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Mobile Geo-Targeting: Inside vs. Outside a Mall

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Mobile Geo-Targeting: Inside vs. Outside a Mall

ABSTRACT

Although the extant literature has much research on location-based targeting, it does not distinguish between inside and outside a location. This paper extends the literature by considering mobile coupons issued outside and inside the location in the setting of a shopping mall with multiple stores, where each store may issue mobile in-app coupons to potential customers. We first empirically examine the effect of coupons on stores' sales using a proprietary dataset from a large Chinese shopping mall. We show a stronger sales effect of coupon clicks made by consumers outside the mall than inside the mall, implying a traffic-conversion effect – bringing additional traffic to the mall – that has been overlooked in prior literature. Our data also suggest that stores may not gain more sales from issuing coupons, but can benefit from free-riding on other stores' coupons. Motivated by our empirical findings, we build a mathematical model to investigate optimal location-based coupon strategy. Our analytical results identify the conditions regarding whether and where a store selling experiential or functional products should issue coupons, which not only echo our empirical findings, but also show that without distinguishing inside or outside a location, marketers may underestimate these coupon effects and may target the wrong consumers. Lastly, we show the existence of the prisoner's dilemma where stores would not offer coupons, although they would be better off issuing coupons; moreover, we show that the driver is the coupons' traffic-conversion effect. This underscores the needs for mall owners to coordinate marketers in making coupon decisions.

Keywords: location-based targeting, mobile in-app coupon; game theory; empirical data; experiential/functional products

1. Introduction

The rapid adoption of mobile devices and the unprecedented growth in mobile applications (apps) present marketers with increasing opportunities to utilize mobile promotions and location-based targeting (LBT). According to App Annie (2020), annual worldwide downloads of mobile applications have grown 45% in the past three years since 2016. Downloads of mobile apps in 2019 alone surpassed 12.3 billion in the US and 160 billion in China, with China making up 80% of the total downloads worldwide (App Annie 2020). Although short message service (SMS) and mobile banner ads are still commonly used approaches for mobile promotions, mobile in-app couponing (i.e., issuing mobile coupons within a mobile app) has become a prevailing method in recent years for marketers to communicate with and incentivize customers. Taking advantage of mobile technologies (e.g., GPS technology, WIFI enabled-location tracking technology, cellular tracking technology), marketers are increasingly able to track consumers' usage of mobile coupons (i.e., when and where consumers click on mobile coupons; whether and how often consumers make a purchase by redeeming a coupon). Some advanced marketers are even able to offer customized mobile coupons based on customers' real-time locations (i.e., location-based coupons).

These emerging practices have stimulated a growing number of studies investigating various issues related to mobile promotions and location-based targeting (Narang and Shankar 2019; Luo et al. 2014; Fang et al. 2015; Fong, Fang and Luo 2015; Andrews et al. 2016; Chen Li and Sun 2017; Ghose, Li and Liu 2019). Specifically, a few of these studies have investigated how the effectiveness of location-based coupons (LBC) varies with the distance between marketers issuing coupons and consumers receiving these coupons (e.g., close, middle, and far distances) and other contextual factors such as coupon type, coupon expiry length, product type, customer characteristics, along with location-specific characteristics (Xu and Teo 2009; Luo et al. 2014; Danaher et al. 2015; Fang et al. 2015; Fong, Fang and Luo 2015; Andrews et al. 2016; Zubcsek, Katona and Sarvary 2017; Ghose, Li and Liu 2019). When investigating the effectiveness of location-based coupons, however, these studies have primarily focused on the distance between a marketer and consumers, without distinguishing whether consumers are inside or outside the marketer's

location (e.g., inside or outside a shopping mall). It is crucial to distinguish consumers' location relative to a marketer in terms of inside or outside the marketer's location because the effect of the mobile coupons differs. For example, when consumers are inside a shopping mall, issuing location-based coupons mainly serves to stimulate consumers' purchase interests and potentially increase sales, an effect that we define as the sales-conversion effect. However, when consumers are outside a shopping mall, location-based coupons may not only potentially increase sales (i.e., creating a potential sales-conversion effect), but may also drive consumers to the shopping mall, an effect that can potentially benefit both the coupon-issuing store and all other stores in the mall, which we define as the traffic-conversion effect. Prior LBT researchers have mostly concentrated on the former effect (i.e., sales-conversion effect) when designing their studies (e.g., experiments) and examining the effectiveness of location-based coupons, while overlooking the latter effect (i.e., traffic-conversion effect). Without considering the latter effect of mobile coupons, as shown in our analytical analysis, marketers may underestimate the benefits of location-based coupons and may target the wrong consumers when engaging in LBT.

This study employs both empirical and analytical research methods to investigate the effect of mobile in-app coupons and optimal LBC decisions. We first empirically examine the effect of mobile in-app coupons on stores' sales using a proprietary dataset from a large Chinese shopping mall. We then build an analytical model to examine an optimal LBC strategy by considering both the sales-conversion and traffic-conversion effects of LBC. Utilizing two research methods allows us not only to demonstrate empirical evidence on the effect of LBC, but also to provide prescriptive insights regarding optimal LBC decisions by taking into account the key findings from empirical studies involving LBC. However, most prior literature has empirically examined the impact of LBC using field data (Xu and Teo 2009; Luo et al. 2014; Danaher et al. 2015; Fang et al. 2015; Fong, Fang and Luo 2015; Andrews et al. 2016; Zubcsek, Katona and Sarvary 2017; Ghose, Li and Liu 2019), limited of them have further investigated the conditions for optimal LBC decisions using analytical modeling methods. A recent study has pioneered the use of two research methods in examining related issues on LBC; nevertheless, they focus on optimal pricing decisions rather than LBC decisions (Dubé, Fang, Fong and Luo 2017).

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In our empirical analysis, we analyze the impact of mobile in-app coupons on 603 stores' sales in a shopping mall from January 1 to August 15, 2015 with a window of 227 days. When doing so, we distinguish between (1) mobile coupons issued by focal stores and other stores; (2) the locations where consumers click on a mobile coupon inside or outside the shopping model; and (3) two types of stores—experiential-product stores (e.g., restaurants, coffee shops, salons and spas) and functional-product stores (e.g., stores selling home electronics, clothes, shoes, watches and jewelry). Our empirical analysis reveals three key findings. First, we show that stores issuing mobile coupons do not necessarily lead to more sales, but they can gain more sales from other stores' coupons. The former result may seem disappointing to stores offering mobile coupons, whereas the latter result demonstrates a free-riding effect from other coupon-stores, most likely due to the traffic-conversion effect of mobile in-app coupons. Second, when we distinguish between stores offering experiential versus functional products, we find that experiential-product stores can actually benefit from offering mobile in-app coupons in generating more sales; however, this benefit does not hold for functional-product stores. These findings imply fundamental differences in the effect of mobile in-app coupons between experiential- and functional-product stores. Unlike functional products where consumers can search for information and make purchases online, consumers must visit the shopping mall to touch and feel experiential products, which significantly increases the likelihood that consumers will redeem coupons for experiential products in the shopping mall. Last, and most interestingly, when we distinguish between the location of consumers' coupon clicks (i.e., inside or outside the shopping mall), we find that the more coupon clicks are made by consumers outside the shopping mall, the more sales the coupon-issuing stores can gain. Moreover, such a coupon-click location effect is stronger for coupon clicks made by consumers outside the shopping mall than inside. Because coupon clicks outside the shopping mall can lead to both traffic- and sales-conversion effects (whereas coupon clicks inside the shopping mall creates only the sales-conversion effect), our results further demonstrate empirical evidence on how the impact of mobile in-app coupons differs with respect to the location of consumers' coupon clicks (i.e., outside or inside the shopping mall).

Built on these key empirical findings, we then set up an analytical model by incorporating (1) the two effects of mobile in-app coupons in traffic and sales conversion, and (2) the free-riding effect of focal stores' coupons on other stores. In particular, we consider two stores in a shopping mall making LBC decisions, with one being an experiential-product store and the other being a functional-product store in our analytical model. We demonstrate that it is not always optimal for either experiential- or functional-product stores to offer mobile in-app coupons when considering the effectiveness of mobile in-app coupons in the traffic- and/or sales-conversion rate and the cost of doing so (i.e., the discount rate). Only when the traffic and/or sales conversion rates are sufficiently large or when the issuing coupon is not too costly is it optimal for a store to issue in-app coupons. Interestingly, we find that there is no situation under which *only* functional-product stores find it optimal to offer mobile in-app coupons. However, it doesn't apply for experiential-product stores vice versa (i.e., there are cases where *only* experiential-product stores find it optimal to offer coupons alone).

