

TopQuants

Integration of Credit Risk and Interest Rate Risk
in the Banking Book

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Introduction

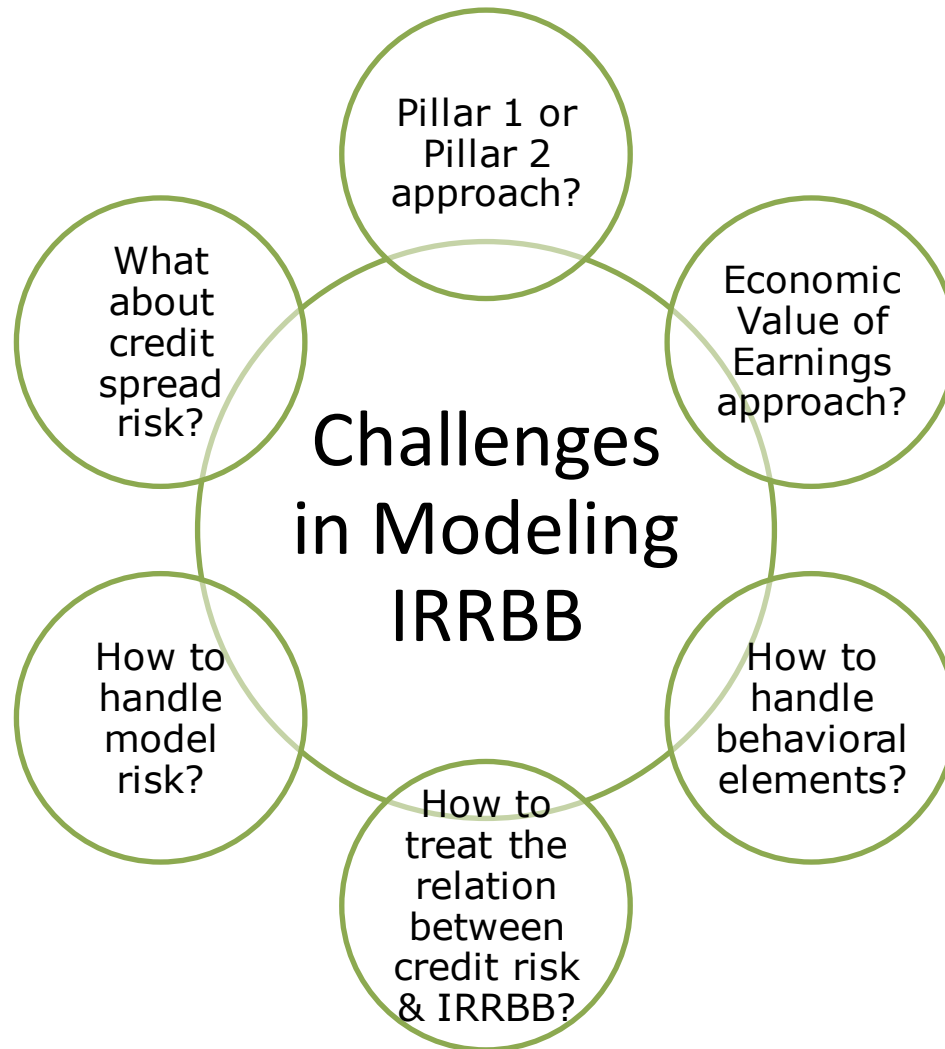
As already addressed in the B2 Accord (art.762), IRRBB is considered a potentially significant risk

Due to the heterogeneity across internationally active banks, it was then concluded that IRRBB should be captured under Pillar 2

In the Fundamental Review of the Trading Book the possibility of a transfer to Pillar 1 is mentioned

Currently, a task force on interest rate risk (TFIR) is given the mandate to investigate whether IRRBB can be transferred to Pillar 1

Introduction



Introduction

Market survey

<To be inserted, pending the results of the survey>

Introduction

Today's focus

- Today's focus is on how to model the **integration** of the capital charge for credit risk and IRRBB
- The following **starting points** are thereby relevant:
 - Focus is on credit risk and IRRBB
 - Operational risk is omitted in this analysis
 - No trading book positions assumed

Proposed Case

Lets consider a Dutch Bank

- Or more specific a banking portfolio
- Grain the portfolio per product group and repricing period
- Expected net earnings of 4,5 billion EUR

