Chapter 10
Buyer Valuation Uncertainty and Firm Information Provision Strategies

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Abstract This chapter reviews research on buyer valuation uncertainty originated from information asymmetry between the firm and consumers, and the firm's information provision strategy. Before purchase, consumers could be uncertain about the product's vertical attributes, i.e., quality uncertainty, and/or the product's horizontal attributes, i.e., fit uncertainty. For each type of uncertainty, we discuss the firm's inventive and instruments to disclose information, as well as other mechanisms to reveal information that help consumers resolve such valuation uncertainty. We then review recent literature on advance selling and opaque selling strategies, where the firm benefits from creating consumer valuation uncertainty. We conclude the chapter with discussions on future research directions.

Key words: buyer valuation uncertainty, information provision, quality disclosure, fit revelation, information asymmetry

10.1 Overview

Consumers are commonly uncertain about the value of a product prior to purchase and such valuation uncertainty impedes their purchase intentions. Endowed with more product information, firms may have incentive to disclose such information to help resolve consumer valuation uncertainty originated from information asymmetry. In this chapter, we review research works that investigate motivations and consequences of firms' information provision activities.

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A product can be viewed as a collection of vertical and horizontal attributes. Vertical attributes, such as material and craftsmanship, constitute the product's quality, which can be measured and compared on a one-dimensional scale. Consumers have homogeneous preferences for product vertical quality in the sense that they all derive a greater consumption value from a higher quality product, despite their different willing to pay for the quality premium. For example, consumers are likely to agree that a flute made with superior material and craftsmanship has a high value, but not everyone accepts its hefty price tag. The homogeneous nature of consumer quality preferences leads consumer valuations of a product to *converge* upon firm disclosure of the product's vertical attributes. In particular, disclosure of a product quality higher (lower) than expected shifts all consumers' product valuations upward (downward). As such, a firm that offers a higher product quality has stronger incentive to disclose vertical attributes of its product. Moreover, since quality can be measured and compared on a scale universally agreed upon, an individual consumer can learn about a product's vertical quality from other consumers' product experiences. In recent years, the growing prevalence of online review platforms has greatly alleviated consumer quality uncertainty.

While early research has mainly focused on issues related to disclosure of product vertical attributes, recent research has focused on issues related to disclosure of product horizontal attributes has flourished. Horizontal attributes, such as color and flavor, differentiate products even when they have the same quality. Consumers have heterogeneous preferences for product horizontal attributes in the sense that they are endowed with heterogeneous tastes, which lead to their different "fit" with a product. For example, some consumers like red color, whereas some others like green; similarly, some consumers like sweet flavor, whereas some others like spicy flavor. A product that provides a good fit or a high value for some consumers may be perceived as offering a "bad fit" or a low value for other consumers. This heterogeneous nature of product fit preferences leads consumer valuations of a product *diverge* upon firm disclosure of the product's horizontal attributes, posing a sharp contrast to the consequence of firm disclosure of a product's vertical attributes.

Moreover, note that a consumer's perceived product fit is specific to the individual consumer as well as the particular product. While the consumer perceives fit uncertainty because of her lack of information on product horizontal attributes, the firm also perceives uncertainty about how its product fits the consumer, owing to its lack of information on the consumer's taste. When the firm discloses horizontal attributes of its product, the former type of fit uncertainty perceived by the consumer is resolved, but the latter type of fit uncertainty perceived by the firm remains. That is, disclosing product horizontal attributes actually puts the firm at an information disadvantage, which suppresses its disclosure incentive. Another implication of the idiosyncratic nature of product fit is that knowing other people's fit with a product does not necessarily help a consumer evaluate her own product fit. The helpfulness of third-party reviews in resolving consumer fit uncertainty is thus limited, providing firms' opportunities to manipulate consumers' fit search via marketing tools. These complexities about consumer fit uncertainty add to the richness of this research area,

which has drawn attention of scholars in the field of economics, marketing, operations management, and information systems as well.

Our review focuses on buyer valuation uncertainty that originated from information asymmetry between consumers and profit-maximizing firms. This can be mitigated through various information provision activities of the firm. A product's value may be subject to factors beyond the firm's knowledge or control. For example, a highly rated refrigerator may arrive with a defect after a rough delivery; a well-planned vacation may be ruined by unexpected weather conditions. In these cases, consumer valuation uncertainty remains despite the firm's full information disclosure, and can be mitigated though warranty, insurance, or compensation policies (e.g., Chen et al, 2009; Png and Wang, 2010). In some institutional purchase contexts where the firm and the buyer co-create customized products such as production equipment, architecture design, or software systems, valuation uncertainty arises when the buyer is unable to articulate their needs *ex ante* and can be mitigated via the adoption of interactive communication tools (e.g., Terwiesch and Loch, 2004). Our discussion does not cover this type of consumer uncertainties.

In the following, we first review earlier research related to firm disclosure of product's vertical attributes and then move on to review more recent research related to firm disclosure of product horizontal attributes. We then discuss the literature on firm's advance selling and opaque selling strategies, which create consumer valuation uncertainty by withholding product information. We conclude this chapter with discussions on future research directions.

10.2 Firm Disclosure of Product Vertical Attributes

The issue of consumer quality uncertainty has caught research attention since the 70's. Akerlof (1970) considers less developed markets where truthful, credible disclosure is prohibitively expensive and concludes that all sellers would misrepresent quality. Milgrom (2008) and Dranove and Jin (2010) provide excellent reviews of early economic literature on quality disclosure and certification. Our discussion focuses on business contexts where information on product quality can be truthfully and credibly communicated to end customers. We review three major streams in this type of literature. The first stream investigates a firm's incentive to disclose product quality in various market structures. The second stream of literature examines direct and indirect instruments for quality disclosure. And the third stream of literature empirically investigates issues related to vertical quality disclosure.