Furthermore, we show the conditions under which it is optimal for stores to target consumers who are either outside or inside the mall. For example, experiential-product stores can be better off by targeting consumers outside rather than inside the mall when the traffic-conversion rate is sufficiently large or when the cost of issuing coupons is low. It is important to note that, with the understanding of the free-riding effect generated by mobile in-app coupons, our results reveal a condition under which the prisoner's dilemma exists where both experiential- and functional-product stores would not offer coupons, although doing so would benefit both. For example, our results show that both experiential- and functional-product stores should offer coupons, but would not do so when the sales conversion rates of both stores are small, and at the same time, the traffic conversion rate for experiential-product stores is larger than that for functional-product stores. As stated earlier, this indicates the possibility that marketers may underestimate the conditions for optimal LBC when neglecting the traffic-conversion effect triggered by mobile in-app coupons.

These findings from both our empirical and analytical analyses make important contributions to the literature on LBT and provide implications to marketers when implementing LBC. First, our analyses

bring forth two new decisions to the LBT literature regarding whether and where to issue coupons that are crucial to marketers before designing LBC. Most existing empirical studies that investigate the effectiveness of LBC by varying distance and location have an underlying assumption that engaging in LBC is profitable to marketers. However, our analyses show that this is not always the case. In fact, our empirical analysis shows no overall empirical evidence on the sales effect of mobile in-app coupons in general, but only experiential-product stores can gain more sales from issuing coupons. Our analytical analysis also demonstrates findings regarding the conditions under which it is not optimal for marketers to issue coupons. With an understanding of these findings, marketers should exercise caution in identifying the optimal conditions before engaging in LBC. Additionally, we highlight that where coupons should be issued (i.e., targeting consumers inside or outside a location) is also an important decision that the LBT literature should consider, given that LBT on consumers who are outside or inside a location creates two different effects. As stated earlier, prior literature has mainly focused on the sales-conversion effect of mobile coupons when studying the impact of LBC; the traffic-conversion effect triggered by mobile coupons has not been explored. Our analyses present empirical evidence on this effect (i.e., the location effect of consumers' coupon clicks outside the shopping mall) and further demonstrate the conditions under which stores can be better off by offering mobile in-app coupons to assist marketers' making LBC decisions.

Furthermore, when marketers target consumers outside a shopping mall by mobile in-app coupons, it also creates a spillover effect on other particular stores in the same location that can free ride. Our analytical analysis reveals that this spillover effect (or free-riding effect) can create a prisoner's dilemma such that marketers (e.g., experiential- and functional-product stores) may not be willing to offer coupons and let other stores free ride, even though doing so would benefit both stores. This finding draws attention to the low-incentive issues caused by the prisoner's dilemma and underscores the needs for the mall owner to incentivize stores to offer mobile in-app coupons. For example, the shopping mall can act as a central organization and coordinate the two stores to issue coupons. This can be done by (1) designing a contract to require the stores to provide discounts, (2) coordinating a discount rate that fall outside this prisoner's

dilemma region, or (3) providing some monetary subsidy to incentivize the stores to offer coupons. The consequence of this coordination effort is a win-win situation not only for the stores, but also for the shopping mall.

2. Literature Review

Our work is closely related to the stream of research on Location-Based Mobile Targeting (LBT). As stated earlier, most previous works are empirical studies in which the location factor is characterized by the distance between the coupon receiving point and the coupon issuing point; none of them has examined the differential impacts of mobile coupons targeting consumers inside vs. outside a location. Specifically, a few papers have investigated how a coupon's redemption was affected by various factors such as coupon type (Xu and Teo 2009), distance (Danaher et al. 2015, Zubcsek et al. 2017), trajectory (Ghose et al. 2019), coupon expiry length (Danaher et al. 2015), and product type (Khajehzadeh et al. 2015) inside a shopping mall. For example, Danaher et al. (2015) considered the scenario in which mobile coupons were issued in a shopping mall and consumers' coupon redemptions were recorded. Their findings suggested that consumers would be more likely to redeem coupons when they received them at a location near the store. The results also indicated that the coupon redemption rate was lower for longer coupon expiry lengths, and it differed for various product types. Andrew et al. (2016) designed a randomized field experiment inside a location (i.e., subway train) to examine the effect of contextual factors such as physical crowds on consumers' responses to mobile coupons. Luo et al. (2014), Fong et al. (2015), and Fang et al. (2015) conducted similar field experiments to study how different levels of distance (along with various coupon discounts) influence coupon redemptions; however, they all focused on consumers outside a location (i.e., a movie theatre).

While the data in our paper were also obtained from a large shopping mall, we were able to track and identify whether consumers click on stores' in-app coupons before or after visiting the mall (i.e., outside or inside the mall), based on WIFI-enabled location tracking technology. To the best of our knowledge, our study is the first to assess the impact of consumers' coupon clicks in locations inside or outside a mall.

Examining such a location effect involving consumers' coupon response is important, as mentioned above, because two effects arise from issuing coupons: the sales-conversion effect and the traffic-conversion effect. All existing LBT studies have primarily focused on the first effect while overlooking the second effect.

As opposed to the abovementioned empirical works, some researchers have addressed the LBT problem from a purely analytical perspective (Chen Li and Sun 2017, Wan et al. 2019, Luo Li and Chen 2021). While empirical data capture relationships in real-life situations, a stylized model can provide important prescriptive implications. A multimethod approach allows us to analyze the problem through a different lens. Dubé et al. (2017) is the only paper in the literature that combines both empirical and analytical methodologies in the LBT research. They conducted a large-scale randomized field experiment where two competing movie theatres sent special offers with three different discount levels to consumers in several locations outside a movie theater. Then they built a demand model based on the experimental data to obtain optimal pricing strategies in a static Bertrand–Nash equilibrium. Our paper also implements both empirical and analytical methodologies with real data analysis results, motivating the parameters used in the analytical analysis via game theory. Different from Dubé et al. (2017), we consider a shopping mall with two stores selling experiential and functional products, respectively, and consumers can be in one of two locations: inside or outside a shopping mall. Additionally, instead of finding optimal pricing strategies such as in Dubé et al. (2017), we focus on studying whether or not to issue a coupon for each type of store and how the effectiveness of traffic- and sales-conversion (as well as the coupon cost) impact the equilibrium coupon strategies for both stores.

Furthermore, because of our unique setup that considers locations inside or outside a shopping mall, we are also able to provide suggestions about where to aim the coupons in different locations: inside or outside the shopping mall, which has not been discussed in the literature. By incorporating the two coupon effects, our analytical model can show when it is optimal for a store to target customers either inside or outside the mall. Lastly, our analytical model incorporates the free-riding effect from issuing coupons, which has not been addressed in the literature, but provides important managerial implications for shopping

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malls regarding the potential economic behavior of the prisoner's dilemma in stores' coupon issuing strategy.

3. Empirical Data and Findings

3.1 Data

We investigate the impact of mobile in-app coupons and consumers' coupon-click behaviors on store sales using a proprietary dataset from a large shopping mall in China. This shopping mall launched its mobile application in late April 2014. As of 2014, the shopping mall featured 603 famous brands of stores on four floors, with a total size of 2.9 million square feet. Since the launch of the mall's app, stores frequently issued coupons within the app, and the mall normally released stores' coupons to app users at midnight. Using advanced detection technology, the shopping mall can track when consumers click on store coupons and when they enter and leave the mall. Most interestingly, based on the tracking information, we could identify when consumers click on stores' in-app coupons before or after they visit the mall (i.e., outside or inside the mall).

Overall, we obtained data from the mall in terms of four aspects: (1) daily store sales, including information about the quantity of products sold to members of the mall in each store per day, as we could only obtain sales data from members of the mall; (2) the store's product type (e.g., home electronics, clothes, shoes, watches, jewelry, restaurants, coffee, salons and spas); (3) in-app coupon information about whether a store issued an in-app coupon every day; and (4) location information, the most unique information in our dataset, including consumers' coupon-click location (i.e., outside or inside the mall). To examine the coupon effect on stores' sales, we created a dummy variable, *Coupon*, to indicate if a store issued a coupon on a particular day (i.e., *Coupon*=1). For a focal store, we also counted the number of coupons issued by other stores on the same day to capture the potential cross-store coupon effect (or spillover coupon effect) on the focal store's sales and denoted it as *Coupon_Others*. Our data on in-app coupons and store sales span from January 1 to August 15, 2015 with a window of 227 days.

