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# Optimal Checkout Strategies for Online Retailers

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**Abstract**

Growth in online retailing has driven firms to focus on optimizing the consumers' shopping journey and one of the most important aspects of online shopping is the checkout process offered by the retailer. In this paper, we focus on factors influencing retailers' choice of offering either a flexible checkout or a restricted checkout option to consumers. We define a checkout strategy to be flexible when consumers can purchase items in their shopping cart either as a guest or by logging into their account whereas with a restricted checkout strategy, the consumers are required to login to the account to make purchases. With a game-theoretic model and duopolistic framework, the current study identifies conditions in which online retailers might adopt symmetric strategies and those in which two ex-ante symmetric firms might prefer asymmetric strategies. The analysis suggests that relative proportion of privacy conscious vs. convenience conscious consumers, additional utility due to account registration, reduction in transaction cost and additional revenue due to targetability are the important determinants of the strategies adopted by online retailers.

*Keywords: Digital marketing strategies, Guest checkout, Account checkout.*

# 1 Introduction

Online shopping is growing at a tremendous pace. The global e-commerce sales are expected to grow year-over-year by about 17.9% (Young 2019) and thus, will double between 2018 and 2023 to surpass 6.5 trillion US dollars by 2023 (Statista 2020). But this growth has been hampered by consumers abandoning online shopping carts. Thirty-five percent of users cite account creation as a key reason for abandoning the checkout process. Thus, an optimal checkout strategy is important to prevent shopping cart abandonment. In this paper, we focus on factors that influence retailers' choice of offering either a flexible checkout or a restricted checkout option to consumers. We define a checkout strategy to be flexible when consumers could purchase items in their shopping cart either as a guest or by logging into their account whereas with a restricted checkout strategy, the consumers are required to login to the account to make purchases. [1]

## 1.1 Guest checkout

Securing point by point information at individual level evokes blended responses from shoppers. Although shoppers recognize that providing additional information during the checkout process could enable firms to not only provide easier, quicker and more streamlined shopping experience during future purchase occasions but also allow firms to offer customized products consistent with their needs, consumers may be concerned that firms may leverage the data in ways that they don't desire. Recent data suggests that consumers are less likely to share their information with companies (Lafayette 2019). For example, fewer individuals are willing to share their domestic address (down from 41% in 2018 to 31% in 2019). Similarly, the fraction of consumers eager to share their email address is down from 61% (in 2019) to 54% (in 2018) (Swant 2019). Some consumers consider targeted promotion irritating and perceive as an infringement of their privacy (Johnson 2013). Sixty-five percent of businesses encounter delays in sales due to privacy concerns, with an average delay of two months (Levine 2018). A number of recent research papers also highlight that shoppers are highly concerned with privacy issues

[1] In our modeling framework, we do not consider the scenario in which a retailer offers only the guest checkout option to consumers as it is not consistent with industry practice.

(Aguirre et al. 2015, Bleier and Eisenbess 2015, Inman and Nikolova 2017). As per the Federal Trade Commission (FTC) 2017 survey, around 40 million online shoppers were the victims of online fraud in 2017 because of revealing their information to e-commerce websites. The guest checkout option also requires a low level of commitment which is suitable for those shoppers who are not willing to share their credit card information with retailers (Kowalick 2019). In addition, since guest checkout is quicker, it may reduce cognitive load and positively impact the shoppers' buying process (Kruglanski and Webster 1991, Livi 2003, Webster et al. 1996, Lalwani 2006). All these evidence supports the argument that consumers are now less willing to register online which negatively impacts the revenues of online retailers. Consequently, many online retailers offer a guest checkout option (e.g., eBay - see Figure 1). The shopper has to fill minimum details as compared to account checkout option to buy as a guest. The guest checkout allows the shoppers to buy from an online store without logging in and online retailers do not save any personal information such as username, password, shipping/billing address, credit card details. Since shopper's information is used only for the current order and not stored for usage in the future, it reduces shopper's privacy concerns, in turn increasing conversion rates.

Insert Figure 1 about here

## 1.2 Account checkout

With account checkout, if an online shopper wants to buy a product, she will see a screen before the checkout process which asks her either to create an account (register or sign up) or to log in now. The first-time shopper has to give details such as name, password, email-id, and shipping and billing addresses. It is a one-time registration process and the registered user can log in and avoid repeating the process of registration. When a shopper uses account checkout option, the information of the shopper is stored by online retail website. The account checkout option allows shoppers to use the previously provided information when they later return to the same retail website (for e.g., Amazon offers 1-Click ordering for registered users). Figure 2 shows the account registration process on Amazon's website.

Insert Figure 2 about here

There are several underlying reasons driving retailers' decision to offer account checkout. First, retailers can engage in additional cross-selling of complementary products based on purchase history. These additional products are the set of products which are highly associated with each other on the basis of goal based inter-relationships (Englis and Solomon 1996, Diehl et al., 2015). For example, the retail website may show roasted coffee packs as a recommendation when a shopper intends to buy a coffee machine. This cross-selling could increase their sales and boost revenues. Second, online retailers collect and use information provided by shoppers for targeted advertising (Naylor 2016). Sometimes they share this information data package with the advertisers (or sellers) for segmentation and targeting. This is another source of revenue generation for websites which act as two-sided retailers. Companies such as AT&T, Comcast, Charter Communications, Google Fiber, etc. have gathered data from consumers to segment them efficiently for targeted advertising (Krouse and Haggin 2019). eBay conducts real-time analysis of the data collected at the individual-level to maintain greater relevancy for consumers (Karu 2016). The increase in volume of sign-ups may lower attrition rate, increase number of loyal shoppers and improve customer lifetime valuation (Akçura and Srinivasan 2005). Third, account registration makes it convenient for mobile users because completing personal details during each purchase occasion using the mobile keyboard is tedious. Currently, mobile internet traffic has more than 50% share of global online traffic (Clement 2019). Therefore, account checkout option could also be an excellent strategy to target mobile internet users and increase sales to them. Finally, exchanges, returns and refunds are also tricky in guest checkout because transaction record is not permanent whereas it is fairly straightforward if consumer account information is available (Iovation 2020).

Consumers are also motivated to adopt account registration because the shoppers can get a first-time sign-up discount after registering with the website. Many retailers provide this discount as a welcome gift. Table 1 shows the list of 27 retailers who provide sign up discounts. Another significant benefit of the account checkout option is rewards and points to redeem. After account checkout, the retail stores may also offer some loyalty programs. Evy's Tree Who's Hoo reward program is one of the successful reward programs which brings 83 times ROI, 58% increases in repeat purchase and $1032 reduction in monthly ad spend (Orendorff

2018). In addition, consumers can even personalize their visit by providing all necessary information to the website (Figure 2, step 3). This personalization helps shoppers to get relevant deals when they open the webpage next time. The order history in account checkout is saved. This reduces the problems with returns, reordering and exchanging of products and provides additional convenience.

Insert Table 1 about here

The above discussion highlights potential benefits as well as drawbacks of guest and account checkout options. Guest checkout may increase the conversion rate, but account checkout may provide retailers with additional information about their customer base. Thus, it seems reasonable that firms may want to offer both checkout options to consumers. However, many online retailers use only account checkout option i.e., a restricted checkout policy rather than a more flexible checkout policy (i.e., offering both account and guest checkout options). Table 2 shows the partial list of online retailers offering a restricted vs. a flexible checkout policy. Thus, it is puzzling why some online retailers offer only a restricted checkout policy and our objective in this paper is to provide a consumer-driven plausible explanation for the distinct strategies used by competing online retailers.[2] More specifically, we focus on the following two research questions: (1) What role does underlying firm and consumer characteristics play in an online retailer's decision to offer a restricted checkout strategy (account checkout only) or a flexible checkout strategy (account and guest checkout)?, and (2) Under what conditions will we observe competing online retailers offering asymmetric checkout strategies (i.e., one firm using flexible whereas a competing firm using restricted checkout strategy) and conditions under which both firms offer symmetric checkout strategies (i.e., both firms offering either flexible or restricted checkouts). To answer these questions, we develop a horizontal differentiation model of duopolistic retailer competition, accounting for realistic retailer characteristics (e.g., additional revenues due to targeted advertising) and consumer characteristics (e.g., relative proportion of privacy conscious consumers and convenience conscious consumers, additional utility obtained by account registration).[3]

[2]One could also imagine that offering a more flexible checkout strategy increases organizational complexity as well as administrative costs; in this paper, we do not focus on such additional drivers of a firm's choice of checkout strategies.

[3]We describe these firm and consumer characteristics in detail in Section 3.

Insert Table 2 about here

Our analysis makes the following contributions. First, we provide guidance to online retailers on the appropriate checkout strategy (restricted or flexible). As stated earlier, e-commerce business continues to increase and it is important for online retailers to implement optimal strategies to grow their business. Second, we highlight how underlying consumer and firm characteristics impact choice of checkout strategy. For example, new startups with limited resources may want to study heterogeneity among their customer base to identify the appropriate strategy. Finally, we show that in a competitive environment, firms shouldn't just imitate the checkout strategy of their competitor. Under some conditions, firms may be better off choosing a distinct checkout strategy relative to their competitor.

