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Loss given default models incorporating macroeconomic variables for credit cards

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ABSTRACT

Based on UK data for major retail credit cards, we build several models of Loss Given Default based on account level data, including Tobit, a decision tree model, a Beta and fractional logit transformation. We find that Ordinary Least Squares models with macroeconomic variables perform best for forecasting Loss Given Default at the account and portfolio levels on independent hold-out data sets. The inclusion of macroeconomic conditions in the model is important, since it provides a means to model Loss Given Default in downturn conditions, as required by Basel II, and enables stress testing. We find that bank interest rates and the unemployment level significantly affect LGD.

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1. Introduction

Loss Given Default (LGD) is the loss incurred by a financial institution when an obligor defaults on a loan, given as the fraction of exposure at default (EAD) unpaid after some period of time. It is usual for LGD to have a value between 0 and 1, where 0 means that the balance is fully recovered and 1 means the total loss of EAD. LGD is an important value that, for several reasons, banks need to estimate accurately. Firstly, it can be used along with the probability of default (PD) and EAD to estimate the expected financial loss. Secondly, a forecast of LGD for an individual can help to determine the collection policy to be used for that individual following default. For example, if a high LGD is expected, then more effort may be employed to help reduce this loss. Thirdly, an estimate of LGD, and therefore of the portfolio financial risk, is an integral part of the operational calculation of capital requirements to cover credit loss during extreme economic conditions. The Basel II Capital Accord (Basel Committee on Banking Supervision, 2006) allows banks the opportunity to estimate LGD using their own models via the advanced internal ratings based (IRB) approach.

In this paper we focus on modelling and forecasting LGD for UK retail credit cards based on account variables (AVs), and also on the inclusion of macroeconomic variables (MVs). Our prior expectation is that as interest rates rise, so the cost of mortgages and other debts will increase, making it more difficult for an obligor to repay outstanding credit card balances, thus increasing the mean LGD. Equally, an increase in the level of unemployment means that more people find themselves in circumstances where they cannot repay credit, which also increases the mean LGD. On the other hand, an increase in earnings means that more people have more income available to pay off debts, and therefore decreases the mean LGD. In addition, some defaulters will be less able to repay than others when the state of the economy changes. For example, those who are unemployed at the time of a credit card application may be particularly sensitive to interest rate increases, as may home owners with mortgages. Similarly, borrowers with higher default balances may be particularly sensitive to increases in interest rates. For this reason we also consider interactions between MVs and account data. We consider four key research questions:

Q1. Which credit card application and default variables are the key drivers of retail LGD?

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Q2. What is the best modelling approach for retail LGD?
Q3. How well do the models perform for forecasting LGD?
Q4. Does the inclusion of MVs lead to improved models of retail LGD?

We investigate these questions by building several alternative models of LGD. We find that there are many important drivers of LGD taken from application details and default information. Given that the distribution of LGD is a bimodal U-shape, we consider a Tobit model and a decision tree model, along with various transformations of the dependent variable. Although LGD is not easy to model and a poor model fit is typical, we nevertheless find that models can be built which provide improved estimates of LGD and good forecasts of the mean LGD across a portfolio of accounts. Surprisingly, we find that the best forecasting model is Ordinary Least Squares (OLS) regression. Economic conditions are included as values of MVs for the bank interest rate, the level of unemployment and the earnings growth at the time of the account default. We find that the first two MVs are statistically significant explanatory variables that give rise to improved forecasts of LGD in hold-out tests at both the account and portfolio levels. Building LGD models with MVs also addresses the Basel II requirement to estimate the "downturn LGD", since stressed values of MVs can be used in the model to forecast LGD in poor economic conditions. This can be done by stressing interest rate values, as we explain in our conclusions.

The modelling and forecasting of LGD for retail credit using macroeconomic conditions is a new area of study. There is an extensive body of literature regarding LGD models for corporate loans (see for example Altman, Resti, & Sironi, 2005). However, there is less about *forecasting* LGD. An exception is the work of Gupton and Stein (2005), who describe a predictive LGD model for corporate loans using Moody-KMV's Losscalc© software. There is also very little in the literature regarding retail credit LGD, even though this is a large financial market: total lending in the UK consumer credit market reached over £1.4 trillion in 2009 (source: Bank of England). Grippa, Iannotti, and Leandri (2005) published empirical LGD models for a sample of 20,724 Italian accounts, including both small businesses and households. They observed differences in LGD and recovery periods across different geographic regions and recovery channels. They also conducted a multivariate analysis that showed a statistically significant negative relationship between the presence of a collateral or personal guarantee and LGD, and a positive relationship with the size of the loan. However, the range of variables used is far more limited than that available to financial institutions that have made credit card or personal loans, and the study did not attempt to forecast LGD. Dermine and de Carvalho (2005) model LGD for loans to small and medium-sized firms in Portugal. They apply mortality analysis and include the annual GDP growth as an explanatory variable. However, they find that the GDP growth is not significant, and suggest that this may be due to the fact that the period of analysis, 1995–2005, did not include a significant recession. We may also note that their training sample size (374 defaults) was relatively small, and may not have been large enough for a significant relationship between the economy and LGD to be discovered. Querci (2005) provides an LGD model for loans to small businesses and individuals by an Italian bank. The author shows the importance of regional differences in LGD variation, but does not include time varying macroeconomic conditions. Figlewski, Frydman, and Liang (2007) model the effect of macroeconomic factors on corporate default, with a detailed study of numerous economic conditions including the level of unemployment, inflation, GDP and a production index. They found that many of these MVs were significant explanatory variables. Saurina and Trucharte (2007) model PD for retail mortgage portfolios in Spain. They show that the GDP growth rate is a significant cyclical variable in the regression and has a negative sign, as we would expect. That is, during downturns (low GDP growth), PD increases. However, they also include an interest rate variable, and although it has a positive sign and is significant, report that including interest rates does not improve the accuracy.

The novelties of our paper are that, unlike published work, we (1) consider forecasts of LGD for retail credit cards, (2) report the results of model comparisons, (3) include macroeconomic conditions in our models, and (4) do so using a very large sample across several different credit card products. In Section 2 we describe our modelling and performance assessment methods. In Section 3 we discuss the application and the macroeconomic data used. In Section 4 we provide model comparisons and test results, along with a description of an explanatory model with MVs. Finally, in Section 5 we provide some conclusions and discussion.

2. Method

We consider several models as combinations of different variables, modelling frameworks and data transformations.

2.1. Models

In general, for retail credit, there are five categories of circumstances that will affect the amount an individual repays on a defaulted loan and can be used to build models of LGD:

(1) individual details, some of which can be collected at the time of application, such as age, income, employment, housing status and address;
(2) account information at default: date or age of account at default and outstanding balance;
(3) changes in personal circumstances of an obligor over time;
(4) macroeconomic or business conditions at the date of default, or possibly with either a lag or lead on the date of default;
(5) operational decisions made by the bank, such as the level of risk they were willing to accept on the credit product and the process they used to follow up bad debts.

Of these, the richest source of explanatory variables we have is the information provided at the time of the application for credit, along with the credit bureau score collected by the bank at the time of application. These

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