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2 Peer-to-Peer Sharing of Private Goods: Sellers' Response and Consumers' Benefits

2 JIONG SUN, HENDRARTO SUPANGKAT, AND SIVA BALASUBRAMANIAN

ABSTRACT We study how the presence of consumers' peer-to-peer sharing option in addition to exclusive ownership affects sellers' pricing and product design decisions, as well as consumers' benefits. We identify the conditions in which a seller would accommodate or hinder sharing by pricing the product appropriately. The seller's profit can be enhanced by accommodating sharing when consumer valuation heterogeneity is neither too high nor too low. Second, sharing does not always improve consumers' access to goods, and consumers' access is the most constrained in product categories of medium intrinsic value. Third, existing consumers who seek exclusive ownership may end up being worse off in markets where, without the sharing option, the seller would price the product such that sharing consumers could afford to own the product. Finally, sharing enhances the seller's incentive to improve product quality in markets where sharing consumers cannot afford to own the product if sharing is precluded.

3 Technology has reduced transaction costs, making sharing assets cheaper and easier than ever—and therefore possible on a much larger scale. The big change is the availability of more data about people and things, which allows physical assets to be disaggregated and consumed as services.
—*The Economist* (2013)

1. INTRODUCTION

With increasingly connected consumers and recent advancement of technology, peer-to-peer social sharing groups have recently grown tremendously and make it possible for people to share their privately owned goods with friends, neighbors, and even strangers. Smartphones allow people to search for the nearest shareable goods, social networks provide a way to build trust, and online payment systems handle the billing (*The Economist* 2013). The goods being shared are typically mid-grained lumpy goods that are widely owned by people who do not make full use of them, for example, cars, bikes, power tools, snow blowers, garden equipment, kitchen appliances, and party supplies. In this article, we focus on peer-to-peer sharing of private goods. Peer-to-peer sharing is characterized by the pooling and allocation of household resources and private goods treated as common within a group (Belk 2010; Lamberton and Rose 2012).¹

The recent surge of many peer-to-peer sharing programs signals that markets are giving way to this alternative mode of consumption. Botsman and Rogers (2010) anticipate that the consumer peer-to-peer rental market will become a \$26 billion sector and estimate that the sharing economy, in total, is a \$110 billion-plus market. Zhao (2010) projects that the number of car-sharing members in North America is expected to reach nine million by 2020. As an alternative consumption mode, peer-to-peer sharing competes with the traditional consumption mode, that is, exclusive ownership, because of its increased convenience (Bardhi and Eckhardt 2012; Geron 2013).

Peer-to-peer sharing offers both opportunities and challenges to consumers compared with exclusive ownership. On one hand, it offers benefits of exploiting slack capacities and lowering consumption costs. The average car in North America and Western Europe is in use 8% of the time, and most owners use their electric drills and KitchenAid mixers

Jiong Sun (jionsg@gmail.com), Illinois Institute of Technology, Chicago, IL. Hendrarto Supangkat, PPM School of Management, Jakarta, Indonesia. Siva Balasubramanian, Illinois Institute of Technology, Chicago, IL.

1. Peer-to-peer sharing spans almost all types of tangible goods. For example, RelayRides and Getaround allow people to borrow cars from neighbors, Liquid allows people to share bikes, and NeighborGoods and Zilok allow people to rent power tools, ladders, camcorders, vacuums, etc. Among others, Wheelz, Uber, Lyft, Buzzcar, LocalMotion, Zimride, Spride, and Sidecar are programs for sharing vehicles; RentTheRunway for sharing designer dresses, evening gowns, and accessories; and Rentoid, ShareSomeSugar, Sharetribe Snapgoods, TechShop, and Cyclingboom are resources for various household goods, gadgets, and tools.

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only a few minutes a year (Sacks 2011; Triple Pundit 2012). The low usage of these goods together with maintenance costs create a burden of sole ownership. Sharing products with others reduces these consumption costs. On the other hand, communal consumption is the major distinction of peer-to-peer sharing from exclusive ownership as well as other “sharing” activities (Belk 2010; Botsman and Rogers 2010). In peer-to-peer sharing communities, one can be the owner of a good (e.g., power screwdriver) and a renter of another (e.g., bike). The community sense and mutual benefits make exploiting slack capacities the main purpose of peer-to-peer sharing, which in turn makes peer-to-peer sharing cheaper for consumers to rent goods when compared to corporate-owned sharing programs or renting services.

On the other hand, however, compared with exclusive ownership, sharing may lead to inconvenience given the loss of flexibility from the non-copyability characteristic of tangible goods. For example, a car may not be available for sharing at a nearby location when desired. Lambertson and Rose (2012) empirically showed that the risk of nonavailability is a key determinant of a consumer’s sharing propensity. The inconvenience of sharing also includes the search effort needed to assess availability as well as any travel related to pick-up and return of the good (Lambertson and Rose 2012). In addition, if the goods are considered extensions of the individual users (e.g., consumer electronics), sharing may leave some traces of multiple users (Belk 2007).

Peer-to-peer sharing also poses both opportunities and challenges to sellers. Sharing opens up more market potential by gaining access to consumers who would not purchase otherwise. However, sharing in groups may result in fewer purchases for sole ownership. Different from renting services or corporate-owned services such as Zipcar, owners are also users. In other words, sellers are not able to do differential pricing because they are not able to differentiate buyers seeking exclusive ownership from those seeking sharing. Also, owners may not foresee their low utilization and can decide to share with others after their purchase. Firms need to understand and respond to this alternative consumption mode with appropriately revised pricing and product strategies.

Despite its growing practical importance, few studies exist on sellers’ response to sharing and its impact on existing consumers. In this article, we study a practical problem: under what conditions would peer-to-peer sharing (labeled hereafter as “sharing” for brevity) become a widespread and viable form of consumption, and whether or not it benefits sellers and existing buyers who seek exclusive ownership.

Furthermore, sharing has attracted praise for its potential to enhance the access of budget-conscious consumers’ to goods that they may not normally consider. At this time, sellers’ strategic response to sharing and the resultant impact on consumers remain unexplored. We study the following questions: (1) When would a seller choose to accommodate or hinder sharing? (2) What roles do market characteristics (e.g., valuation heterogeneity and size of the sharing segment), product characteristics (e.g., quality level and inconvenience cost), and consumers’ connectivity (size of sharing groups) play? (3) Can accommodating sharing improve the seller’s profit, and if so, when? (4) Does sharing always enhance access to goods? (5) Will sharing benefit or hurt existing (high-valuation) consumers who seek exclusive ownership? (6) Will sharing encourage or discourage the seller to design a high quality product? (7) How do the results change if sharing consumers can endogenously choose their group size?

This article offers several major insights. First, we find that the seller will accommodate sharing when the product’s intrinsic value is sufficiently high and consumers’ valuation heterogeneity is neither too high nor too low. Sufficiently high intrinsic values assure that the benefits from reduced consumption costs exceed any inconvenience costs. When the valuation heterogeneity is intermediate, such benefits can be shared with the seller to the extent that she chooses to accommodate sharing. In some cases, such benefits are strong and even make the seller gain higher profits than without the sharing option.

