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Model Validation Techniques

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Presenters



Peter is a student member of the Institute and Faculty of Actuaries with more than 4 years experience consulting with the largest players in both the life insurance and banking industries.

He has designed, calibrated, reviewed and validated simple risk models through to complex with-profit capital models.



Neels heads up the Traded Risk modelling team within Deloitte's Risk Advisory practice. Before joining Deloitte he was Principal Risk Specialist in Traded Market and Counterparty Risk at the PRA. He has held positions in risk management and methodology at HSBC, Nedbank, and ABSA.

Agenda

1. Introduction

- Terminology
- Capital Models

2. Model Verification

3. Model Validation

- Back Testing

4. Learnings

Introduction

- New regulation incentivising better risk management and measurement
- Improving technology, increased capacity at reduced cost
- Both contribute to more numerous & sophisticated models
- Whether for regulatory or business use
- How can we know if the model does what it should or does what it needs to?
- i.e. is it fit for purpose?

Terminology

Difference between verification and validation

Verification - ensuring it does what it should - correctly implemented to match specification and assumptions

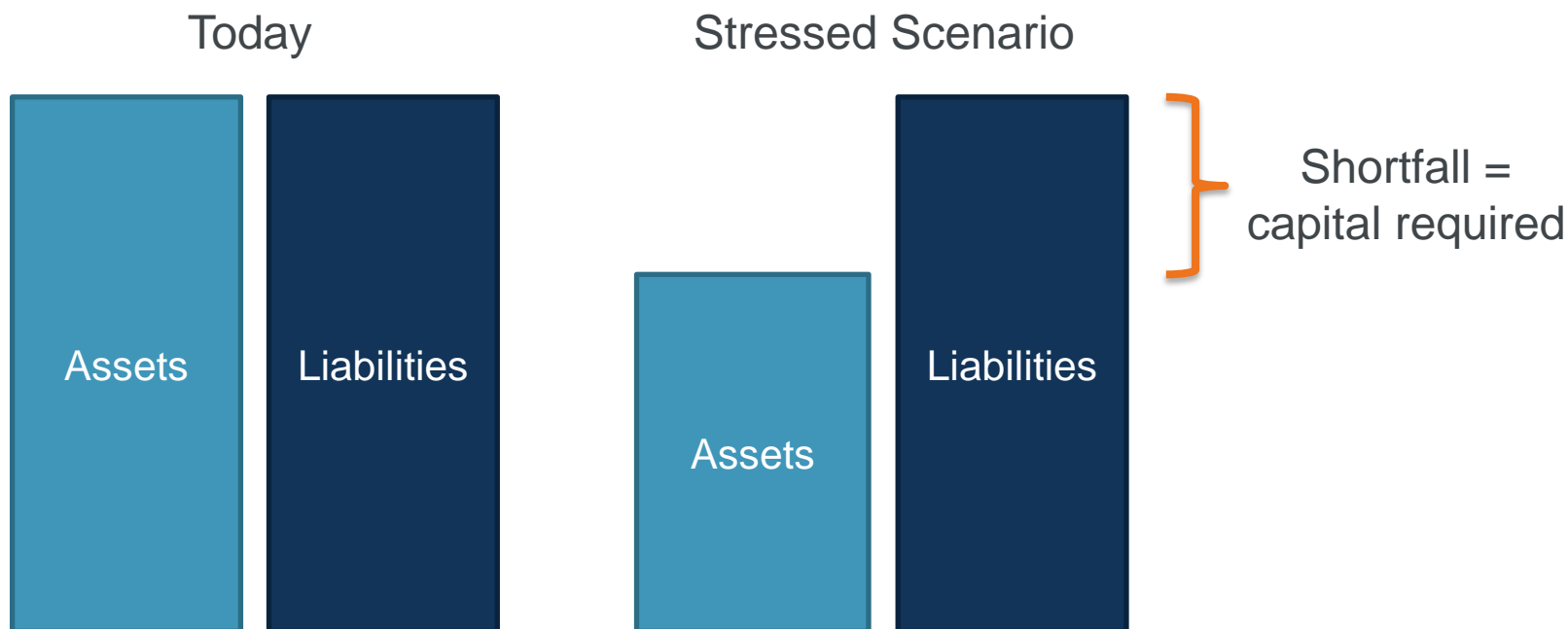
Validation - ensuring it satisfies the need - i.e. suitably represents the real world system it intends to model

Take together to determine if the model is **fit for purpose**

Capital Model Explained

Calculating the shortfall of assets under stress

- Used to calculate the potential balance sheet impact in (usually extreme) scenarios



Capital Models – plural?

