

The Double-Edged Effects of E-Commerce Cart Retargeting: Does Retargeting Too Early Backfire?

Jing Li¹, Xueming Luo², Xianghua Lu, and Takeshi Moriguchi

Abstract

Consumers often abandon e-commerce carts, so companies are shifting their online advertising budgets to immediate e-commerce cart retargeting (ECR). They presume that early reminder ads, relative to late ones, generate more click-throughs and web revisits. The authors develop a conceptual framework of the double-edged effects of ECR ads and empirically support it with a multistudy, multisetting design. Study 1 involves two field experiments on over 40,500 customers who are randomized to either receive an ECR ad via email and app channels (treatment) or not receive it (control) across different hourly blocks after cart abandonment. The authors find that customers who received an early ECR ad within 30 minutes to one hour after cart abandonment are less likely to make a purchase compared with the control. These findings reveal a causal negative incremental impact of immediate retargeting. In other words, delivering ECR ads too early can engender worse purchase rates than without delivering them, thus wasting online advertising budgets. By contrast, a late ECR ad received one to three days after cart abandonment has a positive incremental impact on customer purchases. In Study 2, another field experiment on 23,900 customers not only replicates the double-edged impact of ECR ads delivered by mobile short message service but also explores cart characteristics that amplify both the negative impact of early ECR ads and positive impact of late ECR ads. These findings offer novel insights into customer responses to online retargeted ads for researchers and managers alike.

Keywords

e-commerce, e-commerce cart retargeting, field experiment, online shopping cart abandonment, recency bump, timing

Online supplement: <https://doi.org/10.1177/0022242920959043>

Empowered by modern e-commerce technologies, many companies shift their online ad budgets to immediate retargeting. That is, companies actively engage in e-commerce cart retargeting (ECR), defined as a form of digital behavioral retargeting wherein online reminder ads are delivered to consumers who had carted products but left without purchasing. For instance, Amazon sends emails to inform customers of their carted products as a call-to-action reminder. Macy's regularly sends short mobile messages to remind customers who inspected and shortlisted products but did not buy (Garcia 2018). Indeed, the rate of cart abandonment in e-commerce is high: over 69% customers abandon carts online, and the lost sales amounted to over \$4.6 trillion in 2019.¹ These statistics suggest a colossal opportunity for firms to deploy ECR ads. It is

no wonder that Booking.com, Taobao, and Target deliver app notifications *within minutes* after customers abandon their shopping carts (Statista 2020).

Such prevalent industry practices of immediate retargeting are fueled by the "recency bump," wherein early reminder ads, relative to late ones, are premised to generate more click-throughs and web revisits (Prioleau 2013). At first glance, this recency bump makes sense because timing is critical. Ads may

Jing Li is Assistant Professor, School of Business, Nanjing University, China (email: jingli@nju.edu.cn). Xueming Luo is Charles Gilliland Chair Distinguished Professor of Marketing, Strategy, and MIS, and Founder/Director of the Global Center for Big Data in Mobile Analytics, Fox School of Business, Temple University, USA (email: xueming.luo@temple.edu). Xianghua Lu (corresponding author) is Professor of Information Systems, School of Management, Fudan University, China (email: lxhua@fudan.edu.cn). Takeshi Moriguchi is Professor of Marketing and Director of the Research Center of Consumer Behavior, Faculty of Commerce, Waseda University, Japan (email: moriguchi@waseda.jp).

¹ Baymard Institute reports that the highest abandonment rate is on travel sites (81.1%) and the lowest on fashion websites (69.1%) (<https://baymard.com/lists/cart-abandonment-rate>, accessed September 29, 2020).

Table 1. Literature Gap.

	Negative Effects of Ads	Positive Effects of Ads
Retargeting	Our article	Lambrecht and Tucker (2013); Bleier and Eisenbeiss (2015); Hoban and Bucklin (2015); Johnson, Lewis, and Nubbemeyer (2017); Sahni et al. (2019)
Nonretargeting	Aaker and Bruzzone (1985); Yoo and Kim (2005); Goldstein et al. (2014); Jenkins et al. (2016)	Bettman (1979); Alba and Chattopadhyay (1985); Tellis (1988); Lewis and Reiley (2014); Van Heerde et al. (2004, 2013)

have immediate recency: immediately retargeted reminders can be still relevant to user intent, consistent with the common wisdom of “striking while the iron is hot” (Moore 2013).

However, this recency bump can be misleading because it does not measure the *causal* impact of immediate retargeting. It simply measures the different consumer responses between early and late ECR ads (among the treatment group with all retargeted ads), yet the latter is not a valid comparison baseline for the former due to many alternative explanations (i.e., missing the control group without retargeted ads). For example, consumers who have recently filled an e-commerce cart may be intrinsically more likely to purchase than a consumer for whom it is longer ago because the latter consumer’s revealed hesitance may indicate a lack of purchase intent. If so, it is customer self-selection or other confounds, rather than ad recency, that causes the purchase bump. Thus, the valid comparison baseline of a randomized immediate control (without early ECR ads) with similar consumers is required to scientifically quantify the causal impact of immediate retargeting (with early ECR ads).²

Worse, immediate retargeting, relative to the control, may annoy customers and backfire. That is, as consumers’ memory has not faded yet, an early ECR ad sent within minutes after cart abandonment may be too pushy and may seem like the retailer is telling them what to do so that it can make more profits, which can trigger ad annoyance and thus lead consumers to purchase less (e.g., Aaker and Bruzzone 1985; Goldstein et al. 2014; Todri et al. 2020; Yoo and Kim 2005).

Against this backdrop, we develop a conceptual framework of the double-edged effects of ECR and empirically support it with a multistudy, multisetting design. Study 1 involves two field experiments on over 40,500 customers who are randomized to either receive an ECR ad via email and app channels (treatment) or not receive it (control) across different hourly blocks after cart abandonment. Results show that in the absence of ECR ads, customer purchases in the control group decayed over time, in line with the memory decay literature. However, relative to the early control, early ECR ads sent within 30 minutes to one hour after cart abandonment have a significantly negative incremental impact on customer

purchases. That is, the immediate retargeting is less effective than the randomized early control. In other words, the purchase rate with early ECR ads is even worse than that without them. By contrast, a late ECR ad sent 24–72 hours after cart abandonment has a positive incremental effect: late retargeting ads are more effective than the randomized late control. While the early retargeting treatment generates higher purchase rates than the late retargeting treatment, the early control has even higher purchase rates than the late control. Thus, the *causal* incremental impact is negative for early ECR but positive for late ECR, in support of the double-edged effects of ECR ads on customer purchases.

Study 2 involves another field experiment on over 23,900 customers from a different company with ECR ads delivered by mobile short message service (SMS). The results first replicate the double-edged impact of ECR ads. Furthermore, because customers have different reasons for cart abandonment, they may have quite different purchase responses to ECR ads. Leveraging the detailed clickstream data on shopping cart characteristics such as product quantity and product prices, we find that the double-edged effects of ECR ads are significantly moderated by these cart features. That is, both the negative impact of early ECR ads and the positive impact of late ECR ads are amplified when the products in the retargeted carts are of a larger quantity and at higher average prices.

Our findings contribute to the literature in three key ways. (1) Substantively, as Table 1 shows, we are among the first to reveal a causal adverse incremental impact of immediate retargeting on customer purchases. Advancing prior research on retargeting (Bleier and Eisenbeiss 2015; Johnson, Lewis, and Nubbemeyer 2017; Lambrecht and Tucker 2013; Sahni, Narayanan, and Kalyanam 2019), we not only conceptually differentiate early ECR from late ECR but also empirically demonstrate the double-edged effects of ECR ads and explore the moderated effects. (2) Methodologically speaking, we leverage a multistudy, multisetting research design with three large-scale randomized field experiments based on a fine-grained hourly level of retargeted ads and over 64,000 customers from different companies, which can rigorously test the causal incremental effects of early and late ECR ads and attain a higher generalizability of our findings. (3) Managerially, companies should not blindly follow the recency bump and shift their online ad budgets to immediate retargeting. Delivering the ECR ads too early can engender worse purchase rates

² For ease of exposition, we use “immediate retargeting” and “early ECR ads” interchangeably.

than without delivering them, thus wasting online advertising budgets. Prudent advertisers ought to match the timing of ECR ads with the retargeted cart features (for detailed research and managerial implications, see the “Discussion and Implications” section).

Literature and Hypotheses

Retargeting Literature

A recent stream of research in marketing has examined retargeting ads (Bleier and Eisenbeiss 2015; Johnson, Lewis, and Nubbemeyer 2017; Lambrecht and Tucker 2013; Sahni, Narayanan, and Kalyanam 2019). As Table 2 shows, researchers investigated with days or weeks after abandonment. That is, retargeted ads in prior studies were sent in the first few days or weeks after consumers left the focal website. In contrast, we examine with *hours*: our immediate retargeted ads are sent within 30 minutes to one hour after cart abandonment. Because the retargeting technology aims to “reduce the time lag between the consumers leaving the website and the beginning of the campaign to almost zero” (Sahni, Narayanan, and Kalyanam 2019, p. 401), a finer-grained time interval with hours (relative to days or weeks) after abandonment can more accurately capture the immediacy in retargeted reminder ads.

In addition, prior studies focused on ad personalization and compared different ad copies (Bleier and Eisenbeiss 2015; Lambrecht and Tucker 2013), whereas we put the spotlight on the causal effects of early and late retargeted ads. For both early and late ECR ads, we have the randomized early and late controls to scientifically identify the incremental effects. Recently, Sahni, Narayanan, and Kalyanam (2019) examined the frequency and timing of retargeted ads at daily level. They found that the effect of frequent retargeting ads is positive and largest for the first day within the first week. We extend their study by examining retargeted ads at hourly level, uncovering the potential annoyance effect of retargeted ads when delivered too early and exploring the moderating role of cart characteristics.

Furthermore, prior works rely on one channel—namely, internet banners—to deliver the retargeted ads (Bleier and Eisenbeiss 2015; Johnson, Lewis, and Nubbemeyer 2017; Lambrecht and Tucker 2013; Sahni, Narayanan, and Kalyanam 2019). By contrast, we use multiple channels: email, app, and mobile SMS, which enhances the generalizability of the findings across different customer touchpoints. Indeed, companies are now retargeting their customers via emails, app notifications, and SMS in an omnichannel manner (Garcia 2018; Statista 2020).