Second, we show that, in the presence of the sharing option, when taking into account the reactions of the seller and consumer heterogeneity, low-valuation consumers’ access to the product can be enhanced or reduced. Specifically, consumers’ access to the product is minimal (in terms of the number of market types characterized by consumer heterogeneity) for medium-value categories.

Third, consumers can be worse off or better off when sharing is accommodated. We show that accommodating sharing would improve both the seller’s profit and consumers’ surplus when the market is not yet saturated, that is, low-valuation consumers cannot afford the product without sharing. However, if sharing is introduced into a market where all consumers can afford to buy the product, then either the seller or the high-valuation consumers (or both) will be worse off.

Fourth, the presence of the sharing option affects the seller’s incentive to design the product’s intrinsic value. We show that the endogenous intrinsic value can be en-

hanced or reduced, compared with the case of no sharing option. More importantly, differing from the conventional wisdom that stronger consumer heterogeneity leads to higher product quality targeted at high-valuation consumers, we show that, in the presence of the sharing option, stronger consumer heterogeneity may lead to lower quality. Finally, we extend our model to situations where the sharing groups have an influence on group size. We show that the major insights listed above still hold.

Our work extends and complements several streams of literature, as described next. Studies of social sharing are limited. Belk (2007, 2010) built the conceptual foundation of this alternative consumption mode. Lambertson and Rose (2012) empirically measured consumers' perceptions and personal determinants to accept sharing. They find that the perceived risk of scarcity related to sharing is a central determinant of its attractiveness. Bardhi and Eckhardt (2012), using Zipcar as an example, find that this type of sharing lacks identification. Similarly, in peer-to-peer sharing, consumers do not identify themselves with the shared objects as much as appreciating the opportunity to engage or relate with other consumers (e.g., Belk 2010; Chen 2009). Bardhi and Eckhardt also found that corporate-owned sharing programs deter the sense of community because no personal interaction takes place as it does in peer-to-peer sharing. While the difference between corporate-owned sharing and exclusive ownership has been noted in the literature, there is still a lack of an understanding of the seller's reaction to peer-to-peer sharing. In other words, the drivers of sharing propensity remain unclear. In this study, we advance understanding of the competition effect between the two consumption modes in consumers' choice and the seller's reaction to accommodate or hinder sharing.

Our article is related to the literature on sharing digital products. For example, Galbreth et al. (2012) examined the seller's profitability under different consumer network structures (centralized, decentralized, and incomplete) in sharing information goods. Differing from Galbreth, Ghosh, and Shor (2012), we focus on the consumer valuation heterogeneity and assume sharing occurs among the same type of consumers who tend to have similar connectivity and valuation, which is a salient feature of peer-to-peer sharing of noncopyable durable goods, mainly because of consumers' geographical proximity. Hence, our article also differs from Bakos, Brynjolfsson, and Lichtman (1999), who study how sharing can reshape demand (or valuation heterogeneity) by aggregating different types of consumers' valuations in a group. Valuation heterogeneity of consumers in the same sharing groups is the key driver of profit increase in their

study. However, this type of reshaping effect is absent in peer-to-peer sharing where members are mainly neighbors and friends. We show that sharing among low-valuation consumers can also enhance the seller's profit, in an indirect way, by gaining additional profits from those consumers seeking exclusive ownership. In addition to profits, differing from these articles we also study consumers' access to goods.

Our article is also related to the literature on psychological ownership, the conceptual core of which is a sense of possession and part of the "extended self" (Belk 1988; Hillenbrand and Money 2015; Jussila et al. 2015; Pierce, Kostova, and Dirks 2001). Psychological ownership can exist in the absence of legal ownership and can be extended to the group or community level (Hulland et al. 2015; Pierce and Jusila 2010). This explains why the sense of ours could exist in peer-to-peer sharing. A study by Lessard-Bonaventure and Chebat (2015) shows that psychological ownership increases consumers' willingness to pay when the financial risk is low. Peer-to-peer sharing offers such a mechanism of reducing owners' financial burden because it allows owners to exploit slack capacities.

In the following section, we set up our model and describe our approaches to the two alternative consumption modes and the seller's decisions.

2. MODEL SETUP

2.1. Consumer Utilities

Consumer Type. Sharing programs currently gain most popularity among budget consumers (Geron 2013). Similar to the previous literature (Varian 2000), we model two types of consumers, high- and low-valuation consumers. The low-valuation consumers, of proportion γ , have a marginal willingness to pay, denoted by θ_l , for each unit of the intrinsic value. The high-valuation consumers, of proportion $1 - \gamma$, have a higher marginal willingness to pay denoted by θ_h ($>\theta_l$).

Consumer Utilities. When a consumer of type $\theta_i, i \in \{h, l\}$, chooses to own exclusively a unit of the product priced at p , she derives utility $U_O(q, p) = q\theta_i - p$. In the case of sharing, we follow Lambertson and Rose (2012), by considering the following sharing costs: search costs associated with retrieving availability and location information, the negative consequences associated with the risk of unavailability of the good when desired, and technical costs associated with coping with and learning how to use unfamiliar products. Among these costs, the potential wait time for a

product to become available and the hassle of returning it are considered the major factors that hinder users' decision to join. Hence, we refer to the costs of sharing as inconvenience costs.

Other issues such as damage, malfunction, or impurity in the goods are potential concerns for both owners and users. However, it turns out that consumers perceive a greater need for careful handling as compared to ownership due to their concern about their reputation and feeling of being a part of the community (Baumeister and Wangenheim 2014). For example, Ozanne and Ozanne (2011) reported that in the context of toy rental libraries, parents place even more importance on careful handling when toys are rented rather than owned. Practices show that members do behave responsibly and it is rare that cars are returned late, dirty, or with no gas. Therefore, the major inconvenience cost can be considered independent of functionality or intrinsic value, which is similar to the previous literature (Varian 2000). Furthermore, we assume that consumers derive the same transaction utility each time they access the product. That is, we focus on the most important functional features of the product categories. Experiential and symbolic features are considered less important.

Consequently, when sharing the product of price p within a group of size n , a consumer of type $\theta_i, i \in \{h, l\}$, derives utility $U_S(\theta_i; q, p, n) = (q - t_i)\theta_i - f(p, n)$, where t_i is the inconvenience cost incurred in sharing, and $f(p, n)$ is the price each user pays on average. Each sharing consumer may have access to multiple units of the product. Hence, the group size n can be thought of as the inverse of the average accessibility.

Equal-Pay Budget-Balancing Mechanism. Similar to the previous literature (e.g., Galbreth et al. 2012; Varian 2000), we adopt the simplest and commonly used form of price distribution within a group, that is, an equal-pay budget-balancing mechanism, whereby each willing group member pays an equal share of the price, that is, $f(p, n) = (p/n)$. We justify the equal-pay budget-balancing mechanism from three aspects. First, as argued above, the major objective of peer-to-peer sharing is to exploit slack capacities, and the owners do not intend to make a significant profit from sharing (Benkler 2004).

