Leeds Building Society

UK aggregate mortgage arrears behaviour: Determinants and comparison between CML and firm level data.

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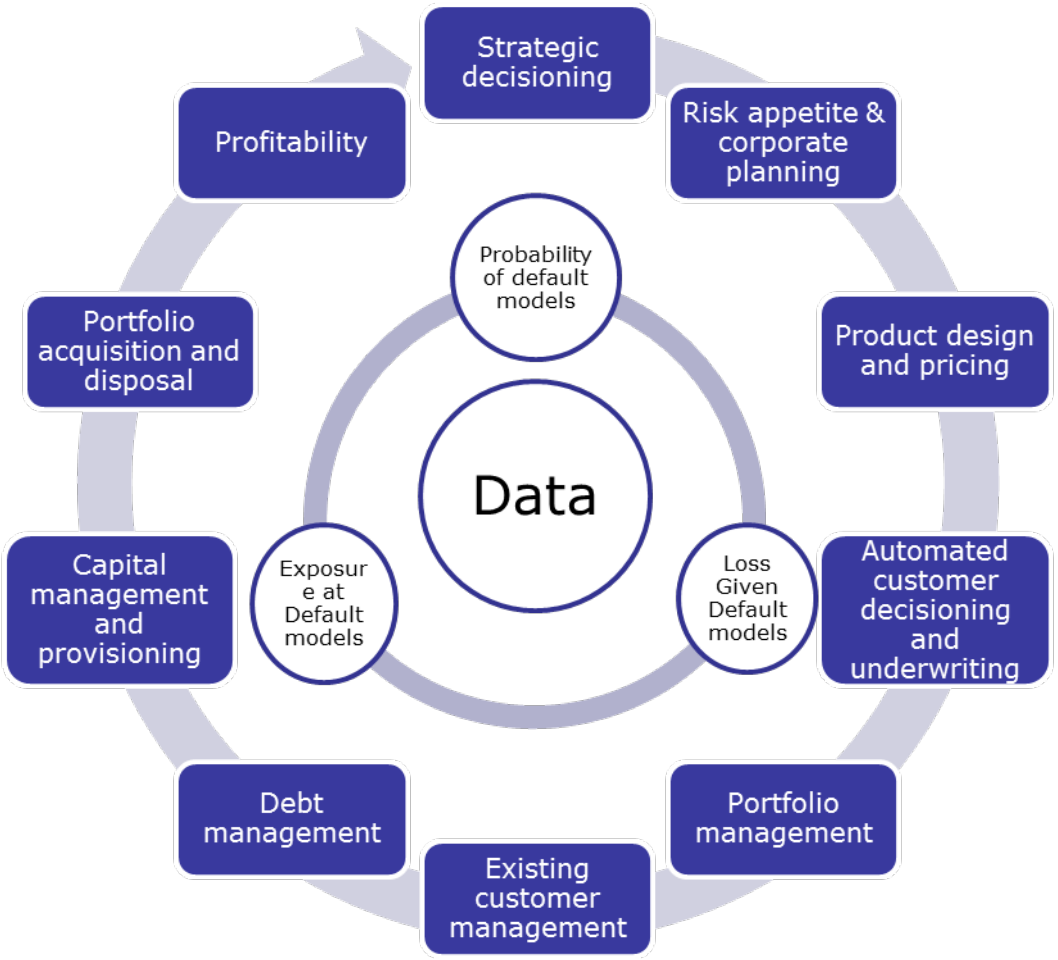
Where we want to go

Society making step changes to improve credit risk management capabilities.

Ensuring adequate risk measurement tools available to support a segmental lending strategy and financial adequacy assessment.

IRB strategic project is being undertaken and leveraged to support wider improvements in risk management across the Society.

This project has been undertaken in support of these wider Society aims.



Develop a Forecasting Mechanism

Main scope

Develop a mechanism that will be able to extrapolate (forecast) internal default rates or other information (e.g. months in arrears) when there is lack of information.

Direct application

This mechanism will be used for populating 25 years of default rates at aggregated level which can then be used for calculating Through The Cycle (TTC) Probability of Default (PD) at a more granular level.