Assets

Mortgages	80%
Corporate loans	15%
Sovereign bonds	5%

Liabilities

Funds entrusted	75%
Other funding	25%

Specifics

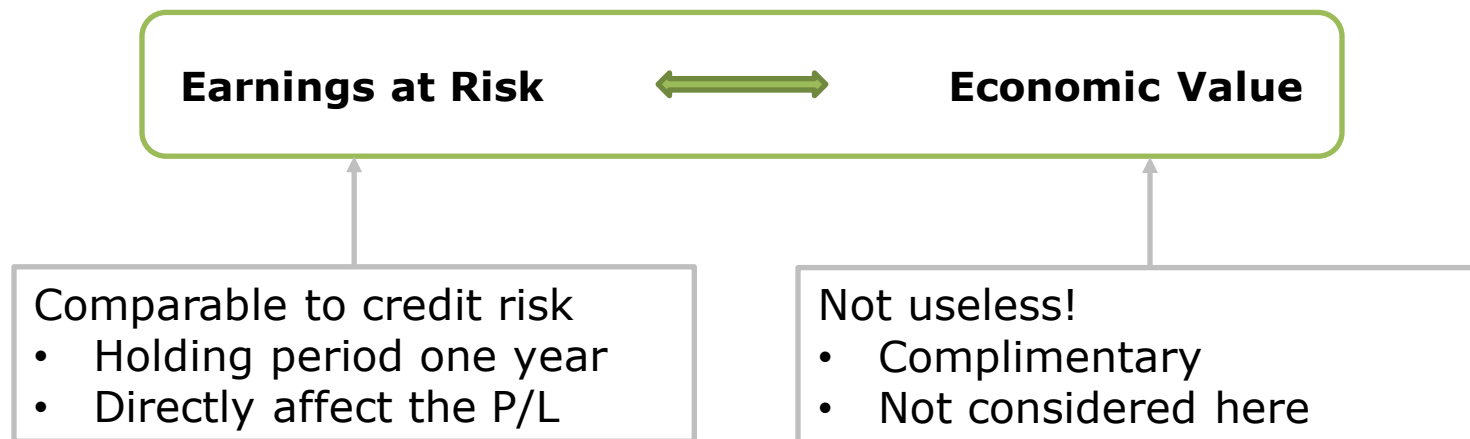
Low repricing periods	
Leverage ratio	7.0%
Duration of equity	2.7

Quantifying Our Case

We want to be able to control the coming year's net earnings

- Credit losses
- Interest rate gross earnings

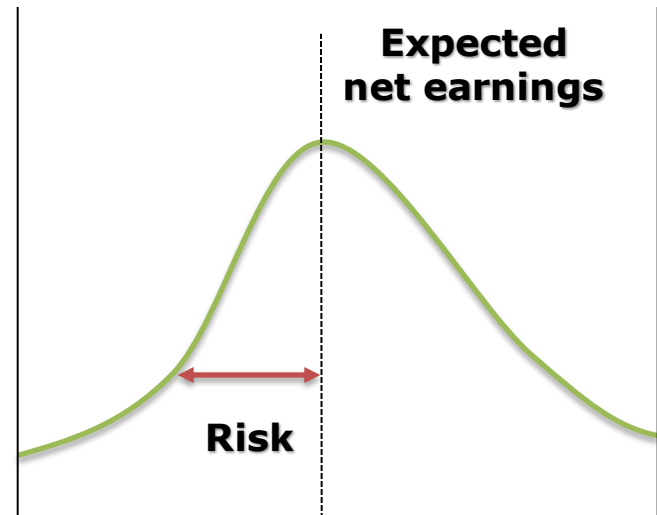
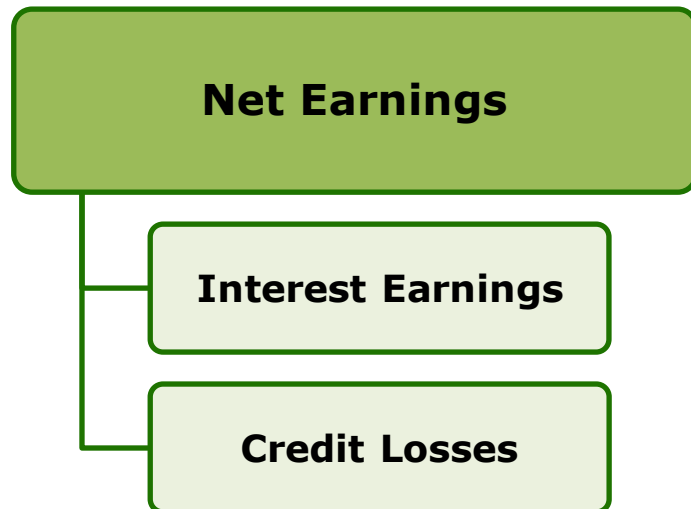
How to measure interest rate risk?



Quantifying Our Case

Net earnings as a risk measure

- Constructed from interest earnings and credit losses
- Evaluated per simulation
- Determining the banking book risk (interest rate risk + credit losses)



Quantifying Our Case

How can we model the P/L of the bank?