Second, any nonequal payment structure will lead to free rides and hence may hinder the formation of a sharing group in the first place (Varian 2000). As argued in Galbreth et al. (2012), this mechanism ⁴ has been shown to have strong efficiency properties and to uniquely satisfy several desirable conditions (see also Dearden and Einolf 2003;

Norman 2004), as well as being consistent with experimental evidence on sharing in social networks. Therefore, in the context of peer-to-peer sharing, the equal-pay mechanism is intuitive and easy to implement because of the sense of community engendered in sharing with people who are neighbors or friends with similar valuations. Benkler (2004) argues that social-based sharing mechanisms are more prevalent than market-based sharing mechanisms because of lower transaction costs, better information, and stronger motivation for owners. Hence, consumption costs can be equally shared among sharing members.

Third, we do not distinguish owners from users. As argued by Belk (2010), in peer-to-peer sharing, possession or ownership is joint, with no separate terms to distinguish members. When consumption of a good is shared, all consuming members are assumed to have the same usage needs (e.g., power tools a couple of times a year). As argued by Lamberton and Rose (2012), in a commercial sharing context a consumer will expect trusted others to refrain from overuse or abuse of the shared product.

Inconvenience Costs. A higher marginal willingness to pay may represent not only a more affluent consumer but also a higher level of importance or necessity of the product to the person (Belk 2007; Lamberton and Rose 2012). Hence, wealthy consumers tend to value convenience more (Berry, Seider, and Grewal 2002; Deacon and Sonstelie 1985; Johnson, Herrmann, and Huber 1998). Accordingly, we assume that high-valuation consumers value convenience more than do low-valuation consumers, that is, $t_h > t_l$. For simplicity, we assume that t_h is sufficiently high, that is, $t_h > [(n-1)/n]q$, such that sharing is not a viable option for high-valuation consumers, as in Varian (2000). In addition, for sharing to be a viable option to low-valuation consumers, we should have $t_l \leq [(n-1)/n]q$. We hereafter use t to refer to the inconvenience cost of the low-valuation consumers for brevity. The impact of group size on the inconvenience cost is relevant and is considered when we endogenize the group size in section 3.3, where we assume that the inconvenience cost is an increasing function of group size.

2.2. The Firm and Decisions

The firm sells a product of intrinsic value q at price p to a market the size of which is normalized to unity. The seller chooses a single price p because of its inability to differentiate sharing from owning. Each unit sold incurs a cost of c , which is normalized to zero. This simplification also allows us to limit our study to the parameter space where high-

valuation consumers can always afford to purchase one unit of the product. When the product quality q is a decision variable, we assume a fixed, convex cost of producing quality, given by $K(q) = \frac{1}{2}kq^2$. In this article, we consider peer-to-peer models, where owners are also users, for example, RelayRides, rather than corporate models, where a corporation owns the object being shared, for example, Zipcar. Thus, there is no third party between the seller and consumers.

3. ANALYSIS

We first examine a baseline model in section 3.1, where exclusive ownership is the only consumption option. In section 3.2, we study the main model where both ownership and sharing are present as alternative modes. Our discussion focuses on how the presence of the sharing option influences the seller's equilibrium price and profit in section 3.2.1, the consumers' access to goods and consumer surplus in section 3.2.2, and the seller's quality decision in section 3.2.3. We then extend our analysis in section 3.3, where size of the sharing group is an endogenous decision of sharing consumers. All results are obtained analytically. Additional results can be found in appendix A and proofs are provided in appendix B (apps. A and B available online).

3.1. Benchmark Case: No Sharing

In this section, we briefly discuss the benchmark case where each consumer either buys one unit or does not consume the product, that is, the sharing option is absent. It is known that the seller will either price low such that all consumers buy, referred to as the $Mass^{BM}$ strategy, or will price high such that only the high-valuation consumers buy, referred to as the *Niche* strategy. The superscript "BM" denotes benchmark to differentiate the same strategy from the sharing case in which the seller charges a different equilibrium price.

We show that it is profitable for the seller to serve the low-valuation consumers in addition to the high-valuation consumers only when the valuation heterogeneity is sufficiently low, that is, $\theta_h/\theta_l \leq 1/(1-\gamma)$. In this type of market, the seller incurs a profit reduction from high-valuation consumers who are paying less than their utility. However, this profit reduction is dominated by the additional profit gained from serving the low-valuation segment when θ_h/θ_l is sufficiently low. More details can be found in lemma 1 in appendix A.

3.2. Peer-to-Peer Sharing

In this section, we study the case where (low-valuation) consumers have an option of sharing in groups in addition to exclusive ownership.

3.2.1. Optimal Pricing Strategies and Profits. Similar to the previous literature (Varian 2000), the seller can price such that each consumer type chooses to own or share the product, or not to consume. Specifically, low-valuation consumers can choose to own the product if the price is low

$$p \leq \frac{t}{1-(1/n)}\theta_l,$$

or not to consume the product if the price is high $p > (q-t)n\theta_l$. For high-valuation consumers, with the assumption of high inconvenience costs, they choose to own the product when $p < q\theta_h$, or not to consume the product otherwise.

Consequently, the seller has four possible pricing strategies to induce the above consumer choices: (1) both high- and low-valuation consumers buy one unit each, referred to as the $Mass^S$ strategy; (2) high-valuation consumers buy one unit each and low-valuation consumers share in groups, referred to as the *Sharing* strategy; (3) high-valuation consumers buy one unit each and low-valuation consumers neither buy nor share, referred to as the *Niche* strategy; and (4) high-valuation consumers do not buy and low-valuation consumers share. In the following, we show that the *Niche* strategy is the same as in the benchmark; and the $Mass^S$ strategy differs from the $Mass^{BM}$ strategy in the benchmark because the seller charges different prices. The superscript "S" denotes the case of sharing. We further assume that the number of low-valuation consumers is not too large, that is, $\gamma < [nt/(q-t)(n-1)]$, such that the unrealistic case (4) above does not arise in equilibrium.² Define

$$q_{\min} = \frac{t}{(n-1)[1-(n-1/n)\gamma]} + t,$$

$$\underline{\theta} = \frac{t}{(n-1/n)[1-(n-1/n)\gamma]q},$$

$$\bar{\theta} = \left(n + \frac{\gamma}{1-\gamma}\right) \frac{q-t}{q}.$$

2. In the appendix, we show that, with a relaxation of the assumption, the presence of this case does not change our key insights.

Proposition 1 below characterizes the conditions under which the seller will accommodate or deter sharing in equilibrium. Equilibrium prices and profits can be found in proposition 5 in appendix A.

Proposition 1: In the presence of consumers' sharing option ($n \geq 2$),

- 1) The seller may accommodate sharing only if the intrinsic value is sufficiently high, that is, $q \geq q_{min}$.
- 2) When $q \geq q_{min}$, sharing arises when the valuation heterogeneity θ_h/θ_l is intermediate, that is, $\theta_h/\theta_l \in (\underline{\theta}, \bar{\theta}]$.