Future application

This same mechanism can also be deployed across the following areas:

- Portfolio stress testing
- Arrears and default rates forecasting
- Capital ratios and provisioning forecasting

Forecasting Mechanism Principles

The intention is to establish a forecasting mechanism that considers the following:

- Incorporating mortgage default and repossession rates at UK aggregate level (CML data) through time.

- Permitting macro economical parameters to shape the internal default rate performance across time.

- Factoring internal parameters such as: lending policy changes, changes in portfolio risk profiles (income multiple, LTV) and changes in regional concentration (adjusted HPI indexation).

- Establishing a dynamic relationship between the internal default rate and the explanatory parameters (variables).

Error Correction Models

- An Error Correction Model (ECM) is a dynamic system with the characteristics that the deviation of the current state from its long-run relationship will be fed into its short-run dynamics.

- An ECM is not a model that corrects the error in another model.

- ECMs are a category of multiple time series models that directly estimate the speed at which a dependent variable returns to equilibrium after a change in an independent variable.

- ECMs are useful for estimating both short term and long term effects of one time series to another.
  - Thus, they often integrate well with theories around political and social processes.
  - Theoretically-given approach to estimating time series models.

- ECMs are useful models when dealing with integrated data but can also be used with stationary data.

Introduction to LBS ECM Project

Steps

- Investigate if the internal data capacity and quality is able to support Error Correction Modelling.

- Identify determinants (external/internal) of aggregate default rates at firm level.

- Identify the role of internal determinants and how these could influence the performance of the model.

- Support potential selections and outcomes with rational explanation.

- Collect evidence that Error Correction Modelling can be deployed as a forecasting mechanism for supporting the development of TTC PD, portfolio stress testing and forecasting.

DATA structure

- The data used, covered the period between 2003 to 2011.
- Quarterly information was used wherever was possible.
- Data imputation method was used for populating values (from semi-annual to quarter) where was necessary (e.g. CML data).
- All variables were seasonally adjusted and the difference of the natural logarithm (elasticity) was used for modelling purposes.
- Unemployment rate and House Price Index were adjusted to reflect the portfolio distribution at a regional level.
- Only internal data that was deemed sufficiently robust throughout the whole development period was considered.

Potential determinants

Variable	Source	Description
Society's Default Rate	Internal data	Proportion of mortgage loans in 6 or more months in arrears or in possession.
Loan to Value	Internal data	Average Loan to Value ratio at portfolio level
Interest Rate	Internal data	Average interest rate at portfolio level.
Income Multiple	Internal data	Balance at origination divided by total annual gross applicants' income.
CML Default rate	Council of Mortgage Lenders	Proportion of mortgage loans in 6 or more months in arrears, including possession cases (taken to possession)
Port. HPI	Lloyds Banking Group	House prices index: weighted to reflect portfolio's distribution across regions.
Nominal Income	Bank of England	Nominal Income
Base rate	Bank of England	Bank of England Base Rate
Household Savings	Bank of England	Household Savings
Port. Unemployment Rate	Office for National Statistics	Unemployment rate regionally adjusted to reflect the firm's lending distribution.

DATA & portfolio limitations

- Data quality doesn't follow the same standards across the whole period (2003-2011).Prior to 2006 the data quality declines.
- The Society has recently put in place data governance procedures. This has materially improved the data quality during the last 3 years.
- The Society's portfolio orientation has changed significantly across time. This change has an impact in regional and product concentration. Therefore, breaking points in default rates across time have been caused.
- The Society has invested in specialised products like Shared Ownership mortgages and therefore it differs from typical UK mortgage lenders.

