BANK OF ENGLAND
PRUDENTIAL REGULATION
AUTHORITY

IRB Mortgages Round Table

5 October 2020

Opening

Scope

- IRB models used to calculate capital requirements for residential mortgage exposures.

Background

- Material changes to policy requirements and PRA expectations.
- PRA review of Hybrid mortgage models to date highlighted cross-firm modelling issues.
- Risks to implementation timelines due to COVID-19 and numerous modelling pressures.

Purpose

- Increase dialogue between PRA and firms before model submissions.
- PRA to provide further clarifications on common cross-firm modelling issues.
- Firms to highlight risks and challenges to development and implementation timelines.

Terms of Engagement

- This presentation does not set new PRA expectations.
- This presentation is not a detailed list of all modelling issues.
- Examples are stylised and aim to illustrate modelling issues and facilitate discussion. They are not step by step instructions.

Agenda

Topic	Presenter	Time (approximate)
Opening *Background, purpose and terms of engagement*	PRA	10m
Session 1: overall expectations for model change applications *PRA to provide an overview of expectations regarding completeness and quality of model applications*	PRA	10m
Session 2: Development of Hybrid PD Models *PRA to provide an overview of expectations, and highlight most common modelling issues, in the following areas:* ○ *Calibration* ○ *Measurement of Cyclicality* ○ *Modelling of sub-portfolios* ○ *Margins of Conservatism*	PRA	40m
Comfort break		10m
Session 3: Managing model developments *Firms to lead discussion on:* ○ *Most challenging areas of development* ○ *Key areas of focus from internal governance* ○ *Key risks to implementation timelines and PRA submission*	Firms	35m
Session 4: Development of LGD Models *PRA to provide an overview of expectations and highlight most common modelling issues, in the following areas:* ○ *Downturn periods* ○ *Probability of Possession Given Default* ○ *Use of Rating Scales* ○ *Treatment of unresolved*	PRA	40m
Close	PRA	5m

Overall expectations for model change applications

- Completeness of applications
- Quality of documentation

Model change applications

Completeness and Quality

- The PRA often receives model change applications that are incomplete or where documentation is not detailed enough to allow an assessment of compliance with CRR requirements and PRA expectations. This increases review timelines and delays model approval.
- The PRA is committed to processing high quality and on-time applications in order to allow implementation by the relevant deadlines. In order to facilitate this we will assess the completeness and quality of applications before initiating a detailed review. This initial assessment will be partly informed by firm meetings which we plan to hold within two weeks of submission.

Area	Further clarifications
Completeness of model change applications	• Model change applications to be submitted using the 'PRA pro-forma' and, as a minimum, include ○ summary of the material elements of the model change; ○ development and validation documents for non-defaulted and defaulted exposures (including BEEL); ○ materials presented to approval committee and associated minutes; ○ a self-assessment against all relevant provisions of the CRR, SS11/13, and applicable Regulatory Technical Standards and Guidelines; ○ a model monitoring framework, including tolerances and triggers; ○ a stress testing methodology (with indicative outputs where available); and ○ a high-level implementation plan.
Quality of documentation	• Model documentation should be sufficiently detailed and accurate to allow a third party to fully understand the rating system and assess compliance with CRR requirements and PRA expectations. • Model documentation should describe in detail all material aspects of the model development process, and be taken through appropriate internal challenge.

Development of Hybrid PD Models

- Calibration
- Measurement of cyclicality
- Modelling of sub-portfolios
- Margins of Conservatism

Model Calibration

Data adjustments and representativeness

- Firms are required to build models using data that are representative of their actual exposures. As a result, data needs to be representative of the current portfolio's risk profile.
- However, we observe that firms often struggle to meet this requirement because either:
  - they don't make the necessary adjustments to ensure representativeness; or
  - they don't provide enough evidence to demonstrate that any data adjustments are appropriate.
- Typically this can be achieved by providing a clear explanation for all data adjustments (or for decisions that no adjustments are necessary), and demonstrating that PD estimates remain appropriate for the portfolio.

