Not Registered? Please Sign-up First:

A Randomized Field Experiment on the Ex-ante Registration Request

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Abstract

Online commerce websites often request users to register in the online shopping process. Recognizing the challenges of user registration, many websites opt to delay their registration request until the end of the conversion funnel (i.e., ex-post registration request). Our study explores an alternative approach by asking users to register with the website at the beginning of their shopping journey (i.e., ex-ante registration request). Guided by a stylized analytical model, we conducted a large-scale randomized field experiment in partnership with an online retailer in the U.S. to examine how the ex-ante request affects users' registration decisions, short-term customer conversions, and long-term purchase behaviors. Specifically, we randomly assigned the new users in the website's incoming traffic to one of two experimental groups: one with an ex-ante registration request preceding the ex-post request (treatment), and the other with only an ex-post registration request (control). Our results show that the ex-ante request leads to an increased probability of user registration; that is, the users in the treatment group on average are 58.08% relatively more likely to register with the website than those in the control group. Furthermore, the ex-ante request leads to significant increases in customer purchases in the long run. Based on our estimation of the local average treatment effects, the ex-ante registered users are 10.89% relatively more likely to make a purchase, place a 16.76% relatively greater number of orders, and generate 13.22% relatively higher total revenue for the firm in the long run. Finally, the ex-ante request also does not impact customer conversion in the short-term. Further investigation into the long-term and short-term effects provides suggestive evidence on several potential mechanisms, such as firm-initiated interaction and screening of low-interest users. Our study provides managerial implications to the e-commerce websites on customer acquisition and contributes to the research on IT artifact design.

Keywords: user registration, ex-ante request, customer conversion, online commerce, randomization field experiment, IT artifact design

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1. Introduction

Shopping online commonly requires a consumer to create a user account on the e-commerce website and enter detailed personal information, such as email, name, and shipping address, etc., a process called user registration (Li and Pavlou 2013). User registration is crucially important for the e-commerce firms because it captures valuable user information for customer analytics, customer relationship management, and business strategy formulation (Jayachandran et al. 2005; Awad and Krishnan 2006; Chen and Stallaert 2014; Zhu and Iansiti 2012). However, registration could be vexatious for online consumers because they face cognitive effort to fill out the input fields or actively enable a third-party login (Koch and Möslein 2005; Frutiger et al. 2014) and privacy concerns since they are revealing their personal information in the registration process, at risk from data leak or identity theft (McKnight et al. 2002; Gefen et al. 2003; Dinev and Hart 2006; Goldfarb and Tucker 2012).

Considering the challenges in requesting customers to register, e-commerce websites often delay their registration request to the end of the conversion funnel; for example, after customers check out the product and decide to make a purchase. Herein we refer to this approach as an "ex-post registration request," which allows users to explore and cultivate an interest in the site before registration, and the website may obtain sales without interrupting the shoppers (Xia and Sudharshan 2002; Liu 2008). However, with the ex-post registration request, an e-commerce website may *forgo the opportunity to re-engage with those users* who have left the website in the middle of the conversion funnel (Moriguchi et al. 2016). For example, after users add products to the shopping cart, they may abandon the cart and leave the website without registration or checking out (Luo et al. 2019). Such opportunity costs could be substantial, but they are often neglected by the websites.[1]

An alternative approach is placing an "ex-ante registration request" at the beginning of the conversion funnel; for instance, right after the users land on the product pages. The ex-ante registration

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[1] On the e-commerce website we collaborate with, over 80% of users who initiate the shopping journey do not purchase any product. Under the ex-post registration request, it was challenging for the website to re-engage with those lost users.

request presents both risks and benefits to new users. On the one hand, one major concern with the ex-ante request is that it might screen away potential customers due to its upfront registration cost, because it happens before the conversion funnel and the potential customers have not had an opportunity to learn about the site (Li and Pavlou 2013). On the other hand, the ex-ante registration comes with benefits. To begin with, the ex-ante registration request could capture users' contact information in advance, which provides the website the opportunity to re-engage with the users in the future. Additionally, the ex-ante registration request could push users to overcome the registration hurdle early on, which clears the way for the following purchase process of users (Morath and Münster 2018).

Although the digital capabilities of modern e-commerce have drastically reduced the sizable development cost of an online registration system, the optimal design of the registration request remains an open question with limited answers. Indeed, industry practice has shown a clear divergence on the implementation of an ex-ante registration request. Some online commerce websites implement the ex-ante registration request (e.g., *Massdrop.com*, *Lissworld.com*, *Thesill.com*), while others choose to rely solely on the ex-post registration request (e.g., *Target.com*, *Lowes.com*, *LivingSocial.com*). Thus, the purpose of this study is to investigate the role of the ex-ante registration request in the context of a business-to-consumer (B2C) website. Specifically, we hope to examine the following research questions: ***1) How does the inclusion of an ex-ante registration request (vs. the absence of an ex-ante request) affect user registration on the website? 2) What are the effects of the ex-ante registration request on customer purchases in the short-run and in the long-run? 3) What are the potential mechanisms underlying the observed relationships?***

We report a large-scale randomized field experiment conducted on an online commerce website in the U.S. to evaluate the economic implications of the ex-ante registration request. In the experiment, the website's incoming traffic was randomly assigned to either the control group or the treatment group. In the control group, the users received the ex-post registration request at the bottom of the conversion funnel when they were at the "checkout" stage right before making the final purchase decisions. Alternatively, in the treatment group, in addition to the ex-post registration request that matched the

control, the users faced an ex-ante registration request that nudged them to register with the website before proceeding down the conversion funnel. We then collected data from both the randomized field experiment and the website's archival database to identify the causal effects of the ex-ante registration request on users' registration and purchase behaviors and to explore the possible mechanisms.

Multiple insights emerge from the field experiment. To begin with, we find that the ex-ante registration request directly elevates user registration, resulting in a 58.08% relative increase in users' registration likelihood in the treatment group, compared with the baseline in the control group. Next, the ex-ante registration request appears to also result in significant and positive increases in long-term customer purchases.[2] Particularly, we employ a local average treatment effect (LATE) framework, use the ex-ante request as an instrument for the users' registration behavior, and identify the causal effects of user registration driven by the ex-ante request (i.e., induced registration) on the long-term purchase outcomes. The estimates of LATE reveal that the induced registration leads to a 10.89% relatively higher purchase probability and a 16.76% greater number of orders, which translates to a comparative increase of 13.22% in total revenue to the firm in the long run. Lastly, we observe null evidence on the impact of the ex-ante request on short-term conversion. We also conducted a series of follow-up analyses to explore the potential explanations for the observed main relationships. Our results support the idea that the additional email addresses captured by the ex-ante registration request enabled follow-up firm-initiated interactions through email marketing campaigns, which leads to long-term purchase outcomes (Reinartz et al. 2005; Wattal et al. 2012). Further, we find evidence on the screening of low-interest users by the ex-ante registration request. Comparisons of observable covariates reveal that users who left the website upon the ex-ante request share matching characteristics with users who did not register in the control group.

Our research contributes to the literature on IT artifact design (e.g., Fang et al. 2014; Xiao and Benbasat 2015; Li et al. 2019), particularly registration system design, by exploring the optimal design of

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[2] We consider the short-term window as less than 24 hours after user entry because it takes customers approximately an average of 23.7 hours to go through the conversion funnel and complete the entire shopping process. Meanwhile, the long-term period includes 47 days, with the 17-day experiment plus 30 days after the experiment.

a user registration system that raises challenges and opportunities to e-commerce websites (e.g., Li and Pavlou 2013; Morath and Münster 2018). While most prior work has focused on the antecedents of users' registration behavior, we expand the scope of previous work and quantify the business impact of ex-ante user registration on online commerce websites. Additionally, this work adds to the extensive body of prior literature on customer conversion in online commerce (e.g., Moe and Fader 2004; Luo et al. 2012; Ludwig et al. 2013). While prior work considers user registration being only a complementary step for completing the purchase process (Jayachandran et al. 2005; Li and Pavlou 2013), our study makes a pioneering effort in demonstrating the viability of separating registration from conversion and leveraging the ex-ante registration request to effectively facilitate the conversion of potential customers through long-term firm-customer engagement.

The findings of our study provide actionable managerial implications for online commerce websites. Our study suggests that, although it appears safe to use the traditional ex-post registration request in the short run, it could be optimal for websites to nudge users to register early in the shopping process in order to maximize user registration rates and customer purchases in the long run. As the value of the ex-ante registration request does not seem to manifest itself in the short run, it is useful for the website to utilize follow-up marketing communication strategies to continuously engage with the induced registrants, which in turn could help cultivate the potential customers' long-term purchase interests.

