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International Journal of Forecasting 19 (2003) 71–85

international journal
of forecasting

www.elsevier.com/locate/ijforecast

Forecasting consumer credit card adoption: what can we learn about the utility function?

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Abstract

How to accurately predict customers' adoption behavior is becoming more important and challenging to many credit card marketers as competition increases. This calls for more knowledge about the consumer utility function and the corresponding decision behavior. In this study, we challenge the commonly used logit model which implies linear utility function and constant marginal rate of substitution (MRS) with a neural network model that can accommodate nonlinear utility function and changing MRS between card attributes. Using the data from a national survey of credit card usage, we find that the neural network model significantly outperforms the logit in predicting consumer card adoption decisions. Our results indicate that consumers do not make linear tradeoffs between card attributes and the MRS between card features does not remain constant even within the same demographic group.

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Keywords: Neural networks; Forecasting; Credit card adoption; Utility function; Marginal rate of substitution

1. Introduction

For direct marketers of credit cards, it is very important to understand how consumers make their card adoption decisions. When a consumer receives a credit card offer, it is natural for the consumer to compare the attributes, such as APR (annual per-

centage rate), annual fee, credit limit, and cash rebate, etc., of the card offered to the cards one already holds. Depending on the primary purpose of using credit cards various attributes may affect the decision very differently. For people who use credit cards primarily for convenience, they may never carry a credit card balance, thus APR might be irrelevant in their decision on whether to accept a credit card offer. Instead, they will compare annual fee, credit limit, and cash rebate, etc. However, for people who use credit cards primarily for borrowing, APR might be the key element in their decision making. They will adopt a card that offers lower APR though it may have a higher annual fee and no cash rebate.

These behaviors suggest that within certain ranges, card attributes such as annual fee and cash rebate

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might not be compensatory to APR, and vice versa. Other card features such as annual fee, credit limit, cash rebate, etc, however, might be compensatory. For example, a consumer may be willing to pay a not-so-small annual fee if a card offers a lucrative cash rebate. Note, however, that the normally non-compensatory attributes may become compensatory in certain extreme ranges. For example, if the APR becomes so low that the credit card becomes an attractive way of financing, then even convenience seekers may start to make tradeoffs between APR and other card features. Furthermore, even when the compensatory weighted-additive rule is applicable, the marginal rate of substitution (MRS) between card attributes is unlikely to be constant. For example, when the credit limit on a card is low, the consumer may be willing to pay a higher fee to raise his or her credit limit, say a \$10 fee hike for each \$1,000 increase in credit limit. However, when the credit limit has been raised higher and higher, the consumer will be willing to pay less and less for each additional \$1000 raise in credit limit. Therefore, it is reasonable to believe that the MRS between fee and credit limit diminishes as the credit limit increases.

From the above discussion, one can easily see that whether a consumer will accept or reject a credit card offer is a complex decision making behavior. The consumer utility function may be noncompensatory. Even if it is compensatory in certain ranges and between certain features, the utility function is unlikely to be linear and the MRS between various features is unlikely to be constant. Therefore, for different types of consumers, for different card features, and at different values of card attributes, the MRS between features may not be the same, and it may range anywhere from 0 or infinity (indicating noncompensatory decision making) to certain non-zero values (indicating compensatory decision making). As such, the standard linear utility function and constant MRS implied by the commonly used statistical models, such as probit and logit, will fail to provide an accurate prediction of consumer credit card adoption decisions. This calls for models that can accommodate nonlinear and/or noncompensatory consumer decision making.

Artificial neural networks (NN) have drawn considerable attention in many disciplines that involve pattern recognition and forecasting. This rich class of

flexible nonlinear models can approximate any function (linear or nonlinear) arbitrarily well (see Hornik, Stinchcombe, & White 1989; White, 1990, among others). While NN have been widely studied in various applications,² they have also been found useful in several marketing and consumer behavior studies. For example, Bentz and Merunka (2000) used NN as a diagnostic and specification tool for multinomial logit (MNL) in modeling brand choice decisions. In a simulation study and a study on consumer patronage behavior, West, Brockett, and Golden (1997) find that NN can offer significant improvement over traditional linear models such as discriminant analysis and logistic regression because NN can capture nonlinear relationships associated with the use of noncompensatory decision rules. Agrawal and Schorling (1996) apply NN to forecast brand shares in grocery product categories, and find that NN is better able to handle nonlinearities in the data than the commonly used multinomial logit model. Kumar, Rao, and Soni (1995) compare NN with logistic regression in modeling the decision of a supermarket chain whether to carry new products, and find that NN are parsimonious, produce better classification, handle complex underlying relationships better, and are stronger at interpolation. These and other studies³ show that NN are promising for classification and multiple criteria decision making in terms of predictive accuracy, adaptability, and robustness.

Despite its practical and theoretical importance, very few studies have been conducted on consumer credit card usage. Previous empirical work on the credit card market predominantly employs probit/logit models. For example, Canner and Cynrak (1986) use a logistic regression model to understand

²See, for example, option pricing (Hutchinson, Lo, & Poggio, 1994; Garcia & Gencay, 2000), time series prediction (Swanson & White, 1995, 1997a,b; Balkin & Ord, 2000; Darbellay & Slama, 2000; Tkacz, 2001), stock market prediction (Gencay, 1998; Qi, 1999; Qi & Maddala, 1999), exchange rate forecasting (Gencay, 1999), and student performance prediction (Gorr, Nagin, & Szczyplula, 1994).

³Additional studies comparing NN to traditional statistical models in classification and multiple criteria decision making include Malakooti and Zhou (1994), Dasgupta, Dispensa, and Ghose (1994), Hruschka (1993), Archer and Wang (1993), Tam and Kiang (1992), and Salchenberger, Cinar, and Lash (1992) etc.

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