Quality Disclosure and Product Selection[*]

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June, 2022

Abstract

If entry requires accommodation by retailers, an incumbent manufacturer may transfer profits to retailers to maintain his dominant position. We show that such an incentive to transfer will induce a high-quality entrant to disclose quality information prior to entry. Interestingly, retailers will accommodate not only a high-quality entrant but also an intermediate-quality entrant who chooses not to disclose. If disclosure is mandatory, however, only a high-quality entrant can enter the market. Therefore, mandatory disclosure may be excessive in terms of consumer welfare.

Keywords: quality, transfer, exclusion, voluntary disclosure, mandatory disclosure

JEL Codes: L14, L15, L22, L42

[*] I would like to thank the Editor and two anonymous referees for their constructive and insightful feedback. I also thank John Asker, Heski Bar-Isaac, Yuk Fai Fong, Johannes Hörner, Xinyu Hua, Yangguang Huang, Wooyoung Lim, Ke Liu, Yang Lu, Chengzhong Qin, Larry Qiu, Monika Schnitzer, Pengfei Wang, Susheng Wang, Yasutora Watanabe, Xiaojian Zhao, Wen Zhou, and several seminar participants for valuable comments and advice. All errors remain my own.

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1 Introduction

Retailers, as product carriers, play an important role in aggregating and displaying information about product quality. They provide space for manufacturers to sell and advertise their products (e.g., Amazon and eBay). They reduce search costs by making it easier for consumers to acquire product information (Alba et al. 1997; Bakos 1997). More importantly, rich information about product quality allows consumers to make better purchase decisions.

There are some interesting observations about the quality information of products carried by retailers. One is that high-quality products generally disclose more quality information than lower quality products. For example, in pharmacies high-quality drugs often report detailed information in their instructions while others report less information; on digital platforms, high-quality smartphones reveal more information about their features than low-quality smartphones; a study of supermarket data from New York state showed that all the low-fat salad dressings disclose their fat content on the product label, while only 9% of the high-fat salad dressings choose to disclose (Mathios 2000). Additional examples of this disclosure pattern are easy to find. In addition, it is also observed that shelf space is often allocated to the relatively high quality products in a category (Sudhir and Rao 2006). Given these facts, it seems important to investigate whether retailers play a nontrivial role in quality disclosure and product selection.

However, the literature on quality disclosure has mainly focused on the interactions between sellers and consumers and relatively neglected the role of retailers. For instance, the seminal papers by Grossman and Hart (1980), Grossman (1981), and Milgrom (1981) consider a market with only sellers and consumers and show that sellers will voluntarily disclose their quality information because of skeptical consumers. In their models, sellers and consumers are the only participants and thus consumers can directly influence the disclosure behavior of sellers. Here, we ask the following questions: If retailers are taken into account, what are the mechanisms that drive a seller to disclose? What are the patterns of disclosure and entry among sellers? Do mandatory disclosure laws raise or reduce consumer welfare?

In this paper, we propose a simple model to explore these questions. We consider a market with an incumbent manufacturer (the incumbent or "he" hereafter), a potential entrant (the entrant or "she" hereafter), and $n \geq 2$ retailers. Entry incurs no cost but requires accommodation by retailers who provide space for manufacturers to sell their products. At the beginning of the game, the entrant chooses whether or not to disclose her quality information to other players. The incumbent and the entrant then bid for each retailer's product-carriage decision (by offering transfers), and retailers simultaneously choose whether or not to accommodate entry. We find that if disclosure is voluntary, only a high-quality entrant discloses quality information. Interestingly, retailers accommodate not only a high-quality entrant but also an intermediate-quality entrant who chooses not to disclose. If disclosure is mandatory, however, only a high-quality entrant can enter the market. Since entry intensifies competition between manufacturers, consumer welfare will be paradoxically higher under voluntary disclosure than under mandatory disclosure.

The driving force behind disclosure is the incumbent's incentive to deter entry. In this model, the incumbent has an incentive to offer transfers to retailers to convince them not to accommodate entry. However, if the entrant can "prove" herself to be sufficiently competitive, the incumbent will not offer any positive transfers to retailers because a strong entrant will offer a larger transfer to a retailer to induce accommodation. Since product quality is a typical measure of competitiveness (Crinò and Epifani 2012; Kugler and Verhoogen 2012), an effective way for a strong entrant to prove herself is to disclose quality information. Therefore, to enter the market without making costly offers to retailers, a strong entrant will voluntarily disclose her quality information.

On the other hand, there is also an incentive for an entrant *not* to disclose information. The intuition behind this incentive is the following: by choosing not to disclose, an entrant can pool with the entrant types who conceal information. Facing a group of nondisclosing types, it will be too costly for the incumbent to deter all the types; thus, the incumbent optimally offers less to retailers, which deters only a subset of these types. Consequently, the relatively high nondisclosing types will be able to enter the market by offering a moderate transfer to a retailer. To better understand this, consider the entrant type slightly below the lowest type who voluntarily discloses. Apparently, this entrant type will be deterred if she discloses. However, given that the incumbent has no incentive to deter all the nondisclosing types, this entrant type can induce accommodation by concealing information and offering a higher transfer than the incumbent to a retailer.

In Section 4, we consider several extensions of the basic model. The purpose is to study how the results change when the model is made more realistic. Specifically, we consider a market in which there are multiple incumbents; an infinite-horizon game in which the entrant is allowed to disclose information and make the entry decision at any period; and the transfers that are contingent on whether entry has occurred or not. We show that the mechanism that drives disclosure in the basic model is robust to these specifications.

Finally, we discuss the value of disclosed information and the desirability of mandatory disclosure laws. Based on the results, we identify two opposing effects of disclosed information on consumer welfare: the benefits of voluntarily disclosed information to consumers and the potential harms of excessive information to consumers. When disclosure is voluntary, both disclosed information and pooled information can facilitate entry. However, if all firms are required to disclose, i.e., disclosure is mandatory, pooling information is not possible; thus, from the ex ante point of view, entry will be less likely under mandatory disclosure than under voluntary disclosure. Since entry intensifies competition between manufacturers, excessive information disclosure that limits entry will in effect make consumers worse off. Therefore, laws or rules that mandate seller disclosure can be consumer-welfare-reducing.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 develops a simple model in which retailers play an important role in quality disclosure and product selection. Section 4 considers several extensions of the basic model. Section 5 concludes.

2 Related Literature

There is a large literature on quality disclosure.[1] In the early literature, Grossman and Hart (1980), Grossman (1981), and Milgrom (1981) established the well-known "unraveling" result (or the "full disclosure" result) that a privately informed seller will voluntarily disclose quality information if disclosure is credible and costless.[2] The intuition is that because rational consumers infer nondisclosure as indicating the lowest quality, the best quality firm will disclose so as to distinguish itself from lower quality firms. For the same reason, the second best firm will also choose to disclose. This process will repeat itself until all firms (except for the lowest quality type) disclose.