# 2 Literature Review

Prior research has focused on various strategies that firms could use to improve online retailers' profitability. Holzwarth et al., (2006) investigate the advantages of using avatars (graphic animation representation) on the company's commercial websites. They show that usage of avatars has a positive effect on consumer online shopping behavior. Baye and Morgan (2009) analyze the interaction of the brand advertising with pricing and listing decisions of online retailers. They find that under endogenous branding decisions, online retailers will get loyal customers which depends upon the pricing strategy of the retailers. The branding decisions can be affected by average prices, best prices, the volume of advertising, and price dispersion. Consistent with these papers, our research contributes to this stream of research by focusing on the choice of optimal checkout strategy which impacts online retailers' profitability.

Since account checkout option could exacerbate consumers' privacy concerns, our research is related to prior research on online consumer's privacy (Smith et al. 1996; Stewart and Segars 2002; Malhotra et al. 2004; Brown and Muchira 2004; Camp 2003; Chellappa and Sin 2005; Solove 2006; Dinev and Hart 2006; Hann et al. 2007; Huberman et al. 2007; Inman and Nikolova 2017). Chellappa and Shivendu (2006, 2010) find that privacy concerns of consumers influence strategies and service level of a third party which provides personalization. Hui et al.,

(2007) find that the privacy statement from the retailers helps the consumers to disclose more of their personal information. The monetary incentive has a positive impact on information disclosure and the amount of data has a negative effect on information disclosure. Tsai et al., (2011) determine the impact of privacy information accessibility on consumer's purchase decisions. Consumers consider their private information and purchase from those websites which offer at least a medium level of privacy and they are also willing to pay a premium to maintain privacy. Lee et al. (2011) find that privacy protection mitigates the competition in offering personalization option because privacy conscious consumers prefer those firms which offer privacy protection. Building on this stream of literature, we consider a proportion of consumers in the market to be privacy-conscious such that they are unwilling to register themselves on an online retailer's website.

Our paper is also related to the literature on the impact of privacy concerns on advertising revenues. Goldfarb and Tucker (2011) investigate the impact of privacy regulation on advertising. They show empirically that in European countries where privacy laws are implemented, the effectiveness of banner advertising reduces by 65% in terms of stated purchase intent. Tucker (2014) finds that if consumers have more control over their personal information, personalized ads for charity work better. Casadesus-Masanell and Hervas-Drane (2015) analyze the profit of the firm under the setting where consumers choose the amount of personal information to share and firms choose amount of information to reveal to a third party. They find that a single source of revenue can be more beneficial for the firms which attracts more consumers. Inman and Nikolova (2017) find that privacy concerns mediate the relationship between technology acceptance and the likelihood to purchase. Gal-or et al. (2018) find that privacy concerns lead to a reduction in targeted advertising and escalate price competition between the firms. Building on this stream of research, in our modeling framework, we consider advertising revenue only from those consumers who register themselves on an online retailer's website.

# 3 Model

We consider two competing online retailers, described by subscripts 1 and 2, and each retailer offers one product. We analyze competition between retailers using the Hotelling framework (Hotelling 1929). The Hotelling framework has been used extensively to understand competitive strategies in marketing contexts (e.g., Pazgal, Soberman, and Thomadsen, 2016; Tyagi, 2000). The two retailers are located at opposite ends of a Hotelling line of unit length. Retailers sell their product in two periods to consumers and each retailer offers a product which gives $V$ utility to consumers each period and $V$ is sufficiently high such that each consumer purchases one unit of the product in each period from the retailer which provides him/her with the highest utility. Retailers strategically choose between a restricted or flexible checkout strategy based on consumer characteristics which we describe in the next subsection. With a restricted checkout strategy, retailers allow shoppers to purchase only after account registration whereas with a flexible checkout strategy, the retailers offer both guest as well as account checkout options to purchase products.

## 3.1 Online shopper characteristics

We consider two types of consumers in the market: (i) Convenience-conscious (CC) consumers and (ii) Privacy-conscious (PC) consumers. We assume that both types of consumers are uniformly distributed along the line segment. The total consumers in the market has been normalized to 1 and we assume that there are $\alpha$ and $1-\alpha$ proportion of CC and PC consumers respectively.

*Convenience-conscious (CC) Consumers:* CC consumers always choose to purchase after account registration. CC consumers derive two key benefits through account registration. Firstly, they get the benefit of personalized recommendations in future occasions, freedom to rate/review, exclusive offers, wish list option etc. We use a parameter $\kappa$ to capture this additional utility for the CC consumers. Secondly, when CC consumers register themselves on a retailer's website, they can purchase the product easily from that website in subsequent purchase occasions. The online registration in the first period reduces the travel cost of the CC

consumers in the second period. We use a parameter $\theta$ to capture this reduction in travel cost for CC consumers. We use $\theta$ as a multiplicative factor of the travel cost parameter which is consistent with Chen (2006) who uses a parameter to show the reduction in consumer transaction cost (Page 109, section 4). The total utility of CC consumers is the sum of the utilities of the two periods which is given by:

$$U_{\alpha} = V - p_i - t\,|x - l| + \delta(V + \kappa - p_i - \theta t\,|x - l|) \tag{1}$$

where $\delta$ represents the common discount factor for future utility of the consumer and profits for the firm. [4]

*Privacy-conscious (PC) Consumers:* Contrary to CC consumers, PC consumers are more concerned about consumer privacy and purchase from the retailer only if guest checkout option is available. Their decision to buy depends upon the price of the current period and their valuation for the product, $V$ captures all the benefits associated with guest checkout option such as low level of commitment, maintenance of privacy, no bombardment of spam emails, etc. $p_i$ is the price of the product provided by the retail platform $i$ and $t$ is the travel cost parameter for PC consumers which shows the degree to which the product of the retailers can be substituted. We assume that a buyer located at x incurs a linear travel cost to buy the product of the retailer platform located at $l$ for $(l = 0, 1)$. The PC consumers' utility will be same in two periods. Thus, the total utility of a PC consumer who buys the product from the platform i is given by.

$$U_{1-\alpha} = (V - p_i - t\,|x - l|)(1 + \delta) \tag{2}$$

## 3.2 Retailer characteristics

The retailer $i$ charges a price $p_i$ $(i = 1; 2)$ to consumers which is endogenously determined in our model and does not change across periods. The market is horizontally differentiated and the marginal cost is identical and set to zero. All online shoppers are aware of the locations of retail

[4] We recognize that creating an account in the first period could increase consumer's transaction cost leading to higher travel cost in the first period. As a robustness check, we consider an augmented model with such an increase in travel cost in Period 1 for the CC consumers and show that our results continue to hold in Section 5.3.

stores and vice versa (Ofek et al., 2011).

Retailers will get the information of all CC consumers because these consumers have registered themselves on the site before buying a product. Retailers can utilize this information and show relevant advertising to these consumers and provide a better user experience with the help of personal information. Goldfarb and Tucker (2011) show that digital targeting improves the conversion rate and it declines when there is a reduction in access to consumer information. Online ad targeting could increase conversion rates when consumers see personally relevant information. Accepting cookies online can make targeted advertising more valuable (Hatch 2019). For example, apparel companies like Stitchflix and Modcloth have very personal information for clothing, and they use the collected information to ensure a better fit for the consumers during online purchase of apparel. In addition, prior literature also suggests that firms disclose consumers information to gain profit from advertisers because advertisers could use this information to show consumers relevant ads (Casadesus-Masanell and Hervas-Drane 2015). We use $\eta$ parameter to capture the extent of the profitability of this targeted advertising and it depends on the proportion of CC consumers. The PC consumers do not contribute to additional profits due to targeted advertising because they are more concerned with privacy and do not share their personal information with the website.

### 3.2.1 Platform profitability under various strategies

Platform profitability under various strategies are as follows:

1. Restricted checkout case: (Price X Demand from CC consumers in each period) + Advertising revenue from the total number of CC consumers
2. Flexible checkout case: (Price x Demand from CC and PC consumers in each period) + Advertising revenue from the total number of CC consumers

Note that the price of the product in each case is endogenously derived. The additional revenue is based on the demand of CC consumers. Table 3 summarizes the notation used in the paper.

Insert Table 3 about here

### 3.3 Sequence of decisions

In our duopolistic competition model, the online retailers choose the restricted or flexible checkout strategy based on how firm profitability is impacted due to underlying consumer preferences. The game has three stages, and we solve for the subgame perfect equilibrium using backward induction.

1. Stage 1: The retailers choose restricted or flexible checkout strategy.
2. Stage 2: The retailers simultaneously choose the price of the products $p_i$ $(i = 1, 2)$.
3. Stage 3: Each consumer in the market purchases the product from the retailer who provides the highest utility.