ECM 1st stage – Stationarity tests

- Phillips – Perron test has shown:
  - The variables are not stationary at levels
  - Their 1st differences are stationary

Phillips-Perron		
	Levels	**1st difference**
	PP	**PP**
LTV	-1.16	-26.18***
PortHPI	0.17	-12.24***
PortUR	0.50	-16.27***
BOER	-0.82	-13.70***
NomInc	0.25	-14.51***
CML	0.55	-8.59**
IR	-0.01	-23.46***
HS	-1.04	-47.70***
BTL_DR	1.04	-14.33***
DR	1.05	-7.91**
IM	0.10	-6.19**

Note: *p<0.10, **p<0.05, ***p<0.01; Test period 2003 Q1- 2013 Q2

ECM 2nd stage – Co-integration & Long term model

- The first step of the Engle-Granger approach has shown that co-integration exists between the firm-level Default Rates and:

- CML Default Rates
- The portfolio adjusted unemployment rates
- The portfolio adjusted House Price Index
- The dummy variable (policy reflection)
- The internal average Interest Rate (portfolio level)
- Household saving ratio

- The static long-run model is structured to be:

DR=10.01+0.573*(CML)+1.764*(PortUR)-0.03*(HSD)+0.486*(DUM)-1.498*(PortHPI)+0.93*(IR)

ECM 3rd stage – Full model

- The model diagnostics are satisfactory.
- The adjusted R -squared shows that the model fits the population well (model is significant) and there are no issues with auto-correlated errors.
- The coefficients are plausible.
- The error correction implies convergence to the long-run equilibrium at a rate of 43.4%.
- The relative short-term lag structures are similar to other relevant studies.

Explanatory Variables	Estimated Coefficient	t-stat
Constant	0.035	1.10*
$\Delta_1 \ln(CML)_{t-2}$	1.042	2.92***
$\Delta_1 \ln(DR)_{t-2}$	-0.222	-1.46*
$\Delta_1 \ln(HSD)_{t-4}$	-0.044	-1.96**
$\Delta_1 \ln(PortUR)_{t-1}$	1.430	1.96**
$\Delta_1 \ln(IR)_{t-2}$	2.713	2.78***
$\Delta_1 \ln(PortHPI)_{t-2}$	-2.240	-2.85***
EC_{t-1}	-0.434	-3.02***
*p<0.10; **p<0.05; ***p<0.01		
Diagnostics:		
Adjusted R^2	0.74	
SE	0.16	
DW	1.82	
F-test***	12.02	
RESET	1.34	
LM/ARCH	0.19	
Jarque-Bera	1.9	