In practice, however, information is often partially disclosed rather than fully disclosed. Scholars have offered several explanations for this observation; in particular, they focus on the nature of the information, the costs of disclosure, the structure of the market, and the role of consumers. For instance, if a seller can credibly claim to have no information (even if the seller has some information), low type sellers may choose not to disclose information so as to pool with the uninformed sellers (Dye 1985; Matthews and Postlewaite 1985; Jung and Kwon 1988; Ben-Porath et al. 2018; DeMarzo et al. 2019).[3] If disclosure is costly, only sellers with quality above a threshold will disclose because only then will the gains from consumer expectations outweigh the costs of disclosure (Viscusi 1978; Grossman and Hart 1980; Jovanovic 1982; Shavell 1994). Competition among sellers may also be a reason for the failure of full disclosure. When disclosure leads to intense competition that sufficiently reduces profits, a seller may choose not to disclose information even if the disclosure cost is low (Cheong and Kim 2004; Board 2009; Levin et al. 2009; Hotz and Xiao 2013). Full disclosure requires consumers to be rational and fully understand disclosed information. If some consumers do not infer nondisclosure as indicating the lowest quality, low-quality sellers may take advantage of this naivety and choose not to disclose (Fishman and Hagerty 2003; Hirshleifer et al. 2004).

[1] See Milgrom (2008) and Dranove and Jin (2010) for recent surveys of the literature.

[2] For the oligopoly case, see Okuno-Fujiwara et al. (1990).

[3] For dynamic models in this context, see Acharya et al. (2011) and Guttman et al. (2014).

In this paper, we offer a new explanation for partial disclosure: after introducing retailers into a disclosure game, we find that the selection effects of retailers can give rise to both disclosure and nondisclosure. The most important feature of the model is that the information that is accessible to consumers is determined by the disclosure game that involves only sellers and retailers. Thus, the model rules out the effects of consumer perceptions of nondisclosure, which are the main forces that drive disclosure in many of the papers cited above, and allows us to focus on the pure effects of retailers on information disclosure.

This paper is also closely related to the literature that considers both entry and information disclosure.[4] In this literature, studies generally focus on information disclosure by the incumbent(s). For example, Darrough and Stoughton (1990) and Feltham and Xie (1992) show that an incumbent with favorable information may disclose information to raise its valuation in the financial market, while an incumbent with unfavorable information may also disclose information to discourage entry. Hwang and Kirby (2000) find that mutual disclosure of cost information can soften competition between incumbent firms, whereas disclosure has no effect on the expected level of entry. Pae (2002) studies information disclosure in a two-period oligopoly model and finds that it is optimal for the incumbent to disclose information in the first period, because the entrant in the second period can fully anticipate the incumbent's intertemporal incentive to withhold information. Oh and Park (2019) consider a model of quality disclosure in which an incumbent makes quality and disclosure choices to influence the likelihood of entry. The authors show that the incumbent's nondisclosure behavior can successfully deter entry when nondisclosure makes it impossible for the entrant to determine a profitable quality level. Our paper differs from this literature in that we consider information disclosure by an entrant rather than by an incumbent. We show that either disclosure or nondisclosure can be used as a strategy to facilitate entry.

Another related literature is that on naked exclusion arising from exclusive dealing contracts. A number of scholars in the literature argue that an incumbent firm can convince

[4] There is also a literature on how signaling affects entry. For an example, see Milgrom and Roberts (1982).

retailers not to accommodate an entrant by offering attractive terms in the contracts (e.g., Aghion and Bolton 1987; Rasmusen et al. 1991; Segal and Whinston 2000).[5] One of the important reasons for retailers to sign exclusive dealing contracts is that they can obtain higher rents from the incumbent firm when exclusion leads to higher total industry profits (Asker and Bar-Isaac 2014; Prat and Valletti 2021). In this paper, retailers have a similar incentive (as in Asker and Bar-Isaac 2014 or Prat and Valletti 2021) not to accommodate entry. We show that this incentive can be a reason for an entrant to voluntarily disclose information.

This paper also adds to the literature on the role of intermediation in product markets. In this literature, Alba et al. (1997), Bakos (1997), and Lynch and Ariely (2000) find that electronic marketplaces can improve market efficiency by reducing consumers' costs to search for and acquire information about products. Bergemann and Bonatti (2015) show that consumer information from a data provider can allow firms to tailor their advertisements to the match value with each consumer.[6] Antràs and Costinot (2011) consider a model of international trade with intermediation and show that trade intermediaries can facilitate the realization of gains from trade when there are search frictions. Ahn et al. (2011), Felbermayr and Jung (2011), and Akerman (2018) find that the presence of intermediary firms can lead to productivity sorting, with the most productive firms exporting directly on their own and intermediate-productivity firms exporting through intermediaries.[7] We add to this literature by showing that as intermediaries in the product market, retailers can play an important role in selecting product quality and driving information disclosure by manufacturers.

[5] See Bloom et al. (2000), Fumagalli and Motta (2006), Simpson and Wickelgren (2007), Wright (2009), and Hristakeva (2021) for more discussion of this point.

[6] There is a growing literature on the role of information intermediaries (e.g., Admati and Pfleiderer 1986; Lizzeri 1999; Bergemann and Bonatti 2011, 2015; Bonatti and Cisternas 2020; Bergemann et al. 2021). For a recent survey of the literature, see Bergemann and Bonatti (2019).

[7] See Bernard and Moxnes (2018) and Bernard et al. (2019a, 2019b, 2020) for more discussion on the role of intermediation in trade.

3 Model

We consider a market in which there are an incumbent manufacturer (the incumbent), a potential entrant (the entrant), and $n \geq 2$ homogeneous retailers. The incumbent and the entrant each produce a single product and they sell to final consumers via retailers. Here, retailers do not purchase products from manufacturers; they only provide space for manufacturers to sell and advertise their products.[8] Examples of such retailers include outlets, supermarkets, and digital platforms.

The two products are not only horizontally differentiated, with degree of differentiation denoted by $\rho > 0$, but also vertically differentiated in product quality.[9] We assume that the incumbent is already established in the market and the quality of his product is known to all players. The quality of the entrant's product, which is denoted by q_e, is privately known to the entrant prior to entry, and it is common knowledge that q_e is drawn from a general distribution G with positive density g over the interval [0,1].

The entrant may disclose her quality information q_e to other players prior to entry, and disclosure is assumed to be both credible and costless.[10] The tie-breaking rule for disclosing information is that when the entrant is indifferent between disclosing and not, she will choose not to disclose.[11]

Entry incurs no cost but requires accommodation by retailers, and each manufacturer needs only one retailer to supply the whole market.[12] The game has five stages. Prior to the first stage, the entrant has yet to enter and the incumbent has guaranteed market access

[8] Thus, issues such as resale price maintenance are not relevant in this paper.

[9] In the rest of the paper, we use "differentiation" to represent "horizontal differentiation."

[10] Credibility is a standard assumption in the disclosure literature. In reality, sellers may choose not to lie because of antifraud laws or reputation concerns. We assume costless disclosure for two reasons. First, it rules out the mechanisms that generate disclosure due to positive disclosure costs (e.g., Viscusi 1978; Grossman and Hart 1980; Jovanovic 1982), and second, it greatly simplifies the analysis of the model. Nevertheless, our results are robust to small disclosure costs.

[11] The tie-breaking rule here can be justified by an infinitesimal disclosure cost.