To investigate whether and how the impact of coupons on store sales differs by the location of consumers' coupon clicks (i.e., coupon clicks outside vs. inside the mall), we also counted the number of coupon-clicks every day by consumers who were outside and inside the mall when they clicked on coupons, denoting them as *Coupon_Clicks_Outside* and *Coupon_Clicks_Inside*, respectively. Lastly, we are interested in understanding if the location effect of consumers' coupon-click behaviors varies across different product types. Specifically, we categorize stores in the mall into two groups based on the products/services provided: experiential- and functional-product stores. In line with the literature (Cooper-Martin 1991; Kivetz and Zheng 2017; Kushwaha and Shankar 2013), we classified stores that offered products/services with dominant experiential attributes as experiential-product stores, including restaurants, coffee shops, salons and spas. Stores that offered products with dominant functional attributes were then classified as functional-product stores, including stores selling home electronics, clothes, shoes, watches and jewelry. The key characteristics of experiential products are that consumers must take time to consume and experience the products in order to fully understand the quality of these products (Cooper-Martin 1991; Chung and Rao 2012; Lim, Al-Aali and Heinrichs 2015). Hence, it is relatively more difficult for consumers to fully evaluate experiential products online (and without actual consumption), relative to functional products. Accordingly, we used a dummy variable *Store_E* to distinguish experiential- and functional-product stores (i.e., *Store_E*=1 if the respective store provides experiential products/services).

Table 1 provides the summary statistics of all variables. Store sales are measured as the quantity of a product sold to members of the mall per store and per day. Although we are only able to obtain the sales' quantity from the members of the mall, they represent the mall's app users, as consumers must register for the mall's app and become members of the mall in order to receive coupons regularly. On average, about 2.248 units of product were sold in each store per day. Because the mobile app was newly launched during the time period in our dataset, about 0.3% stores issued coupons per day, and 2.04 coupons were issued on average per day in the mall. According to the tracking information, the maximum number of coupon-clicks was eleven per store per day by consumers outside the mall and was five for consumers inside the mall.

Overall, the coupon-click average of 0.382 was made outside the mall, and the coupon-click average of 0.218 was made inside the mall per store per day.

[Insert Table 1 here]

3.2 Coupon Effect

We build an econometric model to first examine how issuing in-app coupons affects store sales. We specify a random-effect model as follows:

$$Ln(Sales)_{it} = \alpha_{0i} + \alpha_1 Coupon_{it} + \alpha_2 Coupon\_Others_{it} + \alpha_3 Store\_E_i + \alpha_4 Ln(Sales)_{i,t-1} +$$

$$\alpha_5 Weekend_t + \alpha_6 Holiday_t + \varepsilon_{it}, \qquad\qquad (1)$$

where we followed the literature (e.g., Lee, Choi, Cho and Lee 2020) and used the log-transformed store sales as the dependent variable. In the model, we capture not only the coupon effect (i.e., how issuing coupons affects sales), but also the spillover coupon effect (i.e., how coupons issued by other stores affects the sales of the focal stores). In addition, we incorporate control variables such as store types, previous sales, weekends and holidays where the two dummy variables, *Weekend* and *Holiday*, are used to indicate whether the specific date is a weekend and a national holiday, respectively (i.e., *Weekend*=1 if the specific date is a Saturday and Sunday; and *Holiday*=1 if the specific date is a national holiday[1]). The heterogeneity of stores is controlled by our random-effect model.

Table 2 presents our estimation results. As shown in Table 2, the overall impact of issuing coupons is not significant (α_1=0.038, p=0.144), whereas the spillover coupon effect is significantly positive (α_2=0.001, p<0.05). These two results are very interesting and imply that while issuing coupons might not necessarily lead to more sales for their own stores, stores can generate more sales from other stores' coupons. In other words, stores might not be able to take advantage by issuing coupons, but can free ride

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[1] National holidays in our data include "New Year's Day" (01/01/2015-01/03/2015), "Chinese New Year" (02/18/2015-02/24/2015), "Qingming Festival" (04/04/2015-04/06/2015), "May Day" (05/01/2015-05/03/2015), and "Dragon Boat Festival" (06/20/2015-06/22/2015).

on other stores' coupons. Why it cannot increase sales significantly by issuing coupons may be because a coupon only provides monetary incentives for consumers to come and consume in the mall, whether or not consumers will use the coupon to make a purchase also depends on other factors such as the product type and consumers' coupon-click behaviors.

Hence, we rerun the analysis using separate data from the experiential- and functional-product stores, respectively. Interestingly, we found that the coupon effect becomes significant for experiential-product stores (i.e., the coefficient of *Coupon* is 0.1, $p<0.05$), but is still insignificant for the functional-product stores (i.e., the coefficient of *Coupon* is -0.004, $p>1$). Similarly, the cross-store coupon effect also holds for experiential-product stores, but not for functional-product stores. That is, coupons issued by other stores offering experiential products/services created a spillover effect on the focal stores of the same type (i.e., the coefficient of *Coupon_Others_E* is 0.005, $p<0.05$). However, such a spillover effect does not hold for stores selling functional products (i.e., the coefficient of *Coupon_Others_F* is 0.001, $p>0.1$). These results are intriguing and indicate a fundamental difference in the coupon effect and cross-store coupon effect between experiential- and functional-product stores. For example, due to the essential characteristics of experiential products, consumers must visit the mall if they want to redeem coupons for experiential products/services and consume inside the mall (e.g., dining in a restaurant, enjoying a massage in a spa, etc.). Unlike experiential products, consumers can easily surf the Internet/smartphone to search for information about functional products, and eventually make a purchase online. Thus, issuing coupons for experiential products can increase not only the likelihood of consumers to make purchases by redeeming coupons (i.e., sales-conversion likelihood), but also the likelihood of them to visit the mall (i.e., traffic-conversion likelihood). The latter coupon effect of driving traffic to the mall is higher for experiential-product stores than for functional-product stores. As shown in Table 2, it is also evident that stores benefit more from releasing coupons if they offer experiential products or if the coupons are from other experiential-product stores.

[Insert Table 2 here]

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3.3 Location Effect

We further examine the location effect of consumers' coupon-click behaviors on store sales by incorporating consumers' coupon-click locations: *Coupon_Clicks_Outside* and *Coupon_Clicks_Inside*. Examining such a location effect of consumers' coupon clicks allows us to further distinguish the coupon effect for traffic conversion and sales conversion because coupon clicks outside the mall can induce both traffic conversion and sales conversion; whereas coupon clicks inside the mall generates only sales conversion. Specifically, instead of using a dummy variable, *Coupon*, to indicate if the focal store issued coupons at time *t*, we incorporate the two location variables of coupon clicks in our equation (2) to capture potentially different location effects of coupon clicks.

$$\ln(Sales)_{it} = \beta_{0i} + \beta_1 Coupon\_Clicks\_Outside + \beta_2 Coupon\_Clicks\_Inside$$
$$+ \beta_3 Coupon\_Others + \beta_4 Store\_E_i + \beta_5 \ln(Sales)_{it-1} \qquad (2)$$
$$+ \beta_6 Weekend_t + \beta_7 Holiday_t + \varepsilon_{it},$$

As shown in Table 3, the coefficient of *Coupon_Clicks_Outside* is significantly positive (β_1=0.093, $p<0.01$), while the coefficient of *Coupon_Clicks_Inside* is marginally significant and positive (β_2=0.102, p=0.055). These two results show that the more consumers clicked on the focal store's coupons (especially outside the mall), the more sales the store could gain from issuing coupons. When we categorize stores into two groups, we also see a marginally significant sign regarding the location effect of coupon clicks outside the mall for experiential-product stores. This stronger location effect of coupon clicks by consumers outside the mall for experiential products again reveals two insights: (1) the benefit of coupon clicks outside the mall, which induces both a higher likelihood of consumers to visit the mall and an increased likelihood of consumers to purchase the coupon products; and (2) the advantage of experiential products involving the coupon effect, relative to functional products.

Given our key findings on the coupon and location effects of consumers' coupon-click behaviors, as well as the differences in these two effects between experiential- and functional-product stores, it is interesting to explore how stores can optimize their coupon strategy by considering these empirical insights.

In the next section, we build an analytical model to investigate optimal coupon strategy for experiential- and functional-product stores.

4. The Mathematical Model

Consider a shopping mall with two stores, $i \in \{E, F\}$, selling products to customers at price p_i. Store E sells experiential products, and store F sells functional products. Without any in-app coupon, there are X_0 customers in the mall, and the number of customers who will buy product i is $\lambda_0 X_0$, where λ_0 is the sales conversion rate. Appendix A presents a table of notations.