## 4 Analysis

With two possible strategies for each firm, we consider the four possible strategy combinations in sequence. In the parameter space under consideration, we compare profits under these four strategy subgames to find equilibrium outcomes. To represent firm prices and profits, we use the subscript $RR$ in the subgame in which both retailers adopt restricted checkout strategy, we use the subscript $FF$ in the scenario in which both retailers use flexible checkout strategy, and we use the subscript $FR$ in the subgame in which Firm 1 uses a flexible strategy and Firm 2 uses a restricted checkout strategy. [5]

### 4.1 Both retailers adopt restricted checkout strategy

If both retailers adopt restricted checkout strategy, then only the *CC* consumers will purchase the product from the retailers. The *PC* consumers prefer to buy the product from guest checkout. If the guest checkout option is not available, they decide not to buy from either platform. In this case, the retailers will get the profit only from *CC* consumers. We use the *CC* consumer's utility function to solve endogenously for equilibrium prices and determine retailer

[5] There is also a fourth strategy in which Firm 1 chooses to use a restricted checkout strategy and Firm 2 uses a flexible one but it is completely analogous to the $FR$ subgame.

profitability. The profit functions of retailer 1 and 2 are:

$$\pi_{1RR} = \alpha x_{CC} p_{1RR}(1+\delta) + \eta\alpha x_{CC}, \text{ and} \quad (3)$$

$$\pi_{2RR} = \alpha(1-x_{CC}) p_{2RR}(1+\delta) + \eta\alpha(1-x_{CC}), \quad (4)$$

in which $x_{CC}$ represents the marginal CC consumer.

We calculate the first-order conditions by differentiating the profit functions of the retailers with respect to the price of products. The equilibrium price and profit function of the retailers are given by $(i = 1, 2)$

$$p^*_{iRR} = \frac{t - \eta + t\delta\theta}{1+\delta}, \text{ and} \quad (5)$$

$$\pi^*_{iRR} = \frac{\alpha(t + t\delta\theta)}{2}. \quad (6)$$

The price charged by each retailer depends upon the disutility parameter due to registration, additional advertising revenue parameter, and reduction in traveling cost scaling parameter in equilibrium. The profit of the retailers depends upon disutility parameter due to registration, and reduction in traveling cost scaling parameter in equilibrium.

## 4.2 Both retailers adopt flexible checkout strategy

In this scenario, both types of consumers prefer to buy the product from the retailers. The CC consumers prefer to buy through the account checkout option from any of retailers. The utility obtained by CC consumers is given in equation 1. PC consumers can buy from any of the retailers through guest checkout option and receive utility provided in equation 2. The retailers will generate profit from both types of consumers. The profit function of the retailers 1 and 2 are given by

$$\pi_{1FF} = \alpha x_{CC} p_{1FF}(1+\delta) + (1-\alpha) x_{PC} p_{1FF}(1+\delta) + \eta\alpha x_{CC}, \text{ and} \quad (7)$$

$$\pi_{2FF} = \alpha(1-x_{CC}) p_{2FF}(1+\delta) + (1-\alpha)(1-x_{PC}) p_{2FF}(1+\delta) + \eta\alpha(1-x_{CC}), \quad (8)$$

in which $x_{CC}$ and $x_{PC}$ represent the marginal CC and PC consumers respectively. Again, we calculate the first-order conditions by differentiating the profit functions of the retailers with respect to the price of products. The equilibrium price and profit function of the retailers are given by (i=1,2)

$$p^*_{iFF} = -\frac{t(t-\alpha\eta+t\delta\theta)}{t(-1+\alpha\delta(-1+\theta)-\delta\theta)}, \text{ and} \tag{9}$$

$$\pi^*_{iFF} = -\frac{-(-1+\alpha)\alpha\gamma\eta+t\alpha\delta\eta(-1+\alpha+\theta-\alpha\theta)+t^2(1+\delta)(1+\delta\theta)}{2(t(-1+\alpha\delta(-1+\theta)-\delta\theta))}. \tag{10}$$

The prices and profit of the retailers depend upon the disutility parameter due to registration, additional revenues due to CC consumers, the proportion of CC consumers and traveling cost scaling parameter in equilibrium.

## 4.3 Retailers adopt asymmetric strategies

We consider a scenario in which retailer 1 adopts a flexible checkout strategy and retailer 2 adopts a restricted checkout strategy. In this asymmetric case, the profit functions of retailers 1 and 2 are given by:

$$\pi_{1FR} = \alpha x_{CC} p_{1FR}(1+\delta) + (1-\alpha)x_{PC}p_{1FR}(1+\delta) + \eta\alpha x_{CC}, \tag{11}$$

$$\pi_{2FR} = \alpha(1-x_{CC})p_{2FR}(1+\delta) + \eta\alpha(1-x_{CC}), \tag{12}$$

Again, we calculate the first-order conditions by differentiating the profit functions of the retailers with respect to the price of products. The equilibrium price and profit function of the retailers are given by [6]:

[6]Note that the profitability of retailers doesn't depend on $\kappa$ as CC consumers always choose one of the two retailers such that $\kappa$ cancels out.

$$p^*_{1FR} = \frac{3t\alpha(\eta) + 4tV(-1+\alpha)(1+\delta\theta) - 3t^2(\alpha+\alpha\delta\theta)}{-8t(1+\delta\theta) + t\alpha(5+\delta(-3+8\theta))}, \tag{13}$$

$$p^*_{2FR} = \frac{\begin{pmatrix} (t^2(1+\delta\theta)(\alpha+\alpha\delta(-3+4\theta) \\ -4(1+\delta\theta) + t(2V(-1+\alpha)(1+\delta)(1+\delta\theta) + \eta(4+4\delta\theta \\ +\alpha(1-3\delta-4\delta\theta)) \end{pmatrix}}{(1+\delta)(-8t(1+\delta\theta) + t\alpha(5+\delta(-3+8\theta))}. \tag{14}$$

$$\pi^*_{1FR} = \frac{\begin{pmatrix} -((9t^4\alpha^2(1+\delta)(1+\delta\theta)(\alpha+\alpha\delta(-1+2\theta) \\ -2(-1+\delta\theta) \\ -3t^3\alpha(32\eta(1+\delta\theta)^2 + 4\alpha(1+\delta\theta)(3\gamma(1+\delta) \\ +4\eta(-3+\delta-4\delta\theta)) + 8V(-1+\alpha)(1+\delta)(1+\delta\theta) \end{pmatrix}}{\begin{pmatrix} (1+\delta)(-8t(1+\delta\theta) + t\alpha(5+\delta(-3+8\theta)) \end{pmatrix}}, \tag{15}$$

$$\pi^*_{2FR} = \frac{\begin{pmatrix} \alpha(t+t\delta\theta)(2(-1+\alpha)(V(1+\delta)+2(\eta)) \\ +t(-4+\alpha-3\alpha\delta-4\delta\theta-4\alpha\delta\theta))^2 \end{pmatrix}}{2(-8t(1+\delta\theta) + t\alpha(5+\delta(-3+8\theta))^2)}. \tag{16}$$

# 5 Results - Equilibrium characterization and comparative statics

In order to derive managerial insights based on our analysis, we study the outcomes of our modeling exercise under two distinct scenarios. These scenarios capture possible decision-making settings that managers in online retailing firms might face based on the data available. In the first scenario, we analyze the equilibrium in terms of proportion of CC consumers and revenues from targeted advertising parameter. In the second scenario described subsequently, we interpret the equilibrium in terms of proportion of CC consumers and travel cost scaling parameter.

## 5.1 Case 1: Analysis in terms of proportion of CC consumers $(\alpha)$ and revenues from targeted advertising $(\eta)$

In the closed form expressions of firm profits, we fix the values of base utility, travel cost, and travel cost scaling parameter, so that we can analyze the equilibrium in terms of proportion of CC consumers and revenues from targeted advertising. Our analysis of the conditions in which a symmetric or asymmetric equilibrium holds reveals two symmetric equilibria: one when both platforms use restricted strategy and another in which both platforms use flexible strategy and one asymmetric equilibrium when platform 1 adopts flexible checkout strategy and platform 2 adopts restricted checkout strategy, as we detail in Proposition 1 and 2.

**Proposition 1** *The asymmetric equilibrium with one firm choosing the restricted checkout strategy and the competing firm choosing a flexible checkout strategy holds when the proportion of CC consumers is relatively high and revenues due to targeted advertising are in the intermediate range.*

When a firm offers a flexible checkout strategy, both types of consumers purchase from that retailer. Consider the scenario in which the revenue from targeted advertising parameter is in the intermediate range and both firms are following a flexible checkout strategy. As the proportion of CC consumers increases, one firm realizes that it could charge higher prices by catering to only CC consumers and foregoing the demand from PC consumers. The PC consumers prefer to buy from the guest checkout option. So, they will purchase from the retailer with flexible checkout strategy. Thus, an asymmetric strategy could arise in equilibrium. Our result provides a demand-based (rather than just a cost-based) justification as a plausible explanation for why horizontally differentiated firms may adopt asymmetric checkout strategy in equilibrium.