2. Related Literature

2.1. User Registration

Our study contributes to the prior research on IT artifact design in general and on the optimization of user registration systems in particular (e.g., Zhu et al. 2010; Xiao and Benbasat 2015). Online user registration is an important IT artifact for websites since the user accounts from registration preserve the website visitors' otherwise anonymous personal data (Lambrecht et al. 2014). Prior work on online user registration mostly focuses on understanding the different antecedents of users' registration behavior

(e.g., Awad and Krishnan 2006; Dinev and Hart 2006; Li and Pavlou 2013).[3] To our knowledge, only one prior study has explored the option of ex-ante registration using analytical models to theoretically consider separating the registration cost from the final purchase cost, which potentially increases the sales probability of goods (Morath and Münster 2018). Note that the ex-ante registration *requirement* in Morath and Münster (2018) is different from the ex-ante registration *request* in our study, because the former necessitates registration, otherwise users must leave the site, while the latter simply induces users to register, and the users can register, leave, or skip the request and proceed down the conversion funnel.

Our study extends previous research on the design of the user registration system by empirically investigating how the ex-ante registration request (*vs.* the absence of one) influences users' registration as well as their short-term conversion and long-term purchase behavior. With the majority of previous research residing in successful user registration as the final outcome (Awad and Krishnan 2006; Li and Pavlou 2013; Putnam-Farr and Riis 2016), we contribute to the literature by quantifying the causal effect of ex-ante user registration on the downstream economic consequences. Additionally, we show that the ex-ante registration request does not need to be a requirement, as considered by Morath and Münster (2018), to be a valuable design option for user registration systems. Our study offers the first experimental evidence on the effectiveness of an ex-ante request. Meanwhile, above and beyond Morath and Münster (2018), in our attempts to explore the underlying mechanisms, we found suggestive evidence of firm-initiated interaction and the screening role of the ex-ante request as potential explanations, improving our understanding of ex-ante registration request as an IT artifact.

2.2. Customer Conversion in Online Commerce

Customer conversion in online commerce is a cross-disciplinary topic, and a great deal of research has been conducted on this matter (e.g., Moe and Fader 2004; Luo et al. 2012; Ludwig et al. 2013). Besides

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[3] For example, some suggest that consumers employ a privacy calculus that weighs the perceived risks and interest in a website (Tsai et al. 2011; Ackerman et al. 1999) before deciding on whether to register with it (Dinev and Hart 2006; Malheiros and Preibusch 2013); others show that the registration approaches, namely social login *versus* regular user registration (Frutiger et al. 2014), registration request format, particularly Yes/No choice format *versus* a simple request to login (Putnam-Farr and Riis 2016), consumers' brand awareness, and perceived popularity about a website are influential factors of user registration (Li and Pavlou 2013).

the factors related to products (Chang and Wildt 1994; Hee Kwak and Kang 2009), pricing (Reibstein 2002; Martín-Consuegra et al. 2007), and customer service (Zhang and Prybutok 2004; Ba and Johansson 2008), prior work has established that website design plays an important role in driving customer conversion (e.g., Jiang and Benbasat 2004; Xiao and Benbasat 2007; Hu et al. 2017; Huang et al. 2019).[4] Our work intends to contribute to the related literature on website design and customer conversion by investigating the idea of designing a user registration system with an ex-ante request on a website to increase consumer purchases. Prior research on user registration in online commerce considers that user registration is primarily a complementary finishing step toward completing the purchase process (e.g., Jayachandran et al. 2005; Dinev and Hart 2006; Li and Pavlou 2013). For instance, Dinev and Hart (2006, p. 63) measured "willingness to register" and "to transact on the Internet" as one overarching outcome of their conceptual framework on privacy calculus in online commerce. Changing prior view on the passive role of user registration, our experiment tries to actively place a registration request at the beginning of the conversion funnel and empirically identifies the causal effects of an ex-ante registration request on the downstream outcomes, such as user registration and customer conversion.

3. Theoretical Framework

Before reporting on the randomized field experiment, we devised a stylized analytical model to outline the key considerations related to the implications of an ex-ante registration request to the website and its users. From the website's (or firm's) perspective, there is a central *tradeoff* on whether or not to include an ex-ante registration request on the site. On the one hand, having an ex-ante registration request might filter out a proportion of users upfront. Customers face uncertainty in their initial valuation and can only gradually learn about the relevant products on the website and form their final valuation of the website's

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[4] For example, Jiang and Benbasat (2004) conducted a series of laboratory experiments and illustrated that web interface design with visual as well as functional control could effectively improve consumers' perceived helpfulness of the site and subsequent purchase intentions. In addition, Xiao and Benbasat (2007) proposed that including a recommendation system on a website, with the proper usage of the system, could reduce the consumers' search efforts and improve product sales. Further, Huang et al. (2019) conducted a randomized field experiment to show that the integration of a word-of-mouth system into a website could help consumers move down the conversion funnel.

offering. The presence of the ex-ante registration request imposes a risk-benefit calculation upfront and thus may deter some users from proceeding down the conversion funnel (Malheiros and Preibusch 2013).[5] On the other hand, there is also an opportunity cost of not having an ex-ante registration request on the website. Without an ex-ante request, the users who walk away from the site in the middle of the conversion funnel will be untraceable to the firm, and thus the firm loses the opportunity to re-engage with those users. Alternatively, the ex-ante registration request captures the users' registration information early on without the users proceeding down the conversion funnel. In the long run, the firm could then leverage the registration information and ask the users via email communication to return to the website and resume their prior conversion funnel activities. Therefore, the websites have to take into account customers' initial valuation and additional learning, while also balancing the negative impact of the ex-ante registration request on website traffic in the short run with the benefits of the ex-ante request-induced registration in the long run. Bearing the above in mind, we set up the model framework as follows.[6]

Suppose there is one website and a consumer market of size one. Each consumer has a unit demand from the website and an initial valuation of the site's offering, which is an independent draw from a cumulative distribution function F with support $(0, 1)$[7], i.e. $v \sim F(0, 1)$. A consumer's initial valuation of the website might differ from her final valuation, from which the consumer decides whether to purchase from the site. Upon arrival, the consumer could experience and learn about relevant products on the website to form her final valuation. Hereby, we denote a consumer's *change* in valuation of the site as s. Without a loss of generalizability, we can assume s is following a cumulative distribution function G with support $(-1, 1)$, and allow a correlation between v and s. We can map all the consumers on the two quadrants in Figure 1 below.

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[5] Although the users can click on the cross-sign and remove the ex-ante request, some users might simply walk away from the site if their initial valuation of the site is low.

[6] Our model extends the existing analytical framework (Morath and Münster 2018) to account for the scenarios directly related to our study context. For example, the framework by Morath and Münster (2018) situates on the subscription business model of, for example, *Spotify* or *Netflix*, yet our study focuses on the business-to-consumer (B2C) product sales business model, like *Carter's* or *Nike*.

[7] It is reasonable to assume that the consumers' initial valuations are positive, as otherwise they would not organically visit the website.

First and foremost, we consider user registration on the website. Suppose that the site has a registration process that asks the consumers to input personal information, such as email address and password, which leads to a non-monetary cost $R > 0$.[8] In the absence of an ex-ante request, a consumer could navigate the products and develop their valuation of the site without registration until the end of the conversion funnel. Then the consumers would face a registration request before the purchase (i.e., ex-post request), and the cost R is incurred only if a consumer decides to buy (i.e. all consumers with the valuation $v + s > R$, as shown in the gray area in Figure 1). The consumers' total demand depends on the density of the area as defined by the joint distribution of F and G. However, such an approach comes with an opportunity cost of missing the registration information of the consumers who are left in the middle of the conversion funnel (blank area $v + s < R$). Since the short-term valuation of consumers ($v + s$) do not reflect their valuations in the long run, firms essentially lose the opportunity to re-engage them.

**Figure 1. Characterizing Customers in the Case without the Ex-ante Registration**
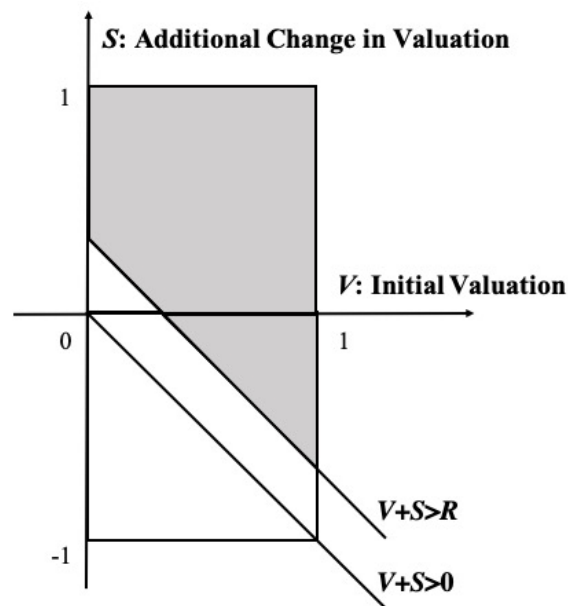
Next, we consider the scenario of including an ex-ante registration request on the website. If the firm places a registration request at the beginning of the conversion funnel, registration incurs a cost $R > 0$

upfront. As shown in Figure 2, apparently, the consumers with initial valuation $v < R$ do not have enough initial interest to overcome the ex-ante registration cost, and thus might leave the site upon request (i.e., screened out consumers due to the ex-ante request).[9] The remaining consumers with $v > R$ would register at a cost of R, proceed into the conversion funnel, and update their valuations $v + s$ at the end to decide whether they want to purchase from the site. Thus, the consumers with $v > R$ & $v + s > 0$ would purchase from the site through the short-term conversion funnel, whereas the consumers with $v > R$ & $v + s < 0$ would not purchase in the short run and exit the website, but remain registered (i.e., added registered consumers due to the ex-ante request). The consumers' total demand here consists of the immediate conversion of consumers in the short run and the delayed long-term purchase that is proportional to the additional ex-ante registered consumers who have not made a purchase.

