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### More is Less? Design Free Sample Strategy via Field Experiment and Double/Debiased Machine Learning

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# More is Less? Design Free Sample Strategy via Field Experiment and Double/Debiased Machine Learning

Short Paper

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## Abstract

*Free sample strategy has attracted considerable interest among practitioners and academics, it has been widely adopted in digital content industries (e.g., e-books, music, and videos). There are two issues that have been the continuous concerning and constantly optimized focus. How many free samples should be taken? How to design a personalized free samples strategy considering the contexts? To better understand these issues, we collaborated with an online reading platform in China to design and conduct a field experiment based on Construal Level Theory (CLT). The results showed an inverted U-shaped relationship between free sample quantity and consumer purchase decisions and also suggested when free chapters were offered, book popularity and quality were also found to positively moderate consumers' purchase decisions. Moreover, by combining the causal forest (CF) technique and the double/debiased machine learning model (DML), we develop a personalized free sample strategy and provide managerial implications.*

**Keywords:** Digital Content; Free samples; Field Experiment; Construal Level Theory; Double Machine Learning

## Introduction

From 2021 to 2025, the total revenue of digital content industries (e.g., e-books, movies, and music) is expected to show an annual growth rate of 11.25%, resulting in a projected market volume of US \$12,251 million by 2025. Digital content industries present new opportunities. However, the quality and preference fit of digital content products with hedonic properties and high consumer heterogeneity can only be determined after consumers experience said products. As such, most digital content platforms have widely adopted a free sample strategy to reduce consumer uncertainty (Zhang et al. 2021). Digital content platforms, such as Netflix, Spotify, Financial Times, Amazon, and Tapas, offer free samples to appeal to consumers and generate revenue. The most important feature of these products is connectedness (Russell et al., 2004), meaning that what a consumer previews previously would play quite an important role in the subsequent purchases of the product. For example, the strategy of Amazon Kindle Vella, a host platform for serial stories, is to give users free access to a handful of initial episodes before charging for all successive

episodes. How many free episodes should be taken? How to design a personalized free samples strategy considering the contexts? These two issues have been the most concerning and constantly optimized focus in practitioners. Indeed, scholars have investigated the effects of various aspects of free samples on product demand, subscriptions, and total revenue (Gu et al. 2018; Reza et al. 2021; Shi et al. 2019; Aral and Dhillon 2021; Ji et al. 2021; Sheng et al. 2022; Wang et al. 2022). Yet, despite these advancements and attention from both academics and practitioners, the managerial implications and optimal design of this strategy in hedonistic digital products, remain underexplored.

The particularity of digital content products determined the difference in their free sample strategy from other products. Digital content products are hedonic, and experience-based, and come from the digitalization of traditional content products; they differ from utilitarian products in that they focus on individual preferences in product evaluations rather than product functionality (Kannan et al. 2009; Li 2021). Thus, different consumers will have different utilities for the same product. Notably, most existing studies have examined the free sample strategy in relation to utilitarian products at the expense of hedonic product experiences. For example, the mechanism and design of free sample strategies in software, a typical representative of utilitarian products, has been widely explored by numerous studies. Multi-version products like software are usually distributed as a full version free for a limited time or as a permanently free low-end version with a high-end version that requires purchase. Nevertheless, the free sample strategy for digital content is usually implemented by offering the first few content items free and charging for the rest. Key differences exist between these two strategies, with connectedness being the biggest one (Russell et al. 2004). Specifically, the free and charged parts of multi-version products are in a substitute relationship, while digital content products like online novel have a serialized and complementary relationship that connect to the storyline. Accordingly, what works for utilitarian products may not work for hedonic experience products.

