



# IFRS9 Data analytics

**A machine learning early warning system for  
trend recognition and portfolio optimisation**

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# IFRS9 day 2 lessons

## The need for management information (MI)

During the last 4 years, the industry has focused on developing models and production systems that would be compliant with the standard

The new impairment model has a significant impact on the ROI, banks need a strategic view of IFRS9 post implementation

However, not enough attention was put on timely and flexible MI to allow banks to understand better the IFRS 9 impact on their businesses, capital management and strategic planning

Banks want to become more proactive in the management of the volatile IFRS9 impairments (in a broader context of tightening margins and more strict capital requirements). The industry is looking for:

**Faster computing:** current runtimes prevent simulation environments and early warning systems to be used as risk management tools

**Trend recognition :** IFRS 9 is data intensive and the models are complex and highly dimensional. It is difficult to find useful patterns in the data that would allow them to reduce introduced volatility



### Volatility drivers

- Identifying the main ECL drivers
- Disentangling the effect of individual parameters
- Testing sensitivity to assumptions made



### Regulatory requirements

- Responding to increasing scrutiny from regulators
- Answering complex disclosures requests e.g. PRA disclosures and sensitivity to macro-economic variables (MEV)



### Management information

- Understanding IFRS 9 impact on business
- Proactive IFRS9 impairment management
- Strategic planning and decision making

# Current challenges in MI production



## What if scenarios and operational risk

- Ad-hoc copies of production systems add a considerable operational risk when running multiple scenarios
- Current approach is mainly based on hard coding implementation
- One man risk and human error are constantly delaying deliveries
- **Version control** and **reproducibility** is covered for production systems, but often not guaranteed for MI systems



## Calculation speed

- Current systems not conceived for speed nor flexibility
- **Calculations time prevents multiple scenarios runs**
- it is common to observe 8 to 12 hours for single runs for medium size portfolios.
- Implementation efficiency: How to run multiple scenarios in shorter periods of time?
- Cloud implementation and scalability + migration to new languages



## High dimensionality and trends

- Complex and high dimensional models often make difficult to interpret scenario results
- On BAU, ECL attribution remains a challenge: What is driving my ECL changes between reporting periods?
- Data mining, volatility understanding and trends identification are an expensive and time consuming tasks for analysts.
- **Machine learning can improve early warning systems and scenario analysis and be used for portfolio optimisation.**

# Our simulation environment (1/2)

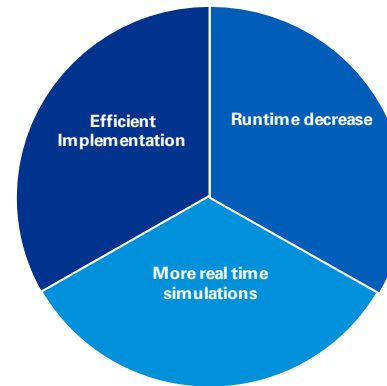
## Increasing calculation speed

Calculations run time remains the main challenge for organisations, limiting the capacity of running multiple scenarios. Depending on the portfolio size, runtimes vary between **hours and days**.

First implementations were not conceived to be fast and rely on legacy systems. However, banks are exploring “new” technologies (R, Python)

Matrix calculations – suited for IFRS9 type models- dramatically reduce run time (**3 hours SAS 9.4 vs 90 seconds in R**)

Run time reduction allows real time simulation environments. Cloud computation further increases the benefits ( 2 million lines portfolio running on AWS and Azure in approx. 100 seconds)



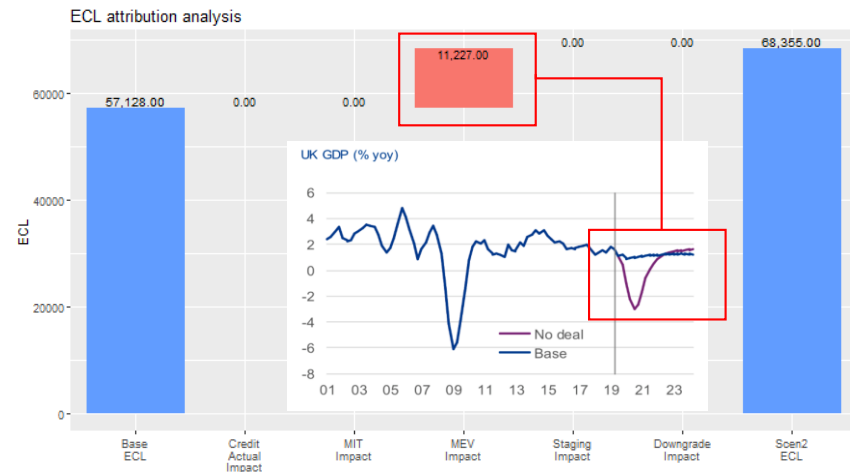
## Early warning system - Macroeconomic Scenarios

Real time simulation environments allow integration of multiple macroeconomic shocks within early warning systems. These shocks are often based on scenarios prescribed by regulators.

