IMPLEMENTING PIT-TTC PD FRAMEWORK IN CREDIT RISK CLASSIFICATION SYSTEM

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INTRODUCTION

• According to the Basel II IRB approach...

• In real life...

WHY THROUGH-THE-CYCLE PD ADJUSTMENT?

• For calculation of capital buffer against unexpected losses, the through-the-cycle PD (unconditional of the states of economic cycle, PD) should be used in the RWA formulas.

• Most models are so-called hybrid models, i.e. models that vary with the economic cycle to a certain extent, but not fully.
WHY THROUGH-THE-CYCLE PD ADJUSTMENT?

- Capital requirement
- Actual default frequency/ PIT PD
- Rating model output
- TTC PD

PD vs. Time
INTRODUCTION

EXISTING PD ADJUSTMENT APPROACHES

• Constant increase in RWA in downturn of economy when “PIT” PD increases. Not stable TTC PD estimate over time.

• Deterioration/Improvement of portfolio not connected to economy cycle is not captured. No underlying dynamics model of scalar, is complex to calculate.

• Difficult to build because almost all risk factors move somehow with economic cycle.

• Lack of good quantitative methodology to estimate degree of “point-in-time” of each rating model

• Constant scaling of rating model “PIT” PD estimates to TTC level

The variable scalar approach

Other attempts to build pure TTC model

All methods above
ESTIMATION OF THE ECONOMIC CYCLE BY USING EXTERNAL DATA

- Standard Basel II Merton assumptions are used: \( X_i = \sqrt{\rho} Z + \sqrt{1 - \rho} \varepsilon_i \ B_i \)
- Bank portfolio is a part of the external global portfolio
- The same average “economy effect” on each obligor in the global portfolio, dependent on the sector specific variable \( Z \) and \( \rho \)
- The observed default rate in global portfolio will be: \( DF = \Phi\left( B - \sqrt{\rho} Z / \sqrt{1 - \rho} \right) \)

- Where \( B \) can be interpreted as belonging to average or “central tendency” client of the global portfolio
- Economy state \( Z \), and correlation \( \rho \) can be calculated by using Maximum Likelihood or Method of Moments, see for example Paul Demey et al, Risk, November 2004, Maximum likelihood estimate of default correlations
- Input: DF (quarter),
- Output: correlations \( \rho \), states of sector specific variable \( Z \)
BANK'S PORTFOLIO AND THE GLOBAL PORTFOLIO

Global portfolio, \( B=-2.49 \), \( PD=0.64\% \)

- Bank A
  - \( B=-2.51 \)
  - \( PD=0.6\% \)

- Bank B
  - \( B=-2.58 \)
  - \( PD=0.5\% \)

- Bank C
  - \( B=-2.17 \)
  - \( PD=1.5\% \)

Uniform economy effect 

\( Z, \rho \)
THE ECONOMIC CYCLE - EXAMPLE OF Z STATES

Z (dotted line)

Annualized bankruptcy frequency

10,0%
9,0%
8,0%
7,0%
6,0%
5,0%
4,0%
3,0%
2,0%
1,0%
0,0%
EXAMPLES OF LARGER GLOBAL PORTFOLIO

BALTIC AND SWEDISH BANKRUPTCY DATA USED TO CREATE DF TIME SERIES

1. Estonia: Centre of Registers and Information Systems (2005Q1 and onwards)
2. Latvia: Lursoft (2005Q1 and onwards)
3. Lithuania: Creditreform (2005Q1 and onwards)
4. Sweden: SCB (1985Q1 and onwards), UC (2001Q1 and onwards)
5. Russia: ?

Use of internal relationship between bankruptcy data and default rate to create final DF time series

Instead of bankruptcy/defaults data the methodology could be run using external ratings PDs for specific segments
CALCULATING AN OBLIGOR’S TTC PD IN THE CASE OF 100% PIT RATING MODEL

\[
PIT\_PD_i(Z) = P(X_i < B_i \mid Z) = \Phi((B_i - \sqrt{\rho} Z)/\sqrt{1-\rho})
\]

\[
TTC\_PD_i = Average\_over\_Z(PIT\_PD_i(Z)) = \Phi(B_i)
\]

where obligor specific can be calculated from inverting formula above (PIT_PD is from PD model)

\[
B_i = \sqrt{\rho} Z_{now} + \sqrt{1-\rho} \Phi^{-1}(PIT\_PD_i)
\]
HOW MUCH IS THE PD MODEL MOVING WITH THE ECONOMIC CYCLE (% POINT-IN-TIME)

Hybrid PD model
LRDF (TTC level, 100% TTC PD model)

Time
CALCULATING AN OBLIGOR’S TTC PD IN THE CASE OF A HYBRID RATING MODEL - MODELING RATING MODEL BEHAVIOR ITSELF

\[
MODEL \_ PD_i = PD_{i,\alpha} (Z) = \Phi \left( B_i - \sqrt{\rho \alpha Z} / \sqrt{1 - \rho ^2} \right)
\]

Averaging over all states of economy \( Z \) gives rise to the same result for \( TTC\_PD = \Phi(B_i) \) and does not depend on \( \alpha \)

\[
B_i = \sqrt{\rho \alpha Z_{\text{now}}} + \sqrt{1 - \rho ^2} \Phi^{-1}(PD_{i,\alpha})
\]
In the ideal portfolio, with the same quality over time, the movement of these 2 terms is coordinated, for example, given upturn in the economy, $Z$ increases and model PD decreases correspondingly, giving rise that TTC_PD will be stable all the time.