Area	Further clarifications
Data representativeness	**Adjustments to internal data** • The data used to develop models needs to be representative of the firm's actual obligors or exposures. • Firms need to demonstrate that data adjustments (or decisions not to make adjustments) result in representative data being used. • Consideration should be given to changes in lending practices and the portfolio's risk profile over the economic cycle. For instance, forbearance activity is likely to be highly correlated with the economic environment with low volumes of forbearance activity observed during an upturn period and high volumes of forbearance activity observed during a downturn period. **Sampling and Exclusions** • The PRA notes that sampling techniques and data exclusions may be used due to data limitations. In these circumstances, the PRA expects firms to be able to demonstrate the appropriateness and prudence of modelled outputs for the overall portfolio.

Model Calibration

Data adjustments and representativeness - Example

- A firm uses all available data to back-cast internal default rates (DR) using third-party data.
- However, a more consistent relationship between internal default rates and third-party default rates is observed in the most recent years of data.

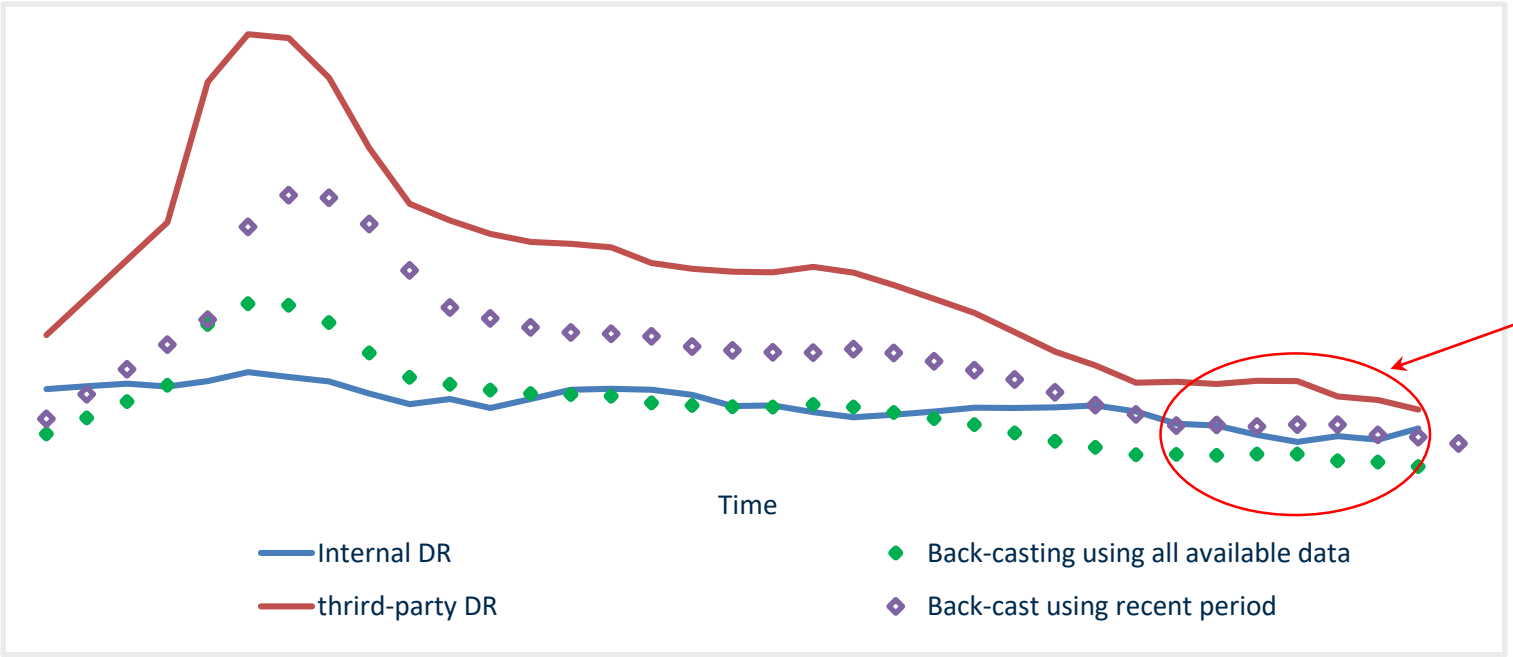


Illustration
More consistent relationship between internal DR and third-party DR

- Therefore, a more recent period should be used to link internal and external default rates.

