Showrooming and Shipping Costs in Price Competition between Online and Physical Stores*

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Abstract

Today, consumers purchasing goods can choose between physical stores (or "brick-and-mortar" stores) and online stores (or e-tailers). If a consumer purchases an unfamiliar good online, she is likely to receive a mismatched good. On the other hand, consumers who purchase goods from a physical store must incur the transportation costs and the shipping costs while major online stores generally do not pass on shipping charges to the consumers. Facing this dilemma, some consumers might go to a physical store for reducing mismatch; subsequently, they purchase the product from an online store to avoid the shipping charges. Such free-riding behavior of consumers is referred to as ■showrooming■.

This article analyzes showrooming and its effect on price competition between physical stores and online stores by formulating a spatial market model, and we show that one of two types of equilibrium might exist in the price competition, where some consumers display showrooming and others do not. In the model, we emphasize the role of shipping costs incurred by consumers only when they purchase goods from physical stores, which would determine the equilibrium that arises. In conclusion, both physical stores as well as online stores charge lower prices and obtain lower profits in equilibrium with showrooming than they do in equilibrium without showrooming.

Keywords: showrooming, e-commerce, retailing channel

1　Introduction

Today, consumers purchasing goods can choose between two retail channels: physical stores (or ■brick-and-mortar■ stores) and online stores (or e-tailers). These two alternative channels have their distinct advantages and disadvantages. If a consumer purchases an unfamiliar good such as clothes, shoes, and food online, she is likely to receive a mismatched good

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in terms of size, color, or taste because of the paucity or lack of information about the good in the online catalog. On the other hand, consumers who purchase goods from a physical store incur the transportation costs of visiting the store; in addition, they must forgo the advantages of cost savings associated with online shopping because major online stores generally do not pass on shipping charges to the consumers.

While purchasing goods from online stores, consumers face disutility due to the lack of match, as Balasubramanian (1998) notes. For example, some consumers might reconcile themselves to the curtain that was delivered but a little mismatched to their room in terms of color. They cannot return the good to the seller under the conditions of the contract; even if they could return the purchased good, they would have to waste time in searching for another suitable good. However, if consumers visit physical stores to obtain information about the good, this disutility disappears. They can confirm the color of the curtain, for example, and immediately obtain the most suitable pattern of the good.

In the case of online stores, however, besides benefiting from the absence of transportation costs, consumers need not incur any shipping costs (with some conditions) if they use some major e-commerce retailers. For example, Amazon.com offers “free shipping” for some of the products they sell. According to the site’s terms and conditions:[1]

> You receive free shipping if your order includes at least $35 of qualifying merchandise, excluding gift-wrap and taxes. Eligible items will display “Free Shipping” next to their price. Items must be sold or fulfilled by Amazon to qualify toward reaching the $35 minimum purchase for free shipping by Amazon. Certain oversize and heavy items aren’t eligible.

While online stores are able to offer free shipping for several reasons, one important reason would be the well-developed delivery networks they have built, which traditional stores cannot replicate. For example, online stores with large lot orders are generally important transaction counterparts of delivery and logistic companies, who discount the shipping charges for delivering the goods ordered in these online stores. Thus, online shoppers can benefit from lower costs.

Facing the dilemma of choosing between physical stores and online stores, some consumers might display another behavior for minimizing costs and disutility. They go to a physical store to obtain relevant product information for reducing mismatch; subsequently, they purchase the product from an online store to avoid the shipping charges. Thus, an online store selling the same product as a physical store does can take advantage of the product information shared with the consumer by the physical store. Such free-riding behavior of consumers is referred to as “showrooming” in recent literature (Bosman 2011; Zimmerman 2012).

This article analyzes showrooming and its effect on the competition between physical

1 About Free Shipping by Amazon," http://www.amazon.com/gp/help/customer/display.html/?nodeId=201117690 (accessed on 2 August 2014).

stores and online stores. We formulate a spatial market model in which the consumer can purchase a particular good from either a physical store or an online store, and we show that one of two types of equilibrium might exist in the price competition. In the model, we emphasize the role of shipping costs that are assumed to be incurred by consumers only when they purchase goods from physical stores, which would determine the equilibrium that arises.

The research on online markets versus physical markets has increased significantly in recent years. We owe the basic framework of this article to Balasubramanian (1998). In his model, some physical stores are symmetrically located on a circular market similar to Salop's (1979) model, and one direct retailer such as a catalog merchant exists. Consumers who are distributed on the circular market must travel to the nearest physical store and bear the associated transportation costs; the direct retailer would then ship the product to the consumer for a fee. There is some disutility for the consumers in this market. In price equilibrium, a wedge form of market arises, where consumers are segregated in their locations. A drawback of Balasubramanian's (1998) study is the assumption of homogeneous disutility for consumers. Yoo and Lee (2011) provide another model with heterogeneous disutility for analyzing the two alternative channels. They find that the introduction of e-commerce does not necessarily have an impact on the competition. Our research draws on Yoo and Lee's (2011) heterogeneous disutility; we examine a model with two types of disutility in this article. Digital format sales such as e-books affect the form of selling and contracts between manufacturers and retailers. Abhishek, Jerath, and Zhang (2015) highlight the externality between physical markets and online markets to determine the optimal formats of digital goods. Our findings suggest an implicit collusion between physical stores and online stores, which accounts for the effect across the two markets.

In the context of multi-channel distribution, Shin (2007) studies a free-riding problem where consumers who obtain information about goods from one retail channel may eventually purchase the goods from another channel. Given symmetric costs to use the two channels, he suggests that such free-riding may increase the profits of both the retailers. However, Mehra, Kumar, and Raju (2014) introduce heterogeneous costs across the two retail channels and conclude that showrooming would induce an intensification of price competition because the price-cutting incentive of the physical stores due to showrooming dominates the price increase incentive of the online stores due to the acquisition of showrooming consumers. Eventually, the profits of physical stores decrease with showrooming. Liu (2013) extends such free-riding models to investigate the price-matching strategy in a vertical differentiation model. This study introduces consumer heterogeneity in "hassle" costs and suggests that a price-matching guarantee can increase the profits when the level of quality free-riding is sufficiently high.

To the best of our knowledge, Balakrishnan, Sundaresan, and Zhang (2014) present a model that is most similar to ours. Similar to our model, their model assumes heterogeneous consumers in terms of the relative costs to use the two retail channels (i.e., physical stores and online stores), and they identify three types of consumer behaviors. Their main finding is that showrooming reduces the profits of both physical stores as well as online stores by the intensification of price competitions. This finding may appear to be quite similar to ours at a glance. However, there are several decisive differences between these two models. First, Balakrishnan et al. (2014) incorporate heterogeneous costs associated with purchasing from online stores while we use a Hotelling-Salop model where consumers must incur transportation costs for visiting the nearest physical store. Second, in their model, whether a consumer likes the good is determined ex ante with some degree of probability; consumers do not purchase the good from any store if they find that it is not to their taste. On the other hand, we implicitly assume that physical stores offer goods of all sizes, colors, or tastes such that every consumer can find a good that satisfies her requirement. That is, a mismatch in size, color, or taste would appear only when purchasing online without showrooming. Third, in order to focus on the relative costs of purchasing from retail channels, we do not consider the option of returning the product, which is incorporated in the prior model. Instead, we combine dissatisfaction, lack of physical fitness, cognitive costs, and even return fees into a fixed parameter of the disutility arising from using online stores. That is, we show that showrooming can occur even without returns. Finally, Balakrishnan et al.'s (2014) model derives three types of equilibrium while our model shows only two. Despite such differences in settings, the two models agree that in equilibrium with showrooming, both physical stores as well as online stores charge lower prices and obtain lower profits than they do in equilibrium without showrooming.