Based on the above research gap, this paper thus focuses on the particular hedonic experience product of online novels and addresses two key issues: how free sample quantity affects consumer purchase decisions and how consumers and books with different characteristics react to different free sample strategies. Based on a field experiment grounded in Construal Level Theory (CLT), our study explores the impact of free sample quantity. The results showed free sample quantity significantly impacted consumers' motivation to continue reading and make purchases via an inverse U-shaped curve. It was also found that book popularity and quality positively moderated consumers' purchase decisions when free chapters were offered and that new, high-activity consumers were more receptive to the free chapter's incentive. Finally, combining the causal forest (CF) technique and the double/debiased machine learning model (DML), we can develop a personalized free sample strategy and provide managerial implications. This study enriches information system and management literature on free samples and deepens extant understandings of consumer purchase decisions in accordance with Construal Level Theory (CLT). Our results also clarify the relationship between consumers' direct and indirect experiences. In line with CLT, we use empirical analysis to propose strategies for designing optimal free sample quantities for digital content platforms.

## **Literature Review and Hypotheses**

In this section, we apply a CLT perspective to the relationships between free sample quantity, and purchasing decisions in the context of digital content products. Figure 1 presents the overall research scope and we conclude by delineating the study's hypothesis.

Construal Level Theory (CLT) originated in the field of social psychology and was developed by Trope et al. (2007), which is a leading contemporary theory for explaining and predicting consumers' decision-making behaviors (Fiedler 2007). According to CLT, as one dimension of psychological distance, informational distance conceptually represents the amount of relevant information or knowledge a consumer perceives regarding decision alternatives. It is a monotonic function of sample size or the amount of information available; that is, the denser the amount of information, the smaller the informational distance to decision options. In the context of this study, CLT holds that the informational distance between consumers and a target book will decrease as the quantity of free samples increases. Another important factor affecting consumer decision-making in CLT is that the quantity of information and expertise can impact consumer satisfaction. Large free samples can lead to decision conflicts and distractors based on cognitive load, which in turn can reduce consumer satisfaction. Given this, informational distance can bring about two opposite effects. Specifically, less informational distance eliminates uncertainty but simultaneously raises

consumers' cognitive costs and results in cognitive overload. The interaction of these two effects may therefore cause free sample quantity to have a non-linear effect on consumers' purchase decisions. Accordingly, we propose:

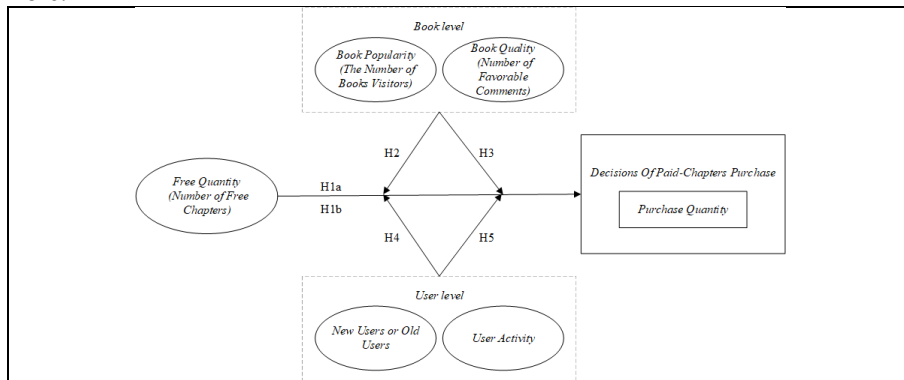
- *Hypothesis 1.* There is an inverted U-shaped relationship between the number of free chapters offered and consumer purchase decisions.