Model Calibration

Back-casting methodology

- For UK residential mortgages, the PRA expects firms to estimate long-run PDs using a representative mix of good and bad periods ('economic cycle') which must include economic conditions equivalent to those observed in the early 1990s.
- In practice, most firms don't have a complete internal data series going back to the 1990s, and therefore need to use third-party data to back-fill the missing data (back-casting).
- The PRA has observed a high degree of complexity in back-casting methodologies. Whilst we understand the need for complexity, we often observe lack of detail explaining modelling decisions and evidence that modelled outputs remain appropriate and prudent as a result.
- Firms often struggle to demonstrate model compliance on an on-going basis when using highly complex approaches.

Area	Further clarifications
Back-casting methodology	• When internal data are not available over the economic cycle, a modelled relationship between internal default rates and third-party data sources can be used to back-fill the missing data, provided firms can adjust third-party data to reflect their own experience and default definition. • Firms should analyse the strength and consistency of the modelled relationship over time, make adjustments where necessary, and select the most representative period. • The PRA does not necessarily expect firms to use the full available data series when there is evidence that the relationship between internal default rates and third-party data changes over time.

Model Calibration

Back-casting portfolio default rates using a scalar approach

- The PRA observes that a common approach to model the relationship between internal data and third-party data is a scalar approach, i.e. where a simple ratio between internal default rates and third-party default rates is calculated over time ('observation period'). This scalar is then used to back-cast default rates.
- The PRA also notes there are two possible ways to calculate this scalar/ratio:
  - Option 1 (default-weighted): $$\text{Scalar} = \frac{\text{Average internal default rate during observation period}}{\text{Average third} - \text{party default rate during observation period}}$$
  - Option 2 (time-weighted): $$\text{Scalar} = \text{average}\left(\frac{\text{internal default rate}}{\text{third}-\text{party default rate}}\right)\text{during observation period}$$
- The CRR requires firms to estimate PDs by obligor grade from long run averages of one-year default rates. Therefore, each year should be weighted equally in the estimation of long run average default rates.
- By using the "ratio of the averages", and not the "average ratio", more weight is being given to years with high default rates. As a result, the appropriate approach to use **is option 2**.

Model Calibration

Back-casting grade-level default rates

- The PRA has set a maximum cyclicality assumption of 30% for the purpose of back-casting grade level internal default rates, where internal data are not available.
- This is typically achieved by taking a weighted average of back-cast 'Through-the-Cycle' (TTC) and 'Point-in-Time' (PIT) grade level default rates (70% TTC + 30% PIT).
- The PRA observes that firms often back-cast portfolio default rates and TTC grade-level default rates in two separate steps. Whilst we raise no concerns with this approach, firms need to ensure TTC grade level default rates are consistent with book level default rates.

What if internal grade level default rates are partially available for the economic cycle?

- The cap need only be used for the period of the economic cycle where grade level observed default rates are not available.
- Therefore, in this scenario grade-level PD estimates will be driven by observed and back-casted default rates.

Area	Further clarifications
Back-casting of grade level default rates	• The methodology for estimating back-casted grade level default rates under a 'through-the-cycle' assumption should not result in TTC grade level default rates inconsistent with book level default rates.

Model Calibration

Back-casting grade-level default rates - Example

Issue

- A firm's back-casting methodology results in back-cast TTC default rates that exceed 100% for certain rating grades.

Firm considerations

- The firm could consider applying their methodology without further adjustment, but this would not be appropriate if it resulted in implausible PD estimates for certain rating grades.
- The firm could consider capping back-cast TTC default rates in each rating grade at 100%, but this would lead to an inconsistency with back-cast portfolio default rates.

Possible Solutions

- Compensate for the application of a cap by uplifting default rates in other rating grades; or
- Develop an alternative back-casting approach that does not result in implausible estimates.

PRA approach

- The PRA would accept any reasonable approach which result in TTC grade level default rates consistent with book level default rates.

