Crisis and LGD: Developing a model for the retail portfolio

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Discussing LGD

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

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 depencence 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, decison 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

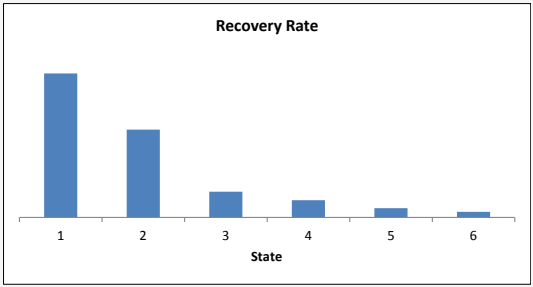
- New restructure products
- Extension of the duration and reduction of the instalment amount for the first years
- Increase in the number of possible states that a loan may be observed
- Account state depends not only on the existence of restructure but also on the compliance with the restructure terms
- 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 $\rightarrow$ worst)



Typical Recovery Rate Distribution

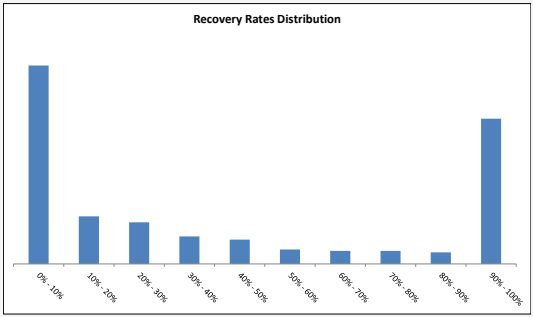


Figure: Distribution of Recovery Rates, 7 years after the default event.

Focus on Account State Recovery Rate Distribution

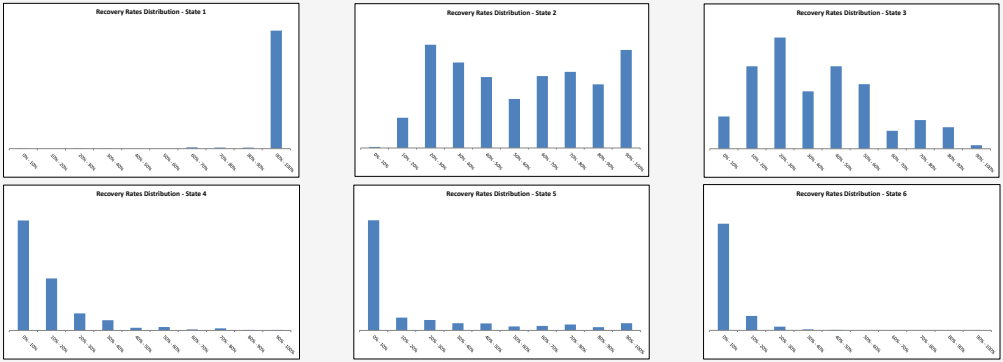
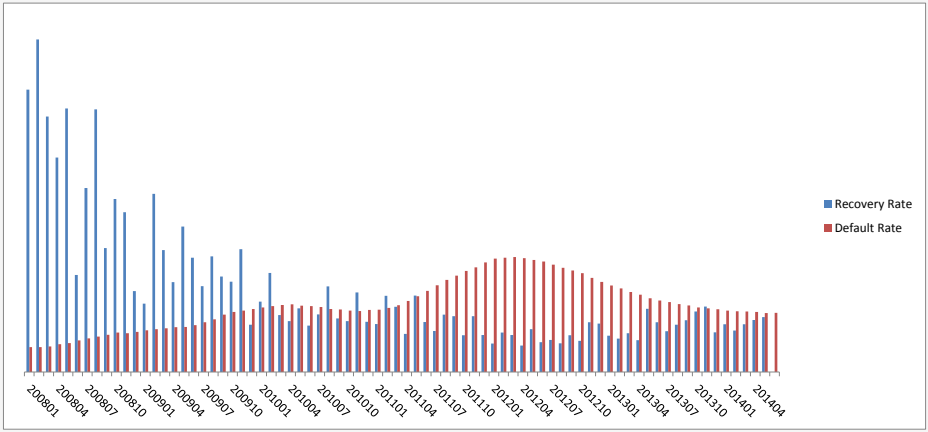
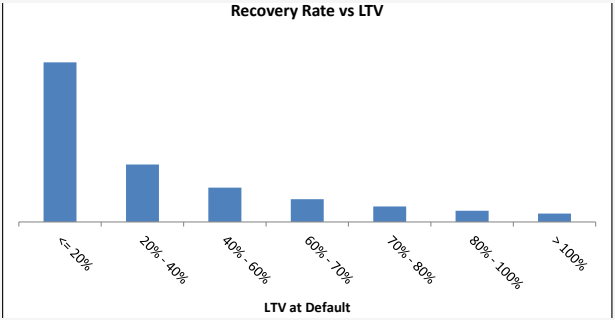


Figure: Recovery Rate distribution for each of the 6 account states

Economic Crisis and Recovery Rates



Economic Crisis and Real Estate



The Macroeconomic Environment-Factors

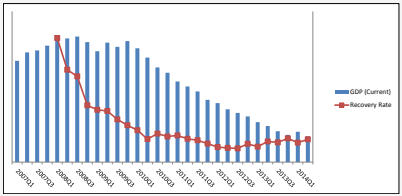


Figure: GDP compared to Recovery Rate

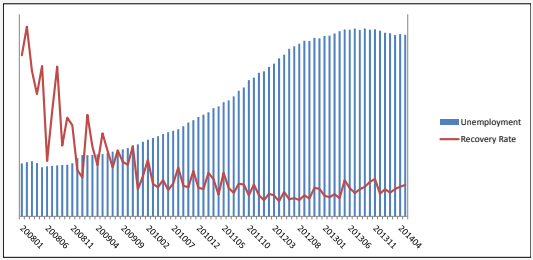


Figure: Unemployment Rate compared to Recovery Rate

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

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 $beta(y; a, b)$, 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 $var(y) = \dfrac{\mu(1-\mu)}{1+\phi}$

Stage 2 continued

- Maximum likelihood estimators of β (i.e. vector of unknown regression parameters) and ϕ are obtained by numerically maximizing the log-likelihood function using nonlinear optimization algorithms
- Recent articles suggest reasonable initial estimates for β and ϕ
- 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

Conclusions

- 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