Not one model but many

- Asset models
 - Derivative models
 - Market prices
- Liability models
 - Cash flow models
 - ESGs
- Risk models
 - Time series & stationarity
 - Stochastic vs deterministic
- Aggregation models
 - Variance-covariance
 - Copulas
- Proxy models
 - Polynomial
 - Cash flows
 - Least Squares Monte Carlo



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Industry Comparison

Banking vs Insurance

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Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals
Support

Environmental

Comparing the playing field facing each industry

- Business model
 - Sources of profit
 - Attitude to risk
- Balance sheet structure
 - Traded vs non-traded instruments
 - Allocation of risk
- Regulatory environment
 - Basel vs Solvency
 - Risk horizon

Modelling

Comparing industry choices to similar questions

- Modelling requirements
 - E.g. use & frequency
- Methodology choices and constraints
 - Run time, approximations, granularity
- Validation strategies
- Model risk



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Verification

Are we building the model right?

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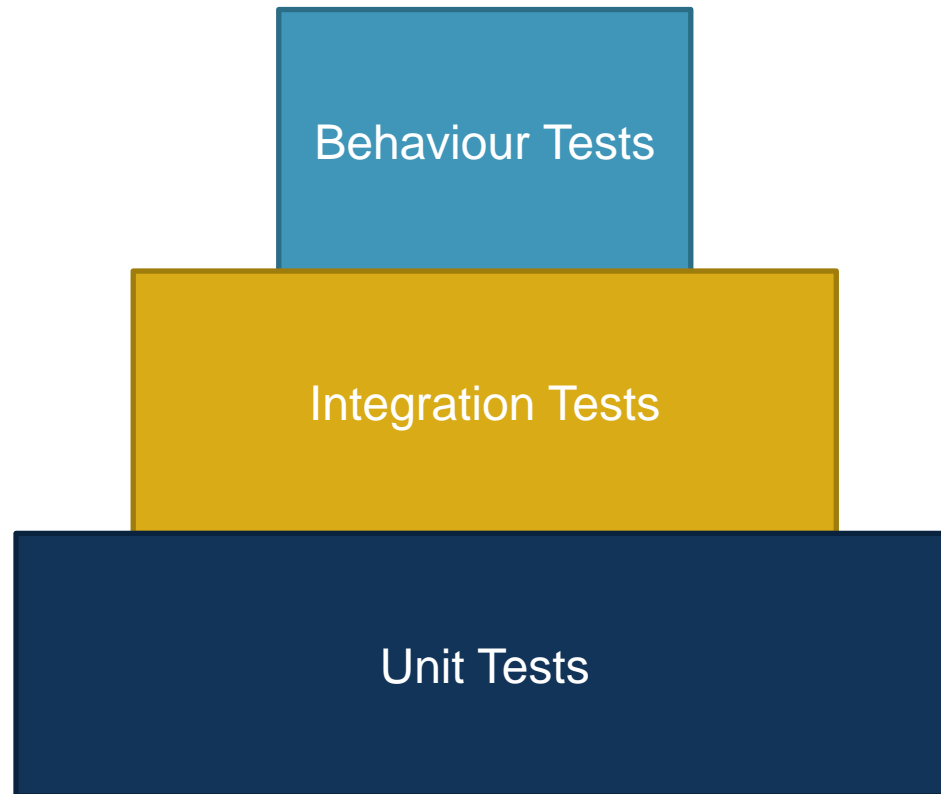
Independent Implementation

Reduced chance of independent implementation of the same mistakes

- Different implementations of the same model
 - Independent approaches unlikely to include the same bugs
 - Still at risk of group think
- Prototyping and production
 - Implement in different environments
 - Part of a development cycle
 - Prototypes can be more transparent through inefficiencies

Other Verification Techniques

Testing what we can





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Validation

Are we building the right model?