Figure 2. Characterizing Customers in the Case with the Ex-ante Registration
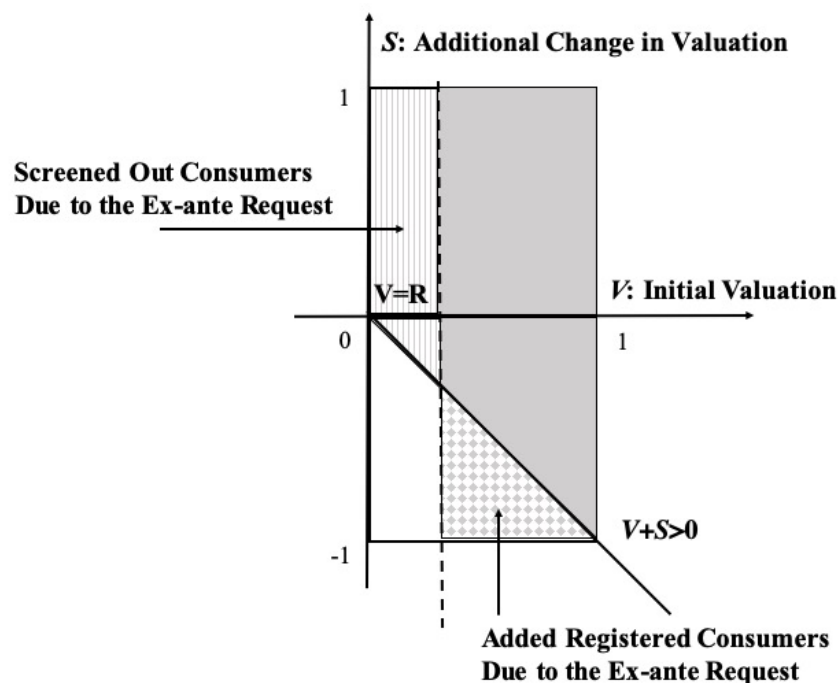

Comparing the common practice of ex-post registration, the website faces a critical tradeoff, as revealed in Figure 3. On the one hand, without an ex-ante registration request, an ex-post request could

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[9] It is possible that some consumers opt to skip the ex-ante request and stay on the site, and those consumers follow the valuation of $v + s > R$, since the registration cost of R still incurs at the end of the conversion funnel.

postpone the registration cost and avoid screening upfront, yet it also carries the opportunity costs of missing the registration of users who have left the website in the middle of the conversion funnel. In contrast, with an ex-ante registration request, the website might screen out a portion of the consumers of low interest (i.e., with low initial valuations) upfront but, at the same time, capture additional registration information of the consumers with a relatively higher initial valuation to the site. Thus, the firm can then re-engage with potential customers through their registered information (e.g., firm-initiated interaction). Note that in analyzing the effects of implementing an ex-ante registration request, it is important to consider the request's long-term benefits on conversions (and the opportunity cost of not capturing these). This is a blind spot of most websites in their current practice of registration system design.

Figure 3. Comparison of the Case with and without Ex-ante Registration
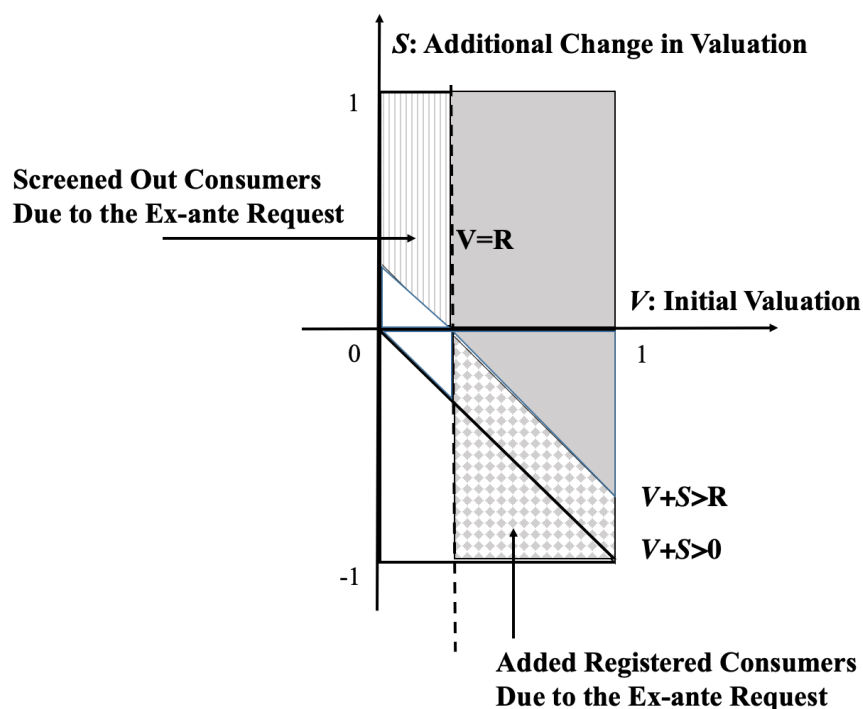
Given the above, the optimal decision on whether to adopt an ex-ante registration request depends on the relative magnitude of the customers lost from screening (the top-left area in Figure 3) and the additional registered customers from long-term engagement (the bottom dotted area in Figure 3). Mathematically, the comparison of the two areas is jointly determined by the registration cost R, the

density of customers who would have a low initial valuation but a high final valuation[10], as well as the effectiveness of firm-initiated interaction on engaging those customers in the long run. Even though the analytical model enables us to consider the different effects of the ex-ante registration request under a coherent framework, it is unclear to what extent an ex-ante registration request would impact registration likelihood, short-run conversion, and long-run sales in a real-life setting. Therefore, a further empirical investigation is necessary as well as meaningful, which we report in the remainder of this paper.

4. Randomized Field Experiment

4.1. Study Context & Experimental Design

We conducted a randomized field experiment in collaboration with a large online commerce website in the U.S. (hereafter referred to as "the partner website").[11] The partner website primarily sells custom-printed household products. Specifically, users can build collages by uploading photos and customizing the layout and design and then purchase the products with the collages printed on various types of materials like blankets, canvases, photo-books, etc. Prior to this experiment, the website had only an ex-post registration request at the end of the conversion funnel. With the ex-post request, before registration, all new users could participate in the activities along the conversion funnel, and then the new users were asked to register before making the final purchase. During our field experiment, we incorporated an ex-ante request as the treatment, with which the registration request occurred at the beginning of the conversion funnel.[12]

Employing a between-subjects design, the randomized field experiment focuses on all new users who visited the partner website during a period of 17 days in May 2018. Specifically, we identified the

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[10] Based on a stream of research on customers' online shopping behaviors in the conversion funnel (Moe and Fader 2004, Zhang et al. 2019), there is a strong correlation between a customer's initiate valuation (state) and final valuation (state) in the shopping process. Thus, most of these customers with a low initial valuation are likely to leave the website without purchase and drop out in the conversion process even without the ex-ante request.

[11] *https://www.collage.com/*

[12] On average, the partner website attracts over tens of millions of visitors per year, while a large proportion of those visitors are new users that do not have registered profiles. Practically, capturing the registration information of the fresh traffic can be a key path for customer conversion (e.g., Jiang and Benbasat 2004; Villanueva et al. 2008; Li and Pavlou 2013). By investigating the economic impact of an ex-ante registration request, our study also adds to the effort of elevating the conversion rate from traffic to sales. Therefore, it is important and valuable to understand the implications of an ex-ante registration request to new customer acquisition and conversion.

new users in the site's incoming traffic based on their HTTP cookies[13] and then randomly assigned them into one of two experimental groups: i) the control group, in which the users received only the ex-post registration request at the end of the conversion funnel, and ii) the treatment group, in which the users experienced the ex-ante registration request treatment in addition to the traditional ex-post request. In the treatment group, if a new user visited the website multiple times within the 17-day experiment window, the user would receive the ex-ante registration request on only their first-time visit.[14] Within the experimental period, we observed a total of 75,914 new visitors to the website, with 38,787 subjects being assigned to the control group and 37,127 participants being directed to the treatment group.