First Method

- Form two departments
- Separating interest and credit risk
- Simulate the contributions
- Results in net earnings
- Defined:

Aggregated approach

Second Method

- Only one department
- Collin-Dufresne model
- Simulate their behavior
- Results in net earnings
- Defined:

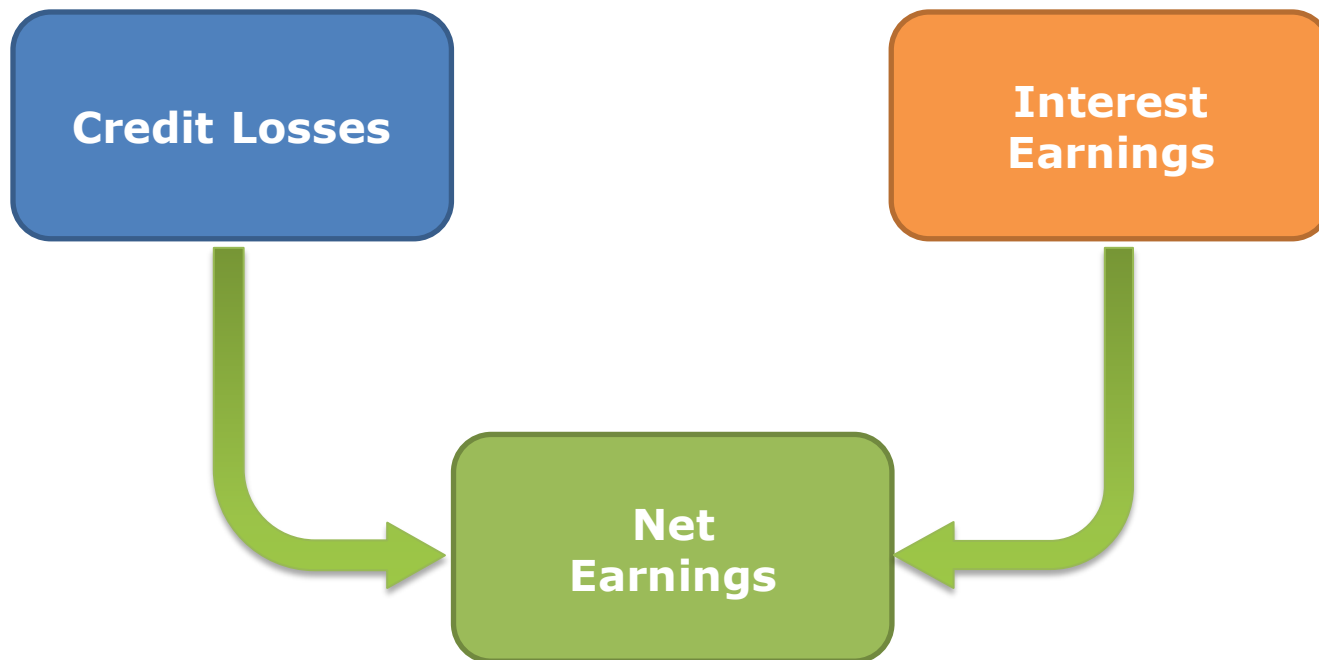
Integrated approach

The difference lies in the interaction of the risk contributions

Aggregated Approach

We form 2 separate departments

- Credit loss modeling
- Interest earnings modeling



Assuming no correlation

Aggregated Approach

Credit losses

- PD from rating model
- Simulated defaults
- LGD assessment per product
- No migration or concentration

Earnings at risk

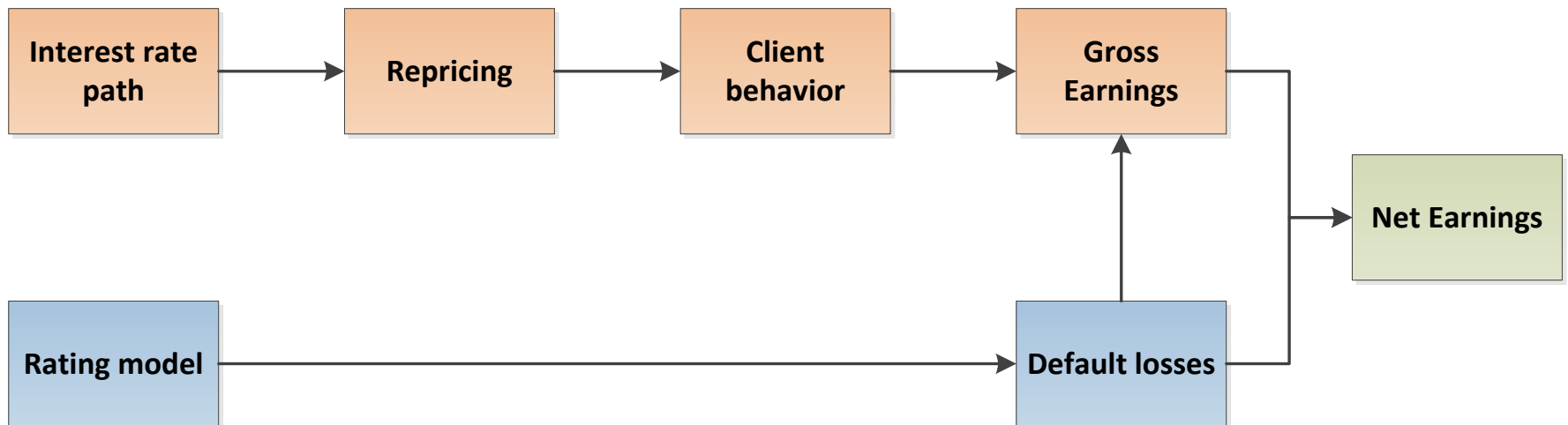
- Simulated interest rate path (historical Vasicek model)
- Behavioral prepayments and savings models
- Defaults impact coupon payments
- Interest income and expenses at each period
- Cumulative over one year

