The statistical dilemma: Forecasting future losses for IFRS 9 under a benign economic environment, a trade off between statistical robustness and business need.

Katie Cleary

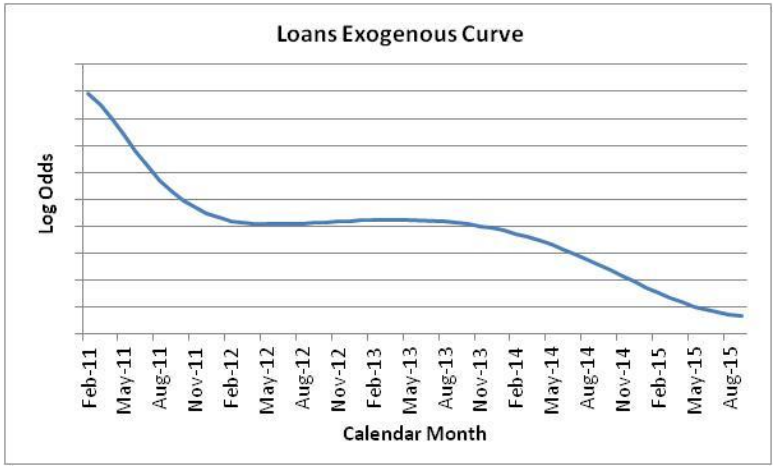
Introduction

- Presenter: Katie Cleary
- Graduated from Glasgow University in 2009: BSc with Honours in Mathematics and Statistics.
- Graduate Statistician member of the Royal Statistical Society.
- Worked in a variety of roles within Banking over the last 7-8 years including Corporate and Retail operational and Basel credit risk modelling and Asset Liability Management (ALM).
- Most recent focus has been the development of IFRS 9 impairment models for TSB.
- This presentation explores the challenges of building an Economic Time Series model without having Bank specific data from a full economic cycle. I will describe the process of developing the economic component of the TSB Unsecured Loans IFRS 9 Probability of Default model.
- Due to the limited data availability, the Exogenous curve used to build the economic component only contained data from February 2011 to September 2015. This data sample does not span a full economic cycle.
- I will outline the challenges that led to a two stage model approach being developed and how the final approach tried to balance compromises in statistical robustness with producing a model that was fit for business purposes.
- Given the very real impact on the Bank's balance sheet, any models also need to be well understood by the Bank board members particularly Risk, Finance and Audit Directors. This results in a preference to use statistical methodologies that are already used and well understood within the Bank, where possible.

Model Development Constraints

- The IFRS 9 Probability of Default (PD) methodology used provided two key outputs:
  - A time series of forward in time (FiT) estimates of monthly conditional PDs from a given observation point, per Risk Grade Where the conditional PD at time t represents the probability of defaulting at time t given that the customer is open and Not in Default at time t-1.
  - An exogenous component representing the impact on default risk that can be explained by the wider economy. Future forecasts of the economy can then be incorporated within the model to provide a view of lifetime PD based on these forecasts.

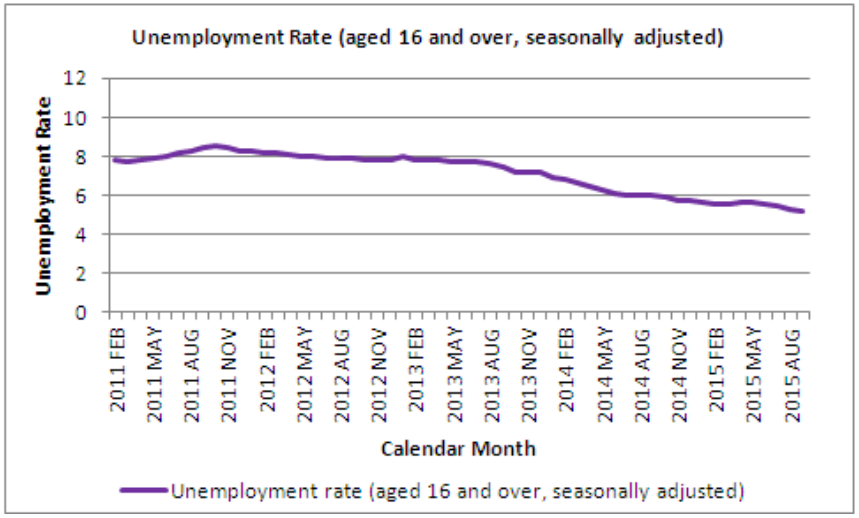
- Due to the limited data available for the Unsecured Forward in Time Probability of Default (FiT PD) model, the Exogenous curve derived as part of the overall FiT PD development only contains data from Feb11-Sep15. This data sample is outside of the 2008-2009 recession period and therefore doesn't span a full economic cycle.

