Loss Aversion Estimation in Brand Choice Using Markov Chain Monte Carlo

Haihao Guo*

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1 Literature Review

This paper contributes to documentation of empirical prospect theory and reference effects, which have been a focal area of interest in behavioral economics and marketing. This also contributes to the literature of applying MCMC to address the potential heterogeneity issue.

1.1 Background: Prospect Theory

One fundamental question in economic research is that how do people make decisions in different scenarios? The view of expected utility theory assumes that people make decisions based on the principle of maximizing their expected utility (Von Neumann & Morgenstern, 1947; Savage, 1954). That is, people would prefer the alternative with the highest expected utility among all the alternatives. However, the perspective of the expected utility theorem has been challenged by the prospect theory, which believes that people make decisions depends on the gain or loss regarding a reference point, rather than the overall utility level(Tversky & Kahneman, 1979, 1991, 1992). Prospect theory also suggests that the ex-

^{*}Master of Computational Social Science, University of Chicago, email:haihao@uchicago.edu

istence of loss aversion drives people to react stronger to a loss from the reference point than a gain of the same amount (Tversky & Kahneman, 1979, 1991, 1992). Prospect Theory brought lots of insight and reconsideration into many problems, and it is proved empirically to be true that loss aversion exists and affects people's behavior in many fields including willingness to pay(Kahneman, Knetsch, & Thaler, 1990), bag usage(Homonoff, 2018), selling decisions (Genesove & Mayer, 2001), sports (Pope & Schweitzer, 2011; Allen, Dechow, Pope, & Wu, 2017), filling tax (Engström, Nordblom, Ohlsson, & Persson, 2015) and labor supply (Camerer, Babcock, Loewenstein, & Thaler, 1997).

1.2 Loss Aversion Estimation in Marketing Research

Prospect theory also receives lots of attention from the field of marketing research and choice modelers. Loss aversion and the well-accepted reference price concept and their impact on consumer choice have continuously been studied in pricing research. According to (Klapper, Ebling, & Temme, 2005), "a reference price is defined as an internal or external price against which consumers evaluate the actual prices of products in a choice context". The usage of panel data on consumer purchase enables researches on empirically detecting the reference price effect and the loss aversion(Bell & Lattin, 2000; Hardie, Johnson, & Fader, 1993; Chang, Siddarth, & Weinberg, 1999). This is proved to be true in many real life settings including grocery shopping items(Hardie et al., 1993), housing decisions(Genesove & Mayer, 2001), game show contestant behavior(Post, Pedersen, Wilmers, & Forchhammer, 2008), and insurance purchase decisions(Barseghyan, Prince, & Teitelbaum, 2011).

(Winer, 1986) is one of the first to empirically find the reference price in the brand choice settings, it examined the reference price formation process and its effect on purchases in coffee brands and sizes, further research also find similar result regarding the existence of the reference price effect(Lattin & Bucklin, 1989; Kalwani, Yim, Rinne, & Sugita, 1990), and the loss aversion in price(Kopalle, Rao, & Assuncao, 1996; Fibich, Gavious, & Lowengart, 2003).

Except of examining reference effect and loss aversion on one aspect, many researchers are also interested in finding multi-dimensional reference point. (Hardie et al., 1993) examines multi-attribute reference points in both price and quality setting of the grocery choice. (Tereyağoğlu, Fader, & Veeraraghavan, 2018) find the existence multi-attribute reference points in both price and seat sales.

1.3 Heterogeneity Concerns

Using the same dataset of (Hardie et al., 1993), (Bell & Lattin, 2000) found some interesting result after take heterogeneity into consideration. (Bell & Lattin, 2000) proved that loss aversion may be viewed as a phenomenon of not adequately modeling consumer heterogeneity in brand choice models. (Klapper et al., 2005) used the Gibbs sampling method to get the posterior distribution of the individual parameters and detect the relationship between the parameters and individual's specific demographics and psychological variables.

This paper follows (Bell & Lattin, 2000), using the MCMC sampler to check if the conclusion still holds in Cracker and Yogurt Market. Follow this article, I use a random walk Metropolis MCMC sampler to estimate the multinomial logit model and obtain individual-specific parameters in Cracker and Yogurt Market.

1.4 Data and Model

The usage of panel data on consumer purchase enables researches on empirically detecting the reference price effect and the loss aversion (Bell & Lattin, 2000; Hardie et al., 1993; Chang et al., 1999). I would follow the marketing research on the data choice and I use two sets of panel data of household purchases record in Cracker and Yogurt market and use the Multinomial logit model (McFadden et al., 1973) that incorporates heterogeneity to make an estimation using Markov Chain Monte Carlo sampler.

The first panel data is provided by Information Resources Incorporated, and it is the optical scanner panel data for saltine cracker purchase in Rome, GA. It has been used to

apply the Random-Coefficients Logit Brand-Choice Model (Jain, Vilcassim, & Chintagunta, 1994) and dynamic multinomial probit model for brand choice (Paap & Franses, 2000). The second data set is provided by A. C. Nielsen, and it is a scanner panel data for yogurt purchase in Springfield, MO. Both datasets have household consumption records on those product categories and last for 2 years, this has been used to apply the Random-Coefficients Logit Brand-Choice Model (Jain et al., 1994). Therefore, the panel data provides a complete purchase data for individuals over time, which enables us to get both stimulus-based reference price and the memory-based reference price for each consumer.

The first goal of this paper is to empirically identify the existence of the reference price that consumers rely on to make a decision and to show that assuming homogeneity, there exists loss aversion compared to the reference point. Next I want to follow (Bell & Lattin, 2000) to check the effect of heterogeneity on the degree of loss aversion. I would use the method of MCMC(Markov Chain Monte Carlo) to estimate the parameters and the potential heterogeneity within the group of people in the model. Lastly, I would do an analysis of the posterior correlation matrix, and to find some insights into the relationship between promotion and price sensitivity.

Using the Multinomial logit model (McFadden et al., 1973) on panel data sets on 2 market and examine the heterogeneity issue by applying the method of MCMC (Markov Chain Monte Carlo), I show that the effect of reference price and loss aversion is obvious assuming homogeneity, using the classical MLE method. However, considering heterogeneity makes the effect much smaller and even disappear, which is similar to what (Bell & Lattin, 2000) found in the market of refrigerated orange juice. Lastly, I make the posterior analysis on the correlation matrix, and found that promotion (display, feature advertising) effect would possibly have a negative effect on consumer's price sensitivity.

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