Expert Judgement

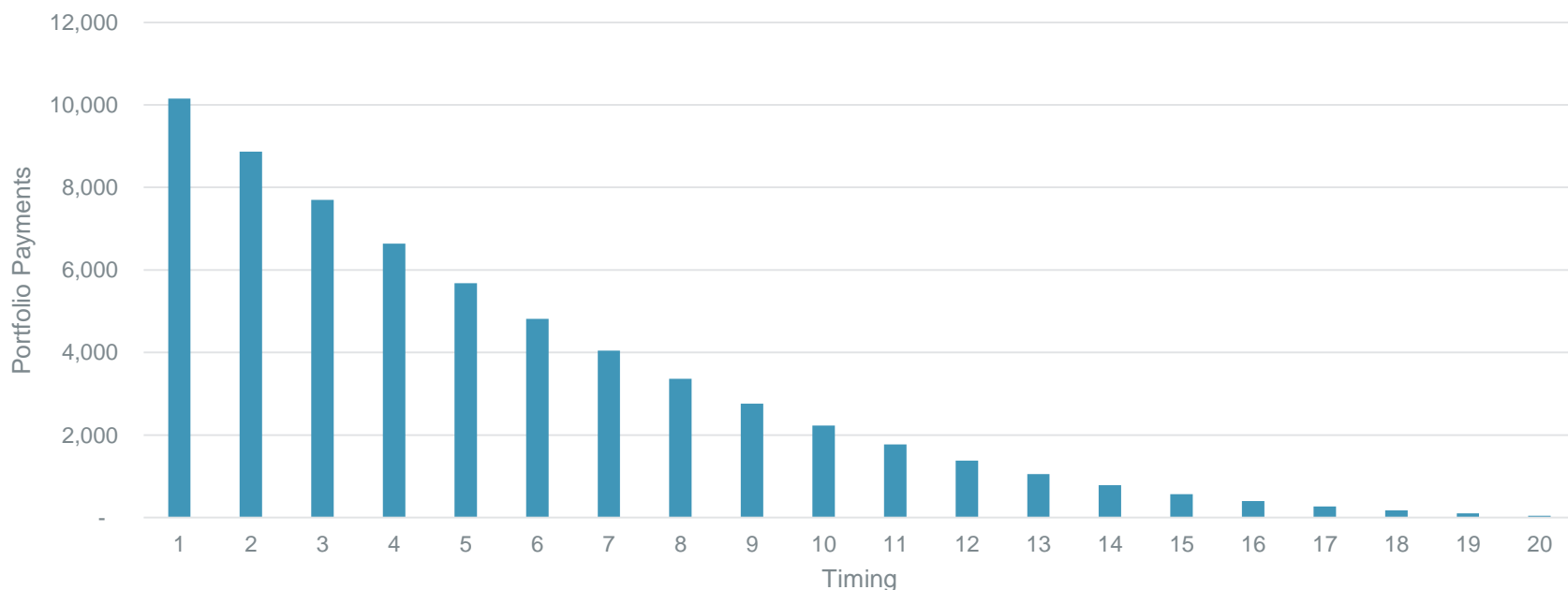
Too often the only validation carried out

- Necessary but not sufficient – problems include:
 - Number and complexity of models
 - Availability of expertise
 - Model risk – use, aggregation; hidden assumptions and biases
 - Lacks consistency and repeatability
 - Regulatory expectations of banks explicitly include:
 - Independence of model validation
 - Quantitative assessment of model stability, discriminatory power, and appropriateness of risk factors
 - Formal assessment and governance of model risk – requires a more rigorous and quantitative approach
- Similar direction of travel in Insurance
- Increasing disclosure requirements around the impact of model assumptions for banks and insurers

Simple Back Testing

How the model would have performed over a historical period

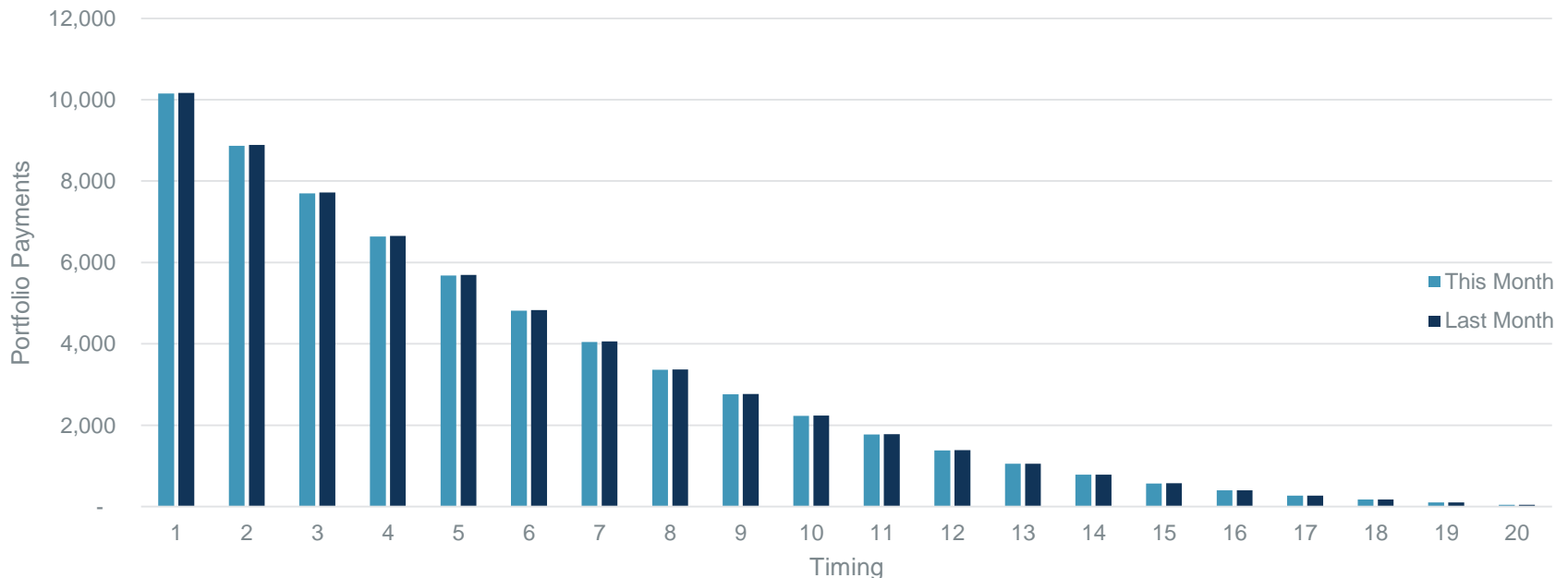
- Consider a simple portfolio with known future cashflows
- PV today of £58,097
- 99% 1-month VaR today of £1,407 (approx. 2.4%)