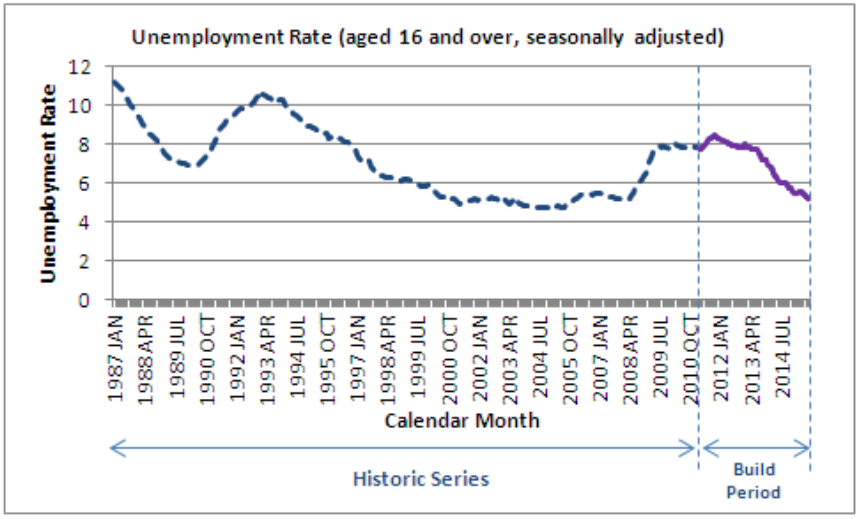


- As a result, there is greater importance that the final model can be validated by back-testing and stressing the model in different scenarios.

- Statistical robustness was also considered including: stationarity; autocorrelation and normality of residuals