Model Calibration

Consistency of portfolio level PDs and the 30% cyclicality assumption

- To ensure a 30% cyclicality assumption where internal data are not available, a weighted average of back-cast 'Through-the-Cycle' (TTC) and 'Point-in-Time' (PiT) grade level default rates (70% TTC + 30% PIT) is commonly used.
- The PRA observes that firms often define a calibration period that includes all available internal data (the calibration period is used to estimate the PiT component of grade level hybrid PDs and is used to fix grade distribution from which the TTC component is estimated). This approach results in hybrid PDs being effectively calibrated to the average point of the calibration period.
- One potential consequence of this choice of initial calibration period is that PDs may by materially inconsistent with the 30% cyclicality cap calibration assumption at the point of model submission. In order to address this firms need to consider alternative options for selecting the calibration period.
- [NB: Theoretical 30% cyclical PD = 70% TTC + 30% Observed Default Rate]

Area	Further clarifications
Consistency between portfolio hybrid PD estimates and the 30% cyclicality assumption	• Firms need to ensure that the choice of initial calibration period does not result in PDs that are inconsistent with the 30% cyclicality cap calibration assumption.

Model Calibration

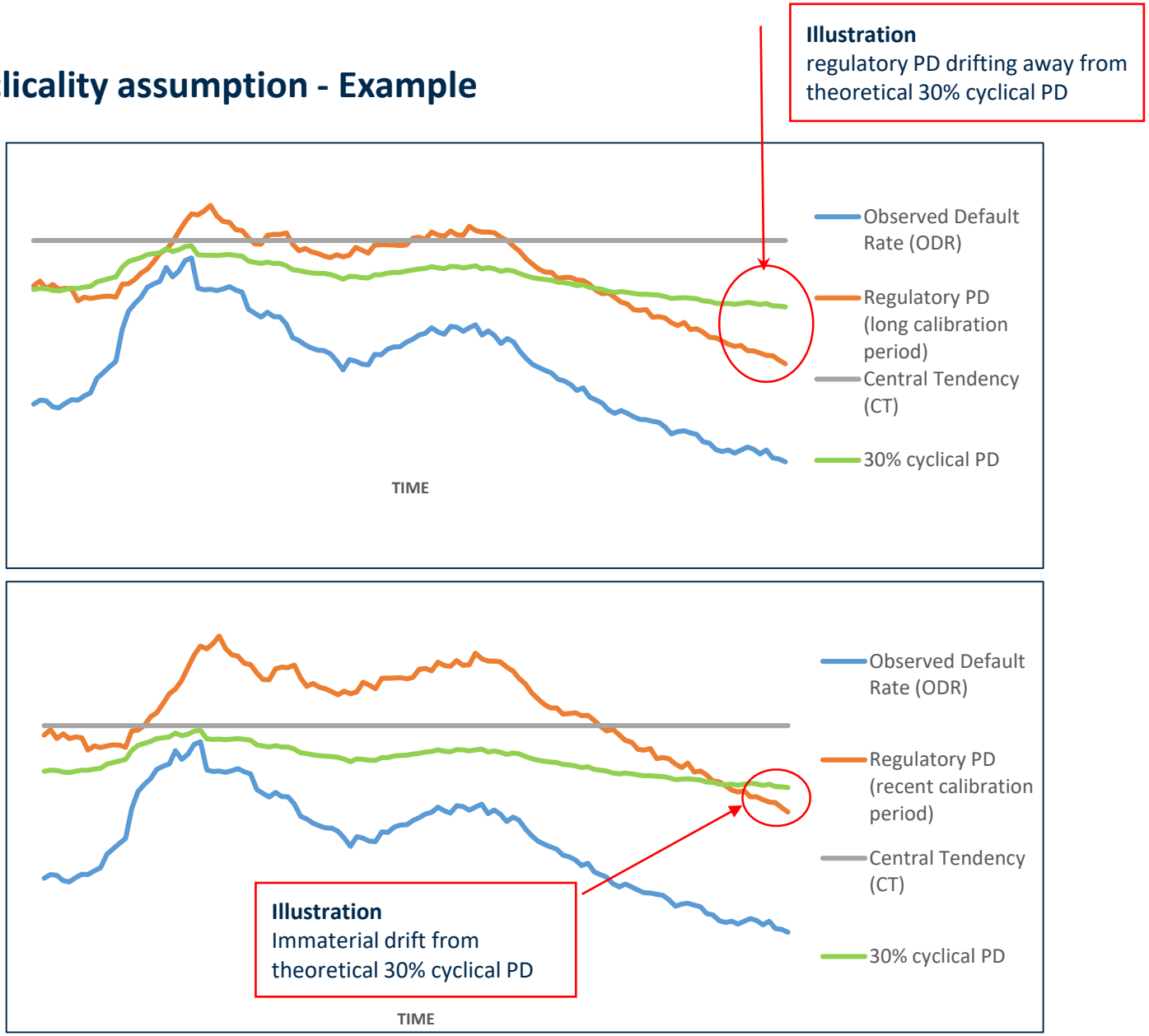
Consistency of portfolio level PDs and the 30% cyclicality assumption - Example