10.2.1 Firm Incentive to Disclose Product Quality

(a) Monopoly Market. Grossman (1981) considers a model where a monopolistic seller knows the true quality of its product and can claim either the exact quality

level (full disclosure), or a range of its product quality that can be verified *ex post* at negligible cost. Examples of quality statements verifiable *ex post* at negligible cost include "*the seller is selling boxes of oranges... states that there are ten oranges in a box*" and "*the seller states that the diamond weighs one ounce*." In this market, if the seller claims a quality range, consumers with rational expectations will assume that the product's true quality is the lowest of the given range. The monopolist, anticipating this, makes a full disclosure in equilibrium, that is, to disclose the exact quality level of its product. Grossman and Hart (1980) and Milgrom (1981) obtain similar results in the context of takeover bids.

Jovanovic (1982) considers a different setup where a seller does not know its product's true quality, but observes a private signal drawn from a distribution with its mean being the true quality. For example, the true quality of a used car can be the average quality of all of the car's components, and the private signal the seller observes is how these components function on his particular driving habit. The seller can withhold the private signal, or disclose the signal truthfully and credibly to the buyer after incurring a cost. In this market, disclosure can happen only if the cost of doing so is not too high, and the seller that observes a higher quality signal has a stronger incentive to disclose.

(b) Competitive Market. Guo and Zhao (2009) considers a duopoly market where the seller knows the true quality of its product, but not the true quality of its rival's product. A higher disclosure cost shifts the threshold for quality disclosure toward the high end, and consequently elates consumers' expectation on a product's quality when no vertical attribute information of the product are disclosed. This effect suppresses the incentive of a high-quality seller to disclose quality. Moreover, competition reduces sellers' expected benefits from quality disclosure, further inhibiting their disclosing incentive. While Guo and Zhao (2009) assumes that each firm does not know its rival's product quality, Board (2009) obtains similar results that competition inhibits firms' incentive to disclose quality information under the assumption that firms know each other's product quality.

Kuksov and Lin (2010) consider a duopoly market where consumers *ex ante* are not only uncertain about the quality of competitive products, but uncertain about their quality preferences, or how much they are willing to pay for a quality premium. While the former type of uncertainty is specific to the product, the latter type is specific to the consumer. Each firm endogenously chooses the quality level of its product. A firm then decides whether to disclose the quality of its own product, and whether to provide information that helps consumers find their quality preferences that apply to both products. The study shows that in equilibrium, the two firms differentiate in their product quality levels as well as the type of information they provide. In particular, the high-quality firm is more likely to disclose its product's quality and the low-quality firm is more likely to provide information that helps consumers to find their quality preferences. Extending Kuksov and Lin (2010), Lin and Pazgal (2016) considers the case when exogenously determined product quality enter the consumer market sequentially. The study shows that the first entrant always discloses its product quality. A late entrant with a superior product may choose not

to inform consumers of its better quality, but instead provide information to help consumers to find their quality preferences. On the other hand, a late entrant offering an inferior product may wish to admit so.

(c) Distribution Channel. Guo (2009) considers a distribution channel where a manufacturer sells its product through a retailer under the wholesale price contract. Both channel members know the true quality of the product. The manufacturer can disclose the quality directly to end customers (e.g., through national advertising), or leave to the retailer to decide whether to disclose (e.g., through free samples and returns, sales assistance, in-store media). The study shows that more information is revealed under retailer disclosure than under manufacturer disclosure. This is because the manufacturer can, through wholesale price cuts, partially absorb the retailer's effective disclosure cost, which elevates the retailer's disclosing incentive.

Guan and Chen (2017) considers a similar channel structure and examines the case when the monopolistic manufacturer has private information about its product quality, but has less information about the consumer's quality preferences than the retailer has. The study shows that the manufacturer's decisions to disclose information on its product quality and to acquire information on consumers' quality preferences interact, and together influence the retailer's rational inference about the product quality level and channel relationship.

10.2.2 Firm Instruments to Disclose Product Quality

Studies that investigate firm incentive to disclose quality commonly assume that such information can be fully and truthfully communicated to end consumers. In contrast, studies on firm's instruments to disclose quality typically consider a more realistic setting where quality cannot be fully disclosed through direct communication. In this case, various signaling mechanisms such as pricing, uninformative advertising, warranty, and money-back guarantee can be leveraged to help consumers differentiate a high-quality product from the low-quality one.

Starting with the pioneering work of Nelson (1974), a large body of literature has examined how price and conspicuous advertising can help firms signal product quality to imperfectly informed consumers (e.g., Kihlstrom and Riordan, 1984; Milgrom and Roberts, 1986; Bagwell and Riordan, 1991; Linnemer, 2002). Warranty has also been recognized as an effective quality signal since it is very costly for low-quality firms to mimic the terms offered by high-quality firms (e.g., Spence, 1977; Cooper and Ross, 1985; Gal-Or, 1989). Besides serving as a quality signal, warranty can also be used to sort consumers based on their heterogeneous risk preferences (Kubo, 1986), provide protection against product failures (Heal, 1977; Courville and Hausman, 1979; Menezes and Currim, 1992; Padmanabhan and Rao, 1993), or incentivize the seller to improve product quality (Prosser, 1943). These four functions of warranty are summarized in Emons (1989) and later empirically tested in Chu and Chintagunta (2011). A related literature stream examines design and profitability of

extended service contracts offered by retailers and/or manufacturers beyond the basic warranty (e.g., Lutz and Padmanabhan, 1995; Padmanabhan, 1995; Chen et al, 2009; Jiang and Zhang, 2011).