[12] The assumption that a manufacturer needs only one retailer to supply all of the consumer demand is also discussed in Fumagalli and Motta (2006), Simpson and Wickelgren (2007), Asker and Bar-Isaac (2014), and others.

via at least one of the retailers (e.g., through contracts). The timing of the game is as follows:

Stage 1: The entrant chooses whether or not to disclose her quality information q_e to other players.

Stage 2: The incumbent offers a transfer $T^r \in [0, \infty)$ to each retailer r, and T^r is payable if retailer r agrees not to accommodate the entrant.[13]

Stage 3: After observing $\{T^r\}$, the entrant offers a transfer $T_e^r \in [0, \infty)$ to each retailer r, and T_e^r is payable if retailer r agrees to accommodate the entrant.

Stage 4: Retailers simultaneously choose to accept either the incumbent's offer or the entrant's offer.

Stage 5: If at least one retailer accommodates the entrant, we say that the entrant successfully enters the market. After entry, the incumbent and the entrant compete in the market and then all profits are realized.[14] If no retailer accommodates the entrant, the incumbent will be the only supplier in the market.

Here, the transfers $\{T^r\}$ are assumed to be observable to the entrant at the beginning of stage 3.[15] This situation is possible when the entrant is allowed to communicate with retailers about $\{T^r\}$. For instance, in symmetric cases where the incumbent offers the same transfer T to each retailer, each retailer will truthfully report T to the entrant because the entrant only needs to pay to the retailer who reports the lowest transfer.

The competition between the incumbent and the entrant is modeled by reduced-form profit functions. Specifically, the postentry profits of the manufacturers are functions of q_e and ρ only. Given q_e and ρ, if entry occurs, the incumbent and the entrant earn $\pi(q_e, \rho)$ and $\pi_e(q_e, \rho)$, respectively; if entry does not occur, the incumbent earns the monopoly profit

[13] In practice, the transfers can be slotting allowances or loyalty rebates.

[14] In this model, we do not consider collusion between the incumbent and the entrant or collusion among retailers.

[15] The observability of $\{T^r\}$ ensures the existence of an equilibrium with entry. We discuss an alternative setting in Section 4.3.

π^M and the entrant earns zero profit.[16] The two assumptions below specify the properties of the profit functions $\pi(q_e, \rho)$ and $\pi_e(q_e, \rho)$ and the effects of the degree of differentiation ρ on these profits.

Assumption 1: *$\pi(q_e, \rho)$ and $\pi_e(q_e, \rho)$ are continuously differentiable in q_e and ρ.*

Assumption 2: *For any $q_e \in [0,1]$, $\frac{\partial \pi(q_e,\rho)}{\partial \rho} > 0$ and $\frac{\partial \pi_e(q_e,\rho)}{\partial \rho} > 0$.*

To highlight the mechanism that drives disclosure, we fix the degree of differentiation ρ in the main analysis and revisit it in Section 3.3. Then we can rewrite the postentry profits as $\pi(q_e)$ and $\pi_e(q_e)$. We assume that (for any $\rho > 0$) the profit functions have the following properties over the interval [0,1].

Assumption 3: *$\pi_e(0) = 0$ and $\pi^M > \pi(q_e) > 0$.*

Assumption 4: *$\pi'_e(q_e) > 0$ and $\pi'(q_e) < 0$.*

Assumption 5: $\pi_e(1) > \frac{\pi^M - \pi(1)}{n}$.

Assumption 6: $\pi'_e(q_e) > -\frac{\pi'(q_e)}{n}$.

The first three assumptions are standard in the industrial organization literature. Assumption 4 states that after entry, a higher quality entrant earns a higher profit and her rival, the incumbent, earns a lower profit. Thus, we can regard quality level q_e as an entrant's type, with a higher q_e indicating a higher type. Indeed, empirical evidence shows that high-productivity firms often choose to improve their product quality while low-productivity firms tend to focus on low-quality products (Verhoogen 2008; Amiti and Khandelwal 2013). Moreover, higher quality firms are in general more competitive and have larger market shares (Khandelwal 2010; Crinò and Epifani 2012; Kugler and Verhoogen 2012; Feenstra and Romalis 2014; Manova and Yu 2017). Therefore, although higher

[16] Since it is a single-period game, we assume that the quality levels of the products are exogenously given, i.e., the incumbent and the entrant do not adjust the quality of their product. In the long run (which is beyond the scope of this paper), however, some firms may choose to upgrade product quality (Verhoogen 2008; Amiti and Khandelwal 2013).

quality products are more costly to produce, more competitive firms endogenously choose to become higher quality producers and earn higher profits in the market.

Assumption 5 means that the highest quality entrant (with $q_e = 1$) earns a sufficiently high profit after entry. This assumption rules out uninteresting cases in which disclosure never occurs and thus allows us to restrict our attention to the entrant's incentive to disclose information. Assumption 6 is made to obtain a simple pattern of disclosure while remaining inessential to the mechanism that drives disclosure in this model. Specifically, it ensures a unique quality level above which quality information will be voluntarily disclosed. We will discuss this assumption in detail in Section 3.1.

3.1 Complete Information

In this section, we consider the case in which the entrant's quality level is known to all players prior to entry and characterize subgame perfect equilibria of the game. Thus, it is equivalent to assume that the entrant is required to disclose her quality information at stage 1 of the game. The purpose of this section is to analyze the pattern of entry when disclosure is mandatory and provide a baseline for discussing the entrant's incentive to disclose information when disclosure is voluntary (Section 3.2).

First, we characterize the conditions under which exclusion is possible in equilibrium. In Lemma 1 below, we provide a necessary and sufficient condition for an exclusionary equilibrium to exist. By exclusionary, we mean an equilibrium in which no retailer accommodates the entrant.

Lemma 1: *Given q_e, an exclusionary equilibrium exists if and only if*

$$\frac{\pi^M - \pi(q_e)}{n} \geq \pi_e(q_e). \tag{1}$$

If the inequality is strict, then there exist only exclusionary equilibria.

Proof: Given offers $T^r(q_e)$ and $T_e^r(q_e)$, retailer r will accept the incumbent's offer (the entrant's offer) if $T^r(q_e) > T_e^r(q_e)$ ($T^r(q_e) < T_e^r(q_e)$), and is indifferent between the two offers if $T^r(q_e) = T_e^r(q_e)$. This is true for all r.

Let $\underline{T}(q_e) \equiv \min\{T^r(q_e)\}$ be the minimal value of the transfers offered by the incumbent and let $\underline{r}$ be some retailer who is offered $\underline{T}(q_e)$. Since the entrant with quality q_e earns $\pi_e(q_e)$ after entry and zero if she stays out of the market, her total transfer to retailers must be no larger than $\pi_e(q_e)$. Then given the belief that each retailer r will accept the incumbent's offer when $T^r(q_e) \geq T_e^r(q_e)$, a best response of the entrant to the incumbent's offers $\{T^r(q_e)\}$ is to offer a zero transfer to each retailer if $\pi_e(q_e) \leq \underline{T}(q_e)$, and offer a transfer slightly higher than $\underline{T}(q_e)$ to retailer $\underline{r}$ to induce accommodation and zero transfers to all other retailers if $\pi_e(q_e) > \underline{T}(q_e)$.