However, these scenarios often focus on main macro variables and don't include other variables used by banks models. Lack of transparency and consistency in scenario expansion through satellites models.

We integrated a **Dynamic Latent factor scenario expansion model (DFM)** in our simulation environment.

A full variable set forecasts can be automatically conditioned on major macro variables provided by PRA.



# Our simulation environment (2/2)

## Trend recognition with machine learning

Banks are often not able to explain main drivers of ECL changes on a portfolio basis; even less on a more granular basis.

Traditional view of MI (human based data mining) has proven to be inadequate and machine learning techniques appear to be a solution to find patterns that can potentially drive business decisions.

**Example:** an early warning system that identifies the instrument level characteristics that would suffer the highest ECL increases under a stressful macroeconomic environment could lead to changes in lending politics to limit the future increase in ECL.

## Our approach:

We have developed a machine learning based MI system that reveals patterns based on a combination of instrument specific under a certain scenario.

Classification algorithms have been applied to identify clusters that exhibit the highest ECL changes:

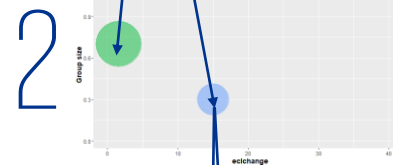
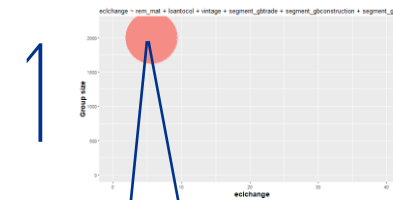
- The “random forest” algorithm clusters the data in segments that exhibit different increases.
- From the global population, the user can gradually split the trees and see a cluster description. Machine learning meets data visualisation

**Example:**

### Global population

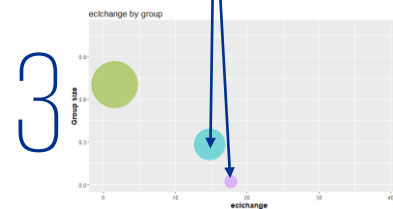
**X-axis.** Cluster size

**Y-axis.** Cluster average ECL increase



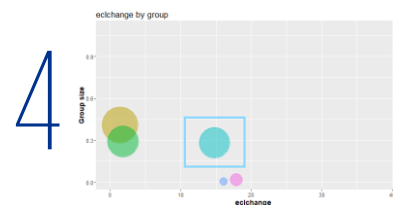
### First split

2 clusters: different ECL variation based on Instrument level data (segment, product type, etc.)



### Second split

Further splitting on more sensitive cluster



### Fourth split

Blue cluster - Significant portion of portfolio (30%) exhibits material increase in ECL (15%).

**What is this cluster?**

# Putting it all together: identifying sensitive cluster under hard Brexit scenario (1/2)

## Credit actuals data set

Approx. 2 million instruments from different segments (retail products, corporate bonds and loans, and trade finance products). Reporting date is 31/12/2018

Data set contains instrument level information: Vintage, remaining maturity, product type, collateral value, loan to value, fixed/floating interest rate, etc.

Each portfolio has 4 Point in Time models (PD, LGD, EAD and Prepayment) which are impacted by macro economic predictions.

## Scenarios

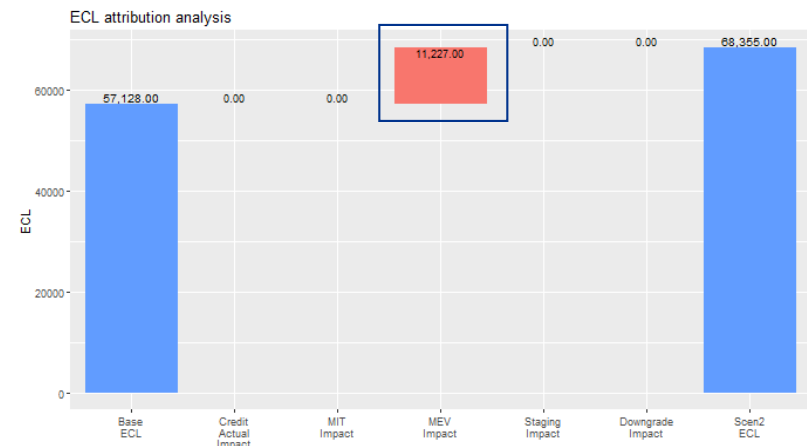
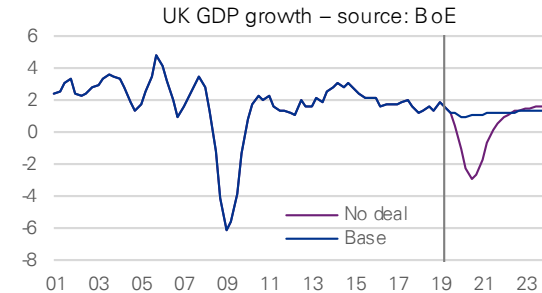
The bank wants to identify the clusters that would drive the ECL increase in case a no-deal Brexit. Two macro scenarios are run on the data set:

