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Loan loss forecasting: a methodological overview

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Abstract

This *Letter* provides an overview of the Central Bank of Ireland's Loan Loss Forecasting framework. This framework, which utilises detailed loan-level data provided on a six-monthly basis by domestic Irish banks, includes internally-developed probability of default (PD) models and a cash flow engine which produces expected loss estimates. The PD models provide estimates of the probability of *transition* into and out of loan default. Exposure at Default (EAD) is calculated on an annual basis using PD estimates and loan-level information on term, interest rate and balance. Loss Given Default (LGD) is calculated using loan-level collateral value data and can be adjusted in residential mortgage models using an internally-developed algorithm which models lenders' choice between mortgage modification and repossession.

1 Introduction

Ireland's financial crisis experience is an acute example of how loan impairments can rapidly rise in an economic downturn resulting in the need for state support. The ability to quantify current provision requirements and how they evolve under various macro scenarios is of paramount importance and is a core component of a prudential policy framework. This *Letter* provides an overview of a framework developed at the Central Bank of Ireland capable of undertaking a loan-level assessment of such losses akin to the recently completed ECB/SSM Comprehensive Assessment.

The development of the models in their current manner was made possible due to the collection of loan-level data from the domestic banks under the Financial Measures Programme (2011). This granular data provides detailed borrower, loan and collateral information that are used as key inputs. The other key inputs are the macroeconomic variables that best explain loan losses. Together, these inputs allow for the development of a suite of loan-level (bottom-up) models for residential mortgage, consumer credit, Small and Medium Enterprise (SME) and corporate loan portfolios. The models all follow a standard loss framework where expected losses are the product of Probability of Default (PD), Loss Given Default (LGD) and Exposure at Default (EAD), with separate modelling methodologies for each of these individual components. Upon completion of the framework, an external validation process was conducted by BlackRock Solutions in June 2013 to ensure that

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the models were fit for purpose and met industry standards.

Flexibility is an essential component of model development, to allow the models accommodate changes in the banking or policy landscape. One example in this framework is the inclusion of a loss adjustment algorithm in the Irish residential mortgage model. The algorithm adjusts LGD for the possibility that banks will offer mortgage modifications rather than move to repossession of defaulted mortgages. This mechanism (Gaffney and Dunne, 2014) lowers LGD relative to a standard calculation based on collateral values and repossession.

This letter introduces the Central Bank of Ireland loan loss forecasting framework. A full description of the methodology and its components can be accessed in the material cited in this *Letter*. An overview of the model is provided in Section 2. Section 3 provides a short conclusion.

2 Model Overview

The Loan Loss Forecasting model (LLF) estimates expected annual cash flows at the loan level. Cash flows, in this context, include flows between performing and defaulted states, as well as repayments of principal and write-offs of and recoveries from defaulted balances. The model combines information on each loan's characteristics, the macroeconomic scenario inputs, coefficients on transitions to default and cure and information regarding collateral to estimate LGD. The model in its totality is summarised in Gaffney, Kelly, and McCann (2014).

Probability of default (PD) is derived from models developed internally in the Central Bank of Ireland. These models generate estimates of the probability of *transitioning* into and out of default, rather than the probability of *being* in default, which is the standard approach to modelling losses where prediction of the stock of losses is the primary aim. These estimates are arrived at using a continuous time version of a transition matrix approach (See Lando and Skodeberg (2002) and (Jackson, 2011)). The Republic of Ireland (ROI) and UK residential models are detailed in Kelly and O'Malley (2014) and McCann (2014), respectively.

The LLF cash flow engine joins up the sub components of annual transition probabilities, cash flows and LGD's to generate expected losses. The PD coefficients from the above-mentioned models feed directly into the cash flow engine, and allow for changes in macroeconomic scenarios to impact each loan's PD. The model allows for regionally-varying unemployment and house price shocks to impact loans differently.

The Central Bank of Ireland LLF model is unique in having developed a tool to model banks' choice between loan modifications and repossession (Gaffney and Dunne, 2014). This allows for lower portfolio LGD relative to standard LGD models which rely solely on collateral values at repossession.

Figure 1 visualises the evolution of a hypothetical performing loan in the LLF. Certain aspects are simplified in this illustration. For instance, the probabilities of default (PD) and cure (PC) are fixed at 5 and 10 per cent, respectively. The red arrows in each case indicate that 5 per cent of period t's performing balance will transition to the defaulted state at $(t+1)$, while 90 per cent of period t's defaulted balance will remain in default at $(t+1)$. The green arrows indicate that 10 per cent of the default balance at t will move to performing at $(t+1)$, while 95 per cent of the period t performing balance will remain performing at $(t+1)$. Performing balances are then amortised at a rate of 2 per cent in this illustration.

