advertising response rates and information search behaviors exhibited distinct spikes on days close to the opening and closing of the car show. Accordingly, in our individual-level model analysis, we compare our individual-level model parameter estimates across the durations before and during car show periods.

Figure 6 shows in our entire data sample, the aggregate relationships between the mean test drive registration rates (REG) and the number of informative (INFOAD) or persuasive (PERSAD) ad pages viewed in a user session. In both charts of Figure 6, the dotted blue lines plot the observed mean values while the undotted trend line fits a quadratic prediction line. It is clear that the lines in both charts are generally upward sloping (across most of the data range), which thus suggest that as users view or access more informative or more persuasive ad pages on the campaign WAP site, the probability of responding to the advertisement in terms of registering for a car test drive increases.

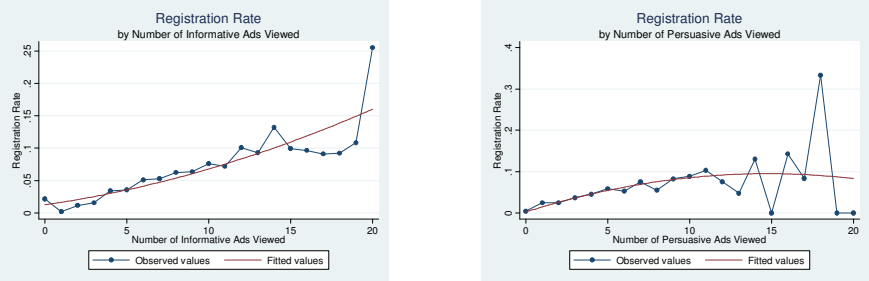


**Figure 6 – Registration Rate by Number of Informative/Persuasive Ads**

Similarly, Figure 7 shows that in our entire data sample, the aggregate relationships between the mean test drive registration rates (REG) with the number of information categories searched (INFOCAT) and with the number images viewed (IMGVIEW) in a user session. As is the case in Figure 6, the lines in both charts of Figure 7 are upward sloping, with INFOCAT exhibiting increasing marginal returns to REG, but with IMGVIEW showing diminishing marginal returns to REG on the aggregate. These suggest that in general, as users search for more information categories or view more images on the campaign WAP site, the probability of responding to the advertisement in terms of test drive registration increases.

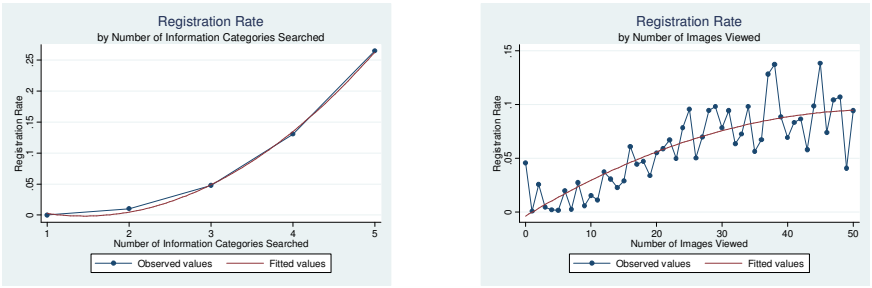


**Figure 7 – Registration Rate by Number of Information Categories and Images Viewed**

## *Individual-Level Models and Analyses*

While the aggregate-level data analysis provided some interesting insights into the relationships between mobile advertising response and information search behaviors, it does not account for unobserved heterogeneity or differences between individual mobile phone users across time and space. In addition, aggregate-level statistics provide only a univariate analysis of ad response and search behavior and do not control for the impact of other potential relevant factors. Importantly, aggregate-level analyses also do not account for the inter-dependence or simultaneity of ad responses and information search behaviors (Cameron and Trivedi 2005).

In order to account for these issues in our empirical analysis, we propose a joint simultaneous model of:

1. Individual panel-level random-effects binary logit model (i.e., logistic regression model) of advertisement response decision (REG)
2. Individual panel-level random-effects Poisson count model of information search depth (DEPTH)
3. Individual panel-level random-effects Poisson count model of information search breadth (INFOCAT)

Specifically, the binary logit model accounts for the discrete binary nature of the advertising response decision of the consumer, while the Poisson count model accounts for the non-negative, discrete integer distribution of our consumer information search depth and breadth measures (Cameron and Trivedi 2005, 1998).