Proposition 1 suggests that peer-to-peer sharing arises in equilibrium when the product's intrinsic value is sufficiently high and the valuation heterogeneity is intermediate. The former ensures that the inconvenient cost of sharing (which is independent of intrinsic value) does not dominate the benefits of sharing. Second, the valuation difference between high- and low-valuation consumers should not be too large such that the seller is willing to forego high profit margins from selling the product only to high-valuation consumers at a high price. Meanwhile, the valuation difference should not be too small such that the seller would not price such that all consumers buy it for exclusive ownership. Linking to real life examples, we do observe that goods being shared are typically mid-grained goods, for example, snow blowers, garden equipment, bikes, etc. The intrinsic values of these technology goods are not low and consumers' valuation may not differ too much from each other.

We explain our insights in more details as follows. Peer-to-peer sharing does not arise in equilibrium when q is sufficiently low, that is, $q \leq q_{min}$ (or the sharing group size n is sufficiently small because $(dq_{min}/dn) < 0$). This is intuitive because when the intrinsic value is low such that the price is low, the benefit of reduced consumption costs by sharing is insignificant. This lowers consumers' willingness to pay for sharing relative to exclusive ownership and in turn renders sharing less profitable for the seller to accommodate. Figure 1a illustrates the seller's optimal strategy space in the space of θ_h/θ_l versus q . Figure 1b illustrates the seller's optimal price as a function of θ_h for a given $q > q_{min}$. In the following, our discussion focuses on $q > q_{min}$ such that sharing will emerge in equilibrium.

When the intrinsic value is sufficiently high, the seller may accommodate sharing, which happens when the valuation heterogeneity is intermediate. When consumer het-

erogeneity is large such that $(\theta_h/\theta_l) \geq \bar{\theta}$, it is more profitable to adopt the *Niche* strategy by focusing on high-valuation consumers and pricing the same as in the benchmark, that is, $p^* = q\theta_h$. Note that the critical valuation heterogeneity $\bar{\theta}$ indicates a bound below which the high-valuation consumers may gain a positive surplus by paying the same price as low-valuation consumers. It can be shown that this critical value is lower than that in the benchmark, that is, $\bar{\theta} \leq \theta^{BM}$, for low intrinsic values q ; higher, that is, $\bar{\theta} > \theta^{BM}$, otherwise. This implies that the high-valuation consumers may be better- or worse off in the presence of sharing consumers. More details will be discussed in section 3.2.2.

When consumer heterogeneity θ_h/θ_l reduces and reaches $\bar{\theta}$, the relative appeal of low-valuation and high-valuation segments changes such that serving only the high-valuation consumers becomes less profitable. The seller will choose to accommodate sharing (by low-valuation consumers) in the intermediate region $(\theta_h/\theta_l) \in (\underline{\theta}, \bar{\theta}]$. Two subcases arise. When heterogeneity θ_h/θ_l is not too low, that is,

$$\frac{\theta_h}{\theta_l} \in \left(\frac{(q-t)n}{q}, \bar{\theta} \right],$$

such that the sharing group's valuation $[(q-t)n\theta_l]$ is lower than high-valuation consumers' valuation of exclusive ownership ($q\theta_h$), the seller prices the product at the sharing group's valuation, that is, $p^* = (q-t)n\theta_l$. When heterogeneity θ_h/θ_l is in a lower subregion,

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{(q-t)n}{q} \right],$$

the sharing group's valuation $[(q-t)n\theta_l]$ becomes higher than high-valuation consumers' valuation ($q\theta_h$). Hence, the seller still accommodates sharing by pricing the product at a level acceptable to high-valuation consumers, that is, $p^* = q\theta_h$. The former case occurs where consumers' value perceptions vary significantly. In such cases, the high-valuation consumers who seek exclusive ownership would benefit from the existence of such sharing programs by paying a price lower than their willingness to pay and gaining a positive surplus. The latter scenario occurs where consumers' valuation does not vary significantly, or people are closely connected, for example, gated communities or college towns. In such cases, the sharing consumers gain a positive surplus.

When the market is relatively uniform, that is, $(\theta_h/\theta_l) \leq \underline{\theta}$, the low-valuation consumers' willingness to pay for owning the product is sufficiently high. Intuitively, it is more profitable for the seller to price such that all consumers will

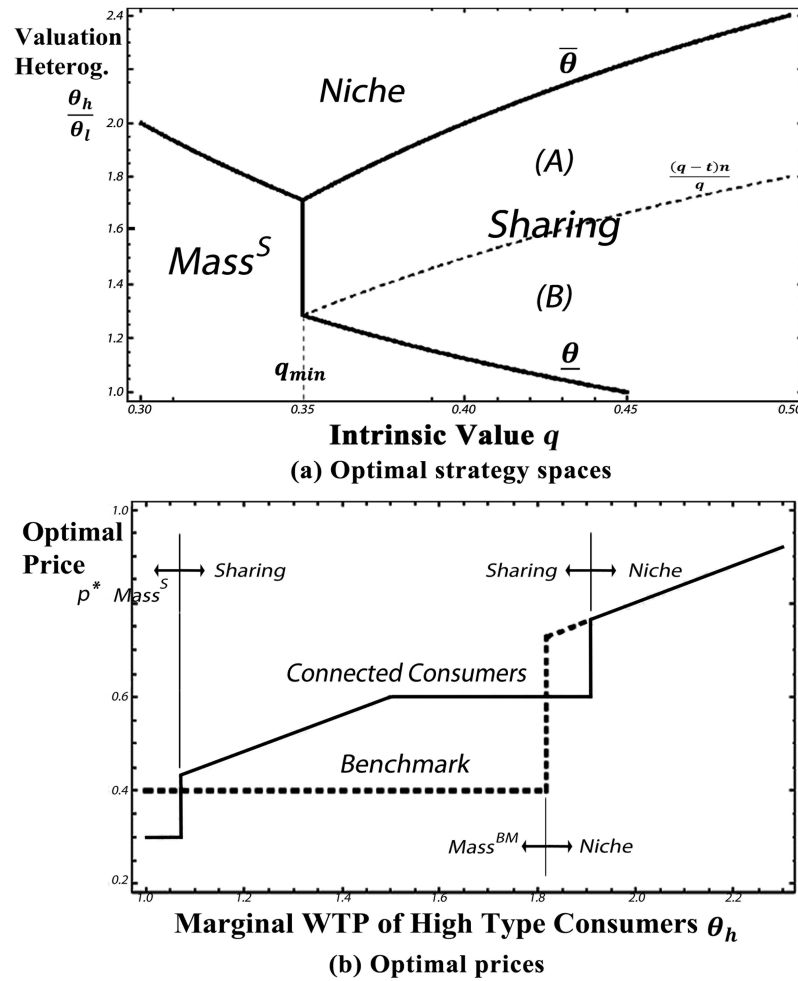


Figure 1. Optimal strategy spaces and prices.

buy one unit of the product, that is, the $Mass^S$ strategy. The price should be sufficiently low such that the inconvenience cost of sharing dominates the benefits of reduced consumption costs. In other words, sharing is deterred by pricing even lower than the low-valuation consumers' willingness to pay for owning, that is,

$$p^* = \frac{t}{1 - (1/n)} \theta_l < q \theta_l.$$

Optimal prices in proposition 1 imply that the seller may gain higher profits only when sharing is accommodated. This is because when sharing is deterred in the $Mass^S$ strategy, the seller has to price lower than in the benchmark; while in the *Niche* strategy, the seller prices the same as in the benchmark. We discuss in the following proposition 2 the conditions under which the seller is better off with the presence of consumers' sharing option.