Since only the minimal value of $\{T^r(q_e)\}$ matters for exclusion, to most effectively discourage entry, the incumbent will offer the same transfer $T^r(q_e) = T(q_e)$ to each retailer r. Moreover, the incumbent's profit without entry less the total transfer must be no less than the profit from allowing entry, i.e., $\pi^M - nT(q_e) \geq \pi(q_e)$, which implies

$$T(q_e) \leq \frac{\pi^M - \pi(q_e)}{n}. \tag{2}$$

If $\frac{\pi^M - \pi(q_e)}{n} \geq \pi_e(q_e)$, then there exists an exclusionary equilibrium in which the incumbent offers $\pi_e(q_e)$ to each retailer, the entrant offers a zero transfer to each retailer, and all retailers accept the incumbent's offer. This demonstrates that condition (1) is sufficient. To see that condition (1) is necessary, suppose that $\frac{\pi^M - \pi(q_e)}{n} < \pi_e(q_e)$. Then the entrant can always induce a retailer to accommodate entry by offering a transfer $T_e \in \left(\frac{\pi^M - \pi(q_e)}{n}, \pi_e(q_e)\right)$ to this retailer, and this is profitable for the entrant.

If the inequality in (1) is strict, then $\pi^M - n\pi_e(q_e) > \pi(q_e)$. This means that the incumbent's net profit from offering each retailer a transfer slightly higher than $\pi_e(q_e)$ will be strictly higher than that from allowing entry. Thus, any equilibrium must be an exclusionary equilibrium. There are multiple exclusionary equilibria because the entrant may offer each retailer an arbitrary transfer less than that from the incumbent. □

To better interpret this result, we denote the left-hand side of condition (1) by $W(q_e) = \frac{\pi^M - \pi(q_e)}{n}$. Since $W(q_e)$ is about the gap between the monopoly profit and the incumbent's profit from competing with the entrant when entry occurs, we can regard $W(q_e)$ as the incumbent's willingness to pay to deter entry. Then there is a clear interpretation for condition (1): the incumbent has an incentive to deter entry only when his willingness to pay $W(q_e)$ is above a specific level $\pi_e(q_e)$. Moreover, since $W(q_e)$ and $\pi_e(q_e)$ are both increasing in the entrant's quality q_e, condition (1) also indicates that although the incumbent is willing to pay more to deter entry when he faces a higher quality entrant, entry deterrence is more difficult due to a higher postentry profit $\pi_e(q_e)$.

Lemma 2: *If $\frac{\pi^M - \pi(q_e)}{n} < \pi_e(q_e)$, then there exist only equilibria with entry. Furthermore, both the incumbent and the entrant offer a zero transfer to each retailer in any equilibrium.*

Proof: See the Appendix. □

Building on Lemmas 1 and 2, we can now characterize the transfers and the pattern of entry of the game. We focus on equilibria in which an entrant is excluded whenever possible.[17] In Proposition 1 below, we show that although the incumbent's willingness to

[17] Focusing on such equilibria only simplifies the discussion about the marginal types (type q_e^* in Proposition 1 and type q_e^{**} in Proposition 3) whose entry can either be deterred or accommodated in equilibrium; the discussion about all other types is unaffected.

pay $W(q_e)$ is increasing in q_e, the transfer paid by the incumbent to each retailer is not necessarily increasing in q_e over the interval [0,1].

Proposition 1: *There exists a unique $q_e^* \in (0,1)$ such that in each subgame perfect equilibrium*

(i) *if $q_e \in [0, q_e^*]$, then the incumbent offers $T^*(q_e) = \pi_e(q_e)$ to every retailer and the entrant offers $T_e^{r*}(q_e) \in [0, \pi_e(q_e)]$ to each retailer r; all retailers accept the incumbent's offer and entry is deterred;*

(ii) *if $q_e \in (q_e^*, 1]$, then both the incumbent and the entrant offer a zero transfer to every retailer; at least one retailer accepts the entrant's offer and entry is accommodated.*

Proof: See the Appendix. $\square$

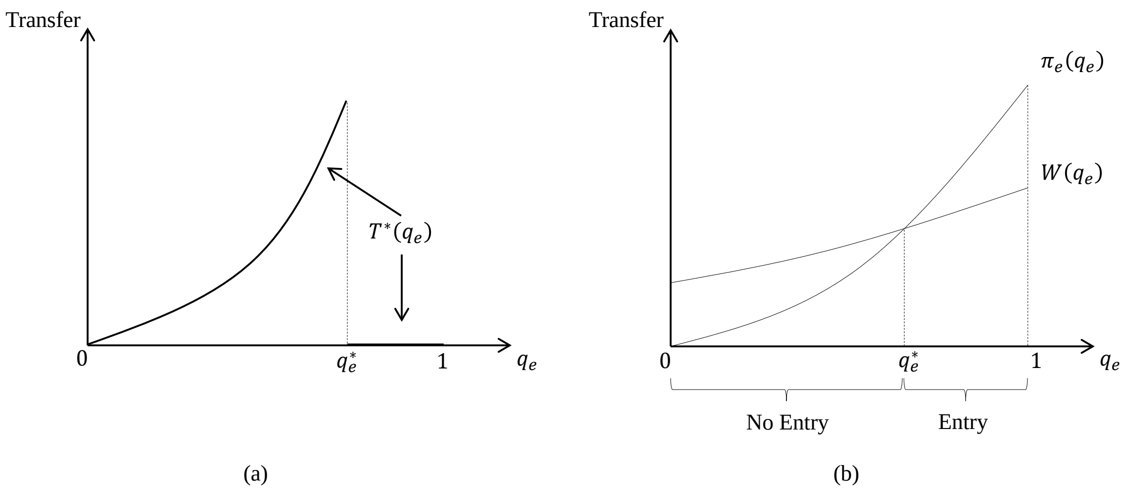

Figure 1: Equilibrium Transfers from the Incumbent (a) and Pattern of Entry (b)

Proposition 1 illustrates a simple pattern of entry when the entrant's quality is publicly known. It shows that only an entrant with quality above the specific threshold q_e^* can enter the market. From Figure 1(b), we can see that the incumbent's willingness to pay $W(q_e)$ is above the entrant's maximal transfer $\pi_e(q_e)$ when $q_e \leq q_e^*$ and is below $\pi_e(q_e)$ when $q_e > q_e^*$.

The intuition is that, if the entrant is relatively less competitive ($q_e \leq q_e^*$), the incumbent has an incentive to deter entry by offering each retailer a transfer that the entrant cannot afford. In this case, the incumbent will pay more to deter entry when the entrant is more competitive (see the increasing curve in Figure 1(a)). If the entrant is highly competitive ($q_e > q_e^*$), however, it will be too costly for the incumbent to deter entry because the entrant can always pay more than the incumbent to induce accommodation. Then given that entry will occur, neither the incumbent nor the entrant will have an incentive to make costly offers to retailers.