Figure 4 presents the user interface of the ex-ante registration request. Such an interface has been commonly used in industry practice, such as by *Ebay.com*, *Target.com, Macys.com*, *Wayfair.com*, etc. Facing a registration request, either ex-ante or ex-post, a user can enter the information to register and create an account with the website, click the cross sign (×) to skip the request and continue shopping or leave the site by closing the browser tab entirely.

Next, Figure 5 illustrates the flow of the field experiment in the control and the treatment groups. After the ex-ante request, the users in the treatment group experienced the same conversion funnel as the users in the control group. As a result, any difference between the control and the treatment groups in user registration could be attributed to the ex-ante registration request. Once a new user registered and created an account, the firm could track the user's response to the follow-up email campaigns as well as the re-visits to the website from its registered user base. The site also kept the login status of the registered users for 30 days dating back to the last sign-in date (i.e., persistent login), and thus the re-visiting users could conveniently resume the remaining conversion funnel activities from the prior sessions (e.g., customization, add-to-cart).

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[13] When a user visited the website for the first time, the HTTP cookies sent from the partner website were stored in the user's device, assembling a unique ID of the new visitor within the website's database.

[14] For clarification, each user was tracked by the HTTP cookies and received the treatment only once. That is, if a user in the treatment group left the website in the first visit, the user would not receive an ex-ante registration request again the next time that user visited the website.

Figure 4. Registration Request in the Field Experiment
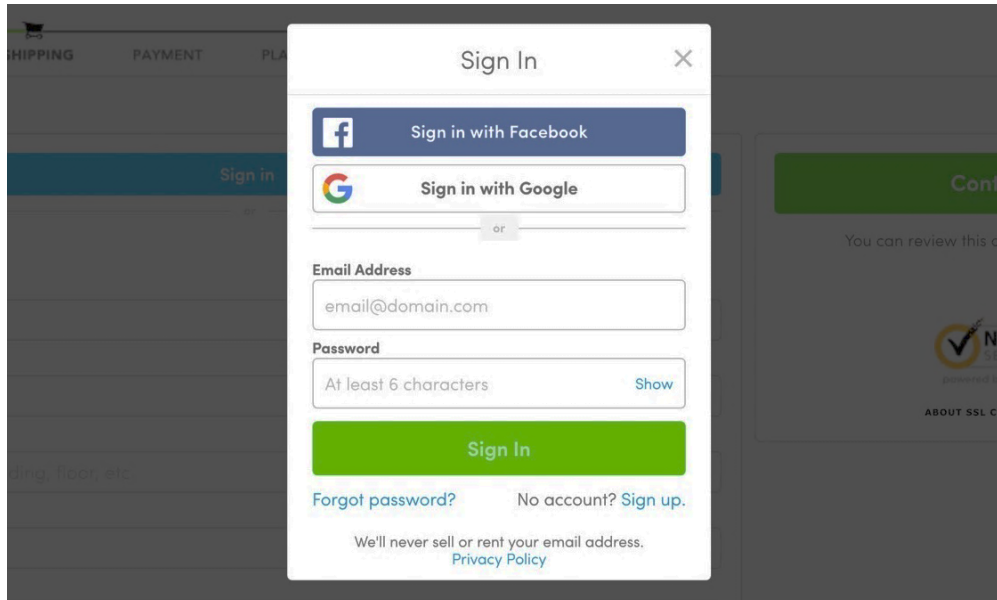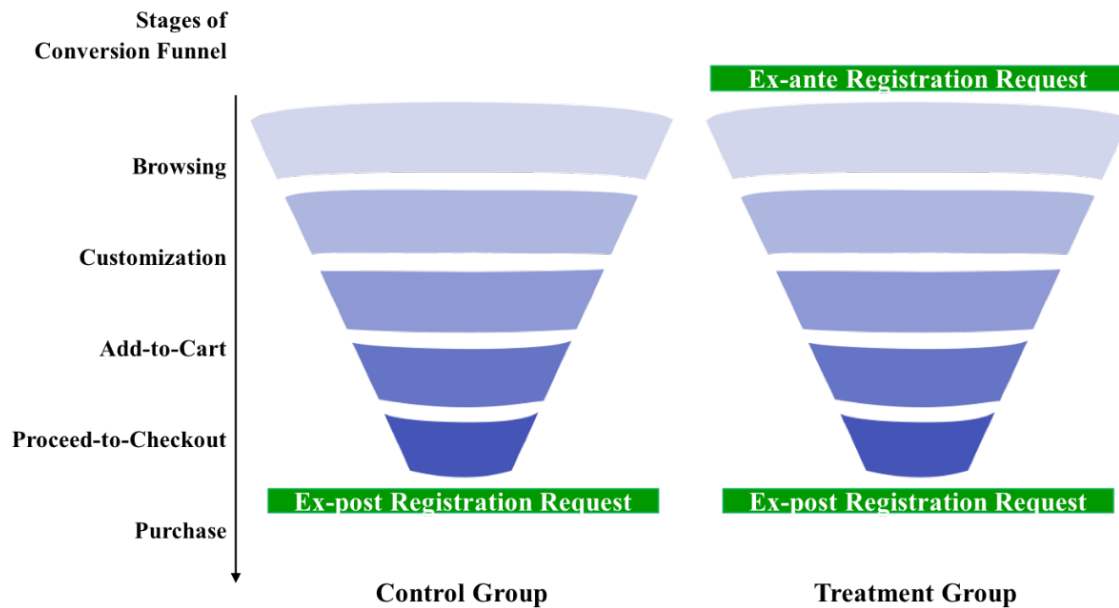

Figure 5. Flow of the Treatment *vs*. Control Groups in the Experiment

4.2. Data & Measures

For empirical analyses, we obtained proprietary data from multiple sources on the website to capture the

digital footprints of the experimental participants before, during, and after the experiment. Before the

experiment, the website's experiment system pinpointed each new user's unique identifier, experimental group assignment, as well as the date and time when each new user entered into the experiment. During the 17-day experiment period, the website's event log system recorded the clickstream data on the users' registration behavior (e.g., page load URL, session time, registration status, and email address used for registration) as well as their activities in each stage of the conversion funnel (e.g., browsing, customization, adding a product to the cart, and proceeding to checkout). Meanwhile, the firm's transaction database stored each user's purchase outcomes, including but not limited to the product(s) purchased, the number of total purchases, and the revenue generated. It is notable that our study aimed to understand the impact of the ex-ante registration request on both short-term conversion and long-term purchases. After the experiment, we continued collecting data on the users' follow-up purchases up to 30 days after the experiment.

The granularity of the data allows us to construct measures of the users' registration, browsing activities, and purchase outcomes at the individual level. We present the list of the variables and definitions used in our study in Table 1, and the summary statistics of these variables are reported in Table 2. Particularly, our study focuses on three primary outcomes: i) New user registration (*registration*), measured as whether the user created an account on the website and left an email address; ii) Customer conversion in the short run (*order_short_term*), intended to capture the probability of a new user making purchase(s) within 24 hours after website entry; iii) Customer purchases in the long run (a total of 47 days in our study), operationalized as the probability, quantity, and generated total revenue of purchasing from the website (*order_long_term*, *order_num*, and *total_revenue*, respectively).

We followed the related prior literature to categorize the short-term *vs.* long-term observation windows in our study (e.g., Blattberg and Neslin 1989; Berglöf and Von Thadden 1994; Schwartz and Smith 2000). Specifically, we used the 24-hour cutoff point for short-term conversion based on the detailed analyses of users' event data from the website, which suggests that it took the customers on average approximately 23.7 hours to complete the conversion process from entry to purchase. We consider that the relationship of the ex-ante request on the short-term conversion captures the immediate

effect of the treatment. Meanwhile, the long-term observation window covered the 17-day experimental period plus 30 days after the experiment, adding to 47 days in total.[15] To conclude, examining these outcomes helped us understand the main effects of the ex-ante registration request (*vs.* absence of one) on users' registration and purchase behavior in the short run as well as in the long run.

Table 1. Variable Definitions

Variable	Definition
Ex-ante_request	Whether a user is in the treatment group (1 = the user received the ex-ante registration request in addition to the ex-post request) or the control group (0 = the user received only the ex-post registration request).
Registration	Whether a user registered with the website using an email address (0 = did not register, 1 = registered).
Order_short_term	Whether a user placed order(s) on the website within 24 hours of joining the experiment (0 = did not order, 1 = placed one or more orders).
Order_long_term	Whether a user made purchase(s) from the website during the 47-day observation window (0 = did not make any purchase, 1 = made one or more purchases).
Order_num	Total number of purchases made by a user during the study period.
Total_revenue	Total sales revenue generated by a user (in U.S. dollars) in the study period.