Net Earnings

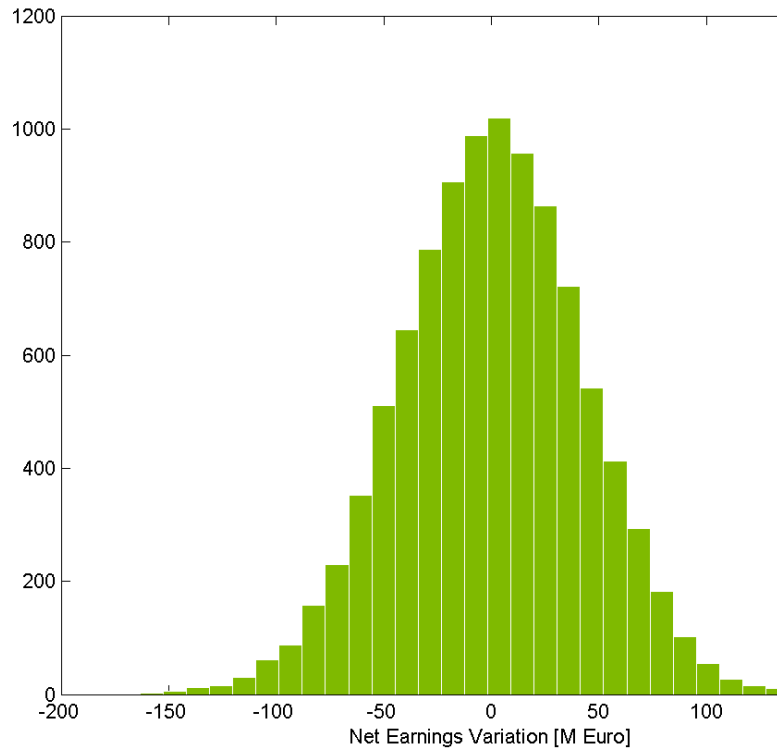
- Positive gross earnings
- Losses have a negative impact
- Combined per simulation
- Repeated 10.000 times to find the distribution