Alternately, consider the scenario in which the proportion of CC consumers is high and the advertising revenue parameter is relatively low. As the advertising revenue parameter increases, the additional revenue from advertising as well as the ability to charge higher prices incentivizes one of the firms to switch from flexible checkout strategy to a restricted checkout strategy. The competing firm continues with a flexible checkout strategy as it is able to generate profits even from PC consumers who are more concerned about privacy issues.

**Proposition 2** *(a) The symmetric equilibrium with both firms choosing a restricted checkout strategy holds when the revenues due to targeted advertising are relatively high.*

*(b) The symmetric equilibrium with both firms offering a flexible checkout strategy holds when proportion of CC consumers and revenues due to targeted advertising are relatively lower.*

When retailers adopt a restricted checkout strategy, they will benefit from the CC consumers as they are forward-looking and expect a higher utility in the second period due to account registration in the first period. In this scenario, retailers with restricted strategy will also get additional revenues due to targeted advertising. They will get these additional revenues in the second period, once CC consumers registered in the first period.

When the revenues from targeted advertising is lower, offering a flexible checkout strategy enables online retailers to generate additional demand from PC consumers. Hence, retailers prefer to offer a flexible checkout strategy to get the benefit of higher demand from the consumers. Figure 3 shows the equilibrium conditions region plot for Case 1.

Insert Figure 3 about here

Next, we calculate the comparative statics of retailers profits with respect to some of the underlying parameters in the model. The key results from this analysis are presented in Proposition 3.

**Proposition 3** *(a) The profit of the firm which adopts restricted strategy always increases with the increase of proportion of CC consumers whereas the profit of the firm which adopts flexible checkout strategy decreases with the increase of proportion of CC consumers.*

*(b) The profit of the firm which adopts restricted strategy always increases with the increase of additional revenues due to targeted advertising whereas the profit of the firm which adopts flexible strategy increases with the increase of additional revenues when (a) proportion of CC consumers are low or (b) proportion of CC consumers are high and additional revenues due to targeting is low.*

The firm with restricted strategy will benefit from an increase in the number of CC consumers because of increased demand. However, all PC consumers prefer to buy from the firm with

flexible strategy. If the number of CC consumers is increasing, the firm with flexible strategy charges a lower price leading to lower margins and consequently their profits gradually decrease with the increase of CC consumers.

The firm with restricted strategy will get benefit as the additional revenues due to targeted advertising increases because it increases the overall profit of the firm. However, the profit of the firm with flexible strategy increases with the increase in additional revenues under two conditions. First, if the proportion of CC consumers is low, then this increase in additional revenues will not affect the profit of the firm because the firm gets revenues from PC consumers. Second, if CC consumers are more and marginal increase in additional revenues is low, then the overall profit of the firm still increases due to PC consumers.

## 5.2 Case 2: Analysis in terms of proportion of CC consumers $(\alpha)$ and travel cost scaling parameter $(\theta)$

In the closed form expressions of firm profits, we fix the values of base utility, travel cost, and additional revenue due to targeted advertising, so that we can analyze the equilibrium in terms of proportion of CC consumers and travel cost scaling parameter. Again, we get equilibrium conditions for two symmetric equilibria: one when both platforms use restricted strategy and another in which both platforms use flexible strategy and one asymmetric equilibrium when platform 1 adopts flexible checkout strategy and platform 2 adopts restricted checkout strategy, as we detail in Proposition 4 and 5.

**Proposition 4** *The asymmetric equilibrium, with one firm utilizing restricted checkout strategy and the competing firm utilizing flexible checkout strategy holds under two conditions: (i) when the proportion of CC consumers is in the intermediate range and travel cost scaling parameter is relatively lower OR (ii) when the proportion of CC consumers as well as travel cost scaling parameter are relatively high.*

When a firm offers a flexible checkout strategy, both types of consumers purchase from that retailer. Consider the scenario in which both firms offer flexible strategy. As the proportion of CC consumers increase, one firm realizes that it could charge a higher price by focusing only on

CC consumers (and willing to forgo the demand from PC consumers). The PC consumers prefer to buy from the guest checkout option. So, they will purchase from the platform with flexible checkout strategy. Consequently, we see an asymmetric choice of checkout strategy in equilibrium.

When the proportion of CC consumers and traveling cost scaling parameters are relatively high, the platform with the restricted checkout strategy will get benefit from the CC consumers. However, the platform with the flexible checkout strategy also has the option of account registration. So, CC consumers who are close to the platform with the flexible checkout strategy will buy the product using the account checkout option from this platform. Secondly, the platform with flexible checkout strategy will also get benefit from the PC consumers because they prefer to buy from the guest checkout option.

**Proposition 5** *(a) The symmetric equilibrium with both firms following a restricted checkout strategy holds when the proportion of CC consumers is higher than a threshold and traveling cost scaling parameter is relatively low.*

*(b) The symmetric equilibrium with both firms following flexible checkout strategy holds when the proportion of CC consumers is below a threshold.*

When the proportion of CC consumers is high, and a traveling cost scaling parameter is low, both firms realize that using a restricted checkout strategy enables them to charge higher prices and concentrate on the demand only from CC consumers. In such a scenario, the PC consumers do not make a purchase from either firm. Each retailer's profitability is further enhanced due to the revenue from advertising.

When the proportion of CC consumers is below a threshold, both firms have an incentive to cater to the demand from PC consumers as well. Since PC consumers prefer to purchase using the guest checkout option, firms offer a flexible checkout policy. Even though the relative prices are lower with a flexible checkout strategy, the incremental demand from PC consumers allows each retailer to improve profitability with a flexible checkout strategy. Figure 4 shows the region plot for Case 2 with distinct regions in which the asymmetric and symmetric equilibrium exists.

Insert Figure 4 about here

Similar to case 1, we also calculate the comparative statics under this scenario and get some interesting results which are given in Proposition 6.

**Proposition 6** *(a) The profit of the firm which adopts a restricted checkout strategy always increases with the increase of proportion of CC consumers whereas the profit of the firm which adopts flexible strategy increases with the increase of proportion of CC consumers only when the proportion of CC consumers is higher than a threshold.*

*(b) The profit of the firm which adopts a flexible checkout strategy always increases with the increase in traveling cost scaling parameter whereas the profit of the firm which adopts a restricted checkout strategy increases with the increase in traveling cost scaling parameter when the proportion of CC consumers is higher than a threshold.*

When the proportion of CC consumers is increasing, the firm with restricted strategy will get a higher number of registrations because these consumers are forward-looking, and they know that they will get more benefits with the registration in future. The firm which adopts flexible strategy also has a good volume of PC consumers who are not willing to register themselves due to privacy concerns. This firm will get profit from the increase in proportion of CC consumers only when the proportion is higher than a threshold because the benefit from the relatively higher prices that it can charge outweighs the drop in profitability due to a decrease in demand from PC consumers.

When the traveling cost scaling parameter increases, the equilibrium price increases. So, the firm with flexible checkout strategy will get benefit from consumers paying a higher price. However, the firm with restricted checkout strategy will get profit with the increase in travel cost only when the proportion of CC consumers is high. When the proportion of CC consumers is low, the relatively lower prices as well as lower demand (since they do not cater to PC consumers) reduces profits of the firm following a restricted checkout strategy.

### 5.3 Robustness Check - Accounting for disutility due to account registration process

Given that CC consumers have to invest time and effort to complete the registration process for the account checkout in the first period, one could imagine that they incur a disutility which increases their travel cost in Period 1. Let this disutility be represented by a parameter $\gamma$ ($\gamma > 0$) and it could be another factor that influences the choice of checkout strategy. To check the robustness of our main results, we reanalyze the model with $\gamma > 0$. Note that the parameter $\gamma$ is present only in the utility function of CC consumers. As stated earlier, the total utility of CC consumers is the sum of the utilities across the two periods. The utility function of CC consumers in this scenario is given by

$$U_{j\alpha i} = V - p_{ij} - (\gamma + t)x_{CC} + \delta(V + \kappa - p_{ij} - \theta t x_{CC}). \tag{17}$$

in which $j = RR, FF, FR$ depending on the scenario under consideration and $i = 1, 2$.

Our analysis reveals that the pattern of results is replicated in this scenario. In the region plot of the equilibrium conditions, we see that the area under the symmetric flexible checkout strategy and asymmetric equilibrium expands and the area under the symmetric restricted checkout strategy equilibrium conditions shrinks. But the insights from our main model continue to hold in this scenario. Figure 5 shows the region plots for Case 1 and Case 2 with distinct regions in which the asymmetric and symmetric equilibrium exists for $\gamma = 1/5$ and values of the other parameters as discussed in the equilibrium analysis of the main model for Cases 1 and 2.