As consumers enable hands-on interactions with products, offering free samples is a way for consumers to have direct product experiences (Hamilton and Thompson 2007). Consumers can additionally have secondary experiences in the form of online reviews, and more to evaluate product quality and alleviate the uncertainty of preference fit (Choi et al. 2019). Indeed, the literature suggests product quality can significantly affect consumers' purchase decisions (Minnema et al. 2016). Consumers' purchasing decisions can also be influenced by a product's popularity. The limited nature of consumer attention means less popular products will receive less attention. Consumers' sense of a product's popularity can and often does result in a credible product reputation (Tucker and Zhang 2011), which ultimately increases sales volume. Experiential distance in CLT can be used to clarify these, which is defined according to information source-comes from first-hand sources or third-hand channels. Although third-hand information is often imprecise and abstract, it is still an important source from which consumers obtain information and communicate with other consumers (Choi et al. 2019). As such, direct and indirect experiences cannot substitute for one another and have a combined effect on consumers' purchase decisions. Indirect experience is often complementary to direct experience in that it can moderate the effects of direct experience. Hence, we propose:

- *Hypothesis 2.* Book popularity positively moderates the effect of free sample quantity on consumer purchase decisions.
- *Hypothesis 3.* Book quality positively moderates the effect of free sample quantity on consumer purchase decisions.

Moreover, consumer heterogeneity has been known to affect consumers' perceived product value (Hoang and Kauffman 2018). The degree of consumer involvement is an important indicator of a consumer's activity and familiarity with a given platform. Consequently, individual involvement can greatly influence consumer decision-making (Fang et al. 2016). We focus on two specific dimensions of consumer heterogeneity: consumer activity and new vs. long-term consumers. Most studies agree that highly engaged consumers are most often people who interact with products. New consumers will likely exhibit greater curiosity towards the products than existing consumers<sup>1</sup>, whereas long-term consumers may already possess a higher level of familiarity with the platform's offerings. However, in a new market, a lack of product/service awareness could significantly reduce average consumption compared to a mature market (Reza et al. 2021). Given product perception may differ among consumers, we posit:

- *Hypothesis 4.* Consumers with high activity are more sensitive to the stimulation of free chapters than those with low activity.
- *Hypothesis 5.* Long-term consumers are more sensitive to the stimulation of free chapters than new consumers.



<sup>1</sup> Based on company statistics, new users engage with an average of 2.3 categories of books per week, whereas existing users typically explore 1.2 categories of books. This indicates that new users are more curious about the platform and more willing to explore it.

<b>Figure 1. Overall Research Framework</b>
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## Research Context and Data

This study was conducted in collaboration with a leading e-book platform in China. Customers of the platform can access nearly 0.5 million novels and published books via the platform's mobile app. All books on the platform are available with a small number of free chapters accessible through the Preview function (same for all consumers and books). However, novels usually have thousands of chapters, so the small number of free samples of one novel may not be as substantial as other chapters of the novel and may not effectively reduce uncertainty. To address this issue and investigate the impact of free chapter quantity on consumers' purchase decisions, we designed and implemented a randomized experiment (limited time (3 days) and limited chapters activity) using a pool of 223 books by distributing one book from the pool via a pop-up window, thus we can generate different free sample quantity for different consumers. We tracked these consumers' purchase behaviors (whether consumers continued to pay and the total number of chapters a consumer paid for in a given book) during the experiment and for one month after the experiment<sup>2</sup>. Finally, we obtain 1,786,800 observations<sup>3</sup>.

Our data contains three type variables: dependent, independent, or control variables. To quantify the effect of the number of free chapters on consumer purchase decisions, a binary variable (*IsPay*) and a continuous variable (*PaidChapters*) were introduced. *IsPay* was used to indicate whether consumers continued to pay; it equals 1 if the consumer paid anything and 0 otherwise. *PaidChapters* was used to express the total number of chapters a consumer paid for in a given book. To examine the impact of the free sample strategy on purchase behavior, the independent variable was set as the quantity of free chapters (*Free*). We also introduce a quadratic term *Free*<sup>2</sup> to exam non-linear effects. The control variables consisted of two levels: book-level and consumer-level. The definitions and statistics of variables are shown in Table 1.

