Profit Enhancing Leakage (Showrooming), Platform Deterrence and Beneficial Ban *

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Abstract

Buyers could showroom on the platform which is bad for the platform in the literature. And the platform might apply price parity clauses to deter showrooming. Different countries have different regulations for this clause. In contrast to the literature, we show that showrooming could be good for the platform in general conditions. Without commitment power, the platform would deter showrooming and hurt itself. The ban on price parity clause helps the platform to commit and benefit all players. With commitment power, the platform would optimally choose an interior level of showrooming and it is socially too small. The results hold for the wholesaler model.

Keywords: Leakage, Showrooming, Price Parity Clause, Ban.

JEL Classification: D21, D43, L13, L22.

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1 Introduction

The literature finds that showrooming (search on the platform and switch to sellers and buy directly from sellers, hence, no fee is charged by the platform.) is bad for the platform. Alternatively, consumers visit an offline seller to look for the ideal product and then switching to buy the product online at a lower price (windows shopping). Further, there could be webrooming (consumers search online and then buy the product offline). In other cases, buyers search on one platform, and switch to another platform due to discounts. For other examples, a house buyer could directly buy from the seller after using the service of the house broker. The same thing happens for house renters.

Firms pay commissions or kickbacks to information intermediaries for recommendation. A broker for insurance or financial products may suggest buyers which insurance or financial product they should purchase. A physician may advise patients which drug to take. Retailers may provide advice to shoppers for experience or credence goods over which product they should buy. An online platform may recommend which seller is best for the consumer. In all these cases, after receiving the recommendation from the intermediary, buyers could bypass the intermediary and buy directly from the sellers at a lower price.

Hence, there are lots of examples like showrooming with more applications. Hence, we call it leakage, according to the terminology by Hagiu and Wright (2023). In our paper, we might use showrooming in the context, instead of leakage. They are interchangeable, and they mean the same thing. We use showrooming because it is more important and universal in the literature and industry.

Actually, allowing buyers switch to sellers charging a lower price than on the platform is obviously bad for the platform. Hence, the platforms try the best to deter showrooming. One common strategy is the so-called price parity clauses and most favored nation clause. Alternatively, Price Coherence in Edelman and Wright (2015, a, b). Edelman and Wright (2015, a) illustrate thirteen markets with price coherence, and their origin and outcomes as well as concerns and policy issues. Edelman and Hu (2017) informally discuss various strategies to combat showrooming ("disintermediation" in their language.) Hagiu and Wright (2023) consider more strategies for the platform to deter showrooming or leakage in their language. Jing (2018) discussed strategies to deter showrooming as well.

Due to heterogenous in buyers' switching cost or inconvenience cost of buying directly, Hagiu and Wright (2023) allow partial leakage like our model. The key difference is that in our model, the

showrooming activity is modelled in a probability parameter, and we allow the platform optimally choose it. In real life, common sense tells us that all showrooming activity is partial, neither 0 or 1. According to the survey by ZBJ.com, the largest online freelance marketplace in China, they show that about 90% of total transactions are conducted outside the platform after clients and freelancers have been matched on its platform. (See Gu and Zhu, 2021.) Based on the survey, if the service provider's income based on the platform is RMB 100,000, however, the real revenue could be RMB 1 million. For details, please refer to Zhu et al. (2018). It is confirmed in empirical studies. There is a paper (Rider and Samila 2019) on brokerage which points out that brokers are more likely to be disintermediated when they do not control information. Hunold et al. (2020) provide evidence of steering due to showrooming on hotel booking platforms. Further, they show Booking and Expedia could give less prominent placement (like recommendation) to hotels that offer lower prices on the their own website or on a competing platform's site. Gu and Zhu (2021) show that more online trust between consumers and third-party freelancers lead to more showrooming on an online freelancer marketplace. Zhou et al. (2021) show that higher customer-agent interaction frequency, higher transaction prices, service repetitiveness and proximal customers could potentially raise showrooming.

The showrooming in universal to the platform in our real life. For example, Amazon, Booking.com and Expedia, and they price-parity clauses to deter showrooming. However, in the case of insurance, financial and medical products, intermediaries impose no such restrictions, and sellers typically do not offer lower prices for direct sales relative to intermediated sales. Shen and Wright (2019) offer a theory to explain why online marketplaces and hotel booking platforms impose price-parity clauses to prevent showrooming, while insurance and financial advisors do not.

The price parity clauses are widely used by almost all platforms all over the world. For example, Amazon use this clause by requiring that the price of the seller on Amazon must be at or lower than the seller offers via any other platforms or the seller's own channel. In 2012, due to the regulations of German and UK, Amazon removed this clause in Europe from 2013. However, it kept requiring it in the USA until 2019 due to political pressure. In 2015, European authorities' investigations of the clause, Booking.com and Expedia committed to remove the wide price parity clauses in Europe while retained the narrow ones.

For the most favored nation (MFN) clauses, the Department of Justice Antitrust Division's (DOJ) had filed several antitrust actions alleging that particular MFN clauses violated Sherman

Act no. 1 and induced anticompetitive effects. All over the world, there is a wide concern about the issue of MFN in regulation authorities.[1]In the e-book market, Apple and Amazon were found guilty by the authority for the MFN. For more details, please refer to Klein (2017). The European Commission adopted on 10 May 2022 the new Vertical Block Exemption Regulation (VBER) and Vertical Guidelines (Guidelines) which come into force on 1 June 2022.[2]On 8 August 2022, the UK Competition Appeal Tribunal ("CAT") set aside the Competition and Markets Authority's ("CMA") first infringement finding against Compare The Market for the use of most favored nation clauses ("MFN clauses").[3]

There are legal and government investigation of this policy of the platforms for the price parity clauses. In the world, different countries apply different policies for the price parity clauses. In some cases, platforms have removed the price parity clauses due to the government investigations or regulatory pressure. For example, Amazon in Europe from 2013 and in the U.S. from 2019. In Europe, several countries (Austria, Belgium, France, Italy) prohibit the price parity clauses via online travel agencies (OTAs). In Germany and Sweden, the ban only applies to certain OTAs (HRS and Booking.com in Germany, and Booking.com in Sweden), while other OTAs continue to use price parity clauses within these markets. In many other major markets, however, these OTAs continue to use the price parity clauses. Further, in Austrian, Belgian, French, and Italy, they passed laws to ban this clause.

Previous researches on showrooming and price parity clauses include Edelman and Wright (2015, a, b), Boik and Corts (2016), Johnson (2017, b), Johansen and Verg‘e (2017), Carlton and Winter (2018), Ronayne and Taylor (2018), Wals and Schinkel (2018), Gomes and Mantovani (2020), Mariotto and Verdier (2020) and Liu et al. (2021), Wang and Wright (2020).

Edelman and Hu (2017) informally discuss various strategies to combat showrooming ("dis-

[1]See Department of Justice, Federal Trade Commission to Hold Workshop on "Most-Favored-Nation" Clauses, August 17, 2012, the United States Department of Justice, https://www.ftc.gov/news-events/news/press-releases/2012/08/ftc-department-justice-hold-workshop-most-favored-nation-clauses, and https://www.justice.gov/atr/events/public-workshop-most-favored-nation-clauses-and-antitrust-enforcement-and-policy. Implications of E-commerce for Competition Policy, June, 2018, OECD, http://www.oecd.org/competition/e-commerce-implications-for-competition-policy.htm, accessed on April 10, 2023.

[2]https://www.linklaters.com/en/knowledge/publications/alerts-newsletters-and-guides/2022/may/13/vertical-block-exemption-regulation-final-text-published-and-ready-for-launch-on-1-june-2022, accessed on April 10, 2023.

[3]https://www.ashurst.com/en/news-and-insights/legal-updates/competition-law-newsletter-october-2022/cn04—cmas-first-infringement-finding-on-most-favoured-nation-clauses-set-aside/, accessed on April 10,2023.

intermediation" in their language.) Hagiu and Wright (2023) consider more strategies for the platform to deter showrooming or leakage in their language. Jing (2018) discussed strategies to deter showrooming as well.

For the showrooming and price parity clauses and platform investment, please refer to Edelman and Wright (2015), Maruyama and Zennyo (2020), and Wang and Wright (2023). Hagiu and Wright (2023) also consider it as one of their strategies to deter showrooming.

In these studies, the common results show that it is a dominant strategy for the platform to use the price-parity clause that prevents sellers from setting lower price in their direct channel (or other cheaper platforms) so as to eliminate showrooming. Although the effects on prices and welfare might be different.

However, in our study, we show that the showrooming could be good for the platform with higher profit under mild conditions. And we allow the platform to choose optimal probability of showrooming. And we show that the ban on price parity clauses is good for everyone including the platform itself. Our model also has some policy implications and empirical predictions.

In fact, some country ban price parity clauses. The government ban it to protect buyers and sellers. Government ban on price parity clauses actually help the platform to commit to positive showrooming probability and earn a higher profit. Under this case, the surplus of sellers and buyers and social welfare are higher as well. Hence, the ban on price parity clauses benefits every player in the game.

In our paper, counterintuitively, we show that showrooming could be good for the platform. Allowing showrooming leads to higher surplus for the buyers. To visit the platform, the buyers need to pay a random cost. Higher surplus leads to more visit, and it is good for the platform as well. Although showrooming lowers the profit of the platform per buyer, however, if the demand enhancing effect dominates, showrooming is good for the platform.

If the showrooming probability is endogenously decided by the platform after the entry of the buyers, then given the entry decision of the buyers, even if showrooming is good for the platform ex ante, then platform would forbid showrooming ex post. And the platform hurts itself. However, if the showrooming probability is endogenously decided by the platform before buyers' entry with commitment, and it is public information, then the platform would choose the optimal showrooming probability.

For surplus for buyers, sellers and social welfare, consumer surplus is increasing in the show-

rooming probability, hence the measure of the visitors is increasing in the probability as well. Consequently, the social welfare increasing in the showrooming probability too. Hence, for policy implications, the government should make showrooming easier than the one chosen by the platform. For example, the government could make sellers information in public and easier to obtain for buyers, reduce the switch cost for both buyers and sellers, teach naive buyers about related details of showrooming, make the sales directly from sellers and from platform less differentiated (payment instrument, insurance, delivery, security, logistic and so on), promote the communication between buyers and sellers.

However, even if the showrooming decision is made by the platform before visit decision of buyers, while the platform can not commit to it, then the platform would forbid showrooming. Alternatively, the buyers do not know the showrooming probability before visiting the platform or the showrooming decision is made after entry of buyers, then it is the same, the platform would forbid showrooming. In this case, the platform hurts itself.

Consequently, the platform would apply different sorts of strategies to deter showrooming. One particularly commonly used is the price parity clauses. However, the price parity clauses hurt the platform. For policy implications, some country ban price parity clauses to restrict the behavior of the platform and promote the surplus of the sellers and buyers. Our theory suggests that most times the ban on price parity clauses actually help the platform to commit and earn a higher profit and reduce the surplus of sellers and buyers.

The ban of price parity clauses in several European countries lead to empirical studies of the effects of price parity clauses. Hunold et al.(2018) used data from Kayak (a price comparison website) to check the changes in the German hotel industry after the ban. Mantovani et al. (2021) conduct quasi-experimental evidence on the full ban of price parity clauses in France for hotels listed on Booking.com. Ennis et al. (2020) study the impact of EU's ban of wide price parity clauses. Song (2023) studies how Amazon's removal of the clause in March 2019 affects product prices on Amazon and eBay. The key of these empirical studies is the effect of the ban on prices and product availability across different selling channels.

We show this result by a simple example. Then set up a general model. Later, we show that the result is robust to different settings. The main model assumes the following timing. Stage 1, Rational buyer anticipates the prices, and the cost of the visit is realized, and buyers make visit decisions. Stage 2, the platform charges a fee. Stage 3, sellers charge a price. Stage 4,

the value of the product is realized. And whether the buyer could showroom is realized. There are several important elements here. First, the buyers need to pay a visit cost before knowing the information about the trade. Second, the showrooming behaviors are characterized by the showrooming probability which is the same to all buyers. Third, with endogenous showrooming probability, with commitment power, the committed showrooming probability is public information and buyers could observer ex ante, otherwise, it is the same to the case without commitment or buyers can not observer this information, and the platform would deter showrooming and hurt everyone. Hence, the ban on price parity clauses is good for every player. Forth, for the case with platform pricing which is public information before visit decision of buyers, or the platform could commit to the transaction fee which is public information ex ante, then, the showrooming is neutral in these cases. The results are quite robust. Further, we argue why the timing of our main model makes sense and important to study. We argue how the platform could affect the showrooming behaviors through different strategies of showrooming deterrence policies, and hence optimally choose it. In our model, the platform commits to showrooming probability if possible, however, if the platform commits to the transaction fee, then it is the same to the alternative timing. Further, we make argument why our model makes more sense to consider the case for the platform commits to showrooming probability instead of the transaction fee.