Table 2. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Ex-ante_request	0.489	0.500	0	1
Registration	0.358	0.479	0	1
Order_short_term	0.131	0.337	0	1
Order_long_term	0.166	0.372	0	1
Order_num	0.186	0.467	0	22
Total_revenue	10.046	31.151	0	1452.61

4.3. Randomization Check

We performed randomization checks between the treatment and the control groups on the observable covariates, including users' device information (e.g., mobile *vs.* non-mobile, operation system, and browser type) and timing of entry to the experiment (e.g., time of day,[16] day of week, and date of month). Table 3 reports the results of our randomization check using pairwise *t*-tests, in which we can see that

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[15] Acknowledging that the 47-day window might not have been long enough, we conducted further analysis on the longer-term effects over an extended observation window of one year (May 2nd, 2018–May 1st, 2019). We thank the AE for the valuable suggestion.

[16] Using Greenwich Mean Time, the time of day variable is categorical on four quartiles of a 24-hour day cycle.

there are no significant differences between the treatment and control groups on the observable

covariates. We also consider the potential interference in our experiment deriving from the offline

interaction of subjects between the treatment and control groups. Correspondingly, we inspected the

geographical distribution of the website's incoming traffic based on their IP address (using the

IP2Location V11 database) and observed that our new users were spread across more than 9,000 different

ZIP code areas; thus, offline user contamination was unlikely.[17] As a result, one can conclude that the

treatment and control groups are well-balanced, confirming the validity of our randomization procedure.

Table 3. Randomization Check

Variable	Treatment	Control	t-value	p-value
Device				
Mobile	0.668 (0.002)	0.672(0.002)	1.278	0.201
Operating system				
Linux	0.168 (0.37)	0.171 (0.38)	-0.986	0.324
Apple iOS	0.640 (0.48)	0.636 (0.48)	0.989	0.323
Windows	0.179 (0.38)	0.182 (0.39)	-0.918	0.359
Android	0.167 (0.37)	0.169 (0.38)	-0.929	0.353
Browser type				
Chrome	0.362 (0.48)	0.364 (0.48)	-0.635	0.526
Safari	0.930 (0.26)	0.928 (0.26)	0.916	0.360
Timing of entry				
Time_of _day	2.909 (0.92)	2.901 (0.92)	1.156	0.248
Day_of_week	3.017 (2.01)	3.003 (2.00)	1.015	0.310
Date_of_month	10.679 (5.10)	10.673 (5.10)	0.155	0.877

Notes: We report the covariates' average values with standard deviation by treatment *vs*. control groups. Pairwise *t*-test statistics with no adjustment are presented.

5. Experimental Results

5.1. Main Effects

5.1.1. Intention-to-Treat Effect (ITT)

We first considered the intention-to-treat (ITT) effects that estimated the average causal effects of the

treatment assignment on the outcomes (Lee et al. 1991). We started to examine the ITT effects by

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[17] As an additional robustness check, we further examined the equality of users' geo distributions as identified by the ZIP code areas across the experimental groups using the Kolmogorov-Smirnov test. The results show that the distributions of users' geolocations by experimental groups are not statistically different from each other (*Combined K-S* = .0043, *p* > .10).

conducting mean comparisons on the outcome variables across treatment *vs*. control groups. The *t*-test

results, as reported in Table 4, suggest that the users in the treatment group (i.e., those who received an

ex-ante registration request) compared to those in the control group showed a higher probability of

registration ($t = 62.649$, $p < .01$) and greater economic value to the site in the long run, as measured by

the likelihood of purchase ($t = 2.498$, $p < .05$), the number of orders ($t = 1.983$, $p < .05$), and the total

sales revenue ($t = 2.228$, $p < .05$). Meanwhile, there appears to be no significant difference in short-term

user conversion ($t = 0.357$, $p > .10$) between the treatment and control groups.

Table 4. Mean Comparisons between Treatment and Control Groups

Variable	Treatment	Control	t-value	p-value
Registration	0.466 (0.50)	0.254 (0.44)	62.649	**0.000**
Order_short_term	0.131 (0.34)	0.130 (0.34)	0.106	0.916
Order_long_term	0.170 (0.38)	0.163 (0.37)	2.498	**0.013**
Order_num	0.189 (0.46)	0.182 (0.47)	1.983	**0.047**
Total_revenue	10.303 (30.79)	9.800 (31.49)	2.228	**0.026**

Notes: $N_{\text{treatment}} = 37,127$ and $N_{\text{control}} = 38,787$.

We then conducted the regression estimations on the effect sizes of ITT. Specifically, we related

our treatment indicator to the binary outcome variables (*registration*, *order_short_term*, and

order_long_term) using linear probability models (LPM) and to the continuous outcome variables

(*order_num* and *total_revenue*) with ordinary least squares (OLS) estimations. As robustness checks, we

estimated alternative regression models such as Logit, Negative binomial, and Zero-inflated negative

binomial models.[18] We provide the estimation equation (Equation 1) below, where *i* indexes each user,

$ExAnte\_request_i$ is a binary indicator for the experimental group assignment of the user *i*, and

$Outcome_{it}$ represents each of the outcome variables for user *i* and period *t* in the regressions.[19] We also

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[18] We employed the zero-inflated negative binomial model on the outcome *order_num*, considering the zero counts in the order numbers.
[19] The period *t* includes the time period of 17 days (during the experiment) for the short-term effects and the observation window of 47 days (during plus post the experiment) for the long-term outcomes.

included additional controls on the device (*Mobile$_i$*) and day of week (*Day_of_week$_j$*) that a user entered into the experiment. Our coefficient of interest is β, which captured the ITT effects.

$$Outcome_{ijt} = \alpha + \boldsymbol{\beta} * ExAnte\_request_i + Mobile_i + Day\_of\_week_j + \epsilon_{ijt} \qquad (1)$$

We report the results of the LPM and OLS estimations in Table 5. In the regression analyses, we were particularly interested in understanding the effect sizes of ITT. Hereby, we have paid attention to the LPM and OLS estimations that feature a straightforward interpretation of the regression coefficients. Based on the results in Table 5, we found that the users in the treatment group, on average, were 21.2% (and 58.08% relatively) more likely to register with the website,[20] 2.33% relatively more likely to make a purchase,[21] along with a relative lift of 2.07% on the number of purchases,[22] and generated 2.67% relatively higher total revenue for the firm in the long run than the users who encountered only an ex-post request in the control group.[23] These effects are not only statistically significant but also economically meaningful because, based on the firm's calculation that takes into account the substantial number of new users in the website's traffic, the ex-ante registration request is projected to increase at least 9,000 purchases that amount to more than $700,000 in total revenue per year.

Table 5. ITT Effects of the Treatment on Registration and Purchase

	LPM			OLS	
	(1)	(2)	(3)	(4)	(5)
Variable	Registration	Order_short_term	Order_long_term	Order_num	Total_rev
Ex-ante_request	**0.212***	0.001	**0.006**	**0.006**	**0.438**
	(0.003)	(0.003)	**(0.003)**	**(0.003)**	**(0.224)**
Constant	0.365***	0.211***	0.257***	0.290***	16.377***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.399)
Control variables	Yes	Yes	Yes	Yes	Yes
Observations	75,723	75,723	75,723	75,723	75,723
F-test	789.77	142.75	234.35	198.62	137.86

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

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[20] (0.212 / 0.365) * 100% = 58.08%
[21] (0.006 / 0.257) * 100% = 2.33%
[22] (0.006 / 0.290) * 100% = 2.07%
[23] (0.438 / 16.377) * 100% = 2.67%

Our regression results are also robust with the alternative estimation methods, as shown in Table 6. Meanwhile, consistent with the mean comparison results, we observe an insignificant impact of the ex-ante request on short-term user conversion in all regression estimations. To conclude, the results of our regression analyses closely align with the findings reported in our pairwise comparisons of group means.

Table 6. ITT Effects with Logit and Zero-Inflated Negative Binomial Estimations

Variable	Logit			Zero-inflated Negative Binomial	Negative Binomial
	(1) Registration	(2) Order_short_term	(3) Order_long_term	(4) Order_num	(5) Total_rev
Ex-ante_request	0.966***	0.004	0.043**	0.036**	0.044*
	(0.016)	(0.022)	(0.020)	(0.018)	(0.023)
Constant	-0.602***	-1.367***	-1.056***	-1.702***	2.788***
	(0.021)	(0.032)	(0.029)	(0.012)	(0.034)
Control variables	Yes	Yes	Yes	Yes	Yes
Observations	75,723	75,723	75,723	75,723	75,723
F-test/Chi2	5281.52	1362.86	2112.28	2012.48	1511.57

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Based on the ITT results, we observe that the ex-ante registration request leads more users to register and results in positive and significant increases in long-term customer purchases in the treatment group, compared to the control group. Yet, recognizing the fact that the ex-ante request directly influences user registration decisions, which subsequently affects users' purchase outcomes, it is important to further understand the causal effects of the exogenous variation in user registration on the purchase outcomes. Accordingly, we consider that the relationship from the ex-ante request to customers' purchases can be dissected to two sequential processes: i) The ex-ante registration request induces more users to complete registration; ii) The induced registration gives rise to the users' purchases in the long run. Next, we further examine these processes by utilizing a LATE framework.