Aggregated Approach

Model flow chart



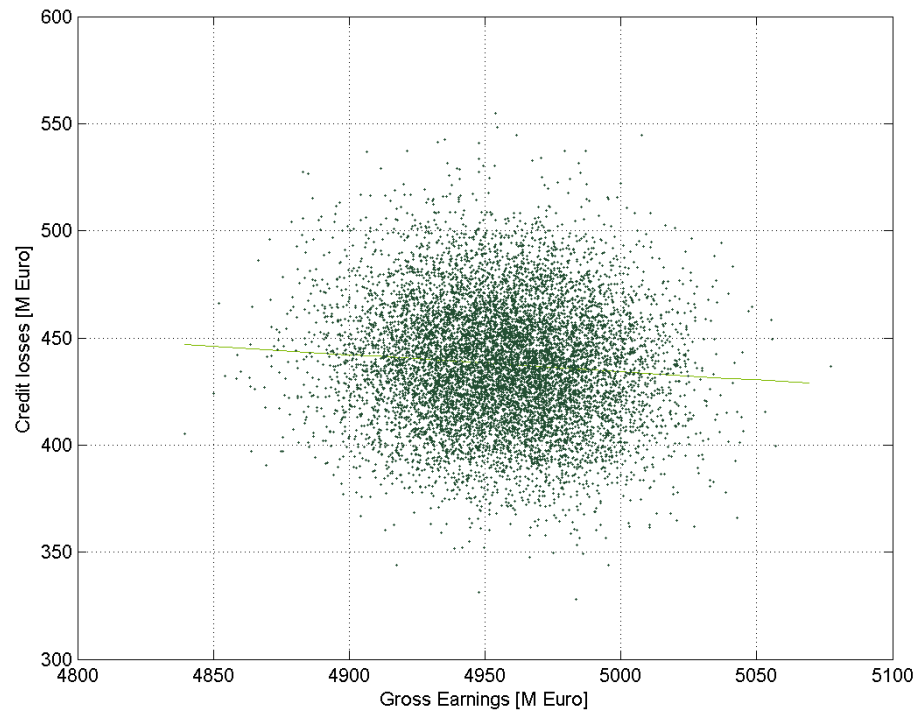
Aggregated Approach



95%-VaR: -156 bp

Contribution to variance

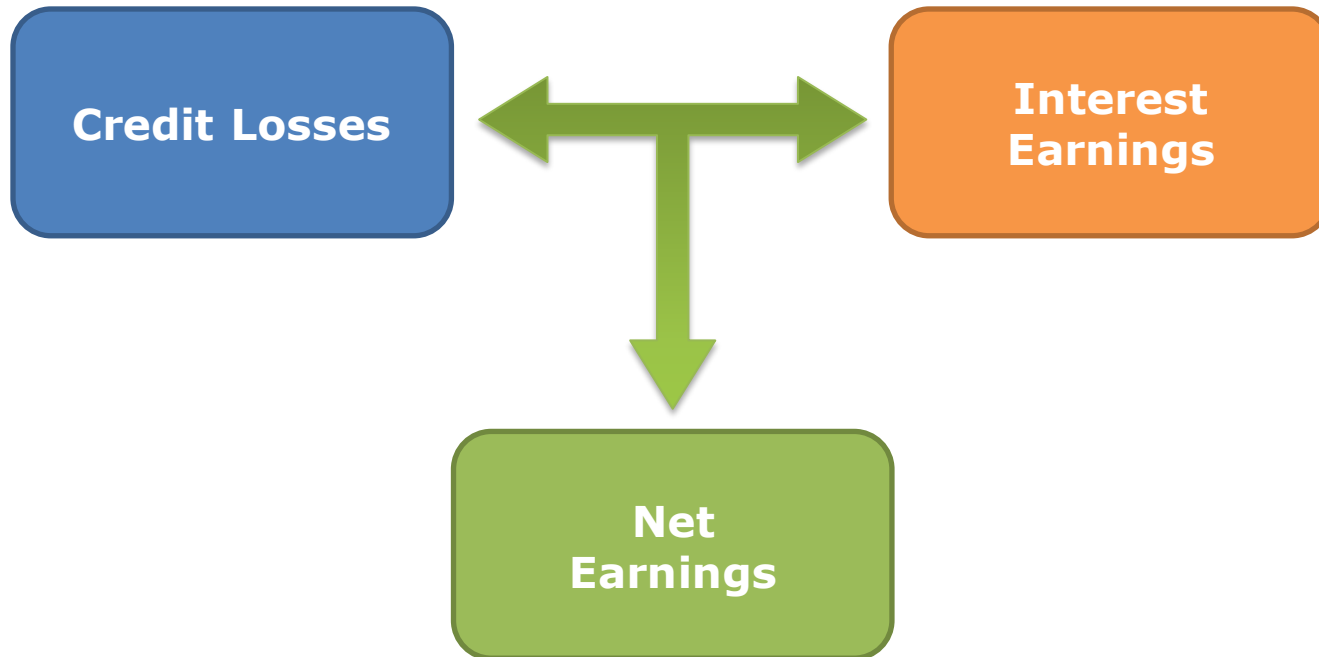
CR	EaR	Interaction
45%	48%	7%



Integrated Approach

Lets consider one assessment

- Combination of dependent defaults and interest rate path
- Default frequency is dependent on interest rate (Collin-Dufresne)



Empirical correlation

Integrated Approach

Collin-Dufresne and Goldstein (2001)

Merton-type counterparty model under stochastic interest rates:

$$dr = \kappa(\theta - r) dt + \eta dW_1$$

Defining log-firm value:
$$dy_t^Q = \left(r_t - \delta - \frac{\sigma^2}{2} \right) dt + \sigma dW_2$$

and log-default boundary:
$$dk_t = \lambda [y_t - v - \varphi(r_t - \theta) - k_t] dt$$

Evaluating over a r and t grid gives the probability of default (under risk-neutral or real-world measure)

Calibration done using MLE on CDS data

Integrated Approach

Credit losses

- Simulated interest rate path (historical Vasicek model)
- Collin-Dufresne assessment mapped to PD
- Migration is possible
- Simulated defaults
- LGD assessment per product