Simple Back Testing (2)

Consider the portfolio value at a previous time point

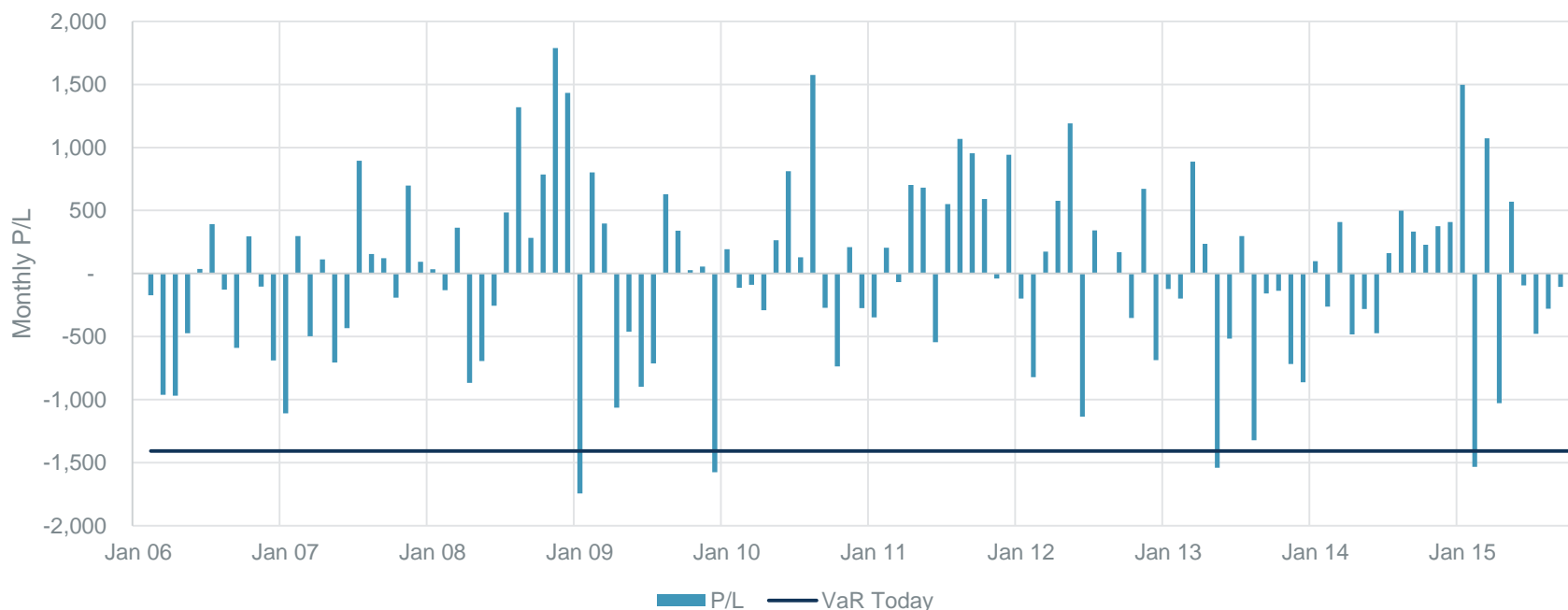
- Consider the portfolio last month
- PV then of £58,528 i.e. it has decreased by £484
- Less than our Value at Risk (£1,407)



Simple Back Testing (3)