Stationarity



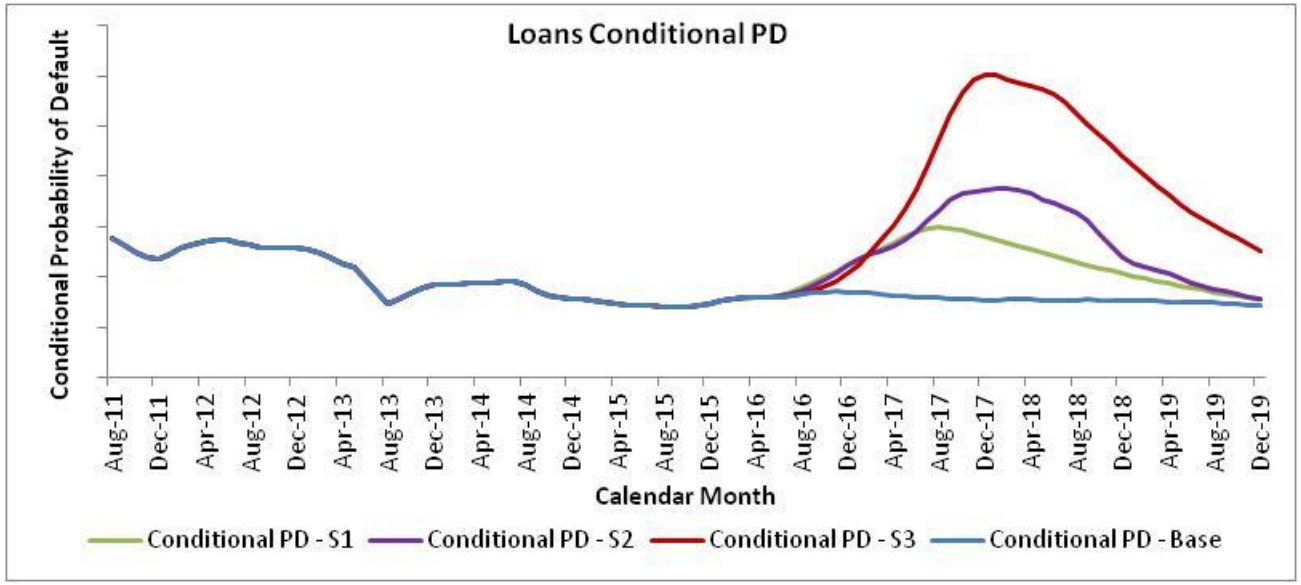


- Many statistical time series methods are based on the assumption that the time series can be made approximately stationary through the use of mathematical transformations.
- For a time series to be considered stationary it must have a fixed mean value with constant variance over time.
- When the independent variables are non-stationary, R-squared values and t-statistics no longer follow the usual distributions and can largely be misrepresented. Therefore hypothesis testing is not reliable and there is the risk of a spurious regression model being built.
- Many transformations that were tested including, amongst others, taking the difference, percentage change and ratio at different lagged periods.
- Each transformed exogenous series was modelled against the macroeconomic variables. However, all of these approaches raised challenges where either the back-test validation did not produce a sensible results or the forecasts were not intuitive and did not meet expectations.
- The short model build period available affects the robustness of the stationarity test as the data does not cover a full economic cycle (as illustrated in the figures above).
- Given these constraints, the final direction taken was to model the exogenous series without transformation. The resulting compromise to statistical robustness was mitigated through expert judgement.

Expert Judgement and Model Requirements

Measurement of expected credit losses

IFRS 9 Standard 5.5.17: An entity shall measure expected credit losses of a financial instrument in a way that reflects:
(a) an unbiased and probability-weighted amount that is determined by evaluating a range of possible outcomes;
(b) the time value of money; and
(c) reasonable and supportable information that is available without undue cost or effort at the reporting date about past events, current conditions and forecasts of future economic conditions.