- Base: forecasts for each variable were generated by our dynamic expansion model out to 20 quarters ahead (Q1 2019 – Q3 2023).
- No deal scenario: we use the Bank of England’s “Disruptive” no deal scenario paths for UK GDP, UK Bank rate and GBP/Euro exchange rate, and allow our expansion model to solve for consistent paths for the remaining 7 variables used by the point in time models.

## Portfolio level Results

In case of materialisation of no-deal scenario, the portfolio ECL will increase by **20%**, compared to current base scenario. This is expected.

**But, can the bank take management actions to reduce the upcoming increase in ECL?** Sensitive clusters must be identified in order to design the Bank’s mitigation strategy.



Runtime on AWS: 100 seconds

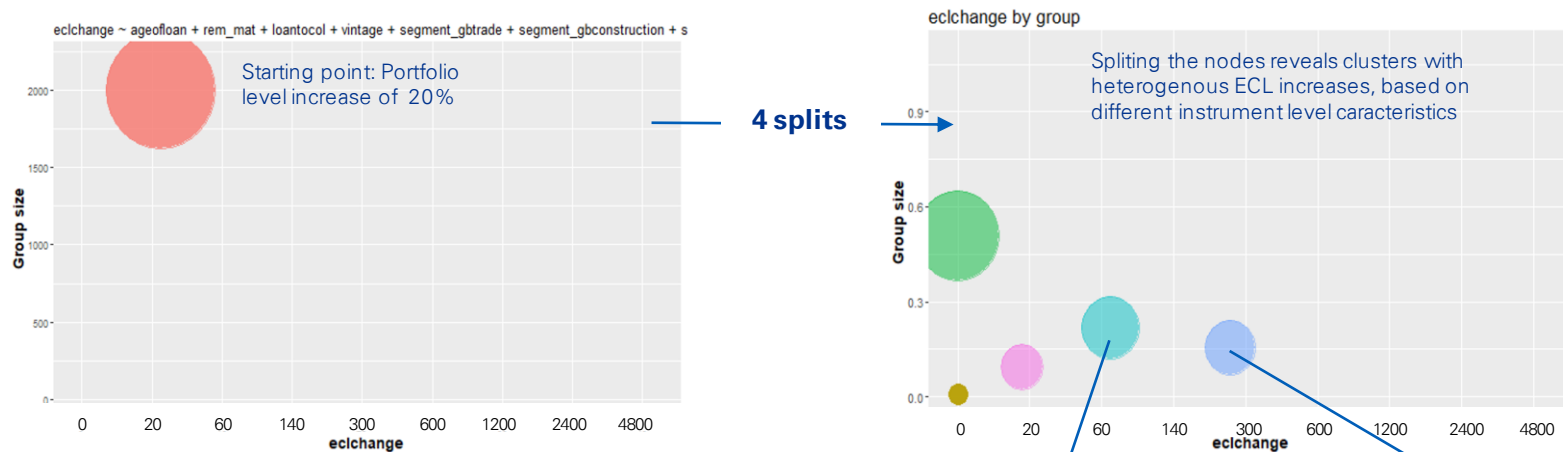


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# Putting it all together: identifying sensitive cluster under hard Brexit scenario (2/2)

## Trend recognition with machine learning

A random forest is fit on the data set; The relative ECL change is set as the target variable and the model features are selected from the credit actuals data set. Specific combinations of vintages, product types and LTV buckets for both the retail and the international trade portfolio are identified as highly volatile (up to +300% ECL increase).