Accordingly, we specify the individual-level binary logit model as follows:

$$\Pr(y_{i1},\cdots,y_{iT_i}\,|\,x_{i1},\cdots,x_{iT_i}) = \int_{-\infty}^{\infty} \frac{e^{-\upsilon_i^2/2\sigma_\upsilon^2}}{\sqrt{2\pi}\sigma_\upsilon}\left(\prod_{t=1}^{T_i} F(y_{it}, x_{it}\beta+\upsilon_i)\right)d\upsilon_i \tag{1}$$

$$F(y,x) = \begin{cases} \dfrac{1}{1+\exp(-x)}, & \text{if y=1} \\ \dfrac{1}{1+\exp(x)}, & \text{if y=0} \end{cases} \tag{2}$$

where subscript *i* indexes the user, while subscript *t* indexes the session of the user, $y_{it}$ is the advertising response in each session, $x_{it}$ is a vector of model covariates as listed in Table 1. The individual user unobserved heterogeneity or characteristics $\upsilon_i$ is assumed to be a random effect distributed as $N(0,\sigma_\upsilon^2)$. The estimated parameter $\hat{\sigma}_\upsilon$ is thus a measure of the extent of individual-level user heterogeneity in the data.

We next specify the individual-level Poisson count model (Cameron and Trivedi 1998) as follows:

$$\Pr(z_{i1},\cdots,z_{iT_i}\,|\,x_{i1},\cdots,x_{iT_i}) = \int_{-\infty}^{\infty} \frac{e^{-\upsilon_i^2/2\sigma_\upsilon^2}}{\sqrt{2\pi}\sigma_\upsilon}\left(\prod_{t=1}^{T_i} F(z_{it}, x_{it}\beta+\upsilon_i)\right)d\upsilon_i \tag{3}$$

$$F(z,x) = \exp\left(-\exp(x) + zx - \log(z!)\right) \tag{4}$$

where $z_{it}$ is the depth or breadth of search in each session, $x_{it}$ is a vector of model covariates in Table 1. The individual user unobserved heterogeneity $\upsilon_i$ is also assumed to be a random effect distributed as $N(0,\sigma_\upsilon^2)$.

Using the entire data sample, we estimate the above joint simultaneous models of advertising response, depth and breadth of search behaviors using simulated maximum likelihood methods. In our model estimations, we included all model covariates listed in Table 1. Guided by our research propositions and findings from the aggregate analysis, we included some quadratic terms of our model covariates (e.g., squared term of INFOCAT). Although not reported, we also included as covariate various mobile phone attributes such as screen size and memory capacity; the estimated model parameters associated with these phone attributes were all not significant, and as such, we dropped them from our final specification's results reported here. Table 4 shows the model estimation results.

In the first column of Table 4 for REG as the dependent variable, increased depth and breadth of information search were associated with higher propensities to respond to the advertisement in terms of registering for a car test drive. In addition, this individual-level model analysis of REG indicates that while the breadth of search in terms of INFOCAT exhibited a positive linear term effect on the advertising response REG, it also had a significant negative non-linear relationship to REG. This thus suggests that, contrary to the aggregate analysis results, the breadth of search in terms of INFOCAT exhibited a diminishing (rather than increasing) marginal returns effect on the advertising response REG.

In terms of the number of informative or persuasive ad pages viewed in a session, both the INFOAD and PERSAD variables showed significant negative non-linear relationships with the advertising response REG. This result is in contrast to the aggregate level findings where INFOAD and PERSAD were found to have aggregate positive relationships with the mean advertising response rates. In this individual-level model analysis, advertising content viewed in terms of INFOAD and PERSAD are thus found to have a downward-sloping, U-shaped relationship with advertising response REG.

Table 4 – Model Estimation Results (Entire Sample)