In extension, we show that the platform model we analyzed is the same to the wholesale model where the intermediary is wholesale. We show that the results are exactly the same.

The rest of the paper is organized as follows. Section 2 uses a simple example to show how showrooming could be good for the platform. Section 3 conducts a general model with competitive sellers charging marginal pricing to show condition for profit enhancing showrooming for the platform. We show the optimal showrooming probability chosen by the platform if it can commit to it. Further, without commitment power, the platform would deter showrooming and hurt itself. The ban on price parity clauses actually helps every stakeholder and help the platform to commit to not deter showrooming. Hence, our model supports the ban on price parity clauses. For extensions, section 4.1 considers monopoly seller and the results are exactly the same. Section 4.2 considers competitive platforms in the Hotelling model with similar results. Section 4.3 considers the case trade directly with seller leads to disutility and it leads to similar results. Section 4.4 considers alternative timing and show that the showrooming is neutral. Section 4.5 considers wholesaler model. Section 4.6 considers different cumulative distribution functions with the same results.

Sections 4.7 and 4.8 make some illustration of other effects on showrooming, and we leave them for future research. Section 5 concludes.

2 A Simple Example

The literature finds that showrooming (search on the platform and switch to sellers and buy directly from sellers, hence, no fee is charged by the platform.) is bad for the platform.

However, I want to show that sometimes showrooming is good for the platform. The logic is that allowing showrooming gives the buyers higher utility. Hence, more buyers would use the platform. On the one hand, it leads to more purchases, on the other hand, it leads to higher advertising revenue. Alternatively, the platform could make recommendation, and it might lead to more profit from other products.

Game Structure

1. Players

Buyer The value of the buyer is fixed at v, and it takes cost c_v to visit the platform. Buyer could choose whether to pay a visit cost c_v to visit the platform. Without showrooming, the buyer can only trade with the seller on the platform. With showrooming, the buyer could trade with the seller directly.

Seller Sellers are competitive and charge a marginal price. The competitive marginal cost of sellers is fixed at c_s. Given the transaction fee f charged by the platform, the seller charge buyer a price equal to $f + c_s$.

Platform The platform charges a transaction fee f. In the case without showrooming, the transaction fee is the only decision variable chosen by the platform. With showrooming, the platform could choose the optimal showrooming probability p.

2. Timing

Without Showrooming

Stage 1, rational buyer anticipates the prices, and buyers make visit decisions.

Stage 2, the platform charges a fee.

Stage 3, sellers charge a price.

Stage 4, the buyer makes purchase decision.

With Showrooming

Stage 0, The probability of showrooming could be chosen by the platform with commitment before buyers' entry and it is public information.

Stage 1, rational buyer anticipates the prices, and buyers make visit decisions.

Stage 2, the platform charges a fee.

Stage 3, sellers charge a price.

Stage 4, whether the buyer could showroom is realized. And the buyer makes purchase decision.

3. Payoffs

Without Showrooming

Consumer Surplus (CS) The gain minus the price and visit cost if the buyer choose to visit the platform, $v - c_v - f - c_s$. Otherwise, if the buyer does not visit the platform, then $CS = 0$.

Seller Profit They are competitive and charge marginal price with 0 profit.

Platform Profit The profit of the platform is equal to the transaction fee f if the buyer chooses to visit the platform. Otherwise, if the buyer does not visit the platform, then the profit of the platform is equal to 0.

Social Welfare (SW) is equal to the sum of CS and platform profit.

With Showrooming

Consumer Surplus (CS) The gain minus the price and visit cost if the buyer chooses to visit the platform, $v - c_v - (1-p)(f + c_s) - p * c_s$. Otherwise, if the buyer does not visit the platform, then $CS = 0$.

Seller Profit They are competitive and charge marginal price with 0 profit.

Platform Profit The profit of the platform is equal to the transaction fee $(1-p)f$ if the buyer choose to visit the platform. Otherwise, if the buyer does not visit the platform, then the profit of the platform is equal to 0.

Social Welfare (SW) is equal to the sum of CS and platform profit.

4. Equilibrium Concept

We use subgame perfect equilibrium (SPE) as the solution concept, and solve the game by backward induction.

In this case, there is a platform and competitive sellers which charge marginal price. The value of the buyer is fixed at v, and it takes cost c_v to visit the platform. The cost could be time spent on it, search cost, the price paid for internet, package for the cell phone, membership fee, time spent due to search diversion, driving fee, parking fee, payment for the cell phone, laptop,

knowledge of how to use the platform, APP and facilities, and so on. The competitive marginal cost of sellers is fixed at c_s. The platform charges a transaction fee f. In our model, buyers have unit demand. According to Hagiu and Wright (2023), for unit demand and positive marginal costs, the ad-valorem or proportional fee is equivalent to the transaction fee, and they prove it for their baseline model in Online Appendix B.

In this example, there is a single buyer with fixed value and visit cost. Alternatively, we could think a continuum of homogeneous buyers with measure one. Further, the showrooming probability is committed by the platform and it is public information and known by the buyer ex ante. We deal with other issues in later part of this section and general model.

Without showrooming, when the platform is visited, it will charge seller a fee $f = v - c_s$, with total price v. The buyer has 0 surplus, and due to visit cost, the buyer will not choose to visit the platform, and hence, the market collapses. The payoffs for all players are 0.

With showrooming, suppose that the buyer has probability of p being able to showroom. It could due to asymmetric information, switch cost, being naive, online habit, laziness, personal knowledge, and so on. Some buyers have more information, lower switch cost, different knowledge about sellers, disutility form switching, they are more experienced. Otherwise, they care less about the convenience of the platform (payment instrument, insurance, delivery, security, logistic and so on). To fix idea, we could assume that this proportion of buyers are informative about sellers or with 0 switch cost, while other buyers can not showroom. Or those buyers are captive and loyal while others belong to the switching group.

Under this case, the surplus of the buyer is given by

$$\begin{aligned} 1-p \quad &: \quad f = v - c_s, cs = 0, \\ p \quad &: \quad cs = v - c_s. \end{aligned}$$

Hence, the expected surplus is given by

$$p * (v - c_s) - c_v.$$

If $p*(v-c_s)-c_v > 0$, then, the buyer chooses to visit. And it leads to higher consumer surplus and social welfare than the case without showrooming. Otherwise, if $p * (v - c_s) - c_v < 0$, then the buyer does not visit the platform with 0 payoffs for all players.

The profit of the platform is given by

$$(1-p)(v - c_s) > 0.$$

Hence, if $p * (v - c_s) - c_v > 0$, then, showrooming is good for the platform.

If the probability of being able to showroom is sufficiently high, then visiting the platform brings higher surplus to the buyer, then the buyer will visit the platform for sufficiently high p. And visiting leads positive profit to the platform. Alternatively, if the cost of sellers or visiting is sufficiently low, or the value is sufficiently high, then it brings positive surplus to the buyers visiting the platform. Hence, it leads to positive profit for the platform accordingly.

Supposedly, the probability of showrooming p is endogenously decided by the platform. The question is what is the equilibrium showrooming probability. Under this case, the platform must be able to commit to the showrooming probability and it should be known by the buyers before their visit. In other words, the showrooming is public information.

As the profit of the platform is decreasing in p, then, the lower the probability, the higher the profit. However, Low probability leads to lower buyers' surplus and buyers will not choose to visit. Hence, in equilibrium, the platform will set optimal probability as following

$$\begin{aligned} p^* * (v - c_s) - c_v &= 0, \\ p^* &= \frac{c_v}{v - c_s}. \end{aligned}$$

The profit of the platform is given by

$$(1 - p^*)(v - c_s) = v - c_s - c_v.$$

Under this case, the platform takes away all the surplus, while it is efficient.

However, even if the showrooming decision is made by the platform before visit decision of buyers, while the platform can not commit to it, then the platform would forbid showrooming, and the market collapses. Alternatively, the buyers do not know the showrooming probability before visiting the platform or the showrooming decision is made after entry of buyers, then it is the same, the platform would forbid showrooming. In this case, the platform hurts itself.

Consequently, the platform would apply different sorts of strategies to deter showrooming. One particularly commonly used is the price parity clauses. However, the price parity clauses hurt the platform. For policy implications, some country ban price parity clauses to restrict the behavior of the platform and promote the surplus of the sellers and buyers. Our theory suggests that most times the ban on price parity clauses actually help the platform to commit and earn a higher profit. Under our example, the surplus of sellers and buyers are always equal to 0 for both cases with and

without endogenous showrooming. Without the ban, the market does not exist, while with it, the platform takes away all the surplus and it is socially efficient.

Hence, we obtain the following results.

Result 1 *Without showrooming, no buyer visits the platform. With showrooming, then,*

1. It leads to higher consumer surplus and social welfare.

2. If $p*(v-c_s)-c_v>0$*, then, showrooming is good for the platform.*

3. If p is endogenous decided by the platform before buyers' entry with commitment, then $p^*=\frac{c_v}{v-c_s}$*. Otherwise, the platform would forbid showrooming and hurts itself.*

4.. The equilibrium showrooming probability is too small for buyers, sellers and social welfare.

5. Government ban on price parity clauses actually help the platform to commit and earn a higher profit. And under this example, the ban is socially efficient.

6. Under endogenous showrooming, the surplus of sellers and buyers are always 0.

In this example, if the platform could commit to the transaction fee which is public information and known before the visit of the buyers, platform could achieve the same results. In this example, the platform could commit a price $f=v-c_s-c_v$. Under this case, the platform takes away all the surplus as well. Hence, it is interesting to compare the case with commitment power to showrooming and to transaction fee. However, due to the following reasons, we focus on the case with commitment power on showrooming. Actually, commitment power on the showrooming probability ex ante makes our timing of main model interesting. The alternative timing in the extension makes the showrooming probability neutral. Commitment power on the transaction fee being public information for buyers is the same to the analysis of the alternative timing model. Further, as argued in the general model, the information for the transaction fee might not be available.

3 A General Model

In this section, we layout the main model. Below is the timing.

Timing

Stage 0, The probability of showrooming could be chosen by the platform with commitment before buyers' entry and it is public information.

Stage 1, Rational buyer anticipates the prices, and the cost of the visit is realized, and buyers make visit decisions.

Stage 2, the platform charges a fee.

Stage 3, sellers charge a price.

Stage 4, the value of the product is realized. And whether the buyer could showroom is realized. And the buyer makes purchase decision.

We take this timing as the benchmark, because without paying a cost to visit the platform, buyers have no information about the value and prices. In our timing, the sellers and the platform set prices by taking the measure of visitors as given. To consider the case where the buyers know all these information in advance, and the prices affect the visit decision, we consider alternative timing in the extension.

In this section, if the sellers and platform charge prices before visit of buyers, and buyers have no information about the prices value and visit cost. Then, the analysis is the same to our timing. As the prices does not directly affect the visit decision, and only the anticipation of the prices affect the decision of buyers.

Following Hagiu and Wright (2023). For the simple model, we assume that v is uniformly distributed on $[0, V]$, while the Cumulative Distribution Function (CDF) of c_v is $G(c) = \frac{1}{C}c^{\theta}$ on $[0, C^{\frac{1}{\theta}}]$. For $\theta = 1$, it is uniformly distributed. Before paying a cost to visit the platform, the value is unknown. Otherwise, if the value is known before visiting the platform, and the platform would charge a price, and those buyer with value higher than the price and visit cost will enter the market. Given this, the platform would charge even higher prices. Hence, the market collapses again.

