Let’s Look at the Broad Picture
Macroeconomics in Credit Risk

Hristiana Vidinova
30 November 2016
Agenda

- IFRS 9 Macro Challenges
- IFRS 9 Methodologies
- Examples
Challenges

- Data
- Level of Detail
- Scenarios
- Forecasts
- Complexity
- Functional Forms
<table>
<thead>
<tr>
<th>Capture full macro scenario</th>
<th>Challenges</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Include just 1-2 macro variables in credit models</td>
<td>• Include a rich set of variables to capture a broad macroeconomic picture</td>
</tr>
<tr>
<td></td>
<td>• Low sensitivity to stress tests</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capture specifics</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Include regional macroeconomic data</td>
</tr>
<tr>
<td></td>
<td>• Labour market for consumer credit</td>
</tr>
<tr>
<td></td>
<td>• HPI for mortgages</td>
</tr>
<tr>
<td></td>
<td>• Include industry-specific data especially for corporate credit</td>
</tr>
</tbody>
</table>

- **Challenges**
  - Include just 1-2 macro variables in credit models
  - Low sensitivity to stress tests

- **Recommendations**
  - Include a rich set of variables to capture a broad macroeconomic picture
  - Include regional macroeconomic data
  - Labour market for consumer credit
  - HPI for mortgages
  - Include industry-specific data especially for corporate credit
- Cleaning and standardizing macroeconomic models for Turkey

- Fully integrating with global models: Economic activity, Trade flows, Prices, Interest rates

- Enhancing the core model by: adding equations for economic variables particularly related to credit risk (e.g. retail models for related to unemployment, wages/household incomes, house prices)

- Supplementing with “satellite” models to generate more granular forecasts (e.g. for geographical regions or demographic groups)
The country models have complete demand and supply sides, also full asset structures

Rational expectations options
- Financial markets
- Labour markets
- Consumption

Country Linkages
- Trade and competitiveness
- Interacting financial markets
- Through international stocks of assets

Supply-side
- Based on CES relationship between capital (K) and labour (L), embedded in a Cobb-Douglas framework with oil (M)

Government
- Direct and indirect taxes, government spending and interest payments.
- Tax rule to ensure long run solvency
Economic Data
A Sample Dataset for Turkey

Macro Factors
- GDP
- Components of demand
- GDP per capita
- Headcount employment by sector
- Value added output by sector
- Total productivity
- Total population
- Working age population
- Workforce
- Unemployment rates
- Unemployment level
- Employment rate
- Participation rate
- Residence based retail sales
- Area
- Population density

Sectorial Classification
- Agriculture Forestry & Fishing
- Mining & Utilities
- Manufacturing
- Construction
- Wholesale & Retail Trade
- Hotels & Catering
- Transport & Communications
- Financial Services
- Business Services
- Other Services
- Public Administration
- Education
- Health

Regional Classification
- İstanbul
- Batı Marmara
- Ege
- Doğu Marmara
- Batı Anadolu
- Akdeniz
- Orta Anadolu
- Batı Karadeniz
- Doğu Karadeniz
- Kuzeydoğu Anadolu
- Ortadoğu Anadolu
- Güneydoğu Anadolu

Data sources
- Eurostat
- OECD
- National Statistics Offices
- Experian Economic
### Link between Macro and Credit

<table>
<thead>
<tr>
<th>Time series</th>
<th>Challenges</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PiT estimates more common than time series analysis</td>
<td>Take long credit and macro series as long as it is available or at least 5 years, try to capture a full economic cycle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extend the credit history by retrospectively calculating scores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Work with high-frequency macro data</td>
</tr>
<tr>
<td>Model specification</td>
<td>Difficulty to find a link</td>
<td>Explore a variety of models and functional forms</td>
</tr>
<tr>
<td></td>
<td>Non stationarities</td>
<td>Aggregate/disaggregate level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error correction model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Panel/separate equations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Include lags</td>
</tr>
</tbody>
</table>
### Scenarios