Insert Figure 5 about here

## 6 Summary and Further Research

Growth in online retailing has driven firms to focus on optimizing the consumers' shopping journey and one of the most important aspects of online shopping is the checkout process offered by the retailer. In this paper, we focus on factors influencing retailers' choice of offering

either a flexible checkout or a restricted checkout option to consumers. The choice of checkout strategy is also becoming important because the proportion of privacy conscious consumers is increasing, and presence of such consumers negatively impacts the profit of online retailers if they focus only on restricted checkout strategy. If they use flexible checkout strategy, then the pricing decision is not very clear. Our research provides a solution to this dilemma in two distinct scenarios with the help of duopolistic competition model. Retailers may adopt either restricted or flexible strategy, based on the proportion of CC consumers, traveling cost scaling parameter and additional revenues due to targeted advertising. Thus, our modeling framework provides a consumer demand based (rather than cost-based) justification as a plausible explanation for why we observe ex-ante identical firms offering distinct checkout strategies.

In the first scenario, we analyze the equilibrium with variation in the proportion of CC consumers and additional revenue parameter due to targeted advertising. In this case, firms adopt a restricted checkout strategy when additional revenues due to targeted advertising are relatively high. Firms adopt a flexible checkout strategy when the proportion of CC consumers and additional revenues due to targeted advertising are relatively lower. Furthermore, an asymmetric equilibrium may also exist when proportion of CC consumers is relatively high and additional revenues due to targeted advertising are in the intermediate range.

In the second case, we analyze the equilibrium with variation in the proportion of CC consumers and travel cost scaling parameter. In this case, we show that firms adopt a restricted checkout strategy when proportion of CC consumers is relatively higher and reduction in travel cost associated with online registration is relatively lower. Furthermore, firms adopt a flexible checkout strategy when the proportion of CC consumers is relatively lower. An asymmetric equilibrium may also exist under two conditions. First, when the proportion of CC consumers is in the intermediate range and travel cost scaling parameter is relatively low. Second, when the proportion of CC consumers and travel cost scaling parameter are relatively high.

## 6.1 Directions of Future Research

We make several assumptions while analyzing our model. For instance, in our model, all consumers buy the product from one of the two retailers. However, there is a possibility that

few consumers may opt-out of buying the product from any retailers. Secondly, we also assume that each consumer is buying one product from one retailer at one time. There is a possibility that one consumer could buy products from multiple retailers simultaneously. Third, we assume that consumers are uniformly distributed to neutralize the effect of consumer's distribution in our equilibrium model. Fourth, we assume that there is no distinction in the product in terms of quality. In reality, retailers may sell the product either of low or high quality and in such a scenario, one may have to consider a vertically differentiated framework to study quality competition among online retailers. Our model can also be extended by including an advertiser as an additional player in the game.

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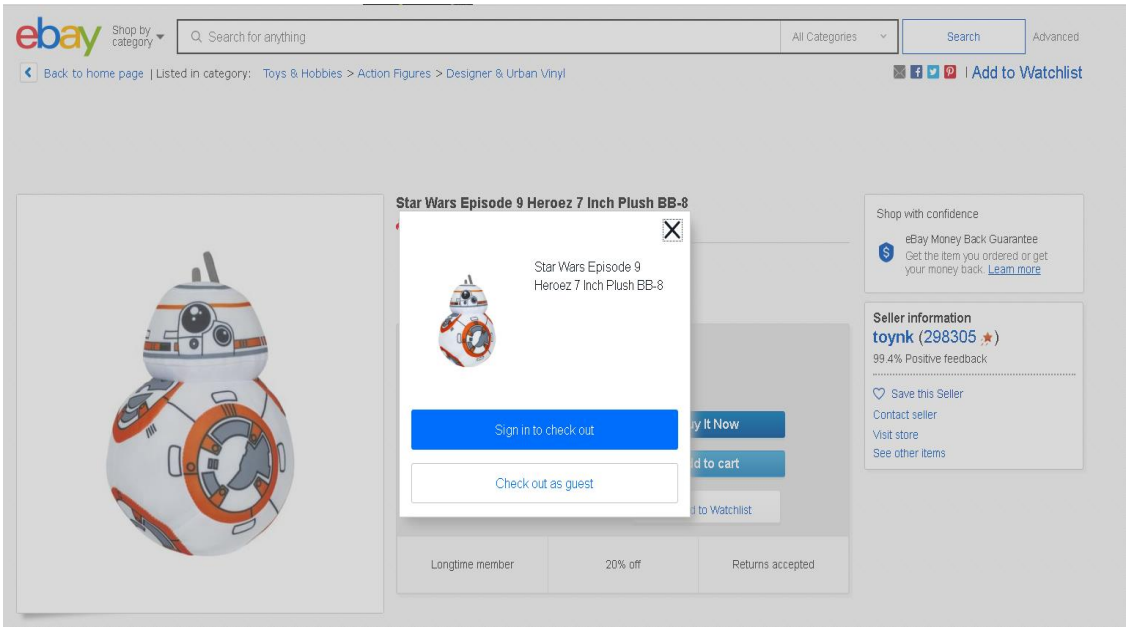