In addition, whereas most prior studies rely on website revisits and click-throughs (cf. Lambrecht and Tucker 2013), we use customer purchases to measure the outcome of retargeting. While web clicks and visits are important, they are upper-funnel metrics heralding sales revenues. By contrast, customer purchases are lower-funnel outcomes directly related to sales revenues for companies. Furthermore, advancing prior studies

on retargeting consumers who abandoning websites in general (some of them just browse around, while others inspect product details), we take a deeper dive into the consumer decision-making journey by focusing on retargeting consumers who have placed products in their carts but then left the online store. Extending Lambrecht and Tucker (2013) and other studies that documented the positive impact of retargeting sent in days after abandonment, we uncover the *negative* impact of immediate retargeted ads delivered within the first hour after cart abandonment.

Hypothesis Development

Figure 1 presents our conceptual framework of the negative incremental impact of early ECR ads and positive incremental impact of late ECR ads on customer purchases. In our framework, the timing of retargeted ads refers to the time lag (e.g., hours, days) between a consumer abandoning the online shopping cart without buying and the start of retargeting ad campaigns. Specifically, early ECR ads are delivered to customers within the first hour after cart abandonment,³ whereas late ECR ads are delivered at least one day after cart abandonment.

As Figure 1 illustrates, in the absence of ECR ads, customer purchase rates decrease over time with a downward trend in the control group. This is because, according to the memory decay theory (Brown 1958; Mueller et al. 2003; Thorndike 1914), after consumers abandon the shopping carts, their memory of the products fades over time; thus, their purchase probability of the carted products dwindles as the time elapses after abandonment. Ad reminders then can be leveraged to rekindle this memory, as the ability of ads to remind consumers is fairly well established (Alba and Chattopadhyay 1985; Bettman 1979).

However, the *incremental* effects of early and late ECRS ads, over the early and late control, are not straightforward. Specifically, our conceptual framework posits that early ECR ads, relative to the early control, have a negative incremental impact on customer purchases, whereas late ECR ads, relative to the late control, have a positive incremental impact. This contrasting pattern results from the two driving forces: negative ad annoyance and positive ad reminder.

³ Our definition of early ECR ads within one hour after abandonment is in line with industry practices, where immediate retargeting means sending ads within one hour after consumers leave the website in retailing, fashion, travel, and other industries (Garcia 2018; Statista 2020). We do not consider time over a week in our late ECR ads because if a very long time has elapsed after cart abandonment, consumer memory can be totally lost and is notoriously difficult to restore (Kelley and Gorham 1988). Indeed, research has found that retargeted ads sent one week after abandonment are ineffective in generating incremental purchases (Moriguchi, Xiong, and Luo 2016). We return to this point in the “Discussion and Implications” section. Furthermore, because consumers rarely put cars in shopping carts online (most people would still need to test drive the cars in the physical world offline), immediate retargeting is more applicable to online purchases in business sectors such as retailing and fashion.

Table 2. A Comparison of Prior Studies on Retargeted Ads.

Article	Timing Interval	IV	Channel	DV	Moderators	Key Findings
Lambrecht and Tucker (2013)	Days after abandonment	Ad content	Banner	Customer purchase	Browsing review website	Dynamic retargeted ads (relative to generic ads) have a positive effect for consumers who browsed a review website.
Bleier and Eisenbeiss (2015)	Weeks after abandonment	Ad content	Banner	Click-throughs	—	Retargeted personalization ads (relative to nonpersonalization ads) have a positive effect, but quickly lose effectiveness as time (in days) passes since that last visit.
Hoban and Bucklin (2015)	Days after abandonment	Ad content	Banner	Web revisit	Pre-experiment stages	Retargeted ads (relative to charity ads) have a positive effect for visitors except those without creating the account.
Johnson, Lewis, and Nubbemeyer (2017)	Days after abandonment	Ad content	Banner	Website visit	—	Retargeted ads (relative to ghost ads) have a positive effect.
Sahni, Narayanan, and Kalyanam (2019)	Days after abandonment	Ad frequency and timing	Banner	Web revisit	—	Retargeted ads (relative to control) have a positive effect and are most effective for the first day of the first week.
Our study	Hours after abandonment	Early and late ECR ads	Email, app, mobile SMS	Customer purchase	Cart features such as product quantity and prices	Retargeted ads have double-edged effects: early ECR ads within 30 minutes to one hour (relative to the early control) have a negative effect, while late ECR ads in one to three days (relative to the late control) have a positive effect.

Notes: IV = independent variable, DV = dependent variable.

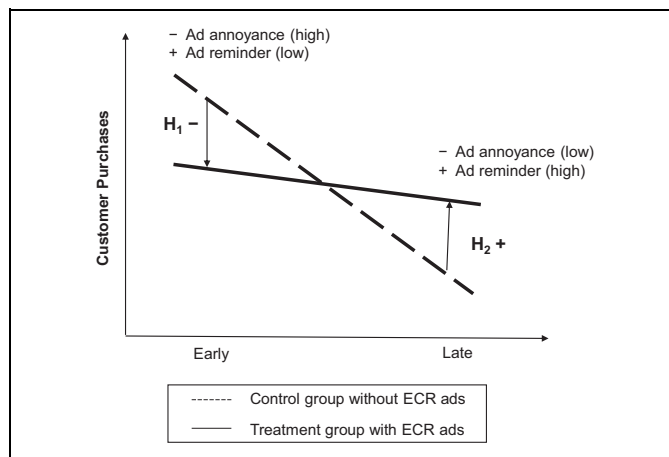


Figure 1. Conceptual framework.

Notes: Early = within the first hour after cart abandonment; Late = one to three days after cart abandonment. This framework is empirically supported by our multisetting research design with three large-scale randomized field experiments on over 64,000 customers retargeted by email, app, and SMS ads of different companies.

On the one hand, ads may annoy consumers. Prior studies have pointed out some adverse effects of ads. For example, Yoo and Kim (2005) note that fast animation banner ads can annoy customers and result in negative attitudes toward the advertisers. Others find that consumers are irritated when exposed to commercial ads that are too strident and frequent (Aaker and Bruzzone 1985; Burke and Edell 1986; Pokrywczynski and Crowley 1993). By and large, the literature suggests that ad repetition may annoy consumers and negatively affect the purchase funnel (Todri et al. 2020) because it interrupts consumer goals, such as surfing the internet (Goldstein et al. 2014) and accomplishing a task online (Jenkins et al. 2016). Extending this stream of research that frequent ads engender consumer annoyance, we note that the one-time ECR ad may also annoy consumers when it is delivered too early.⁴

On the other hand, ads may remind consumers. Advertising can allow brands to signal superior quality over rivals and commendably remind consumers about their products (Bagwell 2007; Lewis and Reiley 2014; Nelson 1974; Van Heerde, Leeflang, and Wittink 2004). Viewing reminder ads can rekindle memories⁵ associated with the advertised products and thus help consumers recall the focal brands (Alba and

Chattopadhyay 1985; Bettman 1979; Van der Lans, Pieters, and Wedel 2008). In other words, advertising can persuade consumers and enable advertisers to win in the marketplace (i.e., through output interference and displacement of other ads; see Leenheer et al. 2007; Sahni, Narayanan, and Kalyanam 2019; Van Heerde et al. 2013). These two competing forces lead to the differential effects between early and late ECR ads, as we elaborate next.

Negative incremental effects of early ECR ads. When retargeted ads are deployed as soon as customers abandon their shopping carts, their memories have not faded yet, so there is little benefit from rekindling memory (i.e., low positive ad reminder effect; Tellis 1988; Van Heerde et al. 2004, 2013). However, consumers may feel a high level of the negative ad annoyance effect. This is because as consumers' memories have not wilted yet, early ECR ads (relative to a control without early ECR ads) sent within minutes after cart abandonment may be too pushy and seem like the retailer is telling them what to do so that it can make more profits. This can trigger ad annoyance and thus negatively influence customer purchases. In other words, very early retargeting comes across as too pushy, almost like a too-insistent salesperson who desperately wants customers to buy but actually annoys them and ends up with fewer sales (Babin et al. 1995; Gillis et al. 1998; Martin 2017). By contrast, a control group without early ECR ads has the same time elapse after cart abandonment but no such negative ad annoyance because it has no reminder ads served. Thus, to the extent that early ECR ads (relative to a control without early ECR ads) lead to a high level of negative ad annoyance but low positive ad reminder, early ECR ads likely backfire with a negative incremental impact on customer purchases.

H₁: Relative to the randomized early control, early ECR ads backfire with a negative incremental impact on customer purchases.

Positive incremental effects of late ECR ads. In the case of late ECR ads, consumer memory has faded extensively, and the reminders help overcome this. That is, as the memory wanes, late ECR ads (relative to a control group without late ECR ads) can rekindle the rusty memory of the carted products, thus leading to a high positive ad reminder effect (Alba and Chattopadhyay 1985; Bettman 1979; Leenheer et al. 2007). Furthermore, because of the extensive memory loss, late ECR ads may not be too pushy to consumers and thus trigger little ad annoyance. The late control without late ECR ads also has the same time elapse after cart abandonment but no such positive ad reminder effect, because no ads are served. Thus, to the extent that late ECR ads (relative to a control group without late ECR ads) lead to a high positive ad reminder effect but low negative ad annoyance, late ECR ads likely have a positive incremental impact on customer purchases.

⁴ As we discuss subsequently, the one-time exposure to an immediate ECR ad can stimulate annoyance because very early retargeting, when consumer memory has not faded yet, comes across as too pushy, akin to a too-insistent salesperson. Indeed, for preliminary evidence that early ECR ads lead to ad annoyance among consumers, which then reduces their purchase intention, see Web Appendix A.

⁵ Prior psychology literature has noted that human memory decays over time (i.e., forgetting) (Thorndike 1914). Forgetting is a function of age, perceptual speed, and central executive functioning (Fisk and Warr 1998), and different people have different memory decay patterns. While some still have a fresh memory after a long time, others forget quickly; thus, unobserved heterogeneity exists across consumers. Consequently, we conducted field experiments to account for such unobserved heterogeneity by randomizing

consumers who have the same time elapse after cart abandonment into treatment and control groups.

H₂: Relative to the randomized late control, late ECR ads have a positive incremental impact on customer purchases.