Assessing the performance of the model

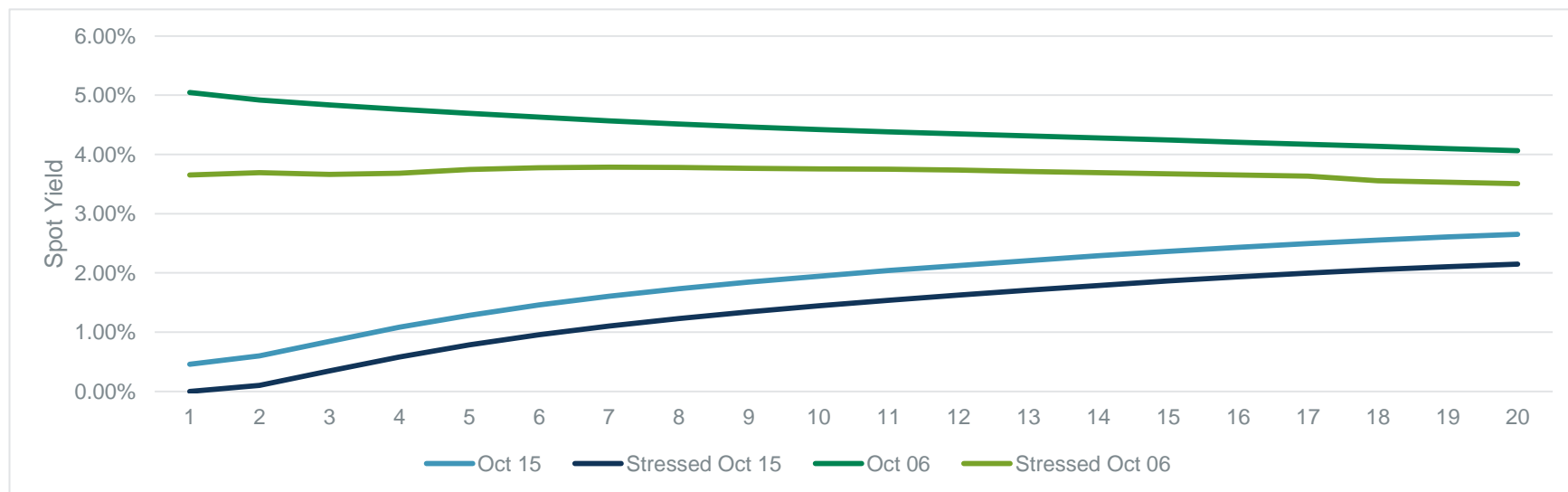
- Portfolio profit / loss each month
- Since 2006 the portfolio has maintained a stable size
- Loss exceeded VaR 4 times in 117 months (i.e. 3.5%)



Simple Back Testing (4)

A look at the yield curve

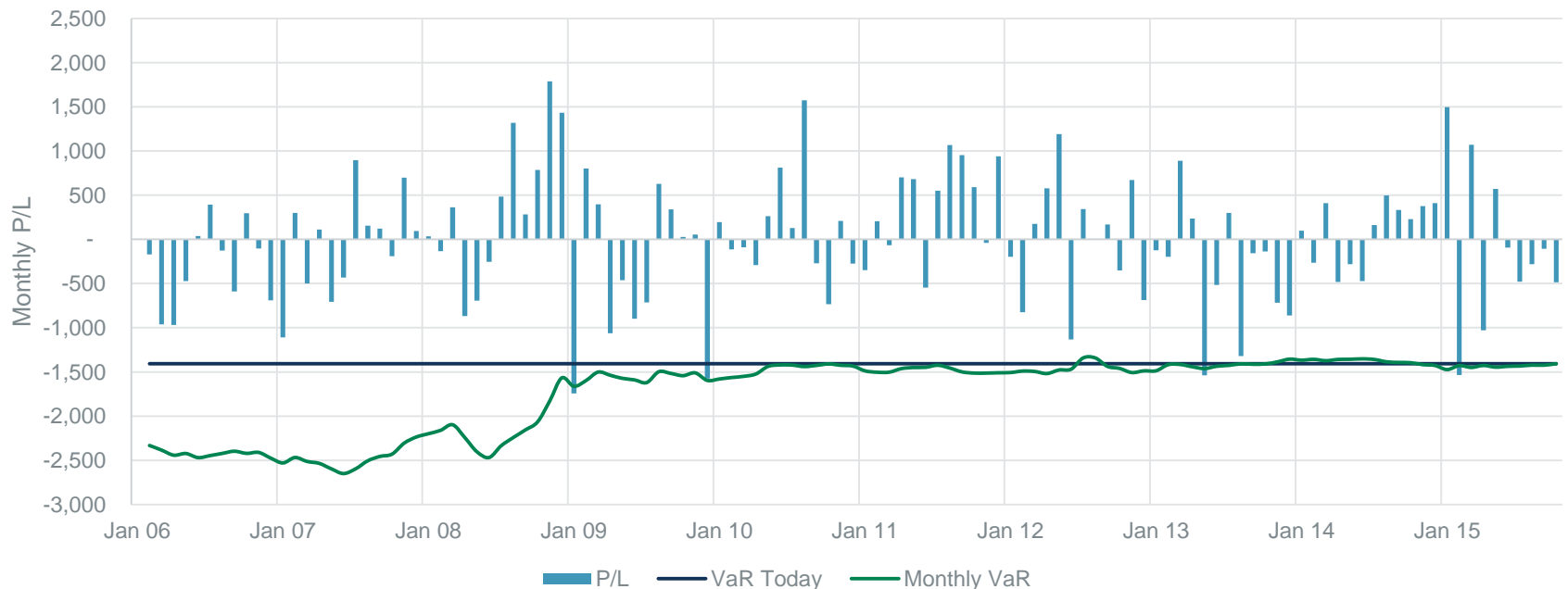
- In 2006 the yield curve was 4-5%
- Stresses of 0.5-1.5%
- In 2015 the yield curve is <3%
- Stresses of <0.5%