Proposition 2: In the presence of consumers' sharing option ($n \geq 2$), the seller's profit increases when the seller accommodates sharing, and when the product's intrinsic value q is sufficiently high and the valuation heterogeneity θ is intermediate, that is,

$$q \geq \frac{(n-n\gamma + \gamma)t}{n-n\gamma + \gamma - 1} \quad \text{and} \quad \frac{\theta_h}{\theta_l} \in \left(\frac{n}{n - (n-1)\gamma}, \bar{\theta} \right].$$

Proposition 2 suggests that by accommodating sharing, the seller does not always gain a higher profit than in the absence of the sharing option. Accommodating sharing is profitable for (1) those products that low-valuation consumers could not otherwise afford, and (2) those products for which in the absence of the sharing option, the seller sells to the entire market with a strong cannibalization ef-

fect, that is, high-valuation consumers enjoy a significant surplus. Linking to real life examples, product categories such as boats and skiing equipment may fall into the above two cases.

Figure 2a depicts such a profit-enhancing region, and figure 2b shows the profit breakdowns from the two consumer segments for a given $q > q_{min}$. The seller is able to gain higher profits than in the absence of the sharing option, in two types of scenarios: (1) gaining additional profits by allowing low-valuation consumers, who would not otherwise be able to afford the product, to share, as marked by (1) in figure 2b; and (2) enhancing the profit earned from the exclusive-ownership consumers, as marked by (2) in figure 2b.

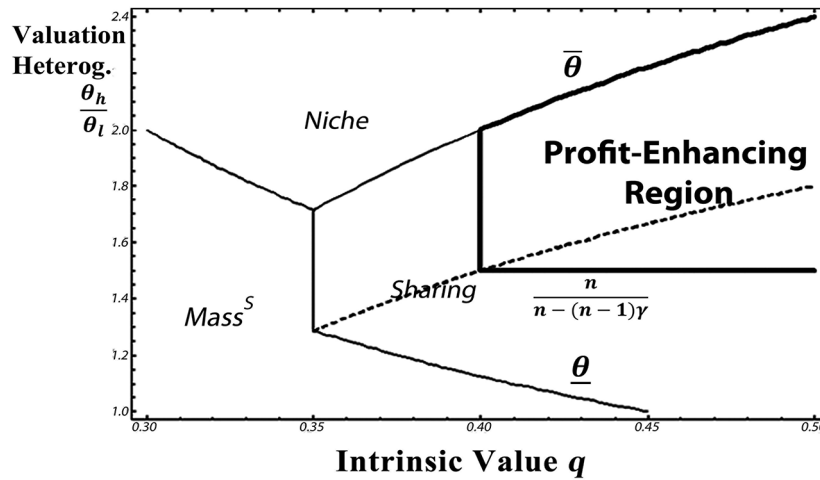
Recall that the seller accommodates sharing in an intermediate valuation heterogeneity $(\theta_h/\theta_l) \in (\underline{\theta}, \bar{\theta}]$. In an up-

per region $(\theta_h/\theta_l) \in (\theta^{BM}, \bar{\theta}]$, where it falls into the region of the *Niche* strategy in the benchmark case, the seller now accommodates sharing by charging the sharing group's willingness to pay. In this case, the price is lower than in the benchmark, where the seller serves only high-valuation consumers, that is, $p^* = (q-t)n\theta_l < p_{BM} = q\theta_h$, as illustrated by prices in figure 1b. Although gaining a lower profit from the existing (high-valuation) consumers, the seller gains additional profit from the sharing (low-valuation) consumers.

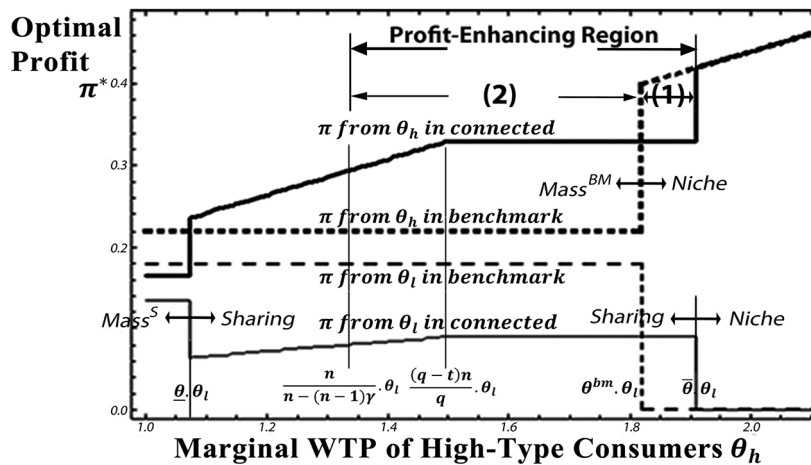
In an intermediate region

$$\frac{\theta_h}{\theta_l} \in \left(\frac{n}{n-(n-1)\gamma}, \theta^{BM} \right],$$

where it falls into the region of the *Mass^{BM}* strategy in the benchmark, because the sharing consumers' valuation is



(a) Seller's profit-enhancing region



(b) Seller's profit breakdowns

Figure 2. Seller's profit-enhancing region and profit breakdowns.

not too low, the seller now is able to price the product at the minimum of the sharing group's willingness to pay or the high-valuation consumers' willingness to pay, whichever is lower, that is, $p^* = \min[(q-t)n\theta_l, q\theta_h]$. In this case, the seller charges a price higher than that in the benchmark, where the seller serves both segments by offering a low price, that is, $p^* > p^{BM} = q\theta_l$, as illustrated by prices in figure 1b. Without the sharing option, the seller prices the product at the low-valuation consumers' valuation, $q\theta_l$, in order to motivate all consumers to buy one unit each. Hence, the high-valuation consumers enjoy a positive surplus without the sharing option. Such a profit loss from the high-valuation consumers (i.e., the cannibalization effect) is reduced in this case of sharing. That is, the seller's ability to profit from the high-valuation consumers is enhanced.

Accommodating sharing can also hurt the seller. This happens in a lower region,

$$\frac{\theta_h}{\theta_l} \in \left(\bar{\theta}, \frac{n}{n-(n-1)\gamma} \right],$$

because the profit reduction from the low-valuation consumers, who pay on average a low price by sharing in groups, dominates the enhanced profit from the high-valuation consumers, as illustrated in figure 2b.

