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The impact of household level heterogeneity in reference price effects on optimal retailer pricing policies☆

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Abstract

The field of marketing has witnessed substantial improvement in modeling household level heterogeneity. However, relatively little has been written about how modeling household heterogeneity translates into better marketing decisions. In this paper, we study the impact of household level heterogeneity in reference price effects on a retailer's pricing policy. Reference prices are certain anchors or standards that households use to compare the observed purchase price of a product against. If the observed price is greater than the reference price it is perceived as a "loss" and if it is smaller than the reference price it is perceived as a "gain". In order to study the impact of heterogeneity in reference price effects on retail pricing, we test a nested logit model under two alternative reference price (memory and stimulus based) and heterogeneity (finite mixture and hierarchical Bayes) specifications. In the empirical analysis, we find that households are quite heterogeneous in terms of their gain and loss effects. For some households a gain has higher impact than a corresponding loss, while the opposite is true for others. Using individual level estimates we then develop a normative pricing policy for a retailer maximizing category profit. Our results indicate that the optimal pricing policy derived from the heterogeneous case is qualitatively different, and more profitable, than the case when heterogeneity is ignored. We show that for an important marketing problem pertaining to a retailer, the optimal pricing decisions for various brands in a category are inextricably related to household heterogeneity in reference effects and brand preference.
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Keywords: Brand choice; Reference price; Pricing research; Promotion; Hierarchical Bayes; Heterogeneity; Dynamic optimization

Introduction

Over the last two decades, the field of marketing has witnessed substantial improvement in modeling household level heterogeneity. The progression from aggregate (e.g., Guadagni and Little 1983; Basu, Mazumdar, and Raj 2007) to latent class (Kamakura and Russell 1989) to hierarchical Bayes (Rossi, Allenby, and McCulloch 2005) models reflects the inroads we have made in characterizing household differences. While these methodological advances are commendable, relatively little has been written about the impact of modeling household heterogeneity on marketing decisions (Basu and Vitharana 2009; Rossi, McCulloch, and Allenby 1996). In this paper, we demonstrate the pricing and category profit implications of incorporating heterogeneity in reference price effects for a retailer (Brown and Dant 2009; Grewal, Krishnan, Baker, and Borin 1998; Grewal, Monroe, and Krishnan 1998). We show that for an important marketing problem pertaining to a retailer, the optimal pricing decisions for various brands in a category are inextricably related to household heterogeneity in reference effects and brand preference.

A considerable amount of research exists on reference prices (Han, Gupta, and Lehmann 2001; Kalyanaram and Winer 1995; Krishnan, Biswas, and Netemeyer 2006; Mazumdar and Papatla 2000; Moon, Russell, and Duvvuri 2006; Mazumdar, Raj, and

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Sinha 2005; Popkowski Leszczyc, Qiu, and He 2009; Yadav and Seiders 1998). Reference prices are certain anchors or standards that households use to compare the observed purchase price of a product against. If the observed price is greater than the reference price it is perceived as a "loss" and if it is smaller than the reference price it is perceived as a "gain". Empirical evidence regarding the relative impact of perceived gains and losses on household choice has been quite mixed. For example, Putler (1992) found that, consistent with prospect theory (Kahneman and Tversky 1979), the effect of a loss on demand is greater than that of an equal gain. Greenleaf (1995), on the other hand, finds that the effect of a gain is greater than that of a loss.

While investigating the effects of reference price on household utility is of considerable theoretical interest, an equally interesting issue is the normative impact of these effects on a retailer's pricing policy. Some papers (Greenleaf 1995; Kopalle, Rao, and Assunção 1996) in marketing have studied the normative implications of reference price effects from the standpoint of a retailer. Kopalle et al.'s (1996) results suggest that when the impact of a price gain is greater than that of a loss, "hi/lo" prices are optimal; on the other hand, when the impact of a loss is greater than that of a gain, constant prices are optimal. This result is consistent with Greenleaf's (1995) monopoly analysis. A limitation of the above normative models is that they do not take into consideration household level heterogeneity in reference price effects.