Variables	Description	Mean	Std.	Min	Max
<i>Free</i>	The number of free chapters consumers read	150.83	101.19	20	500
<i>Ispay</i>	Whether the consumer pays	0.2990	0.4578	0	1
<i>PaidChapters</i>	Total number of chapters paid by consumers	19.18	108.15	0	4324
<i>ChaptersAll</i>	The total number of chapters in a book	1123.07	714.59	310	4504

**Table 1. Definitions and Descriptive Statistics for Variables**

## Model and Empirical Results

Several econometric models were constructed to test the hypotheses. The first variable of interest was the dummy variable of whether consumers paid (*Ispay*). For this, we chose the well-known logistic regression model to estimate the effects. The second dependent variable was the number of chapters a consumer paid for (*PaidChapters*). As the variable *PaidChapters* belongs to count and censored data, the Type II Tobit regression model was applied, where  $PaidChapters = \max(0, PaidChapters^*)$ . The models were run at the consumer level following the specification in Equation 1 to identify the effect of different free sample quantities on consumers' purchase decisions. The variables  $y_{ij}$  refer to consumer  $i$ 's variables related to purchase decisions ( $Ispay_{ij}$ ,  $PaidChapters_{ij}$ ). We also concern with two key independent variables ( $Free_{ij}$ ,  $Free^2_{ij}$ ), which present the quantity of free samples, and add a set of control variables, including consumer-level and book-level control variables ( $\sum B_{sj}$ ,  $\sum U_{ri}$ ). Term *interaction* indicates the interaction variables and term  $\varepsilon_{ij}$  represents the error term. The estimation results of the above model are reported later.

<sup>2</sup> According to statistics, more than 90% of consumers completed the interaction with experimental books within a month.

<sup>3</sup> We do not consider consumers who finished the entire book during the experiment because they will no longer interact with that book and will no longer pay for it.

$$y_{ij} = \beta_o + \beta_1 Free_{ij} + (\beta_2 Free_{ij}^2) + \beta_{s3} \sum B_{sj} + \beta_{r4} \sum U_{ri} + \varepsilon_{ij} \tag{1}$$

$$y_{ij} = \beta_o + \beta_1 Free_{ij} * interaction + (\beta_2 Free_{ij}^2 * interaction) + \beta_{s3} \sum B_{sj} + \beta_{r4} \sum U_{ri} + \varepsilon_{ij} \tag{2}$$

**Impact on Purchase Decisions**

In this section, we estimate the model results according to Equation 1 and present the main findings on the effects of free chapter quantity on consumer purchase decisions (H1). The polynomial model was used to present our empirical findings. Table 2 shows the estimated results.

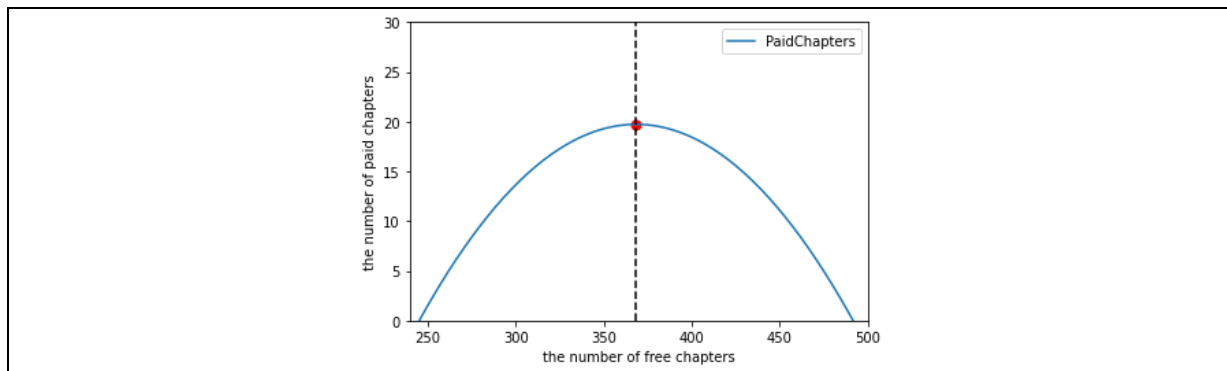
	Ispay	PaidChapters
Free	0.0092***(6.13e-05)	0.9580***(0.0075)
Free <sup>2</sup>	-1.11e-05***(1.33e-07)	-0.0012***(1.62e-05)
Controls	Yes	Yes
Observations	1,786,800	1,786,800