Store i decides whether or not to issue a coupon to K customers. By using the coupon, the customers can buy product i at price δp_i, where $\delta < 1$ is the discount rate. A fraction β of these K customers are inside the mall when they click on the in-app coupon, and the other $1 - \beta$ are outside the mall. In general, a coupon has two impacts on a customer's shopping behavior. First, when the customers are outside the mall, clicking on product i's coupon brings a fraction λ_T^i of customers to the shopping mall. Second, when the customers are inside the mall, clicking on product i's coupon leads to more sales, i.e., $\lambda_S^i \geq \lambda_0$. Note that the sales conversion rate λ_S^i captures those customers who click on the in-app coupon and buy the product. Our empirical analyses (cf. Section 3) show that the effect of the other store's coupon and the effect of one's own store coupon are significantly stronger for experiential products than for functional products. The data also demonstrate that the increased sales from the number of coupon-clicks outside the mall is significantly larger for experiential products than for functional products. Hence, in the math model, we assume that the traffic conversion rate λ_T^i and the sales conversion rate λ_S^i are larger-than-or-equal-to for an experiential product than for a functional product, i.e., $\lambda_T^E \geq \lambda_T^F$ and $\lambda_S^E \geq \lambda_S^F$.

5. Analysis

In this section, we first examine whether or not a store should issue the coupon in Subsection 5.1, provided that β is a parameter that the stores can estimate based on the best educated guess about the location of the customers when the coupon is issued. The empirical data of our paper also illustrate the scenario in which the stores do not have advanced technology to determine the location of each customer when they issue the coupon. However, based on prior experience, the stores may estimate the distribution of all customers. Next, we consider the stores' coupon decision in terms of (1) whether or not, and (2) where to issue a coupon in Subsection 5.2, given the scenario in which stores can use advanced location tracking technology (e.g., GPS) to target the coupon to customers at a specific location (i.e., inside or outside a mall). In this scenario, then, β is a decision variable. When we examine the equilibrium coupon strategy, we simplify the stores' decision-making by assuming that the price is exogenously determined for two reasons. First, by simplifying stores' decision-making, it allows us to focus on the two key decisions: whether and where to issue mobile in-app coupons. Secondly, in practice, there are normally many stores in a mall that are either channel resellers or small. Hence, they basically have no market power, but simply follow market prices. Although there are also a few multinational brands in a mall that have market power, stores selling these brands do not usually adjust their prices often, as they wish to preserve their luxury brand image.

5.1. Stores Decide Whether to Offer a Coupon

In this subsection, we consider the scenario in which the two stores decide whether or not to provide an in-app coupon. Depending on the two stores' coupon decision, we have the following cases:

Case 0: None of the stores provides a coupon

For mathematical tractability, throughout the analysis, we normalize all production costs to zero. Then store i's profit is as follows:

$$\pi_i = \lambda_0 X_0 p_i \qquad (3)$$

Case 1: Only store i provides a coupon

Store i's profit is as follows:

$$\pi_i = \lambda_0(X_0 - \beta K)p_i + \lambda_S^i[\beta K + \lambda_T^i(1 - \beta)K]\delta p_i \qquad (4)$$

The first term, $\lambda_0(X_0 - \beta K)$, captures the number of customers inside the mall and who purchase the product at the regular price, p_i, and βK customers click on the in-app coupon inside the mall. The second term is the profit from selling to the customers who buy the product at the discounted price, δp_i. In particular, $\lambda_S^i \beta K$ is the number of customers inside the mall when they click on the coupon and make the purchase. Moreover, $\lambda_S^i \lambda_T^i(1 - \beta)K$ represents the customers outside the mall when they click on the coupon; they come to the mall (through the traffic conversion rate λ_T^i) and make a purchase (through the sales conversion rate λ_S^i) at the discounted price.

We use store j, where $j \neq i$, to denote the other store. Then the profit of store j is:

$$\pi_j = \lambda_0[X_0 + \lambda_T^i(1 - \beta)K]p_j \qquad (5)$$

Our empirical analyses show that the store sales increased from the other store's coupon (Section 3). In particular, $\lambda_T^i(1 - \beta)K$ is the number of customers outside the mall and who come to the mall because of store i's coupon. These customers have a normal sales conversion rate, λ_0, and purchase the product at the regular price p_j.

Case 2: Both stores provide a coupon

Because the two stores are selling different types of products, we assume that the two stores issue coupons to different customers. Then store i's profit is

$$\pi_i = \lambda_0(X_0 + \lambda_T^j(1 - \beta)K - \beta K)p_i + \lambda_S^i[\beta K + \lambda_T^i(1 - \beta)K]\delta p_i \qquad (6)$$

The first term, $\lambda_0(X_0 + \lambda_T^j(1 - \beta)K - \beta K)$, is the number of customers who purchase from store i without any coupon. Specifically, X_0 is the original number of customers in the shopping mall; some

customers come to the mall due to store j's coupon, $\lambda_T^j(1-\beta)K$. Some of these customers (βK) receive

store i's coupon inside the mall. The sales conversion rate for all of these customers is the normal

conversion rate, λ_0. The second term in Equation 6, $\lambda_S^i[\beta K + \lambda_T^i(1-\beta)K]\delta p_i$, is identical to the second

term under Case 1 (cf. Equation 4), i.e., the impact of store i's coupon on store i's sales.

There are four possible cases. We use a two-letter superscript to denote the store's strategy. The

first letter represents store E's decision, and the second letter represents store F's decision. Then we have

the following 2x2 payoff matrix:

		Store F	
		No coupon	Yes coupon
Store E	No coupon	(π_E^{NN}, π_F^{NN})	(π_E^{NY}, π_F^{NY})
	Yes coupon	(π_E^{YN}, π_F^{YN})	(π_E^{YY}, π_F^{YY})

First, we define the following thresholds: $\hat{y} \equiv \frac{\lambda_0}{\lambda_S^E}\frac{\beta}{\beta+(1-\beta)\lambda_T^E}$, $\dot{y} \equiv \frac{\lambda_0}{\lambda_S^E}\frac{\beta-(1-\beta)\lambda_T^F}{\beta+(1-\beta)\lambda_T^E}$ and $\tilde{y} \equiv$

$\frac{\lambda_0}{\lambda_S^E}\frac{\beta+(1-\beta)\lambda_T^F}{\beta+(1-\beta)\lambda_T^E}$. It can be shown that $\dot{y} \le \hat{y} \le \tilde{y}$. Then Lemma 1 examines the comparison of store E's profit.

The proofs are presented in Appendix C.

Lemma 1: *The comparison of store E's profit is as follows.*

    a. $\pi_E^{NN} < \pi_E^{NY}$.

    b. $\pi_E^{YN} < \pi_E^{YY}$.

    c. $\pi_E^{NY} > \pi_E^{YY} \Leftrightarrow \delta < \hat{y}$.

    d. $\pi_E^{NN} > \pi_E^{YN} \Leftrightarrow \delta < \hat{y}$.

    e. $\pi_E^{NN} > \pi_E^{YY} \Leftrightarrow \delta < \dot{y}$.

    f. $\pi_E^{NY} > \pi_E^{YN} \Leftrightarrow \delta < \tilde{y}$.

Store E is always better off when store F provides an in-app coupon ($\pi_E^{NN} < \pi_E^{NY}$ and $\pi_E^{YN} < \pi_E^{YY}$). This is because store F's coupon increases the traffic flow to the shopping mall, so store E can free-ride on store F's coupon offering.

Next, we investigate whether or not store E is better off issuing a coupon (i.e., the comparisons between π_E^{NY} and π_E^{YY}, and between π_E^{NN} and π_E^{YN}). This decision depends on how effective the coupon is (traffic and conversion rates λ_T^E, λ_S^E), when compared to how much of a discount store E needs to provide (δ). Both comparisons rely on the threshold $\hat{y}$. In particular, when store E makes a large discount to its price ($\delta < \hat{y}$), store E is worse off in terms of providing the coupon, whether or not store F issues a coupon (i.e., $\pi_E^{NN} > \pi_E^{YN}$ and $\pi_E^{NY} > \pi_E^{YY}$; cf. Lemmas 1c and 1d). Otherwise, store E is better off offering the coupon.

The other two thresholds, ($\dot{y}$ and $\tilde{y}$), correspond to the remaining comparisons. Specifically, store E is better off if both stores do not provide a coupon than if both stores provide a coupon ($\pi_E^{NN} > \pi_E^{YY}$) if $\delta < \dot{y}$ (cf. Lemma 1e). Moreover, when there is only one store offering a coupon, store E is better off being the store that provides a coupon ($\pi_E^{NY} < \pi_E^{YN}$) if $\delta > \tilde{y}$ (Lemma 1f).

Based on the profit comparisons, Corollary 1 presents all possible rankings of store E's profit. These rankings are useful when deriving the equilibrium in-app coupon strategy.