### Mainly insensitive (+2%)

- Retail mortgage book where current loan to values are below 82%. Decrease in HPI is not enough to start triggering losses
- Pre 2017 vintages.
- Slight increase in ECL mainly driven by PD increase due to strong Unemployment Rate deterioration.
- 48% population

### Average sensitive (+20%)

- Corporate B onds and Loans are impacted by the worsening macroconditions
- Main driver is the PD increase, highly sensitive to the GDP growth

### Highly sensitive (+65%)

- Trade finance portfolio is impacted by the worsening of Exchange rates
- Exchange rates scenario increasing the PDs from UK buyers
- CCF also increases due to exchange rate deterioration, having a material Impact on credit lines with a low utilisation rate

### Extremely sensitive (+300%)

- 2018 retail mortgage vintage, around 15% of the portfolio
- LTV of these new mortgages are between 82% and 90% as per Bank strategy
- Decrease in HPI is strong enough to start triggering Losses, massively increasing the LGDs, and ECL by a factor of 3

# Possible management actions

## Facts

Mainly insensitive (+2%)	Average sensitive (+20%)	Highly sensitive (+65%)	Extremely sensitive (+300%)
<ul style="list-style-type: none"> <li>— Retail mortgage book where current loan to values are below 82%. Decrease in HPI is not enough to start triggering losses</li> <li>— Pre 2017 vintages.</li> <li>— Slight increase in ECL mainly driven by PD increase due to strong Unemployment Rate deterioration.</li> <li>— 48% population</li> </ul>	<ul style="list-style-type: none"> <li>— Corporate Bonds and Loans are impacted by the worsening macroconditions</li> <li>— Main driver is the PD increase, highly sensitive to the GDP growth</li> </ul>	<ul style="list-style-type: none"> <li>— Trade finance portfolio is impacted by the worsening of Exchange rates</li> <li>— Exchange rates increasing the PDs from UK buyers</li> <li>— CCF also increases due to exchange rate deterioration, having a material Impact on credit lines with a low utilisation rate</li> </ul>	<ul style="list-style-type: none"> <li>— 2018 retail mortgage vintage, around 15% of the portfolio</li> <li>— LTV of these new mortgages are between 82% and 90% as per Bank strategy</li> <li>— Decrease in HPI is strong enough to start triggering Losses, massively increasing the LGDs, and ECL by a factor of 3</li> </ul>

## Actions

Mainly insensitive (+2%)	Average sensitive (+20%)	Highly sensitive (+65%)	Extremely sensitive (+300%)
<ul style="list-style-type: none"> <li>— Increase is limited , no action required</li> </ul>	<ul style="list-style-type: none"> <li>— <b>Consider selling UK corporate bonds</b> at discount and replace by other products, if the P&amp;L Impact from discount bonds is lower than the P&amp;L Impact from the ECL increase.</li> </ul>	<ul style="list-style-type: none"> <li>— The Bank has granted several credit lines that are currently unutilized (Utilisation rate below 20%)</li> <li>— Consider <b>reducing these credit Limits</b> to limit the absolute impact of a CCF increase</li> <li>— Reducing credit limits reduces EAD and ECL.</li> </ul>	<ul style="list-style-type: none"> <li>— <b>Revisit the LTV policies</b> for future mortgage origination, ensuring that the threshold effect observed on LTV higher than 85% is avoided. Important considering that the portfolio is growing fast</li> <li>— <b>Deleverage the current portfolio</b> (vintage 2018) .Discount sell Impact on P&amp;L is expected to be largely lower than impact on P&amp;L from ECL increase</li> </ul>

**The early warning system results can be embedded into business decision and management actions. The simulations are running on real time and the bank knows the impact of the updated macroeconomic scenarios on the P&L before the next reporting date. The management actions are expected to reduce the total P&L impact: ECL increase 5% - 10% vs 20% initial expected increase**

# Conclusions

- **IFRS9 requires better MI:** Post IFRS9 implementation, not enough attention was put on timely and flexible Management Information (MI) to allow banks to understand better the IFRS 9 impact on their businesses, capital management and strategic planning.
- **Leveraging new technologies;** banks should consider efficient implementation as a priority for their MI and simulation environments. Banks are currently struggling to get insights from their data or respond to regulatory requests, and new technologies and languages appear as alternatives to rigid and expensive legacy systems
- **Combining machine learning with MI:** IFRS9 models are complex and highly dimensional. In addition to modelling purposes (Scorecards, point in time models), machine learning can be combined with data visualisation to produce insights that can trigger business decisions
- **Early warning for impairment management:** Faster and integrated simulation environments open new possibilities. Real time early warning systems will allow banks to improve their impairment management, and to embed IFRS9 into the business
- **Optimisation under IFRS9 and Basel IV:** Portfolio optimisation under IFRS9 will become a key element of the banks credit risk management. This is not limited to actions triggered from early warning systems, but should include other optimisation possibilities (i.e. collateral allocation) and the interaction between IFRS9 Impairment and regulatory capital post Basel IV.



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