Sudden deterioration of clients in portfolio not connected to economy, but captured by rating model will give rise to increase of second term > increase in TTC_PD

Given $Z_{now}$ and model PD, for every quarter TTC_PD can be calculated. $\rho$ as a slowly varying parameter, is calculated once a year.

$$TTC\_PD_i = \Phi \left[ \alpha \sqrt{\rho} Z_{now} + \sqrt{1 - \alpha^2} \rho \Phi^{-1}(PD_{i,\alpha}) \right]$$

$$B_i = \sqrt{\rho} \alpha Z_{now} + \sqrt{1 - \rho} \alpha^2 \Phi^{-1}(PD_{i,\alpha})$$

$$PIT\_PD_i(Z) = \Phi \left[ (B_i - \sqrt{\rho} Z) / \sqrt{1 - \rho} \right]$$
PIT PD AND TTC PD, EXAMPLE

Graph showing PIT PD and TTC PD values over time.
METHOD OF ESTIMATION OF DEGREE OF PIT OF PD MODELS

\[ \Phi^{-1}(PD_{i,\alpha}(Z_1)) = (B_i - \sqrt{\rho \alpha Z_1}) / \sqrt{1 - \rho \alpha^2} \]

\[ \Phi^{-1}(PD_{i,\alpha}(Z_2)) = (B_i - \sqrt{\rho \alpha Z_2}) / \sqrt{1 - \rho \alpha^2} \]

\[ \Delta \text{Average}_\text{portfolio}(\Phi^{-1}(PD_{i,\alpha}(Z))) = -\sqrt{\rho \alpha}(\Delta Z) / \sqrt{1 - \rho \alpha^2} \]

\[ \Delta \text{Average}_\text{portfolio}(\Phi^{-1}(PD_{i,\alpha}(Z))) = -\sqrt{\rho \alpha}(\Delta Z) \]

METHOD DESCRIPTION

Assuming that portfolio composition is the same over time we have in 2 different points in time (with corresponding \(Z_1\) and \(Z_2\))

Averaging over the portfolio and taking deference give rise to

Or neglecting small term

The PIT degree calculated above should be confirmed by PD model owner and by the review of PIT degree of parameters of corresponding regression model
Several years with very low default frequency and one extremely high value (the crisis 2008/2009)- typical situation in Eastern Europe
Incorporation of macro economical expert judgment in distribution fitting in terms of frequency of “bad” years

Qualitative benchmarking for B and $\rho$ for different portfolios, countries etc. Artificially prolong default statistics back in time using macro economical models
Setting initial alpha by investigating qualitatively degree of PIT of rating model risk factors
FSA APPROVAL

VALIDATION OF MODEL PARAMETERIZATION

- Validation of $B$ and $\rho$ for global portfolio with new external data – once a year
- Validation of 100% PIT PD against actual DF data (usual Chi and Binomial tests)
- Validation of $\alpha$ – once a year (comparison of new point estimates with average $\alpha$ used)
- Other tests to fulfill regulatory demands, as, for example, simple correlation test
- Back testing of both TTC, PIT functionality as well as RWA for getting first FSA approval
EXTENSIONS

FUTURE VALUES Z FACTOR

- Until now no assumptions about Z dynamics in time are made.
- From realized time series we can see that Z values are strongly auto-correlated.
- If we have no underlying explaining variables for Z, one can model future Z pure statistically as AR process using historic Z values.
- If Z process can be explained by movement of macro economical variables a sensitivity type model can be developed.
- Both models can complement each other as macro model can be used for stress testing and ICAAP, where macroeconomic scenario is given, while for other situations pure statistical AR model can be used.
Z as an economic cycle (credit cycle) process should exhibit two partially offsetting characteristics:

- Mean reversion – tends to trend up when low and trend down when high
- Momentum – moves in the same direction as the previous year

Z is modeled as a second-order autoregressive process which has properties mentioned above:

$$Z_t = k_1 \cdot Z_{t-1} + k_2 \cdot Z_{t-2} + e_t$$

where $e_t$ is normally distributed with 0 average. Degree of conservatism can be achieved by using upper value of 95% confidence interval for predicted $Z$ instead of actual predicted value of $Z$.
EXTENSIONS

Z PREDICTION AS A FUNCTION OF NORMALIZED MACRO ECONOMIC VARIABLES, SENSITIVITY MODEL

Makes PD (CL), RWA calculation for Pillars I and Pillars II on the same basis, Z factor is only predicted parameter for model

\[
\Delta Z = k_1 \Delta \text{Short rate} + k_2 \Delta \text{Unemployment} + k_3 \Delta \text{GDP} + k_4 \Delta \text{Oil price} + k_5 \Delta \text{SEKUSD} + \varepsilon
\]
The quarterly statistics can have some seasonal effects. For rating/scoring model the development is expected to change smoothly over time, therefore seasonal effects should be removed.