| | **Dependent: REG** | | **Dependent: DEPTH** | | **Dependent: INFOCAT** | |
|---|---|---|---|---|---|---|
| | ***Coef.*** | ***Z statistic*** | ***Coef.*** | ***Z statistic*** | ***Coef.*** | ***Z statistic*** |
| REG | -- | -- | -0.047 | -3.35 | -0.109 | -8.03 |
| DEPTH | 1.274 | 13.26 | -- | -- | 0.324 | 99.75 |
| INFOCAT | 2.197 | 8.07 | 1.193 | 151.77 | -- | -- |
| INFOAD | -3.098 | -20.02 | -0.032 | -4.30 | 0.241 | 31.92 |
| PERSAD | -3.538 | -27.02 | 0.079 | 15.55 | 0.030 | 5.86 |
| IMGVIEW | 0.362 | 11.51 | -0.015 | -8.88 | -0.044 | -26.69 |
| CHARVIEW | -0.002 | -4.99 | 0.001 | 5.59 | -0.001 | -30.12 |
| $INFOCAT^2$ | -0.228 | -5.51 | -0.209 | -124.51 | -- | -- |
| $INFOAD^2$ | 0.022 | 5.14 | 0.003 | 9.51 | -0.006 | -19.98 |
| $PERSAD^2$ | 0.055 | 9.02 | -0.006 | -14.25 | -0.003 | -7.81 |
| $IMGVIEW^2$ | 0.001 | 2.47 | 0.001 | 5.09 | 0.001 | 19.05 |
| $CHARVIEW^2$ | 0.001 | 5.52 | -0.001 | -14.40 | 0.001 | 6.85 |
| URLUNQ | 3.137 | 28.69 | 0.121 | 27.33 | 0.171 | 42.27 |
| PGVIEW | 5.224 | 24.48 | 0.095 | 10.05 | 0.284 | 33.25 |
| PGFAIL | -5.730 | -21.54 | -0.099 | -10.28 | -0.289 | -33.29 |
| SESSDUR | 0.001 | 7.34 | 0.001 | 0.47 | 0.001 | 5.93 |
| SESSFIRST | -0.512 | -3.99 | -0.004 | -0.78 | -0.002 | -0.32 |
| SESSRETN | 0.745 | 4.85 | -0.004 | -0.96 | 0.003 | 0.70 |
| SESSFREQ | -0.044 | -0.64 | 0.004 | 4.11 | -0.005 | -4.46 |
| Constant | -22.322 | -28.24 | -1.119 | -86.69 | -0.685 | -57.28 |
| Phone attributes | - not shown - | | - not shown - | | - not shown - | |
| SIM card type | - not shown - | | - not shown - | | - not shown - | |
| Province dummies | - not shown - | | - not shown - | | - not shown - | |
| Number of obs = | 505841 | | 505841 | | 505841 | |
| Log-likelihood = | -4638.709 | | -558689 | | -558604 | |
| Wald $chi^2(56)$ = | 1115.93 | | 123400.05 | | 133252.62 | |

Similarly, our individual-level model estimation showed that advertising content in terms of the number of images (IMGVIEW) and characters (CHARVIEW) viewed exhibited both positive and negative non-linear effects on advertising response REG respectively. In addition, we find evidence that an increased number of pages which failed to load from the WAP site (PGFAIL) contributed to a lower propensity to respond to the advertising campaign. Interestingly, we also find that increased session durations (SESSDUR) and return visit sessions (SESSRETN) are associated with higher advertising response rates in REG. Finally, we report that the estimated individual-level heterogeneity parameter $\hat{\sigma}_{\upsilon}$ which quantifies the standard deviation of heterogeneity is very precisely estimated to be at 1.75 with a z-statistic of 12.72. Consequently, our individual-level model estimation result here thus shows the importance of accounting for individual consumer-level unobserved heterogeneity in empirical modeling and analyses of such mobile advertising responses.

In the second column of Table 4 for DEPTH as the dependent variable, we find that while the number of informative ad pages viewed (INFOAD) exhibits a negative non-linear relationship with DEPTH, the number of persuasive ad pages viewed (PERSAD) exhibits a positive non-linear relationship with DEPTH. Interestingly, increased session frequency of user visits is related to a greater depth of information search behavior.

In the third column of Table 4 for INFOCAT as the dependent variable, we however find that both the number of informative and persuasive ad pages viewed exhibit a positive non-linear, diminishing returns relationship with INFOCAT. We also find that while increased duration per session is related to an increased breadth of information search behavior in INFOCAT, increased session frequency of user visits is related to a lower breadth of information search behavior. This thus suggests that across different session visits, users seem to be increasing the depth of information search but decreasing the breadth of information search in terms of the number of information categories searched.

Table 5 – Model Estimation Results (Capital City vs. Other Provinces: Before & During Show)