**Table 2. Impact of Free Chapter Quantity on Consumer Purchase Decisions**

Notes: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

The first stage of activating them to move from free to paid, and the second stage is how stimulating consumers to pay more, which was the most crucial. The coefficients reported in columns 1 and 2 in Table 1 show the coefficient for the linear term (*Free*) was positive and significant, while the coefficient for the square term (*Free*<sup>2</sup>) was negative and significant. This suggests the existence of an inverted U-shaped relationship between free sample quantity and purchase decisions. More specifically, as the number of free chapters increased, consumers’ purchase willingness increased and then decreased. As the above analysis confirms the relationship between purchase decisions and free sample quantity, Hypothesis 1 (H1) was supported.

For a clear presentation and to identify the optimal paid chapters range for the selected books in this experiment, the relationship between the number of free chapters and the quantity of paid-for chapters was graphed by plugging the estimated coefficients. In Figure 2, the abscissa represents the number of free chapters, and the ordinate represents the consumers’ quantity of paid chapters. Reading more free chapters did not always correlate with a consumer paying more for the book. In the beginning, consumer purchase quantities increased as the number of free chapters increased. However, they began to decline when the number of free chapters reached a certain level.



**Figure 2. Relationship Between Free Chapter Quantity and Consumer Purchases**

For our first hypothesis (H1), we confirmed the inverted U relationship between free chapter quantity and consumers’ purchase decisions. According to consumer trust and consumer perceived value theory, there was a positive correlation between customers’ perceived value and purchase intention. Consumers pursue the maximization of perceived value such that the greater the perceived value, the stronger the purchase intention. This revealed the mechanism of these results: when consumers read just a few free chapters, their

understanding of the book was not deep enough to warrant a purchase, and trust and perceived value were insufficient for optimizing (from the platform’s view) consumers’ purchase decisions. The optimum occurred when consumers felt trust and perceived value maximization. Beyond the optimum, consumers’ sense of marginal utility diminished and the product’s perceived value declined.

**Moderating Effects**

Moderating effects analyses were performed to test Hypotheses 2 through 5 and deepen current understandings of how books and consumer characteristics influenced the effects of the experiment’s free sample strategy. In alignment with the existing literature, book visitor volume, and favorable reviews were found to be effective indicators of book popularity and quality. Both influenced consumers’ judgment of a given book. We further consider what kinds of consumers are most responsive to the free sample strategy. Consumers’ understanding and degree of familiarity with a platform depend on their interactions. We thus considered two key characteristics: consumer activeness and whether consumers were new or long-term platform customers. Based on this, interacting variables were introduced into Equation 1, with a quadratic interacting variable and a polynomial interacting, respectively.

**Book Popularity and Book Quality**

To examine the moderating effect of book popularity and book quality on consumers’ purchase decisions (Hypotheses 2 and 3), the models that regress on two interacting variables were estimated using new variables: Visitors and Reviews. Visitors represent a book’s popularity, or how many consumers read the book, while Reviews was the number of the book’s positive comments from readers. The coefficients reported in column 2 of Table 3 show that book popularity positively moderated the effect of free sample quantity. Specifically, the more popular the book, the greater the marginal utility of the free chapter strategy, which ultimately led to higher consumer purchase willingness. Thus, Hypotheses 2 was supported. Next, the estimation results for interaction terms reported in column 3 of Table 3 show book quality positively moderated the main effect. These results support hypotheses 3 and demonstrated that, when adopting the free sample strategy, consumers’ book reviews (indirect experience) still significantly impact consumer’s purchase decisions. In the context of this study, the higher the number of favorable reviews, the more consumers were willing to believe in a book’s quality, which in turn had a significant positive moderating effect on the influence of free chapter quantity on consumers’ purchase decisions.