Remark: Assumption 6 is important for obtaining this simple pattern of entry because it ensures a unique quality level above which $W(q_e) < \pi_e(q_e)$. We will show in the next section that this assumption will lead to a simple pattern of disclosure which is also driven by the inequality $W(q_e) < \pi_e(q_e)$ for q_e above a certain level. Nevertheless, Assumption 6 is not essential to the mechanism that drives disclosure in this model, because even without this assumption, Assumption 5 still ensures the existence of a quality level above which $W(q_e) < \pi_e(q_e)$. Hence, Assumption 6 is provided only to simplify the analysis.

3.2 Voluntary Disclosure

We now consider the full game in which the entrant can voluntarily disclose her quality information q_e (more generally, her type) to other players at stage 1 and characterize perfect Bayesian equilibria of the game. First, we describe the incumbent's belief about the entrant's type conditional on the entrant not disclosing information. Let $S \in \mathcal{B}([0,1])$ be some set of entrant types who choose not to disclose, where $\mathcal{B}([0,1])$ denotes the Borel algebra on [0,1]. If the incumbent believes that the entrant's type belongs to S, then we say that the incumbent's belief about q_e is (S, G_S), where G_S is the probability distribution assigned to S.[18]

Lemma 3: *An equilibrium with disclosure exists if and only if there exists $T > 0$ such that it is optimal for the incumbent to offer T to every retailer given belief* $\left([0, q_e^*], G_{[0,q_e^*]}\right)$.

Proof: We first prove the sufficiency part. Given that the incumbent chooses to offer $T > 0$ to every retailer given belief $\left([0, q_e^*], G_{[0,q_e^*]}\right)$, an entrant who does not disclose and wants to enter has to offer at least T to one retailer. Then by Proposition 1, an entrant with $q_e \in (q_e^*, 1]$ will choose to disclose information so as to enter the market at no cost; an entrant with $q_e \in [0, q_e^*]$ cannot benefit from disclosing and thus will not disclose. Since belief $\left([0, q_e^*], G_{[0,q_e^*]}\right)$ is consistent with this disclosure pattern and transfer T is optimal for the incumbent given this belief, an equilibrium with disclosure exists.

The necessity part is proved by contradiction. Suppose not. Then we need to verify two cases: (i) $T > 0$ and belief $(S, G_S) \neq \left([0, q_e^*], G_{[0,q_e^*]}\right)$ and (ii) $T = 0$. If $T > 0$, then following the proof of the sufficiency part, any belief $(S, G_S) \neq \left([0, q_e^*], G_{[0,q_e^*]}\right)$ cannot be supported in equilibrium. If $T = 0$, by the tie-breaking rule for disclosing, no entrant type has an incentive to disclose because disclosing information cannot further lower the incumbent's transfers; thus in this case, the only consistent belief is $\left([0,1], G_{[0,1]}\right)$. Therefore, in both cases, there exists no equilibrium with disclosure. $\square$

Lemma 3 is important for understanding the mechanism that generates disclosure in this model. It indicates that if the incumbent has an incentive to offer positive transfers to retailers given the right belief about which entrant types will not disclose, then disclosure

[18] The cumulative distribution function G_S is calculated using Bayes' rule.

will appear in equilibrium. In other words, it is the incumbent's incentive to transfer that drives an entrant to disclose information. There is a simple intuition behind this result: if the incumbent offers a positive transfer to every retailer when disclosure does not occur, an entrant who conceals information and wants to enter has to make costly offers to retailers. However, if the incumbent knows that the entrant is strong, he will have no incentive to offer positive transfers to retailers because it is impossible to deter such an entrant. Therefore, a strong entrant will voluntarily reveal her type to the incumbent so that she can enter the market at no cost—that is why disclosure appears in equilibrium.

With Lemma 3, we are now ready to state our main result.

Proposition 2: *In every equilibrium with disclosure, an entrant with quality* $q_e \in (q_e^*, 1]$ *discloses, while an entrant with quality* $q_e \in [0, q_e^*]$ *does not disclose.*

Proof: By Lemma 3, belief $\left([0, q_e^*], G_{[0,q_e^*]}\right)$ must be consistent with an entrant's disclosure behavior in an equilibrium with disclosure. Hence, in every equilibrium with disclosure, only an entrant with quality $q_e \in (q_e^*, 1]$ will disclose. $\square$

Proposition 2 shows that every equilibrium with disclosure is partially revealing: only an entrant with quality above q_e^* will voluntarily disclose quality information. But so far, it is unclear as to how much the manufacturers offer to retailers and which entrant types can eventually enter the market. In the following proposition, we characterize the transfers and the patterns of disclosure and entry in an arbitrary equilibrium with disclosure.

Proposition 3: *Consider an arbitrary equilibrium with disclosure. In equilibrium,*

(i) *an entrant with quality* $q_e \in (q_e^*, 1]$ *discloses and both the incumbent and the entrant offer a zero transfer to every retailer; at least one retailer accepts the entrant's offer and entry is accommodated;*

(ii) *when disclosure does not occur, the incumbent's optimal transfer to every retailer is* $T^{**} = \pi_e(q_e^{**})$, *where* $q_e^{**} \in (0, q_e^*)$;

(iii) *an entrant with quality* $q_e \in (q_e^{**}, q_e^*]$ *does not disclose and offers* $T_e^{r'**} = \pi_e(q_e^{**})$ *to some retailer* r' *and* $T_e^{r''**} \in [0, \pi_e(q_e^{**})]$ *to each retailer* $r'' \neq r'$; *only retailer* r' *accepts the entrant's offer and entry is accommodated;*

(iv) *an entrant with quality* $q_e \in [0, q_e^{**}]$ *does not disclose and offers* $T_e^{r**} \in [0, \pi_e(q_e^{**})]$ *to each retailer* r; *all retailers accept the incumbent's offer and entry is deterred.*

Proof: See the Appendix. □

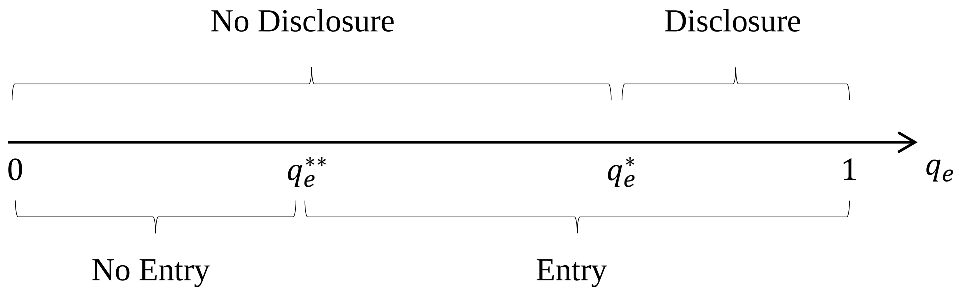

Figure 2: Pattern of Disclosure and Pattern of Entry

As is illustrated in Figure 2, Proposition 3 shows an interesting pattern of entry for the "intermediate types" which belong to the interval $(q_e^{**}, q_e^*]$. Together with Proposition 1, we can see that while an entrant with quality $q_e \in (q_e^{**}, q_e^*]$ cannot enter the market under complete information (see Figure 1(b)), she can now successfully enter the market by keeping her information secret. The intuition for why the intermediate types can enter is that nondisclosure can make the incumbent less aggressive in deterring entry. To be specific, facing the set of nondisclosing types $[0, q_e^*]$, it is too costly for the incumbent to deter all the types (or the highest type) in this set because lower types are less competitive; thus, the incumbent optimally offers less to retailers, which deters only a subset of those types. This then allows the relatively high types (i.e., the intermediate types) in this set to enter the market by offering a higher transfer than the incumbent to a retailer.