Polynomial approximation is a simple and standard way of smoothing data. A smaller degree than 3 would not be able to follow a cycle. A higher degree than 3 would be possible, but may introduce artificial effects.

The time-frame should be moving, as trying to fit a third degree polynomial to a long time series will not give good fits. Also, we are really interested in the latest values of $Z$ values.

More complicated techniques can be used.
MEASURING DETERIORATION OF PORTFOLIO QUALITY NOT CONNECTED TO ECONOMY

• When quality of portfolio remains the same it should be (movement of portfolio PD is equal to expected economy effect):

\[ \text{Mean}_{\text{portfolio}}(\Phi^{-1}(PD_{i,\alpha}(t_2)) - \text{Mean}_{\text{portfolio}}(\Phi^{-1}(PD_{i,\alpha}(t_1))) \approx \sqrt{\rho} \alpha (Z_{t_2} - Z_{t_1}) \]

• When movement of left side is not equal to right side, it means deterioration or improvement of portfolio quality (movement of portfolio PD is not corresponding to expected PD movement due to economy effect)
ANNUALLY/QUARTERLY UPDATES

1. Annual Process
   i. Correlation is estimated annually, except of the case of soon downturn
   ii. Validation/estimation of PIT degree of each rating model and validation of 100% PIT PD against actual DF

2. Quarterly process
   i. Z value is calculated based on new external quarterly data
   ii. Seasonal adjustment for Z is done
   iii. TTC PD and RWA are calculated for each obligor rated in current quarter
   iv. Prediction of future values of Z are made, possible override of Z for steering.
   v. 100% PIT PD are calculated for each obligor
ALGORITHMIC USE OF THE METHOD

PRODUCES TWO NEW PD

1. **PIT** REFLECT CURRENT CONDITIONS
2. **TTC** INSENSITIVE FOR CYCLICAL MOVEMENTS, WHILE SENSITIVE FOR CHANGES IN RISK PROFILE

**Internal Rating**
Partly reflects current state of economic cycle, i.e. partly point-in-time

**TTC PD**
Output from the rating model is adjusted so that the corresponding PD estimate reflects an average economic state, i.e. is through-the-cycle

**Legal capital Requirement**
Scales up risk estimates reflecting an average economic state to the 99,9 % worst state of the economic cycle

**PIT PD**
When methodology is fully implemented, "pure" PIT PDs can be derived for each exposure reflecting the risk the coming year

**Business steering**
PIT PDs can improve business steering in all parts of the credit process
### PRACTICAL EXAMPLE

#### ALGORITHMIC USE OF THE METHOD

<table>
<thead>
<tr>
<th></th>
<th>Q1 2011</th>
<th>Q1 2012 (data)</th>
<th>Q1 2012 (steering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model PD</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Z</td>
<td>1.12</td>
<td>1.93</td>
<td>1</td>
</tr>
<tr>
<td>TTC PD</td>
<td>3.99%</td>
<td>5.82%</td>
<td>5.82%</td>
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<tr>
<td>RWA</td>
<td>128.6%</td>
<td>148.46%</td>
<td>148.46%</td>
</tr>
<tr>
<td>100% PIT PD</td>
<td>0.59%</td>
<td>0.33%</td>
<td>1.21%</td>
</tr>
<tr>
<td>PIT EL</td>
<td>0.27%</td>
<td>0.15%</td>
<td>0.54%</td>
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<tr>
<td>TTC EL</td>
<td>1.8%</td>
<td>2.62%</td>
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<td>RAROC 1y</td>
<td>17.38%</td>
<td>15.85%</td>
<td>13.19%</td>
</tr>
<tr>
<td>RAROC 5y</td>
<td>5.46%</td>
<td>-0.8%</td>
<td>-0.8%</td>
</tr>
</tbody>
</table>

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![Diagram](image-url)
CONCLUSION

ADVANTAGES OF NEW APPROACH

1. Gives possibility to recalculate any PD value from not 100% PIT hybrid rating model to the corresponding 100 % PIT PD value

2. Basel II based methodology

3. Makes possible to run future economy ICAAP stress scenarios per portfolio and per obligors levels

4. The new methodology gives quantitative estimates of “point-in-time” degree for each rating model

- New estimate of TTC_PD is stable over time

- Can capture change in underlying risk characteristics of portfolio not connected to economic cycle


5. Barry Belkin, Daniel H. Wagner Associates Larry Forest, KPMG Peat Marwick “The Effect of Systematic Credit Risk on Loan Portfolio Value at Risk and on Loan Pricing”


THANK YOU
UNDERSTANDING-CAPITAL-REQUIREMENTS BY ALEXANDER PETROV
ON SAS KNOWLEDGE EXCHANGE:
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