Corollary 1: *The rankings of store E's profit are as follows.*

- $\pi_E^{YN} < \pi_E^{YY} < \pi_E^{NN} < \pi_E^{NY}$ *if* $\delta < \dot{y}$.

- $\pi_E^{YN} < \pi_E^{NN} < \pi_E^{YY} < \pi_E^{NY}$ *if* $\dot{y} < \delta < \hat{y}$.

- $\pi_E^{NN} < \pi_E^{YN} < \pi_E^{NY} < \pi_E^{YY}$ *if* $\hat{y} < \delta < \tilde{y}$.

- $\pi_E^{NN} < \pi_E^{NY} < \pi_E^{YN} < \pi_E^{YY}$ *if* $\delta > \tilde{y}$.

Next, Lemma 2 investigates the comparisons of store F's profit. Define $\hat{z} \equiv \frac{\lambda_0}{\lambda_S^F} \frac{\beta}{\beta + (1-\beta)\lambda_T^F}$, $\dot{z} \equiv \frac{\lambda_0}{\lambda_S^F} \frac{\beta - (1-\beta)\lambda_T^E}{\beta + (1-\beta)\lambda_T^F}$ and $\tilde{z} \equiv \frac{\lambda_0}{\lambda_S^F} \frac{\beta + (1-\beta)\lambda_T^E}{\beta + (1-\beta)\lambda_T^F}$. It can be shown that $\dot{z} \leq \hat{z} \leq \tilde{z}$.

Lemma 2: *The comparisons of store F's profit are as follows.*

a. $\pi_F^{NN} < \pi_F^{YN}$.

b. $\pi_F^{NY} < \pi_F^{YY}$.

c. $\pi_F^{NN} > \pi_F^{NY} \Leftrightarrow \delta < \hat{z}$.

d. $\pi_F^{YN} > \pi_F^{YY} \Leftrightarrow \delta < \hat{z}$.

e. $\pi_F^{NN} > \pi_F^{YY} \Leftrightarrow \delta < \dot{z}$.

f. $\pi_F^{YN} > \pi_F^{NY} \Leftrightarrow \delta < \tilde{z}$.

The logic concerning these comparisons is similar to that of store E (cf. Lemma 1), so we omit the explanation to avoid redundancy. Then Corollary 2 presents the rankings of store F's profit.

Corollary 2: *The rankings of store F's profit are as follows:*

- $\pi_F^{NY} < \pi_F^{YY} < \pi_F^{NN} < \pi_F^{YN}$ *if* $\delta < \dot{z}$.

- $\pi_F^{NY} < \pi_F^{NN} < \pi_F^{YY} < \pi_F^{YN}$ *if* $\dot{z} < \delta < \hat{z}$.

- $\pi_F^{NN} < \pi_F^{NY} < \pi_F^{YN} < \pi_F^{YY}$ *if* $\hat{z} < \delta < \tilde{z}$.

- $\pi_F^{NN} < \pi_F^{YN} < \pi_F^{NY} < \pi_F^{YY}$ *if* $\delta > \tilde{z}$.

Lemma 3 illustrates a mathematical property for the thresholds that will be used in the equilibrium strategy.

Lemma 3: *The thresholds satisfy $\hat{y} < \hat{z}$.*

Proposition 1 presents the stores' equilibrium in-app coupon strategy.

Proposition 1: *The equilibrium coupon strategy is as follows:*

- *None of the store provides a coupon (strategy NN) if $\delta < \hat{y}$.*

- *Only store E provides a coupon (strategy YN) if $\hat{y} < \delta < \hat{z}$.*

- *Both stores provide a coupon (strategy YY) if $\delta > \hat{z}$.*

The general idea of the stores' equilibrium coupon strategy is as follows. The cost of a coupon to a store is the difference between the original and discounted price, i.e., $p_i - \delta p_i$. If the traffic or sales conversion rate is low, relative to the high coupon cost (i.e., $\delta < \hat{y}$), both stores do not use a coupon. On the other hand, both stores provide a coupon if the traffic or sales conversion rate is high, relative to the low coupon cost (i.e., $\delta > \hat{z}$). In the intermediate value ($\hat{y} < \delta < \hat{z}$), only store E provides a coupon; there is no situation under the equilibrium where only store F uses a coupon. This is because the traffic and sales conversion rates are higher for experiential products than for functional products ($\lambda_S^E \geq \lambda_S^F$ and $\lambda_T^E \geq \lambda_T^F$). This means that store E's coupon is more effective in converting shopping mall traffic to sales than store F's coupon. Therefore, when the coupon cost is intermediate, only one store provides a coupon, and this store is store E.

Proposition 2 illustrates an important managerial insight to the shopping mall hosting these two stores.

Proposition 2: *Both stores will not provide a coupon, even though both stores are better off when they provide a coupon ($\pi_i^{YY} > \pi_i^{NN}$), if and only if $max[\dot{y}, \dot{z}] < \delta < \hat{y}$.*

When the stores issue a coupon with a discount rate that satisfies $\delta > max[\dot{y}, \dot{z}]$, the two stores are better off if each store provides a coupon (i.e., $\pi_i^{YY} > \pi_i^{NN}$). However, as we stated in Proposition 1, the two stores will not offer any in-app coupon when the discounted price from using a coupon is sufficiently low (i.e., $\delta < \hat{y}$). Therefore, the economic behavior of the prisoner's dilemma occurs under the parameter setting $max[\dot{y}, \dot{z}] < \delta < \hat{y}$. This is because each store is worse off if only it provides a coupon, but is better off if both stores give out a coupon. Hence, both stores offering coupons cannot be in equilibrium because each store has the incentive to deviate so that it benefits from not giving out any coupon while enjoying the additional traffic flow brought in from the other store's coupon.

Because the stores are independent entities, neither of them can credibly promise the other store that it will issue a coupon. This limitation is harmful not only to each store, but also to the shopping mall

because there is less traffic when neither of the stores offers a coupon. Therefore, the managerial recommendation is that the shopping mall should act as a central organization and coordinate the two stores so that they issue coupons.

Recall that a fraction β of coupon customers are inside the mall when they click on the coupon, and the other $1 - \beta$ are outside the mall. In Proposition 1, we examine the equilibrium coupon strategy given the scenario in which stores cannot target customers at a specific location, and β is a given parameter based on stores' best guess. However, their guesses may have errors in the estimated value β. Thus, Proposition 3 presents a sensitivity analysis and shows how the customer's location (β) affects the equilibrium coupon strategy if the marketer has over- or underestimated the value β. Figure 1 plots the equilibrium strategy when $X_0 = 1$, $\lambda_0 = 0.5$, $K = 0.3$, $p_E = p_F = 1$, $\lambda_T^E = 0.1$, $\lambda_T^F = 0.05$ and $\lambda_S^E = \lambda_S^F = 0.7$. The x-axis is the fraction of coupon customers inside the store (β), and the y-axis is the discount from using the coupon (δ).
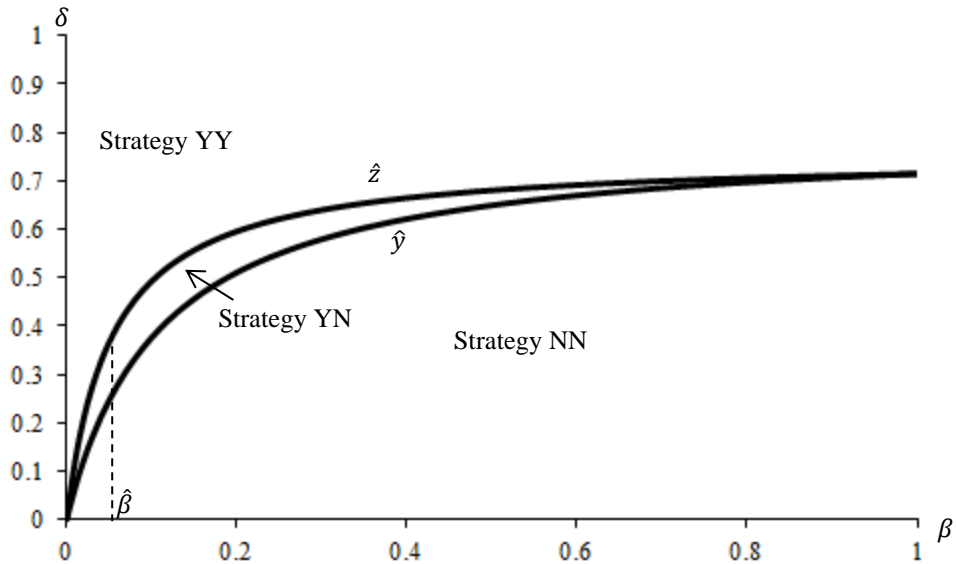
Figure 1: Equilibrium strategy

Proposition 3:

a. When $\beta = 0$, the equilibrium strategy is always YY.[2]

b. When β increases, strategy YY is optimal for a smaller range of δ, and strategy NN is optimal for a larger range of δ.

c. Strategy YN is optimal for the largest range of δ when $\beta = \hat{\beta} \equiv$

$$\frac{(\lambda_T^E - \lambda_T^F)\sqrt{\lambda_T^E \lambda_T^F \lambda_S^E \lambda_S^F} - \lambda_T^E \lambda_T^F \left(\lambda_S^F(1-\lambda_T^F) - \lambda_S^E(1-\lambda_T^E)\right)}{\lambda_T^E \lambda_S^F (1-\lambda_T^F)^2 - \lambda_T^F \lambda_S^E (1-\lambda_T^E)^2}.$$

d. When $\beta = 1$ and $\lambda_S^E = \lambda_S^F$, strategy YN is never the equilibrium. The equilibrium strategy is NN if $\delta < \hat{y}$, and is YY otherwise.