Issue

- A firm calibrates hybrid PDs using 2007-2019 as the calibration period. (This period is used to obtain PiT default rates and acts as a starting point to back-cast TTC default rates.)
- The true model cyclicality is above 30%.
- Default rates materially decline following the mid-point of the calibration period. This causes final portfolio hybrid PDs to materially drift away from a theoretical 30% cyclical PD.

Possible solution

- A reasonable approach to address this issue would be to use a more recent calibration period.
- The PRA would accept any reasonable approach which does not result in an underestimation of grade level PDs and ensures consistency with a 30% cyclicality assumption.



Measurement of Cyclicality

- The cyclicality of a rating system measures the extent to which changes in observed default rates through an economic cycle are reflected in portfolio PDs. The PRA has defined the cyclicality of a rating system as follows:

$$\text{cyclicality\%} = \left(\frac{\text{PD}_t - \text{PD}_{t-1}}{\text{DR}_t - \text{DR}_{t-1}}\right)$$

- For example, if a model is 30% cyclical then a 100bp increase in default rates will result in a 30bp increase in portfolio PDs.
- Cyclicality can also be understood in terms of the extent to which changes in default rates are reflected in the model. For example, a 30% cyclical rating systems assumes that:
  - 70% of the resulting change in portfolio level default rate is reflected in changes in grade level default rates (factors external to the model); and
  - 30% of the resulting change in portfolio level default rate is reflected in grade migration (model risk drivers).
- The PRA has observed that application of the cyclicality formula over a short period of time or a period of stable default rates can result in highly volatile outputs, and firms are adopting a range of approaches to address this.

Area	Further clarifications
Measurement of cyclicality	• Cyclicality should be measured in a robust way. This could include measuring over an extended period of time that is reflective of a significant change in default rates. • Firms should, as a minimum, measure of cyclicality for each rating system in a way that is consistent with SS11/13, which reflects all non-defaulted exposures, and which is based on the final regulatory PD. This does not prevent firms developing other measures of cyclicality where considered appropriate.

Measurement of Cyclicality

Example

Issue

- A firm measures model cyclicality over a short time period (e.g. quarterly) and observes highly volatile and extreme values (e.g. >100%, <0%).

Firm considerations

- The firm could consider making no adjustments, but the cyclicality measure would not be a useful metric.
- The firm could consider excluding outliers but this along may not make the estimates reliable.
- The firm could also consider taking an average of the quarterly data, but this may put undue weight on periods where default rates are relatively stable.

Possible Solutions

- Consider measuring cyclicality over a longer time period during which default rates materially changed.
- Consider separate measures over both increasing and decreasing periods of default rates where data is available.

PRA approach

- Firms should at a minimum adopt a robust cyclicality measure that is consistent with SS11/13. Other measures can also be used when considered appropriate.