Moorthy and Srinivasan (1995) considers a market where consumers are uncertain about whether the seller is of high or low quality, and demonstrates that a high-quality seller can effectively use money-back guarantee as a quality signal supplemental to other quality signals such as price or uninformative advertising. The superiority of money-back guarantee over other quality signals resides in its high cost to the low-quality seller, which inhibits the low-quality seller from mimicking the high-quality seller's strategy.

Bhardwaj et al (2008) considers a context where a firm discloses its product's vertical attributes to end consumers through a salesperson, but the limited bandwidth in sales communication only allows the salesperson to transmit a subset of all vertical attributes. The focal research question concerns the format of sales communication: should the firm choose the attributes to show to consumers (i.e., seller-initiated communication) or should it let consumers choose which attributes they want to see (i.e., buyer-initiated communication)? While seller-initiated communication grants the firm more control over quality disclosure, buyer-initiated communication credibly signals that the firm has nothing to hide, or that the product has a high quality.

Mayzlin and Shin (2011) examines a context where a firm discloses its product's vertical attributes to end consumers through advertising, which is nonetheless ineffective at disclosing all vertical attributes. Consumers may conduct a costly search for the true product quality, and the extent of search is endogenously determined by the content of advertising. The focal research question concerns the format of advertising: Should the firm use informative advertising that emphasizes product vertical attributes or uninformative advertising that makes vague claims (or no claims) about product vertical attributes? Compared to informative advertising, uninformative advertising motivates consumers to search for the true quality themselves, thus leading to a more accurate quality valuation *ex ante*. A high-quality firm, thus, has a stronger incentive than a low-quality firm to invite consumer search through uninformative advertising. As such, uninformative advertising, when coupled with consumer search, can be used by a monopolistic firm to signal its high quality.

10.2.3 Empirical Research on Firm Quality Disclosing Strategies

Early empirical research on firm quality disclosing strategies focuses on testing the signaling effect of uninformative advertising. Tellis and Fornell (1988) uses PIMS (Profit Impact of Market Strategies) dataset to examine how advertising spending affects product quality measured with the difference between the sales percentage of products superior to those of the rivals and products inferior to. Caves and Greene (1996) and Moorthy and Zhao (2000) construct brand quality measurement using Consumer Reports survey and examine how brands' advertising spending affects their quality scores. Similar investigations were conducted by Thomas et al (1998)

by using data from the US automobile industry and Horstmann and MacDonald (2003) by using data from compact disc players industry. Some researchers use experiments to investigate how manipulated conditions of advertising spending affects participants' perceived product quality (e.g., Kirmani and Wright, 1989; Kirmani, 1990; Moorthy and Hawkins, 2005). Animesh et al (2010) tests the advertising-quality relationship by using the online paid search advertising data (e.g., Animesh et al, 2010).

Recent empirical research has focused on examining quality uncertainty in online markets. A product sold online can be viewed as a bundle of the core product (i.e., the product's physical attributes) and the extended product (i.e., service provided by the online seller), and quality uncertainty can arise from either. While theoretical studies typically treat the bundled product as a whole, empirical research has tried to distinguish the two sources of quality uncertainty. In online markets, consumer uncertainties about the vertical attributes of the core product often come from the difficulty for the seller to describe the product's physical attributes. This uncertainty is more severe for used goods, whose wearing conditions can vary significantly. Using data from the motor vehicle industry and the computer industry, Heiman and Muller (1996) shows that the number and the length of product demonstration affect product acceptance by mitigating consumers' perceived product quality uncertainty.

Consumer quality uncertainties about the extended product concern two roles the seller fulfills: providing product information and delivering products. Prior to purchase, consumers are likely to be uncertain about the vertical quality of the seller, particularly for unfamiliar ones, such as whether the seller would intentionally misrepresent the product to increase sales or whether the seller will deliver the wrong product due to negligence or incompetence. In online markets, such uncertainty is exacerbated, because buyers are unable to infer seller characteristics by observing social cues from personal interactions or body language (Gefen et al, 2003). On the other hand, the online market provides opportunities to mitigate seller quality uncertainty through information systems such as online feedback ratings (e.g., Ba and Pavlou, 2002; Dellarocas, 2003), user-generated textual comments (e.g., Ghose and Ipeirotis, 2011; Pavlou and Dimoka, 2006), third-party escrows (e.g., Pavlou and Gefen, 2004), and product diagnostic tools (Jiang, 2007).

Some researchers compare the effect of quality uncertainty in the core product and the extended product. Ghose (2009) examines used goods trading data in multiple product categories and shows that both seller-related (e.g., seller characteristics) and product-related (e.g., condition of used cars) quality uncertainty lead to adverse selection, which does not completely disappear even with mechanisms such as seller reputation feedback and product quality disclosure. Dimoka et al (2012) examines auction data on used cars and shows that, compared to seller-related quality uncertainty, product-related quality uncertainty has more adverse effect on price premium. The study also shows that both types of uncertainties can be reduced by IT-enabled solutions such as diagnostic product descriptions and third-party product assurances.

10.3 Firm Strategy to Disclose Product Horizontal Attributes

Lewis and Sappington (1994) is one of the earliest works that recognize the heterogeneous consumer valuations for product horizontal attributes and investigate firm's incentive to help consumers to learn their idiosyncratic fit with a product. Research on firm strategies to disclose product's horizontal attributes has developed rapidly in recent years accompanying the growing popularity of online third-party reviews. It is generally believed that it has effectively alleviated consumers' uncertainty about quality. The efficacy of online reviews in resolving consumers' quality uncertainty resides in consumers' homogeneous preferences for product quality, which allows different consumers to measure and compare quality on a scale universally agreed upon. A consumer can conveniently infer a product's quality level from its "valence score" or average review rating. Moreover, the "valence score," as a numerical quality indicator, is easy to understand and process, which encourages consumer usage of the score. In contrast, consumers' heterogeneous preferences for a product's horizontal attributes make it difficult for an individual to infer her own fit from others' perceived fit. As such, consumer fit uncertainty persists despite the presence of third-party reviews. Moreover, compared to product vertical attributes such as material and craftsmanship, product horizontal attributes such as color and style are often hard to describe or quantify, making such information hard to communicate. Commonly, a personal inspection is necessary to find out the consumer's true fit with a product.