5.1.2. Local Average Treatment Effect (LATE)

We begin by introducing the intuition behind using the LATE framework in our empirical setting. The key idea of the LATE framework is to estimate the causal effect of the instrument-induced shift in a predictive variable on the outcome of interest (Imbens and Angrist 1994; Angrist et al. 1996). In our study

context, we introduced exogenous variation into user registration by implementing an ex-ante request in the treatment group. Thus, the ex-ante request can be considered an instrument for users' registration behavior driven by the treatment (i.e., induced registration), which affects the subsequent outcomes.[24] Econometrically, we employ a two-stage least squares (2SLS) regression to estimate LATE. That is, we use the ex-ante registration request as an instrumental variable (IV) and regress on user registration as the outcome. We then regress the outcome variables on the instrumented user registration.

$$Purchase\_outcome_{ijt} = \delta + \boldsymbol{\gamma} * Registration'_i + Mobile_i + Day\_of\_week_j + \sigma_{ijt} \qquad (2)$$

As shown in Equation 2, i denotes each user and t indexes the time period of the purchase outcome. $Registration'_i$ is a binary indicator on the instrumented registration status of the user i, $Purchase\_outcome_{it}$ represents the outcome variables related to users' long-term purchase behaviors, and $Mobile_i$ and $Day\_of\_week_j$ are included as control variables. Our coefficient of interest is γ, which captures the effect size and significance level of LATE. We report the results of the 2SLS regressions in Table 7, which show consistent findings with our ITT effects. Yet, with LATE, we use the ex-ante registration request as an instrument to calculate the induced shift in registration (i.e., induced user registration), and then γ estimates the causal effect of induced user registration on customer purchases.

From panel (i), the first-stage regression, we observe evidence consistent with the ITT effect that the ex-ante registration request has a significant and positive effect on users' registration likelihood. From the regressions in panel (ii), we then identify the causal effects of the induced user registration on the long-term purchase outcomes. The results show that the induced user registration leads to significant

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[24] We should note that the identification of LATE builds on two assumptions: i) Monotonicity, which requires that the registration request should increase the probability of user registration in the treatment *vs.* the control groups (i.e., Pr[registration_treated] > Pr[registration_control]). Our experimental setting satisfies the monotonicity assumption because the registration request is designed to be a simple nudge for the user to register, and users who opt not to register ex-ante can easily skip the request and continue down the conversion funnel; ii) Exclusion restriction, meaning that there should not be a direct effect from the treatment to the outcome. In our experiment, we designed the ex-ante registration request solely to nudge user registration and did not offer any other incentives on purchases. Hence, the exclusion restriction assumption is complied with, since the registration request does directly influence purchase, and any consequences of the registration request on sales should be passing through registration.

increases in the long-term purchase likelihood (*Order_long_term*), the number of orders (*Order_num*), and total revenue (*Total_revenue*). That is, the ex-ante request-induced registration appears to result in higher long-term customer value as those users are 10.89% relatively more likely to make a purchase, in the long run,[25] place 16.76% relatively more orders,[26] and generate 13.22% relatively more total revenue.[27] The collaborating firm implemented the ex-ante registration request after the experiment.

Table 7. Causal Effect of Induced User Registration on Purchase Using LATE

Panel (ii) LATE Stage 2 – Regression on Outcomes			
	(1)	(2)	(3)
Variable	Order_long_term	Order_num	Total_revenue
Registration'	**0.027****	**0.029****	**2.066****
(induced user registration)	**(0.012)**	**(0.016)**	**(1.046)**
Constant	0.248***	0.173***	15.622***
	(0.007)	(0.007)	(0.611)
Control variables	Yes	Yes	Yes
Observations	75,723	75,723	75,723
F-test	242.32	3.44	140.46

Panel (i) LATE Stage 1 – IV Regression	
	(1)
Variable	Registration
Ex-ante_request	**0.212*****
	(0.003)
Constant	0.365***
	(0.005)
Control variables	Yes
Observations	75,723
F-test	3961.77

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.2. Potential Mechanisms

The results on the main effects show that the ex-ante registration request leads to increases in users' registration likelihood, which results in greater purchase outcomes in the long-term (a total of 47 days in our case). However, the potential mechanisms behind the observed main effects remain unclear, and it is

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[25] (0.027 / 0.248) * 100% = 10.89%
[26] (0.029 / 0.173) * 100% = 16.76%
[27] (2.066 / 15.622) * 100% = 13.22%

important, for scientific inquiry, to further understand the possible explanations for why the ex-ante registration request leads to the observed outcomes in the long run and short run. Here, guided by the stylized analytical model in Section 3, we consider multiple potential mechanisms, including firm-initiated interactions with the registered users (Reinartz et al. 2005) for the long-term effects, as well as the possible screening role of the ex-ante registration request (Li and Pavlou 2013) for the short-term results. To explore the potential mechanisms, we extracted additional email campaign and browsing data from the firm and conducted further analyses, the empirical evidence of which we present below.

5.2.1. Firm-initiated Interaction

Firm-initiated interaction refers to the firm-customer interactions that were enacted by the firm; for instance, email marketing campaigns (e.g., Wiesel et al. 2011; Wattal et al. 2012). The success of firm-initiated interaction depends on user registration because the contact information in the registered accounts allows the firm to contact the customers and foster the interactions (Li and Kannan 2014). After the field experiment, our partner firm sent out email marketing campaigns to all the registered users on a weekly basis, and the emails mostly contained promotional content like product introductions and sales information.[28] The idea is that ex-ante requests lead more users to register with the website, which creates an opportunity for the firm to initiate interactions with those users and subsequently convert them into buying customers. If the firm-initiated interaction was a potential mechanism underlying the observed long-term effects, we would expect that firm-initiated interaction significantly mediates the relationships from the induced user registration to the purchase outcomes.

To explore this possible mechanism, we leveraged detailed email campaign data with more than 4.8 million records at the user-action-time level to capture firm-initiated interaction as the mediator. Specifically, we observed the firm's initiation of email campaigns to the registered users in the experiment and the users' corresponding interactions with those emails, recorded in action name (e.g., receives, opens, clicks) and timestamps (e.g., 2018-05-16 17:37:52) in the data. The granularity of the

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[28] The email campaigns were standardized and managed the same way for all registered users, regardless of the experimental groups.

data is to capture the fact that a user could take multiple actions on an email campaign at different points in time. To operationalize firm-initiated interactions, we then calculated the total number of action-time on the email campaigns at the user-level during our long-term observational window. In other words, the firm-initiated interaction totaled the number counts for each user every time the system recorded an action linked to the user on an email campaign.[29]

After obtaining the measurement of firm-initiated interaction (M = 8.943, $S.D.$ = 14.221, Min = 0, Max = 1171), we first performed a simple t-test to understand the direction of the relationship from induced user registration to firm-initiated interaction. The results show that the treatment group exhibited a significantly higher level of firm-initiated interaction than the control group (t = 260, $p < .001$), confirming our expectation. We then performed mediation analyses following the causal mediation approach (Imai et al. 2010a, 2010b; Hicks and Tingley 2011).

Advancing the traditional Sobel-Goodman tests that primarily rely on mutual correlations (e.g., MacKinnon and Dwyer 1993; Preacher and Hayes 2004), the causal mediation analysis estimated mediation effects in the counterfactual framework (Imai et al. 2010a, 2010b). In the mediation analyses, we considered firm-initiated interactions as the mediator (*Firm_initiated_interaction*), the ex-ante request-induced registration as the independent variable (*Registration'*), and the long-term outcomes as the dependent variables; namely, the probability of order (*Order_long_term*), the number of orders (*Order_num*), and the total revenue to the firm (*Total_revenue*).