| | **Column (1)** | | **Column (2)** | | **Column (3)** | | **Column (4)** | |
|---|---|---|---|---|---|---|---|---|
| | ***Capital Province*** Before Show | | ***Capital Province*** During Show | | ***Other Provinces*** Before Show | | ***Other Provinces*** During Show | |
| | ***Coef.*** | ***Z statistic*** | ***Coef.*** | ***Z statistic*** | ***Coef.*** | ***Z statistic*** | ***Coef.*** | ***Z statistic*** |
| DEPTH | -1.087 | -1.75 | 1.179 | 2.02 | 0.586 | 3.56 | 1.502 | 14.09 |
| INFOCAT | 4.773 | 3.79 | -0.448 | -0.28 | 1.041 | 2.39 | 0.934 | 2.83 |
| INFOAD | -3.433 | -5.01 | -8.512 | -7.17 | -3.208 | -11.56 | -5.680 | -31.92 |
| PERSAD | -3.910 | -8.31 | -5.886 | -7.11 | -3.656 | -14.53 | -5.046 | -40.20 |
| IMGVIEW | 0.586 | 4.11 | 0.695 | 3.63 | 0.509 | 8.57 | 0.630 | 18.16 |
| CHARVIEW | -0.006 | -1.88 | 0.018 | 4.42 | -0.002 | -1.90 | 0.006 | 9.36 |
| $INFOCAT^2$ | -0.887 | -4.60 | 0.180 | 0.80 | -0.182 | -2.68 | -0.039 | -0.80 |
| $INFOAD^2$ | 0.002 | 0.06 | 0.121 | 3.73 | 0.046 | 6.81 | 0.026 | 4.77 |
| $PERSAD^2$ | 0.094 | 1.85 | -0.028 | -0.36 | 0.094 | 8.70 | 0.046 | 15.37 |
| $IMGVIEW^2$ | -0.001 | -0.04 | 0.005 | 2.03 | -0.001 | -2.13 | 0.002 | 6.29 |
| $CHARVIEW^2$ | 0.001 | 2.02 | -0.001 | -3.11 | -0.001 | -0.63 | 0.001 | 3.49 |
| URLUNQ | 4.025 | 13.06 | 3.457 | 6.62 | 3.136 | 15.57 | 3.095 | 35.89 |
| PGVIEW | 3.242 | 3.81 | 7.092 | 7.34 | 3.965 | 10.98 | 6.300 | 32.49 |
| PGFAIL | -3.128 | -3.64 | -7.071 | -6.43 | -4.276 | -10.02 | -7.297 | -25.87 |
| Number of obs | 8084 | | 6615 | | 203526 | | 283926 | |
| Log-likelihood | -212.178 | | -69.524 | | -1384.709 | | -1761.828 | |

Table 5 compares the focal individual-level model parameter estimates (omitting session characteristics and other control variable parameters in the interest of space) for the REG binary logit model across the durations before and during the car show periods, and also across the capital city and other provinces.

Comparing the model parameter estimates for the capital city province before and during the car show period (column (1) vs. column (2)), we find that the sensitivity of advertising response REG to the content-related variables of INFOAD, PERSAD, IMGVIEW, and CHARVIEW to be higher during the car show period. Before the car show, only the breadth of information search in terms of INFOCAT is positively related to the advertising response REG, while during the car show, only the depth of search in terms of DEPTH is positively related to REG.

Comparing column (3) with column (4) for all other provinces before and during the car show periods, we also find that the sensitivity of advertising response REG to the content-related variables of INFOAD, PERSAD, IMGVIEW, and CHARVIEW to be higher during the car show period.

During the car show period, the sensitivity of advertising response REG to the variables INFOAD, PERSAD, IMGVIEW, and CHARVIEW is generally higher for users in the capital city province compared to those in other provinces. Before the car show period however, there do not seem to be any significant differences in the sensitivity of advertising response REG to the variables INFOAD, PERSAD, IMGVIEW, and CHARVIEW across the capital city province and other provinces.

## Discussion and Implications

The main aim of our study is to empirically examine and validate the relationships between information search behavior and advertising response, as well as the impacts of other user session-level measures on information search and advertising response in the context of mobile advertising. In summary, all our research propositions were supported by the findings of our model estimations and data analyses in this study.

From our results, it is shown that visitors who search more broadly are more likely to register, as are those who perform deeper searches. Nonetheless, we noted that there are diminishing returns from the breadth of search conducted towards the decision to register and the depth of search. This corroborates with Peterson and Merino's (2003) findings that information-overload adversely impacts consumers' costs associated with processing this information both cognitively and physically. Our finding here, unlike prior research findings of linear advertising

effects in conventional Internet or e-commerce settings, also presents some tentative evidence to the non-linear threshold effects of limited screen size and network bandwidth of mobile devices on consumer advertising responses. Nonetheless, the depth of users' information search is related positively to the registration decision as well as the breadth of search.

