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Fuzzy products

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ABSTRACT

A fuzzy product (FP) has characteristics specified only imprecisely at time of sale. Building fuzziness into its product gives a firm flexibility to exploit favorable supply opportunities that arise between sale and delivery, and so reduce expected costs. While increased competition reduces price, the effect on fuzziness is ambiguous. Socially-optimal fuzziness is characterized. Firms provide goods that are too fuzzy compared to first-best, though entry serves to correct this inefficiency for certain types of goods. Considering competition with a niche good, a FP sells for a lower price, although it captures a larger market share and is more profitable.

1. Introduction

In many markets goods are traded that are only "fuzzily" defined at the moment of purchase—a consumer has imperfect information about some characteristic of the good, with this characteristic only realized after purchase. While the study of *experience goods* is not new, in certain cases a firm may want to deliberately leave some characteristics of a good less than precisely defined *ex-ante* and only define such characteristics *ex-post*, after sale but before delivery.[3] This gives a firm the ability to exploit favorable supply conditions that arise between sale and delivery. In essence, a firm may wish to sell a *lottery* over product characteristics.

To capture this, we (1) introduce the notion of a fuzzy product (FP), and (2) develop a theoretical model to understand the role of product fuzziness in firms' product design decisions. We define a FP as a good or service that (a) is traded in a market (i.e., not something individually contracted between a firm and a buyer) and (b) whose *horizontal* characteristics are imprecisely defined at the moment of sale. Before considering real-world examples, it may be useful to consider an abstract example to make the structure of a FP clear and frame the real world examples. Consider a product that can take on one of three different characteristics: a, b, and c. An example of a FP is then $\{a, c\}$. A consumer can buy a FP in the market today with the understanding that tomorrow they will receive a good of either variety a or variety c. The variety delivered will depend on whichever variety turns out to be cheapest before delivery.

Example 1. *When a condominium is bought "off plan" builders routinely make adjustments during construction. The buyer is entitled to a home of agreed square-footage on a particular lot, but within that envelope the builder has much flexibility. In a default building contract in the state of Florida, for example, "[t]he builder retains the option to re-site the home on the lot, reverse the floor plan, modify room dimensions or exterior elevations, change amenities, substitute appliances and other buyer selections, and add to, modify or delete community features and facilities."* (Bowie, 2014, *para. 3*).

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[3] This paper does *not* offer a model of experience goods in the usual sense; the distribution of characteristics is known to the buyer before purchase. Models of experience goods typically assume that the seller has perfect (or at least better) information regarding these characteristics and the resulting asymmetry of information causes incentive problems which have been much studied (e.g., Akerlof, 1970). In our paper, the characteristics of the good that is finally delivered are not known by either buyer or seller until after the transaction. Both buyers and sellers do, however, have rational prior distributions over them. Further those prior distributions coincide (there is at no asymmetry of information between buyer and seller).

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Example 2. *Home-delivered organic fruit and vegetable boxes have become popular in many cities. Suppliers offer to send a seasonally appropriate mixture of produce, determined week to week according to what is in good supply in the local market. This means that " … you don't know what you'll get each week and you might end up with veg you've never heard of (or know you don't like) let alone know how to cook."* (Blackmore, 2013, *para. 4*).

Example 3. *Package holidays bundle tickets, hotel nights, tours and other elements but " … tour operators not only allow themselves the right to alter flight times but can also change your hotels, resorts, itinerary and the airport from which you're flying. And that's after your holiday is booked and paid for."* (Butler, 2012, *para. 2*). *The article goes on to observe that the most frequent adjustments are to flight times and departure airports, resulting from " … an operator trying to cut costs through 'consolidation', the term used when passengers on two planes flying to the same destination and departing on the same day, are put on a single flight." In addition, travel operators increasingly sell packages—particularly for discount and last minute bookings—that explicitly leave unspecified the resort, hotel or other details but simply constrain it within broad parameters (3 star, Majorca, family-oriented resort, accommodation allocated on arrival).*

Example 4. *When subscribing to a magazine, the reader knows the general topic of the publication, such as "sports" or "baseball," but the content of any particular issue is only known after delivery. A reader purchasing a baseball magazine knows that the articles within will be about baseball, but for which teams or players the articles relate are not known at the time of subscription. Certain magazines also have a broader scope than others; a sports magazine covers a broader range of stories than a baseball magazine. A sports magazine may have an article about baseball, but a baseball magazine will have one for sure.*

In each example the supplier leaves some "wiggle room" by defining inexactly what characteristics the delivered product will embody. This fuzziness allows the supplier to adjust what is actually delivered in a way that minimizes cost. In each example, a consumer purchasing a FP is purchasing a lottery over the horizontal characteristics of a good. In the context of a model of horizontal product differentiation, an ice cream vendor chooses a neighborhood of the beach to place his stand, selecting the cheapest location in that neighborhood to setup on any particular day.