As shown in Table 8, from the mediation analyses, we find evidence that firm-initiated interaction significantly mediates the relationships from the induced user registration to the users' long-term purchase outcomes. Specifically, approximately 37% of the total effect on the user's long-term probability of ordering is contributed by the increased firm-initiated interaction from the induced user registration, the mediation effect of firm-initiated interaction accounts for 44% of the total effect on the

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[29] For clarification, the users in the control group could register with the website via the ex-post registration approach, and then the registered users in the control group could also receive the email campaigns. As a result, we observed firm-initiated interactions in both the treatment and the control groups.

number of orders, and 51% of the total effect on user-level revenue is attributed to the mediation effect of firm-initiated interaction. These results support our prior conjecture that firm-initiated interaction could be a potential underlying mechanism that explains the effects of the ex-ante request-induced user registration on users' long-term purchase outcomes, lending support to the theoretical prediction of our analytical model.[30]

Table 8. Mediation Analyses of Firm-initiated Interaction on Long-term Outcomes

DV = Order_long_term	Average Effect	
Mediation	0.15	[0.14, 0.15]
Direct Effect	0.25	[0.24, 0.25]
Total Effect	0.39	[0.39, 0.40]
Proportion Mediated	**0.37**	**[.368, .378]**
DV = Order_num		
Mediation	0.19	[0.19, 0.20]
Direct Effect	0.24	[0.23, 0.25]
Total Effect	0.44	[0.43, 0.44]
Proportion Mediated	**0.44**	**[0.44, 0.45]**
DV = Total_revenue		
Mediation	12.13	[11.78, 12.45]
Direct Effect	11.50	[10.65, 12.06]
Total Effect	23.64	[23.16, 24.06]
Proportion Mediated	**0.51**	**[0.50, 0.52]**

Notes: IV = Registration' (Induced user registration), MV = Firm_initiated_interaction.
95% confidence intervals reported in square brackets (# *simulations* = 100 times).
We used the *medeff* package to perform the causal mediation analyses in Stata 15.0 (e.g., Imai et al. 2010a, 2010b). Another available package for causal mediation analysis is *paramed* in Stata (e.g., Valeri and VanderWeele 2013), which generates highly consistent results as medeff in our case.

Note that the mediator firm-initiated interaction explains certain portions of the total effects of induced user registration on the purchase outcomes. As a result, besides firm-initiated interaction as one potential mechanism, there likely exist other possible mechanisms that also help explain the main effects.

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[30] Although employing the estimation framework of causal mediation, we do not make any causal claim on our mediation results. This is because causal mediation analyses rely on the assumption of sequential ignorability, which requires that "the observed mediator is independent of all potential outcomes given the observed treatment and pretreatment covariates" (Imai et al. 2010a, p. 310). Put differently, given the actual treatment status and pretreatment confounders, the observed mediator is not ignorable. Admittedly, we were unable to achieve the sensitivity tests due to computational limitations.

5.2.2. Screening of Low-interest Users

Our empirical results suggest that the ex-ante registration request increases customer purchases in the long run, while there is null evidence of the ex-ante request's impact on short-term customer conversion. Considering that the absence of evidence is not evidence to the contrary, we further inquire into the conversion funnel to help elucidate the role of the ex-ante request in the experiment. Specifically, we decompose the different stages of the short-term conversion funnel across the experimental groups, counting the number of active users at each stage of the funnel for the treatment and control groups.[31] Such granular examination afforded us to dive into the micro-processes underlying the observed conversion processes. Meanwhile, we acknowledge that due to fundamental challenges in examining the processes in the intermediate stage, such an analysis is not causal and is largely descriptive, but the descriptive analyses provide suggestive evidence and may shed light on the underlying mechanisms.

Recall our model framework in Section 3. With an ex-ante registration request, the website might screen out a significant portion of consumers upfront. However, these customers would be of low interest, i.e., with low initial valuations of the website and in a potentially disengaged state. Thus, even without the ex-ante request, most of these dropouts would otherwise not proceed to the conversion and may leave the website without checking out and purchase. Aligned with the framework of our model, we present our results on conversion funnel decomposition in Table 9. As shown in the percentage changes, the ex-ante registration request appears to screen out a proportion of the users from proceeding into the conversion funnel. Specifically, the ex-ante request occurred in the treatment group before users entered into the browsing stage, and there was a noticeable drop in the number of active users at the browsing stage in the treatment group, compared with the initial sample. In other words, approximately 12.75% of the new users left the website immediately upon receiving the ex-ante registration request in the treatment group (*vs.* about 0.53% of the user attrition at the browsing stage in the control group). This is aligned with the

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[31] For clarification, it is possible that a user moved back and forth between different stages in the conversion funnel. Thus, to avoid double-counting in our analysis, the number of counts captured the furthest stage that a user remained active along the conversion funnel.

prediction of the model. As a result, after the initial screening of the ex-ante registration request, there were significantly more active users in the control *vs.* the treatment group in the upper conversion funnel.

Table 9. Decomposing Short-term Conversion Funnel by Experimental Groups

Stages of Conversion Funnel	Treatment	Control	Diff.	t-value	p-value
1. Browsing	32,392 (87.25%)	38,583 (99.47%)	-6,191	-9.706	0.000
2. Customization	21,240 (57.21%)	24,348 (62.77%)	-3,108	-15.673	0.000
3. Add-to-cart	11,201 (30.17%)	12,345 (31.83%)	-1,144	-4.938	0.000
4. Proceed-to-checkout	7,800 (21.01%)	8,118 (20.93%)	-318	-0.262	0.789
5. Purchase	4,854 (13.07%)	5,061 (13.05%)	-207	-0.106	0.916

Notes: Percentages of the active users to the group sample size in parentheses.
$N_{treatment} = 37,127$ and $N_{control} = 38,787$.

Based on the information processing theory (Bettman et al. 1998, Lambrecht et al. 2011), a customer's purchase process involves multiple stages of progression down the conversion funnel and can be mainly categorized into the consideration (Bleier and Eisenbeiss 2015, Moriguchi et al. 2016) and evaluation stages (Chandon et al. 2000, Lewis et al. 2006). In the consideration stages (e.g., browsing, customization, add-to-cart), the users process information about a product and consider adding it to the shopping cart, whereas in the evaluation stages (e.g., proceed-to-checkout, purchase), the users evaluate the product in the cart and make a decision on whether to purchase it. As shown in Table 9, we find that, although there were more users in the control than the treatment group in the consideration stages, the convergence of active users occurred at the transition into the evaluation stages. Specifically, the number of active users in the treatment group were comparable to that in the control group at proceed-to-checkout ($t = -0.262$, $p = 0.789$) and purchase ($t = -0.106$, $p = 0.916$). This observation suggests that the additional users in the consideration stages of the control group (*vs.* the treatment group) failed to proceed into the evaluation stages, indicating a low interest in purchasing from the site. Such finding is aligned with the prediction of the model and these additional dropouts are the counterfactual of the users who were

screened out by the ex-ante request. Considering the equivalence of active users in the evaluation stages across the experimental groups, it is reasonable to infer that the users who walked away upon the ex-ante request in the treatment group also held low interests in purchasing from the site, just like those who left during the consideration stages in the control group.

5.3. Additional Analyses on Extended Observation Window

Although we estimated the long-term effects of the ex-ante request within a 47-day window, one important question remains on whether the observed effects persist over an even longer period. Indeed, the 47-day observation window might not be long enough, and it is important to examine the robustness of our observed long-term effects over an extended period. Following prior work that features long-term perspectives, such as the effect of promotion on sales in 25 weeks (Raju 1992) or in 52 weeks (Ataman et al. 2010), we extracted additional sales data up to May 1st, 2019, from the partner firm. These added data allowed us to investigate the long-term effects of the induced registration on user purchases over a one-year period (May 2nd, 2018–May 1st, 2019). We then re-conducted the LATE analyses over the observations in the extended one-year window. As reported in Table 10, the long-term effects of induced registration on user purchases over one year are consistent with the findings in the 47-day window, adding to the robustness of our experimental findings over an extended time window.

Table 10. Effects of the Induced Registration on Purchase over a One-year Window

Panel (ii) LATE Stage 2 – Regression on Outcomes			
	(1)	(2)	(3)
Variable	Order_long_term	Order_num	Total_revenue
Registration'	**0.054****	**0.061****	**2.515****
(induced user registration)	**(0.013)**	**(0.025)**	**(1.345)**
Constant	0.250***	0.226***	17.090***
	(0.007)	(0.013)	(0.797)
Control variables	Yes	Yes	Yes
Observations	75,723	75,723	75,723
F-test	248.61	2.66	96.10

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

6. Discussion

6.1. Key Findings

This work builds on a stylized analytical model and employs a randomized field experiment to investigate the effects of an ex-ante registration request on new users' registration, short-term conversion, and long-term purchase outcomes in an online commerce website. In the analytical model, we consider the tradeoff the website faces when implementing the ex-ante request. On the one hand, the upfront registration cost of the ex-ante request might turn away a proportion of users before they experience and learn about the site. On the other hand, the ex-ante request might capture additional registrants early in the conversion funnel, which paves the way for firm-initiated interaction that could lead to purchases in the long run. We then empirically test the intuitions of the analytical model with the field experiment. Specifically, we randomly assign the new users of the website into two experimental groups (i.e., without *vs.* with an ex-ante registration request), and empirically identify the causal effects of asking users to register early in the shopping process (i.e., ex-ante registration request) on the users' registration likelihood and their subsequent short-term and long-term purchases on the website.