Study 1

Data and Design

A major Japanese online fashion retailer (that wishes to remain anonymous) cooperated with us to conduct a set of field experiments. The retailer sells fashion products such as clothing, shoes, and handbags, in addition to household items. The retailer targets a wide variety of customers, ranging from children to older adults, and its core customers are men and women aged 20–45 years. The retailer provided us data on customer demographics, such as gender, age, area of residence, and customer tenure, in addition to purchase history, clickstream browsing, and shopping cart data. The time window of the data collected covers three periods: six months before the experiments, during the experiments, and one month after the experiments. From September 21 to October 25, 2016, the retailer conducted two randomized field experiments.

The retailer has two major communication channels: email and a messaging app called Line (similar to WhatsApp's dominance in the United States, Line is the most popular mobile messaging app in Japan). Thus, in Experiment 1, the retargeting message was sent via email to a random sample of 33,234 customers. It is worth noting that email is also the most popular retargeting channel in the United States. In Experiment 2, the retargeting message was sent via Line to a different random sample of 7,314 customers. This smaller sample size reflects the fact that the retailer has many fewer users using its mobile app, which registers users for receiving updates from the retailer on Line. Because customers self-select the email or mobile app channel, customers updated through Line and those updated through email differed in their patterns of shopping behavior. To account for this difference, we conducted two separate experiments to ensure the generalizability of our results.

The research design is similar in the two experiments: the company randomly assigned its customers into 16 groups (8 hour blocks \times 2 retargeting conditions). After extensive consultation among the research team who ensured experimental rigor and company executives who oversaw the experimental execution, the retargeted customers in the treatment groups were sent reminder messages in the eight blocks: .5, 1, 3, 6, 9, 12, 24, and 72 hours after cart abandonment. The retailer also had randomized control groups—customers who were not retargeted and did not receive such messages—for each of the eight blocks. Thus, each of the eight retargeting timings had a unique pair of treatment and control groups, and each pair has the same amount of time elapsed after cart abandonment. This is a crucial feature of our experimental design because it enables us to identify the causal incremental effect of the specific hour block while estimating the whole data set simultaneously. In other words, the randomized control conditions empower us to reveal the causal effects of ECR while accounting for many alternative explanations such as the general loss

of interests in the carted product over time (e.g., customers have bought that or a different product at another store), seasonality, and competition effects in the marketplace.

The retailer's retargeting ads include product information (brand name, category name, and price). It sent the retargeting message to customers who had abandoned only one product in their shopping cart. For these customers, the retargeted product in the message is the same as the abandoned product; this allows them to more precisely identify the effects of the product-specific retargeting message.⁶ Web Appendix B, Panel A, presents some examples of the retargeting message, which contains no new information or price incentives; they are simply reminders about the carted product that was not purchased prior to the experiment (Sahni, Narayanan, and Kalyanam 2019).

As for the experimental execution, if the retailer observed customers to have abandoned the cart and forgone purchasing the product for half an hour, for example, these customers were randomly assigned into either the retargeting treatment or control group. Thus, customers were randomly assigned into all other experimental cells in both Experiments 1 and 2, allowing us to estimate the causal effects. To avoid customer complaints of receiving messages late in the night, the retailer has the policy of not sending messages to customers between 10:00 P.M. and 9:00 A.M. Therefore, some messages could not be sent to subjects in the treatment group who had abandoned the cart late in the day. Our results are robust to additional analyses accounting for bias from this messaging policy.⁷ The analyses included propensity score matching, which was used to balance the subjects of the treatment and control groups for each of the eight timings. The variables in propensity score matching were age, gender, area of residence, customer tenure, total money spent (in JPY) in the past six months, number of products purchased in the past six months, and dummy variables corresponding to the time at which the carts were abandoned.

The characteristics of final subjects in the treatment and control groups are summarized in Web Appendixes C and D. According to the data presented in these appendices, the treatment and control groups did not significantly differ with respect to demographics and past purchases for each of the eight hour blocks. Web Appendix B, Panel B indicates that the distribution of the product categories was highly similar across the treatment and control groups. Therefore, the data passed the randomization checks.

⁶ Among the retailer's customers who abandoned carts, approximately 90% abandoned just one item in their shopping carts.

⁷ This policy might bias our results, as it would not affect the control groups but would affect the treatment groups across the hour blocks. Thus, it may be informative to conduct additional analyses with subjects that abandoned carts between 9 A.M. and 12:59 P.M. because they could be assigned to all hour blocks except the 12 hours. We checked the robustness with these subjects and found consistent results (results available on request).

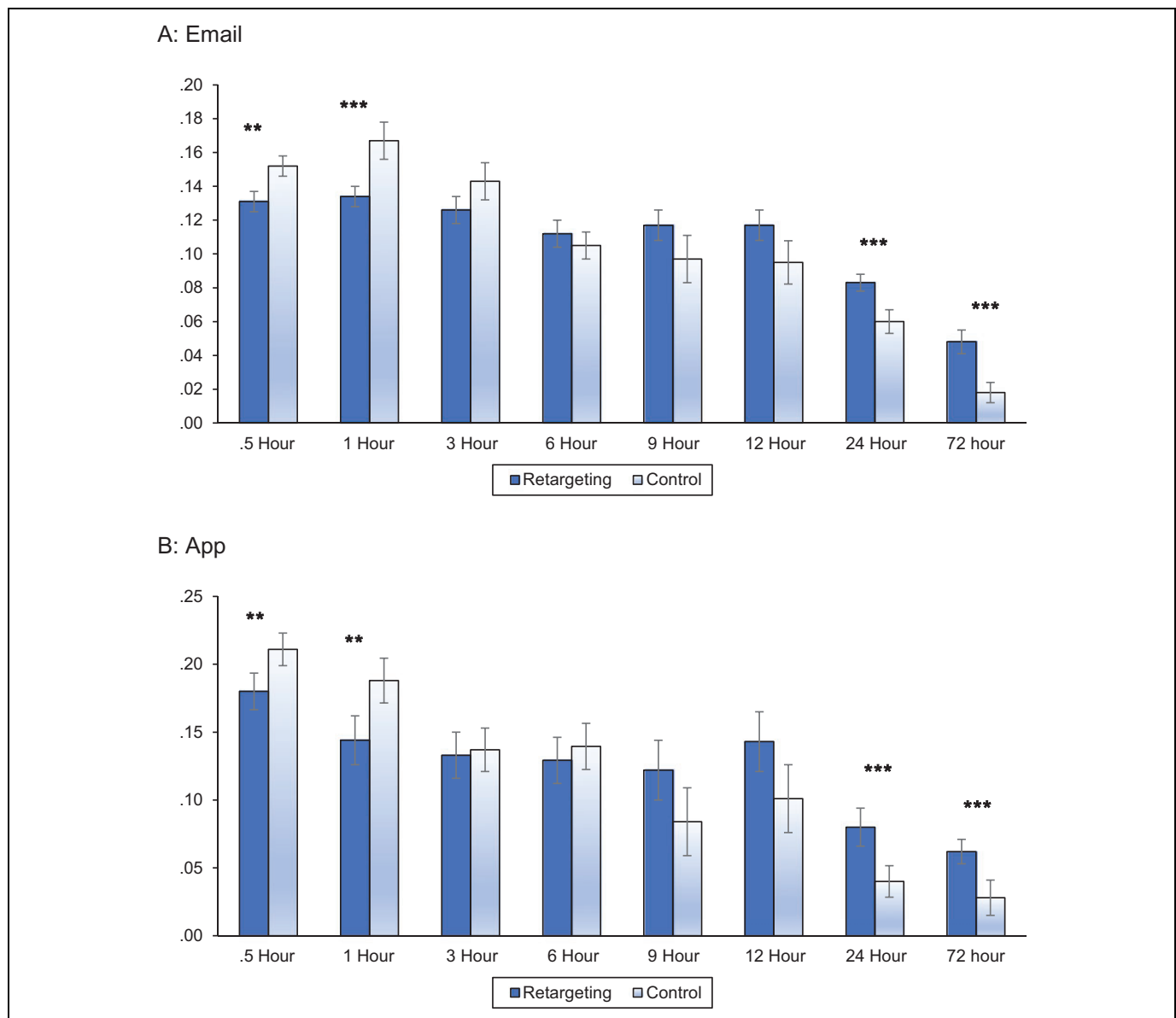


Figure 2. Model-free evidence for the purchase rates of treatment and control (retargeting channels: email and app).

Notes: Error bars here represent ± 1 standard error.

Model-Free Results

Figure 2, Panel A, illustrates the comparison of the purchase rates between the retargeted group (marked by dark bars) and control group (marked by light bars) for the various timings in Experiment 1, along with their 95% confidence intervals. The purchases are measured within one month after sending the retargeting ads to the subjects. In other words, the purchase window is not constrained to the hour block of the retargeting message, but rather one month after because it can take a while before the purchase happens after the message has been received.

Consistent with the theory of organic decaying memory (e.g., Baddeley et al. 1975; Brown 1958; Thorndike 1914), the control

group exhibited a generally downward trend in purchase rates, attributable to the fading memory of the carted products over time when not retargeted. In other words, for the control group without retargeting ads, the organic purchase rate decreases over time, with the highest at .5 hours and 1 hour after cart abandonment, and the lowest at 72 hours after cart abandonment.

Recency Bump or Adverse Impact of Immediate Retargeting?

For the treatment groups, the ad for early ECR (.5 hour or 1 hour) had the highest purchase rate of 13.1%, greater than the other hour blocks ads for late ECR. At first glance, in the

absence of a comparison with the control group, one might erroneously conclude that early ECR is more effective and beneficial than late ECR, as was done in the recency bump (Moore 2013; Prioleau 2013). However, purchase rate comparisons between immediate and late retargeting yield invalid comparisons because user self-selection is not controlled for—users receiving the later message are likely to have not purchased the product for a longer time after abandoning the cart. In other words, consumers who receive an early ECR ad (relative to a late ECR ad) may have higher purchase intent and buy more even without the ad. Luckily, we have the randomized controls (where no retargeting was involved but with the same amount of time elapsed after abandonment), which account for user self-selection such as consumer memory decay over time, lost interests in the products, competition, seasonality, or any other observed or unobserved confounds. Thus, comparisons with these randomized controls can effectively parse these confounds from the retargeting timing effects. That is, we can use the *incremental effectiveness*, by comparing retargeted users with the randomized control within each of the specific hour block groups, to account for this self-selection bias. Such comparison reveals that in the control group, the purchase rate was also highest for the half-hour and one-hour blocks, even higher than that in their respective treatment group. Thus, early ECR within half an hour and one hour had significantly negative effects on purchase rates relative to their respective control groups (.5 hour: 13.1% vs. 15.2%, $p = .012$; 1 hour: 13.4% vs. 16.7%, $p < .01$). That is, purchase rates with the early ECR ad are even significantly lower than those *without* it, thus wasting online ad budgets. Consequently, simple absolute purchases are not causal and can be misleading when used as a measure of retargeting success. By using the *relative purchases incremental* to the early control, we reveal that early ECR ads can actually backfire. That is, immediate retargeting after cart abandonment has a causal adverse impact on customer purchases. Therefore, H_1 is initially supported by such model-free evidence.