Figure 2 provides an illustration of how the LLF uses the default flows in Figure 1 to estimate expected loss. At $t = 1$ in this hypothetical example, €5,000 is expected to be in default. Based on Irish and international empirical evidence, the time that elapses between default and liquidation is set to be two years in this model, which explains why cure flows are only possible for two years after the default events at $t = 1$ and $t = 2$. The two green arrows with cure rates of 10 and 8 per cent indicate that the portion of the loan that defaulted at $(t+1)$ will be allowed to cure for two years, and that the probability of cure will fall as time elapses. Figure 1 illustrates clearly the level of detail built into the LLF: for an individual loan beginning at $t = 0$, the model traces out the probabilistic component that defaults at $t = 1$, along with the two periods of potential cures emanating from that default. Further, it traces the component that defaults at $t = 2$, and the subsequent related two years of cure flows.[2]

[2] In practice there will also be default flows at $t = 3$, with resultant cure flows at $t = 4$ and $t = 5$. These are omitted for ease of exposition.

3 Conclusion

The Central Bank of Ireland has developed a detailed framework for estimating expected credit losses. The methods outlined in this *Letter* and the papers cited herein have been applied to residential mortgage, consumer credit, Small and Medium Enterprise (SME) and corporate portfolios. The models utilise detailed loan-level data submitted by Irish banks to estimate transition probabilities between performing and defaulted loan status. These models have acted and will continue to act as part of a suite of prudential tools available to the Central Bank of Ireland.

References

Gaffney, E., and P. Dunne (2014): "Enhanced modelling of mortgage Loss Given Default for loan-loss forecasting," Mimeo, Central Bank of Ireland.

Gaffney, E., R. Kelly, and F. McCann (2014): "A transitions-based framework for estimating expected credit losses," Research Technical Paper 16RT14, Central Bank of Ireland.

Jackson, C. (2011): "Multi-state models for panel data: The msm package for R," *Journal of Statistical Software*, 38(8), 1–28.

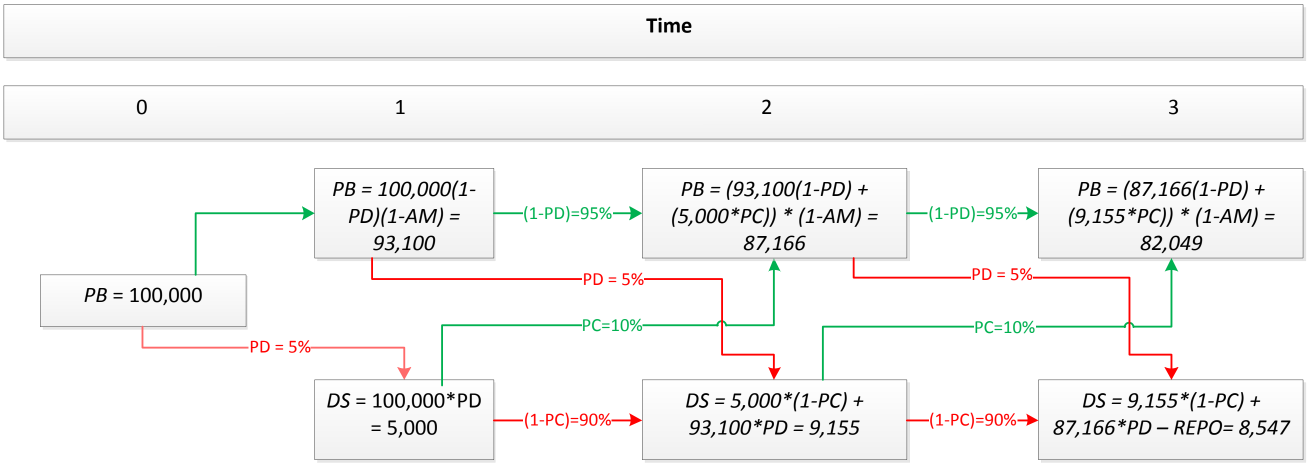
Kelly, R., and T. O'Malley (2014): "A transitions-based model of default for Irish mortgages," Research Technical Paper 17RT14, Central Bank of Ireland.

Lando, D., and T. M. Skodeberg (2002): "Analyzing rating transitions and rating drift with continuous observations," *Journal of Banking & Finance*, 26(2-3), 423–444.

McCann, F. (2014): "Modelling default transitions in the UK mortgage market," Research Technical Paper 18RT14, Central Bank of Ireland.

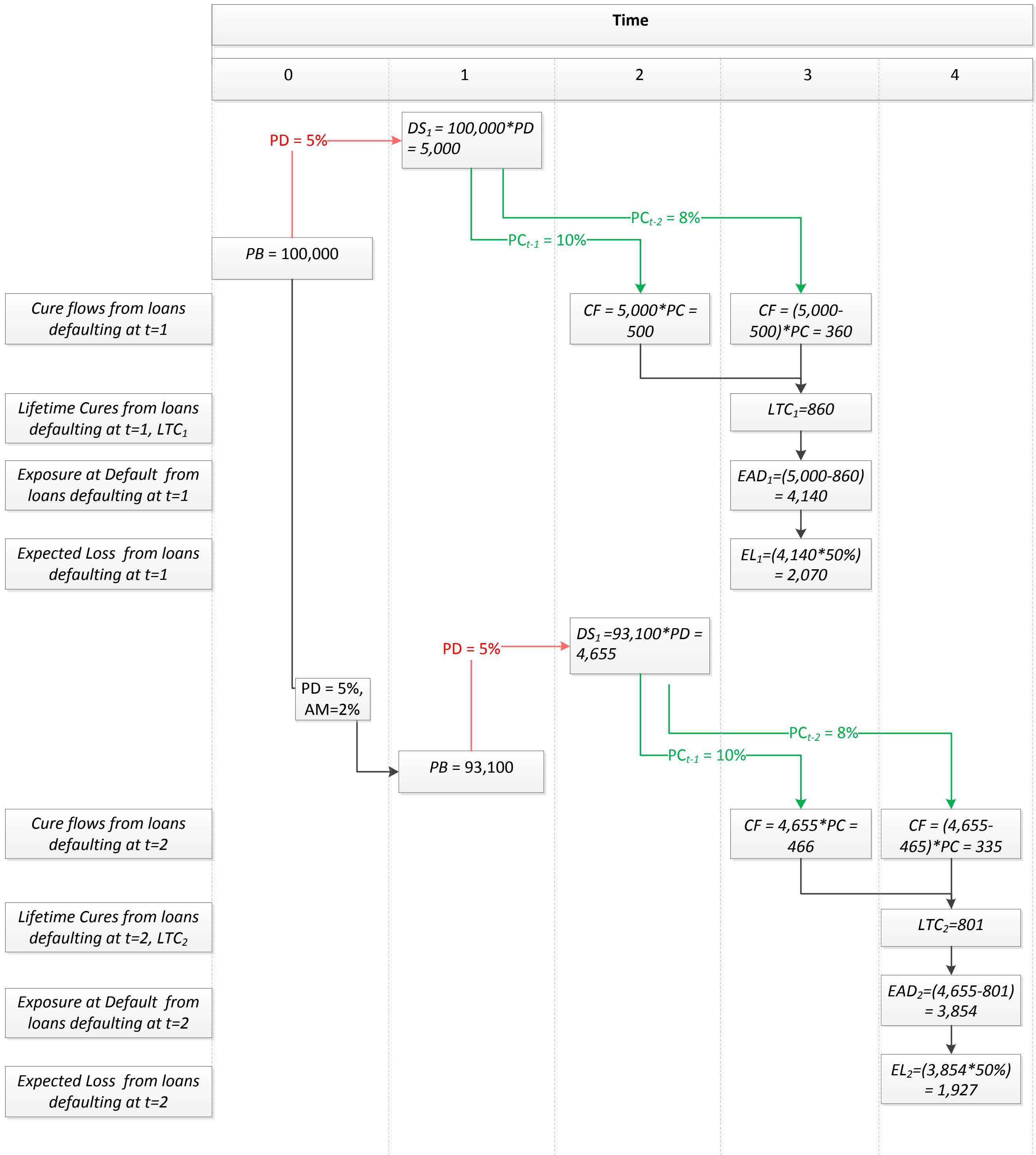
Figures and Tables

Figure 1: Default and cure flows for 3-year horizon of 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 (AM) 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. $REPO$ at $t = 2$ refers to the €4,050 of $t = 1$ default stock that has not cured by $t = 3$, and is thus repossessed.

Figure 2: Derivation of expected loss for portion of loan defaulting at $t = 1$ and $t = 2$



Hypothetical loan with a $t = 0$ balance of €100,000, and a constant set of parameters: PD of 5%; $PCure$ of 10% and 8% one year and two years after default, respectively, reflecting the negative impact of time in default in the model; LGD of 50%. PB refers to performing balance, DS refers to default stock. PD and $PCure$ will vary at the loan level and will derive from the loan-level multi-state model's coefficients. PD does not vary over time in this example due to the simplifying assumption of an unchanging macroeconomic environment for the purposes of this display.