It is also important to notice that since the intermediate types only need to pay $\pi_e(q_e^{**})$ to enter, their net profits after entry will be strictly positive. This means that these types are strictly better off under voluntary disclosure than under mandatory disclosure. From this, we can see that there is a strong incentive for the intermediate types not to disclose information.

Finally, we provide a parametric condition for an equilibrium with disclosure to exist. We have shown that in equilibrium a transfer $T = \pi_e(q_e^0)$ from the incumbent to every retailer deters the entrant types in $[0, q_e^0]$ and allows those in $(q_e^0, 1]$ to enter, where q_e^0 is the marginal type excluded from the market. Thus, the incumbent's expected profit from offering T to every retailer is

$$\Pi(T) = G^*(q_e^0)[\pi^M - nT] + [1 - G^*(q_e^0)] \left[\frac{\int_{q_e^0}^{q_e^*} \pi(q_e) dG^*(q_e)}{1 - G^*(q_e^0)} - (n-1)T \right], \tag{3}$$

where $G^*(q_e) = \frac{G(q_e)}{G(q_e^*)}$ and $q_e^0 = \pi_e^{-1}(T)$ is a strictly increasing function of T. Differentiating (3) with respect to T yields the marginal profit

$$\Pi'(T) = \underbrace{\frac{g(q_e^0)[\pi^M - \pi(q_e^0) - T](\pi_e^{-1})'(T)}{G(q_e^*)}}_{marginal\ revenue} - \underbrace{\left[\frac{G(q_e^0)}{G(q_e^*)} + (n-1) \right]}_{marginal\ cost}. \tag{4}$$

Formula (4) clearly shows that for $T \in [0, \pi_e(q_e^*)]$ and $n \geq 2$, increasing the transfer T to every retailer may raise the incumbent's profit by deterring more entrant types since the first term on the right-hand side of (4) is positive, but it is also costly to do it.

If $\Pi'(0) > 0$, i.e., $\frac{g(0)[\pi^M - \pi(0)](\pi_e^{-1})'(0)}{G(q_e^*)} > n - 1$, then there exists an optimal transfer $T^{**} \in (0, \pi_e(q_e^*)]$ such that $\Pi(T^{**}) > \Pi(0)$; that is, the incumbent has a strictly dominant strategy to offer a positive transfer to every retailer. Hence, condition $\frac{g(0)[\pi^M - \pi(0)](\pi_e^{-1})'(0)}{G(q_e^*)} > n - 1$ is a sufficient condition that guarantees the existence of an equilibrium with disclosure.

Proposition 4: *If* $\frac{g(0)[\pi^M - \pi(0)](\pi_e^{-1})'(0)}{G(q_e^*)} > n-1$*, then an equilibrium with disclosure exists.*

It is interesting to see that $\frac{g(0)[\pi^M - \pi(0)](\pi_e^{-1})'(0)}{G(q_e^*)} > n-1$ always holds for $n=1$, and thus there always exists an equilibrium with disclosure in this case. For $n \geq 2$, the incumbent has an additional cost of increasing the transfer T to every retailer because he needs to pay the transfer to the $n-1$ retailers who choose not to accommodate the entrant in the cases of entry (see the last term in the profit function (3)). This cost is, however, absent if $n=1$. Therefore, this additional cost is a reason why the existence of an equilibrium with disclosure becomes more difficult to establish with more than one retailer.

3.3 Comparative Statics

The previous analysis has shown why certain entrant types disclose information while other types do not. It is then natural to ask the following questions: What factors will influence an entrant's disclosure decision? And, how do changes of these factors determine the distribution of disclosing entrants? In Proposition 5, we summarize three main factors that can influence an entrant's disclosure behavior: the level of monopoly profit, the number of retailers, and the degree of product differentiation.

Proposition 5: *A lower monopoly profit* π^M*, a larger number of retailers* n*, or a higher degree of product differentiation* ρ *will induce more entrant types to disclose their quality information.*

Proof: See the Appendix. □

From Proposition 2, we know that only an entrant with quality $q_e \in (q_e^*, 1]$ will voluntarily disclose information; hence, the range of disclosing types will be solely determined by the marginal type q_e^*. According to Figure 1(b), we can see that a smaller π^M or a larger n will shift $W(q_e)$ down but have no effect on $\pi_e(q_e)$, which leads to a smaller q_e^*. Intuitively, the incumbent's willingness to pay $W(q_e)$ is lower because a lower monopoly profit means less benefit from monopolizing the market and adding an extra retailer would raise the incumbent's cost of deterring entry. Since $W(q_e)$ is lower for all entrant types, the relatively high types are now able to pay more than the incumbent to enter, and therefore they strategically reveal their type to costlessly enter the market.

To formally consider the degree of product differentiation ρ, we rewrite the postentry profits as $\pi(q_e, \rho)$ and $\pi_e(q_e, \rho)$ and the incumbent's willingness to pay as $W(q_e, \rho) = \frac{\pi^M - \pi(q_e, \rho)}{n}$. Again, according to Figure 1(b), a higher degree of product differentiation ρ will shift $W(q_e, \rho)$ down and shift $\pi_e(q_e, \rho)$ up, which also leads to a smaller q_e^*. There are two effects of an increase in ρ: on the one hand, a higher ρ lowers the incumbent's willingness to pay $W(q_e, \rho)$ by reducing the difference between the monopoly profit π^M and the competition profit $\pi(q_e, \rho)$; on the other hand, a higher ρ allows an entrant to earn a higher profit $\pi_e(q_e, \rho)$ after entry. Then for the same reason as above, the relatively high types will choose to disclose information.

4 Extensions

In this section, we consider several variations of the basic model. The purpose is to study how the results change when the model is made more realistic and whether the mechanism that drives disclosure in the basic model is robust to these specifications. To highlight the mechanisms in the new models, we fix the degree of product differentiation ρ as in the main analysis, so that the postentry profits are functions of q_e only.

4.1 Multiple Incumbents

In many situations, an entrant faces a number of incumbent firms rather than a monopolist. Thus, it is natural to consider cases in which there are multiple incumbents. Suppose that there are $m \geq 2$ incumbents in the market. Given quality q_e, each incumbent i earns $\pi_i^1(q_e)$ if entry occurs and π_i^0 otherwise, where $\pi_i^0 > \pi_i^1(q_e) > 0$, $i = 1, \dots, m$. Then, the maximal transfer incumbent i is willing to pay is $\pi_i^0 - \pi_i^1(q_e)$. Aggregating then yields the total maximal transfer $\sum_{i=1}^{m}[\pi_i^0 - \pi_i^1(q_e)]$. Following the same logic as in the proof of Lemma 1, a necessary and sufficient condition for the existence of an exclusionary equilibrium is

$$\text{(5)} \qquad \frac{\sum_{i=1}^{m}[\pi_i^0 - \pi_i^1(q_e)]}{n} \geq \pi_e(q_e).$$

Condition (5) indicates that whether an entrant can be deterred or not now depends on the total transfer from the incumbents. Therefore, to most effectively discourage entry, the incumbents need to perfectly coordinate on the transfers to retailers. If such coordination is possible, then there will be a similar mechanism that drives a high-quality entrant to disclose information.