Figure 1: E-bay purchase as a guest option

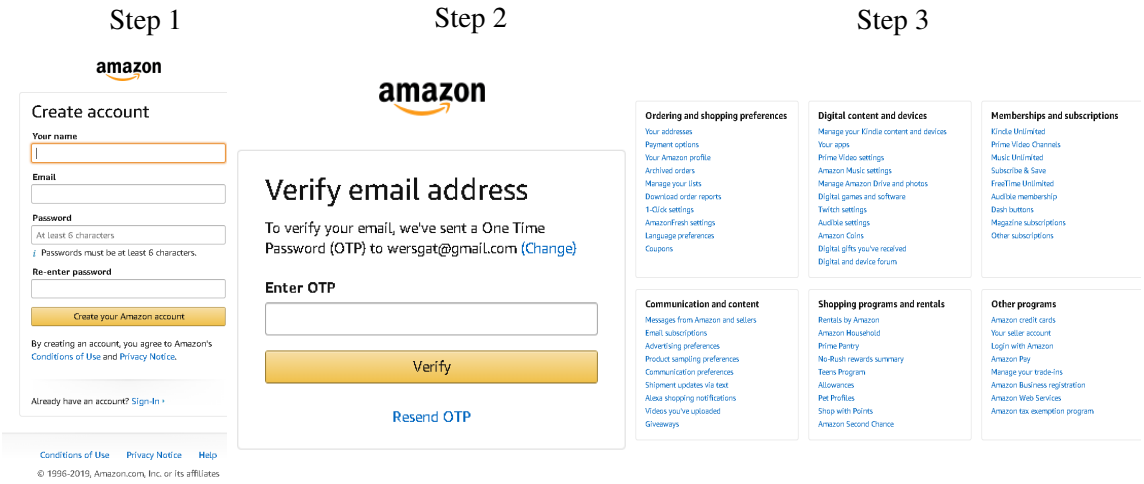



Figure 2: Account checkout process for Amazon

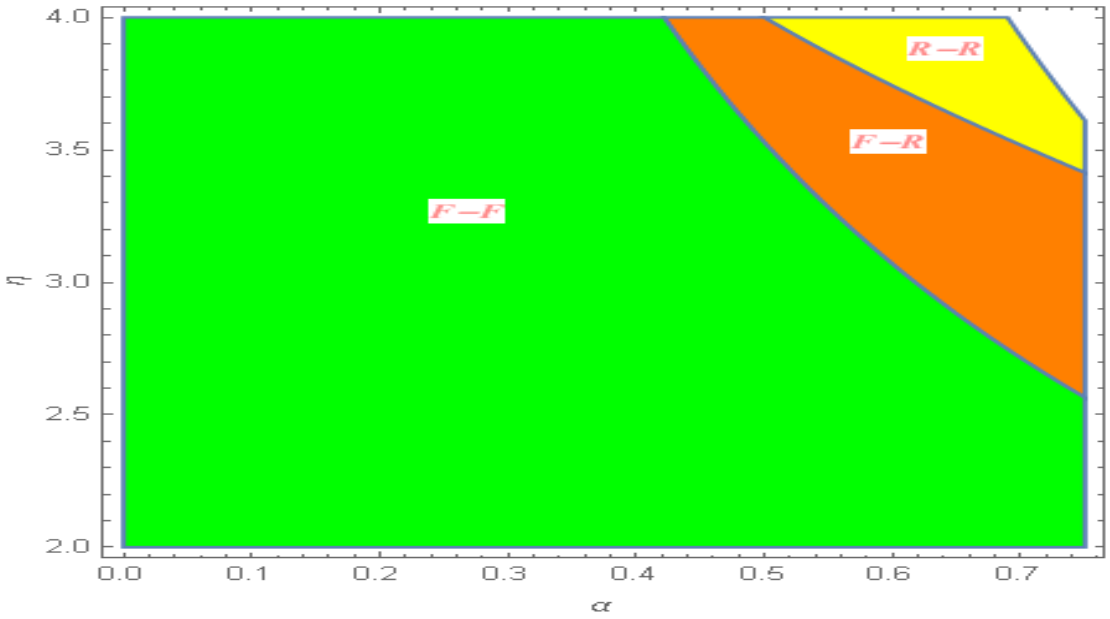



Figure 3: Equilibrium condition regions for Case 1

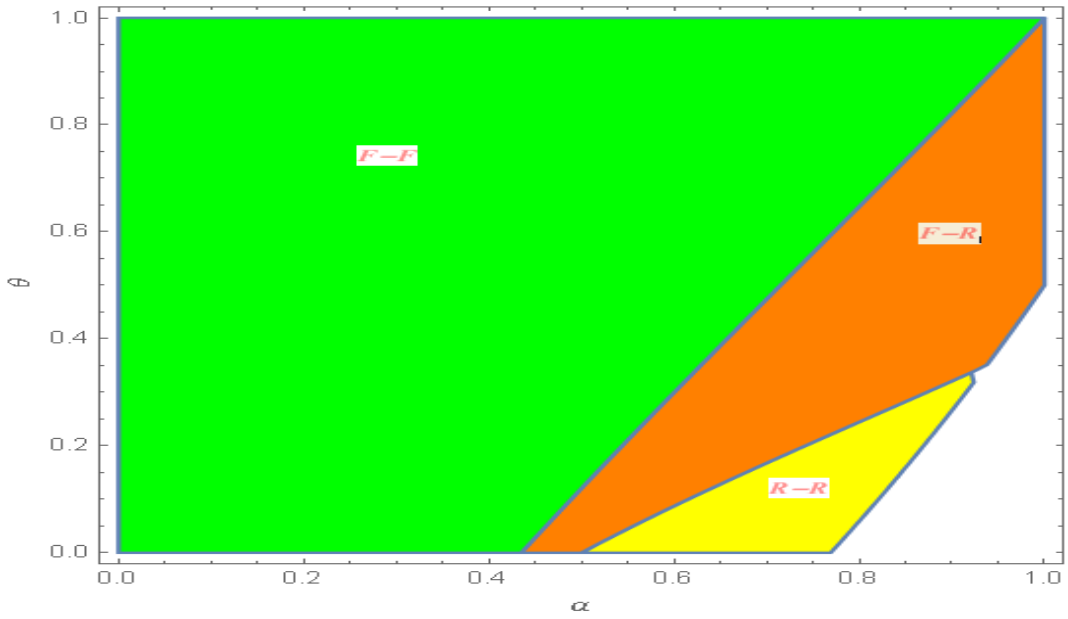
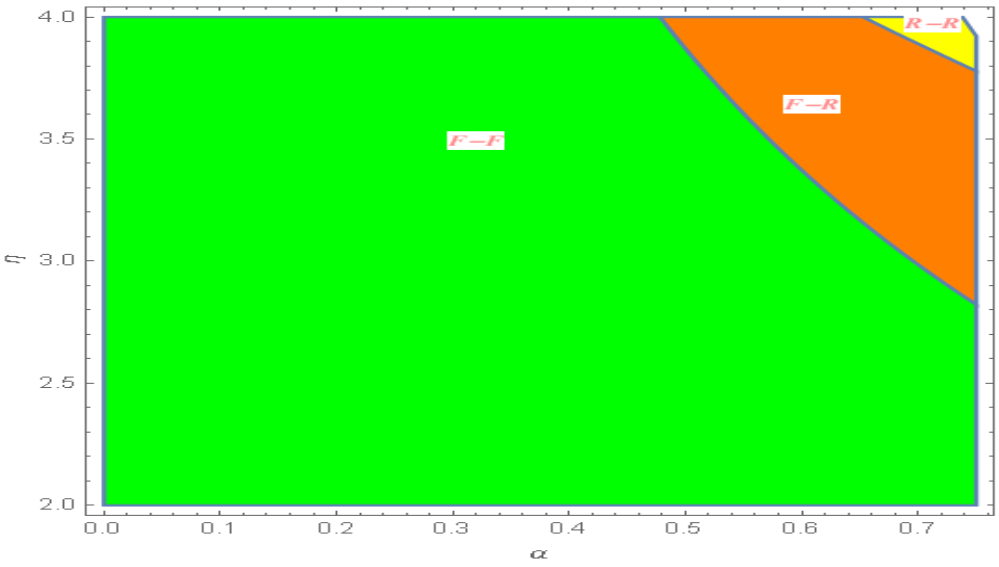
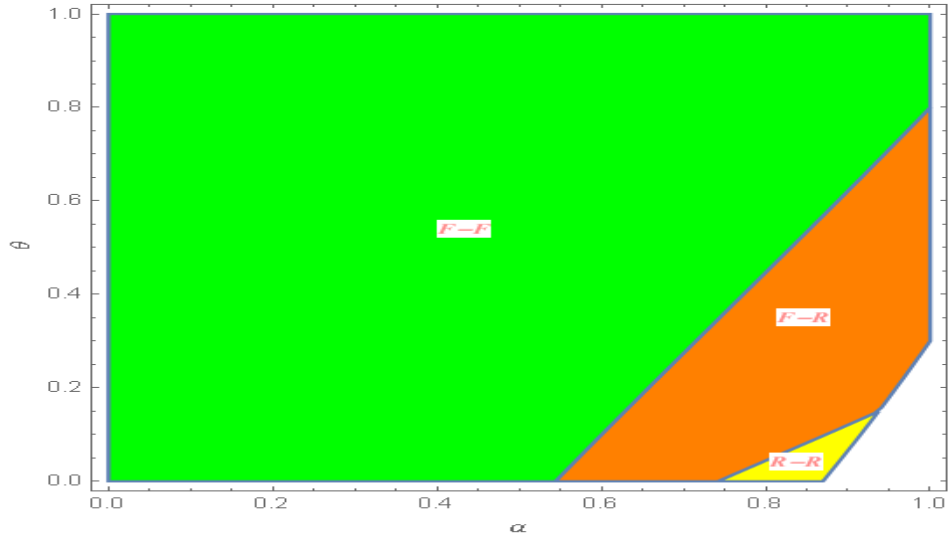



Figure 4: Equilibrium condition regions for Case 2




(a) [Case 1]




(b) [Case 2]

Figure 5: Equilibrium condition regions for Cases 1 and 2 with $\gamma > 0$.

| Online Retailer | Promotion for first time sign ups |
|---|---|
| Aéropostale | Get 15% off your first order when you sign up for Aéropostale emails. |
| Aldo | Sign up for the Aldo newsletter to get 15% off your next purchase. |
| American Eagle | Get 20% off your order when you sign up for emails. |
| Athleta | Save 20% off one regular-priced item with email signup. |
| Bed Bath & Beyond | Enjoy 20% off one in-store item when you're a new subscriber. |
| Bloomingdale's | You'll earn 20% in savings for signing up for emails and texts. |
| Buy Buy Baby | Save 20% off one in-store item when you register for email offers. |
| Crate & Barrel | Take 10% off with email signup. |
| The Children's Place | Enter your email address and get $10 off your next purchase. |
| Dick's Sporting Goods | Sign up and receive 10% off your next online order. |
| Express | Get 20% off your first order after signing up for email. |
| Forever 21 | Save 10% on $50+ after you sign up for a Forever 21 account. |
| Gap | Give your email address to get 25% off non-sale items in your next order. |
| H&M | Sign up for the H&M newsletter, and earn 20% off one item and free shipping. |
| Home Depot | Join Home Depot's promotions program to save $5 on next order of $50+. |
| Justice | Enjoy 15% off your next online purchase with email signup. |
| Kate Spade | Get 15% off when you register for Kate Spade emails. |
| Kohl's | You'll earn 15% off your next purchase, in stores or online, when you sign up. |
| Lands' End | Subscribe to get 40% off one item, plus get free shipping on $50+ orders. |
| Lane Bryant | Save 20% off a future purchase when you share your email with Lane Bryant. |
| Macy's | Sign up for Macy's emails to get 25% off your next online purchase of $100+. |
| NFLShop.com | Give your email and cell number to receive 10% off. |
| Pottery Barn | Get 15% off a regular-priced order when you sign up for emails. |
| Rockport | Earn 15% off for submitting your email, just like that! |
| Sports Authority | Share your mobile number or email address, and you'll get 10% in savings. |
| Steve Madden | Grab a 10% discount for joining Steve Madden's email list. |
| Tarte Cosmetics | 15% discount on your entire order after you sign up for Tarte's e-newsletter. |

Table 1: Examples of retailers which provides sign up discounts (source: Groupon & Retailmenot, 2nd Jan 2020)

| Firms with restricted checkout strategy | Firms with flexible checkout strategy |
|---|---|
| Amazon | eBay |
| Alibaba | Walmart |
| Wish.com | Best Buy |
| AliExpress | Kohl's |
| CDW | Home Depot |
| Newegg | Costco |
| Flipkart | Barnes & Noble |
| Snapdeal | Blue Nile |
| Myntra | Crate & Barrel |
| Banggood | Dell |
| DHgate | Eddie Bauer |
| Lightinthebox | Foot Locker |
| geekbuying | Gap |

