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The market value for product attribute improvements under price personalization[☆]

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ABSTRACT

Personalization of the marketing mix is a topic of much interest to marketing academics and practitioners. Using discrete choice demand theory, we investigate the aggregate market value for product attribute improvements when firms are engaged in personalized pricing. Our results provide a theoretically grounded rule for how to aggregate consumer valuations to assess the overall profitability of attribute improvements under price personalization. Under common pricing, each consumer contributes the same margin. Profitability of an attribute improvement is thus driven by inducing more consumers to buy. Consumers with high choice probabilities are given less weight in the market valuation under common pricing as they are less responsive to attribute improvements. Under personalized pricing, profitability of an attribute improvement is driven by extraction of consumer surplus from high valuation consumers. Consumers with higher valuations, and consequently higher choice probabilities, are given more weight in the market valuation under personalized pricing. Since individual consumers play a more central role in the market valuation under personalized pricing, estimation of consumer-level valuations is of increased importance. Under common pricing, the market valuation for an attribute improvement is robust to extreme estimates of the consumer-level valuations. Through our theoretical and empirical analyses, we demonstrate that this robustness does not hold under personalized pricing.

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1. Introduction

New product development is crucial to sustained firm performance. Companies that fail to develop new products risk being supplanted by more nimble competitors responding to shifts in consumer demand. While new companies often focus on creating disruptive technologies that alter the competitive landscape, most new product development activity focuses on incremental innovation devoted to improving existing products. For example, at Sony, over three quarters of new product activity is dedicated to improving existing products (Kotler & Keller, 2006). Bayus (1994) notes the existence of a similar pattern across a range of industries (Abernathy & Utterback, 1978) as well as evidence that incremental innovation is more crucial to profitability than breakthrough technology (Gomory, 1989). While new product development is undeniably important, it is also risky. Some studies suggest a failure rate of 95% in the U.S. (Kotler & Keller, 2006). To improve the odds of success, product managers must carefully assess how consumers value product attribute improvements and, importantly, how to aggregate consumer valuations into a market-level valuation useful for product planning decisions.

From the perspective of an individual consumer, the value for a product attribute improvement is typically defined as the change in price that would keep consumer utility constant given the attribute improvement (Train, 2003). Appealing to discrete-choice theory of

consumer and firm behavior, Ofek and Srinivasan (2002) derive a market-level analog to this consumer-level valuation termed the market value for an attribute improvement (MVAI). MVAI can be compared to the marginal cost of the attribute improvement, providing product managers with guidance in assessing the overall profitability of the improvement. However, the Ofek and Srinivasan (2002) derivation of MVAI assumes that firms charges a common price to all consumers. In contrast to a homogenous pricing policy, the notion of personalized pricing is of great appeal to both marketing academics and managers (Fay, Mitra, & Wang, 2009). A stream of research in the marketing literature has considered the personalization of the marketing mix from both an empirical and theoretical perspective (Chen & Iyer, 2002; Choudhary, Ghose, Mukhopadhyay, & Rajan, 2005; Heilman, Kaefer, & Ramenofsky, 2003; Khan, Lewis, & Singh, 2009; Knox & Eliashberg, 2009; Liu & Zhang, 2006; Rossi, McCulloch, & Allenby, 1996; Shaffer & Zhang, 2002). Firms from the apparel, airline, bank issued credit-card, and enterprise software industries have engaged in personalized pricing (Choudhary et al., 2005; Montgomery & Smith, 2009; Shaffer & Zhang, 2002). In light of academic and practitioner attention to the topic of personalized pricing, it is interesting to consider whether and how price personalization affects the market value for product attribute improvements.¹

¹ Rather than focusing on the normative question of whether or not firms should engage in price personalization, we adopt a positive point of view to understand the implications of engaging in one-to-one price personalization for estimates of the market value for a product attribute improvement.

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The main contribution of this paper is to derive the market value for product attribute improvements when firms are engaged in price personalization. Our results generalize the MVAI measure for common pricing and provide managerial guidance on product planning decisions under personalized pricing. Similar to Ofek and Srinivasan's (2002) analysis of MVAI under common pricing, we obtain closed form expressions for MVAI under personalized pricing in the context of the widely used multinomial logit demand model. However, two important differences in MVAI under common versus personalized pricing emerge from our analysis. First, under common pricing, every consumer contributes the same margin. Incremental profitability from an attribute improvement is thus driven by inducing more consumers to purchase. Consumers with extreme choice probabilities are given less weight in the aggregate market valuation as these consumers are less responsive to attribute changes. In contrast, under personalized pricing, the profitability of an attribute improvement is driven by the extraction of surplus from consumers with higher valuations and, consequently, higher choice probabilities. Under personalized pricing, consumers with high choice probabilities are given greater weight in the market valuation. The first difference between market-level valuations under common and personalized pricing (i.e., which consumers matter more for the aggregate market valuation) relates to the second difference. As individual consumers matter more under personalized pricing, extreme consumer-level valuations have a greater impact in this setting. Unlike the case of common pricing, computing MVAI under personalized pricing requires more careful attention to the estimation of the consumer-level valuations, a point underscored by the results of our empirical application.