Simple Back Testing (5)

A better assessment of the model

- Portfolio profit / loss each month
- Monthly VaR shows VaR today is close to lowest ever
- Loss only exceeds VaR 3 times (2.5%)



Hypothetical Exposure Back Testing

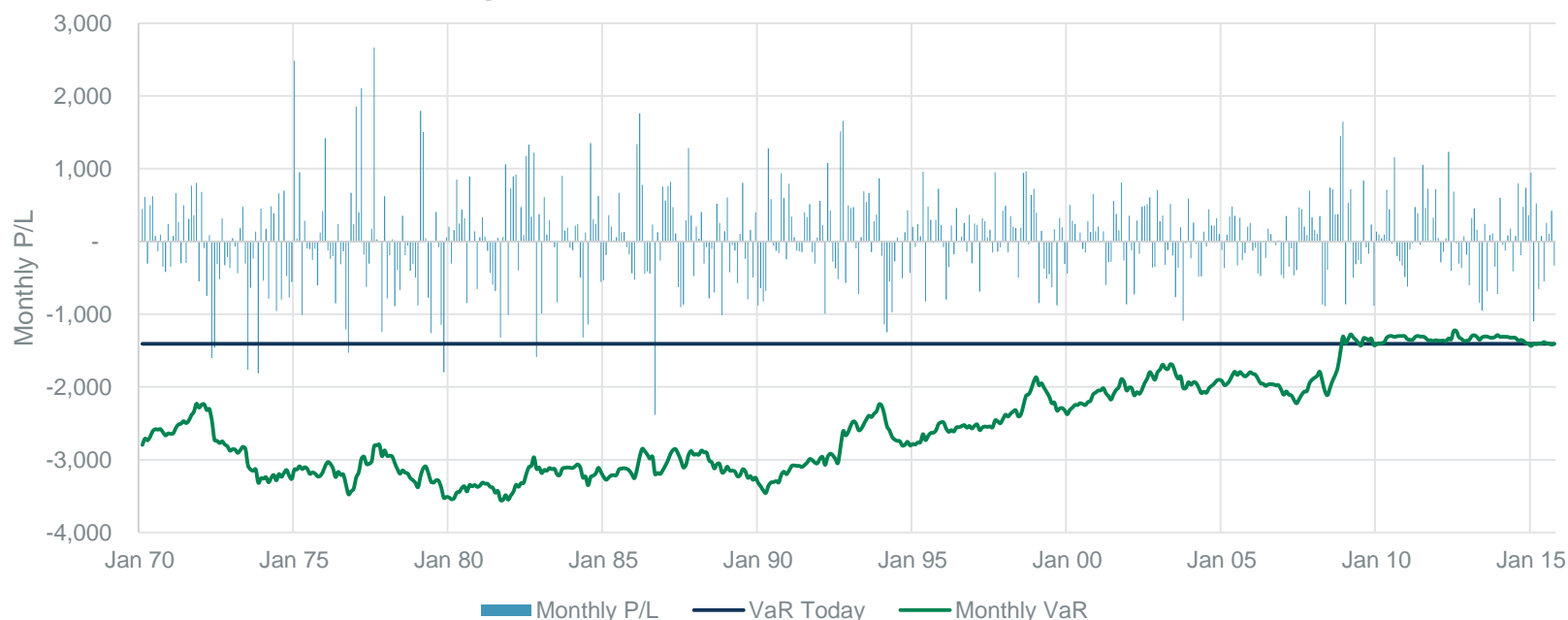
Use a hypothetical business exposure instead of the real exposure