Below we review three main streams of this literature. The first stream examines a firm's incentive to disclose fit-revealing information in various market structures. The second stream of literature investigates direct and indirect instruments that help disclose product horizontal attributes. Finally, the third stream of literature empirically explores issues related to firms' fit-revealing strategies.

10.3.1 Firm Incentive to Disclose Product Horizontal Attributes

(a) Monopolistic Market. Lewis and Sappington (1994) considers a model where consumers are *ex ante* identical in their expected valuations on a monopolistic firm's product, and knowledge of product horizontal attributes leads to differentiation in consumer product evaluations. Disclosing product horizontal attributes creates "targeting" opportunities for the firm, allowing it to sell to a segment of the market at a price higher than the average valuation. Nonetheless, the firm has to abandon the segment of market with below-than-average valuations. This tension between pursuing a higher margin or a larger demand is at the core of the firm's incentive to disclose product horizontal attributes. The firm's optimal strategy is either not to providie any information, which ensures the full advantage of the demand-oriented strategy, or to provide full information, which ensures the full advantage of the margin-oriented strategy. Johnson and Myatt (2006) models differentiation in consumers' product valuations as the result of a rotation of the demand curve, which

can be induced by marketing mix variables such as advertising and product design. Echoing Lewis and Sappington (1994), the study shows that a monopolistic firm obtains maximized profit when differentiation in consumers' product valuations is either very high to facilitate an effective margin-oriented niche strategy, or very low to facilitate an effective demand-oriented mass-market strategy.

Bar-Issac et al (2010) deviates from Lewis and Sappington (1994) and Johnson and Myatt (2006) by considering a market where consumers are *ex ante* heterogeneous in their expected valuations of a monopolistic firm's product, with one consumer segment exhibiting consistently higher willingness to pay for the same fit level, than the other consumer segment. Prior to purchase, consumers find their true fit with the product through a costly inspection, and the firm can manipulate the inspection cost to induce inspection by none, some, or all consumers. The study shows that an intermediate information disclosure strategy can be optimal. It would induce only consumers with low willingness to pay to inspect, but not those with high willingness to pay. That is, the intermediate information disclosure strategy is used as a non-price means to discriminate between different consumer types. Bhargava and Chen (2012) considers a similar setup where *ex ante* the smaller consumer segment has consistently higher willingness to pay for the same product fit level than the larger segment. The firm can disclose information on its product's horizontal attributes, which allow all consumers to find their fit with the product, or withhold such information, which will leave all consumers' fit uncertain. The study shows that full disclosure is profitable when consumer heterogeneity in willingness to pay *ex ante* is moderate, but non-disclosure is profitable when such heterogeneity is very low or very high. Lahiri and Dey (2018) considers versioning as a way to disclose product fit information in the context of information goods. The study shows that if a fraction of consumers is fully aware of their true valuations *ex ante*, information provision through versioning can be more profitable than keeping consumers in the dark.

Chen and Xie (2008) considers a monopolistic firm's strategy to offer either partial or full information on product horizontal attributes when consumers never buy with null fit information and can acquire additional attribute information from third-party reviews. The study assumes the existence of a segment of novice consumers who can only process information provided by third-party reviews but not information provided by the seller, and shows that the availability of third-party reviews may reverse the firm's optimal disclosure strategy. In particular, without third-party reviews, a firm with a low production cost enjoys a high margin and has incentive to pursue a demand-oriented strategy by disclosing only partial information. Third-party reviews, however, forces the firm to switch to a margin-oriented strategy and disclose full information. On the other hand, without third-party reviews, a firm with a high product cost pursues a margin-oriented strategy by disclosing full information. Third-party reviews, however, help inform novice customers, which allows the firm to switch to a demand-oriented strategy and disclose only partial information.

Sun (2011) models a product as containing both vertical and horizontal attributes and examines how a monopolistic firm's fit disclosure strategy is moderated by its product quality level. The study shows that when the product quality level is high,

the firm enjoys a high margin and optimally pursues a demand-oriented strategy through non-disclosure. On the other hand, when the product quality level is low, the firm collects a low margin and optimally pursues a margin-oriented strategy through full disclosure. Anderson and Renault (2013) obtains similar results in a market where consumers are uncertain about a product's quality and price, in addition to being uncertain about the product's horizontal attributes.

A set of research studies examines the sustainability of fit disclosure as a perfect Bayesian equilibrium outcome in an incomplete information game. Anderson and Renault (2006) considers a model where consumers are uncertain about not only the horizontal attributes, but the price of a monopolistic seller's product, and shows the firm should never fully disclose the product's horizontal attributes without disclosing its price. Koessler and Renault (2012) considers a general modeling framework where the monopolistic firm has perfect and private information about the product's attributes, which can be vertical and horizontal, and the single buyer has perfect and private information about her own taste. Their study shows that full disclosure is always an equilibrium when product and consumer types are independently distributed. Çelik (2014) characterizes conditions under which a monopoly seller fully reveals the location of its product on the consumer preference spectrum when an individual consumer's preference is privately known only to herself.