According to Figure 2, Panel A, messages sent in the hour blocks of 3, 6, and 9 hours after cart abandonment have no significant effects relative to the control baseline (3 hours: 12.6% vs. 14.3%, $p = .114$; 6 hours: 11.2% vs. 10.4%, $p = .523$; 9 hours: 11.7% vs. 9.7%, $p = .142$). Such zero incremental effect of middle hour blocks makes sense because of the trade-off between the negative ad annoyance and positive ad reminder effect (i.e., these two forces may cancel each other, thus leading to insignificant effects in the middle hour blocks). However, late ECR ads at 24 hours or 72 hours had significantly positive effects on incremental purchases (24 hours: 8.3% vs. 6.0%, $p < .01$; 72 hours: 4.8% vs. 1.8%, $p < .01$) over the late control baseline. Thus, H_2 is initially supported as well.

Figure 2, Panel B, presents the purchase rates across the hour blocks in the app channel-based retargeting message. Again, early ECR had negative effects on incremental purchase rates (half-hour: 18.0% vs. 21.1%, $p = .098$; one hour: 14.4%

vs. 18.8%, $p = .074$). The treatments and controls in the 3-, 6-, 9-, and 12-hour blocks did not significantly differ (3 hours: 13.3% vs. 13.7%, $p = .842$; 6 hours: 12.9% vs. 14.0%, $p = .673$; 9 hours: 12.2% vs. 8.4%, $p = .060$; 12 hours: 14.4% vs. 10.2%, $p = .099$). Nevertheless, late ECR at 24 and 72 hours had significantly positive effects on incremental purchase rates (24 hours: 8.0% vs. 4.0%, $p < .01$; 72 hours: 6.2% vs. 2.8%, $p = .037$), replicating the pattern observed for the email channel retargeting message. Thus, these initial model-free results support the double-edged effects of ECR: whereas early ECR has a negative incremental impact, late ECR has a positive incremental impact on customer purchases.

Model and Results

We formally test H_1 and H_2 by using a moderated logit regression model as follows.

$$d_{ij} = \begin{cases} 1, & \text{if user } i \text{ in hour block } j \text{ makes a purchase within} \\ & \text{the next month} \\ 0, & \text{otherwise.} \end{cases} \quad (1)$$

This purchasing decision between 1 and 0 is based on a latent-utility function U . Specifically, the differences in purchase decision between the retargeting (treatment) and control groups are moderated by the various hour blocks.

$$U_{ij} = \gamma_0 + \sum_{j \in J} \gamma_1^j \text{Retargeting}_{ij} \times \text{Hour}_{ij} + \gamma_2 \text{Retargeting}_{ij} + \sum_{j \in J} \gamma_3^j \text{Hour}_{ij} + \gamma_k W_{ij} + \epsilon_{ij} \quad (j = 1, 2, \dots, J \text{ hour blocks}), \quad (2)$$

where Retargeting_{ij} is the treatment variable (1 and 0 represent the retargeting treatment and control, respectively), and Hour_{ij} denotes the hour blocks (.5, 1, 3, 6, 9, 12, 24 and 72 hours, and the middle-range block of 6 hours is the baseline). W_{ij} is a vector of covariates (including the customer's gender, age, membership, area of residence, tenure, past message received, past shopping frequency, past shopping expenditure, day fixed effects, and time-of-day fixed effects).

Table 3 reports the results. Compared with the middle hour block, the early and late hour blocks had significantly positive and negative effects, respectively, on purchase rates (all $ps < .01$). That is, similar to previous model-free results and consistent with the memory decay theory (e.g., Baddeley et al. 1975; Brown 1958; Thorndike 1914), the purchase rate generally had an organic downward trend over time if there were no retargeting messages.

Our hypotheses pertain to the interactions between hour block and the retargeting treatment. The results in Table 3 consistently suggest that the interaction effects between early hour blocks (.5 and 1 hours) and retargeting on incremental purchase rate are significantly negative in both the email and app channels (most $p < .05$). As such, these results

Table 3. Regression Results on Incremental Retargeting Effects with Hourly Block Interactions.

	Email Channel	Email Channel	App Channel	App Channel
.5 h × Retargeting (H ₁ : −)	−.321** (.136)	−.324** (.136)	−.307** (.142)	−.315** (.142)
1 h × Retargeting (H ₁ : −)	−.336** (.132)	−.339** (.132)	−.232* (.147)	−.248* (.148)
3 h × Retargeting	−.025 (.049)	−.027 (.069)	.0490 (.290)	.0380 (.291)
9 h × Retargeting	.132 (.182)	.125 (.183)	.243 (.465)	.225 (.466)
12 h × Retargeting	.166 (.159)	.167 (.159)	.482 (.319)	.472 (.319)
24 h × Retargeting (H ₂ : +)	.451** (.191)	.454** (.199)	.824** (.341)	.808** (.342)
72 h × Retargeting (H ₂ : +)	.950*** (.350)	.954*** (.352)	.923** (.461)	.912** (.461)
.5 h	.527*** (.0963)	.506*** (.0965)	.502*** (.168)	.497*** (.168)
1 h	.441*** (.0934)	.405*** (.0936)	.356** (.170)	.369** (.180)
3 h	.358*** (.105)	.341*** (.105)	−.0195 (.203)	.000327 (.203)
9 h	−.0801 (.133)	−.0991 (.133)	−.211 (.275)	−.203 (.276)
12 h	−.110 (.116)	−.131 (.116)	−.358 (.233)	−.348 (.233)
24 h	−.778*** (.137)	−.767*** (.137)	−1.363*** (.262)	−1.349*** (.263)
72 h	−1.868*** (.241)	−1.839*** (.241)	−1.730*** (.369)	−1.698*** (.369)
(Baseline: 6 h)				
Retargeting	.0741	.0723	−.0889	−.0782
(Baseline: control)	(.116)	(.116)	(.211)	(.211)
Covariates	Yes	Yes	Yes	Yes
Product category effects	No	Yes	No	Yes
Time effects	No	Yes	No	Yes
Constant	−2.146*** (.0833)	−2.136*** (.105)	−1.819*** (.147)	−1.950*** (.219)
Pseudo R ²	.0211	.0269	.0377	.0407
N	33,234	33,234	7,314	7,314

* $p < .1$.** $p < .05$.*** $p < .01$.

Notes: Robust standard errors in parentheses.

support the negative effects of early ECR in H₁. In addition, the interaction effects between late hour blocks (24 and 72 hours) and retargeting on incremental purchase rate are significantly positive in both email and app channels (at least $p < .05$), thus supporting the positive effects of late ECR in H₂.⁸

Moreover, Figure 3 plots the model-based incremental impact of retargeting (coefficients in Table 3), which visualizes that early ECR ads (in the .5- and 1-hour blocks) have a

significantly negative incremental impact, while late ECR ads (in the 24- and 72-hour blocks) have a significantly positive incremental impact on customer purchases for both the email channel in Experiment 1 and app channel in Experiment 2.

Furthermore, to more directly test the effects of early and late ECR ads, we combine the .5- and 1-hour blocks into the “Early” group; the 3-, 6-, 9-, and 12-hour blocks into the “Middle” group; and the 24- and 72-hour blocks in the “Late” group. (Web Appendix E visualizes the model-free evidence.) Then, we run the regression models and report the results in Table 4. Again, the interaction effects between Early and Retargeting on incremental purchase rates are significantly negative in both the email and app channels (at least $p < .05$), in support of H₁. Furthermore, the interaction effects between Late and Retargeting on

⁸ We have also estimated the marginal effects for the logit model (where we hold all other variables at the mean level; Norton et al. 2004) and found consistent results. Results are available on request.