As noted above, current normative research on reference prices suggests that at an aggregate level, when the impact of a gain is greater than that of a loss, a retailer should promote. However, uncovering heterogeneity is likely to reveal that not all households are the same with respect to the reference price effects; for some, the impact of a loss may be larger than that of a gain and for others, the reverse may hold. Further, the magnitude of the gain and loss effects may also vary across households. Under such circumstances, it is not clear whether a retailer should price promote, and if so, which brands to promote. Therefore normative policies based on a model that does not account for heterogeneity could potentially result in a pricing policy that does not maximize retailer profits.

Also, from a methodological standpoint, empirical research suggests that it is important to formally consider heterogeneity in reference effects because aggregate models tend to overstate the magnitude of the model estimates. For example, Chang, Siddarth, and Weinberg (1999) use a hierarchical Bayes model to show that upon accounting for the price response heterogeneity, the reference price effect ("sticker shock") gets diminished. Similarly, Bell and Lattin (2000) use a latent class model to show that once the price response heterogeneity is taken into consideration, the impact of reference prices on choices that consumers make is reduced.

The primary focus of this paper is to study the impact of household heterogeneity in reference price effects on normative pricing policies for a retailer. We use a nested logit model with two different heterogeneity specifications (finite mixture and hierarchical Bayes) and develop a normative pricing policy for a retailer maximizing category profit. We then test the robustness of our results to (i) an alternative, stimulus based reference price formation process and (ii) another product category. For different product categories and reference price specifications we find that there is significant heterogeneity in the gain and loss parameters across households. Based on household level estimates we develop normative pricing policies for a retailer maximizing category profit by simultaneously optimizing prices of various brands in the category. Our results indicate that the optimal pricing policy derived from the heterogeneous case is qualitatively different, and more profitable, than the case when heterogeneity is ignored.

The remainder of the paper is organized as follows. In the next section, we provide the conceptual background for our study and describe the relevant literature. This is followed by a description of the model and variables. We then present the empirical results. Next, optimal pricing policy implications for a retailer carrying multiple brands in a category are discussed, followed by additional analyses. Finally, we provide a summary and discussion of our analysis.

Background

Asymmetric response to reference price

It is argued that households are generally more reactive to price increases than to price decreases (Kopalle and Lindsey-Mullikin, 2003; Kumar, Karande, and Reinartz 1998; Monroe 1990; Winer 1986, 1989). This phenomenon is consistent with prospect theory (Kahneman and Tversky 1979) which predicts that households are more sensitive to a loss than to an equal gain. Such an asymmetric household response results in a kinked demand curve and the kink appears at the point where observed price is equal to the reference price (Hardie, Johnson, and Fader 1993; Putler 1992). On the other hand, other empirical studies show differing results. For example, Briesch et al. (1997) show that the effect of a gain is greater than that of a corresponding loss in four different product categories. Greenleaf (1995) finds a similar effect in yet another category. In addition to the aggregate level (i.e., no heterogeneity) empirical evidence cited above, some studies have examined the relative impact of gain and loss at a segment level. For example, Krishnamurthi, Mazumdar, and Raj (1992) find that for one segment the impact of a gain on demand is greater than that of a corresponding loss. For another segment, they did not find a significant difference between gains and losses. Also, Mazumdar and Papatla (1995) find that the impact of gain is greater than a corresponding loss for a two-segment solution in the margarine category while the reverse is true in the liquid detergent category.

Based upon the above review of existing literature, empirical evidence for an asymmetric response to reference price appears to be quite mixed. Some studies show that the effect of a gain is stronger than a loss whereas others find the opposite. Taken together, the above studies highlight the need for accounting household heterogeneity in estimating the relative impact of gains and losses, especially if they were to guide a retailer's pricing policies.

Following Krishnamurthi et al.'s (1992) analysis of transaction utility (Thaler 1985), we note that for some households,

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