Earnings at risk

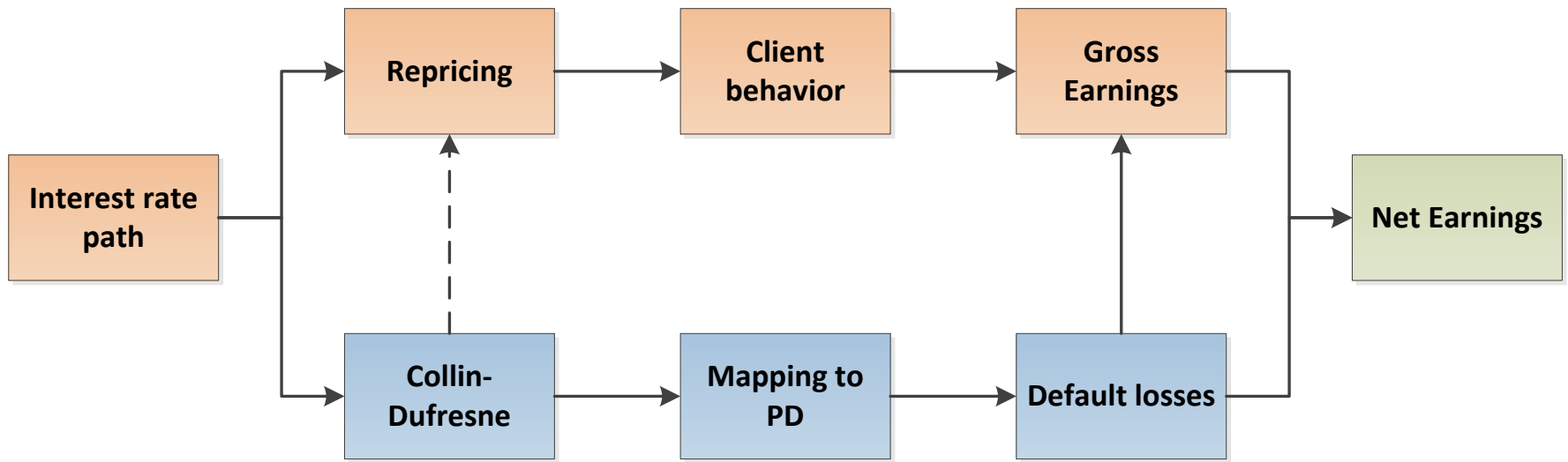
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Net Earnings

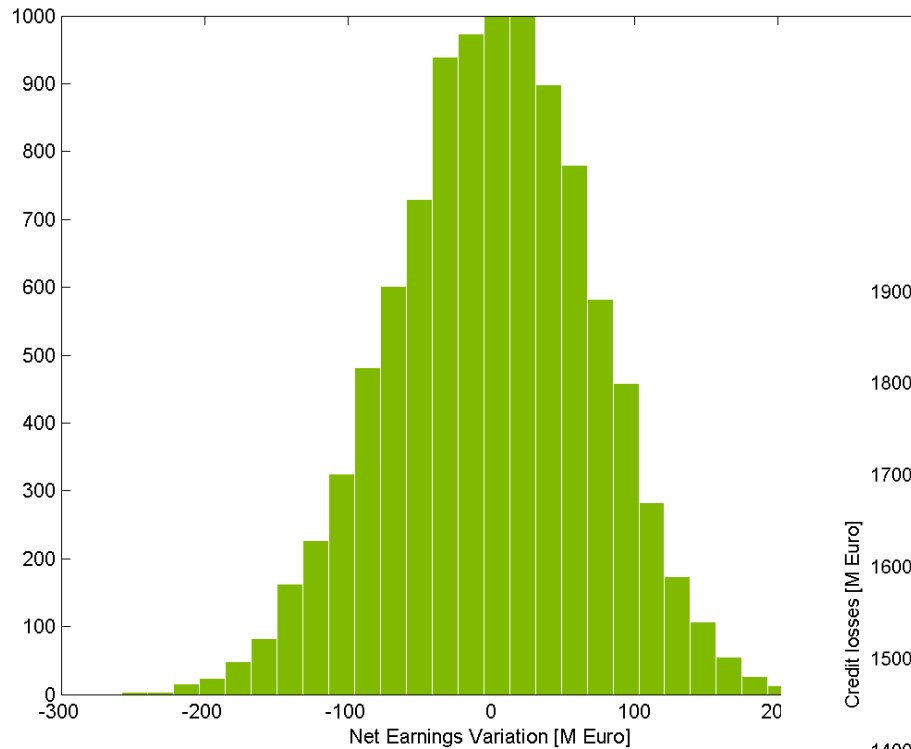
- Positive gross earnings
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Integrated Approach