Choice models specified with additive linear utility imply that the consumer-level valuation for an attribute improvement is identified as the ratio of the estimated attribute and price coefficients (Train, 2003). With a heterogeneous model, the distribution of consumer-level valuations is specified indirectly as a ratio of random coefficients. Such an identification strategy may yield distributions of the valuations that lack finite moments (Daly, Hess, & Train, 2012). Even if finite moments are assured, the distribution may be prone to yield extreme estimates (Meijer & Rouwendal, 2006; Ofek & Srinivasan, 2002). Alternatively, the valuations can be directly identified in the choice model likelihood which avoids ratio estimation and its associated problems (Cameron & James, 1987; Jedidi, Jagpal, & Manchanda, 2003; Sonnier, Ainslie, & Otter, 2007). An interesting and important property of MVAI under common pricing is its robustness to extreme consumer valuations (Ofek & Srinivasan, 2002) which renders the estimation of the consumer-level valuations less important. Our results demonstrate that robustness to outliers is not a general property of the MVAI measure and does not hold under personalized pricing. Using Ofek and Srinivasan's (2002) data set on stated preferences for portable camera mounts we empirically investigate the MVAI under personalized pricing. Computing MVAI under personalized pricing with ratio estimates of the consumer-level valuations suggests that nearly every attribute improvement is profitable for any product. In contrast, using consumer-level valuations that are directly identified and less prone to extreme estimates to compute MVAI under personalized pricing yields estimates that are smaller in magnitude and suggest a smaller subset of profitable attribute improvements.

The remainder of the paper is organized as follows. We begin with a discussion of personalized pricing to motivate the study of product planning decisions under one-to-one pricing. We then review the derivation of the market valuation for an attribute improvement under common pricing and extend the derivation to the case of one-to-one price personalization. In doing so, we also consider the intermediate case of a discrete segment-based price discrimination strategy. We then discuss discrete choice demand models and the specification of consumer-level valuations used to compute the market-level valuation under personalized pricing. Our empirical application follows. The final section summarizes and concludes.

2. Personalized pricing in marketing

The marketing literature has discussed numerous examples of personalized marketing in both consumer and business-to-business markets. Choudhary et al. (2005) discuss examples of firms in the enterprise software industry, such as IBM, Hewlett-Packard, and Sun Microsystems, that use personalized pricing discounts for products of the same quality. In consumer markets, information technology has enabled firms to develop rich databases of consumer information giving firms the ability to reach individual consumers and personalize the marketing mix. Direct marketing firms such as Land's End and L.L. Bean use promotional discounts to tailor prices to individual households (Shaffer & Zhang, 2002). Firms in the bank issued credit card industry, such as Wells Fargo, engage in price personalization through personalized discounts on card fees (Choudhary et al., 2005). The consulting firm Accenture offers clients a personalized pricing tool to assist in implementing a one-to-one price promotion program.² A CNN.com report details price variation across consumers for the same product in a variety of online product categories, including airline tickets, digital cameras, and personal computers.³ The online data provision company Lexis-Nexis sells to different consumers at different prices (Ghose & Huang, 2009). Even when met initially with consumer resistance, firms such as Amazon continue to find innovative ways to implement personalized pricing, such as the Gold Box (Choudhary et al., 2005).

A challenge in implementing a personalized pricing strategy is that firms must obtain consumer willingness-to-pay for the products in the competitive set. Fay et al. (2009) consider conditions under which firms invest in technology to solicit preferences from consumers at the point of purchase versus technology that allows the firm to infer preferences based on past observations. Wertenbroch and Skiera (2002) discuss different methods for determining consumer valuations, or willingness-to-pay, in market research. These methods include Vickery auctions, the Becker-DeGroot-Marshak (BDM) elicitation procedure, and discrete choice models applied to either stated preference data or market transaction data. Cameron and James (1987), Jedidi et al. (2003), and Ofek and Srinivasan (2002) use discrete choice models to estimate consumer valuations for product attributes. Most empirical applications of personalized marketing also utilize discrete choice models (Ansari & Mela, 2003; Khan et al., 2009; Knox & Eliashberg, 2009; Rossi et al., 1996; Zhang & Krishnamurthi, 2004; Zhang & Wedel, 2009). An advantage of using discrete choice models is that with an attribute based utility function (Fader & Hardie, 1996), the valuation for the product can easily be decomposed into the valuations for the product attributes. Furthermore, if the valuations can be linked to consumer characteristics, such as demographics or purchase history, the model can be used to impute the valuations for new consumers conditional on the characteristics enhancing the firm's ability to implement a personalized pricing strategy (Rossi et al., 1996).

In considering the question of whether and how the firm's pricing strategy affects the market value for product attribute improvements it is natural to address the problem from the perspective of firms selling direct to consumers. Shaffer and Zhang (2002) study one-to-one promotions among competing direct marketing firms. Chen and Iyer (2002) study competition among firms that offer personalized prices assuming that firms have an imperfect ability to reach consumers. Choudhary et al. (2005) consider how price personalization in a duopoly impacts firm choices over product quality. It is important to note, though, that selling through a retailer does not preclude the

² Accenture.com, http://www.accenture.com/NR/rdonlyres/6EFFD307-3CBE-40AE-B1929F7FADCS776/0/personalized_pricing_tool.pdf, retrieved on Dec 12, 2009.

³ CNN.com, <http://www.cnn.com/2005/LAW/06/24/ramasastry.website.prices/>, retrieved on Dec 12, 2009.

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