The findings of this article can be summarized as follows. First, we show that there are two types of price equilibrium in the competition between a physical store and an online store. In the first equilibrium, some consumers opt for showrooming, given low prices at both the stores; consumers do not do so in the second equilibrium. Showrooming allows the online store to attract consumers away from the physical store. Second, the physical store and the online store have incentives to deter the first type of equilibrium because the online store must lower the price sufficiently to induce showrooming, which effectively negates the increase in demand. Such incentives suggest an implicit collusion between these stores; the authorities must watch out for and prevent such collusion. Finally, in the case of heterogeneous disutility, the stores face severe price competition, and the first type of equilibrium is less likely to arise when the proportion of consumers with large disutility is large.

In the next section, we formulate the basic model for showrooming and derive the price equilibrium. A discussion of the results follows in Section 3. We examine some comparative statistics and compare these with the results of the case without showrooming. For an extension of the model, we analyze the model with heterogeneous disutility of consumers in Section 4. We conclude the paper with suggestions for further research in Sectiou 5.

2 The Basic Model

2.1 Showrooming and Three Types of Consumer Utility

Following Balasubramanian (1998), we set up a circular spatial market for a good as the basic model. On the circumference L of the market, consumers are uniformly distributed at density one and N physical stores are located symmetrically (Figure 1). Although each store is owned by distinct firms, throughout this article, we focus on a symmetric equilibrium,

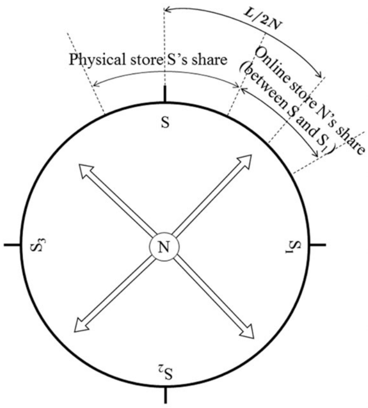


Figure 1. Circular Market (N=4)

which assumes an identical price for a particular good at any store. Therefore, we can choose any store, named S, at point 0 on the circumference. Further, we assume there is a unique online store, named N, located at the center. A consumer must purchase one unit of the good by assuming that the reservation utility from the good (v) is sufficiently large.[2] If a consumer purchases the good from S, she has to pay the transportation cost (t per unit of distance) and the shipping cost (d per unit of distance). In this article, we formulate consumer utility in linear form. Thus, if a consumer located at point s purchases the good from store S, which charges price p_S, the utility for the consumer would be:

$$u_S = v - (t+d)s - p_S \tag{1}$$

Note that while purchasing a good from a physical store, the consumer can take a look at the actual good at the store and obtain complete information about it. We categorize consumers purchasing from store S as Type S, by abuse of notation.

On the other hand, a consumer could visit store S to look at the actual good. However, she does not purchase the good on the spot; instead, she returns home and orders it from the online store, N. This showrooming enables the consumer to obtain complete information about the good and purchase it at the online price. An important assumption in our model for the online store is the advantage in terms of shipping cost. Here, we assume d=0 for store N for reasons of simplicity. That is, consumers do not need to pay any shipping cost while purchasing goods from online store N. Hence, if a consumer located at point s visits store S for showrooming and purchases from online store N who charges price p_S, the utility for the consumer would be:

$$u_A = v - ts - p_N \tag{2}$$

Consumers displaying such showrooming are categorized as Type A.

In the third case, a consumer can purchase the good from the online store N directly. In this case, the consumer does not pay either transportation cost or shipping cost. However,

2 Later in this article, we introduce heterogeneous consumers who do not purchase any good.

the consumer does not get to see the actual good until it is delivered to her home. Consequently, there is always a chance that the delivered good may not fit in size or that it does not match the consumer's expectations about color or other preferences. Let $\mu>0$ denote the disutility from mismatch as a fixed monetary value in the case where the consumer directly purchases from N. Although μ would vary for each consumer, we consider it to be identical, assuming that the consumer preference for risk is homogeneous. Hence, if a consumer located at point s purchases directly from store N, the utility for that consumer would be:

$$u_B = v - \mu - p_N \tag{3}$$

Such direct online buyers are categorized as Type B.

Figure 1 shows the market shares for store S and store N. Assuming symmetry of locations and prices across the stores, store S would face L/2N length interval for the market to the right. Since a consumer located near S would probably purchase the good from the store and other consumers would purchase it from N, the interval is divided into two regions that determine each market's share. Although the utility curves u_S and u_A are downward sloping with distinct slopes, u_B is shaped as a horizontal line.[3] These positions determine the market shares for store S and store N because each consumer's behavior is intended to maximize the utility across u_S, u_A, and u_B.

2.2 Price Equilibrium

We now derive price equilibrium in the competition between store S and store N in the context of the showrooming of consumers. First, we restrict the range of possible disutility.

Assumption 1. $$0<\frac{\mu}{t}<\frac{L}{2N}.$$

This assumption presumes that the intersection of the utility curves u_A and u_B (μ/t) is located in an open interval (0, L/2N). In other words, without store S, Type A and Type B consumers must have market shares. Thus, we have to examine four cases for price p_S to p_N (Table 1).

Table 1. Four Regions and Three Types of Consumers

Region I:	$p_N-\frac{d}{t}\mu<p_S<p_N$	(Type S, A, and B)
Region II:	$p_N+\mu-\frac{(t+d)L}{2N}<p_S<p_N-\frac{d}{t}\mu$	(Type S and B)
Region III:	$p_S<p_N+\mu-\frac{(t+d)L}{2N}$	(Type S)
Region IV:	$p_N<p_S$	(Type A and B)

3 On the contrary, in Balakrishnan et al.'s (2014) model, downward utility lines appear for showrooming and direct online consumers, while a horizontal line appears for physical consumers.