We find that most past studies on consumer behaviors in e-commerce had associated contents to search and buying propensities but did not explicitly discuss the relationship between them (e.g., Mandel and Johnson 2002; Moe 2003; Bucklin and Sismeiro 2004). In our study, we documented distinct U-shape relationships between some of our measures for contents viewed and the users' decision to register, depth of search and breadth of search in the context of mobile advertising. Specifically, informational and persuasive ad pages and the amount of text characters viewed affect users' registration decision negatively initially but with increasing returns after a certain threshold. We see this phenomenon as site visitors being turned away by text and advertisements when they first enter the site, but for those who eventually read on, they may be increasingly persuaded by advertisements and textual contents to register.

Indeed, results from this study imply that mobile marketers could do well to determine precisely the minimum or maximum threshold values of various search advertising measures such as the depth and breadth of information search and the number of informational and persuasive advertisement contents viewed. With such thresholds determined precisely, mobile marketers can then present timely and opportune mobile marketing offers or interventions depending on the state or history of the consumer visitation, information search or mobile browsing patterns. For example, if the mobile marketer determines that a mobile user has crossed the threshold value of the breadth of information search conducted, the marketer can then present a virtual gift voucher redemption coupon to the mobile user in order to capitalize on the increased likelihood of the mobile consumer responding positively to the advertisement campaign. Such timely marketing interventions serve to increase the advertising conversion ratios.

In our study, we documented the positive effects of page views on search behavior in terms of mobile advertising and this supports previous studies which studied this relationship (Bucklin and Sismeiro 2000; Novak, et al. 2000). Furthermore, we have also shown empirically that page views have positive impacts on users' advertising response in terms of their decision to register too. Dellaert and Kahn (1999) demonstrated that users' uncertainty about the waiting time generates negative feelings and may lead to exit from the site. We also documented this finding in the context of mobile advertising in terms of the number of page failures the user experienced. We find that page failures are negatively related to information search depth and breadth, as well as mobile phone users' decision to respond to the advertisement eventually.

Interestingly, our comparison of model estimation results show that the sensitivity of consumers' advertising response to the content-related variables were higher during the mobile advertising campaign's focal promotional event of the industry car show. Indeed, such advertising response sensitivities to informational and persuasive ad pages, as well as the amount of images and text characters viewed were the highest during the car show for consumers located in the capital city province where the most affluent consumers are located. Conceivably, affluent consumers visiting the car show and with intent to purchase new cars were more inclined to respond to the mobile advertising offer of car test drives, which may explain the heightened response sensitivities. For practitioners in high-tech and new media marketing, this result presents evidence of the capabilities of situational targeting, where targeted mobile advertising can be tailored not just to the habits and preferences of consumers but also to their location, place, time and even activity. Such potentials of leveraging mobile technologies for marketing are thus unmatched and unrivaled compared to web-based online advertising on the Internet. Marketing and mobile commerce practitioners can thus learn to capitalize on situational targeting and mobile marketing opportunities in focal advertising campaign events (e.g., industry car shows, major sporting events, cultural shows and festivals), in order to present timely and relevant mobile marketing interventions of promotional offers and product information to potential customers. In addition, our finding that the advertising response sensitivity to informational advertising during such focal advertising campaign events is higher compared to that of persuasive advertising content, suggest that the mobile marketer can more effectively use a rational (rather than emotional) appeal approach in advertising content design so as to increase advertising response rates.

Our conflicting results between aggregate-level and individual-level analyses suggest that marketing managers have to exercise caution when using aggregate-level statistics to make inferences about mobile advertising responses. Several factors explain these differences. For example, aggregate-level statistics do not account for unobserved differences between phone users. Those users who make more or deeper visits may browse differently and may respond differently to visit- and page-specific covariates. In addition, aggregate-level statistics provide only

a univariate analysis of search and ad response behavior and do not account for the impact of other relevant factors. Finally, our proposed individual-level models can account for the possible interdependence between ad response decisions and search behaviors that a simple aggregate-level analysis cannot.

## Conclusion

While this research has found several notable new findings in the context of mobile advertisement response and information search behaviors, we acknowledge some limitations of this research. First, we cannot identify the specific mobile phone users who were subjected to the location-aware context of the car show phone advertisements. With data on which phone users received the mobile ads under the roof of the car show site, we can then specify and estimate a more precise model of advertising response under location-aware effects. Second, we also acknowledge that our dependent variables for the Poisson count models for DEPTH and INFOCAT, are under-dispersed as their variances are smaller than their means. Hence, in planning to derive more accurate model parameter estimates, we intend to specify the search behavior models in terms of a more general Conway-Maxwell-Poisson model. Lastly, due to the lack of behavioral data, we did not consider user's underlying motivations, prior knowledge or brand perceptions in our research model. We would encourage mobile advertisers and marketing researchers to track this information in their available clickstream data and pursue further research in this area.

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