<table>
<thead>
<tr>
<th>Transmission mechanism</th>
<th>Challenges</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Difficulty to get a consistent macroeconomic view</td>
<td>Model of the economy as a system of equations</td>
</tr>
<tr>
<td></td>
<td>Simple projections do not work</td>
<td>Interlinks between regions and sectors</td>
</tr>
<tr>
<td></td>
<td>A shock in one factor transmits through the whole economy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario probability</th>
<th>Challenges</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More than just a baseline forecast is needed</td>
<td>Possibility for stochastic simulations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assigning probability weights to all scenarios</td>
</tr>
</tbody>
</table>
Forecasts and Scenarios

- ‘Top-down’ approach for the forecasts in order to ensure:
  - Transparency of models & assumptions
  - Explicit forecast ‘narrative’
  - Internal consistency
  - Flexible scenario capabilities – including client and regulatory scenarios

- At the country level, granular economic data and forecasts to give real insight into exposures at a granular level
Complexity

The whole model often seen as a black box. IRFS 9 models are usually a complex mixture of:

- Regression equations PD/LGD/beh score etc.
- Assumptions/fixed ratios for instance, between year-end PD and year-average PD
- Macroeconomic forecast
- Forecast of the internal time-varying factors
- Future maturity/vintage effects

Recommendations

**Perform sensitivity tests:**

- Analyse the model
- Identify key assumptions
- Run scenarios through the model to evaluate how changes of the assumptions affect final results (provisions, regulatory capital)
Agenda

- IFRS 9 Macro Challenges
- IFRS 9 Methodologies
- Examples
Methodologies Overview

EMV

Ordered models

PD/behaviour score

Aggregate level

Account level

Segment/pd pool

Survival analysis
The Exogenous Maturity Vintage (EMV) approach disaggregates the portfolio default rate into three components:

- **Vintage Effects** – the part of the portfolio delinquency that is affected by changes in new business quality over time
- **Maturity Effects** – the part of the portfolio delinquency trend that is caused by factors relating to maturity or time on book
- **External Effects** – the part of the portfolio delinquency trend that is to do with external factors, i.e. policy changes or macroeconomic conditions

Partial Least Squares regression is used
### Method 1

**Exogenous Maturity Vintage**

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Widely used – easy to develop and implement</td>
<td>Granularity is lost in the aggregation process</td>
</tr>
<tr>
<td>Ease for forecasting</td>
<td>Difficult to get account level robust information at the later stages</td>
</tr>
<tr>
<td>Does not require complex and detailed data</td>
<td>The resulting components may be correlated (difficulty to distinguish vintage and external effects)</td>
</tr>
<tr>
<td>Provides a high level view which is easy to track</td>
<td>PLS allows for multiple solutions, so it is out of the expert’s discretion which solution to be chosen</td>
</tr>
<tr>
<td>Transparent effect of macroeconomic factors on the overall PD (or loss) when scenarios are run</td>
<td></td>
</tr>
</tbody>
</table>

©2016 Experian Limited. All rights reserved.

Experian Public.
Methodologies
Method 2: PD by segment/PD pool

- More disaggregate than portfolio level models
- Model panel or separate time series performance by pools/segments
- Error correction specification to capture long-term and short-term dynamics

Overall PD

PD of the portfolio is calculated by the multiplying PD by pool and share of accounts by pool

Performance by PD pool

Default rate by pool is modelled as a function of previous performance and macro factors

Distribution of accounts by pool and district

Number of accounts by pool is modelled as a function of portfolio size and macro factors
## Methodologies