Recall that the in-app coupon has two impacts on stores' profit. The first is that the coupon increases the shopping mall's traffic flow. These are new customers whom the stores otherwise do not have. Therefore, the first impact of the coupon on stores is always beneficial. The second impact is that the sales conversion rate for those customers inside the mall is higher, i.e., $\lambda_S^i > \lambda_0$. Without the coupon, some of these customers will buy the product at the regular price; with the coupon, a higher fraction of those customers will buy the product, but at the discounted price. Therefore, the second impact on stores' profit can either be positive or negative, depending on how many extra customers the in-app coupon converts, and how much of a discount the store provides.

When all customers are outside the mall when they click on the coupon ($\beta = 0$), the coupon only has the first abovementioned impact, and the thresholds are $\hat{y} = \hat{z} = 0$. When referring to the equilibrium strategy in Proposition 1, this implies that both stores always provide coupons (strategy YY). In other words, stores are always better off by giving out a coupon when $\beta = 0$, i.e., when the coupon can convert more traffic from outside to inside the mall. Hence, both stores provide a coupon under this setting.

As there are more customers clicking on the coupon inside the mall (cf. Proposition 3b), the second

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[2] While in a real-life situation, it is least likely that customers clicking on the coupon are all inside or outside the mall when location is not a decision, we present Propositions 3a and 3d for mathematical completeness.

abovementioned impact of the coupon becomes more dominant, and the two thresholds, $\hat{y}$ and $\hat{z}$, increase. Therefore, strategy YY is less likely to be the equilibrium, while strategy NN is more likely to be the equilibrium. This is because more customers who click on the coupon are already inside the mall. Whether or not the coupon is beneficial to the stores depends on the sales conversion rate (λ_S^i) and the discount offered by the stores (δ).

Proposition 3c shows that the difference between $\hat{y}$ and $\hat{z}$ is the largest when some customers are inside the mall and some are outside the mall when they click on the coupon ($\beta = \hat{\beta}$; under the parameter setting of Figure 1, $\hat{\beta} = 0.07$). The area in which the equilibrium coupon strategy is, where store E provides a coupon but store F does not (strategy YN) is the largest when $\beta = \hat{\beta}$.

Lastly, all customers who click on the coupon are inside the mall when $\beta = 1$. This is the region where the stores are least likely to provide a coupon in the equilibrium. In addition, when the sales conversion rate for experiential products is the same as that for functional products ($\lambda_S^E = \lambda_S^F$), the effectiveness of both stores' coupon is essentially the same. Then $\hat{y} = \hat{z}$, and there will not be a case where only store E provides a coupon (i.e., strategy YN is never an equilibrium), i.e., their coupon strategy is symmetrical.

5.2. Stores Decide Whether and Where to Offer a Coupon

Subsection 5.1 describes the equilibrium strategy when the customer's location β is a parameter. This subsection derives prescriptive insights if the stores are able to target the coupon at customers in different locations. Specifically, each store decides (1) whether or not, and (2) where to offer coupons. This expands Subsection 5.1 to consider the stores' "where" decision. Note that the profit functions are linear in β, so if the stores were to offer a coupon, the β that maximizes the profit is a boundary value, i.e., $\beta = 0$ (only target customers outside the mall) or $\beta = 1$ (only target customers inside the mall). We plot this result in

Figure 2 using the following parameter settings: $X_0 = 1$, $\lambda_0 = 0.5$, $K = 0.3$, $p_E = p_F = 1$, $\lambda_S^E = 0.9$, $\lambda_S^F = 0.7$ and $\delta = 0.9$. The horizontal axis is the traffic conversion rate of store E's coupon (λ_T^E), and the vertical axis is the traffic conversion rate of store F's coupon (λ_T^F). This figure also illustrates what would happen when the discount rate δ increases. Note that the top left region is infeasible because the traffic conversion rate of store F is assumed to be smaller for store E (i.e., $\lambda_T^F < \lambda_T^E$).
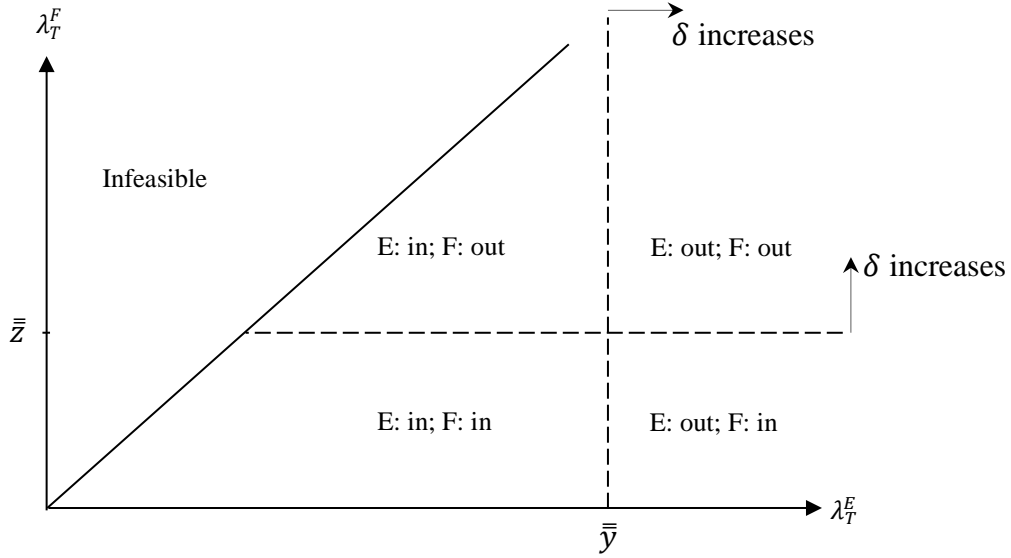
Figure 2: Whether or not and where stores E and F target their coupons

Proposition 4:

a. *Both stores always provide coupons.*

b. *Define $\bar{\bar{y}} \equiv 1 - \frac{\lambda_0}{\delta \lambda_S^E}$ and $\bar{\bar{z}} \equiv 1 - \frac{\lambda_0}{\delta \lambda_S^F}$. Then:*

- *Both stores target customers inside the mall if $\lambda_T^E < \bar{\bar{y}}$ and $\lambda_T^F < \bar{\bar{z}}$.*

- *Store E targets customers inside the mall, and store F targets customers outside the mall if $\lambda_T^E < \bar{\bar{y}}$ and $\lambda_T^F > \bar{\bar{z}}$.*

  - *This strategy can be true even when store E has a higher traffic conversion rate than store F ($\lambda_T^E > \lambda_T^F$).*

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- *Store E targets customers outside the mall, and store F targets customers inside the mall if $\lambda_T^E > \bar{\bar{y}}$ and $\lambda_T^F < \bar{\bar{z}}$.*

- *Both stores target customers outside the mall if $\lambda_T^E > \bar{\bar{y}}$ and $\lambda_T^F > \bar{\bar{z}}$.*

c. *Sensitivity analyses: $\frac{\partial \bar{\bar{z}}}{\partial \delta} > \frac{\partial \bar{\bar{y}}}{\partial \delta} > 0$.*

Offering a coupon to customers inside the mall cannibalizes some of these customers who otherwise (in the absence of a coupon) would buy the product at the regular price. However, there is no cannibalization cost for issuing a coupon to customers outside the mall. This is because the existing customers (no-coupon customers) will buy the product at the original place, and there are extra customers (from the traffic conversion rate) coming to the mall. Therefore, the strategy of "providing coupons to customers outside" always dominates the no-coupon strategy. Hence, firms will always issue a coupon.