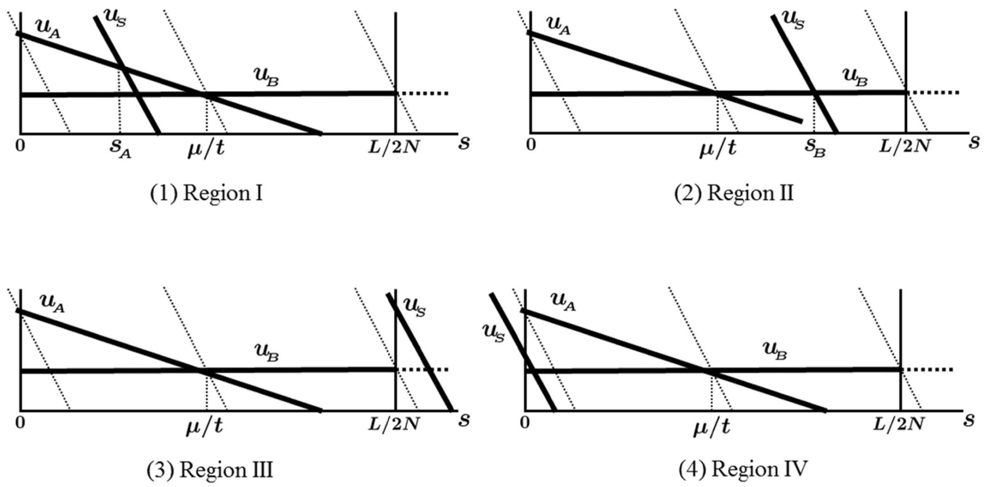


Figure 2. Utility Patterns

The type of consumer is determined according to these regions. For example, in Region I, all types of consumers (Types S, A, and B) can exist, while only Type S and Type B can exist in Region II. Figure 2 shows the positions of the utility curves u_S, u_A, and u_B for each region. At the pair of prices, p_S and p_N, store S obtains s_A, s_B, L/2N, and 0 as the demand in Region I, II, III, and IV, respectively. The profit of store S can be summarized as:

$$\pi_S = \begin{cases} \dfrac{L}{2N} p_S & \text{if} \quad p_S < p_N + \mu - \dfrac{(t+d)L}{2N}, \\ \dfrac{1}{t+d}(p_N - p_S + \mu)p_S & \text{if} \quad p_N + \mu - \dfrac{(t+d)L}{2N} < p_S < p_N - \dfrac{d}{t}\mu, \\ \dfrac{1}{d}(p_N - p_S)p_S & \text{if} \quad p_N - \dfrac{d}{t}\mu < p_S < p_N, \\ 0 & \text{if} \quad p_N < p_S \end{cases} \tag{4}$$

Store S is expected to maximize π_S given p_N in the standard Bertrand game manner. For reasons of simplicity, we ignore all costs (production cost, wholesale price, etc.) for the stores throughout this article.

Next, we compare these profits with one another. The profits in Region I, II, and III are denoted by π_S^A, π_S^B, and π_S^C, respectively:

$$\begin{aligned} \pi_S^A &= \frac{1}{d}(p_N - p_S)p_S \\ \pi_S^B &= \frac{1}{t+d}(p_N - p_S + \mu)p_S \\ \pi_S^C &= \frac{L}{2N} p_S \end{aligned} \tag{5}$$

The four prices are defined as follows:

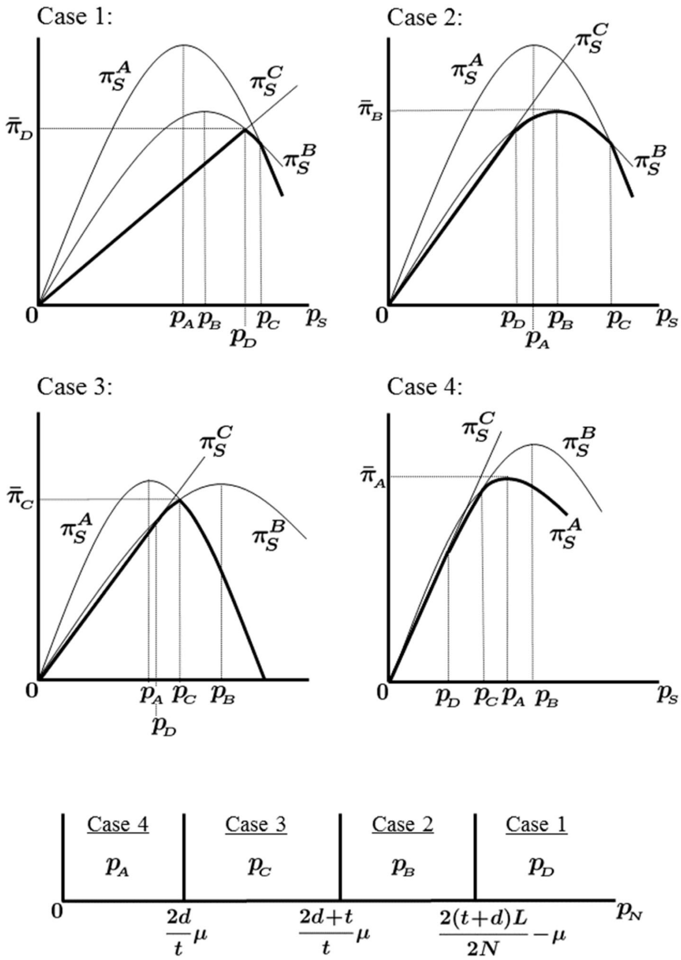
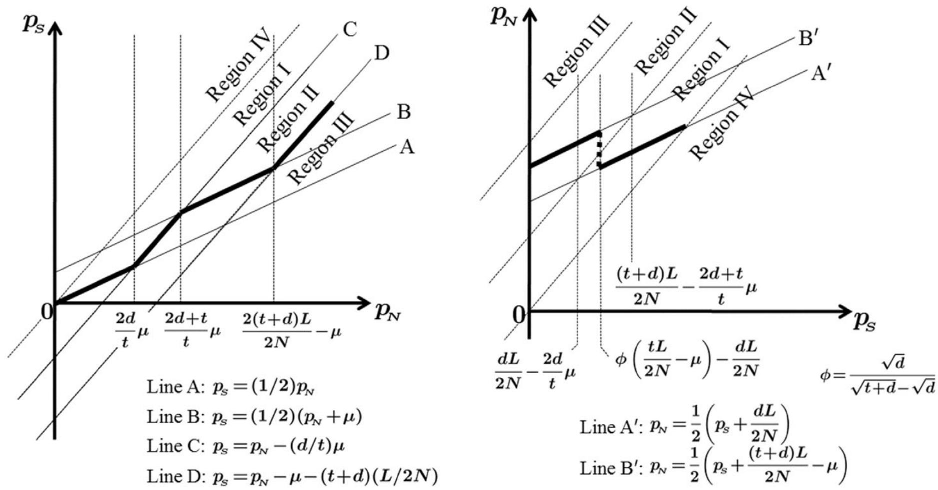


Figure 3. Pattern of Profit for Store S

$$
\begin{aligned}
&p_A=\frac{1}{2}p_N && (\text{maximizes } \pi_S^A)\\
&p_B=\frac{1}{2}(p_N+\mu) && (\text{maximizes } \pi_S^B)\\
&p_C=p_N-\frac{d}{t}\mu && (\text{such that } \pi_S^A=\pi_S^B)\\
&p_D=p_N+\mu-\frac{(t+d)L}{2N} && (\text{such that } \pi_S^B=\pi_S^C)
\end{aligned}
\qquad (6)
$$

These prices are alternatives of the optimal price strategy for store S; thus, they could compose the reaction curve for the store. Note that Regions I-IV can be denoted using these symbols. We can easily show that $p_A<p_B$ and $p_D<p_C<p_N$ for any p_N. Thus, there can be four cases, as shown in Figure 3 (the proof is omitted).