Without showrooming, the sellers charge marginal cost c_s, and the price is $f + c_s$, buyers with $v > f + c_s$ will buy, and stay out of the market otherwise. Hence the demand is given by $1 - \frac{f+c_s}{V}$. The profit after visiting is given by

$$(1 - \frac{f + c_s}{V})f$$

Taking first order condition (FOC),

$$(1 - \frac{f + c_s}{V}) - \frac{f}{V} = 0.$$

And the second order condition (SOC) naturally holds.

we obtain optimal transaction fee

$$\begin{aligned} f &= \frac{V - c_s}{2}, \\ (1 - \frac{f + c_s}{V})f &= \frac{(V - c_s)^2}{4V}. \end{aligned}$$

It requires that

$$\begin{aligned} f + c_s &= \frac{V + c_s}{2} < V, \\ c_s &< V. \end{aligned}$$

For buyer, after visiting, the expected surplus is given by

$$\frac{\int_{f+c_s}^{V} (v - f - c_s) * \frac{1}{V} dv}{1 - \frac{f+c_s}{V}} = \frac{(V - f - c_s)^2}{2(V - f - c_s)} = \frac{(V - f - c_s)}{2} = \frac{V - c_s}{4}.$$

Hence, the measure of buyers willing to visit the platform is given by $\frac{V-c_s}{4} > c_v$, hence the demand is given by

$$\frac{(\frac{V-c_s}{4})^\theta}{C}.$$

Hence, the total profit of the platform is given by

$$\pi_{pn} = \frac{(\frac{V-c_s}{4})^\theta}{C} * \frac{(V - c_s)^2}{4V}.$$

With showrooming, with probability $1 - p$, the equilibrium remains the same, and the profit is the same as well. With probability p, the price is given by c_s, the demand is given by $1 - \frac{c_s}{V}$, and the expected surplus is given by

$$\frac{\int_{c_s}^{V} (v - c_s) * \frac{1}{V} dv}{1 - \frac{c_s}{V}} = \frac{\int_{c_s}^{V} (v - c_s) dv}{V - c_s} = \frac{V - c_s}{2}.$$

The expected surplus of the buyer after visiting the platform is given by

$$p * \frac{V - c_s}{2} + (1 - p) * \frac{V - c_s}{4} > c_v$$

The measure of buyer willing to visit the platform is given by

$$\frac{(p * \frac{V-c_s}{2} + (1 - p) * \frac{V-c_s}{4})^\theta}{C}.$$

Hence, the total profit of the platform is given by

$$\pi_{ps} = \frac{(p * \frac{V-c_s}{2} + (1 - p) * \frac{V-c_s}{4})^\theta}{C} * (1 - p) * \frac{(V - c_s)^2}{4V}.$$

For the comparison of the profit under showrooming and without showrooming is given by

$$\begin{aligned} \frac{\pi_{ps}}{\pi_{pn}} &= (1 - p)(\frac{p * \frac{V-c_s}{2} + (1 - p) * \frac{V-c_s}{4}}{\frac{V-c_s}{4}})^\theta \\ &= (1 - p)(2p + (1 - p))^\theta \\ &= (1 - p)(p + 1)^\theta. \end{aligned}$$

However, due to the fact that $p+1>1$ for $p>0$. Hence, $\frac{\pi_s}{\pi_n}$ is increasing in θ. Hence, there exists a θ^* such that

$$\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(p+1)^{\theta^*} = 1.$$

And showrooming is good for the platform if and only if $\theta > \theta^*$. The logic is following. For larger θ, then the entry inducing effect of showrooming is larger. The slope of the CDF of the entry cost is larger, the increase of the entrance of buyers compared to the case without showrooming is larger. Hence, showrooming is good for the platform for θ sufficienlty large.

For $\theta = 1$, the visit cost is uniformly distributed, and we obtain

$$\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(p+1) = 1-p^2 < 1.$$

For $\theta = 1$, the visit cost is uniformly distributed, and the platform always earn a lower profit than the case without showrooming.

For $\theta = 2$, and we obtain

$$\begin{aligned} \frac{\pi_{ps}}{\pi_{pn}} &= (1-p)(p+1)^2, \\ \frac{\pi_{ps}}{\pi_{pn}} &> 1 \Leftrightarrow 0 < p < \frac{1}{2}(\sqrt{5}-1). \end{aligned}$$

Hence, for $\theta = 2$, and the platform earns a higher profit under showrooming if and only if the showrooming probability is sufficiently low. It is understandable that if the showrooming probability is too high, it would lead to lower profit for the platform under showrooming.

Set

$$\begin{aligned} h &= (1-p)(p+1)^{\theta}, \\ \frac{\partial h}{\partial p} &= (p+1)^{\theta-1}(\theta - 1 - p(1+\theta)) = 0, \\ h(p &= 0) = 1, \\ h(p &= 1) = 0. \end{aligned}$$

For $0 \leq p \leq \frac{\theta-1}{1+\theta}$, h is increasing in p, and for $p > \frac{\theta-1}{1+\theta}$, h is decreasing in p. Hence, there exists a $\overline{p} > \frac{\theta-1}{1+\theta}$, and $(1-\overline{p})(\overline{p}+1)^{\theta} = 1$. For $0 \leq p \leq \overline{p}$, $\frac{\pi_{ps}}{\pi_{pn}} > 1$. Hence, for showrooming probability sufficiently small, showrooming could be good for the platform. In this case, the entry inducing effect of the showrooming dominates the profit reducing for given entry. Otherwise, for

showrooming probability too high, the profit loss is too large and showrooming leads to lower profit.

Further, obviously, we have

$$p * \frac{V - c_s}{2} + (1 - p) * \frac{V - c_s}{4} > \frac{V - c_s}{4}.$$

Hence, given the measure of buyers fixed, showrooming leads to higher surplus for buyer, and further, it leads to higher measure of visitors. Hence, showrooming leads to higher consumer surplus and social welfare for sure.

Further, consumer surplus is increasing in p, hence the measure of the visitors is increasing in p as well. Consequently, the social welfare increasing in p too.

If the probability of showrooming could be chosen by the platform, and the probability is chosen in stage 4. Then, due to the fact given the measure of buyers who pay a visit, the probability of showrooming only lowers the profit of the platform. Hence, optimally, the platform would choose $p = 0$.

Hence, although sometimes allowing showrooming would be good for the platform, the platform can not commit to it and it would not allow showroom in the end. Ex ante, allowing some showrooming is good for the platform, however, ex post, the platform would forbid showrooming and earn a lower profit.

However, if the probability of showrooming could be chosen by the platform with commitment before buyers' entry and it is public information, then there could be an optimal interior showrooming probability.

Hence, with showrooming, the total profit of the platform is given by

$$\begin{aligned} \pi_{ps} &= \frac{(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})^\theta}{C} * (1-p) * \frac{(V-c_s)^2}{4V} \\ &= \frac{(V-c_s)^2}{4V} \frac{1}{C} (\frac{V-c_s}{4})^\theta * (1-p)(p+1)^\theta. \end{aligned}$$

The platform choose p to maximize the profit, which is equivalent to maximize $h = (1-p)(p+1)^\theta$.

Hence, we obtain the FOC as following

$$\begin{aligned}
\frac{\partial h}{\partial p} &= -(p+1)^{\theta} + \theta(p+1)^{\theta-1}(1-p) = (p+1)^{\theta-1}(\theta(1-p)-(1+p)) = 0, \\
\theta(1-p)-(1+p) &= \theta - 1 - p(1+\theta) = 0 \Rightarrow p = \frac{\theta-1}{1+\theta}, \\
\frac{\partial^2 h}{\partial p^2} &= -(1+p)^{\theta-2}\theta(3+p+(-1+p)\theta) = -2^{\theta-1}\theta(\frac{\theta}{\theta+1})^{\theta-2} < 0.
\end{aligned}$$

For $\theta < 1$, $\theta(1-p)-(1+p) < 0$, hence, $p^* = 0$. For $\theta > 1$, $p^* = \frac{\theta-1}{1+\theta} \in (0,1)$.

Hence, we obtain the optimal showrooming probability

$$\begin{aligned}
p^* &= \frac{\theta-1}{1+\theta}, \theta > 1, \\
p^* &= 0, \theta < 1.
\end{aligned}$$

For surplus for buyers, sellers and social welfare, consumer surplus is increasing in p, hence the measure of the visitors is increasing in p as well. Consequently, the social welfare increasing in p too. Hence, for policy implications, the government should make showrooming easier than the one chosen by the platform. For example, the government could make sellers information in public and easier to obtain for buyers, reduce the switch cost for both buyers and sellers, teach naive buyers about related details of showrooming, make the sales directly from sellers and from platform less differentiated (payment instrument, insurance, delivery, security, logistic and so on), promote the communication between buyers and sellers.

However, even if the showrooming decision is made by the platform before visit decision of buyers, while the platform can not commit to it, then the platform would forbid showrooming. Alternatively, the buyers do not know the showrooming probability before visiting the platform or the showrooming decision is made after entry of buyers, then it is the same, the platform would forbid showrooming. In this case, the platform hurts itself.

Remark Ex ante, showrooming is good for the platform due to higher demand with higher surplus upon entry. However, ex post, given the entry decision of buyer, the platform would have incentive to deter showrooming to earn a higher profit for given demand.

Consequently, the platform would apply different sorts of strategies to deter showrooming. One particularly commonly used is the price parity clauses. However, the price parity clauses hurt the platform. For policy implications, some country ban price parity clauses to restrict the behavior of the platform and promote the surplus of the sellers and buyers. Our theory suggests

that most times the ban on price parity clauses actually help the platform to commit and earn a higher profit. Government ban on price parity clauses actually help the platform to commit to positive showrooming probability and earn a higher profit. Under this case, the surplus of sellers and buyers and social welfare are higher as well.

For the comparative analysis, for larger θ, then the entry inducing effect of showrooming is larger. The slope of the CDF of the entry cost is larger, the increase of the entrance of buyers compared to the case without showrooming is larger. For $0 < \theta < 1$, the entry inducing effect is dominated by profit loss due to showrooming, hence, the optimal showrooming probability is 0. However, for $\theta > 1$, $p^* = \frac{\theta-1}{1+\theta}$. In this case, the entry inducing effect dominates the profit loss due to showrooming, and the platform could commit to an interior showrooming probability.

Proposition 1 *Compared with no showrooming,* $\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(p+1)^{\theta}$.

1. The showrooming is good for the platform if and only if $\theta > \theta^*$*, or for* $0 \leq p \leq \overline{p}$, $\frac{\pi_{ps}}{\pi_{pn}} > 1$.

2. Further, showrooming leads to higher consumer surplus and social welfare for sure.

3. Consumer surplus and social welfare is increasing in p.

4. If the probability of showrooming is chosen by the platform after buyers' visit, it leads to no showrooming.

5. The comparison only depends on p and θ*, and unrelated to other modeling parameters.*

6. For $\theta < 1$*, showrooming is always bad for the platform.*

7. If the probability of showrooming is chosen by the platform with commitment power before buyers' visit, then we have the following solution. For $\theta < 1$*, there is no showrooming. For* $\theta > 1$*,* $p^* = \frac{\theta-1}{1+\theta}$.

8. The equilibrium showrooming probability is too small for buyers, sellers and social welfare.

9. Government ban on price parity clauses actually help the platform to commit to positive showrooming probability and earn a higher profit. Under this case, the surplus of sellers and buyers and social welfare are higher as well.

The logic is that compared to the case without showrooming, showrooming leads to lower profit for single buyer. However, showrooming gives the buyer higher surplus, and hence, it leads to more visits from buyers which leads to higher demand for the platform. The positive effect of showrooming on buyers is larger for larger θ. Hence, the demand enhancing effect is larger for the platform for larger θ and it leads to higher profit accordingly.

Without showrooming, demand of visit is given by $\frac{(\frac{V-c_s}{4})^{\theta}}{C}$, with showrooming, the demand of visit is given by $\frac{(p*\frac{V-c_s}{2}+(1-p)*\frac{V-c_s}{4})^{\theta}}{C}$. Further, $p*\frac{V-c_s}{2}+(1-p)*\frac{V-c_s}{4} > \frac{V-c_s}{4}$. Hence, the higher

θ, the larger the difference of demand from visit of buyers, and hence the larger the difference of the profit.