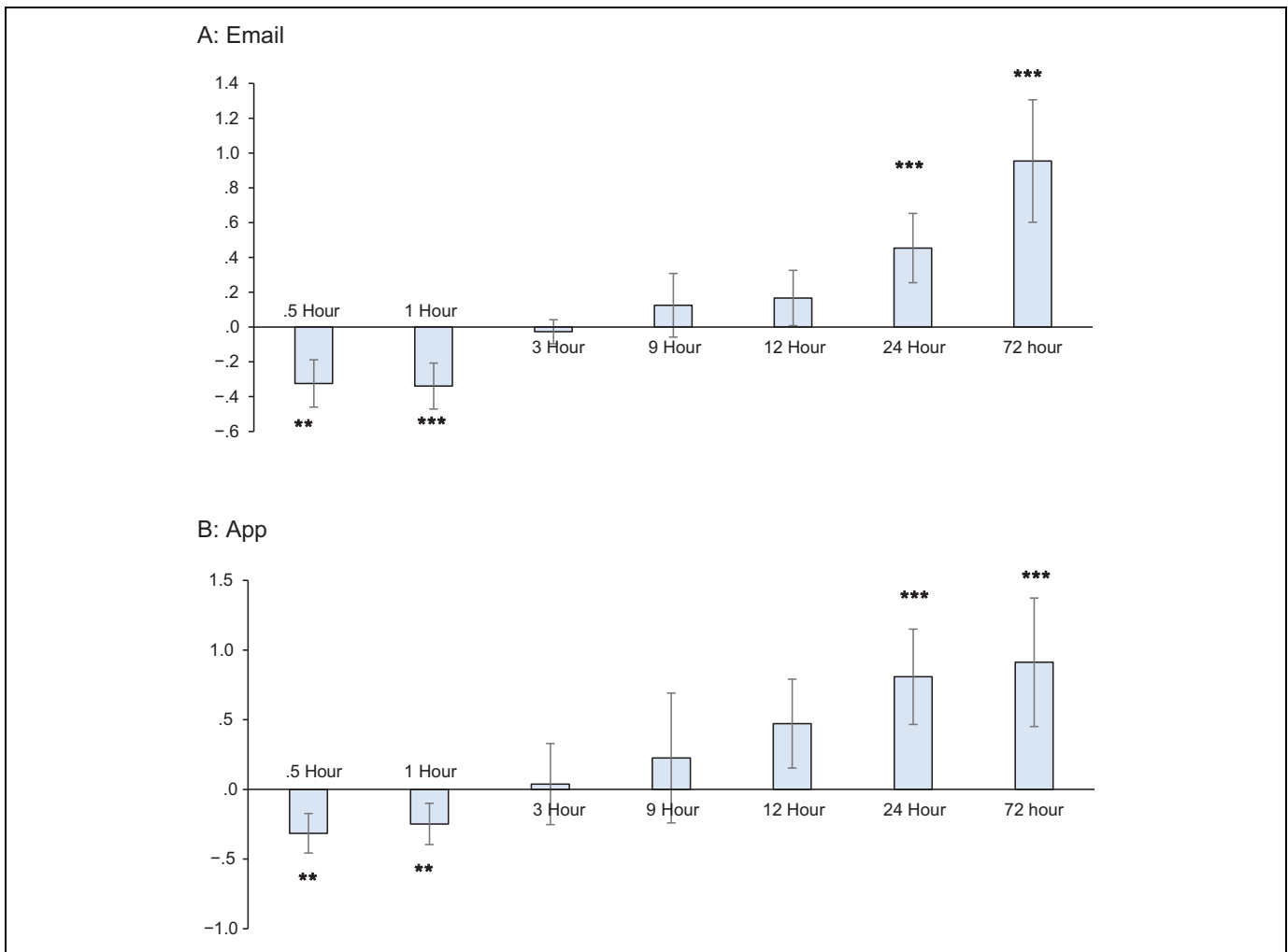


Figure 3. Model-based evidence for the incremental purchases of treatment over control (retargeting channels: email and app).

Notes: These figures plot the coefficients and the robust standard errors in Columns 2 and 4 of Table 3. Baseline is six hours after cart abandonment and without retargeted ads.

incremental purchase rates are significantly positive in both the email and app channels (at least $p < .05$), in support of H_2 .

Overall, these model-free and model-based results provide consistent empirical evidence for H_1 and H_2 and thus strongly support the double-edged effects of ECR ads (the negative incremental impact of early ECR and positive incremental impact of late ECR) on customer purchases across Experiments 1 and 2.

Study 2

The aim of Study 2 is twofold. First, it aims to replicate the double-edged effects of H_1 and H_2 with a different company to improve the generalizability of the findings. Here we engaged a different retailer and used a different channel of SMS to deliver the ECR ads. Our anonymous corporate partner in Study 2 is a category killer (focusing on maternal and baby products) in China. Considering that our partner in Study 1 was a fashion retailer in Japan, our research settings cover more than one

country and two different companies with multiple product lines. Second, Study 2 empirically explores the moderated effects for the double-edged effects of ECR. Cart abandonment in Study 2 involves multiple products left without purchasing. This setting enables us to effectively identify cart characteristics such as the quantity and prices of products left in the retargeted carts to explore the moderated effects, in addition to replicating the double-edged effects of ECR.

Data and Design

Study 2 involves a retargeting message delivered via SMS, thus complementing Study 1's focus on the email and mobile app channels. Compared with email and the mobile messaging app, SMS delivery is displayed as a banner on personal devices (Lai 2004), and the probability that people receive and read the SMS message might be higher (Luo et al. 2014). In addition, SMS promotions are gaining popularity among companies such as Macy's and Target in the United States. Our retail partner in

Table 4. Regression Results on Incremental Retargeting Effects with Hourly Block Interactions.

	Email Channel	Email Channel	App Channel	App Channel
Early \times Retargeting (H_1 : $-$)	-.284*** (.0725)	-.285*** (.0727)	-.369** (.151)	-.370** (.151)
Late \times Retargeting H_2 : $+$.577*** (.134)	.582*** (.134)	.630** (.251)	.624** (.252)
Early	.408*** (.0508)	.393*** (.0509)	.653*** (.106)	.643*** (.107)
Late	-1.167*** (.105)	-1.134*** (.105)	-1.286*** (.201)	-1.276*** (.201)
Retargeting	.0596 (.0553)	.0555 (.0554)	.135 (.114)	.137 (.114)
(Baseline: Middle)				
Covariates	YES	YES	YES	YES
Product Category Effects	NO	YES	NO	YES
Time Effects	NO	YES	NO	YES
Constant	-2.063*** (.0395)	-2.073*** (.0753)	-2.017*** (.0824)	-2.146*** (.180)
Pseudo R^2	.0182	.0242	.0348	.0379
N	33,234	33,218	7,314	7,313

* $p < .1$.** $p < .05$.*** $p < .01$.

Notes: Robust standard errors in parentheses. Early = the .5- and 1-hour blocks; Middle = the 3-, 6-, 9-, and 12-hour blocks; Late = the 24- and 72-hour blocks.

Study 2 is similar to Babies R Us in the United States. The retailer sells a wide variety of maternal and infant supplies, including diapers, infant formula, equipment, toys, baby clothes, and household items. Its customers are primarily young parents with children under four years old. Our retailer partner sent targeted message through SMS to its customers after they had abandoned their carts online (this constituted the triggering event). The experiment involved a random sample of 23,914 customers and was conducted from March 6 to March 9, 2017. To ensure generalizability, the experimental designs of Study 2 were similar to those in Study 1. During our experiment window, if consumers left a new product in the shopping cart, they entered our sample pool and would receive the retargeting message treatment in hours after cart abandonment (or not receive any message if he or she was in the control group). In addition to consumers' demographics and past purchase information, we collected the shopping cart characteristics based on the clickstream data.

The company randomly assigned the customers into eight experiment groups (4 hour blocks \times 2 retargeting conditions). The hour blocks were 1, 3, 9, and 24 hours after the first shopping cart abandonment during our time window. Given time and resource limitations, other hour blocks could not be tested. The company also determined these four hour blocks to be the most common in the local market. As per the standard practice in Chinese e-commerce, the retailer had the mobile numbers of its customers. Their customers are required to provide their mobile numbers when registering as a member on the retailer's website, and this number is used to authenticate their membership. As in Study 1, the experiment in Study 2 had a between-subjects design, where consumers neither were in

multiple experimental conditions nor received more than one SMS message. All subjects were customers who made at least one purchase in the six-month period prior to the experiment. Web Appendix B, Panel C, presents an example of the SMS retargeting treatment message.

An extension in Study 2 is the execution of experiment randomization. In Study 1, customers were randomly assigned to either the retargeting treatment or control groups within each hour block (e.g., 1 hour or 24 hours after cart abandonment), thus allowing for estimating causal effects within each hour block for early and late ECR ads. However, Study 1 did not randomize the hour blocks ex ante by using an intent-to-treat (ITT) approach (Gerber and Green 2012; Johnson, Lewis, and Nubbemeyer 2017). Thus, across the hour blocks, customers might be different due to a self-selection bias (i.e., customers who received ECR ads 24 hours later may be intrinsically less likely to buy the product than those 1 hour later). To further account for this potential bias, Study 2 also randomizes the hour blocks, besides the random assignment of treatment or control groups. More specifically, customers are randomly assigned into the treatment and control across all hour blocks ex ante by using the ITT approach (Gerber and Green 2012; Johnson, Lewis, and Nubbemeyer 2017; Lambrecht and Tucker 2013).⁹ This ITT execution ensures that all individuals are the same ex ante, regardless whether they received the early or late ECR in a specific hour block. In other words, such randomization ensures the unbiasedness of the incremental effects of retargeting (i.e., differences between the ECR and control groups) across all

⁹ Note that ITT design may have an issue of compliance, where treatment is only administrated to individuals who have not dropped out (Gerber and Green 2012).

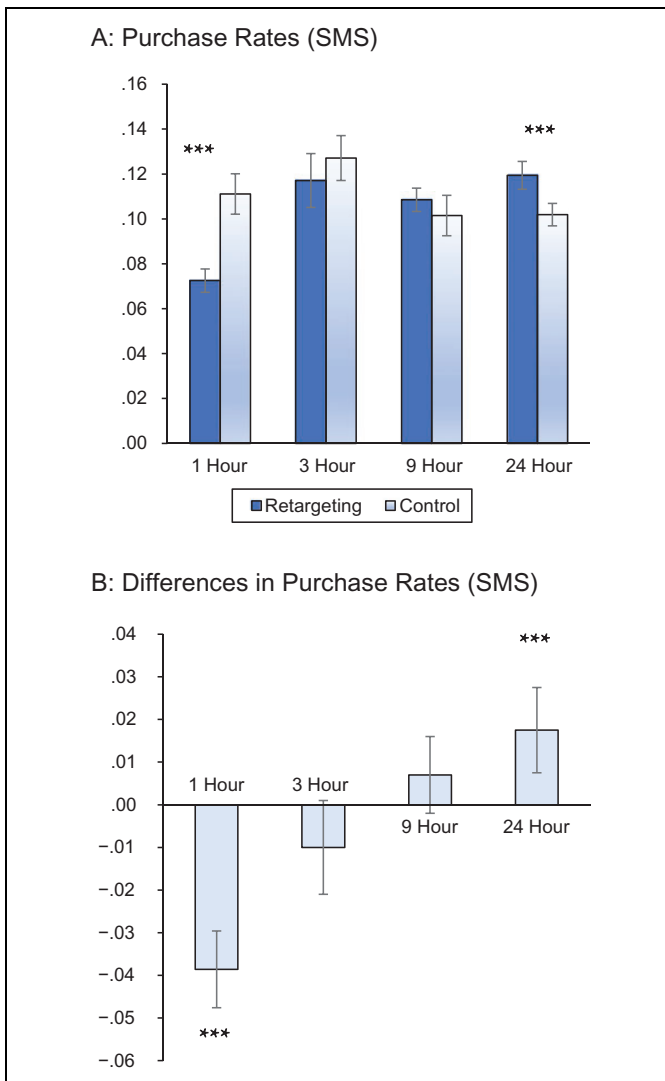


Figure 4. Model-free evidence for the differences in purchase rates between treatment and control (retargeting channel: SMS).

