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A transitions-based framework for estimating expected credit losses

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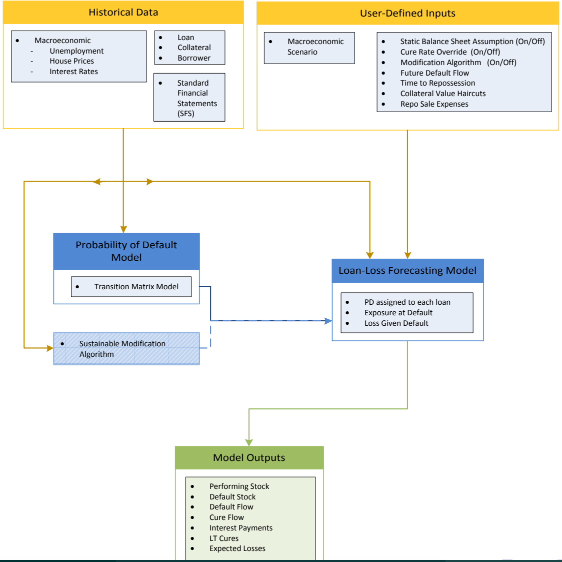
Outline


Historical Data
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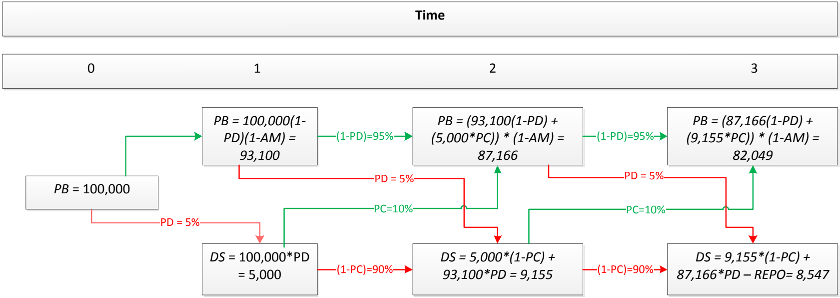
Model Outputs
• Performing Stock
• Default Stock
• Default Flow
• Cure Flow
• Interest Payments
• LT Cures
• Expected Losses

Flows for a hypothetical performing loan



Hypothetical loan with a $t = 0$ balance of €100,000, a constant set of parameters: PD of 5%, $PCure$ of 10% and an amortisation rate of 2%. PB refers to performing balance, DS to default stock in each year. PD and $PCure$ will vary at the loan level and will derive from the loan-level multi-state model's coefficients. $REPO$ refers to the $t = 1$ default stock that has not cured by $t = 3$ and is thus repossessed.

Probability of default overview

- Aim of this framework is to model *transitions* at the *loan level*.
- A traditionally-used logit model will not give us the desired effects.
- Move to a model where loans can move into and out of default.
- Markov Multi-State Model (MSM) enables this type of estimation. Loans are given a zero-one status in each time period (performing or default).
- The impact of covariates on transition probabilities can be estimated.
- Predicted probabilities can be interpreted as the one-year **transition** PD and $PCure$.

Continuous versus Discrete Time transitions

- Lando and Skodeberg (JBF 2002) propose a continuous-time transition matrix model as an improvement on the discrete/cohort methods more commonly used.
- Industry standard models such as JP Morgan's Creditmetrics and McKinsey's CreditPortfolioView use a "cohort method" where the one-year transition probability between state A and state B is

$$p_{AB} = \frac{N_{AB}}{N_A} \tag{1}$$

- Weakness: if no loans start the year in A and finish the year in B, then p_{AB} is estimated to be zero.
- This issue becomes increasingly more important as one estimates the probability of a rare event.

Continuous Time model

- A generator matrix Λ leads to probabilities in the form

$$P(t) = exp(\Lambda t) \tag{2}$$

- $\rightarrow$ All transition probabilities in all time periods are a function of the generator.
- The entries of the generator are the maximum likelihood estimates

$$\lambda_{ij} = \frac{N_{ij}(T)}{\int_0^T Y_i(s)ds} \tag{3}$$

- $Y_i(s)$ is the number of firms in state i at time s, making $\int_0^T Y_i(s)ds$ the total "firm-years" spent in i.

Table: Covariates included in PD models

Factor	Comments	ROI	UK
Bank ID	Intercept adjustment for bank-specific effects for Banks 2, 3 and 4. All coefficients are relative to baseline of Bank 1.	Yes	Yes
Buy-to-Let	Intercept adjustments for buy-to-let mortgages. Baseline is Primary Dwelling Houses.	Yes	Yes
Interest Rate Type	Intercept adjustments for interest rate type effects for Standard Variable Rate and Tracker mortgages. All coefficients are relative to baseline of fixed rate mortgages.	Yes	Yes
Vintage	Vintage (i.e. loan age) is measured in months since the mortgage was issued. Both linear and natural-logged terms enter into the functional form of the model.	Yes	No
Interest Rate	Current interest rates on the mortgage.	Yes	Yes
Time in Default	Time (in months) since loan entered into Default state.	Yes	Yes
Current Loan-to-Value	Current loan-to-value at the property level.	Yes	Yes
Unemployment	National unemployment rate is converted to regional by the model.	Yes	Yes

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Figure: Variation in $PCure$ as a function of Time Since Default, ROI model

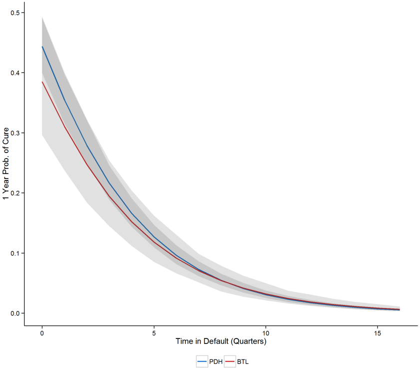
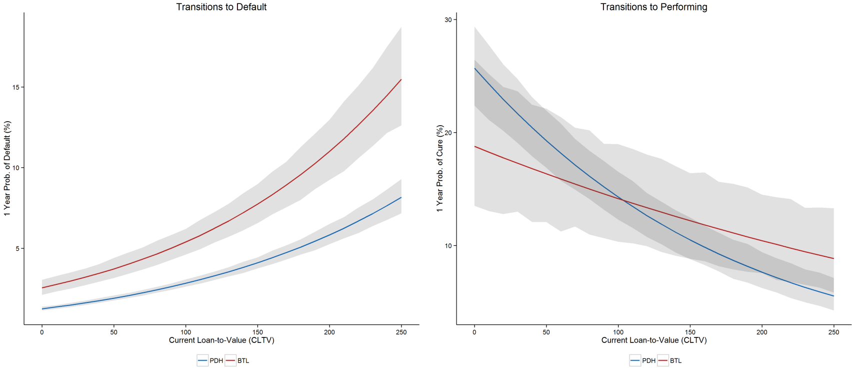


Figure: The role of housing equity in PD and $PCure$, ROI model



Exposure at default

- Explicit default and cure transitions between expected-value performing and delinquent balances at $t = 1, 2, 3$.
- PD share of performing balance flows to default; $PCure$ vice-versa.
- Time-since-delinquency cohorts have different $PCure$.
- Amortisation rate schedules are calculated using interest rate, term, fixed-rate period and interest-only period.
- Prepayment rate is input by the user.
- Balance-sheet assumption: new lending as a share of total amortisation and prepayments (dynamic) or adding these back to each loan, with the same risk profile (static).

Loss given default

- Delinquent loan outcomes: cure or liquidation.
- Each year, loan begins to perform with probability $PCure$.
- After a certain time based on policy/circumstances, loan is foreclosed on. Explicit, unlike a logit model.
- LGD depends on both cure rates and loss given liquidation (LGL), or LGD net of cures.
- LGL not estimated econometrically, but calculated.
- Main factor is indexed LTV, using future amortised balance and house price forecast (from scenario).
- Also accounts for fire-sale discount and repossession costs.

Summary

- Covariates affect transitions into and out of default.
- Continuous Time, one-year PD model replaces logit lifetime PD.
- Time since default affects $PCure$, so the starting point matters.
- Realistic curing and time to liquidation replace annual roll rate.
- Precise timing of losses within a horizon (e.g. three years).
- Loan-by-loan variation of EAD, PD and LGD more granular than portfolio-level models.