Our model has some policy implications and empirical predictions. For policy implications, the only policy applied by the authorities all over the world is either to ban price parity clause or not. However, based on the common sense, data, empirical studies, and theoretical studies, the showrooming behavior is partial, and the ban is not absolutely effective. Further, there are many subtle ways for the platform to deter showrooming, and our model suggests that there is too less showrooming, hence, the government could adjust the instruments to take different strategies of the platform into account. Could the government promote competition among platforms to let them self-regulate? How to regulate sellers on the platform? For the empirical prediction, how the platform designs the showrooming probability in data? What and how different factors affect the optimal extent of showrooming? What is the effects of different strategies of the platform to deter showrooming, do they make any player better off or worse off, especially the platform itself? What is the effects of the ads and unplanned purchases and platform investment? What is the effect of the distribution of the value of the product and the visit cost and factors affecting them, further, is there room for government intervention? What is the difference between monopoly seller and competitive sellers, more generally, oligopolistic competition among sellers? Is it really the same for the monopoly seller and competitive seller in data as our model predicts? What is the competitive effects of platform, does competition lead to more or less showrooming, prices, profits and welfare? What is the disutility from direct sale between buyers and sellers and where it comes from and how to adjust it for better outcome?

Below, we make detailed discussion for the modeling choice, assumptions, justification and concerns about the main model.

Showrooming probability being public information, commitment or not

Usually, the showrooming probability on a platform could be obtained by the buyer ex ante from the public information, news reports, the information spreads by word of mouth, information from friend circles, advertisement of the platform, information on search engines, former experiences. And usually, this probability is a long term strategy, and hence, it would not be hard to obtain information about it.

As for showrooming commitment, we allow for both cases with and without commitment. First, most times, the platform policy is public information and the platform does not change the policy

frequently. Second, even if the platform wants to change the policy accordingly, there is a legal issue, and the authorities forbid it. Third, most policy of the platform is made in the beginning of the entry of the platform, and the policy applies for all future sales. Furth, there are reputation concern for the platform and long term relationship and dynamic effects.

Justification for the Model Choice

Remark 1 In this model, the CDF for the value of the product is uniform so that we could obtain closed form solution for the pricing game of the platform and the seller. And it makes the analysis very clear and neat. Our logic will continue to hold for other CDF for the value of the product, however, it will make the analysis complicated and impossible to solve for some CDF without adding any new insight. Consequently, for other form of CDF, we leave it for future research.

Remark 2 For the CDF of the visit cost, usually, we would deal with the uniform distribution to make the model easy to understand, and most importantly, easy to solve. However, we deal with a more general CDF without masking the intuition and the analysis. Further, with this specific form of CDF, we completely solve the model in a simple way. However, its form is not very important in the analysis. We could allow for other forms of CDF in our extension part (see Section 4.5.), and we could either obtain closed from solution too or the general condition for our result to hold and offer numerical analysis to show that the condition indeed hold.

Remark 3 In real life, people might argue that although there is some cost for entry for buyers, the cost might be not large. In our model, the upbound of the cost does not matter. In other words, the parameter C does not matter for the analysis. Hence, as long as the entry cost follows a distribution, and no matter how small (not zero), our analysis holds.

Remark 4 In our model, buyers know their visit cost ex ante, while they do not know the value of the product before paying. For visit cost, buyers know their preferences and benefits and costs, hence, it is more likely that they know the cost ex ante. However, for the value of the product, although sometimes buyers could have some personal information or taste for the product, without checking it, buyers are not sure whether they march or not, or the value depends on the color, style, materials, size, fitness, sellers' service. That is why most times buyers need to compare different categories, styles, brands, versions, because buyers are not sure of the value of the products, otherwise, if the value is known, purchase decision becomes a simple issue and there is no need for buyers to spend and time.

Remark 5 In our model, we model showrooming behavior with fixed probability, and in aggregation, it leads to partial showrooming in the whole demand. Further, we could assume that there is a continuum of homogenous buyers and the probability is the ratio of the total mass buyers who showroom. They are equivalent.

Remark 6 In our model, the showrooming behavior is the same for all buyers, there is no heterogeneity among showrooming probability. With different showrooming probability or even buyers are uncertain of the probability, it would mess up the neat analysis without any new insight. Hence, we leave it for future research.

Remark 7 In this model, there is no search among sellers, and sellers are homogeneous and it leads to marginal pricing for sellers. For multiple sellers, they are symmetry and there is no need for search among sellers. If there is only one seller, then we come to the monopoly seller model, and we analysis it in the extension section. Our main model assumes that the sellers on the platform are competitive. For most small sellers on the platform, they are more likely to be homogeneous. For sellers for the iPhone, cameras, personal computers, products with the same brand, sellers are believable to be homogeneous and competitive. For different sellers, once with buyers paying for the visit cost and know the sellers, sellers become homogeneous to buyers, hence, they are competitive. For extension, we also deal with monopoly seller with the same conclusions as the competitive seller model. For exclusive sellers, they are naturally monopoly. For big name and brands, seller is close to monopoly. For illustration, by paying a visit cost, with the product search on Amazon, different homogeneous sellers selling the same brand are listed on the web of Amazon, these sellers are competitive. For the monopoly case, there is a single seller for the brand.

Remark 8 In our model, the buyers have to search for sellers or obtain the sellers' information through the platform. Without the platform, there is no room for trades.

How platform chooses showrooming probability

Here, we argue how the platform could choose the showrooming probability and commit to it. For example, the platform could make the information about the seller less clear to buyers, or the platform could make the switching cost sufficiently high and lead to less showrooming. As in Hagiu and Wright (2023), there is a partial leakage or showrooming depending on the platform policy. For interior showrooming probability, as we shown, it is common sense, and there are empirical evidences of factors affecting the ratio of showrooming.

First, Armstrong et.al (2009) model the prominence of a seller by assuming that the prominent

firm will be sampled first by all consumers. Hence, to trade on the platform instead with seller directly is a prominent strategy for many buyers. Second, there could be a default effect playing, it means that buyers prefer to use the default option. That is why Google pay Apple for default search engine and other applications.[4] For the details of the default bias, please refer to Sunstein and Thaler (2008). There is a lawsuit filed against Apple, Google for an agreement to not compete in the online search business which is in direct violation of US antitrust law. In these years, the US Department of Justice argue that Google unlawfully hurt competitors by deals with phone makers to be the default search engine on their devices. Third, there is buyer inertia as some buyers are reluctant to switch. Hence, there is heterogeneity among buyers. Some buyers would showroom if they have the opportunity to do this, while other won't.

Further, according to Hagiu and Wright (2023), in addition to the price parity clauses, the platform applies different strategies to deter showrooming with different effects on showrooming behavior. The efficacy of the showrooming deterrence varies and depends on the market condition, government policy, buyers' attribute and sellers' attribute, the methods and the easiness for the buyers and sellers to avoid the platform deterrence.

First, the platform could invest in additional benefits of doing transactions on the marketplace (e.g. escrow, insurance, and payment facilities on Airbnb, Amazon, eBay, Preply). Second, the platform would like to limit the communication between buyers and sellers, and makes information about transaction parties harder to obtain, making it difficult for them to find each other outside the marketplace before completing the transaction on the platform (e.g. Airbnb, AngelList, eBay, Preply, Upwork). Actually, in a Chinese platform called https://goofish.com/, buyers and sellers are restricted to send sensitive personal information. Third, the platform could switch to charge referrals fee instead of transaction fee (e.g. Capterra, Thumbtack). Fourth, the platform could punish sellers who sell directly to buyers by demoting them in search results (e.g. Booking.com, Expedia, CoachUp). Fifth, the platform could delist the sellers who are caught taking buyers off

[4] According to the following website, we have the following facts. "In 2018, a research firm Goldman Sachs reported that Google paid $9 billion to Apple to secure its position as Apple's default search engine. In 2020 The New York Times stated that Apple received between $8 and $12 billion annually in exchange to make Google Chrome the primary search engine on its iOS devices. It is now estimated that Google's payment to Apple could be to the tune of $20 billion in 2022."

https://dazeinfo.com/2022/01/05/google-pays-apple-for-not-launching-its-own-search-engine/#:~:text=In%202018%2C%20a%20research%20firm%20Goldman%20Sachs%20reported,

the%20primary%20search%20engine%20on%20its%20iOS%20devices, accessed on April 10, 2023.

the platform (Preply, Upwork).

Formal Microfoundation

Here, we provide some microfoundations for the showrooming probability decision. First, the platform could invest in additional benefits of doing transactions on the marketplace (e.g. escrow, insurance, and payment facilities on Airbnb, Amazon, eBay, Preply). Second, the platform would like to limit the communication between buyers and sellers, and makes information about transaction parties harder to obtain, making it difficult for them to find each other outside the marketplace before completing the transaction on the platform (e.g. Airbnb, AngelList, eBay, Preply, Upwork). Actually, in a Chinese platform called https://goofish.com/, buyers and sellers are restricted to send sensitive personal information. Third, the platform could switch to charge referrals fee instead of transaction fee (e.g. Capterra, Thumbtack). Fourth, the platform could punish sellers who sell directly to buyers by demoting them in search results (e.g. Booking.com, Expedia, CoachUp). Fifth, the platform could delist the sellers who are caught taking buyers off the platform (Preply, Upwork).

Microfoundation 1 (Hagiu and Wright, 2023) After searching on the platform, buyers could trade with sellers directly. However, buyers face a disutility of buying directly from sellers (or switch cost), and the disutility follows a distribution. In equilibrium, high switch cost buyers choose not to showroom, while low switch cost buyers choose to showroom. Hence, the platform would charge the fee accordingly, and there is an interior proportion of buyers choose to showroom. To link the partial leakage in Hagiu and Wright (2023) to our showrooming probability, we could assume that the switch cost for buyers is random. To deter showrooming, the platform could apply the showrooming deterrence strategies described above. The detail model is not straightforward to put it in simple way, hence, for details, please refer to Hagiu and Wright (2023).

Microfoundation 2 The platform could affect the showrooming probability through design of the governance or the rules of the platform. For example, from the second to fifth strategies to deter showrooming, the rules of the platform make showrooming costly for buyers and sellers, hence, only some type with sufficiently high benefit or sufficiently low cost chooses to showroom, and it leads to partial leakage as well. To link the partial leakage to our showrooming probability, we could assume a probability distribution for high and low benefit or cost.

To set an example, we could assume any distribution for the benefit v is $G(v)$, and the platform could set the rule which leads to a fixed cost c to showroom, in addition to the transaction fee

f by the platform, then the showrooming probability is given by $1 - G(c + f)$. And ideally, the platform could pick the optimal cost c by designing optimal rules.

To set another example, we could assume that the showrooming benefit is given by f, and the distribution for the cost of showrooming c is $G(c)$, and the platform rules could affect the distribution function $G(c)$. Hence, the showrooming probability is given by $G(f)$. And ideally, the platform could pick the optimal cost distribution $G(c)$ by designing optimal rules.

Microfoundation 3 Here, the platform could invest in additional benefits of doing transactions on the marketplace (e.g. escrow, insurance, and payment facilities on Airbnb, Amazon, eBay, Preply). Further, the platform could make investment to deter showroom at a cost.

In this model, we could allow the showrooming probability being a function of the investment of the platform. The lower the showrooming probability, the higher the cost. Suppose the cost is given by $c(p), c'(p) < 0, c''(p) > 0$. And $v(p)$ is the additional value for not showrooming due to additional benefits of doing transactions on the marketplace, or the disutility or switching cost from switching to sellers directly.

The net surplus for the platform is given by

$$\pi_{ps} - c(p) = v(p) + \frac{(V - c_s)^2}{4V} \frac{1}{C} (\frac{V - c_s}{4})^\theta * (1 - p)(p + 1)^\theta - c(p).$$

The platform choose p to maximize the surplus.

Hence, we obtain the FOC as following

$$\frac{\partial \pi_{ps}}{\partial p} = v'(p) + \frac{(V - c_s)^2}{4V} \frac{1}{C} (\frac{V - c_s}{4})^\theta * (p + 1)^{\theta - 1} (\theta(1 - p) - (1 + p)) - c'(p) = 0.$$

Commitment of the transaction fee and incomplete information

The alternative timing in the extension makes the showrooming probability neutral. Commitment power on the transaction fee being public information for buyers is the same to the analysis of the alternative timing model. Further, the information for the transaction fee might not be available. Hence, it is more interesting to study the showrooming probability commitment model.

