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Using multi-state markov models to identify credit card risk

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Abstract
The main interest of this work is to analyze the application of multi-state Markov models to evaluate credit card risk by investigating the characteristics of different state transitions in client-institution relationships over time, thereby generating score models for various purposes. We also used logistic regression models to compare the results with those obtained using multi-state Markov models. The models were applied to an actual database of a Brazilian financial institution. In this application, multi-state Markov models performed better than logistic regression models in predicting default risk, and logistic regression models performed better in predicting cancellation risk.

Keywords
Credit scoring. Survival analysis. Multi-state Markov models. Credit cards. Markov processes.

1. Introduction

According to Wang & Ikeda (2004), the Brazilian credit card market has been in a maturation phase since the demand for credit boom, after the economy stabilized in 1994 with the implementation of the Real Plan. The deployment of the Brazilian Payment System (SPB) in 2002 has also affected the credit card market by leading to a strong migration from checks to electronic payment system.

The economic stability demanded the use of advanced statistical methodologies, such as logistic regressions, discriminant analysis, survey analysis, decision trees, Bayesian inference, and neural networks, to evaluate credit risk.

In logistic regression, one estimates the probability of the transition from state A, non-defaulting, to state B, defaulting, over a certain period of time (Hosmer & Lemeshow, 2000). Other kinds of transitions are not considered. It is known that there are several possible states in the relationship between clients and financial companies, such as *non-defaulting without revolving credit use, non-defaulting with revolving credit use, in delay, voluntary cancellation and default.* Customers pass through these states over time, and this is a characteristic of recurrent events (Hosmer et al., 2008; Paes & Lima, 2004). The existence of several possible states characterizes multi-state events (Hougaard, 1999).

Trench et al. (2003) developed a markovian decision process in order to guide a bank to determine price and credit lines for credit card holders in order to maximize its profits. So & Thomas (2010) used markov chain modeling transition probabilities in logistic models in order to evaluate credit risk of credit card portfolios.

The motivation for this work comes from the interest in taking advantage of these recurrence characteristics to generate transition probability matrices between several possible states over time. This is why a Multi-state Markov model was estimated (Jackson, 2007) and its performance was compared with models developed using logistic regressions.

In section 2, we give a brief introduction to the typology of credit risk forecasting models. In section 3, we describe the Multi-state Markov model that was used and other statistical techniques. The database is presented in section 4, and the obtained results from the models are presented in section 5. Finally, we weave our final considerations in section 6.

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