(1) Reaction Curve for Store S (2) Reaction Curve for Store N

Figure 4. Reaction Curves

Case 1: $p_B<p_D<p_C$. The maximum is $\bar{\pi}_D$.
Case 2: $p_D<p_B<p_C$. The maximum is $\bar{\pi}_B$.
Case 3: $p_A<p_C<p_B$. The maximum is $\bar{\pi}_C$.
Case 4: $p_C<p_A<p_B$. The maximum is $\bar{\pi}_A$.

where $\bar{\pi}_A=\max \pi_S^A$, $\bar{\pi}_B=\max \pi_S^B$, $\bar{\pi}_C$ is π_S such that $\pi_S^A=\pi_S^B$, and $\bar{\pi}_D$ is π_S such that $\pi_S^B=\pi_S^C$. Consequently, the reaction curve for store S is:

$$P_S(p_N)=\begin{cases} \frac{1}{2}p_N & \text{if} \quad 0<p_N<\frac{2d}{t}\mu, \\ p_N-\frac{d}{t}\mu & \text{if} \quad \frac{2d}{t}\mu<p_N<\frac{2d+t}{t}\mu, \\ \frac{1}{2}(p_N+\mu) & \text{if} \quad \frac{2d+t}{t}\mu<p_N<\frac{2(t+d)L}{2N}-\mu, \\ p_N+\mu-\frac{(t+d)L}{2N} & \text{if} \quad \frac{2(t+d)L}{2N}-\mu<p_N \end{cases} \tag{7}$$

The reaction curve is shown in Figure 4(1). Lines A-D determine the shape of the curve. Figure 4(1) shows that the curve is located under the 45-degree line, except at the origin. Thus, we derive the following proposition.

Proposition 1. No price equilibrium exists in the region where $p_S>p_N$.

The implication of this proposition is trivial. Store S has a disadvantage in the form of shipping costs, which causes the steeper utility curve compared to that of store N [see Figure 4(1)]. If store S sets the price of the good higher than that in store N, even a consumer located at point 0 would prefer to purchase the good from store N rather than from store S. In other words, store N has no incentive to set higher prices than the prices set by store S in equilibrium. Therefore, we can restrict the possibility to the region where $p_N > p_S$ henceforward, and eliminate Region IV from subsequent analyses.

Assumption 2. Store N sets price $p_N > p_S$.

Given this assumption, we examine store N. The profit of store N can be denoted as:

$$\pi_N = \begin{cases} \left[\frac{L}{2N} - \frac{1}{d}(p_N - p_S)\right] p_N & \text{if} \quad p_S < p_N < p_S + \frac{d}{t}\mu, \\ \left[\frac{L}{2N} - \frac{1}{t+d}(p_N - p_S + \mu)\right] p_N & \text{if} \quad p_S + \frac{d}{t}\mu < p_N < p_S - \mu + \frac{(t+d)L}{2N}, \\ 0 & \text{if} \quad p_S - \mu + \frac{(t+d)L}{2N} < p_N \end{cases} \tag{8}$$

We define π_A', π_B', p_A', and p_B' as follows:

$$\begin{aligned} \pi_A' &= \frac{1}{d}\left[\frac{dL}{2N} - p_N + p_S\right] p_N \\ \pi_B' &= \frac{1}{t+d}\left[\frac{(t+d)L}{2N} - p_N + p_S - \mu\right] p_N \end{aligned} \tag{9}$$

$$\begin{aligned} p_A' &= \frac{1}{2}\left(p_S + \frac{dL}{2N}\right) && \text{(maximizes } \pi_A) \\ p_B' &= \frac{1}{2}\left[p_S - \mu + \frac{(t+d)L}{2N}\right] && \text{(maximizes } \pi_B) \end{aligned} \tag{10}$$

We find that only three cases exist:

Case 1: $p_A' < p_B' < p_C'$. The maximum is $\bar{\pi}_B'$.

Case 2: $p_A' < p_C' < p_B'$. The maximum is $\max\{\bar{\pi}_A', \bar{\pi}_B'\}$.

Case 3: $p_C' < p_A' < p_B'$. The maximum is $\bar{\pi}_A'$.

where the definitions of $\bar{\pi}_A'$ and $\bar{\pi}_B'$ are similar to those in the case of store S. We define the following value as:

$$\bar{p}_S^* = \phi\left(\frac{tL}{2N} - \mu\right) - \frac{dL}{2N}, \quad \phi \equiv \frac{\sqrt{d}}{\sqrt{t+d} - \sqrt{d}} \tag{11}$$

This value is p_S, where $\bar{\pi}_A' = \bar{\pi}_B'$.

The reaction curve for store N under Assumption 2 can be denoted as:

$$P_N(p_S) = \begin{cases} \frac{1}{2}\left[p_S - \mu + \frac{(t+d)L}{2N}\right] & \text{if} \quad 0 < p_S < \max\left\{\frac{dL}{2N} - \frac{2d}{t}\mu, \bar{p}_S^*\right\}, \\ \frac{1}{2}\left(p_S + \frac{dL}{2N}\right) & \text{if} \quad \min\left\{\frac{(t+d)L}{2N} - \frac{2d+t}{t}\mu, \bar{p}_S^*\right\} < p_S \end{cases} \tag{12}$$

Figure 4(2) shows the reaction curve for store N when $\frac{dL}{2N} - \frac{2d}{t}\mu < \bar{p}_S^* < \frac{(t+d)L}{2N} - \frac{2d+t}{t}\mu$. The reaction curve is composed of line A′ and line B′ that are parallel to each other. Thus, unlike the reaction curve for store S, store N's reaction curve has a discontinuous region [the dotted line in Figure 4(2)].

We now have the proposition for price equilibrium.

Proposition 2. The equilibrium of the price competition between store S and store N is as follows:

(1) if $\frac{\mu}{t} > \left(\frac{\phi - \frac{4d}{3t}}{\phi}\right)\frac{L}{2N}$, equilibrium prices are $p_S^* = \frac{1}{3}\frac{dL}{2N}$ and $p_N^* = \frac{2}{3}\frac{dL}{2N}$;

(2) if $\frac{\mu}{t} < \left(\frac{\phi - \frac{1}{3} - \frac{4d}{3t}}{\phi + \frac{1}{3}}\right)\frac{L}{2N}$, equilibrium prices are $p_S^* = \frac{1}{3}\left[\frac{(t+d)L}{2N} + \mu\right]$ and $p_N^* = \frac{2}{3}\left[\frac{(t+d)L}{2N} - \frac{\mu}{2}\right]$;

(3) otherwise, there is no equilibrium.