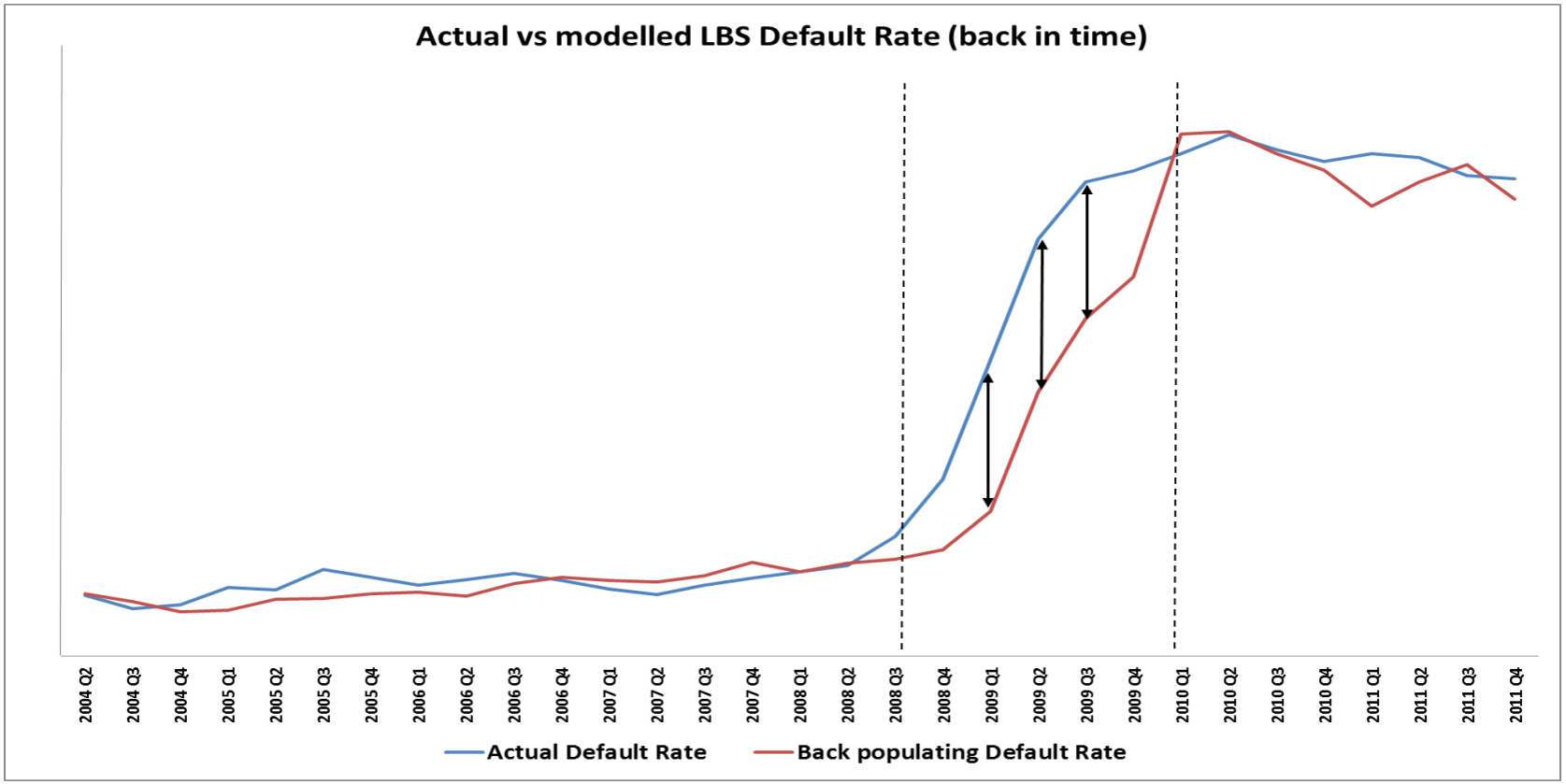
ECM validation and conclusions

- Validation tests:
  - Chow test:
    - ✓ Validation periods: Q1 2003-Q4 2005, Q1 2003-Q4 2007, Q1 2003-Q4 2011
    - ✓ The results indicate that the null hypothesis cannot be rejected in any of these periods (Structural break doesn't exist).
  - Theil U test:
    - ✓ Validation period: Q2 2011 – Q2 2012
    - ✓ Theil's U statistic had a result of 0.69 in out of time test.
    - ✓ Further analysis has shown that there has been a data issue in Q1 2012. By excluding the Q1 2012 the outcome of the test improves to 0.44 (for out of time test). Generally the short out of time data series produces some volatile results although they are well within the acceptable limits.
- Conclusions:

Despite the highlighted data/modelling issues the model performs well and can be deployed across several applications. This conclusion is also confirmed by the model outcomes.

ECM Performance (in Back forecasting)

- Error ratio for the long run PD: (Actual-Modelled) / Actual = 10%



Model's limitations

- The low volume of defaulted accounts causes volatility issues over time. The impact of this is worse in recent years.
- Lending policy has a material impact in portfolio quality. It is evidenced that changes in lending policy over time causes subsequent volatility in model estimates.
- Changes in lending policy were difficult to be monitored efficiently through time. Thus the dummy variable that has been used for simulating lending policy changes in the model needs improvement.
- The Society's product orientation differs its performance against the typical UK mortgage lender. Thus, causes lag and discrepancy issues between internal and CML default rates.
- The model development has been based on the existing data resources. Lack of alignment across these resources could have caused data quality issues.

Next steps

- Increase the data capacity.
  - Use internal data to impute months in arrears prior to 2003.
  - Use internal data to populate better explanatory parameters.
  - Improve the historical data around lending policy changes.

- Improve the data quality.
  - Monitor lending policy changes in more efficient way.
  - Run diagnostic tests based on the available data.
  - Replace or exclude outliers.

- Model improvements.
  - Investigate the period around the crisis (2008-2010) for influencing differently the ECM.
  - Investigate how product segmentation could enhance the model's outcome.
  - Review some of the model components (e.g. exclude/include autoregressive parameters).

Questions