Whether store E targets its in-app coupon to customers inside or outside the mall depends on the two abovementioned impacts of a coupon on stores (cf. the first paragraph of Proposition 3). In particular, when $\lambda_T^E > \bar{\bar{y}}$, a coupon can bring plenty of traffic from customers outside the mall to the mall. At the same time, offering a coupon to customers inside the mall cannibalizes some of these customers who otherwise (in the absence of a coupon) would buy the product at the regular price. Hence, store E only targets the coupon to customers outside the mall. On the other hand, when $\lambda_T^E < \bar{\bar{y}}$, the coupon is not effective in bringing customers to the mall. Moreover, recall that some of the customers will buy the product at the regular price without a coupon, and with coupon, a higher fraction of customers will buy the product, but at the discounted price. This (negative) cannibalization effect to customers inside the mall is relatively inconsequential when compared to a higher fraction of customers inside the mall who will buy the product with the coupon, or compared to the additional traffic that the coupon can bring to the mall under this parameter setting. Therefore, store E targets the in-app coupon to customers inside the mall. The same logic applies to store F's decision about whether to target customers inside or outside the mall.

The 45-degree line in Figure 2 corresponds to the parameter setting where the traffic conversion rates of both products are the same (i.e., $\lambda_T^E = \lambda_T^F$). It can be shown that when $\bar{\bar{y}} > \bar{\bar{z}}$, there are cases where store E targets customers inside the mall, while store F targets customers outside the mall, even when store E's coupon has a higher traffic conversion rate ($\lambda_T^E > \lambda_T^F$). This is because the stores consider not only the traffic conversion rate, but also the sale conversion rate when deciding where to target the in-app coupon. In the case where store E's coupon has a much larger sales conversion rate than store F ($\lambda_S^E > \lambda_S^F$), store E targets customers inside the mall, while store F targets customers outside the mall.

When the coupon cost decreases (δ increases), the two thresholds, $\bar{\bar{y}}$ and $\bar{\bar{z}}$, increase. Therefore, the region where both stores target customers inside (E: in; F: in) increases, while the region where both stores offer coupons to customers outside (E: out; F: out) decreases. Moreover, because $\bar{\bar{z}}$ increases at a faster rate than $\bar{\bar{y}}$, the region where store E targets customers outside while store F targets customers inside (E: out; F: in) increases at a faster rate than the opposite region (E: in; F: out).

6. Conclusion and Managerial Insights

This paper uses a multimethod approach to examine the effect of mobile in-app coupons and the optimal LBC decisions. We highlight the need to differentiate between the impact of mobile coupons targeting consumers inside a location versus those outside a location, an important difference that the LBT literature has not explored, but is essential to firms' LBC decisions. When incorporating the differential impacts of mobile coupons targeting consumers inside or outside a location, we decompose coupon effects into two distinguish ones: traffic-conversion and sales-conversion effects, where the latter one has been the focus in the LBT literature, but the former one is new to the literature. We emphasize that a significant traffic-conversion effect arises from customers outside the location (i.e., a shopping mall in our case) clicking on mobile app coupons; this leads to additional traffic to the mall, as well as a free-riding/spillover effect where

these additional customers also benefit stores that did not issue coupons. This mechanism is the fundamental driver of our paper.

We first empirically examine the effect of mobile in-app coupons on stores' sales using proprietary data from a large Chinese shopping mall. These data show that stores issuing mobile coupons do not necessarily increase their sales by doing so, but they can gain more sales from other stores' coupons, especially for stores selling experiential products. More importantly, our data reveal that coupon-issuing stores can significantly increase their sales from coupon clicks made by consumers outside the shopping mall, demonstrating how the location of the coupon clicks (i.e., outside or inside the shopping mall) strongly affects the impact of mobile in-app coupons.

Next, we set up a mathematical model, which considers a shopping mall that contains a store selling experiential products and another store selling functional products to customers. Each store decides whether or not to issue a coupon to customers. Our results not only identify the conditions under which a store selling experiential or functional products should (or should not) issue coupons, but also derives prescriptive insights regarding where stores should target their coupons if they have the technological ability to aim the coupons at customers in different locations. Namely, we find that in general, whether and where stores should target coupons to consumers depends on the effectiveness of the traffic and sales conversion induced by coupons, relative to the coupon's cost. For example, our results show that stores should issue coupons to customers outside the mall when the traffic conversion rate is large enough. Without understanding this result, stores and shopping malls may underestimate the coupon's benefits by targeting only consumers inside a location.

Furthermore, it is interesting to note that there are cases in which the experiential-product store should target customers inside the mall, and the functional-product store should target customers outside the mall—even when the former has a higher traffic conversion rate than the latter. These results imply that stores should first understand where to target their coupons before determining optimal pricing/discount

levels. Or else they could target the wrong consumers without considering the product types and the effectiveness of the traffic and sales conversion rates.

Lastly, the results from the mathematical model also provide implications for mall owners. For example, as we emphasized earlier, there is the economic behavior of the prisoner's dilemma, where both firms will not provide coupons (even though they would be better off doing so) when the cost of issuing a coupon is intermediate. We also show that while there are cases where *only* experiential-product stores find it optimal to offer coupons alone, there is no situation under which *only* functional-product stores find it optimal to offer mobile in-app coupons. These results underscore the need for mall owners to act as a central organization to resolve this paradox by coordinating the two stores and incentivizing them to offer mobile in-app coupons.

Yet, our paper has some limitations that open avenues for future research in two main directions. First, in terms of our empirical results, we differentiate consumers' clicks according to their location (outside vs. inside the mall), and argue that those outside the location can bring extra traffic to the stores. However, we could not empirically separate the traffic conversion made by outside clicks from the general sales conversion. Although we analyze this effect using game theory, the psychological mechanism requires further investigation. Moreover, we examine the mobile in-app coupon effect using data from a large Chinese shopping mall, in which all stores are located in one building and are close to one another. Additional research is needed to confirm whether these effects hold for Western shopping malls and/or stores that are not as close to one another. Second, in terms of our mathematical model, we develop a stylized model that considers a shopping mall consisting of two stores selling different products. It would be interesting for future research to consider competition among shopping malls, as well as among stores selling similar products.

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Table 1. Descriptive Statistics

Variable	Description	Mean	Std. Dev.	Min	Max
Sales	Units of product sold per day	2.248	7.118	0	225
Coupon	Whether or not a store issued a coupon per day	0.003	0.058	0	1
Coupon_Others	Number of coupons other stores issued during the same day	2.036	3.759	0	14
Coupon_Clicks_ Outside	Number of coupon-clicks made by consumers outside the mall per store per day	0.382	0.934	0	11
Coupon_Clicks_ Inside	Number of coupon-clicks made by consumers inside the mall per store per day	0.218	0.615	0	5

Note: There are 136,881 observations of store sales in units from 603 stores over a window of 227 days in our dataset.

Table 2. Impact of Issuing a Coupon on Sales

	All Stores' Sales	Sales from Experiential-Product Stores	Sales from Functional-Product Stores
Coupon	0.038 (0.026)	0.100^{**} (0.039)	-0.004 (0.035)
Coupon_Others	0.001^{**} (0.0004)		
Coupon_Others_E		0.005^{***} (0.002)	
Coupon_Others_F			0.001 (0.001)
Store_E	-0.010^{***} (0.003)		
Previous sales	0.762^{***} (0.002)	0.742^{***} (0.003)	0.774^{***} (0.002)
Weekend	0.100^{***} (0.003)	0.093^{***} (0.005)	0.105^{***} (0.004)
Holiday	-0.005 (0.006)	-0.002 (0.009)	-0.007 (0.007)
Constant	0.115^{***} (0.003)	0.116^{***} (0.004)	0.108^{***} (0.003)
Number of Observations	136,278	52,206	84,072
Number of Stores	603	231	372
R^2	0.588	0.556	0.606

Notes: Standard errors appear in brackets; $^{**}p < .05$, $^{***}p < .01$.

Table 3. The Location Effect of Coupon Clicks on Sales

	All Stores' Sales	Sales from Experiential-Product Stores	Sales from Functional-Product Stores
Coupon_Clicks_Outside	0.093**	0.079*	0.047
	(0.035)	(0.042)	(0.056)
Coupon_Clicks_Inside	0.102*	0.028	0.066
	(0.053)	(0.064)	(0.091)
Coupon_Others	-0.002	-0.006	0.011
	(0.009)	(0.014)	(0.011)
Store_E	0.123*		
	(0.064)		
Previous sales	0.588***	0.767***	0.126**
	(0.038)	(0.048)	(0.063)
Weekend	0.028	0.044	0.051
	(0.068)	(0.103)	(0.081)
Holiday	-0.003	0.018	-0.033
	(0.085)	(0.135)	(0.097)
Constant	0.212**	0.207*	0.375***
	(0.087)	(0.124)	(0.104)
Number of Observations	463	209	254
Number of Stores	22	9	13
R^2	0.450	0.644	0.027

Notes: Standard errors appear in brackets; $^*p < .1$, $^{**}p < .05$, $^{***}p < .01$. Using detection technology, we were only able to observe 463 coupon-click behaviors for 22 stores' coupons during our data period.