4.2 Many Periods of Competition

We now study whether extending the model to many periods affects the results qualitatively. We consider the infinite-horizon model in Asker and Bar-Isaac (2014) and allow for information disclosure by the entrant at the beginning of each period. As in the basic model, there is only one entrant in the game; hence, if the entrant is deterred at some period, she (the same entrant) will remain as a potential entrant at the next period.

Following the same logic as before, the incumbent must offer the same transfer $T_s^r = T_s$ to each retailer r at period s, $s = 1,2,\dots$, which then generates a transfer flow $\{T_s\}$ to each retailer. At each period s, a reasonable belief about the retailers' behavior is that each retailer r will not accommodate the entrant if the present value of the transfer flow $\{T_s\}$ is weakly greater than the transfer $T^r_{e,s}$ from the entrant, i.e., $\sum_{s'=s+1}^{\infty}\delta^{s'-s}T_{s'} \geq T^r_{e,s}$, where $0<\delta<1$ is the common discount factor for all players. Since an entrant with quality q_e can transfer at most $\sum_{s'=s+1}^{\infty}\delta^{s'-s}\pi_{e,s'}(q_e)$ to a retailer for accommodation at period s, given the belief about the retailers' behavior, an entrant with quality below $\overline{q}_{e,s}$ will be deterred at each period s, where $\overline{q}_{e,s}$ solves $\sum_{s'=s+1}^{\infty}\delta^{s'-s}T_{s'} = \sum_{s'=s+1}^{\infty}\delta^{s'-s}\pi_{e,s'}\left(\overline{q}_{e,s}\right)$.

If the entrant is very competitive (i.e., with a sufficiently high quality), she must be able to pay more than the incumbent to enter the market. Then, if the incumbent knows that the entrant's quality is high at the beginning of period s, he will have no incentive to offer positive transfers to retailers in any period $s' \geq s$. Therefore, to enter the market at no cost, a high-quality entrant will choose to disclose quality information at period 1.

4.3 State-dependent Transfers $\{T^r\}$

In the basic model, the incumbent's transfer T^r depends on retailer r's agreement not to carry the entrant's products. We now consider an alternative setting in which the transfers from the incumbent $\{T^r\}$ depend on whether entry has occurred or not. To be more specific, we assume instead that the transfer from the incumbent to each retailer r, T^r, is payable if entry does not occur (i.e., if no retailer accommodates the entrant).

The full analysis of the model is relegated to the Online Appendix, in which we show that the disclosure mechanism in the basic model is robust to this specification.[19] Here, we briefly discuss some new results and the model setting. First, we find that the incumbent may offer positive transfers to retailers even in a no-exclusion equilibrium.[20] Intuitively, the incumbent's transfer strategies are different from those in the basic model because the incumbent now does not need to pay the transfers if entry eventually occurs (that is, it is in

[19] The Online Appendix is available on the *Journal*'s editorial website.

[20] By no-exclusion, we mean an equilibrium in which all entrant types enter the market. For example, any equilibrium in Lemma 2 is a no-exclusion equilibrium; any equilibrium with disclosure is not a no-exclusion equilibrium because very low types will be deterred.

fact less costly for the incumbent to offer positive transfers to retailers). Also, for this reason, an equilibrium with disclosure will always exist. Second, the entrant offers a zero transfer to every retailer in any equilibrium with entry.[21] This is because regardless of how much the incumbent has offered to each retailer, accepting the entrant's offer (with a zero transfer) is in a retailer's best response set if another retailer chooses to accept the entrant's offer. Third, the assumption that the entrant has perfect information about $\{T^r\}$ can be relaxed; that is, whether or not the offers from the incumbent $\{T^r\}$ are observable to the entrant is not essential to the results. The main reasons are that (i) entry can always occur in equilibrium regardless of how much the incumbent has offered and (ii) all exclusionary equilibria do not rely on the observability of $\{T^r\}$.

5 Concluding Remarks

In this paper, we have analyzed an entrant's disclosure behavior in a model where entry requires accommodation by retailers. We find that when disclosure is voluntary, retailers accommodate not only a high-quality entrant who discloses information but also an intermediate-quality entrant who chooses not to disclose. When disclosure is mandatory, however, retailers accommodate only a high-quality entrant. Since entry intensifies competition between manufacturers, consumer welfare will be higher under voluntary disclosure than under mandatory disclosure. We now discuss the value of disclosed information and the desirability of mandatory disclosure laws.

First, the model indicates that voluntarily disclosed information is valuable to consumers because it is *accessible* to consumers. Indeed, there are a number of potential benefits to consumers if products have detailed quality information. For example, detailed information may intensify competition among sellers, which allows consumers to enjoy lower prices, enriched variety, or improved quality (Hotelling 1929; Salop 1979; Banker et al. 1998; Board 2009; Matsa 2011). Products with detailed quality information may also increase the

[21] Note that in Proposition 3 an intermediate type needs to pay $\pi_e(q_e^{**})$ to a retailer to enter the market.

amount of trade as well as the gains from trade (Jovanovic 1982). Moreover, quality information has direct value to consumers, since it allows consumers to make better choices about the use of a product (Fishman and Hagerty 2003). However, these benefits depend crucially on the fact that the products have successfully entered the market—if entry is deterred, the benefits will never be enjoyed by consumers. In a model where exclusion is taken into account, we find that voluntary disclosure allows high-quality firms to signal their competitiveness by disclosing quality information and thereby ensures their entry into the market. Since such entry brings accessible information to consumers, it is then possible for consumers to benefit from this disclosed information.

While information may benefit consumers in many ways, excessive information can potentially harm consumers. Here, "excessive" means an amount of information that is more than the amount of information voluntarily disclosed. For instance, we have shown that only information in $(q_e^*, 1]$ is voluntarily disclosed and hence disclosing more information in $[0, q_e^*]$ is excessive. In this model, potential harms to consumers come from a reduction of product varieties due to excessive information—an entrant with information $q_e \in [0, q_e^*]$ will be excluded from the market if she discloses information q_e. However, if an entrant is allowed to conceal information, the relatively high types in $[0, q_e^*]$ will be able to enter and serve the market. Although these products do not provide consumers with informational benefits, they may raise consumer welfare by bringing more product varieties to consumers and intensifying competition among sellers. In this sense, excessive information disclosure that limits entry can make consumers worse off.