Model flow chart



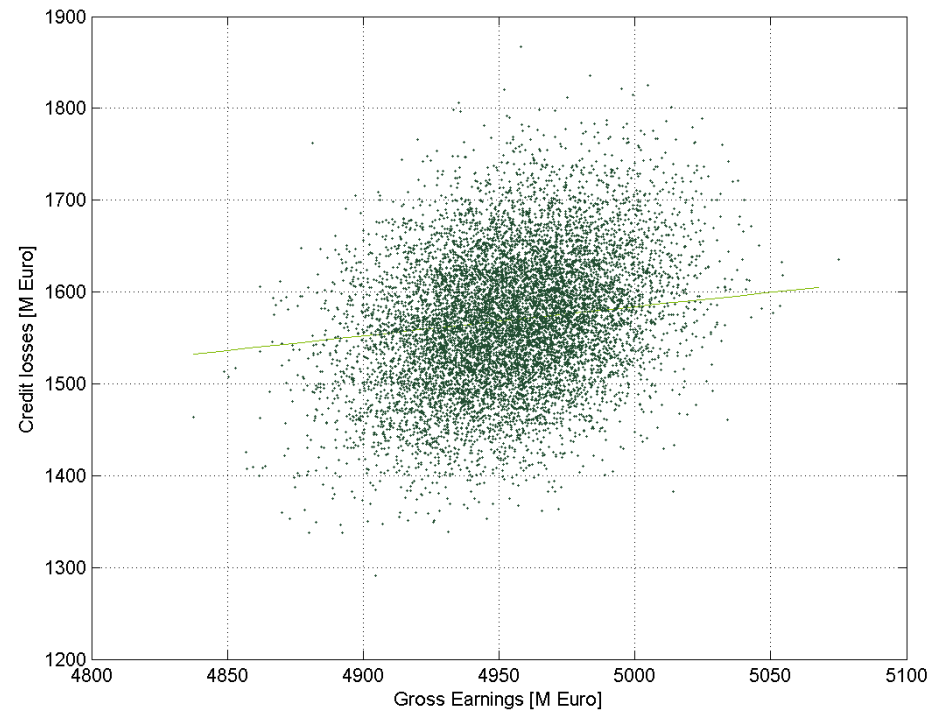
Integrated Approach



95% VaR: -261 bp

Contribution to variance

CR	EaR	Interaction
111%	18%	-29%



Comparison

How do both models compare on net earnings?

Net Earnings Variance

- Integrated modeling increases variance
- In our Case:
67% difference in VaR

Caused by:

- Migration of assets
- Hedging effect

Expected Net Earnings

- 25% decrease in integrated model

Caused by:

- Concentration of defaults in the integrated model

Solutions for aggregated method:

- Mechanically add migration and concentration
- Assume a correlation

Influential Factors

Varying the client rates by means of credit spreads



- In the aggregated model they inflate risk
 - Higher variance and no benefits
- In the integrated model we can use credit spreads to steer the interaction
 - In our case the correlation between gross earnings and credit losses varies from: +32% to +46%

Reduces the VaR by up to 10%
(Whilst preserving expected net earnings)

Influential Factors

Repricing periods

- In our case we choose low repricing periods
- This shows a large interaction
 - Decreases with increased repricing periods
- Less compensation for riskier times
 - Correlation can vary from -8% to +40%



Repricing

Influential Factors

Products



- Portfolio risk
 - Risky assets are more affected by interest rates
 - More interaction between risk types
 - Increased influence client rates
- Weight of mortgages
 - Mortgage defaults are less influenced by interest rates
 - Latent or no effect at all
 - In our case we ignore the effect on mortgages
 - Interaction decreases with larger mortgage weight

Conclusions

Conclusions

What can we learn from this?

- Correlation factors are a significant influence
- Resulting capital is very sensitive to the interaction
- Interest rate shocks influence the defaults

Which model is better?

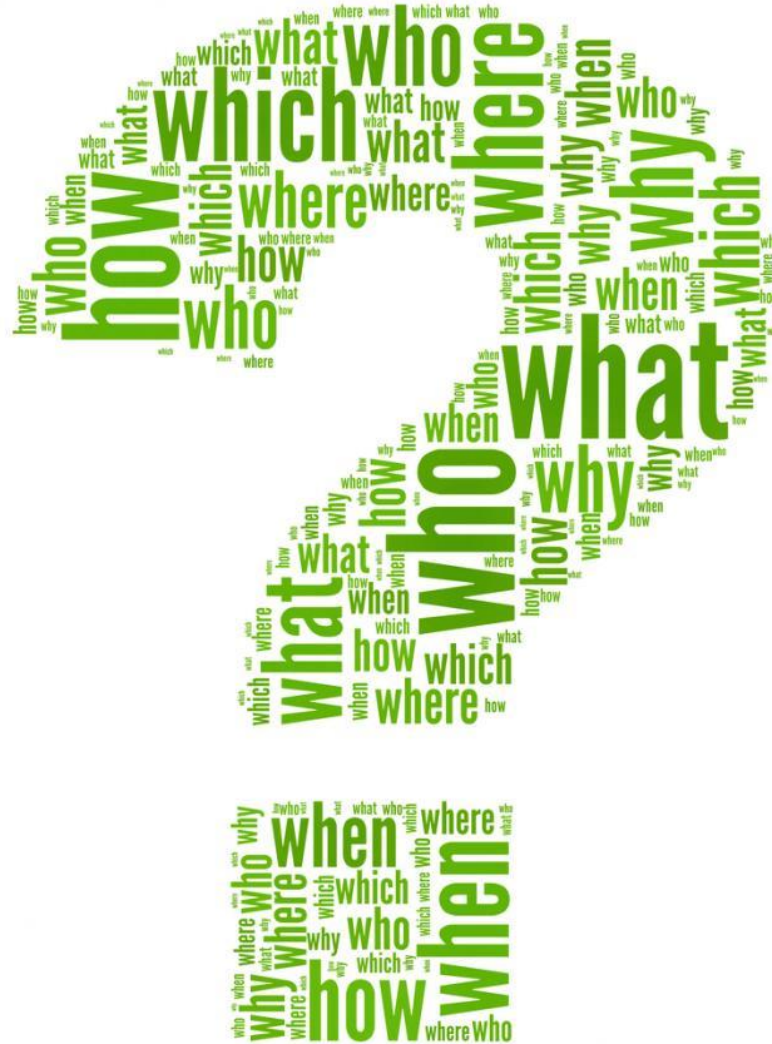
- Aggregated approach relies on assumption
- Integrated approach relies on calibration
- Both have their flaws

