Crisis and LGD: Developing a model for the retail portfolio

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Discussing LGD

\[
LGD = \frac{EAD_i - \sum_{j=1}^{n} R_{i,j}(r) + \sum_{k=1}^{m} P_{i,k}(r)}{EAD_i}
\]  

(1)

where \( R_{i,j}(r) \) and \( P_{i,k}(r) \) denote the discounted recoveries \( j \) and discounted costs/losses \( k \) of credit \( i \), respectively.

- **Recoveries**: Collaterals, securities, cured exposures etc.
- **Costs**: Loss of interest payments, legal costs, labour costs etc.
- **\( r \)**: Discount rate to get net present value (NPV). Various approaches.
Modeling LGD: Deterministic Approaches

Variety of Methods for Corporate Portfolio

- Linear/Nonlinear Regression, OLS
- Parametric Methods
- Nonparametric Methods (e.g. regression trees, neural networks, support vector machines)

Software Products: LossCalc by Moody’s, LGD Estimation Tools by Standard and Poor’s
Modeling LGD: Stochastic Approaches

- Try to capture dependence between default rates and recovery rates
- LGD is not a deterministic factor but it can fluctuate according to the economic cycle
- Initially modelled via a common/single systematic factor (macro-economic)
- Based on an extension of the classic Merton framework
- Other interesting Merton-based methodologies incorporated not only the dependence on a set of factors but also the correlation among LGDs
Modeling LGD: The case of retail portfolios

- Most methodologies adjust and extend practices from the corporate portfolio
- Focus on downturn LGD
- Different methodologies for each subportfolio: regression methodologies, Tobit, decision trees etc.
- LGD estimation is vastly dependent on country specifics (e.g. legislation, structure of economy)
- Among the factors that are important and influence LGD for mortgages are loan to value (LTV) at origination, age and income of debtor, type of property, time on book
- It has been shown that LGD estimations for mortgages are highly influenced by macro-factors, especially local unemployment rates
Greek Banking System: Unique Characteristics

- Purchase of a house constitutes a special feature of Greek culture
- Government policies protect borrowers when they face loan payment difficulties
- Real estate auction is an extremely rare case
- Housing loans are usually backed by mortgage prenotations of first rank
- During the pre-crisis period: the majority of the borrowers are doing their best not to lose their property
- From the onset of crisis and onwards: percentage of loans returning to non-defaulted status without any contract modifications on the part of the bank decreased significantly.
The New Status During the Crisis

- New restructure products
- Extension of the duration and reduction of the instalment amount for the first years
- Increase in the number of possible states that a loan may be observed
- Account state depends not only on the existence of restructure but also on the compliance with the restructure terms
- Need for a model to estimate the LGD in the new conditions
Towards Modelling the LGD: Analysis of Current Situation

The 6 states, a loan may belong:

1. Fully repaid
2. Not defaulted and not restructured
3. Not defaulted and restructured for a period longer than or equal to 12 months
4. Not defaulted and restructured for a period less than 12 months
5. Defaulted and not restructured
6. Defaulted and restructured

The enumeration is ordinal (best → worst)
Typical Recovery Rate Distribution

Figure: Distribution of Recovery Rates, 7 years after the default event.
Focus on Account State Recovery Rate Distribution

Figure: Recovery Rate distribution for each of the 6 account states
Economic Crisis and Recovery Rates
Economic Crisis and Real Estate

Greece - Residential Real Estate Values

Recovery Rate vs LTV

LTV at Default
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Analysing the New Situation

The Macroeconomic Environment-Factors

Figure: GDP compared to Recovery Rate

Figure: Unemployment Rate compared to Recovery Rate
The Proposed Model

- Aim to model the account state movements and the influence of macroeconomic factors
- Two stage model
- Markov chain mixture models the state transitions
- Beta regression is fitted for each account state population
Stage 1

- Let $s_n$ be the account state at time $n$
- In our case we have 6 states, i.e. $s_n \in \{1, \ldots, 6\}$
- Assume only one macro-factor $m$ e.g. GDP with two possible values $m \in \{GDP+, GDP-\}$
- The joint distribution of states plus the macro factor is given by:

$$p(s_n, \ldots, s_1, m) = p(m)p(s_1|m) \prod_{t=2}^{n} p(s_t|s_{t-1}, m)$$

- It can be easily extended to incorporate more factors
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The Proposed Model

Stage 1 continued

- State transition frequencies are quite stable in our dataset $\rightarrow$ stationary Markov chains
- Create conditional transition matrices covering any combination of macro-factors
- Derive the most probable state when the previous state and macro-factors are known
- Various methodologies exist to incorporate combine macro-factors (reduce complexity) and project related values
Stage 2

- Beta regression model, with a different beta distribution fitted for accounts belonging to each of the 6 account states in our dataset.
- Almost all account states follow non-normal distributions, bi-modal with values concentrated near 0 and 1 for some states, and uni-modal distributions with the mode near either 0 or 1 for others.
- Using a response that is beta distributed naturally follows from our dataset.
- The beta regression model uses a parametrization of the beta distribution in terms of its mean and precision, and is similar to a generalized linear model. For a beta density \( \text{beta}(y; a, b) \), for \( \mu = a/(a + b) \) and \( \phi = a + b \), the density can be written as:

\[
 f(y; \mu, \phi) = \frac{\Gamma(\phi)}{\Gamma(\mu \phi) \Gamma((1 - \mu) \phi)} y^{\mu \phi - 1} (1 - y)^{(1 - \mu) \phi - 1} 
\]

with \( E(y) = \mu \) and \( \text{var}(y) = \frac{\mu(1 - \mu)}{1 + \phi} \).
Stage 2 continued

- Maximum likelihood estimators of $\beta$ (i.e. vector of unknown regression parameters) and $\phi$ are obtained by numerically maximizing the log-likelihood function using nonlinear optimization algorithms.
- Recent articles suggest reasonable initial estimates for $\beta$ and $\phi$.
- An R implementation of beta regression inference exists in the `betareg` package.
- Of particular importance for LGD modelling datasets are extensions/generalizations such as the inflated, the multivariate, the mixed etc. beta regression models.
The mortgage portfolios in Greek banks have some very special and important characteristics.

The economic crisis and the new era in the Greek banking system makes all currently used models outdated, if not obsolete.

The proposed model try to incorporate all these unique characteristics and macro-factors that affect LGD as well as the negative correlation between default rates and recovery rates.

Among the next steps is the implementation of the model by selecting appropriately the factors and the validation of the whole work.

The examination of the generality of our model to encompass other cases and conditions (such as other retail portfolios than mortgages and other macroeconomic conditions) is our next-in-line project.