The most important reason is that without paying a visit to the platform, there is no way to know the price information. And even after the visit, the buyers still have no information about the transaction fee. Instead, they only know the final price charged by sellers. There are so many products, there is no way for the platform to show the price information for buyer ex ante. Further, it is more interesting to consider commitment of showrooming probability which

is important for individuals, sellers, platforms, industries, academics, government authorities. It is less important to consider the case where the platform commit to the transaction price. Most likely, buyers may have no information about the related transaction fee of the platform and the final seller fee for a particular product for buyers' first purchase. There are so many platforms in real world, and the fee structure differs for different platforms, product categories, countries, regions, seasons. It is hard for the buyer to tell all the prices information in advance before paying a visit to the platform and the seller. Further, there are so many different prices, it is hard for the platform to commit it in public, and usually, this information is privacy and secrecy. Hagiu and Halaburda (2014) show that, in most real-world case, some agents may not take all prices into account when forming expectations. One side (usually consumers) may do not know the price charged to the other side. For instance, few videogame console players know the royalty fees that console manufacturers charge to third-party game developers. Few iPhone users are aware of the fees charged by Apple to third-party applications developers. Further, even when all prices are public information, buyers may not have sufficient information about the aggregate demand or have the knowledge to compute equilibrium behavior. Instead, buyers often rely on external information (e.g., press announcements, market reports, word of mouth) to form expectations about the behavior of the other side of the platform. Consequently, expectations formed in this way often do not respond to the platform prices.

4 Extensions

4.1 Monopoly Seller

In this section, we consider the case the seller is a monopoly. The seller charges p_m on the platform, and charge p_d if he is able to sell directly.

Without showrooming,

$$\pi_s = (1 - \frac{p_m}{V})(p_m - f - c_s).$$

The seller maximizes profit by choosing price on the platform, taking the transaction fee f as given.

By taking FOC,

$$\frac{\partial \pi_s}{\partial p_m} = (1 - \frac{p_m}{V}) - \frac{(p_m - f - c_s)}{V} = 0.$$

And the SOC naturally holds.

Hence, we obtain

$$p_m^* = \frac{1}{2}(V + f + c_s).$$

The profit of the platform is given by

$$(1 - \frac{p_m}{V}) * f = (1 - \frac{\frac{1}{2}(V + f + c_s)}{V}) * f.$$

The platform maximizes profit by choosing the transaction fee f.

By taking FOC,

$$(1 - \frac{\frac{1}{2}(V + f + c_s)}{V}) - \frac{f}{2V} = 0.$$

And the SOC naturally holds.

Hence, we obtain

$$\begin{aligned} f^* &= \frac{1}{2}(V - c_s), \\ p_m^* &= \frac{1}{2}(V + f + c_s) = \frac{1}{4}(3V + c_s), \\ 1 - \frac{p_m}{V} &= \frac{(V - c_s)}{4V}, \\ (1 - \frac{\frac{1}{2}(V + f + c_s)}{V}) * f &= \frac{(V - c_s)^2}{8V}. \end{aligned}$$

Hence, buyer surplus is given by

$$\frac{\int_{p_m}^{V}(v - p_m) * \frac{1}{V} dv}{1 - \frac{p_m}{V}} = \frac{(V - p_m)^2}{2V(1 - \frac{p_m}{V})} = \frac{V - p_m}{2} = \frac{V - c_s}{8}.$$

The measure of buyers pays a visit is given by

$$\frac{(\frac{(V - c_s)^2}{32V})^\theta}{C}.$$

Hence, the total profit of the platform is given by

$$\pi_{pn} = \frac{(\frac{V - c_s}{8})^\theta}{C} * \frac{(V - c_s)^2}{8V}.$$

With showrooming, with probability p, the seller offers price p_d and earns a profit of $(p_d - c_s)(1 - \frac{p_d}{V})$. With probability $1 - p$, the seller offers price p_m on the platform and earns a profit of $(1 - \frac{p_m}{V})(p_m - f - c_s)$.

Hence, the expected profit of the sell is given by

$$\pi_s = (1 - \frac{p_m}{V})(p_m - f - c_s)(1 - p) + p(p_d - c_s)(1 - \frac{p_d}{V}).$$

The seller maximizes the profit by choosing two prices.

By taking FOC,

$$\begin{aligned}\frac{\partial \pi_s}{\partial p_m} &= (1-\frac{p_m}{V}-\frac{(p_m-f-c_s)}{V})(1-p)=0,\\ \frac{\partial \pi_s}{\partial p_d} &= p(1-\frac{p_d}{V}-\frac{(p_d-c_s)}{V})=0.\end{aligned}$$

And the SOC naturally holds.

we obtain

$$\begin{aligned}p_m^* &= \frac{1}{2}(V+f+c_s),\\ p_d^* &= \frac{1}{2}(V+c_s).\end{aligned}$$

The profit of the platform is given by

$$(1-p)(1-\frac{p_m}{V})*f=(1-p)(1-\frac{\frac{1}{2}(V+f+c_s)}{V})*f.$$

The platform maximizes its profit by choosing transaction fee f.

By taking FOC,

$$(1-p)(1-\frac{\frac{1}{2}(V+f+c_s)}{V}-\frac{f}{2V})=0$$

And the SOC naturally holds.

Hence, we obtain

$$\begin{aligned}f^* &= \frac{1}{2}(V-c_s),\\ p_m^* &= \frac{1}{2}(V+f+c_s)=\frac{1}{4}(3V+c_s),\\ 1-\frac{p_m}{V} &= \frac{(V-c_s)}{4V},\\ (1-p)(1-\frac{p_m}{V})*f &= (1-p)\frac{(V-c_s)^2}{8V}.\end{aligned}$$

Hence, buyer surplus if he can not showrooming is given by

$$\frac{\int_{p_m}^{V}(v-p_m)*\frac{1}{V}dv}{1-\frac{p_m}{V}}=\frac{(V-p_m)^2}{2V(1-\frac{p_m}{V})}=\frac{V-p_m}{2}=\frac{V-c_s}{8}.$$

Further, the buyer surplus if he can showroom is given by

$$\frac{\int_{p_d}^{V}(v-p_d)*\frac{1}{V}dv}{1-\frac{p_d}{V}}=\frac{(V-p_d)^2}{2(V-p_d)}=\frac{V-p_d}{2}=\frac{V-c_s}{4}.$$

Hence, the expected buyer surplus is given by

$$p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8}.$$

The measure of buyers pays a visit is given by

$$\frac{(p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8})^\theta}{C}.$$

Hence, the total profit of the platform is given by

$$\pi_{ps}=(1-p)\frac{(p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8})^\theta}{C}*\frac{(V-c_s)^2}{8V}.$$

For the comparison of the profit under showrooming and without showrooming is given by

$$\frac{\pi_{ps}}{\pi_{pn}}=(1-p)(\frac{p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8}}{\frac{V-c_s}{8}})^\theta=(1-p)(1+p)^\theta.$$

The result is the same as the benchmark.

Although the details of the model differ from the benchmark model, and the absolute value of the profit of the platform is different from the benchmark model. The comparison is exactly the same. The profit ratio under two cases is the same. Hence the results.

Further, for endogenous showrooming, the formulae are the same, hence, the results are the same as well.

The logic behind these results are as following. Without showrooming, the platform profit per buyer is given by $\frac{(V-c_s)^2}{8V}$, and per buyer surplus is given by $\frac{V-c_s}{8}$. With showrooming, the platform profit per buyer is given by $\frac{(V-c_s)^2}{8V}$, and per buyer surplus if he can showroom is given by $\frac{V-c_s}{4}$. Compared with the competitive sellers case, the platform profit per buyer is given by $\frac{(V-c_s)^2}{4V}$, and per buyer surplus is given by $\frac{(V-c_s)^2}{8V}$. With showrooming, the platform profit per buyer is given by $\frac{V-c_s}{4}$, and per buyer surplus if he can showroom is given by $\frac{V-c_s}{2}$.

$$\frac{\frac{V-c_s}{2}}{\frac{V-c_s}{4}}=\frac{\frac{V-c_s}{4}}{\frac{V-c_s}{8}}=2.$$

Consequently, the profit ratio under two cases is the same. Further, the absolute platform profit under showrooming with monopoly seller is proportional to the absolute profit under competitive sellers. Hence, the results for the two cases are the same.

Hence, we obtain the following result for the model with monopoly seller.

Proposition 2 *For the monopoly seller, although the details are different from the model with competitive model, surprisingly, the results are exactly the same.*

4.2 Competitive Platforms

There is a Hotelling line, two platforms are located on the two ends, and the travel cost is t. For simplicity, we assume that the value of the buyer after visit v is fixed and large enough so that the market is fully covered. For sellers, they are competitive so that they charge marginal price c_s. The location of the buyers is random. Buyers take expectation about the location.

In this section, we assume that the two platforms agree on the same showrooming probability. This could due to the government policy, common technology platforms apply, common strategies buyers apply to the platforms, other software or application buyers utilize, the same habit of buyers for platforms, the same behavior of sellers on the platform, and so on. We do not plan to let two platforms make showrooming decision independently, as it make the analysis complicated without adding any new insight. Hence, we leave it to future research.

Further, the showrooming probability for the buyers is the same for both platforms. In other words, if you can showroom on platform 1, then you can showroom on platform 2 as well. Further, if you can not showroom on platform 1, then you can not showroom on platform 2 as well. Hence, showrooming is buyer dependent, and platform independent. If this condition does not hold, then some buyers can not showroom on platform would switch to platform to see whether they can showroom on platform 2. And we leave this case to future research.

Remark For general analysis for competitive platforms with different showrooming probability, we leave this case to future research. And it is too complicated to put the analysis for competitive platforms in the current paper. Hence, we could put the analysis in this section in the appendix.

Without showrooming, given the price of platforms 1 and 2 f_1 and f_2 respectively, and the marginal cost for sellers for both platforms is the same. Hence, the demand for platform 1 is given by

$$\frac{1}{2} + \frac{f_2 - f_1}{2t}$$

The profit of platform 1 is given by

$$(\frac{1}{2} + \frac{f_2 - f_1}{2t}) * f_1$$

Platform 1 maximizes its profit by choosing transaction fee f_1.

Hence, the FOC is given by

$$\frac{1}{2} + \frac{f_2 - f_1}{2t} - \frac{f_1}{2t} = 0.$$

And the SOC naturally holds.

By symmetry, $f_2 = f_1$, hence, the two platforms will charge a price $f = t$ with profit $\frac{t}{2}$, and the expected travel cost before buyers' entry is given by

$$\int_0^{\frac{1}{2}} txdx = \frac{t}{8}.$$

The surplus after visit is given by

$$v - t - \frac{t}{8} - c_s = v - \frac{9}{8}t - c_s > 0.$$

The measure of buyers who want to pay a visit is given by $v - \frac{9}{8}t - c_s > c_v$. Hence the measure of buyers visiting the platform is given by

$$\frac{(v - \frac{9}{8}t - c_s)^\theta}{C}$$

Hence, the total profit of the platform is given by

$$\pi_{pn} = \frac{(v - \frac{9}{8}t - c_s)^\theta}{C} * \frac{t}{2}.$$

With showrooming, with probability $1 - p$ the analysis remains the same. With probability p, the price is given by c_s.

Hence, the surplus of buyer is given by

$$v - \frac{t}{8} - c_s.$$

The expected surplus of buyers is given by

$$p * (v - \frac{t}{8} - c_s) + (1 - p) * (v - \frac{9}{8}t - c_s)$$

The measure of buyers who want to pay a visit is given by $p*(v-\frac{t}{8}-c_s)+(1-p)*(v-\frac{9}{8}t-c_s) > c_v$. Hence the measure of buyers visiting the platform is given by

$$\frac{(p * (v - \frac{t}{8} - c_s) + (1 - p) * (v - \frac{9}{8}t - c_s))^\theta}{C}$$

Hence, the total profit of the platform is given by

$$\pi_{ps} = \frac{(p * (v - \frac{t}{8} - c_s) + (1 - p) * (v - \frac{9}{8}t - c_s))^\theta}{C} * \frac{t}{2} * (1 - p).$$

For the comparison of the profits, we have

$$\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(\frac{p*(v-\frac{t}{8}-c_s)+(1-p)*(v-\frac{9}{8}t-c_s)}{v-\frac{9}{8}t-c_s})^{\theta}.$$

The result is the same.

