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学 位 論 文 題 目	Extending Construct Measurement and Validation in Marketing and Consumer Behavior Research: A Study of Nonlinear Measurement Model and Interpretable Neural Network （マーケティングおよび消費者行動研究における構成概念の測定と妥当性検証の拡張：非線形測定モデルと解釈可能なニューラルネットワークに関する研究）
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論 文 内 容 の 要 旨

This thesis discusses an integrating approach to apply nonlinear measurement models and neural networks in traditional marketing and consumer behavior research. The discussion largely focuses on the mental process in customers' evaluations and specifies a nonlinear processing measurement model. When measuring consumer behavior, many researchers prefer linear models to nonlinear ones. Although linear models can provide easy interpretations, they sometimes lead to misinterpretations. Therefore, we focus on the validity of nonlinear estimations and interpretations in the mental process of consumer evaluation and perception to apply nonlinear measurement models and neural networks. This study intends to increase understanding and promote an approach that integrates social science problems with machine learning. This thesis consists of three chapters

and the references are provided at the end of the paper. The figures, tables, and necessary appendices are placed at the end of each chapter.

Chapter 1 deals with a threshold measurement model based on the prospect theory and zone of tolerance using the SERVQUAL scale to measure latent perceived service quality. The concept of zone of tolerance is one in which customers are willing to accept service discrepancies within a certain standard. The discussion focuses on the three stages of the consumers' mental state and how they relate to observable perceived service quality. It then proposes a model that employs a threshold specification representing the acceptable limits as a zone of tolerance. Because the value function in prospect theory describes human perception as dependent on the evaluation of difference rather than on absolute magnitudes, the proposed model also integrates asymmetric and nonlinear properties. Empirical analysis was achieved using the data collected from several different service sectors, and the proposal model showed better performance when compared to other competitive models. The results also provide an insight into the asymmetric and nonlinear latent structures of consumers' perceived service quality. Three different consumer segments were obtained by clustering estimated thresholds and factor scores.

Chapter 2 refines a method to evaluate the construct validity for a nonlinear measurement model. Construct validation is required when applying measurement and structural equation models to measurement data from consumers and related social science research. However, previous studies have not sufficiently discussed nonlinear measurement models and their construct validation. This study focuses on convergent and discriminant validation as important processes to check whether the estimated latent variables represent defined constructs. To assess the convergent and discriminant validity of a nonlinear measurement model, previous methods were extended and new indices were investigated through simulation studies. Empirical analysis shows that a nonlinear measurement model is better than a linear model in both fitting and validity. Moreover, a new concept of construct validation is discussed for future research. It considers the interpretability of machine learning (e.g., neural networks) because construct validation plays an important role in interpreting latent variables.

Chapter 3 discusses interpretable neural networks for marketing and consumer behavior research using customer reviews instead of a measurement scale to investigate a better understanding of the customer's experience. Customer ratings of service attributes are also used to determine overall customer satisfaction to comparing the customer experience and the service performance. Although many researchers have been interested in the effect of word-of-mouth reviews and its practical applications, the detailed contents of those reviews have been disregarded in many previous studies. One possible reason is the considerable amount of data that includes many individuals and massive volumes of textual data. To solve this problem, this study proposes some useful neural network methods that can make it possible to specify the expected assumptions

based on previous knowledge or theories in consumer behavior research. Because neural networks also help estimate the nonlinear relationship between objective and predictive variables, a partial dependence plot is used to visualize the estimated functions and marginal effects. Empirical results not only provide a highly accurate neural network model but also provide better marketing implications.

In summary, these studies suggest that it is important to investigate nonlinear psychological properties in consumer behaviors and find the interpretations from nonlinear models. The causal mechanism linking latent perceived service quality with difference score requires the nonlinear mental process in consumers' evaluation. Although the SERVQUAL model has been discussed with the linear measurement model in previous studies, the results in Chapters 1 and 2 show that nonlinear SERVQUAL models are better than the linear model. In addition, neural networks help in estimating a complex mental processing model such that Chapter 3 explains the relationship of a neural network with the measurement model. The study also indicates that the marginal effect estimation is important for interpreting nonlinear models.

論 文 審 査 結 果 の 要 旨

本論文では、消費者の心理的要因の消費者行動への影響関係を線形から非線形へ拡張する視点から、マーケティングにおけるサービス品質評価モデル、因子分析における測定方程式モデル、顧客レビューの顧客満足への影響測定モデルについて、それぞれ研究を行っている。

第１章では、消費者によるサービス品質評価のモデルであるSERVQUALにおけるサービス品質とその規定要因の関係を線形から非線形モデルへ拡張し、その妥当性を検証した。とくに消費者行動研究で議論される反応の飽和現象や許容域（Zone of Tolerance）を取り入れた複数の非線形モデルを比較検討している。実証分析では、日本におけるホテル、銀行、小売の３つのサービス産業に関し、それぞれ３００を超える顧客調査データを用いて検証し、非線形モデルの有効性および線形モデルでは得られないマーケティング実践に関する知見を導いている。

第２章では、因子分析モデルにおける測定方程式を非線形モデルとした場合の構成概念の妥当性について検討している。先行研究を拡張した形で非線形モデルにおける妥当性指標を提案し、シミュレーションおよび実データを用いてその有効性を示している。

第３章では、消費者行動に関するニューラルネットワークによる非線形モデリングについて議論している。具体的には、特定のサービスに関して消費者により投稿されたレビューから顧客経験を捉え、顧客経験および特定サービスの属性評価のサービス総合評価への

影響を分析している。顧客レビューや口コミを変数として扱った先行研究の多くは、その内容を大まかに捉えるのに対し、本章ではレビューの単語単位のテキスト情報を直接取り入れ、その際に生じる単語変数の高次元性や属性評価と総合評価の関係性特定化の問題を汎用性の高いニューラルネットワークを応用することで解消する。またモデル推定結果の解釈を可能とするために、理論や目的に関する事前の仮定に基づいて制約を課したネットワークモデルおよび部分依存関数を用いたモデルも比較しながら推定結果の可視化と限界効果の評価を行っている。実証分析の結果、既存モデルに比べて予測精度の向上が得られ、また解釈可能な推定結果によりマーケティング実務への示唆も導いている。

以上により、本論文は博士（経営学）の学位を授与するに値する論文であると認定する。