How would you apply it in practice?

- Reconsider the risk aggregation process
- Reassess the impact of credit spreads
- Assess the correlation of risk types

Not covered here but: take into account the Economic Value

Questions



Contact Details



Erik Vijlbrief
Executive Consultant

T: + 31 35 692 89 89
E: E.Vijlbrief@zanders.eu



Pim Stohr
Intern

T: + 31 35 692 89 89
E: P.Stohr@zanders.eu

Appendices

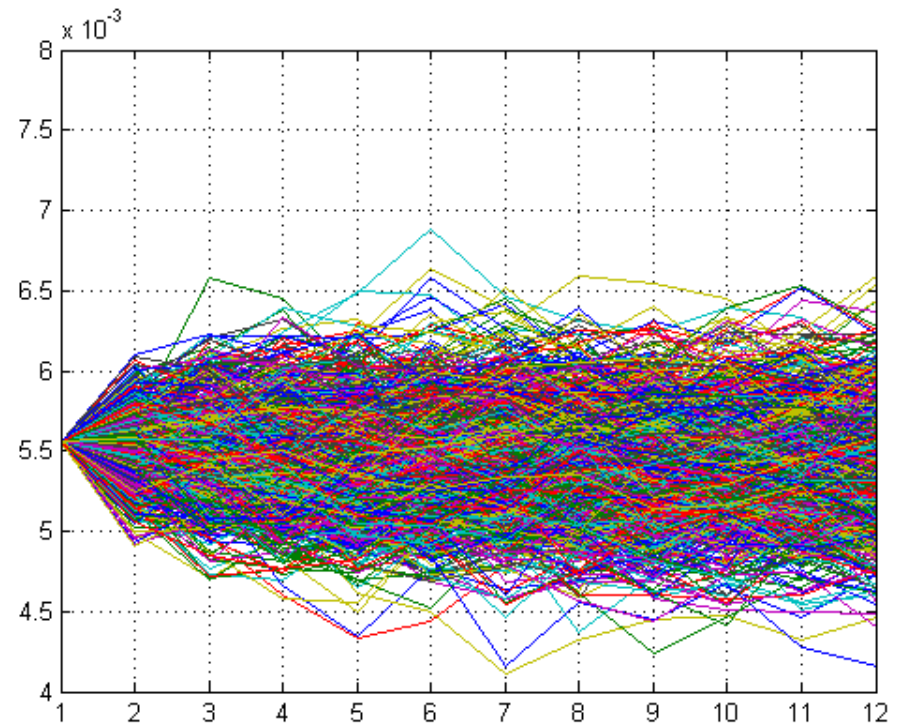
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Appendix I:

Vasicek specification

- Mean-reverting to θ
- Constant volatility η

$$dr = \kappa(\theta - r) dt + \eta dW_1$$



Appendix I:

Collin-Dufresne Goldstein (2001)

Stochastic process describing log-leverage ratio

- Log-firm value: $dy_t = \left(r_t - \delta - \frac{\sigma^2}{2}\right) dt + \sigma dW_2$
- Log-default boundary: $dk_t = \lambda [y_t - v - \varphi(r_t - \theta) - k_t] dt$
- Additionally: $\rho dt = dW_1 dW_2$

The model allows for very exotic behavior but is difficult to implement and estimate

Stochastic interest rates are used from Vasicek

Appendix III:

Calibration slide

Performed on CDS spread data using MLE

Both the term structure and the time series

- 3 on term structure (σ , ν and l_0)
- 2 on time series (ϕ and ρ)

Parameter	Class I	Class II	Class III	Gov
σ	0.267	0.081	0.038	0.145
ν	0.653	0.213	0.000	0.307
ϕ	-205.568	-206.604	-619.100	-206.785
ρ	0.017	0.031	0.080	0.015
l_0	0.578	0.843	0.935	0.741
Log-Likelihood	-955.160	-633.679	-307.097	-883.572
In-Sample R^2	0.859	0.715	0.542	0.813