(b) Competitive Market. In a competitive market, disclosing product horizontal attributes allows a firm to create product differentiation from its competitor, which alleviates price competition. Firms that occupy different competitive status demonstrate different incentives to disclose product horizontal information. Anderson and Renault (2009) considers two competing firms that offer two products differentiated in both vertical and horizontal attributes. Consumers have full knowledge about the two products' quality and price, but are uncertain about their fit with either product. A firm can advertise its own products' horizontal attributes to end customers, and can also disclose its rival's horizontal attributes through comparative advertising. A key finding is that when the quality difference between the two products is large, the high-quality firm never discloses any information; the low-quality firm does not disclose either, if comparative advertising is banned, but otherwise will disclose the fit information about its own product as well as that of the rival product.

Gu and Xie (2013) also considers a setting where consumers face the choice between two competing products with differentiated vertical quality, as well as differentiated horizontal attributes. A consumer's perceived fits with the two products are independent. A firm can help resolve consumers' fit uncertainty regarding its own product through costly marketing activities (e.g., offering free samples or proving free trials), but such activities do not help resolve consumer fit uncertainty regarding the other product. A key finding is that the firm offering the high-quality product implements fit-revealing activities with greater intensity than its low-quality rival, if both products' qualities are sufficiently high and their quality difference is small. This result poses an interesting contrast to the finding in the monopolistic market where the low-quality firm has a stronger incentive to disclose fit. Jing (2016) considers a model where consumers have knowledge about the quality as well as price

of two competing products, but can only find their fit with the product through a costly inspection. Each firm determines the level of customer learning investments (CLI), and a higher investment induces more consumers to inspect its product prior to purchase. In a fully covered market, the firm that makes a larger CLI enjoys a higher demand as well as a higher price. Echoing Gu and Xie (2013), the study shows in equilibrium the firm with a greater relative production efficiency invests more in CLI to facilitate customer fit search.

Boleslavsky et al (2017) models competition between an innovative firm that offers a new product with unknown horizontal attributes and an established firm that offers a product for which the consumers have full information. The result shows that the innovative firm benefits from fully disclosing horizontal attributes of its product through demonstration to resolve consumer fit uncertainty if pricing policy is flexible, but partial disclosure is optimal if the price decision has to be made prior to the demonstration decision.

(c) Distribution Channel. Hao and Tan (2017) considers a vertical channel composed of a supplier and a retailer and demonstrates that the format of channel contract affects channel members' fit-disclosing incentive. Under the agency pricing contract, the revenue sharing mechanism leads the supplier to benefit from more fit disclosure but the retailer to suffer from it. On the other hand, under the wholesale pricing contract, potential misalignment of channel members' interests regarding fit disclosure disappears, if the demand is linear. If the demand is log-concave and derived from common valuation distributions like normal or logistic distributions, however, misalignment reappears, with the retailer benefiting and the supplier suffering from more fit disclosure.

10.3.2 Firm Instruments to Disclose Product Horizontal Attributes

Studies that investigate firm incentive to disclose product horizontal attributes typically focus on disclosure instruments implemented by manufactures, such as advertising and sampling. In business reality, retailers that carry an array of horizontally differentiated products can leverage various instruments to manipulate consumers' fit knowledge *ex ante*. As such, the literature on fit disclosure instruments has merged into the retailing literature.

(a) Disclosing Product Horizontal Attributes Through In-Store Sales Communication. Wernerfelt (1994) considers a model where a seller offers two products with differentiated horizontal attributes to a fit-uncertain buyer and shows that a knowledgeable salesperson can effectively and truthfully match the customer with the product that suits her needs through a "dialogue" or an interactive communication with the buyer. Ofek et al (2011) finds that a monopolistic retailer that sells through both online and offline channels offers less sales assistance in its offline store to match consumers with suitable products, than in the case it operates only an offline channel, because the existence of the online store reduces consumer traf-

fic to the physical store. In a competitive market, however, a dual channel retailer may offer more in-store sales assistance than a pure offline retailer to combat competition. Gu and Liu (2018) extends Wernerfelt (1994) and models a retailer that sells through a salesperson to end consumers two horizontally differentiated products offered by two competing manufacturers. The study shows that the retailer has incentive to demotivate its salesperson from advising consumers, if the effectiveness of such sales advising is too high or too low in helping consumers learn their true fit with products.

(b) Disclosing Product Horizontal Attributes Through Manipulating Consumer In-Store Fit Search Gu and Liu (2013) considers a retailer that sells horizontally differentiated products offered by competing upstream manufacturers and examines the retailer's optimal in-store display decision: whether to display competing products in the same location so that consumers can inspect multiple choice alternatives all at once, or display them in distant locations so that consumers have to inspect one product first and then decide whether to incur a travel cost to inspect another product. The study finds that the former display format is more profitable for product categories with overall high fit probability (e.g., home appliances), whereas the latter display format is more profitable for product categories with overall low fit probability (e.g., apparel).

Branco et al (2016) models how consumers evaluate their fit with a product offered by a monopolistic seller through a sequential search on the products' multiple attributes. Consumers check one attribute at a time after incurring a search cost, learn about the attribute on which the seller provides information, and then decides whether to check more attributes or make a choice decision without further search. The seller decides on which attributes to provide information, but does not know the order of consumers' attribute searches. The study shows that the seller's optimal strategy is to provide information on an intermediate number of attributes. Providing too much information makes the search less informative, and providing too little information makes consumers believe there is less positive information about the product; both strategies will deter consumer search and lower seller profit.

Gu and Tayi (2017) considers a retailer that operates both an online and an offline store and aims at maximizing the omni-channel profit. The retailer carries horizontally differentiated products, and decides whether to sell the products through both channels, or through the online channel only. Through an in-store inspection, consumers learn about their fit with the product offered at the store offline, and make inferences about their fit with the product offered through the online store only. The study shows it can be profitable for the retailer to offer the full assortment through the online store, but only partial assortment through the offline store, and that the retailer benefits more from selling higher-quality or higher-demand products through the online store only.