1. The showrooming is good for the platform if and only if $\theta > \theta^*$, where

$$(1-p)(\frac{p*(v-\frac{t}{8}-c_s)+(1-p)*(v-\frac{9}{8}t-c_s)}{v-\frac{9}{8}t-c_s})^{\theta^*} = 1.$$

The logic is following. For larger θ, then the entry inducing effect of showrooming is larger. The slope of the CDF of the entry cost is larger, the increase of the entrance of buyers compared to the case without showrooming is larger. Hence, showrooming is good for the platform for θ sufficiently large.

2. Further, showrooming leads to higher consumer surplus and social welfare for sure.

3. Consumer surplus and social welfare is increasing in p.

4. If the probability of showrooming is chosen by the platform after buyers' visit, it leads to no showrooming.

However, if the probability of showrooming could be chosen by the platform with commitment before buyers' entry and it is public information, then there could be an optimal interior showrooming probability.

Hence, with showrooming, the total profit of the platform is given by

$$\pi_{ps} = \frac{t}{2C}(1-p)(p*(v-\frac{t}{8}-c_s)+(1-p)*(v-\frac{9}{8}t-c_s))^{\theta}.$$

The platform chooses p to maximize the profit, hence, we obtain the FOC as following

$$\frac{\partial \pi_{ps}}{\partial p} = \frac{t}{2C}(v-\frac{9}{8}t+pt-c_s)^{\theta}\frac{8V-8c_s+t(8p-9-8(1-p)\theta)}{8c_s-8V+(9-8p)t} = 0.$$

Hence, we obtain the optimal showrooming probability

$$p^* = \frac{8c_s-8V+9t+8\theta t}{8t(1+\theta)}, \text{if } 0 < \frac{8c_s-8V+9t+8\theta t}{8t(1+\theta)} < 1.$$

And the SOC is satisfied for this interior solution.

Hence, we obtain the following result.

5. If the probability of showrooming is chosen by the platform with commitment power before buyers' visit, it leads to optimal interior showrooming. And $p^* = \frac{8c_s-8V+9t+8\theta t}{8t(1+\theta)}$,if $0 < \frac{8c_s-8V+9t+8\theta t}{8t(1+\theta)} < 1$.

For $\theta = 1$, the visit cost is uniformly distributed. Hence

$$\begin{aligned}\frac{\pi_{ps}}{\pi_{pn}} &= (1-p)(\frac{p*(v-\frac{t}{8}-c_s)+(1-p)*(v-\frac{9}{8}t-c_s)}{v-\frac{9}{8}t-c_s}) \\ &= (1-p)\frac{8v-8c_s-9t+t(8p-9)}{8v-8c_s-9t}.\end{aligned}$$

For a numerical illustration, let us set $8v - 8c_s = 12t$. Hence, we have

$$\frac{\pi_{ps}}{\pi_{pn}} = \frac{1}{3}(1-p)(3+8p).$$

Then $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if

$$0 < p < \frac{5}{8}.$$

Hence, for the level of showrooming in the interval, it is good for the platform.

For optimal showrooming probability,

$$p^* = \frac{8c_s - 8V + 9t + 8\theta t}{8t(1+\theta)} = \frac{-12t + 9t + 8t}{8t(1+1)} = \frac{5}{16}.$$

Hence, for showrooming probability sufficiently small, showrooming could be good for the platform. In this case, the entry inducing effect of the showrooming dominates the profit reducing for given entry. Otherwise, for showrooming probability too high, the profit loss is too large and showrooming leads to lower profit.

Hence, we obtain the following result.

Result 2 *For competitive platforms, the result is similar.*

1. The showrooming is good for the platform if and only if $\theta > \theta^*$.

2. Further, showrooming leads to higher consumer surplus and social welfare for sure.

3. Consumer surplus and social welfare is increasing in p.

4. If the probability of showrooming is chosen by the platform after buyers' visit, it leads to no showrooming.

5. However, if the probability of showrooming could be chosen by the platform with commitment before buyers' entry and it is public information, then

$$p^* = \frac{8c_s - 8V + 9t + 8\theta t}{8t(1+\theta)}, \text{ if } 0 < \frac{8c_s - 8V + 9t + 8\theta t}{8t(1+\theta)} < 1.$$

6. For $\theta = 1$, the visit cost is uniformly distributed. For a numerical illustration, let us set $8v - 8c_s = 12t$. Then $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if $0 < p < \frac{5}{8}$. For optimal showrooming probability, $p^* = \frac{5}{16}$.

4.3 Sellers Worse than the Platform

In this section, if the buyers buy through the platform, the cases are the same to the general model. However, if the buyers buy directly through sellers instead of the platform, buyers incur a fixed disutility Δ.

The lower utility or extra cost to buy from sellers directly has many reasons. First, there is no insurance for deleverage of the product (such as https://goofish.com/). Alternatively, after you paid the money, there is no guarantee that the sellers would send you the product. Second, the quality of the product directly sold by sellers could be lower than those sold on the platform due to arrangement among sellers and the platform. Third, it could be the case that buyers are uninformed about the existence of seller, hence, they need the platform to discover them, and they need to pay a switch cost to buy directly from sellers. Forth, buyers incur a disutility when they buy directly instead of through the platform. For example, the payment system of the sellers is less convenient or less secure, or logistics are inferior in the case of direct selling rather than via the platform.

With the same setting of the general model, without showrooming, the total profit of the platform is given by

$$\pi_{pn} = \frac{(\frac{V-c_s}{4})^\theta}{C} * \frac{(V-c_s)^2}{4V}.$$

With showrooming, with probability $1-p$, the equilibrium remains the same, and the profit is the same as well. With probability p, with competitive equilibrium, the platform would charge a transaction fee Δ making buyers indifferent from buying through the platform or the sellers directly. With the same surplus, we assume that all buyers buy through the platform. Hence, the price is given by $c_s + \Delta$, the demand is given by $1 - \frac{c_s+\Delta}{V}$. Here, Δ can not be too large and it is more profitable for the platform charge the transaction fee $f = \frac{V-c_s}{2}$.

Hence, the expected surplus is given by

$$\frac{\int_{c_s+\Delta}^{V}(v-c_s-\Delta)\frac{1}{V}dv}{1-\frac{c_s+\Delta}{V}} = \frac{V-c_s-\Delta}{2V}.$$

The expected surplus of the buyer after visiting the platform is given by

$$p * \frac{V-c_s-\Delta}{2V} + (1-p) * \frac{V-c_s}{4} > c_v$$

The measure of buyer willing to visit the platform is given by

$$\frac{(p * \frac{V-c_s-\Delta}{2V} + (1-p) * \frac{V-c_s}{4})^\theta}{C}.$$

Hence, the total profit of the platform is given by

$$\pi_{ps} = \frac{(p * \frac{V-c_s-\Delta}{2V} + (1-p) * \frac{V-c_s}{4})^\theta}{C} * (1-p) * \frac{(V-c_s)^2}{4V}.$$

$\frac{V-c_s-\Delta}{2V}$ is decreasing in Δ, hence, showrooming leads to less surplus for buyer when there is no disutility.

For the comparison of the profit under showrooming and without showrooming is given by

$$\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(\frac{p * \frac{V-c_s-\Delta}{2V} + (1-p) * \frac{V-c_s}{4}}{\frac{V-c_s}{4}})^\theta.$$

However, due to the fact that, for Δ sufficiently small, $\Delta < \Delta^*$, where

$$\frac{p * \frac{V-c_s-\Delta^*}{2V} + (1-p) * \frac{V-c_s}{4}}{\frac{V-c_s}{4}} = 1.$$

Alternatively,

$$\frac{V-c_s-\Delta^*}{2V} = \frac{V-c_s}{4}.$$

For $\Delta < \Delta^*$, we have

$$\frac{p * \frac{V-c_s-\Delta}{2V} + (1-p) * \frac{V-c_s}{4}}{\frac{V-c_s}{4}} > 1.$$

Set

$$\frac{V-c_s-\Delta}{2V} = x * \frac{V-c_s}{4}, 1 < x < 2.$$

Then

$$\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(px + (1-p))^\theta.$$

Hence, $\frac{\pi_s}{\pi_n}$ is increasing in θ. The result is the same. Hence, there exists a θ^* such that

$$\frac{\pi_{ps}}{\pi_{pn}} = (1-p)(px + (1-p))^{\theta^*} = 1.$$

And showrooming is good for the platform if and only if $\theta > \theta^*$.

The logic is following. For larger θ, then the entry inducing effect of showrooming is larger. The slope of the CDF of the entry cost is larger, the increase of the entrance of buyers compared to the case without showrooming is larger. Hence, showrooming is good for the platform for θ sufficiently large.

For $\theta = 1$, the visit cost is uniformly distributed. Then we obtain the following result.

For $x < 2$,

$$(1-p)(px + (1-p))^\theta < (1-p)(p2 + (1-p))^\theta = (1-p)(1+p) < 1.$$

Hence, for uniform distribution, due to $x < 2$, showrooming is always bad for the platform.

However, if the probability of showrooming could be chosen by the platform with commitment before buyers' entry and it is public information, then there could be an optimal interior showrooming probability.

Hence, with showrooming, the total profit of the platform is given by

$$\begin{aligned}\pi_{ps} &= \frac{(p * \frac{V-c_s-\Delta}{2V} + (1-p) * \frac{V-c_s}{4})^\theta}{C} * (1-p) * \frac{(V-c_s)^2}{4V} \\ &= \frac{(V-c_s)^2}{4V}\frac{1}{C}(\frac{V-c_s}{4})^\theta * (1-p)(px+(1-p))^\theta.\end{aligned}$$

The platform choose p to maximize the profit, which is equivalent to maximize $h = (1-p)(px+(1-p))^\theta$.

Hence, we obtain the FOC as following

$$\frac{\partial h}{\partial p} = -(1+p(x-1))^{\theta-1}(1+\theta-x\theta+p(x-1)(1+\theta)) = 0.$$

Hence, we obtain the optimal showrooming probability

$$p^* = 1 - \frac{x}{(x-1)(1+\theta)}, \frac{x}{(x-1)(1+\theta)} < 1.$$

For $\frac{x}{(x-1)(1+\theta)} < 1$, $p^* = 1 - \frac{x}{(x-1)(1+\theta)}$. And the SOC is satisfied for this interior solution.

Further, for $\frac{x}{(x-1)(1+\theta)} < 1$, h is increasing in p for $0 < p < 1 - \frac{x}{(x-1)(1+\theta)}$, and decreasing in p for $p > 1 - \frac{x}{(x-1)(1+\theta)}$.

$$\begin{aligned}h &= (1-p)(px+(1-p))^\theta, \\ h(p &= 0) = 1, \\ h(p &= 1) = 0.\end{aligned}$$

Hence, there exists a $\overline{p}$, where $(1-\overline{p})(\overline{p}x+(1-\overline{p}))^\theta = 1, \overline{p} > 1 - \frac{x}{(x-1)(1+\theta)}$, and $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if $0 < p < \overline{p}$. Hence, for showrooming probability sufficiently small, showrooming could be good for the platform. In this case, the entry inducing effect of the showrooming dominates the profit reducing for given entry. Otherwise, for showrooming probability too high, the profit loss is too large and showrooming leads to lower profit.

Hence, we obtain the following result.

Result 3 *For Sellers Worse than the Platform, we obtain*

1. The showrooming is good for the platform if and only if $\theta > \theta^*$.

2. For $\theta = 1$*, the visit cost is uniformly distributed, for uniform distribution, due to* $x < 2$*, showrooming is always bad for the platform.*

3. Hence, there exists a $\overline{p}$*, and* $\frac{\pi_{ps}}{\pi_{pn}} > 1$ *if and only if* $0 < p < \overline{p}$.

4. Hence, we obtain the optimal showrooming probability

$$p^* = 1 - \frac{x}{(x-1)(1+\theta)}, \frac{x}{(x-1)(1+\theta)} < 1.$$

4.4 Different Timing

In the benchmark model, the buyers visit the platform before the pricing strategy of platform. Hence, when make pricing decisions, platform take the measure of visiting buyers as given and fixed which is unrelated to the pricing strategy. In this section, we let buyers visit the platform after the pricing strategy which will affect the entry of buyers. For some famous products or products with a large network of users, the prices of these products are known publicly before paying visit cost. For simplicity, we assume that the value of the product is fixed at v. And sellers are competitive.