Notes: Error bars here represent ± 1 standard error.

hour blocks. Thus, such ITT estimates allow for not only identifying the causal effects of the early and late ECR ads relative to early and late controls but also directly comparing the causal incremental effect of early ECR with that of late ECR.

The data time window here was six months before the experiment and one week after the experiment. Summary statistics of all variables and randomization check results are reported in the Web Appendix F. The treatment and control groups did not significantly differ with respect to demographics and past purchase characteristics; therefore, the data set passed randomization checks.

Model-Free Results

Figure 4, Panel A, presents the purchase rates for all hour blocks. We use the purchase rate within a week after sending the retargeting ads to the subjects as our outcome variable.

Table 5. Regression Results on Incremental Retargeting Effects with Hourly Block Interactions (SMS Channel).

	Purchase Incidence Logit	Purchase Amount Tobit
1 h \times Retargeting	-.545***	-11.01***
(H ₁ : -)	(.130)	(2.921)
3 h \times Retargeting	-.269	-8.794
	(.278)	(6.047)
24 h \times Retargeting	.104**	1.237**
(H ₂ : +)	(.045)	(.613)
1 h	.351**	3.360***
	(.079)	(.866)
3 h	.203***	2.342***
	(.073)	(.762)
24 h	.0037	.159
	(.089)	(2.045)
(Baseline: 9 h)		
Treatment	-.0743	4.588**
(Baseline: control)	(.0923)	(2.159)
Covariates	Yes	Yes
Product category effects	Yes	Yes
Time effects	Yes	Yes
Constant	-2.180***	16.78***
	(.0570)	(1.310)
Pseudo R ² /R ²	.039	.016
N	23,914	23,914

* $p < .1$.

** $p < .05$.

*** $p < .01$.

Notes: Robust standard errors in parentheses.

Similar to Study 1, for early ECR (1 hour), the treatment group (marked by dark bars) had a significantly smaller purchase rate than its control group counterpart (marked by gray bars). Furthermore, Figure 4, Panel B, presents the differences in the purchase rates between treatment and control groups for all hour blocks. The results suggest that the difference is negative for the early ECR. That is, relative to the early control, retargeting in the 1-hour block had a significantly lower purchase rate ($p < .01$). Thus, the incremental effect of early ECR was negative for this SMS channel data, too. Furthermore, the results indicate that the difference is around zero for retargeting in the 3- and 9-hour blocks. Thus, relative to the control, retargeting in the 3- and 9-hour blocks had similar purchase rates. However, the difference is positive for the late ECR. That is, relative to the late control, retargeting in the 24-hour block had a significantly higher purchase rate ($p < .01$). As such, similar to Study 1 with email and app channels data, the incremental effect of late ECR was positive for this study when using SMS channel data, too.

Model-Based Results

The moderated regression models in Equation 2 were also fitted to the data set of Study 2. The results are reported in Table 5, and the middle range 9 hours block is the baseline. We report effects, as measured by various metrics: purchase

incidence (in the logit model) and purchase amount (Tobit model) one week after sending the ECR ads. The results suggest that across all these effectiveness metrics, compared with the middle hour block, the main effects of early hour blocks had significantly positive effects on purchase rates ($p < .05$), thus supporting the organic decaying memory theory (Baddeley et al. 1975; Brown 1958) in the absence of ECR.

More importantly, the interaction between retargeting treatment and the hour blocks is significantly negative for early ECR (Treatment \times 1 hour) on incremental purchase incidence (logit model) and incremental purchase amount (Tobit model) (all $p < .01$), thereby revealing additional support for H_1 with SMS channel data.

In addition, we observed a significantly positive interaction effect for late ECR (Treatment \times 24 hour) on incremental purchase incidence (logit model) and incremental purchase amount (Tobit model) (all $p < .05$), thus again supporting H_2 .

Exploring the moderating effects of cart characteristics for the double-edged effects of ECR. Because customers have different reasons (e.g., high prices, low budget, multiple products to inspect) for cart abandonment (Garcia 2018; Kukar-Kinney and Close 2010; Luo et al. 2019), they may have quite different probabilities of purchasing after viewing ECR ads. Since we have detailed clickstream data on cart characteristics such as product quantity and product prices, we can further extend prior literature (Bleier and Eisenbeiss 2015; Lambrecht and Tucker 2013; Sahni, Narayanan, and Kalyanam 2019) by exploring whether these cart characteristics may moderate the double-edged effects of ECR ads.

It is plausible that when the products in retargeted carts are of a larger quantity and at higher average prices, the early ECR may induce even *more* ad annoyance among shoppers because they may feel the retailer is pushing them to buy more expensive products in a larger amount to make more profits and hence react more negatively (Goldstein et al. 2014; Yoo and Kim 2005). Meanwhile, when the products in retargeted carts are of a larger quantity and at higher average prices, these customers tend to be more serious shoppers (who may buy more with higher interest in the carted products), so their memory of the carted products is less likely to fade quickly (Leenheer et al. 2007; Tellis 1988). Then, the immediate ECR ads sent too early are more likely to engender low ad reminder effect. Thus, by inducing even more ad annoyance but less ad reminder effect, the negative impact of early ECR ads may be enlarged when the products in the retargeted carts are of a larger quantity and at higher average prices. On the other hand, as time elapses after cart abandonment, and consumer memory of the more expensive and larger quantity of products fades extensively, the serious shoppers will be *more* likely to appreciate the ad reminders rekindling their rusty memory of those inspected products (Raj 1982; Suri and Monroe 2003; Van Heerde et al. 2004, 2013), with even higher ad reminder effects and lower ad annoyance, hence likely strengthening the positive incremental impact of late ECR on customer purchases. As such, the double-edged effects of ECR ads can be moderated by

these cart features: not only the negative impact of early ECR ads but also the positive impact of late ECR ads are amplified when the products in the retargeted carts are of a larger quantity and at higher average prices.¹⁰

To test these moderating effects of the cart characteristics of Product Quantity (Pnum) and Product Price (Pprice), we specify the interaction model in Equation 3.

$$\begin{aligned}
 U_{ij2} = & \xi_0 + \xi_1 \text{Retargeting}_{ij} \times \text{Early}_{ij} \\
 & \times \text{Pnum}_{ii} + \xi_2 \text{Retargeting}_{ij} \times \text{Early}_{ij} \times \text{Pprice}_{ii} \\
 & + \xi_3 \text{Retargeting}_{ij} \times \text{Late}_{ij} \times \text{Pnum}_{ii} + \xi_4 \text{Retargeting}_{ij} \\
 & \times \text{Late}_{ij} \times \text{Pprice}_{ii} + \xi_5 \text{Retargeting}_{ij} \times \text{Early}_{ij} \\
 & + \xi_6 \text{Retargeting}_{ij} \times \text{Late}_{ij} + \xi_7 \text{Retargeting}_{ij} \\
 & \times \text{Pnum}_{ij} + \xi_8 \text{Retargeting}_{ij} \times \text{Pprice}_{ij} + \xi_9 \text{Retargeting}_{ij} \\
 & + \xi_{10} \text{Early}_{ij} + \xi_{11} \text{Late}_{ij} + \xi_{12} \text{Pnum}_{ii} + \xi_{13} \text{Pprice}_{ii} \\
 & + \xi_k W_{ij} + \epsilon_{ij2}.
 \end{aligned} \tag{3}$$

where Early is the 1-hour block, and Late is the 24-hour block (baseline is Middle with the 3- and 9-hour blocks). As shown in Table 6, the results suggest that the three-way interaction between Early, Retargeting, and Product Quantity is significantly negative ($p < .01$) for both purchase incidence and amount. Thus, when the products in retargeted carts are of a larger quantity, the negative effect of early ECR is stronger. In addition, the three-way interaction between Late, Retargeting, and Product Quantity is significantly positive ($p < .05$). Thus, the positive effect of late ECR is also amplified, when the products in retargeted carts are of a larger quantity. Furthermore, results show that the three-way interaction between Early, Retargeting, and Product Price is significantly negative ($p < .01$). As such, when the products have higher average prices, the negative effect of early ECR is also amplified. However, the coefficient of the three-way interaction term between Late, Retargeting, and Product Prices is insignificant. Thus, these explorative results provide some evidence that the double-edged effects of ECR ads are moderated by cart characteristics. By and large, both the negative impact of early ECR ads and the positive impact of late ECR ads are amplified when the products in the retargeted carts are of a larger quantity and at higher average prices.

Discussion and Implications

On the basis of multistudy, multisetting data from randomized field experiments, our research reveals that ECR ads have

¹⁰ There could be other arguments for the effects. For example, more expensive products tend to have longer purchase decision processes, so customers may simply need more time to decide. Another aspect might be that ads retargeting a larger basket of products could be less annoying, as consumers might more quickly forget about the specific items in a large assembly. These arguments can be fruitful for future research.

Table 6. Explorative Results on the Moderating Effects of Cart Characteristics.

	Purchase Incidence	Purchase Amount
Early × Retargeting × Pnum	−.264*** (.0221)	−1.953*** (.430)
Late × Retargeting × Pnum	.0388** (.0196)	6.806** (3.369)
Early × Retargeting × Pprice	−.214*** (.0636)	−1.010** (.482)
Late × Retargeting × Pprice	.0195 (.0181)	4.970 (3.491)
Early × Retargeting	−.872*** (.249)	−2.198*** (.616)
Late × Retargeting	.853*** (.203)	2.100*** (.622)
Retargeting × Pnum	−.202 (.182)	−3.557 (2.709)
Retargeting × Pprice	−.0398 (.0351)	−.291 (.908)
Early × Pnum	−.142 (.0982)	−1.120 (2.362)
Early × Pprice	−.129*** (.0371)	−2.043*** (.568)
Late × Pnum	−.425 (.435)	−7.225 (7.022)
Late × Pprice	.0273 (.0431)	1.195 (1.071)
Early	.286*** (.089)	5.526*** (1.449)
Late	.0854 (.367)	−1.700 (1.382)
Retargeting	.824 (.602)	1.939 (1.108)
Pnum	.0649 (.0571)	1.528 (1.392)
Pprice	−.183*** (.0195)	−3.632*** (.431)
Covariates	Yes	Yes
Constant	.553** (.265)	75.27*** (8.121)
Pseudo R ²	.157	.086
Observations	23,914	23,914

* $p < .1$.** $p < .05$.*** $p < .01$.