(c) Mitigating Fit Uncertainty Through Product Return Policy. When consumers have difficulty evaluating their fit with a product prior to purchase, retailers often use product return policies to mitigate fit uncertainty. Davis et al (1995) demonstrates that money back guarantee can be used to reduce the perceived risk

of fit-uncertainty consumers and enhance their willingness to pay. As opposed to the warranty, money back guarantee allows consumers to return a product for a full refund, even if the product has no quality defect. Shulman et al (2009) indicates that a higher restocking fee will reduce fit-uncertain consumers' purchase intention and a firm in devising the optimal level of restocking fee should consider this impact in addition to the recouping cost associated with product returns. Heiman et al (2001) shows that money back guarantee and demonstrations can be complements or substitutes in revealing product horizontal attributes.

Gu and Tayi (2015) examines a pure online seller's optimal return policy in a context where consumers, uncertain about their fit with a product *ex ante* if finding a misfit after purchase, can choose between making a costly return or self-mending to assure a proper fit. The study shows that an online retailer can benefit from tightening the return policy and maintaining a reasonable return cost for consumers, because such a policy motivates consumers to self-mend a misfit product and consequently eases the firm from the burden of handling returns. Moreover, accompanying the tighter return policy, the firm charges a lower price, which can enhance consumer surplus.

Shulman et al (2015) considers a model where a consumer's perceived *ex post* utility of a product is reference-dependent on a consumer's *ex ante* expectation and makes product return decisions based on the perceived *ex post* utility, rather than the true product value. In this case, *ex ante* fit uncertainty leads to consumers with true high product valuations to form low *ex ante* expectations, which elevates their perceived *ex post* utilities and reduces their return tendency. On the other hand, pre-purchase fit disclosure increases these consumers' *ex ante* expectation and may increase product returns. These theoretical insights are further supported by controlled behavioral experiments as well as econometric analysis of archival data.

(d) Revelation of Product Horizontal Attributes Through Third-Party Reviews. While the valence score of third-party reviews reveals product vertical quality, the text content of reviews often provides useful information about a product's horizontal attributes. As such, research that investigates the impact of third-party reviews in revealing product horizontal attributes typically also considers the impact of such reviews in revealing the product quality. Kwark et al (2014) considers a distribution channel where two competing manufacturers sell through a common retailer, and shows that reviews that disclose products' horizontal attributes by enhancing product differentiation soften manufacturer competition and hurt the retailer. On the other hand, reviews that disclose products' qualities by reducing product differentiation, intensify manufacturer competition and benefit the retailer. Extending this work, Kwark et al (2017) further shows that a retailer can benefit from third-party reviews on product horizontal attributes by adopting the commission scheme, and can benefit from third-party reviews on product vertical attributes by adopting the wholesale pricing scheme, rather than the commission scheme.

Jiang and Guo (2015) examines a monopolistic firm's optimal design of a review system. Hosting a review system facilitates disclosure of product vertical attributes, which is optimal when the product quality is sufficiently high. Moreover,

offering "granular reports" that review specific product attributes facilitates disclosure of product horizontal attributes, which is profitable when misfit significantly reduces in a consumer's willingness to pay. Loginova and Mantovani (2015) examines competing firms' incentive to join an online review aggregator's website (e.g., tripadvisor.com), which expands consumer demand by reducing fit uncertainty but intensifies price competition.

Li (2017) considers a monopolistic online seller that offers two products differentiated in both vertical and horizontal attributes. The menu page shows the list of products, and a consumer has to click a link to go to an individual product's page, where detailed third-party reviews are displayed and consumers can learn both vertical and horizontal attributes of the product. The focal question is whether the online seller should show the products' aggregated valence score in the menu page to disclose product quality before consumers check individual products. The result shows that not showing the quality score can be optimal when consumers have highly heterogeneous preferences for the low-quality product's horizontal attributes.

10.3.3 Empirical Research on Firm Strategy to Mitigate Consumer Fit Uncertainty

Empirical research has generally supported the theoretical predictions that consumer fit uncertainty adversely affects firm profit and that firms' fit disclosing strategies help alleviate such a problem. A stream of research examines how consumers' fit uncertainty affects their purchase intentions. In an empirical study of hundreds of product categories, Kim and Krishnan (2015) show that consumer fit uncertainty inhibits online purchase of higher-priced products, and that accumulated online shopping experience will encourage consumers to purchase more of the cheaper products. The study also shows that online sellers can mitigate consumer fit uncertainty using technology such as digitized video commercials. Using a series of randomized field experiments, Gallino and Moreno (2018) shows that offering virtual fit information in online apparel retail increases conversion, basket sizes, average price of purchased products, and revisits to the site, and also reduces fulfillment costs related to returns and home try-ons. These benefits are more pronounced for products that are more expensive or available in more sizes. Moreover, virtual fitting technology increases customer engagement and loyalty, resulting in a spillover effect for products beyond those available for virtual fitting. Ball et al (2018) uses quasi-experimental methods to assess the effect of opening showrooms for a business that operates as an online-only business. The result shows that opening showrooms has a positive impact on the overall demand, and results in spillovers between the online and the offline channels. This finding is consistent with the notion that offline channels are more effective at providing product fit information than online channels (e.g., Lal and Sarvary, 1999).

Another stream of empirical research examines the impact of consumer fit uncertainty on product returns. Consumers who buy a product under *ex ante* fit un-

certainty are likely to make a return if finding a misfit *ex post*, which causes a return handling cost for the firm. Using consumer survey data from eBay, Hong and Pavlou (2014) shows that product fit uncertainty has more adverse effect on product returns than product quality uncertainty. The study also shows online product forums are more helpful in alleviating product fit uncertainty, whereas website media on product pages are more effective in mitigating product quality uncertainty, and both activities reduce product returns. Using a transaction level dataset, Sahoo et al (2017) demonstrates that the availability of product reviews online leads to higher sales and fewer product returns.