3.2.2. Consumers' Access and Surplus. Peer-to-peer sharing has gained popularity among budget-conscious consumers, most of whom could not afford to purchase the product otherwise. It is reasonable to argue that peer-to-peer sharing enhances consumers' access to the product. Our study shows that, when taking into account the reactions of the seller and consumer heterogeneity, consumers' access may be enhanced or limited in the presence of sharing. Proposition 3 below summarizes our findings about how the sharing option impacts low-valuation consumers' access to the product.

Proposition 3: In the presence of the sharing option:

1. Low-valuation consumers' access first decreases then increases with the intrinsic value q ; and
2. Compared with no sharing, low-valuation consumers' access is improved only when q is sufficiently high.

Proposition 3 suggests that in the presence of sharing, low-valuation consumers' access to the product is most constrained for medium-value categories (around q_{min}) such as power tools, snow blowers, bikes, etc. This is due to the sell-

er's reaction in deterring or accommodating sharing. As discussed above, in the presence of the sharing option, the seller's incentive of serving only high-valuation consumers first increases then decreases as the intrinsic value increases. It consequently suggests that compared with no sharing, low-valuation consumers' access is improved only when the intrinsic value is sufficiently high. We explain below our intuition in more details.

As discussed above, the seller does not accommodate sharing when the intrinsic value q is sufficiently low, that is, the seller will choose to focus on either selling to the high-valuation segment or on enticing all consumers to buy the product, as illustrated in figure 1a for $q \leq q_{min}$. Nevertheless, the existence of an option to share limits the price that the seller is able to charge in the latter case. As shown in proposition 1, in order to deter sharing, the firm makes low-valuation consumers indifferent between sharing and ownership by charging a low price at

$$p^* = \frac{t}{1-(1/n)}\theta_l.$$

The indifference between two consumption modes also makes the product intrinsic value (relatively) irrelevant in the price that the firm is able to charge. In the benchmark, however, the firm is able to charge the price at the low-valuation consumers' utility from ownership, that is, $p_{BM} = q\theta_l$, which is increasing in q . Consequently, with a higher intrinsic value q , the higher is this price reduction, that is, the costs to deter sharing are higher. Hence, when the intrinsic value is sufficiently low, that is, $q \leq q_{min}$, with increasing q , it is more likely that the seller will choose to serve the high-valuation consumers only. As illustrated in figure 1a, the region of the *Niche* strategy enlarges with increasing q for $q \leq q_{min}$.³

For $q > q_{min}$, sharing is accommodated at intermediate valuation heterogeneities. Low-valuation consumers have access to the product (via sharing or owning) for $(\theta_h/\theta_l) \leq \bar{\theta}$. With increasing q , accommodating low-valuation consumers' sharing becomes more profitable than serving high-valuation consumers only, that is, $d\bar{\theta}/dq > 0$. With increasing q , the profitability in the *Sharing* strategy is growing faster than in the *Niche* strategy, because, in the former, the product is priced at the sharing group's willingness to pay. Hence, low-valuation consumers' access is minimized

3. Note that, if q is extremely low, i.e., $q \leq (t/n-1) + t$, sharing is not a viable option because it does not render a higher utility than owning, in which case the situation reduces to the benchmark case.

at an intermediate intrinsic value, that is, $q = q_{min}$. This suggests that, for products with intermediate intrinsic values, sharing may lessen the ability of low-valuation consumers to access the products because of sellers' reaction. It also suggests that, compared with the benchmark case, low-valuation consumers' access to the product is enhanced only when the intrinsic value q is sufficiently high.

The following proposition 4 characterizes the impact of sharing on consumer surplus and social welfare with a focus on the region where sharing is accommodated, that is, $(\theta_h/\theta_l) \in (\underline{\theta}, \bar{\theta}]$.⁴

Proposition 4: In the region where sharing is accommodated that is, $(\theta_h/\theta_l) \in (\underline{\theta}, \bar{\theta}]$, compared with no sharing,

1) High-valuation consumers gain a higher surplus in an upper region,

$$\frac{\theta_h}{\theta_l} \in \left(\max \left[\frac{1}{1-\gamma}, \frac{(q-t)n}{q} \right], \bar{\theta} \right]$$

2) Sharing consumers gain a higher surplus in a lower region,

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{(q-t)n}{q} \right]$$

3) Total consumer surplus is improved in an upper and a lower region,

$$\frac{\theta_h}{\theta_l} \in \left(\frac{1}{1-\gamma}, \bar{\theta} \right]$$

and

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{(q-t)\gamma + q(1-\gamma)}{q(1-\gamma) + (q/n)\gamma} \right]$$

and is reduced in an intermediate region,

$$\frac{\theta_h}{\theta_l} \in \left(\max \left[\underline{\theta}, \frac{(q-t)\gamma + q(1-\gamma)}{q(1-\gamma) + (q/n)\gamma} \right], \frac{1}{1-\gamma} \right]$$

4) The social welfare is improved for

$$\frac{\theta_h}{\theta_l} \in \left(\frac{1}{1-\gamma}, \bar{\theta} \right]$$

4. Proposition 6 in appendix A characterizes the consumer surplus and social welfare.

Proposition 4 suggests that, when sharing is accommodated, high-valuation consumers who purchase for exclusive ownership can be better or worse off. Particularly, high-valuation consumers gain a higher surplus by paying a price lower than that in the absence of the sharing option when the valuation heterogeneity is relatively high. They are worse off when the valuation heterogeneity is relatively low. Low-valuation consumers are never worse off. Linking to real life examples, our results imply that for products, such as boats (where the valuation heterogeneity is relatively high and in the absence of the sharing option, the price is set high such that only high-valuation consumers can afford), accommodating sharing can benefit all parties. On the other hand, for products, such as ordinary households appliances (where the valuation heterogeneity is relatively low and in the absence of the sharing option, the price is set low such that all consumers can afford), when sharing is accommodated, high-valuation consumers would be worse off.

Figure 3a illustrates the region in which each segment of consumers is better- or worse off with sharing. Figure 3b illustrates the change in total consumer surplus compared with no sharing. Details of consumer surplus of each segment can be found in proposition 6 in appendix A.