### Pros and Cons – Method 2

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Relatively small dataset required – default rates by pools and number of accounts by pools</td>
<td>▪ No forecast on account level</td>
</tr>
<tr>
<td>▪ Builds on existing rating scale (use case) and provides useful information to link with EAD/LGD models</td>
<td>▪ Sometimes PDs by pools cannot be modelled via one panel regression, but separate models need to be built for each pool which may lead to end up with numerous regressions.</td>
</tr>
<tr>
<td>▪ Robust forecast of PDs by PD pools</td>
<td></td>
</tr>
<tr>
<td>▪ Error correction models have many applications – eg. to calibrate scores with macro factors; to model PDs by different products or segments</td>
<td></td>
</tr>
</tbody>
</table>
Methodologies
Method 3: Survival model

- Model the time to default
  - Predict if and when an account will enter default

- Account level model – PD prediction for each account

- Specifications
  - Discrete time models – logistic hazard
  - Continuous time – Cox PH

Application characteristics

Time-invariant customer characteristics (income, # of applications, region etc..)

Behaviour characteristics

Time-variant customer monthly information (Behaviour score, days past due, delinquency, age of account)

Macroeconomic characteristics

Time variant external factors (Macroeconomic factors, bank policy change information, etc.)
# Methodologies

## Pros and Cons – Method 3

<table>
<thead>
<tr>
<th>Method 3 Survival Models</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▪ Forecast not just the probability of default, but time to default for better estimation of losses</td>
<td>▪ Requires very detailed account-level data. Possibility for data issues to emerge</td>
</tr>
<tr>
<td></td>
<td>▪ Advanced method, allowing many functionalities</td>
<td>▪ Computationally heavy – the datasets are usually large and require much time for estimation</td>
</tr>
<tr>
<td></td>
<td>▪ Allows for taking into account of rich information – fixed account characteristics, time-varying account information and economic factors</td>
<td>▪ If time-varying account characteristics are included, these need to be forecasted additionally.</td>
</tr>
<tr>
<td></td>
<td>▪ Robust forecasts on account level that can be used for segmentation/targeting/different policies towards different customers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Easy to aggregate to pool and portfolio level</td>
<td></td>
</tr>
</tbody>
</table>
Agenda

- IFRS 9 Macro Challenges
- IFRS 9 Methodologies
- Examples
Default rates at segment level (corporate, commercial, SME and retail) are modelled via macroeconomic factors. Error correction specification is used.

- **Industrial production**
  - Closely correlated with GDP
  - Available on a monthly basis
  - Not seasonally adjusted

- **Money Supply Growth**

- **Consumer Price Index**

- **Local currency Interest rate premium**
  - The difference between the average interest rate on corporate loans in local currency and USD
  - A measure of uncertainty/risk
Case 2: PD by PD pool
Tier 1 South Eastern Europe Example

Modelling portfolio PD at two blocks – PD by pool and distribution of accounts by pool. Macro factors included in both blocks. Error-correction equations.

- Different speed and magnitude by pools to changes in the macroeconomic conditions

- Significant macro factors:
  - GDP growth
  - Wages
  - Interest rate
  - Unemployment rate

- Regional factors included for better fit and stress testing given changes in the regional exposure and shocks
Case 3: EMV Model
Tier 1 South Eastern Europe Example

Decomposition of portfolio default rates by vintage, maturity and external effects.

- Modelling default rates, Personal Loans portfolio
- Five years of monthly data (Jan’2011 through Dec’2015)
- Dataset for EMV generated from account-level data:
  - Vintages start Jan’2004
- Preliminary EMV decomposition results:
  - Economic environment modelled via change in wage growth and inflation rate
  - Maturity component largely has the “expected” shape for this type of product
  - The vintage component seems to relate to known dynamics
Case 4: PD/ Behaviour Score Forecast
Tier 1 South Eastern Europe Example

- Account level estimates
- Modelling portfolio PD at two blocks – behaviour score and delinquency

- Predict behaviour score as a function of:
  - Previous behaviour
  - Account age/month with bank
  - Wage growth
  - Inflation

- Predict delinquency 90+ as a function of:
  - Behaviour score
  - Interest rate
  - GDP