Proof. First, we show that line C in Figure 4(1) and line A$'$ in Figure 4(2) cannot intersect when $p_S < \bar{p}_S^* = \phi\left(\frac{tL}{2N} - \mu\right) - \frac{dL}{2N}$. Since the price of store S in the intersection between line C and line A$'$ is $\hat{p}_S = \frac{dL}{2N} - \frac{2d\mu}{t}$, we have $\hat{p}_S - \bar{p}_S^* = (t\phi - 2d)\left(\frac{L}{2N} - \frac{\mu}{t}\right)$. Here, $\left(\frac{L}{2N} - \frac{\mu}{t}\right) > 0$ from Assumption 1, and $(t\phi - 2d) > 0$ when $t > 0$. Hence, $\hat{p}_S > \bar{p}_S^*$, which implies that line C and line A$'$ cannot intersect when $p_S < \bar{p}_S^*$. Similarly, line C and line B$'$ in Figure 4(2) cannot intersect when $p_S < \bar{p}_S^*$. Therefore, from these two facts and the conditions for store N's reaction curve, we find that there is no equilibrium on line C. It is obvious that line A and line B$'$ cannot intersect in the same region; the case of line B and line A$'$ is similar.[4] Thus, if an equilibrium exists, it must be at either the intersection between line A and line A$'$ [represented as (p_S^{*I}, p_N^{*I}) hereafter] in Region I or the intersection between line B and line B$'$ [represented as (p_S^{*II}, p_N^{*II}) hereafter] in Region II. Given the conditions for the reaction curve of store N, we need $p_S^{*I} > \bar{p}_S^*$ for the former case and $p_S^{*II} < \bar{p}_S^*$ for the latter. The former case corresponds to (1) and the latter corresponds to (2); then, (3) can be shown (Q.E.D.).

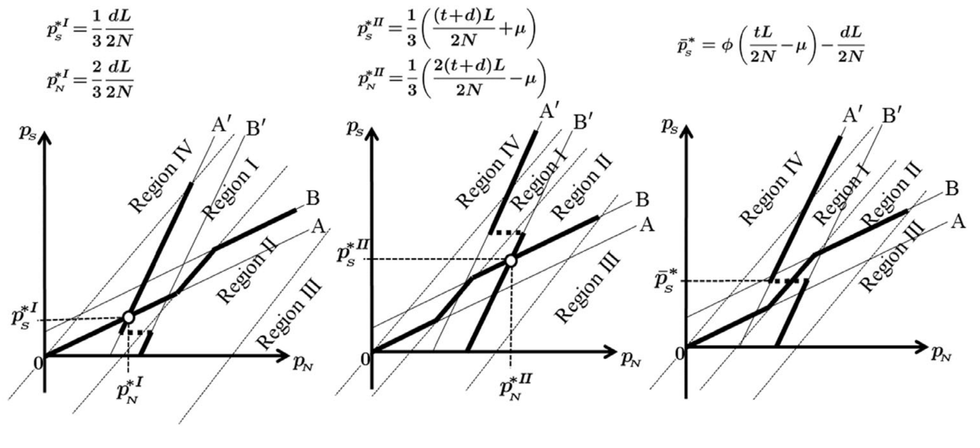
3 Discussion

3.1 Comparative Statistics

In this section, we discuss price equilibrium to determine the implications of the showrooming of consumers in the competition between store S and store N.

Figure 5 shows the three cases for price equilibrium. In Figure 5(1), line A and line A$'$ intersect at point (p_S^{*I}, p_N^{*I}) in Region I. As discussed earlier, there can be different types (S, A, and B) of consumers in this region. Thus, the consumers located near store S purchase the good from store S; the consumers located far from store S access store N directly; and the consumers located midway visit store S to obtain information about the good before pur-

4 We can also show that neither line A$'$ nor line B$'$ in Figure 4(2) can intersect line D in Figure 4(1).



(1) Equilibrium I (2) Equilibrium II (3) Non-Equilibrium

Figure 5. Price Equilibrium

chasing from store N. Another equilibrium is present at the intersection (p_S^{*II}, p_N^{*II}) between line B and line B ′ in Region II, as shown in Figure 5(2). In this case, Type A consumers do not exist; consumers purchase the good from store S or directly from store N without showrooming. Figure 5(3) presents the third case where no equilibrium exists. In this case, line A and line A ′ do not intersect and neither do line B and line B ′. Henceforth, we call (p_S^{*I}, p_N^{*I}) Equilibrium I and (p_S^{*II}, p_N^{*II}) Equilibrium II. These two equilibria can be characterized by the following proposition.

Proposition 3. For each store, the equilibrium price in Equilibrium I is lower than that in Equilibrium II; $p_S^{*I} < p_S^{*II}$ and $p_N^{*I} < p_N^{*II}$.

Proof. $p_S^{*II} - p_S^{*I} = \frac{1}{3}\left(\frac{tL}{2N} + \mu\right) > 0$ and $p_N^{*II} - p_N^{*I} = \frac{1}{3}\left(\frac{2tL}{2N} - \mu\right) > 0$ from Assumption 1 (Q.E.D.).

The implication of Proposition 3 is easy to understand. If μ is sufficiently large toward d, consumers might be attracted to purchase from store S rather than from store N because the disutility caused by lack of information is large, but the advantage of shopping online is small. Consumers would prefer to resort to showrooming to mediate the disadvantages of these two alternatives. In this case, store N must attract the consumers with showrooming tendencies by offering a sufficiently low price; if not, this store would lose out on these consumers. In turn, the low price of store N must cause store S to lower the price due to strategic complements, which leads to low prices in Equilibrium I. On the other hand if μ is not large, the consumers tend to purchase from store N without showrooming because they are less worried about disutility due to lack of information. Therefore, store N would not need to lower the price, which causes high prices in Equilibrium II.

The equilibrium that would arise (or not) depends on the parameters t, d, μ, and L/2N. We define two borders as follows:

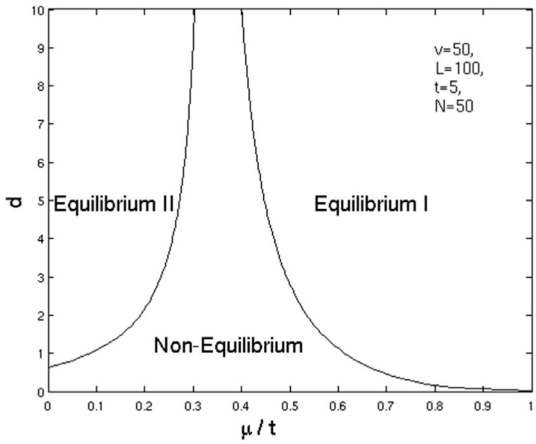


Figure 6. Equilibrium Regions

$$\alpha \equiv \left(\frac{\phi - \frac{4d}{3t}}{\phi}\right)\frac{L}{2N}, \qquad \beta \equiv \left(\frac{\phi - \frac{1}{3} - \frac{4d}{3t}}{\phi + \frac{1}{3}}\right)\frac{L}{2N}$$

Figure 6 demonstrates α and β on space $\left(\frac{\mu}{t}, d\right)$. Given d, Equilibrium I arises when $\alpha < \frac{\mu}{t}$, no equilibrium arises when $\beta < \frac{\mu}{t} < \alpha$, and Equilibrium II arises when $\frac{\mu}{t} < \beta$. We can prove that $\alpha > \beta$ for any t,d>0. The region for Equilibrium II must appear on the left side and that for Equilibrium I on the right side in Figure 6. We can also prove that $0 < \alpha < \frac{L}{2N}$ and $\frac{\partial \alpha}{\partial d} < 0$. Thus, when d is larger, the region for Equilibrium I might be broader. In other words, if the shipping cost of store S is high and store N becomes more attractive to consumers in terms of cost, more consumers would resort to showrooming in this equilibrium. Interestingly, the region for Equilibrium II also seems to be broader for a larger d in Figure 6. Subsequently, the non-equilibrium region becomes narrower if d increases. We can explain this result as follows. A large difference in the shipping costs of the stores implies a large differentiation to the consumers. If the differentiation is large and the disutility involved in shopping online is large, store N would prefer to mediate its disadvantage by letting consumers resort to showrooming. However, if the disutility is small but the two stores are differentiated among the consumers, store N might not need to use the showrooming strategy because it must sacrifice its high profits by lowering the price. Eventually, there is a clear difference in the optimal strategy taken by store N according to the degree of d.

3.2 Non-showrooming

In this section, we discuss how showrooming affects the price strategies of the stores by comparing the earlier results to the results without showrooming. If consumers do not "hit upon" the idea of showrooming in store S, they must compare u_S in Equation (1) and u_B in Equation (2) to determine the store from which to purchase the good. We can derive the profits for store S and N as follows:

$$\pi_S=\begin{cases}\dfrac{L}{2N}p_S & \text{if}\quad p_S<p_N+\mu-\dfrac{(t+d)L}{2N},\\[2ex] \dfrac{1}{t+d}(p_N-p_S+\mu)p_S & \text{if}\quad p_N+\mu-\dfrac{(t+d)L}{2N}<p_S<p_N+\mu,\\[2ex] 0 & \text{if}\quad p_N+\mu<p_S\end{cases}\tag{13}$$

$$\pi_N=\begin{cases}\dfrac{L}{2N}p_N & \text{if}\quad p_N<p_S-\mu,\\[2ex] \left[\dfrac{L}{2N}-\dfrac{1}{t+d}(p_N-p_S+\mu)\right]p_N & \text{if}\quad p_S-\mu<p_N<p_S-\mu+\dfrac{(t+d)L}{2N},\\[2ex] 0 & \text{if}\quad p_S-\mu+\dfrac{(t+d)L}{2N}<p_N\end{cases}\tag{14}$$

Accordingly, their reaction curves are:

$$p_S=\begin{cases}\dfrac{1}{2}(p_N+\mu) & \text{if}\quad p_N<\dfrac{2(t+d)L}{2N}-\mu,\\[2ex] p_N+\mu-\dfrac{(t+d)L}{2N} & \text{if}\quad \dfrac{2(t+d)L}{2N}-\mu<p_N\end{cases}\tag{15}$$

$$p_N=\begin{cases}\dfrac{1}{2}\left[p_S-\mu+\dfrac{(t+d)L}{2N}\right] & \text{if}\quad p_S<\mu+\dfrac{(t+d)L}{2N},\\[2ex] p_S-\mu & \text{if}\quad \mu+\dfrac{(t+d)L}{2N}<p_S\end{cases}\tag{16}$$

Thus, we can derive the price equilibrium, summarized as Proposition 4 (the proof is omitted).

Proposition 4. Without showrooming of consumers, a unique equilibrium of the price competition between store S and store N exists: $p_S^{**}=\frac{1}{3}\left[\frac{(t+d)L}{2N}+\mu\right]$ and $p_N^{**}=\frac{2}{3}\left[\frac{(t+d)L}{2N}-\frac{\mu}{2}\right]$.

The outcome in this equilibrium is equivalent to Equilibrium II (p_S^{*II}, p_N^{*II}) in the price competition with showrooming. Thus, $p_S^{*I}<p_S^{**}$ and $p_N^{*I}<p_N^{**}$. Even if consumers have a chance for showrooming, they would not opt for it in Region II, where store S is sufficiently attractive. With no incentive for store N to induce the consumers to opt for showrooming, the equilibrium prices remain high. Thus, showrooming does not matter in Region II. Therefore, we focus on showrooming in Region I.

Suppose $\alpha<\frac{\mu}{t}$, where Equilibrium I arises if consumers have the chance for showrooming. In this case, store N might reduce the price in the optimal strategy; then, store S's price would also need to be decreased for the consumers who preview the information about the good in store S. Thus, $\pi_S^{*I}<\pi_S^{**}$. Therefore, store S has an incentive to deter consumers from

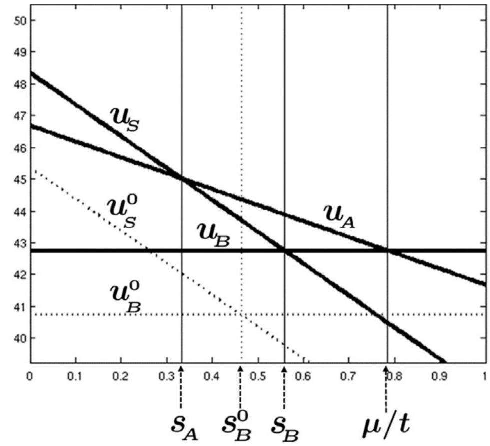


Figure 7. Comparison of Equilibrium in Preview and Non-preview Contexts

showrooming in its store. More interestingly, we find the following fact.[5]

Proposition 5. Store N's profit in Equilibrium I is smaller than its profit in the equilibrium without showrooming: $\pi_S^{*I} < \pi_N^{**}$.

Proof. We can derive:

$$\mathrm{Sign}\{\pi_N^{**}-\pi_S^{*I}\}=\mathrm{Sign}\left\{\left(\frac{2(\sqrt{d}(t+d)-d\sqrt{t+d}}{t\sqrt{d}}\right)\frac{L}{2N}-\frac{\mu}{t}\right\}$$

where the figure in parentheses on the right side is larger than the unity for any $t,d>0$. From Assumption 1, the figure in curly braces on the right side is positive (Q.E.D.).

This finding is not obvious and requires some discussion. First, we have $p_N^{*I} < p_N^{**}$ but $s_N^{*I} > s_N^{**}$, where $s_N^{*I} \equiv \frac{L}{2N} - \frac{1}{d}(p_N^{*I} - p_S^{*I})$ and $s_N^{**} \equiv \frac{L}{2N} - \frac{1}{t+d}(p_N^{**} - p_S^{**} + \mu)$. Thus, if the consumers opt for showrooming in Region I, store N can attract more consumers away from store S, but the price must be lowered. Since $\pi_N^{*I} = p_N^{*I} < p_N^{*I} \cdot s_N^{*I}$ and $\pi_N^{**} = p_N^{**} \cdot s_N^{**}$, which profit is larger depends on the degree of price elasticity of demand. In this case, the decrease of price involves a sacrifice in the increase of consumers because price elasticity is not large. Eventually, store N must forgo the payoff from lower price. Figure 7 shows the equilibrium utilities in a parameter set where u_S^0 and u_N^0 represent the consumer utilities when purchasing from store S and store N, respectively, in the case of non-showrooming. The results show that the prices decrease with showrooming.

This finding involves some implications for policy makers from a consumer welfare perspective. Suppose store S does not want consumers to opt for showrooming in its store; further, suppose the behavior can be prohibited with some measures. Thus, consumers cannot obtain information about the good from store S. In this case, store N would have no incentive to deter this strategy adopted by store S; in fact, the former would prefer this strategy so that high prices can be maintained by both stores. However, consumer welfare would be af-

5 This finding is derived in Balakrishnan et al. (2014) as well.

fected when prices remain high. In short, this is a kind of collusion between those stores. From a consumer welfare perspective, policy makers would need to monitor such deterrence of the consumer's showrooming.

4 Extension: Heterogeneous Disutility

In this section, we extend the basic model to one involving heterogeneous disutility of consumers. So far, the disutility caused by the lack of information about the product was assumed to be identical for all the consumers involved in online shopping, and it was represented as parameter μ. However, this is not very realistic because consumers are likely to have various risk preferences in online shopping. In the example cited in the Introduction, some consumers were willing to reconcile themselves to a curtain that is a little mismatched to their room in terms of color, but others would not be satisfied with such a product. The level of satisfaction varies across individuals, depending on their risk preference. Such varied preferences of consumers affect their behavior with regard to online shopping.

We consider another value of disutility for consumers, assuming that consumers are heterogeneous in terms of their tolerance for mismatch (risk preference). For reasons of simplicity, we formulate two types of disutility.

Assumption 3. There are two types of consumers based on their preferences in terms of purchasing a good without showrooming: one type has low disutility (μ) with probability λ, and the other type has high disutility (μ') with probability $1-\lambda$. Both types are distributed on the interval $\left[0, \frac{L}{2N}\right]$.

We can derive the equilibrium based on Assumptions 4(1) and 4(2).

Assumption 4. (1) $p_N - \frac{dL}{2N} < p_S < p_N$; (2) $\mu < \frac{tL}{2N} < \mu'$

From Assumption 4(1), we can restrict the cases to the two possibilities presented in Table 2.

Table 2. Regions and Types (Heterogeneous Disutility)

Region I:	$p_N - \frac{d}{t}\mu < p_S < p_N$	(Type S, A, and B)
Region II':	$p_N - \frac{dL}{2N} < p_S < p_N - \frac{d}{t}\mu$	(Type S and B)

Assumption 4(2) presumes that when $\lambda = 1$, the case is the same as that discussed in Section 3. When $\lambda < 1$, for consumers with μ' to use store N, the utility from purchasing with showrooming is higher than the utility without showrooming in the whole interval; $u_A > u_B$ for any $s \in \left[0, \frac{L}{2N}\right]$. Thus, the demands for store S and store N are exactly the same as before. In Region II', however, Type S and Type B exist where $u_B > u_S > u_A$, and Type A and Type B exist where $u_B > u_A > u_S$ for consumers with μ (see Figure 8).

Similar to the earlier case, the profits for store S and store N are as follows:

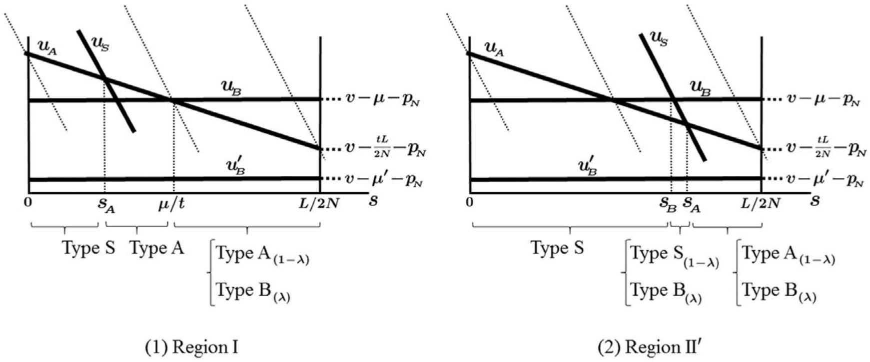


Figure 8. Utility Patterns for Heterogeneous Consumers

$$\pi_S=\begin{cases}\left[\frac{\lambda}{t+d}(p_N-p_S+\mu)+\frac{1-\lambda}{d}(p_N-p_S)\right]p_S & \text{(Region I)}\\ \frac{1}{d}(p_N-p_S)p_S & \text{(Region II}'\text{)}\end{cases} \tag{17}$$

$$\pi_N=\begin{cases}\left[\frac{L}{2N}-\frac{1}{d}(p_N-p_S)\right]p_N & \text{(Region I)}\\ \left[\frac{L}{2N}-\frac{\lambda}{t+d}(p_N-p_S+\mu)-\frac{1-\lambda}{d}(p_N-p_S)\right]p_N & \text{(Region II}'\text{)}\end{cases} \tag{18}$$

The reaction curves are as follows:

$$P_S(p_N)=\begin{cases}\frac{1}{2}p_N & \text{if}\quad 0<p_N<\frac{2d}{t}\mu,\\ p_N-\frac{d}{t}\mu & \text{if}\quad \frac{2d}{t}\mu<p_N<\left(\frac{2d}{t}+\psi\right)\mu,\\ \frac{1}{2}(p_N+\mu) & \text{if}\quad \left(\frac{2d}{t}+\psi\right)\mu<p_N<\frac{2(t+d)L}{2N}-(2-\psi)\mu\end{cases} \tag{19}$$

$$P_N(p_S)=\begin{cases}\frac{1}{2}\left[p_S-\psi\mu+\frac{\psi}{\lambda}\frac{(t+d)L}{2N}\right] & \text{if}\quad 0<p_S<\max\left\{\frac{dL}{2N}-\frac{2d}{t}\mu,\ \bar{p}_S^{*\lambda}\right\},\\ \frac{1}{2}\left(p_S+\frac{dL}{2N}\right) & \text{if}\quad \min\left\{\frac{\psi}{\lambda}\frac{(t+d)L}{2N}-\left(\frac{2d}{t}+\psi\right)\mu,\ \bar{p}_S^{*\lambda}\right\}<p_S\end{cases} \tag{20}$$

where

$$\psi=\frac{\lambda}{t+d}\Big/\left(\frac{\lambda}{t+d}+\frac{1-\lambda}{d}\right) \tag{21}$$

and

$$\bar{p}_S^{*\lambda} = \frac{1}{K}\left\{M_1 \frac{L}{2N} - M_2 \mu\right\}$$

$$K \equiv \sqrt{(t+d)\psi} - \sqrt{d},$$

$$M_1 \equiv \sqrt{d}(t+d)\frac{\psi}{\lambda} - d\sqrt{(t+d)\psi}, \tag{22}$$

$$M_2 \equiv \sqrt{d}\psi$$

The price equilibrium under heterogeneous disutility is stated as Proposition 6.