- The problem is the changing business exposure
- We observe volatility in the exposure which the model does not (and should not) capture
- But we still need to validate the model
- So back test a hypothetical business, e.g. how would today's business have performed?
- Added advantage that we are not limited to the specific historical period when business has been stable (i.e. since 2006)

Hypothetical Exposure Back Testing (2)

Today's business exposure since 1970

- Can observe that the monthly VaR appears to reflect the P/L volatility
- There are 0 occurrences of losses exceeding VaR ,out of 550 months of exposure



Hypothetical Historical Back Testing

Use hypothetical historic experience instead of real experience

- The power of the test is limited by the availability of data
- In this example we used monthly data from 1970
- In practice we might want annual data or have a shorter history available
- Instead we can generate data, as much data as we want
- But need to be careful about assumptions

Hypothetical Historical Back Testing (2)

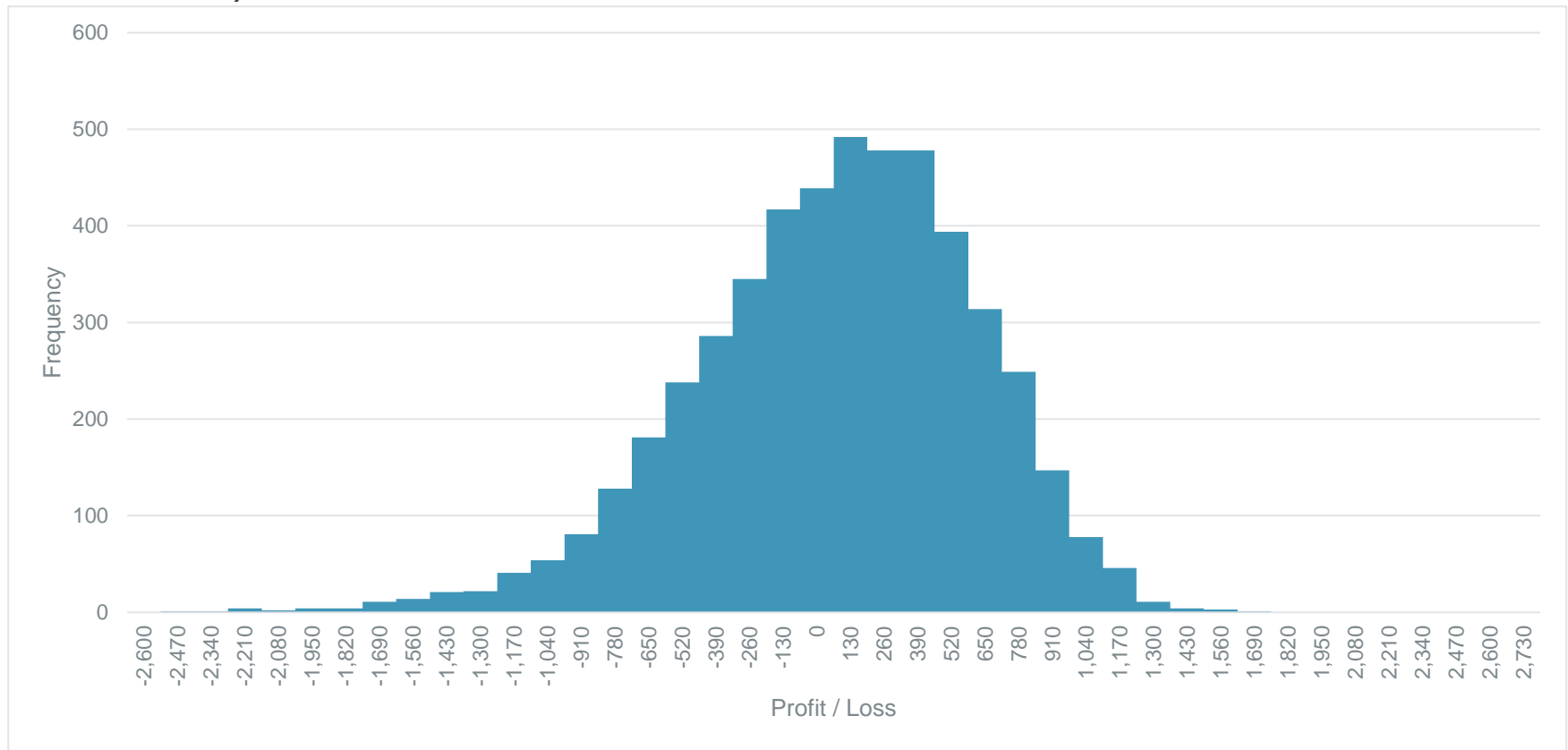
Generating data

- We need to consider how our model is calibrated – there is no use in generating data which will validate the model by construction
- E.g. If VaR model assumes a Normal distribution for a risk driver then comparing the VaR to Normally generated data does not validate it
- Validate the robustness of the model – use alternative possible distributions or bootstrap historical data