Based on our empirical findings from the experiment, the ex-ante registration request induces more users to register with the website. Additionally, our results show that the ex-ante request-induced user registration leads to a higher purchase likelihood, with more purchase quantities, and generates greater total sales revenue in the long run. Further inquiry into the potential mechanisms reveals suggestive evidence of firm-initiated interaction being a mediating factor in the long-term effects of ex-ante request-induced registration on the purchase outcomes. Moreover, although we observe null evidence on the difference in short-term conversion between the two experimental groups, our probe into the decomposition of conversion funnel stages found circumstantial evidence on the ex-ante request's screening role of low-interest users at the beginning of the shopping process.

6.2. Implications to Research

Our study contributes to the related prior literature on user registration systems in particular, and IT artifact design in general, by empirically investigating the economic implications of an ex-ante

registration request on users' registration and purchase outcomes. While prior research has mostly considered the various antecedents of user registration (e.g., Li and Pavlou 2013; Putnam-Farr and Riis 2016), we make a pioneering effort to identify the causal impact of the ex-ante request-induced registration on users' purchases under the LATE framework. Specifically, by instrumenting user registration with the ex-ante request, we find that the ex-ante request-induced registration (*vs.* its counterfactual) leads to a greater likelihood of purchasing and generates a higher sales revenue. This is important because our results offer the first empirical evidence on the theoretical predictions by Morath and Münster (2018) and our own analytical model, which heavily rely on a number of factors that are context-dependent and vary by consumer composition. Therefore, this study conveys important design implications for the online user registration system and adds to the broad stream of prior research on IT artifact design (e.g., Wattal et al. 2010; Xiao and Benbasat 2015; Huang et al. 2019).

Moreover, our study adds to the prior literature on customer conversion in online commerce (e.g., Moe and Fader 2004; Luo et al. 2012; Ludwig et al. 2013). It is widely known that customer conversion is challenging, and firms try various approaches to convert website visitors into buying customers (e.g., Chang and Wildt 1994; Ba and Johansson 2008). Updating the previous notion that user registration is only a complementary step towards purchasing on websites (Jayachandran et al. 2005; Dinev and Hart 2006), our study demonstrates that websites can leverage the benefits of user registration (e.g., the opportunity for future re-engagement) by asking users to register early in the shopping process. In this way, this study is among the first works to empirically evidence that implementing the ex-ante registration request can be a viable website design element for customer conversion in the long run. At last, our study also offers implications on the optimal timing of the collection and usage of user data. Given the recent attention to the privacy regulation of personal data (e.g., Goldfarb and Tucker 2011; Acquisti et al. 2015; Goldberg et al. 2019; Godinho de Matos and Adjerid 2020, Sun et al. 2020), it is important for digital platforms to understand when to obtain user data in the conversion funnel. Our study highlights an important consideration – the opportunity to re-engage with customers – that the firms often ignore but should account when determining the timing to collect user data.

6.3. Implications to Practice

With the rapid development of the Internet, online commerce has bloomed for consumers over the past decade and become a dominating channel in the retail industry (Farber 2016, Abhishek et al. 2016). User registration is a distinctive process for purchasing online because offline shopping typically does not require a customer to register, either before or after purchasing. On that account, the findings of this study provide valuable managerial implications for online commerce websites. In particular, we show that it is economically meaningful to ask users to register early in the shopping process, which effectively separates the registration step from the purchase step. By moving the registration step to the beginning of the conversion funnel, an ex-ante registration request actively influences customers' registration decisions. Specifically, a simple request at the early stage of the shopping funnel leads to about a 58.08% relative increase in user registration. In addition, those induced user registrations lead to an approximate 13.22% relative increase in sales revenue per consumer in the long run.

Further, our exploration into the potential mechanisms shows that the long-term effects of induced registration on purchases possibly operate on firm-initiated interaction. Thus, from a strategy point of view, we ask website managers to caveat the blind implementation of the ex-ante request. Even though implementing an ex-ante registration request is convenient and essentially cost-free, the online commerce sites should also make sufficient efforts toward re-engaging with the registrants to procure the economic return of this registration system design. Further, after the registration stage, firms may use email or website interventions to further engage customers and manage their repeated visits (e.g., Kato-Lin et al. 2016; Zhou et al. 2018). For example, firms may provide information to encourage customers to initiate more product discovery and purchases, or design new incentives to engage them on the website.

Last but not least, our analytical model outlines the scenarios in which an ex-ante registration request would be economically beneficial to the website. Particularly, a firm's choice of whether to adopt the ex-ante registration request depends on different factors, such as the cost of registration and its own ability to engage users in the long run. When the registration cost is intrinsically high (e.g., privacy concern for financial or healthcare products), or when the likelihood to re-engage customers is very low

(e.g., platforms selling durable goods like cars or furniture), the online commerce firms should not use the ex-ante registration request, as it may screen away many potential customers without much gain in the opportunity to successfully engage the customers in the future. However, if the opposite is true, i.e., if platforms offer a convenient way to register without the need for sensitive information or platforms sell products with attractive features for new customers (e.g., "private sales" events), then the firms may benefit from the ex-ante registration request. Under such scenarios, the firms should aim to streamline the registration process and address the privacy concern (to reduce the registration cost R), and to improve their practice to engage the customer at the right time with the right products through the right channel (to increase future engagement). Our experimental findings should mainly be generalized to websites that have low registration costs and support user engagement through firm-initiated interaction in the long run. Further generalization of our results should take into consideration the boundary conditions in our analytical model.

6.4. Limitations & Future Research

This study is subject to a number of limitations, which also points to multiple promising directions for future research. To begin with, we tested a simple yet commonly used version of the ex-ante registration request and did not explore the effectiveness of other supplementary approaches that firms can incorporate to further improve user registration and purchase outcomes. For example, some websites offer discounts or store credits to incentivize user registration. In those cases, new users might be more likely to register and less likely to drop off, as they can redeem the discount or credits in future purchases. An ex-ante registration request in tandem with a financial incentive (e.g. private sales or promotion) could be especially useful to motivate users with low initial valuations to the website, while the profitability of such an approach needs further empirical examination. In the same vein, many fashion websites have used an alternative ex-ante registration request during "private sales," where users must provide their email address and zip code information to browse the products on sale. In this type of registration design, the initial valuation of customers when visiting the website is relatively high (i.e. customers value the sales feature on the website). Thus, the users are also likely to be willing to overcome the ex-ante

registration cost and continue shopping on the website. Future research may extend our study by designing new experiments or identifying new instruments to examine the causal effect of different types of interventions on user registration and conversion.

Furthermore, the present study focuses on the registration request at the beginning of the conversion funnel, and there were limited insights on the ex-post registration request. This is because examining the ex-post request would require one more experimental group that contained no registration request at all, which was absent in our field experiment due to feasibility reasons. Specifically, having an experimental group that was missing a registration step would confuse customers and potentially result in economic losses to the firm. Therefore, it would be interesting for future work to explore the possibility of asking users to register at other points in time. For instance, a registration request in the middle of the conversion funnel could be a suitable compromise between the ex-ante and the ex-post requests, yet the economic implications of this approach call for an empirical examination in the future.

Following the previous idea, another fruitful direction for future research could be developing personalized registration requests that aim to optimize registration and consumption at the individual level. Moreover, we acknowledge that beyond the causal main effects from our field experiment, our further exploration of the potential mechanisms is not causal but rather suggestive in nature. Future studies may leverage exogenous variations, instruments in the intermediate process, or adopt the control function approach using a Gaussian copula model proposed by Park and Gupta (2012) to address the potential endogeneity issue in the mediator and identify causal mechanisms. To fully understand the mechanisms, one might require a new framework such as a different experimental design or structural modeling, which is beyond the scope of our current study. Thus, we encourage future work to explore the causal mediation approaches in shedding light on causal mechanisms.

Finally, although our field experiment found positive value to the ex-ante registration request in the current study context, the economic outcomes of this registration system design depend on multiple other factors, as characterized in our analytical framework, such as the cost of registration, the proportion of new users with low initial valuation, the effectiveness of the follow-up re-engagement effort by the

firm, etc. Therefore, future research should explore the other online commerce contexts that vary among those key factors and examine the boundary conditions of our experimental findings. Specifically, our study is focused on examining the provision of the ex-ante request at the beginning of the conversion funnel. Future research can extend our study and examine how firms may also use different types of information to further engage customers in the conversion funnel (Ghose and Yang 2009, Sharma and Abhishek 2017, Son et al. 2020, Todri et al. 2020, Zhang et al. 2019). Understanding the effect of these interventions, contingent on the customers' registration decision, is managerially relevant and worth more study. More empirical works, guided by the analytical model, may enable researchers to discuss and measure the different effects of the ex-ante registration request under a coherent framework. Our study serves as only a first step toward such an endeavor.

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