Modelling of sub-portfolios

Non-prime, run-off and non-UK exposures

- The PRA has set out a number of expectations relating to 'low historical data' portfolios and run-off portfolios. These expectations mean that:
  - ‘Low historical data’ portfolios and prime portfolios should not normally be combined within the same rating system.
  - The calibration of ‘low historical data’ portfolios needs to result in a sufficient degree of uplift in PDs relative to comparable mortgages in the firm’s prime portfolio (regardless of whether the ‘low historical data’ portfolios are combined in the same rating system).
  - Non-UK portfolios should be treated as ‘low historical data’ portfolios where there are insufficient internal or external data to directly calibrate reliable long-run average PDs.
  - Estimates for Portfolios in run-off need to reflect how the current portfolio would perform through an economic cycle. Where there is insufficient data to calibrate PDs then ‘low historical data’ portfolio techniques should be applied.
- However, we observe that firms often:
  - Combine these exposures with prime within the same rating system and calibration.
  - When using prime data to back-cast default rates, do not demonstrate the appropriateness of the modelled relationship over time.
  - Do not take into account the expected behaviour of run-off portfolios going forward.
  - Do not demonstrate why a margin of conservatism is not necessary.
  - When applying a margin of conservatism, do not demonstrate that the degree of uplift in PD estimates is sufficiently conservative.
- The PRA will assess the degree of uplift in ‘low historical data’ portfolio PDs relative to comparable mortgages in a firm’s prime portfolio.
- Firm should provide detailed evidence supporting modelling decisions and final modelled outputs.

Modelling of sub-portfolios

Non-prime, run-off and non-UK exposures

Area	Further clarifications
Modelling of sub-portfolios	• Firms should not normally combine 'low historical data' and prime exposures in the rating system. Where they are combined firms need to demonstrate there is an appropriate level of risk differentiation for the 'low historical data' portfolios over time. • Firms need to ensure that there is an appropriate uplift in PD estimates for 'low historical data' portfolios such as BTL, Self-certification and Sub-prime relative to comparable mortgages in the prime portfolio. • The calibration of run-off portfolios should reflect how the current portfolio would perform through an economic cycle. One way to achieve this is through an appropriate margin of conservatism. • Firms should demonstrate final hybrid PD estimates are appropriate and conservative for material sub-portfolios

Margins of Conservatism (MoC)

Quantification of PD, LGD and EAD estimates

- In order to comply with the EBA Guidelines firms will need to identify all margins of conservatism in each model and categorise them according to the criteria set out in the Guidelines.
- The PRA notes work will be required to quantify and classify margins of conservatism. However:
  - we do not anticipate that the EBA Guidelines will necessarily lead to increases in the overall level of margins of conservatism, except where firms have not previously identified all model deficiencies or have under-estimated MoCs; and
  - we do not envisage that it will normally be necessary for firms to develop complex approaches in order to quantify MoC.
- Consideration should be given to how MoC are incorporated in PD estimates and how this impacts model cyclicality.

Development of LGD Models

- Identification of a downturn period
- Probability of Possession Given Default
- Use of Rating Scales
- Treatment of unresolved

Downturn LGD

Identification of a downturn period

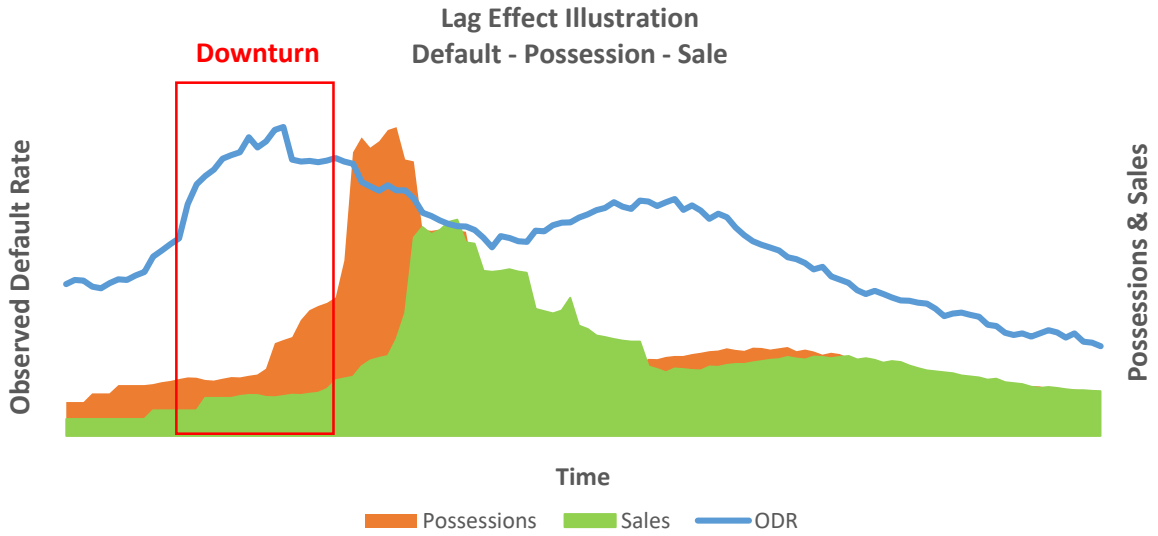
- The CRR requires firms to estimate LGD parameters which are representative of an economic downturn.
- The PRA expects firms to meet this requirement in line with the EBA guidelines and SS11/13. Moreover, the draft RTS on economic downturn specifies a process for identifying the downturn that will need to be followed following application of the RTS in the UK.