Table 2: List of firms following distinct checkout strategies

| Parameter | Description |
|---|---|
| $\alpha$ | Proportion of convenience conscious consumers |
| $V$ | Base utility obtained by consumers from purchasing the product |
| $t$ | Consumer per-unit travel cost |
| $\theta$ | Scaling parameter capturing reduction in travel cost |
| $\eta$ | Additional revenues due to targeted advertising |
| $\gamma$ | Inconvenience due to account registration in first period |
| $\kappa$ | Additional utility due to account registration |
| $\delta$ | Discount factor in the second period |

Table 3: Notation for parameters

# Appendix A

**When retailers adopt restricted checkout strategy**

When retailers adopt restricted checkout strategy, the utility functions of the CC consumer, located at $x_{CC}$, from each retailer is given by:

$$U_{RR\alpha 1} = V - p_{1RR} - tx_{CC} + \delta(V + \kappa - p_{1RR} - \theta t x_{CC}). \tag{A.1}$$

$$U_{RR\alpha 2} = V - p_{2RR} - t(1 - x_{CC}) + \delta(V + \kappa - p_{2RR} - \theta t(1 - x_{CC})). \tag{A.2}$$

The demand function for the CC consumer can be derived by:

$$U_{RR\alpha 1} = U_{RR\alpha 2}. \tag{A.3}$$

Solving, we get the marginal consumer as:

$$x_{CC} = \frac{p_{2RR}(1+\delta) + t(1+\delta\theta) - p_{1RR}(1+\delta)}{2t(1+\delta\theta))}. \tag{A.4}$$

The profit functions of retailer 1 and retailer 2 are:

$$\pi_{1RR} = \alpha p_{1RR} x_{CC}(1+\delta) + \eta\alpha x_{CC}, \text{ and} \tag{A.5}$$

$$\pi_{2RR} = \alpha p_{2RR}(1 - x_{CC})(1+\delta) + \eta\alpha(1 - x_{CC}). \tag{A.6}$$

Substituting the value of $x_{CC}$ in the profit function and using the first order conditions, we get the equilibrium prices and profit functions.

$$p^*_{iRR} = \frac{t + t\delta\theta - \eta}{1+\delta}, \tag{A.7}$$

$$\pi^*_{iRR} = \frac{\alpha}{2}(t + t\delta\theta). \tag{A.8}$$

where $i = 1, 2$

**When retailers adopt flexible checkout strategy**

In this case, demand arises from both CC and PC consumers. When retailers adopt flexible checkout strategy, the utility functions of the CC consumer, located at $x_{CC}$, from each retailer is given by:

$$U_{FF\alpha 1} = V - p_{1FF} - tx_{CC} + \delta(V + \kappa - p_{1FF} - \theta t x_{CC}). \tag{A.9}$$

$$U_{FF\alpha 2} = V - p_{2FF} - t(1 - x_{CC}) + \delta(V + \kappa - p_{2FF} - \theta t(1 - x_{CC})). \tag{A.10}$$

When retailers adopt flexible checkout strategy, the utility functions of the PC consumer, located at $x_{PC}$, from each retailer is given by:

$$U_{FF(1-\alpha 1)} = (V - p_{1FF} - tx_{PC})(1 + \delta). \tag{A.11}$$

$$U_{FF(1-\alpha 2)} = (V - p_{2FF} - (1 - x_{PC}))(1 + \delta). \tag{A.12}$$

The demand function for the CC and PC consumers can be derived by:

$$U_{FF\alpha 1} = U_{FF\alpha 2}. \tag{A.13}$$

$$U_{FF(1-\alpha 1)} = U_{FF(1-\alpha 2)}. \tag{A.14}$$

Solving, we get the demand as:

$$x_{CC} = \frac{p_{2FF}(1 + \delta) + t(1 + \delta\theta) - p_{1FF}(1 + \delta)}{2t(1 + \delta\theta))}. \tag{A.15}$$

$$x_{PC} = \frac{p_{2FF} + t - p_{1FF}}{2t}. \tag{A.16}$$

The profit functions of retailer 1 and retailer 2 are:

$$\pi_{1FF} = \alpha p_{1FF} x_{CC}(1 + \delta) + (1 - \alpha) p_{1FF} x_{PC}(1 + \delta) + \eta\alpha x_{CC}, \text{ and} \tag{A.17}$$

$$\pi_{2FF} = (\alpha p_{2FF}(1 - x_{CC}) + (1 - \alpha) p_{2FF}(1 - x_{PC}))(1 + \delta) + \eta\alpha(1 - x_{CC}) \tag{A.18}$$

Substituting the values of $x_{CC}$ and $x_{PC}$ in the profit function and using the first order

conditions, we get the equilibrium prices and profit functions.

$$p^*_{iFF} = \frac{t(t(1+\delta\theta)-\alpha\eta)}{(\alpha-1)+t(1-\alpha\delta(\theta-1)+\delta\theta)}. \tag{A.19}$$

$$\pi^*_{iFF} = \frac{t(1+\delta)-(\alpha-1)\alpha\eta+t\alpha\delta(\alpha+\theta-\alpha\theta-1)+t^2(1+\delta)(1+\delta\theta)}{2((\alpha-1)+t(1+\delta\theta-\alpha\delta(\theta-1))}. \tag{A.20}$$

where $i = 1, 2$

**When retailer 1 adopts flexible checkout strategy and retailer 2 adopts restricted checkout strategy**

When retailer 1 adopt flexible checkout strategy and retailer 2 adopts restricted checkout strategy, the utility functions of the CC consumer, located at $x_{CC}$, from each retailer is given by:

$$U_{FR\alpha 1} = V - p_{1FR} - tx_{CC} + \delta(V + \kappa - p_{1FR} - \theta t x_{CC}). \tag{A.21}$$

$$U_{FR\alpha 2} = V - p_{2FR} - t(1-x_{CC}) + \delta(V + \kappa - p_{2FR} - \theta t(1-x_{CC})). \tag{A.22}$$

When retailer 1 adopt flexible checkout strategy and retailer 2 adopts restricted checkout strategy, the utility functions of the PC consumer, located at $x_{PC}$, from retailer 1 is given by:

$$U_{FR(1-\alpha 1)} = (V - p_{1FR} - tx_{PC})(1+\delta). \tag{A.23}$$

The demand function for the CC and PC consumers can be derived by:

$$U_{FR\alpha 1} = U_{FR\alpha 2} \tag{A.24}$$

$$U_{FR(1-\alpha 1)} = 0. \tag{A.25}$$

Solving, we get the demand functions as:

$$x_{CC} = \frac{p_{2FR}(1+\delta) + t(1+\delta\theta) - p_{1FR}(1+\delta)}{2t(1+\delta\theta))}. \tag{A.26}$$

$$x_{PC} = \frac{V - p_{1FR}}{t}. \tag{A.27}$$

The profit functions of retailer 1 and retailer 2 are:

$$\pi_{1FR} = \alpha p_{1FR} x_{CC}(1+\delta) + (1-\alpha) p_{1FR} x_{PC}(1+\delta) + \eta\alpha x_{CC}, \text{ and} \quad \text{(A.28)}$$

$$\pi_{2FR} = \alpha p_{2RC}(1 - x_{FRCC})(1+\delta) + \eta\alpha(1 - x_{CC}). \quad \text{(A.29)}$$

Substituting the values of $x_{CC}$ and $x_{PC}$ in the profit function and using the first order conditions, we get the equilibrium prices and profit functions.