Timing

Stage 1, the platform charges a fee.

Stage 2, sellers charge a price.

Stage 3, the prices is public information, and the cost of the visit is realized, and buyers make visit decisions.

Stage 4, the value of the product is fixed. And whether the buyer could showroom is realized.

The Cumulative Distribution Function of c_v is $G(c) = \frac{1}{C}c^\theta$ on $[0, C^{\frac{1}{\theta}}]$.

Without showrooming, the sellers charge marginal cost c_s, and the price is $f + c_s$, buyers with $v - c_v > f + c_s$ will buy, and stay out of the market otherwise. Hence the demand is given by $\frac{1}{C}(v - f - c_s)^\theta$. The profit is given by

$$\frac{1}{C}(v - f - c_s)^\theta f$$

The platform maximizes its profit by choosing transaction fee f.

Taking FOC,

$$\frac{1}{C}((v - f - c_s)^\theta - \theta f(v - f - c_s)^{\theta-1}) = 0$$

And the SOC naturally holds.

Hence, we obtain optimal transaction fee

$$\begin{aligned} f &= \frac{v - c_s}{1+\theta}, \\ \pi_{pn} &= \frac{1}{C}(v - f - c_s)^\theta f = \frac{(\frac{(v-c_s)\theta}{1+\theta})^{1+\theta}}{\theta C}. \end{aligned}$$

With showrooming, with probability $1-p$, the surplus of the buyer is given by $v - f - c_s$. With probability p, the surplus of the buyer is given by $v - c_s$.

The measure of buyer willing to visit the platform is given by

$$\frac{(p * (v - c_s) + (1-p) * (v - f - c_s))^\theta}{C}.$$

Hence, the total profit of the platform is given by

$$\pi_{ps} = (1-p)\frac{(p * (v - c_s) + (1-p) * (v - f - c_s))^\theta}{C} f.$$

By taking the FOC,

$$\frac{\partial \pi_{ps}}{\partial f} = \frac{(1-p)}{C}((p*(v-c_s)+(1-p)*(v-f-c_s))^\theta - \theta f(p*(v-c_s)+(1-p)*(v-f-c_s))^{\theta-1}(1-p)) = 0.$$

And the SOC naturally holds.

Hence, we obtain

$$\begin{aligned} f^* &= \frac{v - c_s}{(1+\theta)(1-p)}, \\ \pi_{ps} &= \frac{(\frac{(v-c_s)\theta}{1+\theta})^{1+\theta}}{\theta C}. \end{aligned}$$

For the comparison of the profit under showrooming and without showrooming, two profits are the same. Compared the case without showrooming, the transaction fee under showrooming is higher, as the platform knows that showrooming leads to more visit with higher demand. Hence, the platform price under showrooming is higher so that the profit per buyer is higher as well. The endogenous transaction fee takes the price on buyers visit into account and the showrooming is neutral in this case.

Actually, the equivalence of the case without showrooming and the case with showrooming is general.

The Cumulative Distribution Function of c_v is $G(c)$ on $[0, C]$.

Without showrooming, the sellers charge marginal cost c_s, and the price is $f + c_s$, buyers with $v - c_v > f + c_s$ will buy, and stay out of the market otherwise. Hence the demand is given by $G(v - f - c_s)$. The profit is given by

$$G(v - f - c_s)f$$

The platform maximizes its profit by choosing transaction fee f.

With showrooming, with probability $1 - p$, the surplus of the buyer is given by $v - f - c_s$. With probability p, the surplus of the buyer is given by $v - c_s$.

The measure of buyer willing to visit the platform is given by

$$G((p * (v - c_s) + (1 - p) * (v - f - c_s))) = G(((v - c_s) - (1 - p)f)).$$

Hence, the total profit of the platform is given by

$$\pi_{ps} = (1 - p)fG((v - c_s - (1 - p)f)).$$

Set $(1 - p)f = f'$. Then, the profit is given by

$$\pi_{ps} = f'G(v - c_s - f').$$

The two cases are obviously the same. The logic is due to the fact the transaction fee under showrooming will take showrooming into account and charge a higher fee making the two cases the same. For higher showrooming probability, the platform could charge a higher fee to neutralize the effect of the showrooming behavior. In equilibrium, the effect of the showrooming behavior is neutral.

Hence, we obtain the following result.

Proposition 3 *Under different timing, the profit of the platform is neutral and unrelated to the probability of showrooming. Showrooming is neutral for the platform.*

Actually, commitment power on the transaction fee being public information for buyers is the same to the analysis of the alternative timing model. As the transaction fee is public information with commitment, then buyers will take it into account before their visit decision. Intuitively, the model is the same to the model with alternative timing. Hence, for commitment power on the transaction fee being public information for buyers, showrooming is neutral.

4.5 Wholesaler Model

In the previous models, we apply the platform model. In this section, we show the results continue to hold if the platform is a wholesaler.

4.5.1 Competitive Sellers

Similar to the benchmark model, we assume that the sellers are competitive. Hence, for the wholesaler, the profit maximization is exactly the same when the wholesaler is a platform. The logic is that the sellers are competitive, and two models are equivalent. With competitive sellers, the platform or the wholesaler is the monopoly, and it leads to the monopoly pricing which is the same for the model of platform or wholesaler.

4.5.2 Monopoly Seller

In this section, we consider the case the seller is a monopoly.

The timing

Stage 1, the seller charges a fee w.

Stage 2, the wholesaler charges a final fee.

We solve the model by backward induction.

Without showrooming, Given w,

$$\pi_w = (1 - \frac{p_w}{V})(p_w - w).$$

The wholesaler maximizes profit by choosing price, taking the fee w as given.

By taking FOC,

$$\frac{\partial \pi_w}{\partial p_w} = (1 - \frac{p_w}{V}) - \frac{(p_w - w)}{V} = 0.$$

And the SOC naturally holds.

Hence, we obtain

$$p_w^* = \frac{1}{2}(V + w).$$

The profit of the seller is given by

$$(1 - \frac{p_w}{V}) * (w - c_s) = (1 - \frac{\frac{1}{2}(V + w)}{V}) * (w - c_s).$$

The seller maximizes profit by choosing the fee w.

By taking FOC,

$$(1 - \frac{\frac{1}{2}(V+w)}{V}) - \frac{(w-c_s)}{2V} = 0.$$

And the SOC naturally holds.

Hence, we obtain

$$\begin{aligned} w^* &= \frac{1}{2}(V+c_s), \\ p_w^* &= \frac{1}{2}(V+w) = \frac{1}{4}(3V+c_s), \\ 1 - \frac{p_w}{V} &= \frac{(V-c_s)}{4V}, \\ \pi_w &= (1-\frac{p_w}{V})(p_w - w) = \frac{(V-c_s)^2}{16V}. \end{aligned}$$

Hence, buyer surplus is given by

$$\frac{\int_{p_w}^{V}(v-p_w) * \frac{1}{V} dv}{1-\frac{p_w}{V}} = \frac{(V-p_w)^2}{2(V-p_w)} = \frac{V-p_w}{2} = \frac{V-c_s}{8}.$$

The measure of buyers pays a visit is given by

$$\frac{(\frac{V-c_s}{8})^\theta}{C}.$$

Hence, the total profit of the wholesaler is given by

$$\pi_{pn} = \frac{(\frac{V-c_s}{8})^\theta}{C} * \frac{(V-c_s)^2}{16V}.$$

With showrooming, with probability p, the seller offers price p_d and earns a profit of $(p_d - c_s)(1 - \frac{p_d}{V})$. With probability $1-p$, the analysis is the same without showrooming.

Hence, the expected profit of the sell is given by

$$\pi_s = p(p_d - c_s)(1 - \frac{p_d}{V}).$$

The seller maximizes the profit by choosing two prices.

By taking FOC,

$$\frac{\partial \pi_s}{\partial p_d} = p(1 - \frac{p_d}{V} - \frac{(p_d - c_s)}{V}) = 0.$$

And the SOC naturally holds.

we obtain

$$p_d^* = \frac{1}{2}(V + c_s).$$

The expected profit for the wholesaler is

$$(1-p)\frac{(V-c_s)^2}{16V}.$$

Hence, buyer surplus if he can not showrooming is given by

$$\frac{\int_{p_w}^{V}(v-p_w)*\frac{1}{V}dv}{1-\frac{p_w}{V}}=\frac{(V-p_w)^2}{2(V-p_w)}=\frac{V-p_w}{2}=\frac{V-c_s}{8}.$$

Further, the buyer surplus if he can showroom is given by

$$\frac{\int_{p_d}^{V}(v-p_d)*\frac{1}{V}dv}{1-\frac{p_d}{V}}=\frac{(V-p_d)^2}{2(V-p_d)}=\frac{(V-p_d)}{2}=\frac{V-c_s}{4}.$$

Hence, the expected buyer surplus is given by

$$p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8}.$$

The measure of buyers pays a visit is given by

$$\frac{(p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8})^\theta}{C}.$$

Hence, the total profit of the wholesaler is given by

$$\pi_{ps}=(1-p)\frac{(p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8})^\theta}{C}*\frac{(V-c_s)^2}{16V}.$$

For the comparison of the profit under showrooming and without showrooming is given by

$$\frac{\pi_{ps}}{\pi_{pn}}=(1-p)(\frac{p\frac{V-c_s}{4}+(1-p)\frac{V-c_s}{8}}{\frac{V-c_s}{8}})^\theta=(1-p)(1+p)^\theta.$$

The analysis is exactly the same as the platform model.

The logic for the same results is following. For the platform model, the consumer surplus without showrooming is given by $\frac{V-c_s}{4}$, and the consumer surplus with showrooming is given by $\frac{V-c_s}{2}$, and only the ratio $\frac{\frac{V-c_s}{4}}{\frac{V-c_s}{2}}=\frac{1}{2}$ matters for the analysis. For the wholesaler model, the consumer surplus without showrooming is given by $\frac{V-c_s}{8}$, and the consumer surplus with showrooming is given by $\frac{V-c_s}{4}$, and only the ratio $\frac{\frac{V-c_s}{8}}{\frac{V-c_s}{4}}=\frac{1}{2}$ matters for the analysis. For the platform model and wholesaler model, the ratios are the same, hence, the results are the same as well.

Hence, we obtain the following result.

Proposition 4 *The platform model and the wholesaler model are equivalent.*

4.6 General CDF

In this section, we assume that the Cumulative Distribution Function (CDF) of c_v is $G(c)$. And we use the benchmark model with competitive sellers. Then based on the analysis of the general model, the total profit of the platform without showrooming is given by

$$\pi_{pn} = G(\frac{V - c_s}{4}) * \frac{(V - c_s)^2}{4V}.$$

With showrooming, the total profit of the platform is given by

$$\pi_{ps} = G(p\frac{V - c_s}{2} + (1 - p)\frac{V - c_s}{4}) * (1 - p) * \frac{(V - c_s)^2}{4V}.$$

For the comparison of the profit under showrooming and without showrooming is given by

$$\frac{\pi_{ps}}{\pi_{pn}} = (1 - p)\frac{G(p\frac{V-c_s}{2} + (1 - p)\frac{V-c_s}{4})}{G(\frac{V-c_s}{4})}.$$

When the CDF difference from $\frac{V-c_s}{4}$ to $p\frac{V-c_s}{2} + (1 - p)\frac{V-c_s}{4}$ is sufficiently large, then showrooming is good for the platform.

Below, we consider several special cases of the CDF to show showrooming could be good for the platform under certain conditions.

For endogenous showrooming probability with commitment power, it is equivalent to maximize

$$h = G(p\frac{V - c_s}{2} + (1 - p)\frac{V - c_s}{4}) * (1 - p)$$

Case 1

To illustrate this condition in an example, we could assume that $G(\frac{V-c_s}{4}) = a, 0 < a < 1$ which is fixed, and $G(p\frac{V-c_s}{2} + (1 - p)\frac{V-c_s}{4}) = a + b$, $0 < b < 1$ and $0 < a + b < 1$.