Notes: Robust standard errors in parentheses. Early = the 1-hour block; Middle = the 3- and 9-hour blocks; and Late = the 24-hour block. Pnum = product quantity (in natural log); Pprice = average product prices (in natural log) of the retargeted carts.

double-edged incremental effects on customer purchases. In particular, an early ECR ad has a negative incremental effect, whereas a late ECR ad has a positive incremental effect. Explorative analyses suggest that such double-edged effects of ECR ads are moderated. Both the negative impact of early

ECR and positive impact of late ECR can be amplified when the products in the retargeted carts are of a larger quantity and at higher average prices. Our findings have broad research and managerial implications.

Research Implications

Our findings offer several research implications. We are among the first to reveal a causal adverse incremental impact of immediate retargeting on customer purchases in e-commerce. Extending prior research on retargeting (Bleier and Eisenbeiss 2015; Lambrecht and Tucker 2013; Sahni et al. 2019), we not only conceptually differentiate early ECR from late ECR but also empirically show the double-edged effects of ECR ads. Our novel insight here is that early ECR ads within the first hour after cart abandonment may backfire with significantly negative incremental effects on customer purchases. This insight is non-trivial for two key reasons. First, it may rectify the wrong one-sided view of the effectiveness of immediate retargeting. By simply comparing purchase responses with early versus late ECR ads in the treatment (as done in the recent bump view) without valid early and late controls, researchers may erroneously conclude that immediate retargeting has a positive impact and is more effective than late retargeting. However, with scientific randomized controls, the opposite is true: the former has a causal negative impact, while the latter has a causal positive impact and is more effective in reality. Thus, research that documents only the positive impact of retargeting ads could overestimate the effect of early ECR ads and should reckon that immediate retargeting within minutes after cart abandonment (ads served too early) might engender harmful impacts on consumer behavior. Second, it may change our vision for the technology–consumer interface. Sahni et al. (2019, p. 401) note that “retargeting technology aims to reduce the time lag between the consumers leaving the website and the beginning of the campaign to almost zero.” We agree and add that the modern retargeting technology is one thing, but consumer response is another. Although technologies can immediately retarget customers based on the fine-grained shopping cart data, doing so too early may actually annoy customers and adversely impact their purchases. Thus, research on the technology–consumer interface should account for the double-edged (both positive and negative) consumer responses to the innovative retargeting technologies.

Furthermore, we leverage a multistudy, multisetting research design with three large-scale randomized field experiments on over 64,000 customers from different companies via a fine-grained hourly level of retargeted ads, which can rigorously test the causal incremental effects of early and late ECR with a higher generalizability in findings. Prior research examined retargeting ads at the daily level and found a generally positive effect on clicks and web revisits (Bleier and Eisenbeiss 2015; Johnson, Lewis, and Nubbemeyer 2017; Sahni et al. 2019). In support of this line of research, we find that late ECR ads delivered one to three days after cart abandonment lift customer purchases. Furthermore, extending this stream of research, we are among the first to operationalize immediate

retargeting at the *hourly* level within the first day after cart abandonment and uncover the negative impact on customer purchases of immediate retargeted ads. A finer-grained time interval with hours (vs. days) can more accurately capture the immediacy in retargeting.

In addition, advancing prior studies that focused on retargeted ads' content, placement, and frequency (Bleier and Eisenbeiss 2015; Johnson, Lewis, and Nubbemeyer, 2017; Lambrecht and Tucker 2013; Sahni et al. 2019), we are among the first to put the spotlight on the *timing* of retargeted ads, a crucial but underresearched factor influencing the conversions in e-commerce. Even with perfectly crafted and placed ad content with the appropriate frequency, retargeting campaigns may bypass the opportunity to earn higher purchase responses by not taking into account the timing (early or late) of ECR ads.

Moreover, our explorative findings enrich the understanding of the moderated double-edged effects of ECR ads. Extending the literature (Bleier and Eisenbeiss 2015; Lambrecht and Tucker 2013; Sahni et al. 2019), we reveal another new insight that both the negative impact of early ECR ads and positive impact of late ECR ads can be amplified when retargeting carts with a larger quantity and higher average price of products. These findings on the moderated double-edged effects are non-trivial because research might over- or underestimate the impact of early and late ECR ads if ignoring the moderating roles of carted product features. Because customers have different reasons for cart abandonment, they will have different probabilities of purchasing after viewing ECR ads (Kukar-Kinney and Close 2010; Luo et al. 2019). This is different from the cross-sectional consumer heterogeneity, because, over time, even the same individual may have different reasons to abandon the shopping cart. Thus, a comprehensive understanding of consumer responses to early and late ECR ads should consider the contextual factors such as cart characteristics. Matching early and late ECR ads with such contextual factors is crucial for the efficacy of retargeted ads in e-commerce.

Relatedly, our findings have implications for the advertising literature. Prior literature has well documented a myriad of ad effects: provide informative content, offer output interference, and displace other ads (Sahni et al. 2019; Tellis 1988; Van Heerde et al. 2004, 2013). We contribute to this literature by uncovering the nuanced timing (early vs. late) effects of ECR ads. Indeed, prior studies on ad annoyance are largely based on the frequency (i.e., ad repetition; Aaker and Bruzzone 1985; Goldstein et al. 2014; Todri et al. 2020). Advancing these studies, we uncover that the one-time ECR ad may also annoy consumers when it is delivered too early.

Furthermore, the negative effects of early ECR ads yet positive effects of late ECR ads help account for the mixed effects of digital advertising in the literature (Aaker and Bruzzone 1985; Goldstein et al. 2014; Lambrecht and Tucker 2013; Manchanda et al. 2006). In this sense, we extend the literature by suggesting the importance of implementing contextual ads in retargeting (i.e., deliver the ads in the right time, not within the first hour after cart abandonment, and for the right shopping carts). This is critical because marketers might stall if they

blindly advertise to customers without accounting for when, how many, and how expensive the carted products are.

Managerial Implications

Given the prevalence of retargeting ads in practice, our findings provide managers with specific guidance on implementing ECR ads to boost return on investment on retargeting campaigns. First, companies should not heedlessly follow the recency bump and shift all their online ad budgets to immediate retargeting. Delivering the ECR ads too early can engender worse purchase rates than without delivering them. That is, reminder ads sent too soon may annoy consumers and backfire, thus not only squandering ad budgets and but also likely hurting customers' long-term satisfaction. Prudent marketers should resist the temptation of using the immediate retargeting, even though advanced digital e-commerce technologies can deliver retargeting ads within minutes after consumers abandon carts online. Nevertheless, early ECR with price discounts or scarcity framing may allow managers to engender more purchase responses (Luo et al. 2019). However, price discounts are not a panacea: when repeatedly used, they may train strategic customers who purposefully cart products and then wait for price discounts before purchasing.

Second, it is pivotal to scientifically gauge the causal impact of ECR ads. Firms should not rely on the absolute purchases as a measure of success but rather adopt the *relative* purchase, (i.e., incremental to the control without retargeting). Naively, if not comparing the retargeting with the control, managers may mistakenly conclude that the early ECR is most effective: our data indeed show that if simply observing the absolute effect, the early ECR within one hour induces the highest absolute purchases. Yet, compared with the early control, the early ECR actually backfires with negative incremental purchase responses. Thus, we underscore the importance of scientific experimental methodology for managers to avoid the erroneous conclusion on the true effects of ECR ads.

Furthermore, we find that a late ECR ad can be effective and win back potential customers with an increase in return on investment on advertising. Thus, firms can better deploy ECR ad campaigns with a delay after consumers abandon carts to minimize the negative ad annoyance, as well as maximize the positive ad reminder effects on customer purchases. Indeed, retargeting carts in e-commerce has enormous business potential because over 69% consumers abandon carts online, which amounts to over \$4.6 trillion (Garcia 2018; Statista 2020). An interesting point is that the right timing of ECR does not incur additional financial costs in retargeting but can significantly lift customer purchases.

Finally, managerial actions call for an appropriate match between the timing of ECR ads and retargeted products. It is necessary to use ECR to cater to different types of cart abandonment; different cases would include carts with a high quantity of products versus carts with only one item, or carts with an expensive product versus those with a cheap one (Kukar-Kinney and Close 2010; Luo et al. 2019). Thus, we reveal the tactic e-commerce retailers can use to more accurately retarget

customers with different digital carts. Strategically, firms can decide the time to turn on ECR, depending on its suitability for different types of carts, to maximize conversions. For example, managers win back more customers by implementing late ECR ads for carts with a larger quantity of products abandoned.

Limitations and Future Research

Our research has several limitations, which serve as avenues for future studies. First, although our findings are drawn from two countries and different companies, they may not be generalizable to other cultures and products. Thus, more empirical evidence from other settings can be provided in the future. For example, an early reminder might work well for impulse purchases about which customers do not have to ponder much, while products that require a lot of deliberation before purchasing (e.g., cars) might benefit from late ECR. Incorporating the idea of the length of the purchase decision process could also be pertinent, because early versus late in retargeted ads can be a relative concept. Moreover, the strength of our field experiment is about documenting the causal impact of early and late ECR ads on customer purchases, rather than the underlying mechanisms. Future research could investigate the related psychological mechanisms in the lab and explore how privacy concerns, seasonality, and ad competition in retargeting messages regulate the effects of ECR. Furthermore, our results on the moderating role of cart characteristics are exploratory in nature. Future research could use survey data to pinpoint consumers' specific reasons for cart abandonment first and then retarget them with different ad framing and incentives to enhance the efficacy of ECR ads.

Finally, our data are limited to the hourly level within the first several days after cart abandonment. Thus, the effect of even later ECR ads (weeks or months later) is not tested here. Future research might investigate the impact of much later ECR at the weekly or monthly level. Nevertheless, Bleier and Eisenbeiss (2015) find that if the time since last online store visit is over 48 days, the incremental effect of retargeted ads on click-through rates is close to zero. Likewise, Moriguchi, Xiong, and Luo (2016) show that retargeted ads sent one week after cart abandonment are ineffective in generating incremental customer purchases. Sahni et al. (2019) find that the effect of retargeted ads on web revisits is positive but becomes negligible by the end of the first week. These findings suggest that too late ECR ads may turn out to be ineffective. Indeed, once too long a time has elapsed (e.g., after several months or years) since cart abandonment, consumer memory of carted products might be totally lost given the large amount of information in social media people are exposed daily. Then, the reminder function of ECR ads will not work anymore because the memory trace is too weak for a reminder ad to be successful: it is difficult to restore or activate the lost memory (Kelley and Gorham 1988). However, if designed with price incentives, too late retargeted ads might still be effective (Luo et al. 2019). Taking a broad perspective of the literature on ad personalization based on customers' preferences and demographic profiles (Lambrecht and Tucker 2013) and

browsing content (Bleier and Eisenbeiss 2015), future research may also consider how these characteristics regulate consumer purchase responses to too late ECR ads.