	PaidChapters	
Free	0.9220***(0.0088)	0.9330***(0.0089)
Free <sup>2</sup>	-0.0012***(1.92e-05)	-0.0012***(1.94e-05)
Free * Visitors	2.35e-05***(3.46e-06)	
Free <sup>2</sup> * Visitors	-7.42e-08***(7.47e-09)	
Free * Reviews		0.0016***(0.0003)
Free <sup>2</sup> * Reviews		-4.06e-06***(7.27e-07)
Controls	Yes	Yes
Observations	1,786,800	1,786,800

**Table 3. The Moderating Effect of Book Popularity and Book Quality**

Notes: Standard errors in parentheses; \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

**Consumer Activeness and New or Long-term Consumer**

To analyze customer heterogeneity, we considered whether consumers were new to the platform and how active they were. To test hypotheses 4, we first examined how consumers with different activity levels responded differently to free chapter quantity. Similar to the analysis of book-level heterogeneity, the model was estimated by using interaction terms. The company categorizes consumers into three activity levels (low, medium, and high) based on their previous behaviors. Low-activity consumers are considered as the baseline group. Two dummy variables, namely *Medium\_Active* and *High\_Active*, are employed to assess

heterogeneity results. Specifically, when a consumer is moderately active, *Medium\_Active* is set to 1, while *High\_Active* equals 1 when the consumer is highly active. The estimated results in Table 4 show that high-activity consumers were found to be significantly more receptive to free chapter quantity than those with medium and low activity levels, while high-activity consumers paid the highest number of total chapters. This result supports Hypothesis 4. Companies may thus be able to use fewer free chapters to encourage high-activity consumers to pay more. The coefficients in column 1 of Table 4 were examined to determine the heterogeneity between new and long-term consumers. The results indicated that, contrary to Hypothesis 5, new consumers exhibited a greater marginal utility in their purchase decisions for the product compared to long-term consumers. The analysis of consumer heterogeneity revealed support for Hypothesis 4 and rejection for Hypothesis 5. This implies that the platform's freemium policy should be oriented towards targeting new and highly active consumers, as they were more receptive to the quantity of free chapters offered.

	PaidChapters	
Free	83.31***(6.601)	0.531***(0.0118)
Free <sup>2</sup>	-0.00117***(3.16e-05)	-0.000690***(2.50e-05)
Free * New	0.0288 (0.0255)	
Free <sup>2</sup> * New	-0.000154*** (5.58e-05)	
Free * Medium_Active		0.0545***(0.0189)
Free <sup>2</sup> *Medium_Active		-9.33e-05**(4.03e-05)
Free * High_Active		0.151***(0.0242)
Free <sup>2</sup> * High_Active		-0.000350***(5.14e-05)
Controls	Yes	Yes
Observations	561,698	795,820
<b>Table 4. The Moderating Effect of Consumers Characteristics</b>		

Notes: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

### Robustness Check

A series of robustness checks were then performed. The first test sought to determine whether the results were robust for alternative books. The most popular books were selected to further verify the robustness of this result. The next test was conducted to analyze alternative independent and dependent variables in the form of proportion. Finally, the findings were tested to verify whether they were robust to alternative model specifications (OLS, Poisson, Negative Binomial). The Generalized Method of Moments (GMM) was also utilized to test the robustness of the results. Overall, the tests confirmed the results of this study were robust.