How should the economic downturn be identified for mortgage LGD

- Firms should examine economic indicators over the previous twenty years, or if necessary longer, and determine an economic downturn.
- It is likely that firms will need to continue using a component-based approach for residential mortgage exposures. When applying a component based approach the same economic downturn should be used for each component; however, time lags should be taken into account so that the peak value within the same downturn is used for each model component.
- Firms will additionally need to adjust downturn collateral haircuts and PPGD estimates in order to ensure that they are consistent with the PRA's minimum 25% peak-to-trough decline in property value expectation. A minimum 5% decline in property value should also be applied where relevant.
- The PRA expectation that firms should use economic conditions equivalent to those observed in the UK during the early 1990 is specific to the estimation of PD.

Downturn LGD

Identification of a downturn period



What if component level downturn estimates are lower than observed peak values?

- The peak value of each component should normally be used if where that peak is caused by the selected economic downturn.
- We would not necessarily expect firms to use a peak value where they can demonstrate that it is not related to the selected economic downturn (but peaks not related to downturns can indicate data representativeness issues).

Area	Further clarifications
Identification of a downturn period	• A minimum 25% peak-to-trough market decline in property value should be used in collateral haircut and PPGD estimates. This may require firms to uplift collateral haircut and PPGD initial downturn estimates (i.e. estimates over the selected downturn period). • It is likely that firms will need to continue using a component-based approach for residential mortgage exposures, the same downturn should be selected for each model component, and time-lags should be considered to ensure that peak values within the select downturn are chosen for each component. • If final component level estimates are lower than observed peak values firms need to demonstrate that the peak is not related to the selected economic downturn.

Downturn estimates

Probability of Possession Given Default (PPGD)

- The PRA has set an expectation that PPGD models should reflect downturn conditions that are consistent with a minimum 25% peak-to-trough house price deflation in property values. To ensure that LGD model estimates applied today reflects losses that would likely be incurred in a downturn this need to be applied to both:
  - **Grade allocation**: allocating exposures to rating grades in line with a minimum 25% peak-to–trough house price deflation (i.e. using a downturn LTV to assign exposures to grades – not applicable if using an origination LTV approach)
  - **Grade level possession rates**: Calibrating grade level possession rates to the downturn period and a minimum 25% peak-to–trough house price deflation. If during the selected downturn period the reduction in property values is not consistent with a minimum 25% peak-to–trough house price deflation, grade level possession rates must be uplifted to meet this expectation.

Area	Further clarifications
Probability of Possession Given Default	• Grade allocation and the calibration of grade level possession rates need to reflect minimum 25% house price peak-to-trough decrease in property values. • A minimum 5% decline in property values should be applied at all times when allocating exposures to grades. • Should PPGD grades be less sensitive to property values (e.g. origination LTV), the firm must demonstrate the model achieves similar outcomes as it would if it was using current property values (indexed LTV) to assign exposures to rating grades, including in stressed scenarios. • When enough internal data is not available, firms should consider applying an additional margin of conservatism.

Downturn LGD

Probability of Possession Given Default – Example

Step 1: Identification of Downturn Period

- For simplicity, indexed LTV is the only model risk driver used to allocate exposures to PPGD rating grades.
- Observed possession rates are calculated for each rating grade using the identified downturn period.

Step 2 – Grade level PPGDs and alignment with 25% HP deflation

- The identified downturn period is not representative of a minimum 25% peak-to-trough house price deflation.
- Therefore, the firm uplifts grade level possession rates to reflect this expectation.