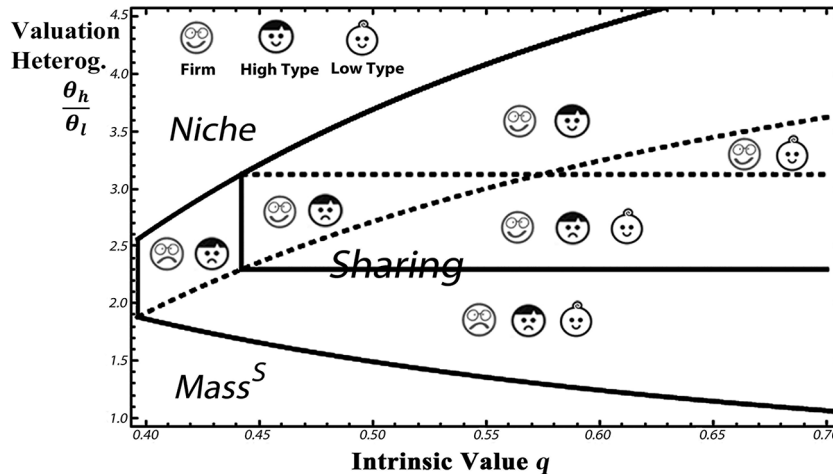
First, high-valuation consumers gain a higher surplus in an upper region

$$\frac{\theta_h}{\theta_l} \in \left(\max \left[\frac{1}{1-\gamma}, \frac{(q-t)n}{q} \right], \bar{\theta} \right]$$

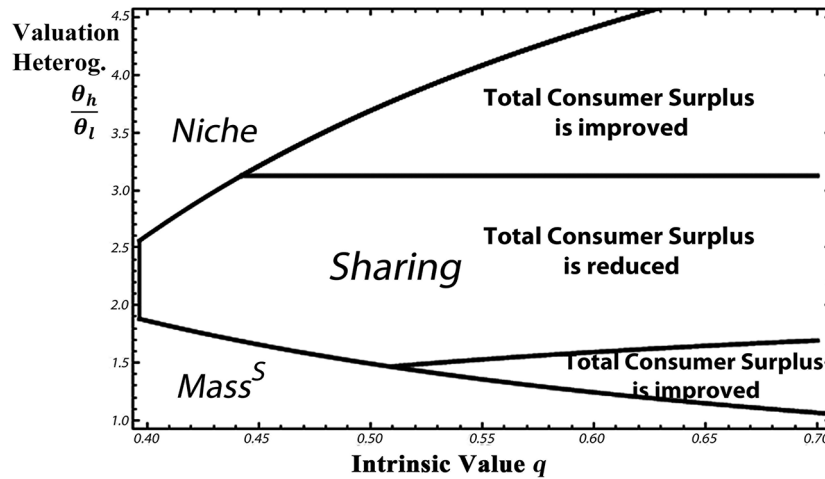
by paying a price (at sharing groups' willingness to pay for sharing) lower than the benchmark case. In the corresponding region in the benchmark, the sharing consumers can not afford to purchase, and high-valuation consumers gain zero surplus (i.e., *Niche* strategy). They are worse off in a lower region

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{1}{(1-\gamma)} \right]$$

by gaining zero surplus. In the corresponding region in the benchmark, all consumers can afford to purchase and high-valuation consumers gain a positive surplus by paying low-valuation consumers' willingness to pay (i.e., *Mass^{BM}*). Low-valuation consumers are never worse off, because they gain zero surplus in the benchmark in either strategy. When sharing is accommodated, they gain a higher (positive) surplus in a lower region



(a) Consumer surplus



(b) Total consumer surplus

Figure 3. Consumer surplus compared with no sharing.

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{(q-t)n}{q} \right]$$

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{(q-t)\gamma + q(1-\gamma)}{q(1-\gamma) + (q/n)\gamma} \right]$$

where they pay a price (at high-valuation consumers' willingness to pay for owning) lower than their willingness to pay for sharing.

The opposing impacts of consumer heterogeneity on the surplus of two consumer segments result in a nonlinear impact on total consumer surplus. Specifically, the total consumer surplus is improved in an upper region

$$\frac{\theta_h}{\theta_l} \in \left(\frac{1}{1-\gamma}, \bar{\theta} \right]$$

because of high-valuation consumers' surplus gain, as well as in a lower region

because of low-valuation consumers' surplus gain. In addition, because the seller is better off in an upper region, the total social welfare is improved in an upper region

$$\frac{\theta_h}{\theta_l} \in \left(\frac{1}{1-\gamma}, \bar{\theta} \right]$$

but is reduced in a lower region

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{1}{1-\gamma} \right]$$

In summary, in the upper region

$$\frac{\theta_h}{\theta_l} \in \left(\frac{1}{1-\gamma}, \bar{\theta} \right],$$

by accommodating sharing in a market where low-valuation consumers could not otherwise afford the product, the value due to connected consumers is significant because not only are the seller and the existing (high-valuation) consumers better off, but low-valuation consumers also gain access to the product. Hence, the introduction of sharing improves both the seller's profit and consumer surplus when the market is not yet saturated. Moreover, the improvement of social welfare is increasing in not only the number γ of sharing consumers, but also the product's intrinsic value q . In the middle region

$$\frac{\theta_h}{\theta_l} \in \left(\frac{1}{1-\gamma + (\gamma/n)}, \frac{1}{1-\gamma} \right],$$

high-valuation consumers become worse off, and their surplus flows to the seller and to the sharing consumers. In the lower region

$$\frac{\theta_h}{\theta_l} \in \left(\underline{\theta}, \frac{1}{1-\gamma + (\gamma/n)} \right],$$

both high-valuation consumers and the seller are worse off. Hence, if sharing is introduced into a market where all consumers can afford to buy the product, then either the seller or high-valuation consumers, or both, will be worse off.

3.2.3. Endogenous Quality. In this section, we study how the existence of sharing affects the seller's decision concerning product quality. The seller first decides on the optimal level of product quality q , by incurring a fixed cost, $K(q) = \frac{1}{2}kq^2$, followed by her pricing decision. We find that (1) for sufficiently low θ_h (relative to θ_l), the seller introduces a product of lower quality than in the benchmark, and (2) in an intermediate region of θ_h (relative to θ_l), the seller introduces a product of higher quality than in the benchmark.⁵ We discuss below the rationale.

In the benchmark case, it is intuitive that the optimal quality level q^{BM} is nondecreasing in consumers' valuation heterogeneity, θ_h/θ_l , because of the nondecreasing profit margin. In the presence of sharing, the optimal quality q^* is nonmonotonic in consumers' marginal willingness to

pay, as illustrated in figure 5 in appendix A. The existence of the sharing option impedes quality improvement if the valuation heterogeneity is low where sharing is deterred (i.e., *Mass*^s) or in a lower subregion of *Sharing*. It promotes quality enhancement when the valuation heterogeneity is intermediate, that is, an upper subregion of *Sharing*. In the following, we discuss the optimal quality level from the perspective of θ_h relative to θ_l because the conditions cannot be expressed simply as a function of θ_h/θ_l . Hence, the role of consumer heterogeneity is still relevant because it is a relative measure.

When the marginal willingness to pay θ_h is low, the seller chooses to deter sharing by offering a low price (lower than in the benchmark case) and selling to both segments. The low profit margin results in a low optimal quality level which is even lower than in the benchmark case.

When the marginal willingness to pay θ_h increases such that the seller chooses to accommodate sharing (whereas in the benchmark case, the seller still adopts the *Mass*^{BM} strategy), the seller is able to charge a higher price which increases with θ_h . The optimal quality level starts increasing with θ_h . When θ_h is sufficiently high, the optimal quality level is higher than in the benchmark case. Recall that, when θ_h is high enough, the optimal price increases to the level of the sharing groups' valuation, and becomes a constant. In this case, the optimal quality is the highest possible when sharing is accommodated, or can even be the highest in all possible strategies. When θ_h is sufficiently high, the seller adopts the *Niche* strategy and the optimal quality level drops to the same level as in the benchmark case.