Then, we obtain

$$\frac{\pi_{ps}}{\pi_{pn}} = (1 - p)\frac{G(p\frac{V-c_s}{2} + (1 - p)\frac{V-c_s}{4})}{G(\frac{V-c_s}{4})} = (1 - p)\frac{a + b}{a}.$$

Consequently, $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if $(1 - p)\frac{a+b}{a} > 1$. $(1 - p)\frac{a+b}{a}$ is decreasing in p and a, increasing in b.

Hence, we obtain the following results.

1. For p, showrooming is good for the platform if and only if $p < p^*$, where $(1 - p^*)\frac{a+b}{a} = 1$.

2. For a, showrooming is good for the platform if and only if $a < a^*$, where $(1 - p)\frac{a^*+b}{a^*} = 1$.

3. For b, showrooming is good for the platform if and only if $b > b^*$, where $(1-p)\frac{a+b^*}{a} = 1$, if $(1-p)\frac{1}{a} > 1$.

The intuition is as follows. As demand under showrooming is higher than that under no showrooming, the lower the probability of showrooming, the higher the profit for the platform. Hence, when the probability is sufficiently low, showrooming is good for the platform. If the demand under no showrooming is low, relatively demand increase from showrooming will be higher, making the profit under showrooming for the platform higher compared to the profit under no showrooming. Hence, if the demand without showrooming is sufficiently low, showrooming is good for the platform. If the demand increase due to showrooming is sufficiently high, it brings higher demand for the platform with low profit per buyer, hence, the higher the demand increase, the higher profit under showrooming. Consequently, for demand increase sufficiently high, the showrooming is good for the platform.

For endogenous showrooming probability with commitment power,

$$h = (a+b) * (1-p).$$

h is decreasing in p, the platform would set $p = p^*$, where

$$G(p^*\frac{V-c_s}{2} + (1-p^*)\frac{V-c_s}{4}) = a + b.$$

In our model, the total measure of buyer is fixed at one. And the same results hold for buyers with measure higher than one. Alternatively, we could assume that there are two cohort of buyers. Without showrooming, one cohort make a visit. With showrooming, two cohort make a visit. And the analysis is the same.

Case 2

For another example, let us assume that Cumulative Distribution Function (CDF) of c_v is $G(c) = \frac{1}{C}x^c$ on $[0, Log_x C]$ with $x > 1$. Then,

$$\begin{aligned}
\frac{\pi_{ps}}{\pi_{pn}} &= (1-p)\frac{G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})}{G(\frac{V-c_s}{4})} \\
&= (1-p)\frac{x^{p*\frac{V-c_s}{2}+(1-p)*\frac{V-c_s}{4}}}{x^{\frac{V-c_s}{4}}} \\
&= (1-p)x^{p*\frac{V-c_s}{4}}.
\end{aligned}$$

As $p * \frac{V-c_s}{4} > 0$, hence, $\frac{\pi_{ps}}{\pi_{pn}}$ is increasing in x. Hence, we obtain the following result.

Showrooming is good for the platform if and only if $x > x^*$, where $(1-p)x^{*p*\frac{V-c_s}{4}} = 1$. The result is the same as the general model.

Further, set $\frac{V-c_s}{4} = 2, x = 2$. Then $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if

$$0 < p < \frac{1}{2}.$$

Hence, for a low level of showrooming, it is good for the platform.

For endogenous showrooming probability with commitment power,

$$\pi_{ps} = G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4}) * (1-p) * \frac{(V-c_s)^2}{4V}.$$

$$\begin{aligned} \frac{V-c_s}{4} &= 2, x = 2, \frac{V-c_s}{2} = 4, \\ h &= (1-p)G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4}) \\ &= (1-p)2^{(4p+2(1-p))} \\ &= (1-p)2^{(2p+2)}. \end{aligned}$$

By taking the FOC, and the SEC naturally holds for it.

The platform would set

$$p = p^* = \frac{Log4 - 1}{Log4} = 0.278652.$$

Case 3

For another example, let us assume that Cumulative Distribution Function (CDF) of c_v is $G(c) = \frac{Log_x c}{C}$ on $[1, x^C]$, and $x > 1$. Then,

$$\begin{aligned} \frac{\pi_{ps}}{\pi_{pn}} &= (1-p)\frac{G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})}{G(\frac{V-c_s}{4})} \\ &= (1-p)\frac{Log_x(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})}{Log_x(\frac{V-c_s}{4})} \\ &= \frac{Log_x(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})^{1-p}}{Log_x(\frac{V-c_s}{4})}. \end{aligned}$$

As $x > 1$, hence, $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if

$$\begin{aligned} (p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})^{1-p} &> \frac{V-c_s}{4}, \\ (1+p)^{1-p} &> (\frac{V-c_s}{4})^p. \end{aligned}$$

$(\frac{V-c_s}{4})^p$ is increasing in $\frac{V-c_s}{4}$, hence, for $\frac{V-c_s}{4}$ sufficiently small, showrooming is good for the platform.

For a numerical illustration, let us set $\frac{V-c_s}{4} = 2$, then by drawing a picture, we know that

$$0 < p < \overline{p}, (1+p)^{1-p} > 2^p, (1+\overline{p})^{1-\overline{p}} = 2^{\overline{p}}.$$

Hence, for a low level of showrooming, it is good for the platform.

For endogenous showrooming probability with commitment power,

$$\pi_{ps} = G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4}) * (1-p) * \frac{(V-c_s)^2}{4V}.$$

$$\begin{aligned} \frac{V-c_s}{4} &= 2, \frac{V-c_s}{2} = 4, G(c) = \frac{Log_x c}{C}, \\ h &= (1-p)G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4}) \\ &= (1-p)G(p*4 + (1-p)*2) \\ &= \frac{1}{C}(1-p)Log_x(2p+2). \end{aligned}$$

By taking the FOC, and the SEC naturally holds for it.

The platform would set

$$p = p^* = 0.111704.$$

Case 4

Here, we consider the Pareto distribution. $G(c) = 1 - c^{-\theta}$ with $\theta > 1$, and the lower bound of the visit cost is 1.

$$\begin{aligned} \frac{\pi_{ps}}{\pi_{pn}} &= (1-p)\frac{G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})}{G(\frac{V-c_s}{4})} \\ &= (1-p)\frac{1 - (p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})^{-\theta}}{1 - (\frac{V-c_s}{4})^{-\theta}} \\ &= (1-p)\frac{1 - ((1+p) * \frac{V-c_s}{4})^{-\theta}}{1 - (\frac{V-c_s}{4})^{-\theta}}. \end{aligned}$$

For a numerical illustration, let us set $\frac{V-c_s}{4} = 1.5, \theta = 1.1$. Then $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if

$$0 < p < 0.317761.$$

Hence, for a low level of showrooming, it is good for the platform.

For endogenous showrooming probability with commitment power,

$$\pi_{ps} = G(p * \frac{V - c_s}{2} + (1-p) * \frac{V - c_s}{4}) * (1-p) * \frac{(V-c_s)^2}{4V}.$$

$$\begin{aligned} \frac{V - c_s}{4} &= 1.5, \theta = 1.1, G(c) = 1 - c^{-1.1}, \\ h &= (1-p)G(p * \frac{V - c_s}{2} + (1-p) * \frac{V - c_s}{4}) \\ &= (1-p)G(p * 3 + (1-p) * 1.5) \\ &= (1-p)(1 - (1.5(1+p))^{-1.1}). \end{aligned}$$

By taking the FOC, and the SEC naturally holds for it.

The platform would set

$$p = p^* = 0.147472.$$

Case 5

Here, we consider the CDF $G(c) = 1 - e^{-\theta c}$ with $\theta > 0$, and the lower bound of the visit cost is 0.

$$\begin{aligned} \frac{\pi_{ps}}{\pi_{pn}} &= (1-p)\frac{G(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})}{G(\frac{V-c_s}{4})} \\ &= (1-p)\frac{1 - e^{-\theta(p * \frac{V-c_s}{2} + (1-p) * \frac{V-c_s}{4})}}{1 - e^{-\theta(\frac{V-c_s}{4})}} \\ &= (1-p)\frac{1 - e^{-\theta(p+1)\frac{V-c_s}{4}}}{1 - e^{-\theta(\frac{V-c_s}{4})}}. \end{aligned}$$

For a numerical illustration, let us set $\frac{V-c_s}{4} = 1, \theta = 0.5$. Then $\frac{\pi_{ps}}{\pi_{pn}} > 1$ if and only if

$$0 < p < 1.43358 * 10^{-16}.$$

Hence, for the level of showrooming in the interval, it is good for the platform.

For endogenous showrooming probability with commitment power,

$$\pi_{ps} = G(p * \frac{V - c_s}{2} + (1-p) * \frac{V - c_s}{4}) * (1-p) * \frac{(V-c_s)^2}{4V}.$$

$$\begin{aligned} \frac{V - c_s}{4} &= 1, G(c) = 1 - e^{-\theta c} = 1 - e^{-0.5 * c}, \\ h &= (1-p)G(p * \frac{V - c_s}{2} + (1-p) * \frac{V - c_s}{4}) \\ &= (1-p)G(p+1) \\ &= (1-p)(1 - e^{-0.5*(p+1)}). \end{aligned}$$

By taking the FOC, and the SEC naturally holds for it.

The platform would set

$$p = p^* = 0.$$

In this case, the showrooming is always bad for the platform, and the platform would choose zero showrooming. Actually, the result is robust, we try for different parameters, the 0 showrooming result holds as well.

Remark In this section, we consider different CDFs for the visit cost. Mainly, we try to find the conditions for showrooming being good for the platform and the optimal showrooming probability. The detailed analysis for different CDF of the visit cost is different from the main model in Section 3, however, the main results are the same. Showrooming could be good for the platform when the showrooming probability is sufficiently small. In this case, the entry inducing effect of the showrooming dominates the profit reducing for given entry. Otherwise, for showrooming probability too high, the profit loss is too large and showrooming leads to lower profit.

4.7 Ad or Unintended Purchase from Buyers

In addition to the sales to buyers, on the other hand, it leads to higher advertising revenue. Alternatively, the platform could make recommendation, and it might lead to more profit from other products. This makes the positive effects of showrooming which leads to higher buyers' surpluses and more visit even strong. Hence, taking these concerns into consideration, it only makes the condition for more profitable showrooming weaker.

Further, when buyers visit the platform, in addition to their intended product, it could lead to unintended purchase. For example, due to search diversion (Hagiu and Jullien 2011, 2014), or recommendation induced purchases, and accidently interested products, visit of buyers could lead to addition profits to the platform beyond buyers' intended product. Hence, taking these concerns into consideration, it only makes the condition for more profitable showrooming weaker. Johnson (2017, a) and Kato and Hoshino (2021) study the unplanned purchase of new products from buyers due to biased beliefs about their future purchase probabilities.

Hence, we leave it for future research.

4.8 Platform Investment

Platform could make investment to increase V which leads to higher demand or increase the fixed disutility Δ for not trading on the platform. Edelman and Wright (2015) study investment in the convenience benefit offered by the platform in completing transactions. Their model is close to increase the disutility Δ from not trading on the platform. However, Their model can also apply to an increase in V. Maruyama and Zennyo (2020) study the implications of investment that raise consumer demand. Their model is close to increase V. Hagiu and Wright (2023) also consider it as one of their strategies to deter showrooming.

The same logic applies here, and it adds no new insights. Hence, we leave it to future research.

5 Conclusion

In the literature, when buyers could showroom on the platform, they conclude that showrooming is bad for the platform. And the platform might apply price parity clauses or MFN to deter showrooming. Different countries have different regulations for this clause. In contrast to the literature, our study shows that showrooming could be good for the platform in quite general conditions. Without commitment power, the platform would deter showrooming and hurt itself. The ban on price parity clause helps the platform to commit and bring higher surplus to all players. With commitment power, the platform would optimally choose an interior level of showrooming probability, while it is socially too small. We show that our results are quite general and robust.

For future research, first, we could analyze the general CDF for both the value of the product and the visit cost. Second, we could allow platform investment which leads to higher demand, disutility from direct sale, visit cost, and so on. Third, we could study advertisement in the platform and pricing decisions. Fourth, we could allow for multiple differentiated sellers and multiple categories of products. Fifth, we could study continuous probability of being able to showroom. There could be heterogeneity among showrooming probability. With different showrooming probability, sometimes even buyers are uncertain of the probability.

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