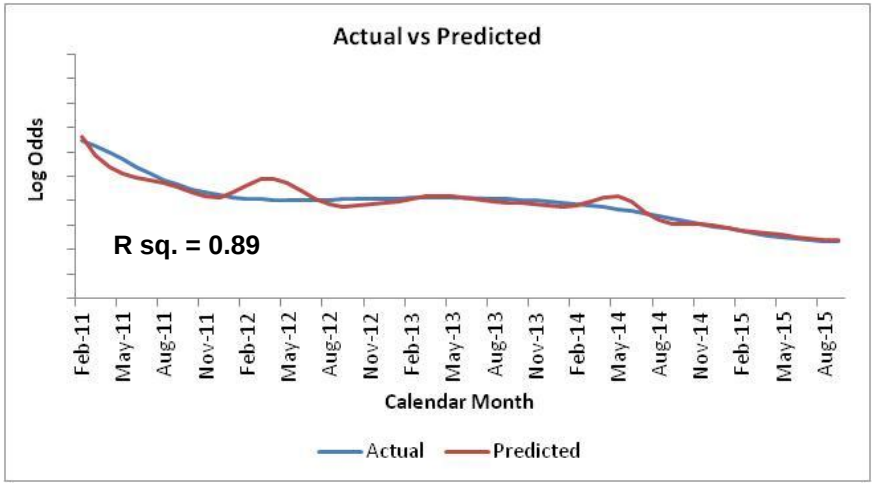


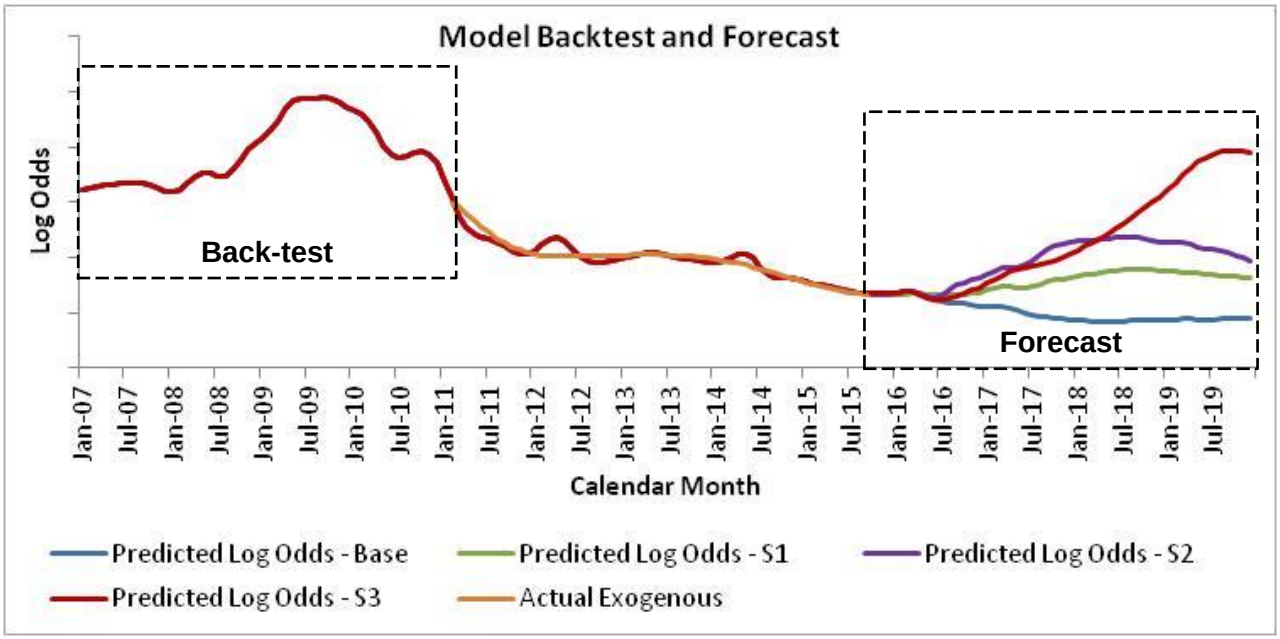
- The aim of the Exogenous model is to incorporate the impact of future economic conditions into the FiT PD curves.
- The requirement is a model that can be run for a number of different stressed scenarios (listed here as S1 to S3 although there can be any number of scenarios).
- These scenarios are then assigned probability weightings and combined to get the final PD estimates for use within the IFRS 9 provision calculations.

- From a Business perspective:
  - The macroeconomic variables in the model should provide an intuitive relationship against the Exogenous curve with intuitive sign for the parameter estimate.
  - The model should contain a good mix of growth and levels variables and any lagged variables considered should be an intuitive length.
  - Back testing the models should produce sensible results in comparison to known trends from other sources. For example data external to TSB.
  - The model should react appropriately to a range of stressed scenarios.

Initial Model (Stage 1 Model)

- An initial linear regression model was built on the original exogenous curve with no transformations. A number of transformations were also tested but all of these raised challenges where either the back-test validation did not produce a sensible results or the forecasts were not intuitive and did not meet expectations.
- Expert judgement was relied on to try to mitigate the compromises in statistical robustness.
- The initial model fit is illustrated in the figure on the right and the back-test and forecast is illustrated below.