Hypothetical Historical Back Testing (3)

Generating data

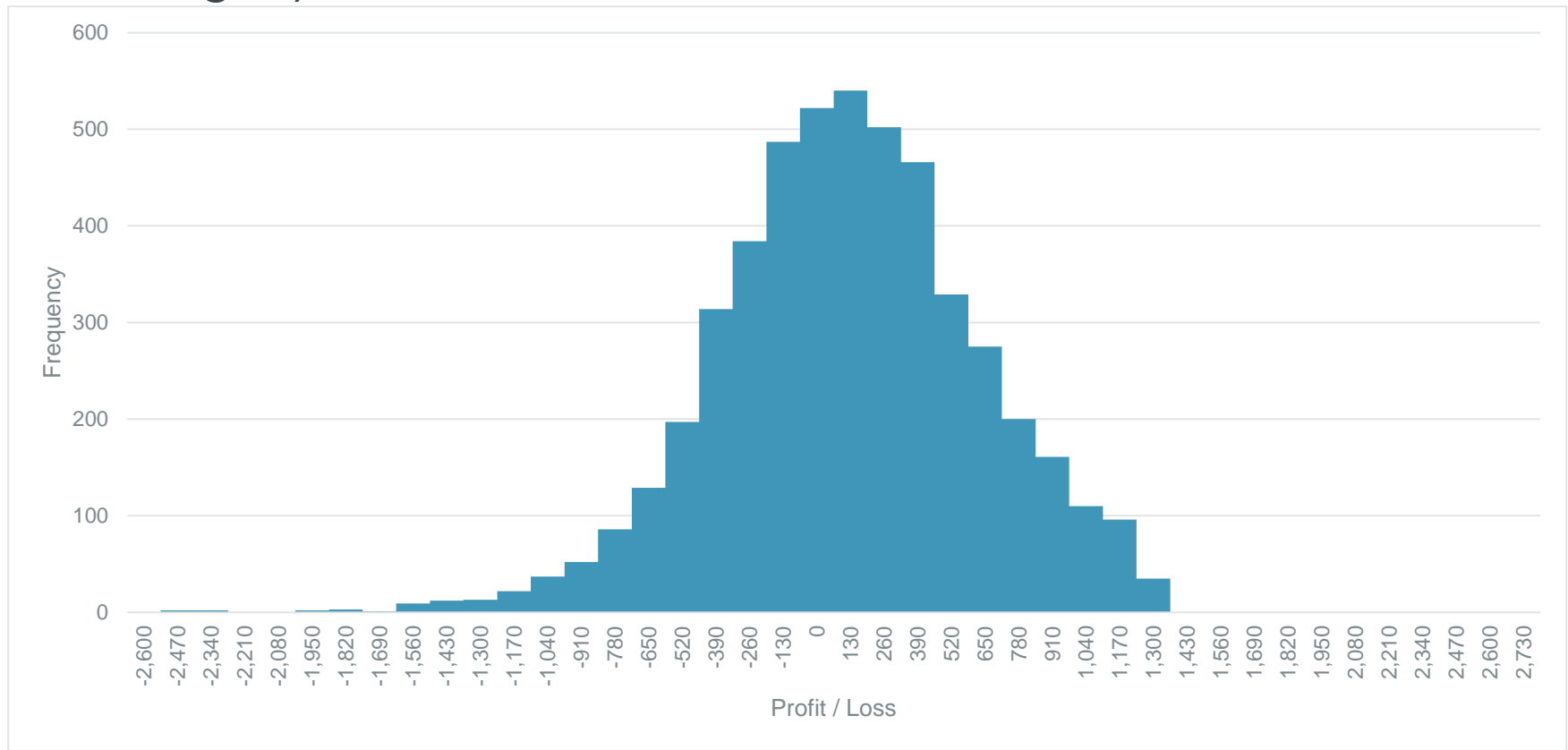
- Generate yield curves (using similar assumptions to the model)



Hypothetical Historical Back Testing (4)

Generating different data

- Generate yield curves (using absolute instead of log changes)





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Learnings

What should you take away?

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Learnings

Remember the purpose

- Verification – are we building the model right?
 - We can show the answer is no, but not necessarily yes
- Validation – are we building the right model?
 - We want a yes or no
 - But often we have conflicting evidence
- So instead ask:
 - How wrong could the model be?
 - What assumptions have we made and do we understand them?
 - Can we do more to justify our model is fit for purpose?



Questions



Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenters.