



# The good, the bad and the impaired: A credit risk model of the Irish mortgage market<sup>☆</sup>



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## ABSTRACT

Using a uniquely constructed loan-level dataset of the residential mortgage book of Irish financial institutions, this paper provides a framework for estimating default probabilities of individual mortgages. In contrast to the popular stock delinquency approach, this model provides estimates of default and cure flows: a requirement of the stress test approach adopted by the European Central Bank's comprehensive assessment. In addition, both default and cure transitions are modelled as functions of micro- and macro-covariates including loan characteristics and current macroeconomic conditions such as house prices and unemployment. When comparing the competing equity and affordability effects, labour market deterioration played a stronger role than house equity in the rise of Irish default rates. For cures, a scarring effect of default is identified and estimated with the probability of a loan returning to performing reducing by almost four per cent each month a loan remains delinquent.

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## 1. Introduction

The presence of significant housing booms and busts across many OECD countries such as Spain, Ireland and the United States has profound financial stability concerns for the financial systems which service these markets. In light of the considerable uncertainty surrounding the “health” or otherwise of financial institutions in these countries, the optimal response of policy makers is guided by an accurate estimate of the presence of loan impairment on the mortgage books. Motivated by studies in corporate credit risk, this paper provides a framework for assessing the credit risk of residential-property lending. In particular, the model is based on a transition matrix framework, allowing for estimates of default and cure flows: a key advantage over a standard stock delinquency model. Indeed, this is a requirement under the new split

stress testing framework comprising asset quality review (AQR) informed test of losses on the stock of default loans and a forward looking piece on the future flow of new defaults. The European Central Bank's (ECB) comprehensive assessment<sup>1</sup> of 127 banks across Europe adopts this approach.

In Ireland, driven by almost a decade of historically low unemployment levels, double digit annual house price growth, development of a residential investment property market and lower interest margins due to increased competition from foreign banks resulted in a mortgage book with a credit risk profile unlike anything that went before. Two models are presented for both the traditional owner occupier (OO) mortgages and loans for investment properties, commonly known as Buy-to-Let (BTL) loans. Both models condition defaults and cures on loan characteristics and macro factors such as house prices and labour market conditions. Support is found for the equity (measured by the Current Loan to Value (CLTV) ratio) and affordability (measured by regional unemployment and loan-level interest rates) hypotheses<sup>2</sup> and their role

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<sup>1</sup> See <https://www.ecb.europa.eu/ssm/assessment/html/index.en.html> for further information.

<sup>2</sup> This is commonly referred to as the “double-trigger” hypothesis in the literature. For example, see Bajari et al. (2008) and Foote et al. (2008, p.241).

in the probability of loans default and curing. For an unemployment (CLTV) increase of one percentage point, the likelihood of a default increases by 5.4 (1.3) per cent. Unemployment also plays an important role in the cure rates for delinquent loans. There is a 6.6 (9.7) per cent increase in the OO (BTL) cure rate for a 1 per cent point fall in unemployment levels.

Due to changes in the conduct of banks in the cases of delinquent loans and a legal case impeding the repossession of property, the loan books of Irish banks provide a unique dataset to investigate the determinants of loans curing, as the number of repossessions were insignificant during the period under investigation. As in the case of default modelling, macro conditions and loan characteristics play an important role. In addition – and to the authors' knowledge the first time – a scarring effect of delinquency is found to be one of the strongest influences on the probability of a loan curing, decaying with every quarter a loan is in arrears. Both the OO and BTL markets show a similar trend with the likelihood of a cure falling 17 per cent for each additional year a loan remains in default. This identifies the importance of early engagement with borrowers in the design of any framework aimed at altering loan terms in the hope of loan recovery.

The rest of the paper is structured as follows; in Section 2 we look at the previous literature on modelling loan arrears, while in Section 3 we outline a transition-based method to estimate default and cure probabilities of loans. Section 4 provides estimates of the default and cure probabilities in an Irish residential property lending context and their sensitivity to macro factors and Section 5 offers some concluding comments.

## 2. Previous literature

There are a variety of different empirical approaches used to tackle the issue of estimating mortgage default. For example, the early literature investigating delinquency in the US mortgage market derived an option based model of default. [Kau et al. \(1992\)](#) view default as an American put option on the house price with a strike price set equal to mortgage value. This pure-option based model assumes that the borrower will default immediately when the value of the property drops below the mortgage value. Key to this framework is the non-recourse nature of some mortgages and the ruthless exercising of the option. Furthermore, the substantial transaction costs of moving property are ignored.<sup>3</sup> The greatest strength of this model, the independence from borrower's solvency is also its greatest weakness as [Aron and Muellbauer \(2010\)](#), amongst others, have shown default very often requires more than the household just experiencing negative equity.

[Schwartz and Torous \(1993\)](#) using a Poisson regression framework find evidence of significant differences in default behaviour. The main drivers are found to be vintage of loan and volatility of housing index returns. More recently, [Mayer et al. \(2009\)](#) provide a detailed overview of loan performance by credit quality for mortgages originating between 2003 and 2007. Although not explicitly modelled, the drivers of delinquency rates are regional unemployment and house prices. House prices played a particularly important role as the sub-prime model involved re-financing after improvement in an individual's credit score before the "teaser" rate period expired. Once these borrowers entered negative equity, re-financing to a lower rate was not possible.

Scoring models provide the most popular framework for conditioning the probability of delinquency on borrower solvency. These models tend to use single-period classification (Logit and variations) techniques to assess the probability of default (PD) for a loan.

<sup>3</sup> See [Vandell \(1995\)](#) for a review of cases where the borrower will not default even with non-recourse mortgages.

[Bajari et al. \(2008\)](#) develop a US sub-prime market scoring model using a bi-variate Probit or "double trigger" framework, requiring two conditions to be satisfied for default to occur. The dual conditions that result in hypothesised mortgage default are: the mortgage to equity ratio exceeds a certain threshold and the second is a function of credit worthiness of the household, its employment status and its expected income growth. The literature is mixed in terms of the dominant effect, with [Foote et al. \(2008\)](#) and [Goodman et al. \(2010\)](#) citing negative equity as the primary influence while [Gerardi et al. \(2013\)](#) show unemployment to be the strongest predictor. [Elul et al. \(2010\)](#) introduces a measure of illiquidity; the utilization of credit card which has a positive impact on default probabilities. In the Irish case, [Lydon and McCarthy \(2013\)](#) take a similar approach to modelling delinquency. Housing equity is found to be a main determinant of default along with a proxy for current repayment burden; originating income adjusted for aggregate changes. [McCarthy \(2014\)](#) estimates a probability of arrears model with a cleaner version of current income, gained from a survey of mortgage holders, which allows for disaggregation of house equity, unemployment and income shocks on the probability of loan arrears. While all three effects have a significant impact, estimates show unemployment has a three times larger effect than an income shock (without job loss) on the probability of arrears.

While stock delinquency models address the causes of arrears and default, they lack a time structure framework; excluding them from use when the flows of default and cures are required, such as in the current ECB led comprehensive assessment (CA). The first component of the CA involves testing of adequate collective provision coverage. This is the equivalent of modelling the loss outcome for the current stock of defaulted loans. The second element involves calculating the future defaults of currently performing loans. A stock delinquency model, with 0 and 1 defined as performing and default, will estimate the stock of defaulted loans both in the current and future time periods, but because each loan takes an expected default probability at each time period, the identification of new defaults and cures is not possible.

Migration models provide another technique for modelling loan delinquency. These models form states based on delinquency status and link directly to the cashflows of individual loans and hence allow for default and cure flow estimation. [Cyert et al. \(1962\)](#) first proposed a Markov model for estimating the loss on accounts receivable, but this type of modelling gained popularity in the fixed income market with CreditMetrics in 1997 (See [Gupton et al., 1997](#)). The approach takes historical credit ratings and estimates a transition matrix through which the migration probability of any bond rating to default could be estimated. [Betancourt \(1999\)](#) develop a migration model of Freddie Mac prime mortgages and concluded that unconditional models provide poor forecasting ability. He proposed two observations which greatly improved the forecasting ability. Firstly, it is advantageous to divide the loan book into portfolio's reflecting loan characteristics such as fixed or floating interest rates. Secondly, loans are more likely to remain performing as they age. More recently, focus has shifted to developing models of the sub-prime loan book. [Grimshaw and Alexander \(2011\)](#) use covariates to augment transition-matrix estimates of the transition probabilities between states for sub-prime mortgages; prediction is improved when repayment behaviour, interest rates and CLTV are introduced into the model.

Independent of the methodology used to estimate the default probabilities, an important consideration is the dependence between the default probability and the loss given default (LGD). Due to unobservable asset correlations, modelling this dependence is conceptually very difficult. Standard capital calculation formula under Basel II assumes a fixed correlation of 15 per cent. [Altman et al. \(2005\)](#) show for the corporate bond market, that recovery rates can be modelled as a function of the demand and supply for the

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