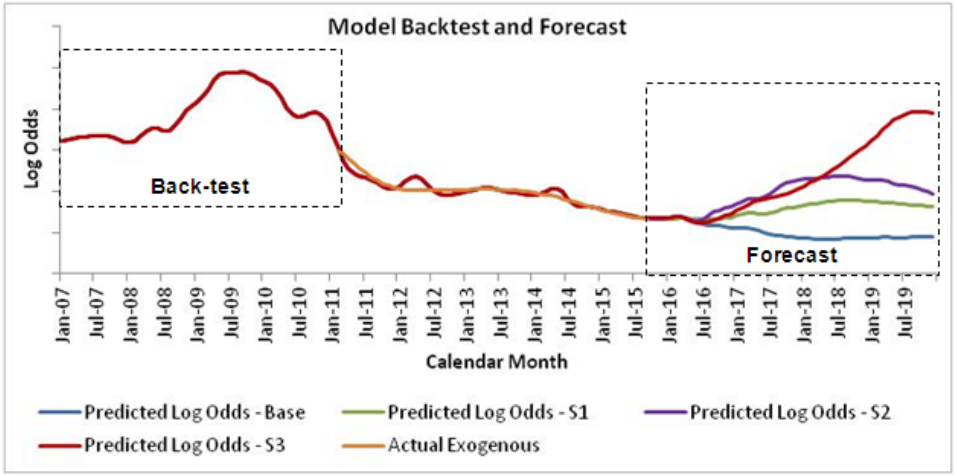


Initial Model Concerns

- From a Business perspective:
  - The macroeconomic variables in the model should provide an intuitive relationship against the Exogenous curve with intuitive sign for the parameter estimate.
  - The model should contain a good mix of growth and levels variables and if any lagged variables considered should be an intuitive length.
  - Back testing the models should produce sensible results in comparison to known trends from other sources. For example data external to TSB.
  - The model should react appropriately to a range of stressed scenarios.

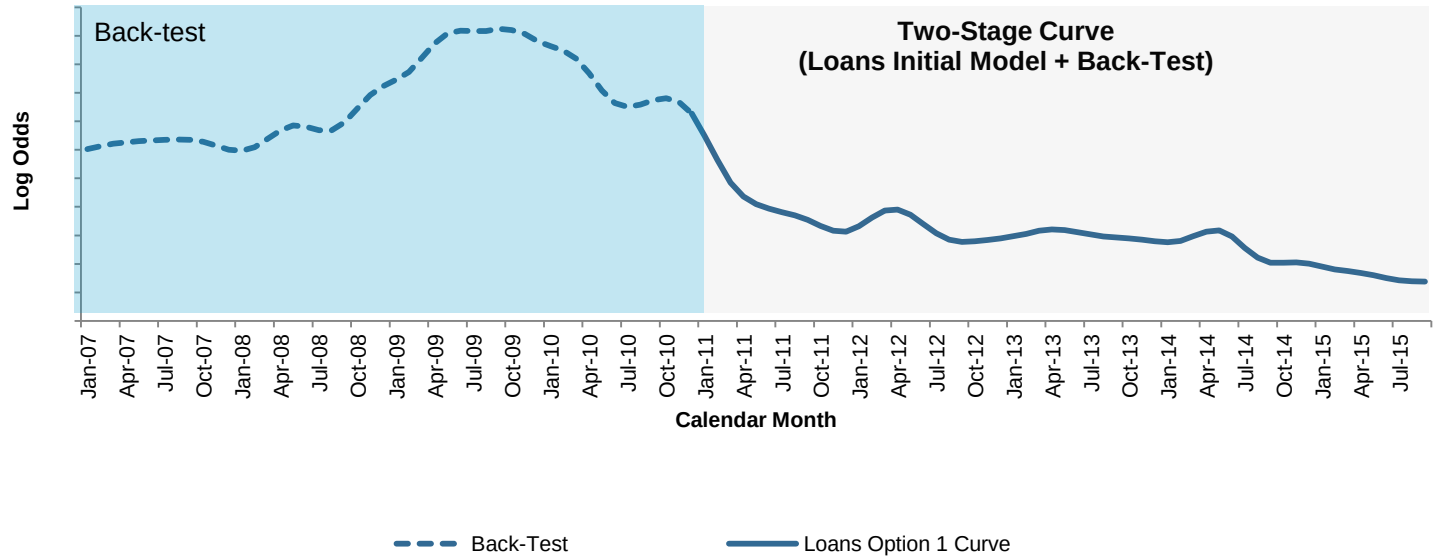
- The following concerns were highlighted for the model by internal experts:
  - The potential counter-cyclicality of some variables, which could move either way in a downturn depending on the economics behind it.
  - The lack of growth drivers within the model.
  - The peak seen in the most extreme stress scenario forecast is too delayed and does not align with business expectation.
  - There is a large lag between economic changes and the default rates which is not intuitive.

- The final agreed approach was constructing a two stage model approach.



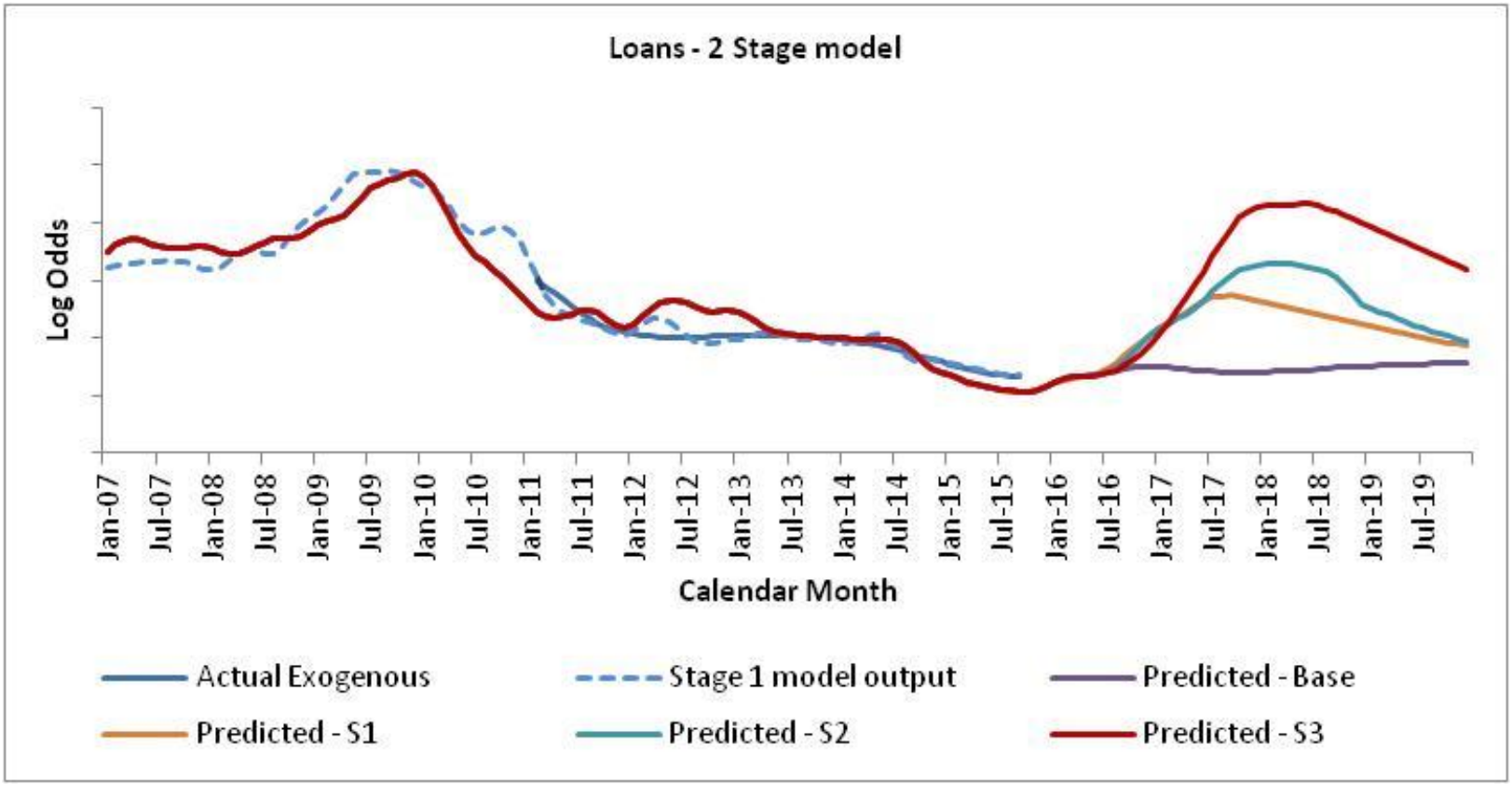
Proposed Two Stage Approach (Stage 2 Model)

- Given the limited sample which prevented a mix of variables entering the model, another approach is to extend the data sample by using the initial model built as a stage 1 model to provide an estimate of the exogenous series as the model provided a sensible trend for 2007-2011.
- A Stage 2 model was constructed on the combined sample of the back-test (Jan 2007 – Jan 2011) and the initial model estimates (Feb 2011 – Sep 2015).
- The final linear regression model is then based on a curve from 2007 to 2015 that therefore includes a wider range of economic conditions.



Stage 2 Model Fit

- The Stage 2 model provides a similar fit to the Stage 1 model (shown by the dotted line in the graph). However, the model now reacts in a more intuitive way to the stressed scenarios because it was possible to include a better mix of variables (including both growth and level variables) under the two stage approach.



Statistical Assumptions

- The model does not meet a number of the key statistical assumptions as illustrated in the table below.

Loans Model			
Statistic	**Result**		**Conclusion**
Stationarity	Single Mean	P value 0.988	Non stationary
Autocorrelation	Durbin Watson	0.071	High Autocorrelation
Normality of residuals	Shapiro-Wilk	P value 0.01	Reject Normality

- The Augmented-Dickey-Fuller (ADF) test was used to assess stationarity of the dependent variables used in the model and the conclusion was that the series is non-stationary.
- Autocorrelation: An assumption of standard linear regression is that the residuals are not autocorrelated i.e. they are independent over time. Autocorrelation is the property of a time series to be correlated to its own previous points separated by a given interval.
- Normality: another assumption of linear regression is that the residuals are normally distributed.
- These compromises in statistical robustness were mitigated through building many iterations of the model with expert judgement used to ensure that all explanatory variables entering the model are logical and that the parameters estimated have an intuitive directional trend against the drivers.
- The back-test and forecast results were used to validate the model.
- The aim of the Exogenous model is to incorporate the impact of future economic conditions into the FiT PD curves.

- From a Business perspective:
  - The macroeconomic variables in the model should provide an intuitive relationship against the Exogenous curve with intuitive sign for the parameter estimate.
  - The model should contain a good mix of growth and levels variables and if any lagged variables considered should be an intuitive length.
  - Back testing the models should produce sensible results in comparison to known trends from other sources. For example data external to TSB.
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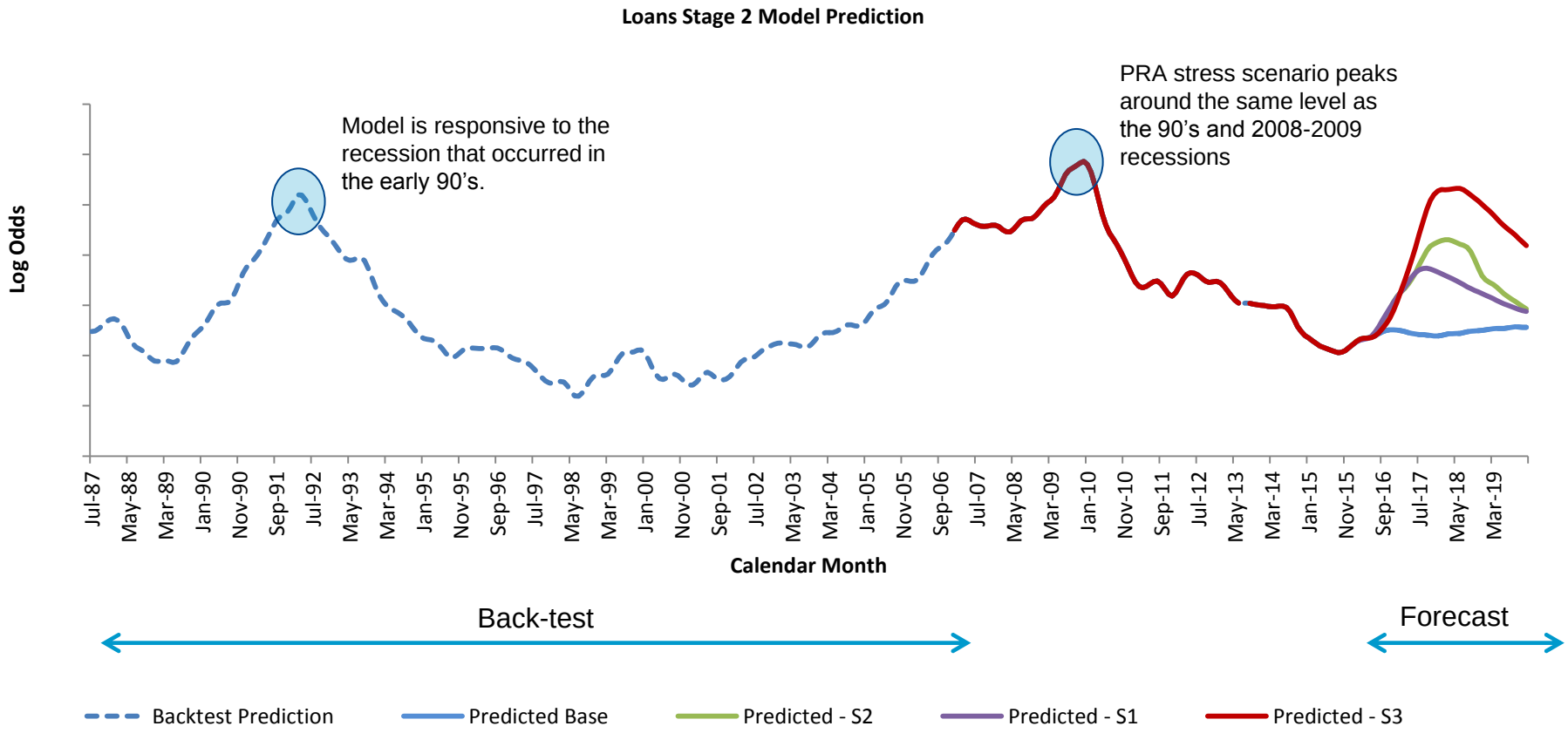
Stage 2 Model Back-test and Forecast



Conclusion

- This presentation describes the process of developing the economic component of an IFRS 9 Probability of Default model. Due to the limited data availability, the exogenous curve used to build the economic component only contained data from February 2011 to September 2015. This data sample does not span a full economic cycle.

- The approach was as follows:
  - An exogenous curve was derived as part of the overall PD model development.
  - An initial model was built on this 2011-2015 exogenous curve.
  - This model was then used to infer the performance between 2007 and 2011 to include a view of the impact from the recent recession.
  - A final model was built on a curve which combines the inferred estimates from 2007-2011 and the initial model estimates from 2011-2015.

- This presentation outlines the challenges that led to this approach being developed and how the final approach tried to balance compromises in statistical robustness with producing a model that was fit for business purposes.