Appendix A: Table of Notations

X_0	Number of customers in the mall without any coupon
p_i	Regular price of product i
λ_0	Conversion rate of customers if they are at the mall and without a coupon
δ	Coupon's discount rate
K	Number of coupons provided by each store and clicked on by customers
β	When providing a coupon, β of these coupons are clicked by customers inside the mall, and $1 - \beta$ are clicked by customers outside the mall.
λ_T^i	Fraction of customers (who are outside the mall) will come to the mall due to a coupon of product i
λ_S^i	Fraction of customers who receive a coupon will purchase product i

Appendix B: Proof of Results

Proof of Lemma 1: The results can be obtained from comparing Equations 3 - 6. □

Proof of Corollary 1: The result follows Lemma 1. □

Proof of Lemma 2: The results can be obtained from comparing Equations 3 - 6. □

Proof of Corollary 2: The result follows Lemma 2. □

Proof of Lemma 3: $\hat{y} \leq \hat{z}$ because $\lambda_S^E \geq \lambda_S^F$ and $\lambda_T^E \geq \lambda_T^F$. □

Proof of Proposition 1:

Strategy NN $\Leftrightarrow \pi_E^{NN} > \pi_E^{YN}$ and $\pi_F^{NN} > \pi_F^{NY} \Leftrightarrow \delta < \hat{y}$ and $\delta < \delta_F^2 \Leftrightarrow \delta < \hat{y}$.

Strategy NY $\Leftrightarrow \pi_E^{NY} > \pi_E^{YY}$ and $\pi_F^{NY} > \pi_F^{NN} \Leftrightarrow \delta < \hat{y}$ and $\delta > \hat{z}$. However, this is infeasible because $\hat{y} \leq \hat{z}$.

Strategy YN $\Leftrightarrow \pi_E^{YN} > \pi_E^{NN}$ and $\pi_F^{YN} > \pi_F^{YY} \Leftrightarrow \delta > \hat{y}$ and $\delta < \hat{z} \Leftrightarrow \hat{y} < \delta < \hat{z}$.

Strategy YY $\Leftrightarrow \pi_E^{YY} > \pi_E^{NY}$ and $\pi_F^{YY} > \pi_F^{YN} \Leftrightarrow \delta > \hat{y}$ and $\delta > \hat{z} \Leftrightarrow \delta > \hat{z}$. □

Proof of Proposition 2: This result can be obtained from Lemma 1e, Lemma 2e and Proposition 1. □

Proof of Proposition 3:

Part a: It can easily be shown that $\hat{y} = \hat{z} = 0$ when $\beta = 0$. Then this result can be obtained.

Part b: $\frac{\partial \hat{y}}{\partial \beta} = \frac{\lambda_0}{\lambda_S^E} \frac{\lambda_T^E}{\beta + (1-\beta)\lambda_T^E} > 0$ and $\frac{\partial \hat{z}}{\partial \beta} = \frac{\lambda_0}{\lambda_S^F} \frac{\lambda_T^F}{\beta + (1-\beta)\lambda_T^F} > 0$. Then the result follows.

Part c: $\frac{\partial(\hat{z}-\hat{y})}{\partial \beta} = \frac{\lambda_0}{\lambda_S^F} \frac{\lambda_T^F}{\beta + (1-\beta)\lambda_T^F} - \frac{\lambda_0}{\lambda_S^E} \frac{\lambda_T^E}{\beta + (1-\beta)\lambda_T^E} > 0 \Leftrightarrow \beta < \hat{\beta}$. Then the result follows.

Part d: It can be shown that $\hat{y} = \hat{z}$ when $\beta = 1$ and $\lambda_S^E = \lambda_S^F$. Then this result can be obtained. □

Proof of Proposition 4: The derivation is similar to that of Proposition 1. Specifically, stores E and F decide (1) no coupon, (2) coupon to inside, and (3) coupon to outside; hence, there are nine possible cases. We use a two-letter superscript to denote the store's strategy. The first letter represents store E's decision, and the second letter is store F's decision. Then we have the following 3x3 payoff matrix:

		Store F		
		No	In	Out
Store E	No	(π_E^{NN}, π_F^{NN})	(π_E^{NI}, π_F^{NI})	(π_E^{NO}, π_F^{NO})
	In	(π_E^{IN}, π_F^{IN})	(π_E^{II}, π_F^{II})	(π_E^{IO}, π_F^{IO})
	Out	(π_E^{ON}, π_F^{ON})	(π_E^{OI}, π_F^{OI})	(π_E^{OO}, π_F^{OO})

Part a: $\pi_E^{NN} = \pi_E^{NI} = \lambda_0 X_0 p_E$, $\pi_E^{NO} = \lambda_0(X_0 + \lambda_T^F K)p_E$, $\pi_E^{IN} = \pi_E^{II} = \lambda_0(X_0 - K)p_E + \lambda_S^E K \delta p_E$, $\pi_E^{IO} = \lambda_0(X_0 + \lambda_T^F K - K)p_E + \lambda_S^E K \delta p_E$, $\pi_E^{ON} = \pi_E^{OI} = \lambda_0 X_0 p_E + \lambda_S^E \lambda_T^E K \delta p_E$, $\pi_E^{OO} = \lambda_0(X_0 + \lambda_T^F K)p_E + \lambda_S^E \lambda_T^E K \delta p_E$. The corresponding profit functions for store F can be defined similarly. It can easily be shown that $\pi_E^{ON} > \pi_E^{NN}$, $\pi_E^{OI} > \pi_E^{NI}$ and $\pi_E^{OO} > \pi_E^{NO}$. Similarly, $\pi_F^{NO} > \pi_F^{NN}$, $\pi_F^{IO} > \pi_F^{IN}$ and $\pi_F^{OO} > \pi_F^{ON}$. Therefore, the only four possible optimal strategies are II, IO, OI and OO.

Part b: The following comparisons of store E's profit can easily be shown: $\pi_E^{OI} > \pi_E^{II} \Leftrightarrow \lambda_T^E > \bar{\bar{y}}$ and $\pi_E^{OO} > \pi_E^{IO} \Leftrightarrow \lambda_T^E > \bar{\bar{y}}$. Similarly, the following comparison of store F's profit can be shown: $\pi_F^{IO} > \pi_F^{II} \Leftrightarrow \lambda_T^F > \bar{\bar{z}}$ and $\pi_F^{OO} > \pi_F^{OI} \Leftrightarrow \lambda_T^F > \bar{\bar{z}}$. Then the optimal strategy is as follows:

- Strategy II $\Leftrightarrow \pi_E^{II} > \pi_E^{OI}$ and $\pi_F^{II} > \pi_F^{IO} \Leftrightarrow \lambda_T^E < \bar{\bar{y}}$ and $\lambda_T^F < \bar{\bar{z}}$

- Strategy IO $\Leftrightarrow \pi_E^{IO} > \pi_E^{OO}$ and $\pi_F^{IO} > \pi_F^{II} \Leftrightarrow \lambda_T^E < \bar{\bar{y}}$ and $\lambda_T^F > \bar{\bar{z}}$

- Strategy OI $\Leftrightarrow \pi_E^{OI} > \pi_E^{II}$ and $\pi_F^{OI} > \pi_F^{OO} \Leftrightarrow \lambda_T^E > \bar{\bar{y}}$ and $\lambda_T^F < \bar{\bar{z}}$

- Strategy OO $\Leftrightarrow \pi_E^{OO} > \pi_E^{IO}$ and $\pi_F^{OO} > \pi_F^{OI} \Leftrightarrow \lambda_T^E > \bar{\bar{y}}$ and $\lambda_T^F > \bar{\bar{z}}$.

Part c: $\frac{\partial \bar{\bar{y}}}{\partial \delta} = \frac{\lambda_0}{\delta^2 \lambda_S^E}$ and $\frac{\partial \bar{\bar{z}}}{\partial \delta} = \frac{\lambda_0}{\delta^2 \lambda_S^F}$. Hence $\frac{\partial \bar{\bar{z}}}{\partial \delta} > \frac{\partial \bar{\bar{y}}}{\partial \delta} > 0$ because $\lambda_S^E > \lambda_S^F > 0$. □