Proposition 6. Under heterogeneous disutility, the equilibrium of the price competition between store S and store N is:

(1) if $\frac{\mu}{t} > \alpha_\lambda$, equilibrium prices are $p_S^* = \frac{1}{3}\frac{dL}{2N}$ and $p_N^* = \frac{2}{3}\frac{dL}{2N}$;

(2) if $\frac{\mu}{t} > \beta_\lambda$, equilibrium prices are $p_S^* = \frac{1}{3}\left[\frac{\psi}{\lambda}\frac{(t+d)L}{2N} + \psi\mu\right]$

and $p_N^* = \frac{2}{3}\left[\frac{\psi}{\lambda}\frac{(t+d)L}{2N} - \frac{\psi}{2}\mu\right]$;

(3) otherwise, there is no equilibrium,
where

$$\alpha_\lambda \equiv \frac{K}{tM_2}\left(\frac{M_1}{K} - \frac{d}{3}\right)\frac{L}{2N}, \qquad \beta_\lambda \equiv \frac{1}{t\left(\frac{M_2}{K} + \frac{\psi}{3}\right)}\left[\frac{M_1}{K} - \frac{1}{3}(t+d)\frac{\psi}{\lambda}\right]\frac{L}{2N}.$$

Instead of proving this proposition, we simply discuss two characteristics to demonstrate how the outcome in this equilibrium would be different from that in the case of homogeneous consumers.

First, Figure 9 shows the lines A, A′, B, and B′ by which we represent parts of the reaction curves for store S and store N (similar to what was done in Section 2). Note that line A and line A′ are exactly same as before, and line B($\lambda=1$) and line B′($\lambda=1$) correspond to the lines in Section 2. When λ decreases, however, line B and line B′ approach line A and line A′, respectively. This causes the intersection between line B and line B′ to move lower left, i.e., there is a low price equilibrium in Region II′. The reason why the equilibrium prices are low in Region II′ is clear. With $\lambda<1$, store N finds out that some consumers favor store S because of significant disutility; it also finds out that some consumers want to opt for showrooming before purchasing from store N. Such findings urge store N to lower the price in order to overcome its disadvantage. Thus, if there is equilibrium in Region II′, the prices must be low.

Second, the existence of consumers with $\lambda<1$ changes the discontinuous region of store N's reaction curve. Thus, the borders of the equilibrium regions (α_λ and β_λ) vary with the value of λ. Figure 10 demonstrates how the equilibrium regions differ for several values of λ. Similar to Figure 6, the regions of Equilibrium I, Non-Equilibrium, and Equilibrium II′ range from right to left. Since the parameters are the same as earlier, the border curves are exactly the same as in Figure 6 when $\lambda=1$. If λ is lower, the region of Equilibrium II′ is

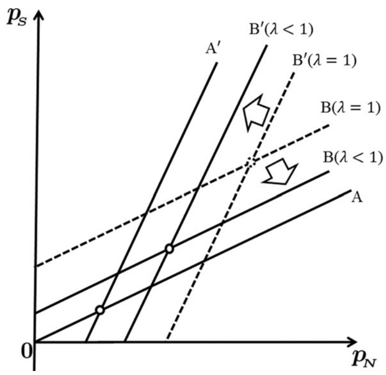


Figure 9. Reaction Curves and λ

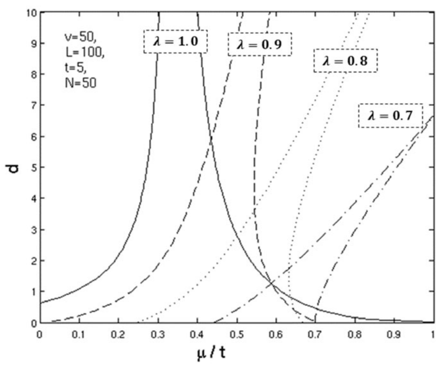


Figure 10. Equilibrium Regions and λ

broader, but the regions of Non-Equilibrium and Equilibrium I are narrower. This is interesting because lower λ implies a larger proportion of consumers with large disutility for online shopping, from which we would expect more consumers to display showrooming. The markedly lower prices in store N can explain why showrooming is abandoned. In order to attract consumers away from its rivals, store N must rely on lower prices. Consequently, the lower prices online would cause the consumers to purchase directly from store N, without showrooming. Eventually, equilibrium is more likely in Region II (Equilibrium II).

From these two characteristics, we can conclude that a greater proportion of consumers with significant disutility would deter the showrooming tendency of consumers.

5 Conclusion

In this article, we present three findings. First, there could be two types of price equilibrium, where some consumers display showrooming and others do not. Second, physical stores as well as online stores have an incentive to deter the first type of equilibrium because an online store must lower the price sufficiently for inducing showrooming. Finally, in the case of heterogeneous disutility, the stores must face severe price competition, and the first type of equilibrium is less likely to arise when the proportion of consumers with significant disutility is large. Our findings indicate an implicit collusion between physical stores and online stores. From a consumer welfare perspective, policy makers would need to monitor the deterrence of consumer's showrooming because both kinds of stores would prefer to deter consumers from showrooming to keep their prices high.

This article has two limitations. First, we do not consider how the differences in the shipping costs of the physical stores and the online stores can be explained. In reality, the costs for shipping are determined in the contract between the retail stores and the shipment companies. Thus, why online stores (e.g., Amazon.com) are able to obtain favorable contracts with shipment companies (e.g., UPS, FedEx) while the physical stores are unable to do so needs to be examined. Including such an analysis in the current model would have made this research too complex; future studies could consider plausible models for this analysis.

Second, we indicated the number of physical stores in the model with the symbol N but did not examine how this value would affect the equilibrium. Instead, we fixed the length of the segmented market (L/2N) and focused on the disutility due to transportation cost (μ/t) according to which consumers change their behavior. However, the model can be extended to include the dynamic aspect. For example, suppose some existing physical stores are thinking about exiting the market, and there are some potential entrants to the market. Their choices of entry and exit would depend on the expectation of discounted values in the long run — a Markov type of dynamic oligopoly model. In the dynamic model, the optimal number of physical stores on the circular market — which determines the length of the segmented market — would need to be considered. The theoretical results can be replicated by numerical calculation and simulation to predict the real figures of e-commerce in the future.

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