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主　論　文　要　旨

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主 論 文 題 名：Essays on the analysis of the effectiveness of promotions

（内容の要旨）

The widespread adoption of mobile applications (apps) has greatly facilitated corporate promotions aimed at boosting both short-term sales and long-term profitability. Since lottery promotions, which are one of the most widely used strategies, remain controversial due to conflicting views on their effectiveness, further empirical research is needed to clarify their impact on consumer behavior. Additionally, to evaluate the effectiveness of promotions comprehensively and cross-sectionally, a new analytical method is required to address the high heterogeneity among promotions and the time-varying nature of their effects. In this thesis, we empirically investigate the short- and long-term effects of lottery promotions and propose a new Bayesian meta-analysis approach for integrating multiple promotions.

In Chapter 2, we analyze large-scale data from multi-shot lottery promotions using a stratified randomized experiment method to compare winners and losers, thereby clarifying how consumer payments change during and after the promotion. Multi-shot lottery promotions allow repeated opportunities to win incentives and are widely employed across various industries. Understanding how implementation costs (e.g., incentive expenses) relate to subsequent consumer payments is essential for improving cost-effectiveness. This chapter examines whether variations in incentive size, ranging from large to small prizes, affect later consumer payments and explores whether winning effects differ according to users' frequency of use. We analyze extensive field data from over one million mobile payment service users, employing a stratified randomized experiment method that addresses user-initiated transaction bias. The findings show that, regardless of which prize is won, total transaction amounts, the number of transactions, and average transaction amounts all increase during the promotion. Notably, small prizes yield a higher ROI than large prizes, and the winning effect is especially pronounced among light users compared to heavy or middle users. However, the influence of incentive size on subsequent payments nearly vanishes after the promotion.

主　論　文　要　旨

In Chapter 3, building on the winner-loser comparison from Chapter 2, we use a Difference-in-Differences (DID) approach with propensity score weighting, taking non-participants as the control group, to quantitatively assess the causal effects of winning and losing on consumer payments. In lottery promotions, winners receive incentives while losers do not. It is crucial to understand how winning or losing in these promotions affects consumer payments both during and after the promotion, given the importance of short- and long-term profitability. However, prior studies have not sufficiently addressed these effects during and after promotions. This chapter empirically examines the influence of winning and losing by using data from a mobile payment provider's lottery promotion. Our DID analysis, which incorporates propensity score weighting to correct for the self-selected nature of promotion participation, reveals that even losing participants increase their payments during the promotion, and overall participation also boosts spending after the promotion. Moreover, the winning effect is more substantial than the losing effect.

Chapter 4 introduces a new Bayesian meta-analysis method, “Shrinkage estimation with Time-trend and Random-Effects for meta-Analysis of Means and variance” (STREAM). Meta-analysis is widely used to integrate results from multiple experiments to obtain generalized insights. Since meta-analysis datasets are often heteroscedastic due to varying subgroups and temporal heterogeneity arising from experiments conducted at different time points, the typical meta-analysis approach, which assumes homoscedasticity, fails to adequately address this heteroscedasticity among experiments. This paper proposes a new Bayesian estimation method STREAM that simultaneously shrinks estimates of the means and variances of experiments using a hierarchical Bayesian approach while accounting for time effects through a Gaussian process. This method connects experiments via the hierarchical framework, enabling “borrowing strength” between experiments to achieve high-precision estimates of each experiment's mean. The method can flexibly capture potential time trends in datasets by modeling time effects with the Gaussian process. We demonstrate the effectiveness of the proposed method through simulation studies and illustrate its practical utility using a real marketing promotions dataset.

Chapter 5 concludes by summarizing the key findings and contributions of this thesis, highlighting the limitations of this research, and outlining directions for future investigation.