Finally, we conclude by discussing the desirability of mandatory disclosure laws. There are two opposing arguments in the literature on this issue: one is in favor of mandatory disclosure laws, arguing that these laws are consumer-welfare-improving (e.g., Moorman et al. 2005; Board 2009; Levin et al. 2009; Hotz and Xiao 2013), while the other one argues that mandatory disclosure laws may not always promote competition and raise consumer welfare (e.g., Jovanovic 1982; Matthews and Postlewaite 1985; Dranove et al. 2003;

Gavazza and Lizzeri 2007; Bar-Isaac et al. 2012; Celik 2014). Our results support the latter argument in this literature. With a focus on the role of retailers, we find that the quality information that is accessible to consumers will be determined by the voluntary disclosure game that involves only sellers and retailers. However, mandatory disclosure brings consumers no more accessible information than voluntary disclosure, because mandatory disclosure provides the incumbent with precise information that allows him to more effectively deter entry. Then, consumers will be worse off under mandatory disclosure since they will never benefit from the products that are excluded from the market even if their quality information is disclosed. Therefore, laws or rules that mandate seller disclosure can be consumer-welfare-reducing.

Appendix. Proofs Omitted from Main Text

Proof of Lemma 2:

First, by Lemma 1, any equilibrium must be an equilibrium with entry if $\frac{\pi^M - \pi(q_e)}{n} < \pi_e(q_e)$. Also, we can easily verify that there are multiple equilibria with entry in which both the incumbent and the entrant offer a zero transfer to each retailer r, where the multiplicity of equilibria arises because any number $m \geq 1$ of retailers may accept the entrant's offer in equilibrium.

We now show that in any equilibrium the transfers offered by the two manufacturers are zero. Suppose that there exists an equilibrium with entry in which a positive transfer is offered by some manufacturer. In order to minimize expenditure, the incumbent and the entrant must offer zero transfers to the retailers who accept the incumbent's offer. Given that entry needs only one retailer's accommodation, the only possible situation is that the incumbent and the entrant offer the same transfer $T^{r'} = T_e^{r'} > 0$ to retailer r' who accepts the entrant's offer and zero transfers to all other retailers. However, this cannot be an equilibrium because the entrant can make herself better off by offering $T_e^{r'} = 0$ to retailer r' and a slightly positive transfer to another retailer r'' to induce accommodation. $\square$

Proof of Proposition 1:

By Assumptions 3 and 5, we have $W(0) - \pi_e(0) > 0$ and $W(1) - \pi_e(1) < 0$. Assumption 6 implies that $W'(q_e) - \pi_e'(q_e) < 0$ on [0,1]. Then continuity ensures there exists a unique $q_e^* \in (0,1)$ such that $W(q_e^*) - \pi_e(q_e^*) = 0$, $W(q_e) - \pi_e(q_e) \geq 0$ for $q_e \in [0, q_e^*]$, and $W(q_e) - \pi_e(q_e) < 0$ for $q_e \in (q_e^*, 1]$.

By Lemma 1, an exclusionary equilibrium exists for $q_e \in [0, q_e^*]$. In each exclusionary equilibrium, it is optimal for the incumbent to offer $\pi_e(q_e)$ to every retailer because the entrant may induce accommodation if the incumbent's minimal transfer is strictly smaller than $\pi_e(q_e)$. Given the incumbent's offers and the belief that each retailer r will accept the incumbent's offer when $T^r(q_e) \geq T_e^r(q_e)$, it is optimal for the entrant to offer an arbitrary transfer less than $\pi_e(q_e)$ to each retailer, and all retailers choose to accept the incumbent's offer. No one has an incentive to deviate. This proves part (i). Part (ii) follows directly from Lemma 2. $\square$

Proof of Proposition 3:

Part (i) follows directly from Propositions 1(ii) and 2. We now show that when disclosure does not occur, the incumbent's optimal transfer to every retailer, $T^{**} = \pi_e(q_e^{**})$, is strictly smaller than $\pi_e(q_e^*)$, so that $q_e^{**} \in (0, q_e^*)$. Let $G^*(q_e)$ denote the cumulative distribution function of q_e on $[0, q_e^*]$, where $G^*(q_e) = G_{[0,q_e^*]}(q_e) = \frac{G(q_e)}{G(q_e^*)}$ by Bayes' rule. By Lemma 3, the incumbent's return from transferring T^{**} to every retailer must be no less than that from offering no transfers to retailers and allowing entry

(6) $$\pi^M - nT^{**} \geq \int_0^{q_e^*} \pi(q_e) dG^*(q_e).$$

Since $\pi'(q_e) < 0$ on [0,1], we have

(7) $$0 < T^{**} = \pi_e(q_e^{**}) \leq \frac{\pi^M - \int_0^{q_e^*} \pi(q_e) dG^*(q_e)}{n} < \frac{\pi^M - \pi(q_e^*)}{n} = \pi_e(q_e^*),$$

which then implies $q_e^{**} \in (0, q_e^*)$.

If the incumbent offers $T^{**} = \pi_e(q_e^{**})$ to every retailer in equilibrium, then an entrant with quality $q_e \in [0, q_e^{**}]$ will be deterred. For $q_e \in (q_e^{**}, q_e^*]$, it is optimal for the entrant to offer $\pi_e(q_e^{**})$ to some retailer r' to induce accommodation and an arbitrary transfer less than $\pi_e(q_e^{**})$ to each retailer $r'' \neq r'$. Retailer r' accepts the entrant's offer and other retailers accept the incumbent's offer. No one has an incentive to deviate. For $q_e \in [0, q_e^{**}]$, the proof is similar to the proof of Proposition 1(i). □

Proof of Proposition 5:

To investigate the range of disclosing types, by Proposition 2, we need only focus on the marginal type q_e^*. By the proof of Proposition 1, q_e^* satisfies the following equation

(8) $$\frac{\pi^M - \pi(q_e^*, \rho)}{n} - \pi_e(q_e^*, \rho) = 0.$$

Differentiating equation (8) with respect to π^M and n, respectively, and using Assumption 6 that incorporates ρ, $\frac{1}{n}\frac{\partial \pi(q_e^*, \rho)}{\partial q_e^*} + \frac{\partial \pi_e(q_e^*, \rho)}{\partial q_e^*} > 0$, we have

(9) $$\frac{\partial q_e^*}{\partial \pi^M} = \frac{\frac{1}{n}}{\frac{1}{n}\frac{\partial \pi(q_e^*, \rho)}{\partial q_e^*} + \frac{\partial \pi_e(q_e^*, \rho)}{\partial q_e^*}} > 0 \quad \text{and} \quad \frac{\partial q_e^*}{\partial n} = -\frac{\frac{\pi^M - \pi(q_e^*, \rho)}{n^2}}{\frac{1}{n}\frac{\partial \pi(q_e^*, \rho)}{\partial q_e^*} + \frac{\partial \pi_e(q_e^*, \rho)}{\partial q_e^*}} < 0.$$

To see the effect of product differentiation ρ on q_e^*, differentiate equation (8) with respect to ρ and we have

$$\frac{\partial q_e^*}{\partial \rho} = -\frac{\dfrac{1}{n}\dfrac{\partial \pi(q_e^*, \rho)}{\partial \rho} + \dfrac{\partial \pi_e(q_e^*, \rho)}{\partial \rho}}{\dfrac{1}{n}\dfrac{\partial \pi(q_e^*, \rho)}{\partial q_e^*} + \dfrac{\partial \pi_e(q_e^*, \rho)}{\partial q_e^*}} < 0. \tag{10}$$

□

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