In conclusion, this study represents an initial effort in examining the double-edged effects of ECR ads on customer purchases. We hope that our study stimulates future research on ECR, an increasingly important topic in digital marketing.

Associate Editor

S. Sriram

Declaration of Conflicting Interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Xianghua Lu acknowledges support from the National Natural Science Foundation of China [Grants 71872050 and 91746302]. Takeshi Moriguchi acknowledges support from the JSPS KAKENHI Grant Number JP16H03675.

ORCID iDs

Jing Li  <https://orcid.org/0000-0002-2242-1987>

Xueming Luo  <https://orcid.org/0000-0002-5009-7854>

References

- Aaker, David A. and Donald E. Bruzzone (1985), "Causes of Irritation in Advertising," *Journal of Marketing*, 49 (2), 47–57.
- Alba, Joseph W. and Amitava Chattopadhyay (1985), "Effects of Context and Part-Category Cues on Recall of Competing Brands," *Journal of Marketing Research*, 22 (3), 340–49.
- Babin, Barry J., James S. Boles, and William R. Darden (1995), "Salesperson Stereotypes, Consumer Emotions, and Their Impact on Information Processing," *Journal of the Academy of Marketing Science*, 23 (2), 94–105.
- Baddeley, Alan D., Neil Thomson, and Mary Buchanan (1975), "Word Length and the Structure of Short-Term Memory," *Journal of Verbal Learning and Verbal Behavior*, 14 (6), 575–89.
- Bagwell, K. (2007), "The Economic Analysis of Advertising," in *Handbook of Industrial Organization*, Vol. 3, Mark Armstrong and Robert Porter, eds. Amsterdam: Elsevier, 1701–844.
- Bettman, James R. (1979), "Memory Factors in Consumer Choice: A Review," *Journal of Marketing*, 43 (2), 37–53.
- Bleier, Alexander and Maik Eisenbeiss (2015), "Personalized Online Advertising Effectiveness: The Interplay of What, When, and Where," *Marketing Science*, 34 (5), 669–88.
- Brown, John (1958), "Some Tests of the Decay Theory of Immediate Memory," *Quarterly Journal of Experimental Psychology*, 10 (1), 12–21.
- Burke, Marian C. and Julie A. Edell (1986), "Ad Reactions Over Time: Capturing Changes in the Real World," *Journal of Consumer Research*, 13 (1), 114–18.

- Fisk, J.E. and P.B. Warr (1998), "Associative Learning and Short-Term Forgetting As a Function of Age, Perceptual Speed, and Central Executive Functioning," *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 53 (2), P112–21.
- Garcia, Krista (2018), "Brands Know They're Being Creepy: Personalization Comes with Known Risks," eMarketer (February 21), <https://www.emarketer.com/content/brands-know-they-re-being-creepy>.
- Gerber, Alan and Donald Green (2012), *Field Experiments: Design, Analysis, and Interpretation*. New York: W. Norton and Company.
- Gillis, Claire, Leyland Pitt, Matthew J. Robson, and Pierre Berthon (1998), "Communication in the Salesperson/Customer Dyad: An Empirical Investigation," *Marketing Intelligence and Planning*, 16 (2), 100–106.
- Goldstein, Daniel G., Siddharth Suri, R. Preston McAfee, Matthew Ekstrand-Abueg, and Fernando Diaz (2014), "The Economic and Cognitive Costs of Bothersome Display Advertisements," *Journal of Marketing Research*, 51 (6), 742–52.
- Hoban, Paul R. and Randolph E. Bucklin (2015), "Effects of Internet Display Advertising in the Purchase Funnel: Model-Based Insights from a Randomized Field Experiment," *Journal of Marketing Research*, 52 (3), 375–93.
- Jenkins, Jeffrey L., Bonnie B. Anderson, Anthony Vance, C. Brock Kirwan, and David Eargle (2016), "More Harm Than Good? How Messages That Interrupt Can Make Us Vulnerable," *Information Systems Research*, 27(4), 880–96.
- Johnson, Garrett A., Randall A. Lewis, and Elmar I. Nubbemeyer (2017), "Ghost Ads: Improving the Economics of Measuring Online Ad Effectiveness," *Journal of Marketing Research*, 54 (6), 867–84.
- Kelley, Derek H. and Joan Gorham (1988), "Effects of Immediacy on Recall of Information," *Communication Education*, 37 (3), 198–207.
- Kukar-Kinney, Monika and Angeline G. Close (2010), "The Determinants of Consumers' Online Shopping Cart Abandonment," *Journal of the Academy of Marketing Science*, 38 (2), 240–50.
- Lai, Tung L. (2004), "Service Quality and Perceived Value's Impact on Satisfaction, Intention and Usage of Short Message Service (SMS)," *Information Systems Frontiers*, 6 (4), 353–68.
- Lambrecht, Anya and Catherine Tucker (2013), "When Does Retargeting Work? Information Specificity in Online Advertising," *Journal of Marketing Research*, 50 (5), 561–76.
- Leenheer, Jorna, Harald J. van Heerde, Tammo H. Bijmolt, and Ale Smidts (2007), "Do Loyalty Programs Really Enhance Behavioral Loyalty? An Empirical Analysis Accounting for Self-Selecting Members," *International Journal of Research in Marketing*, 24 (1), 31–47.
- Lewis, Randall A. and David H. Reiley (2014), "Online Ads and Offline Sales: Measuring the Effect of Retail Advertising via a Controlled Experiment on Yahoo!" *Quantitative Marketing and Economics*, 12 (3), 235–66.
- Luo, Xueming, Michelle Andrews, Zheng Fang, and Chee W. Phang (2014), "Mobile Targeting," *Management Science*, 60 (7), 1738–56.
- Luo, Xueming, Xianghua Lu, and Jing Li (2019), "When and How to Leverage E-Commerce Cart Targeting (ECT): The Relative and Moderated Effects of Scarcity and Price Incentives," *Information Systems Research*, 30 (4), 1203–27.
- Manchanda, Puneet, Jean-Pierre Dubé, Khim Y. Goh, and Pradeep K. Chintagunta (2006), "The Effect of Banner Advertising on Internet Purchasing," *Journal of Marketing Research*, 43 (1), 98–108.
- Martin, Steve W. (2017), "Reasons Salespeople Don't Close the Deal," *Harvard Business Review*, (August 2), <https://hbr.org/2017/08/7-reasons-salespeople-dont-close-the-deal>.
- Moore, James (2013), "Time Means Everything in Programmatic Display," *Marketing Land* (February 25), <https://marketingland.com/the-element-of-time-means-everything-in-programmatic-display-33928>.
- Moriguchi, Takeshi, Guiyang Xiong, and Xueming Luo (2016), "Retargeting Ads for Shopping Cart Recovery: Evidence from Online Field Experiments," working paper.
- Mueller, Shane T., Travis L. Seymour, David E. Kieras, and David E. Meyer (2003), "Theoretical Implications of Articulatory Duration, Phonological Similarity, and Phonological Complexity in Verbal Working Memory," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 29 (6), 1353–80.
- Nelson, Phillip (1974), "Advertising as Information," *Journal of Political Economy*, 82 (4), 729–54.
- Norton, Edward C., Hua Wang, and Chunrong Ai (2004), "Computing Interaction Effects and Standard Errors in Logit and Probit Models," *Stata Journal*, 4 (2), 154–67.
- Pokrywczynski, James and John H. Crowley (1993), "The Influence of Irritating Commercials on Radio Listening Habits," *Journal of Radio Studies*, 2 (1), 51–68.
- Prioleau, Frost (2013), "The Recency Bump: In Retargeting Timing Is Everything," *Search Engine Land* (March 14), <https://searchengine-land.com/the-recency-bump-in-retargeting-timing-is-everything-151099>.
- Raj, S.P. (1982), "The Effects of Advertising on High and Low Loyalty Consumer Segments," *Journal of Consumer Research*, 9 (1), 77–89.
- Sahni, N.S., S. Narayanan, and K. Kalyanam (2019), "An Experimental Investigation of the Effects of Retargeted Advertising: The Role of Frequency and Timing," *Journal of Marketing Research*, 56 (3), 401–18.
- Statista (2020), "Primary Reason for Digital Shoppers in the United States to Abandon Their Carts as of November 2018," (accessed September 30), <https://www.statista.com/statistics/379508/primary-reason-for-digital-shoppers-to-abandon-carts/>.
- Suri, Rajneesh and Kent B. Monroe (2003), "The Effects of Time Constraints on Consumers' Judgments of Prices and Products," *Journal of Consumer Research*, 30 (1), 92–104.
- Tellis, Gerard J. (1988), "Advertising Exposure, Loyalty, and Brand Purchase: A Two-Stage Model of Choice," *Journal of Marketing Research*, 25 (2), 134–44.
- Thorndike, Edward L. (1914), *The Psychology of Learning*. New York: Teachers College.
- Todri, Vilma, Anindya Ghose, and Param V. Singh (2020), "Trade-Offs in Online Advertising: Advertising Effectiveness and Annoyance Dynamics Across the Purchase Funnel," *Information Systems Research*, 31 (1), 102–25.

- Van der Lans, Ralf, Rik Pieters, and Michel Wedel (2008), "Research Note—Competitive Brand Salience," *Marketing Science*, 27 (5), 922–31.
- Van Heerde, Harald J., Maarten J. Gijsenberg, Marnik G. Dekimpe, and Jan-Benedict E.M. Steenkamp (2013), "Price and Advertising Effectiveness Over the Business Cycle," *Journal of Marketing Research*, 50 (2), 177–93.
- Van Heerde, Harald J., Peter S.H. Leeflang, and Dick R. Wittink (2004), "Decomposing the Sales Promotion Bump with Store Data," *Marketing Science*, 23 (3), 317–34.
- Yoo, Chan Y. and Kihan Kim (2005), "Processing of Animation in Online Banner Advertising: The Roles of Cognitive and Emotional Responses," *Journal of Interactive Marketing*, 19 (4), 18–34.