Some empirical studies find that a firm's effort to provide information on product horizontal attributes can have a negative impact on that firm's profit. Jain et al (1995) shows that sampling might have a negative impact on the firm's profit, if the firm cannot control the type and number of consumers who receive samples. Bawa and Shoemaker (2004) points out that offering samples may cannibalize the sales of products with low repurchase rate. Shulman et al (2015) demonstrates, with both theory and field experiments, that fit revealing information provided before the purchase can actually increase decision reversals. Arora et al (2017) shows that the practice of offering free versions of paid apps is negatively associated with adoption speed of apps, and the association is stronger for hedonic apps and in the later life stages of paid apps. This result is consistent with the literature that offering free versions of information goods is suboptimal (Bhargava and Choudhary, 2001, 2008; Jones and Mendelson, 2011), especially when consumer uncertainty is high and price is low (Lahiri and Dey, 2013).

10.4 Firm Strategy to Create Consumer Valuation Uncertainty

While the information disclosure literature focuses on incentive and consequences of firm activities that help resolve consumer valuation uncertainty, related literature on advance/opaque/probabilistic selling examines incentives and consequences of firm's activities that create consumer valuation uncertainty in product transactions. These two streams of literature can be viewed as two sides of the same coin that address the same question: How much product information the firm would like its consumers to have prior to purchase?

Shugan and Xie (2000) and Xie and Shugan (2001) study advance selling strategies, under which a firm sells its product in advance of actual time of consumption. When consumers' utilities from a product or service (such as air travel, hotels, and cruises) depend on their idiosyncratic consumption state such as mood, health, and personal work schedule, the separation between the (advance) time of purchase and the time of consumption results in consumer valuation uncertainty at the purchase time. Because of such uncertainty, consumers make their purchase decisions in the advance period based on their expected valuations, which tend to be more homogeneous. In contrast, their valuations become more heterogeneous at a later time period after their idiosyncratic consumption states are realized, which makes it harder for

the firm that lacks capability of conducting direct price discrimination to extract consumer surplus. The key insight that more information leads to heterogeneous consumer preferences is consistent with Lewis and Sappington (1994) and the literature on firm's strategy to disclose product horizontal attributes ever since. In a more recent study, Yu et al (2015) examines the effects of interdependent consumer valuations and seller's capacity on the firm's advance selling decisions.

While advance selling is essentially a pricing strategy that takes advantage of consumers' valuation uncertainty in the advance time, opaque selling and probabilistic selling add uncertainty to consumer valuations by withholding product information. Under opaque selling, one or more product attributes are deliberately hidden from the buyer until payment has been made. Under probabilistic selling, a firm creates a "virtual" product or service, i.e., a probabilistic good that offers consumers a probability of getting any one of a set of multiple distinct items (Fay and Xie, 2008, 2010, 2015; Fay et al, 2015). While the potential choice set is well defined under probabilistic selling (five identical shirts that only differ in color), it may not be as clear under opaque selling (a 3-star hotel in San Francisco downtown district). Theoretically, these two concepts are similar and sometimes indistinguishable in the literature (Huang and Yu, 2014); we will treat these two terms interchangeable in our discussion.

Under opaque selling, the undisclosed attributes introduce an element of "damaged goods" to the opaque product, which allows the firm to segment the market based on consumers' tolerance level for uncertainty. In many markets, consumers differ in their tolerance level towards product uncertainty. For example, when shopping for hotel rooms, business travelers are likely to have specific location requirements and thus favor hotels with known addresses (i.e., the transparent product) despite its high price, whereas leisure travelers are likely to be more flexible in location choices and thus favor hotels with addresses undisclosed (i.e., the opaque product) as long as the price is sufficiently low. Offering a hotel room with hidden location thus allows the intermediary to price discriminate between buyers with little tolerance for uncertainty and hence low price sensitivity (e.g., business travelers) and those with high tolerance of uncertainty and hence high price sensitivity (e.g., leisure travelers). This strategy was first introduced by online travel agencies (e.g., Priceline and Hotwire) for selling leftover capacity for airlines and hotels and has gained popularity among consumers and service providers (Post and Spann, 2012).

Jiang (2007) and Fay (2008) examine the incentive for a monopoly firm to sell opaque or probabilistic goods. Shapiro and Shi (2008) shows that the ability to price discriminate allows a firm to profit from offering an opaque product, even in a competitive market where the opaque feature virtually erases product differentiation and thus intensifies competition. Fay (2008) considers a setting where two firms use a common intermediary to sell the opaque product and find that an opaque product magnifies price competition, if there is little brand-loyalty in an industry, and curtails price competition, if there is significant brand-loyalty in the industry. Another motivation for firms to adopt opaque selling is that it helps reduce supply–demand mismatches, especially in industries with little flexibility in supply, e.g., airline, hotel, and car rental industries. Gallego and Phillips (2004) examines the optimal design

of a probabilistic product to balance the benefit of increasing overall demand and enabling better capacity utilization at the cost of potentially cannibalizing high-fare demand for specific products. Jerath et al (2010) considers an opaque intermediary who sells last-minute capacity for competing providers facing stochastic demand for the aggregate market. Chen et al (2014) compares posted-price and Name-Your-Own-Price (NYOP) as two pricing mechanisms to dispose of excess inventory in an opaque distribution channel. In this stream of research, the leftover inventory in the opaque channel is subject to the demand shock in the direct channel, which adds another layer of availability uncertainty to the opaque product. Huang et al (2017) highlights the impact of inventory and time on equilibrium prices, expected profit, and channel strategy in the presence of an opaque channel. Cai et al (2013) considers a retailer's strategy of mixing products from competing suppliers to generate a probabilistic good and shows that introducing the probabilistic good is beneficial for the channel members. Additional benefits of opaque selling include softening price competition (Shapiro and Shi, 2008). Recently, Huang and Yu (2014) shows that opaque selling may soften price competition and increase the industry profits as a result of consumer bounded rationality, providing a behavioral rational for opaque selling.