Step 3: allocation of exposures across grades

- The downturn LTV, i.e. the exposure LTV calculated using a minimum 25% peak-to-trough reduction in property value, is used to allocate exposures across PPGD grades.
- A minimum 5% decline in property values is applied at all times.

Downturn LGD

Interaction of margins of conservatism, downturn uplifts, and PPGD reference points – Examples

Example 1

- Relevant data covering the identified downturn period
- Sufficient possession and default data to robustly model PPGD

- **Uplift** to grade level PPGD estimates required if downturn period not consistent with a minimum 25% peak-to-trough decline in property values
- Margins of conservatism should be considered to address risk of estimation errors / specific modelling deficiencies

Example 2

- Incomplete data covering the identified downturn period
- Sufficient possession and default data to robustly model PPGD

- **Uplift** to grade level PPGD estimates required if downturn period not consistent with a minimum 25% peak-to-trough decline in property values
- A specific **margin of conservatism** should be added to PPGD estimates to mitigate the lack of internal downturn data
- Additional margins of conservatism should be considered to address risk of estimation errors / specific modelling deficiencies

Example 3

- Low volumes of defaults or possessions prevents robust modelling of PPGD

- The firm should consider using the PPGD reference points (70% or 100%)

Downturn estimates

PPGD – use of origination LTV

- Firms can choose to incorporate origination LTV into PPGD estimates.
- Should PPGD grades be less sensitive to property values (e.g. as a result of origination LTV), the firm must demonstrate the model achieves similar outcomes as it would if it was using current property values to assign exposures to rating grades, including in stressed scenarios.
- Firms do not need to develop an alternative model to make this comparison but do need to include relevant analysis in their model development documentation. This could include, for example:
  - segmenting observed possession rates per indexed LTV during the identified downturn period ('indexed LTV grades');
  - uplifting indexed LTV grade possession rates to be consistent with a minimum 25% peak-to-trough house price decline in property values;
  - allocating current exposures to each indexed LTV grade consistent with a minimum 25% peak-to-trough house price decline in property values and a minimum 5% decline in property value at all times; and
  - calculating the implied current PPGD and comparing with the outputs from the proposed model for the whole portfolio.

Downturn estimates

PPGD – treatment of unresolved exposures

- The PRA expects LGD estimates to take into account the most up to date experience. Therefore, all relevant data should be used irrespective of significant incomplete workouts (i.e. defaulted exposures for which the recovery process is still in progress and where final realised losses are not yet certain).
- A key modelling assumption of PPGD is that defaulted exposures will either end up cured or possessed. However, even after a long outcome period, a small proportion of defaulted exposures could remain unresolved (i.e. not cured or possessed at the end of the outcome period).
- Therefore, an appropriate estimation of PPGD requires making assumptions for unresolved accounts. The most conservative approach consists of classing all these exposures as a possession event. On the other hand, the least conservative approach consists of classing all these exposures as a cure event.
- The PRA continues to observe that some firms do not focus sufficiently in this aspect of modelling and, as a result, provide very little evidence on the treatment of unresolved exposures. This is typically achieved using a vintage analysis where the behaviour (cure or possession) of unresolved accounts is extrapolated using all relevant data.

Area	Further clarifications
Treatment of unresolved exposures	• PPGD estimates should reflect the most up to date experience, therefore estimation will require analysis of incomplete workouts. • The PRA expects firms to produce robust analysis in supporting the treatment of unresolved exposures for the purpose of estimating PPGD. Consideration should also be given to the impact of unresolved accounts in final 'time to' estimates.

Use of Rating Scales

PD & LGD estimation

- The CRR allows the use of either continuous or discrete rating scales in the quantification of PD and LGD estimates.

Discrete rating scales for LGD models

- The use of discrete rating scales for assigning LGDs to exposures can potentially lead to underestimation at portfolio level where significant concentrations within grades are or could be observed. As a result, firms using a discrete rating scale for LGD that could result in excessive concentration should demonstrate that:
  - the approach provides adequate risk capture through time; and
  - changes in the LGD distribution within each grade would not lead to capital under-estimation through time. One way of demonstrating this is to compare LGD estimates per grade using a continuous vs a discrete approach.