In defining a FP, we restrict attention to variety over characteristics that are horizontal rather than vertical in nature. When discussing a FP we are not talking about variants that are generically "better" or "worse" than one another. While this distinction is not strictly necessary, the rationale is twofold. First, horizontal characteristics seem more interesting. The four examples given all relate to *horizontal* characteristics where quality is held fixed. In Example 2, the vegetable box may end up containing aubergine or may end up containing squash. One is not better or worse than the other – they are simply different – and there is no particular reason to suppose consumers will disproportionately favor one over the other.[4] In Example 3, the hotels are of the same quality but differ horizontally – for example by being located at different parts of a holiday island – between which consumers' preferred types can be expected to vary. Second, there is already a literature that considers contracting over quality. The interest here lies in contracting over variety and abstracting from quality allows for a sharper focus on this point.[5]

The literature on moral hazard and quality in bilateral contracts (e.g., Allen and Lueck, 1995; Baiman et al., 2000) is related but distinct to the analysis here. We envision the contract as defined over variety, not quality, and firms do not face a moral hazard problem. The incentive for a firm to deliver a particular variety is aligned for certain types of consumers. Similarly, the literature on experience goods is concerned with asymmetric information, either moral hazard (Riordan, 1986; Bagwell and Riordan, 1991) or adverse selection (Akerlof, 1970). While a FP shares a key feature with an experience good – the consumer only learns the product's type *after* purchase – the incentive for a firm to minimize cost does not affect consumers uniformly. Simply, there is no asymmetry of information with a FP: the firm is in effect selling a lottery over variety, and the consumer is willingly purchasing this lottery. The literature on "confusopoly," both theoretical (e.g., Gabaix and Laibson, 2006; Chioveanu and Zhou, 2013) and empirical (e.g., Simmons and Lynch, 1991; Brown et al., 2010), is again related but distinct. Agents here have no bounded rationality and there is no scope for a firm to confuse consumers with complex products, or to hide product characteristics. The terms of the lottery that is on sale are equally and fully understood by both buyer and seller. Lastly, with respect to product differentiation, the model here can be seen as a generalization of the standard model of horizontal product differentiation (e.g., Salop, 1979) but with a product being defined by an interval rather than a point.

With respect to results, firms charge a mark-up over marginal cost, with prices as strategic complements. Product fuzziness, however, can be either a strategic substitute or complement, depending on the type of good. For goods where a firm directly incurs the cost of production (e.g., the vegetable box example), fuzziness is a strategic complement, whereas for firms that contract supply (e.g., a magazine), fuzziness is a strategic substitute. The competitive equilibrium features products that are fuzzier than socially optimal, although increased competition can increase product fuzziness if price is sufficiently responsive to competition for goods that behave as strategic substitutes in fuzziness. Otherwise competition reduces product fuzziness. Niche products (those that are precisely defined) command a higher price than fuzzy products, but account for a smaller share of the market and are less profitable.

The remainder of the paper proceeds as follows: Section 2 presents the basic model; Section 3 gives normative results; Section 4 provides a number of extension; Section 5 concludes.

2. Basic model

2.1. Products

Consider a good that can be one of a number of horizontally-differentiated types. While different varieties of a good can be of different quality (e.g., both horizontally and vertically differentiated), the model here treats variety as purely horizontal. The product characteristic space $V \in \mathbb{R}^2$ is the circumference of a circle with diameter $1/\pi$. The circumference of a circle was pioneered by Salop (1979) as a space within which to analyze product differentiation and is commonly used by economists to model variety.

[4] To capture this in the model we endow consumers with horizontally-differentiated preferences but assume them to be uniformly distributed over ideal points. In the binary setting here this amounts to an assumption that half of consumers prefer aubergines, half prefer squash. This seems a natural assumption.

[5] A haircut is an example of something that is *not* a FP. When purchasing a haircut, the cut received is (presumably) "centered" on the consumer's preferred specification. Barbers, however, vary in the precision with which they move their scissors so the resulting cut is noisy around the consumer's preferred specification. But the amount of noise is clearly a measure of *vertical* quality: a higher quality barber takes more care and delivers a haircut that is (probabilistically) closer to that desired.
Note that for a FP to make sense in a vertical setting, it must be possible that the *ex-post* cost of production for a high quality variant is lower than the cost for a low quality variant. Otherwise the model reduces to one of contracting over quality.