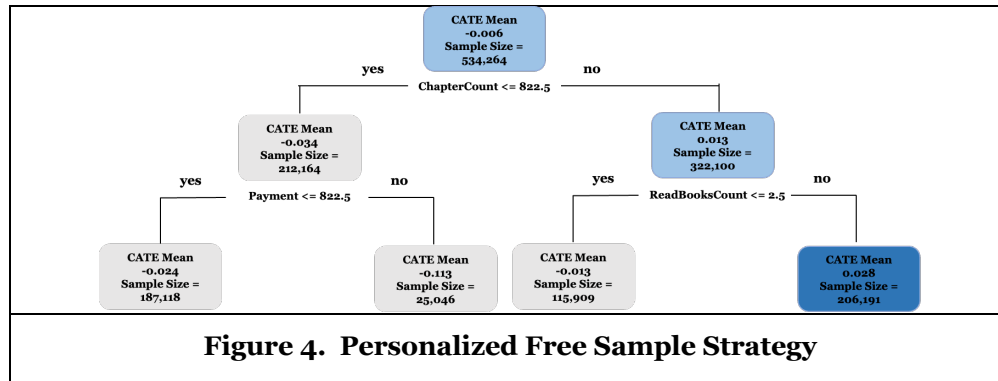
### Design Personalized Free Sample Strategy

We combine the causal forest (CF) technique and the double/debiased machine learning model (DML) to design a personalized free sample strategy. Heterogeneous Treatment Effect (HTE) is to quantify effects on different groups, and thus achieve the goal of differentiated designs. DML is a novel method that models the effect heterogeneity with large flexibility (via techniques such as random forests), while at the same time leveraging techniques from causal inference to preserve the causal interpretation of the learned model (Chernozhukov et al. 2018). The core of this method is easy to understand. It can be divided into two steps: first, using covariables (X) via ML method to predict the treat (T) and dependent variable (Y), respectively, then calculating residuals  $Y - M_Y(X_i)$  and  $T - M_T(X_i)$ , second, regress on residuals to get estimated results. That is  $Y_i - M_Y(X_i) = \tau(X_i)(T_i - M_T(X_i)) + \epsilon_i$ , where  $M_Y(X_i)$  is the outcome obtained by regressing Y on X and  $M_T(X_i)$  is the outcome obtained by regressing T on X, and  $\tau(X_i)$  is the is the estimated result of CATE.

Limited by computational resources, we first use a subsample (534,264 observations including 246,154 consumers, who at least paid for one chapter) for model training and select the random forest model in the first stage to get residual. The importance of features and a personalized free sample strategy are shown in



Figure 4. The results indicated that key factors in our context of designing a free sample strategy are book length and consumer activity. Thus, according to Figure 4, a personalization strategy that can be implemented is to give customers who have read at least 3 books on the platform more free chapters on a long book which is more than 823 chapters. This can drive consumer spending to increase the company's revenue.



## Research in Progress

First, we will use all samples to train a more general and accurate DML model and provides the company with a more detailed design of a personalized free sample strategy. Next, we will use other methods (such as neural network) to check the robustness of a personalized design. Last, we will do more robustness checks.

## Conclusion and Discussion

Leveraging a large-scale field experiment and a series of statistical analyses, this study resulted in three major findings that expand the existing literature on free samples. First, the results demonstrated via an inverted U-shaped relationship that an increase in free chapter quantity did not necessarily increase consumers' purchases. Second, it was also found that, despite adopting the freemium business model, product quality and popularity had a positive moderating effect on consumers' purchase decisions. In other words, even when consumers could directly experience products, other consumers' opinions still influenced their decisions to purchase. Third, long-term and high-activity consumers were more receptive to free chapter quantity. The current study has limitations for future studies to address. The results of this study do not account for how changes in a novel's plot impact consumers' decision-making. Future studies might add a novel's storyline as a key variable to more accurately explore optimal free sample quantity. Despite these limitations, our results enrich the studies about free samples in the fields of information systems and marketing and also deepen extant understandings of consumer purchase decisions in accordance with Construal Level Theory. Moreover, our study reveals the relationship between consumers' direct and indirect experiences. These conclusions can be used to construct strategies and suggestions for the optimal application of personalized free samples for digital content platforms.

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