Whereas most of the opaque selling literature focuses on withholding horizontal attributes, a growing body of literature examines opaque selling with vertically differentiated products. Biyalogorsky et al (2005) considers the airline industry where some firms offer tickets that can be upgraded to higher-class, depending on the availability of higher-class products at the service delivery time, and characterize conditions under which such strategy is profitable. Zhang et al (2015) shows that probabilistic selling in quality-differentiated markets can be profitable by disposing excess capacity, even when quality levels are endogenously determined. Halbheer et al (2018) shows that deliberately randomizing service quality can benefit the provider and society because heterogeneity in customer damages from service failures allows the provider to profit from selling damage prevention services or offering compensation to high-damage customers.

10.5 Future Research Directions

In recent years, researchers' focal interest has shifted from issues related to quality disclosure to issues related to fit revelation. This shift is partially driven by the prevalence of third-party reviews online. Nevertheless, quality uncertainty for services remains a challenge. Moreover, compared to quality uncertainty, consumer fit uncertainty appears to be a much richer construct, determined not only by a product's horizontal attributes known to the firm, but also consumers' idiosyncratic tastes privately known to themselves. Such complexities of consumer fit uncertainty provides abundant research opportunities.

10.5.1 Service Quality Uncertainty

Consumers' quality uncertainty about a standardized product or service can be effectively mitigated when they learn about the product/service's vertical attributes from the seller or other consumers. Interestingly, quality uncertainty remains a concern for professional services such as car repair, real estate sales, and health care. Consumers' needs for professional services are often highly idiosyncratic, causing high variation in both service procedure and outcome. For example, among patients with the same disease, some may have pre-existing conditions that interfere with the treatment. In addition, the completion of a professional service typically involves not only the service provider, but the customer and sometimes third-party players who could potentially bring more shocks to the service quality. For example, not every patient follows the doctor's advice closely, and a dentist's service quality may depend on which nurse is assisting. Moreover, the complexity of professional services often makes it difficult for consumers to evaluate a service's true quality and consumers may form false quality perception based on cosmetic aspects of the service process. For example, a consumer may believe a car repair service is of high quality because of a free car wash, or believe a dentist provides high quality service because of her pleasant attitude. In a recent work, Liu et al (2017) shows that it is inappropriate to interpret reviews for professional services the same way as reviews for commodity. Moreover, deadweight loss in social welfare can occur if the service provider is allowed to select customers to ensure favorable reviews. Future research can investigate mechanisms that facilitate disclosure of product quality in the professional service context.

10.5.2 Uncertainty in Consumer Fit Preferences

While consumers always prefer a higher product vertical quality, their preferences for a product's horizontal attributes may be context-dependent and time-variant. For example, a consumer's preference for fashion products may well depend on her mood. Even if the firm discloses its product's horizontal attributes prior to purchase, the consumer may still find a misfit after purchase due to changes in her mood. This instability of consumer fit preference is more pronounced for hedonic products than for utilitarian products. Moreover, consumers may be unaware of their true preferences for product horizontal attributes at the point of purchase. For instance, when booking a vacation package to Amazon rainforest, a consumer knows that a package that offers more events is of better value. Having never visited a rainforest, however, the consumer may have trouble evaluating which events she is likely to enjoy. Reading descriptions and reviews beforehand cannot fully eliminate pleasant surprises or disappointments. This uncertainty in consumers' preferences for product horizontal attributes is more severe for experience products than for search goods. In these cases, disclosing product horizontal attributes cannot fully resolve consumer fit uncertainty. Firms may use interactive communication tools to learn about consumers

and predict their future preferences. Firms may also adopt new technologies such as virtual reality to help consumers learn about their own tastes. Gu and Tayi (2015) considers a firm's strategy to offer a product that can be customized after purchase to ensure a proper fit. Alptekinoğlu and Ramachandran (2018) examines a dynamic model where consumer preferences may change across time periods and identifies conditions under which offering a consumer-customizable product is more valuable than offering a portfolio of standard products. We encourage future research to explore innovative marketing tools that can be used to alleviate consumer uncertainty on fit preferences.

10.5.3 Interactions Between a Firm's Fit Disclosure Strategy and Other Strategic Decisions

Consumers' knowledge about product attributes changes their information set and may thus affect how they respond to firm strategies on distribution channel, advertising, product line design, etc. Deng et al (2017) shows that a firm's strategy to disclose product horizontal attributes can be complementary or substitutable with advertising and can also be influenced by the firm's quality provision decision. We encourage future research that explores interactions between information revelation and other marketing mix strategies.

The wide adoption of online social media platforms encourage consumers to seek information from their social connections in evaluating a product's fit. For instance, when shopping for vacation packages, consumers are likely to pay more attention to recommendations from their friends than anonymous reviews on Tripadvisor.com. As such, the structural properties of consumer social network can impact consumers' *ex ante* product valuations. Fainmesser et al (2018) considers a two-period model where first-period consumers learn about product fit through advertising and second-period consumers learn about product fit through first-period buyers' product reviews. The study shows that the firm has a greater incentive to advertise in the first period when the social connections between the first and the second period consumers exhibit greater homophily. We encourage future research on how a firm can leverage the power of social media to assist consumers' fit search.

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