This finding has some interesting implications. If sharing is introduced in markets where low-valuation consumers cannot afford the product otherwise or the heterogeneity is so strong that the high-valuation consumers enjoy a large surplus, the seller would provide a higher-quality product in the presence of sharing. On the other hand, in cases where the market is relatively homogeneous, the seller would set a lower quality level in the presence of sharing. This action is meant to hinder sharing among consumers together with a low price.

3.3. Extension: Endogenous Group Size

We assumed in the above sections that the size of sharing groups is exogenously given. However, sharing is a consumer-led initiative and users are also owners. In some cases, users have an influence on the size n of the sharing group. For example, sharing of household goods can be limited to acquaintances in the same neighborhood. We show in propo-

5. Details can be found in proposition 8 in appendix A.

sition 9 in appendix A that with endogenous group sizes, our key insights discussed above still hold. Below, we briefly discuss our additional insights.

First, when the size of sharing groups is endogenously chosen by consumers, it becomes extremely costly to hinder sharing by pricing low when the valuation heterogeneity is low. At low prices, consumers will form small groups to take advantage of a low inconvenience cost. Consequently, the seller has to charge a very low price in order to deter sharing. Hence, endogenous group sizes make deterring sharing an unprofitable strategy. Therefore, sharing can be accommodated even at very low intrinsic values. Recall that *Sharing* arises only if q is sufficiently high such that the price is high and the benefit of lowered consumption costs by sharing dominates.

Second, the possibility of accommodating sharing first decreases then increases with the intrinsic value q . As q increases, the profitability of both the *Niche* and *Sharing* strategies increases. However, at sufficiently low q , the impact of the inconvenience cost is significant and dominates the benefit of reduced consumption costs. Thus, the profitability under *Niche* increases faster than that under *Sharing* and, hence, the likelihood of accommodating sharing would decrease with increasing q at low values. At high values of q , the benefit of reduced consumption costs dominates and increases with q . Thus, the likelihood of accommodating sharing would increase with increasing q at high values.

3.4. Extension: Two Products

In this extension, we consider a situation where the firm has an option of introducing a low-end product to target the sharing consumers. Our results confirm our above major insights. That is, even in the presence of the option of introducing a low-end product to segment the market, the seller would accommodate sharing when the valuation heterogeneity is intermediate.

Our insights also extend. Peer-to-peer sharing can be accommodated in two ways, either by selling the existing product to both types of consumers or by introducing a low-end product to target the sharing consumers. Hence, we are interested in whether the presence of sharing would encourage or discourage the firm's incentive of product differentiation.

We find that the case where sharing and product differentiation coexist arises when the cost of producing the low-end product is sufficiently low and the valuation heterogeneity is intermediate. In some other cases, sharing discourages product differentiation, that is, the firm will use

the existing product for both exclusive ownership and consumer sharing. This situation arises when the intrinsic value of the high-end product is sufficiently high and the valuation heterogeneity is intermediate. When consumers can endogenously choose the group size, it is similar to the main model that the likelihood of accommodating sharing increases. Furthermore, endogenized group sizes may encourage product differentiation compared with the case of exogenous group sizes.

4. MANAGERIAL IMPLICATIONS AND CONCLUSIONS

The trend of sharing, rather than owning, goods profoundly affects consumers' life styles; exclusive ownership is no longer the ultimate expression of consumer desire (Marx 2011). However, academic research has not fully explored the implications of shared consumption for sellers and consumers. Building on previous conceptual and empirical work, we formalize the competition between the two consumption modes (sharing and owning), and show that the introduction of sharing may benefit or hurt the seller, and may benefit or hurt consumers who seek exclusive ownership. Our results provide the following managerial insights.

First, we show that the effort to introduce peer-to-peer sharing is more likely to be accommodated and endorsed by sellers for products with sufficiently high intrinsic values, and intermediate levels of valuation heterogeneity. Examples of such products are nonluxury cars, boats, snow blowers, and garden equipment. Prime sharing locations are mid- to large-sized cities where consumers have relatively diverse valuations. However, sharing is deterred (by pricing low) for products with lower intrinsic values or relatively homogeneous valuations, for example, party supplies and ordinary home appliances. Interestingly, the existence of sharing improves the seller's profit for products: (1) that low-valuation consumers could not otherwise afford, and (2) where consumer heterogeneity is so strong that the seller incurs a large profit loss from high-valuation consumers in order to serve the entire market.

Second, we show that, in the presence of the sharing option and when taking into account the reactions of the seller and consumer heterogeneity, low-valuation consumers' access to goods is most constrained for medium-value categories.

Third, consumers seeking exclusive ownership can be worse or better off when sharing is accommodated. We show that both the seller and consumers seeking exclusive ownership are better off when sharing is introduced and ac-

commodated markets where low-valuation consumers cannot otherwise afford the product. However, if sharing is introduced into a market where all consumers can afford to buy the product, then either the seller or the existing (high-valuation) consumers, or both, will be worse off. In particular, when valuation heterogeneity is intermediate, the seller can benefit from accommodating sharing at the expense of consumers seeking exclusive ownership. When valuation heterogeneity is low, both the seller and consumers seeking exclusive ownership will be worse off. Hence, proponents of peer-to-peer sharing should be careful if they plan to promote such programs, especially if sharing is introduced into a market where all consumers can afford to purchase the product individually and consumer heterogeneity is low-to-intermediate. The initiative will either fail to emerge because of the seller's reaction (by significantly lowering the price) or it will hurt social welfare by rendering both the seller and the existing consumers worse off. Proponents of sharing should also be careful to avoid medium-value categories. Because of the seller's reaction, low-valuation consumers' access to these goods will become more limited compared with no sharing.

Fourth, we show that, in the presence of sharing, when the product's intrinsic value is endogenously chosen by the seller, it can be enhanced or reduced, compared with the benchmark case. In particular, product quality can be highest when sharing is introduced in markets where the sharing consumers cannot otherwise afford to purchase the product.

Our article is also subject to limitations that suggest promising avenues for future research. First, researchers could study how the presence of sharing might encourage or discourage firms' product differentiation in order to serve lower-valuation consumers. Second, sellers can offer sharing as a service by either owning the goods or by connecting existing owners with those seeking temporary access, in addition to selling the goods. Examples include Daimler Benz's Car2Go, BMW's DriveNow, Volkswagen's Quicar, and Peugeot's Mu (Belk 2014). Third, the substitutability between sharing and ownership can be partial because of the symbolic value of owning an object, different object-self relationships, and the endogenous impact of inconvenience on consumers' usage. In particular, the perceived intrinsic value will differ under the two consumption modes if a product is highly personalized or customized. Fourth, it would also be interesting to evaluate the impact of peer-to-peer sharing on the environment. Some studies on car-sharing suggest that the number of cars sold may de-

crease with the existence of consumer sharing. However, sharing may also increase a given product's utilization level. Finally, the sharing option may reduce the seller's incentive to build durability into a product's design. All these aspects warrant future study.

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