$$p^*_{1FR} = \frac{3t\alpha\eta + 4V(\alpha-1) + (1+\delta\theta)(4tV(\alpha-1) - 3\alpha t^2)}{8(\alpha-1) - 8t(1+\delta\theta) + t\alpha(5+\delta(8\theta-3))}. \quad \text{(A.30)}$$

$$p^*_{2FR} = \frac{\begin{pmatrix} 2(\alpha-1)(V+V\delta-2\eta) + t^2(1+\delta\theta)(\alpha+\alpha\delta(4\theta-3) - 4(1+\delta\theta)) \\ +t(2V(\alpha-1)(1+\delta)(1+\delta\theta)+ \\ \eta(4+4\delta\theta+\alpha(3\delta-4\delta\theta-1)) + (\alpha(5-3\delta+8\delta\theta) - 8(1+\delta\theta)) \end{pmatrix}}{(1+\delta)(8(\alpha-1) - 8t(1+\delta\theta) + t\alpha(5+\delta(8\theta-3))}. \quad \text{(A.31)}$$

$$\pi^*_{1FR} = \frac{\begin{pmatrix} -(32V^2(\alpha-1)^3(1+\delta) + 9t^4\alpha^2(1+\delta)(1+\delta\theta)(\alpha+\alpha\delta(2\theta-1) \\ -2(1+\delta\theta)) + 16t(\alpha-1)^2(-V\alpha(1+\delta)(3-2\eta) + 2\alpha\eta(\eta-3)+ \\ V^2(1+\delta)(\alpha(4\delta\theta+3-\delta) - 4(1+\delta\theta)) - 3t^3\alpha(32\eta(1+\delta\theta)^2 \\ +4\alpha(1+\delta\theta)(3(1+\delta) + 4\eta(\delta-4\delta\theta-3)) + 8V((\alpha-1)(1+\delta) \\ (1+\delta\theta)(\alpha+\alpha\delta(2\theta-1) - 2(1+\delta\theta)) - \alpha^2(-16\eta(1+\delta^2\theta(2\theta-1) + \delta(3\theta-1)) \\ +3(1+\delta)(3+\delta(4\theta-1)))) + 2t^2(\alpha-1)(8V^2(\alpha-1)(1+\delta) \\ (1+\delta\theta)(\alpha+\alpha\delta(2\theta-1) - 2(1+\delta\theta)) - V\alpha(1+\delta)(\alpha\eta(\delta(9-16\theta) - 7)) \\ -48(1+\delta\theta) + 16\eta(1+\delta\theta) + 12\alpha(3+\delta(4\theta-1))) + \alpha(16\eta(6-\eta) \\ (1+\delta\theta) + \alpha(9(1+\delta) - 24\eta(3-\delta+4\delta\theta) + \eta^2(7+16\delta\theta-9\delta))))) \end{pmatrix}}{2t(8(\alpha-1) - 8t(1+\delta\theta) + t\alpha(5+\delta(8\theta-3))^2}. \quad \text{(A.32)}$$

$$\pi^*_{2FR} = \frac{\alpha(t+t\delta\theta)(2(\alpha-1)(V(1+\delta)+2\eta) + t(\alpha+4\alpha\delta\theta - 4\delta\theta - 3\alpha\delta - 4))^2}{2t(8(\alpha-1) - 8t(1+\delta\theta) + t\alpha(5+\delta(8\theta-3))^2}. \quad \text{(A.33)}$$

We fix the values of few parameters for case 1: $t = 1; \delta = 1; \theta = 1; V = \frac{3}{4}$. To simplify the results, we also assume that $2 < \eta < 4$. This assumption simplifies the conditions for the existence of symmetric and asymmetric equilibria.

**Proof of Proposition 1**

In proposition 1, we are looking for the conditions under which the asymmetric equilibrium flexible-restricted checkout holds. For this, we have to check the below conditions:

$$\pi^*_{1FR} > \pi^*_{1RR}, \text{ and} \tag{A.34}$$

$$\pi^*_{2FR} > \pi^*_{2FF}. \tag{A.35}$$

After substituting values in equilibrium profits, we get below conditions:

$$\alpha > \frac{1}{2}\left(\frac{185 + 88\eta + 16\eta^2}{(5+4\eta)^2} - \sqrt{\frac{(-5+4\eta)^2(345+216\eta+16\eta^2)}{(5+4\eta)^4}}\right) \tag{A.36}$$

$$\text{and } 2 < \eta \leq \frac{5}{2}. \tag{A.37}$$

**Proof of Proposition 2**

In proposition 2 (a), we are looking for the conditions under which the symmetric equilibrium restricted-restricted checkout holds. For this, we have to check the below condition:

$$\pi^*_{1RR} > \pi^*_{1FR} \tag{A.38}$$

After substituting values in equilibrium profits, we get below conditions:

$$\alpha > \frac{2(55 - 36\eta + 8\eta^2)}{100 - 75\eta + 14\eta^2} - 2\sqrt{\frac{(-5+4\eta)^2(49-26\eta+4\eta^2)}{(100-75\eta+14\eta^2)^2}} \text{ and } \eta > \frac{33}{10}. \tag{A.39}$$

In proposition 2(b), we are looking for the conditions under which the symmetric equilibrium restricted-restricted checkout holds. For this, we have to check the below condition:

$$\pi^*_{1FF} > \pi^*_{2FR} \tag{A.40}$$

After substituting values in equilibrium profits, we get below conditions:

$$\alpha < \frac{1}{2}\left(\frac{185+88\eta+16\eta^2}{(5+4\eta)^2} - \sqrt{\frac{(-5+4\eta)^2(345+216\eta+16\eta^2)}{(5+4\eta)^4}}\right). \tag{A.41}$$

**Proof of Proposition 3**

To prove proposition 3(a) and 3(b), we have to analyze below equations:

$$\frac{\partial \pi^*_{1RR}}{\partial \alpha} > 0 \Rightarrow True \tag{A.42}$$

$$\frac{\partial \pi^*_{1RR}}{\partial \eta} > 0 \Rightarrow True \tag{A.43}$$

$$\frac{\partial \pi^*_{1FF}}{\partial \alpha} > 0 \Rightarrow False \tag{A.44}$$

$$\frac{\partial \pi^*_{1FF}}{\partial \eta} > 0 \text{ for } \eta \leq \frac{61}{24} \text{ or } \frac{61}{24} < \eta < \frac{23}{8} \text{ and } \alpha < \frac{1}{2}\left(\frac{-368+128\eta}{-185+56\eta}\right). \tag{A.45}$$

To simplify the results, we assume that $0 < \theta < 1$. This assumption simplifies the conditions for the existence of symmetric and asymmetric equilibria. Furthermore, for case 2, we set the values of few parameters: $t = 1; \delta = 1; \eta = 2; V = \frac{3}{4}$.

**Proof of Proposition 4**

In proposition 4(i) and 4(ii), we are looking for the conditions under which the asymmetric equilibrium i.e. flexible-restricted checkout holds. For this, we have to check the below conditions:

$$\pi^*_{1FR} > \pi^*_{1RR}, \text{ and} \tag{A.46}$$

$$\pi^*_{2FR} > \pi^*_{2FF}. \tag{A.47}$$

After substituting values in equilibrium profits, we get the following conditions:

$$\widehat{\theta} > \theta > \frac{10 - 13\alpha}{4\alpha - 10} \text{ and } \alpha > \frac{15}{16}. \tag{A.48}$$

or

$$\widehat{\widehat{\theta}} < \theta \quad < \quad \widehat{\theta} \text{ and} \tag{A.49}$$

$$\frac{1}{2} < \alpha \quad < \quad \frac{15}{16}. \tag{A.50}$$

in which $\widehat{\theta}$ and $\widehat{\widehat{\theta}}$ depends on $\alpha$. We illustrate the threshold $\widehat{\theta}$ and $\widehat{\widehat{\theta}}$ for different values of $\alpha$ in Table 4.

| $\alpha$ | $\widehat{\widehat{\theta}}$ | $\widehat{\theta}$ |
|---|---|---|
| $3/5$ | 0.08737 | 0.29979 |
| $3/4$ | 0.20637 | 0.56093 |
| $4/5$ | 0.24453 | 0.64745 |
| $9/10$ | 0.32085 | 0.82170 |

Table 4: Thresholds on the travel cost scaling parameter for the asymmetric equilibrium

**Proof of Proposition 5**

In proposition 5(a), we are looking for the conditions under which the symmetric equilibrium restricted-restricted checkout holds. For this, we have to check the below condition:

$$\pi^*_{1RR} > \pi^*_{1FR} \tag{A.51}$$

After substituting values in equilibrium profits, we get below conditions:

$$0 < \theta < \frac{7}{20} \text{ and } \frac{1}{2}\left(\sqrt{\frac{(7 + 3\theta - 4\theta^2)^2(9 - 12\theta + 16\theta^2)}{(6 + 24\theta^2 - 17\theta - 16\theta^3)^2}}\right) < \alpha < \frac{10(1+\theta)}{13 + 4\theta} \tag{A.52}$$

In proposition 5(b), we are looking for the conditions under which the symmetric equilibrium flexible-flexible checkout holds. For this, we have to check the below condition:

$$\pi^*_{1FF} > \pi^*_{2FR} \tag{A.53}$$

After substituting values in equilibrium profits, a sufficient condition for the flexible-flexible checkout strategy to be an equilibrium, is as follows:

$$\alpha \leq 0.43488. \tag{A.54}$$

**Proof of Proposition 6**

To prove proposition 6(a) and 6(b), we have to analyze below equations:

$$\frac{\partial \pi^*_{1RR}}{\partial \alpha} > 0 \Rightarrow True. \tag{A.55}$$

$$\frac{\partial \pi^*_{1RR}}{\partial \theta} > 0 \text{ for } \alpha > \alpha'. \tag{A.56}$$

$$\frac{\partial \pi^*_{1FF}}{\partial \alpha} > 0 \text{ for } \alpha > \sqrt{3} - 1. \tag{A.57}$$

$$\frac{\partial \pi^*_{1FF}}{\partial \theta} > 0 \text{ for } 0 \leq \alpha \leq 1. \tag{A.58}$$