Model Risk Assessment

Case Study Based on Hedging Simulations

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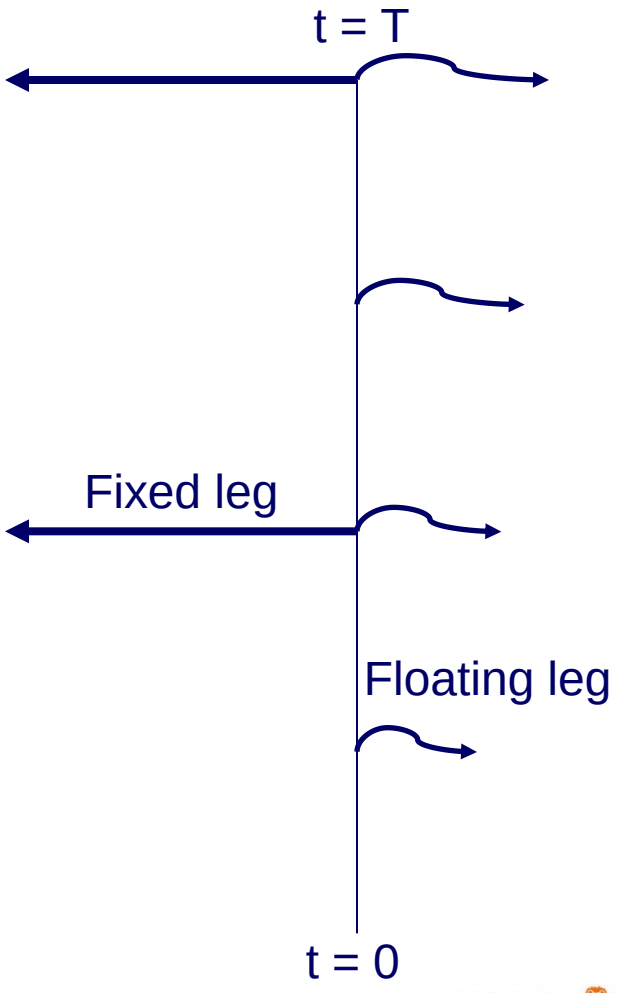
Agenda

- Quick Introduction to Interest Rate Derivatives and Valuation
  - Plain Vanilla IR Derivatives
  - From Plain Vanilla to Exotics
- Model Risk
  - A Practical Definition
  - A Case Study
- Concluding Remarks

Plain Vanilla Interest Rate Derivatives
Interest Rate Swaps

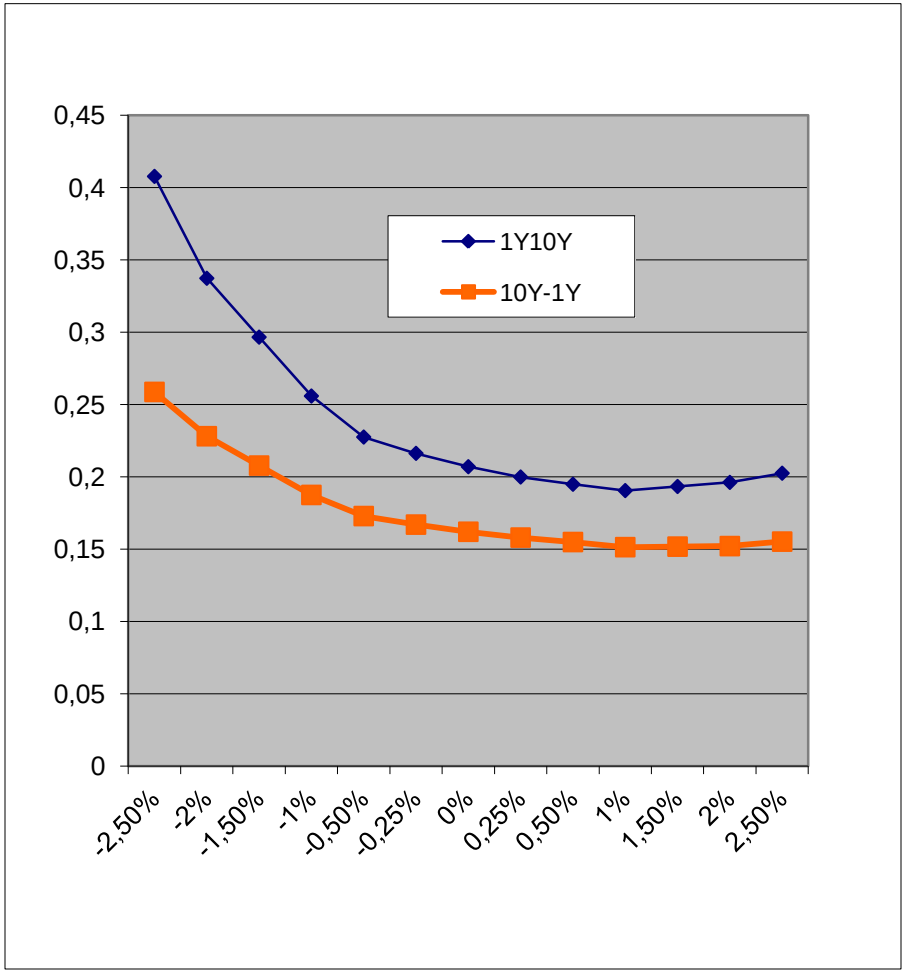
- Consists of fixed and floating leg
- **Liquid** Market in many currencies
  - Markets quotes par swap rates
  - For many maturities (up to 50Y)
- Products can be priced on a curve
  - No need for a sophisticated model
  - Today's reality a bit more tricky



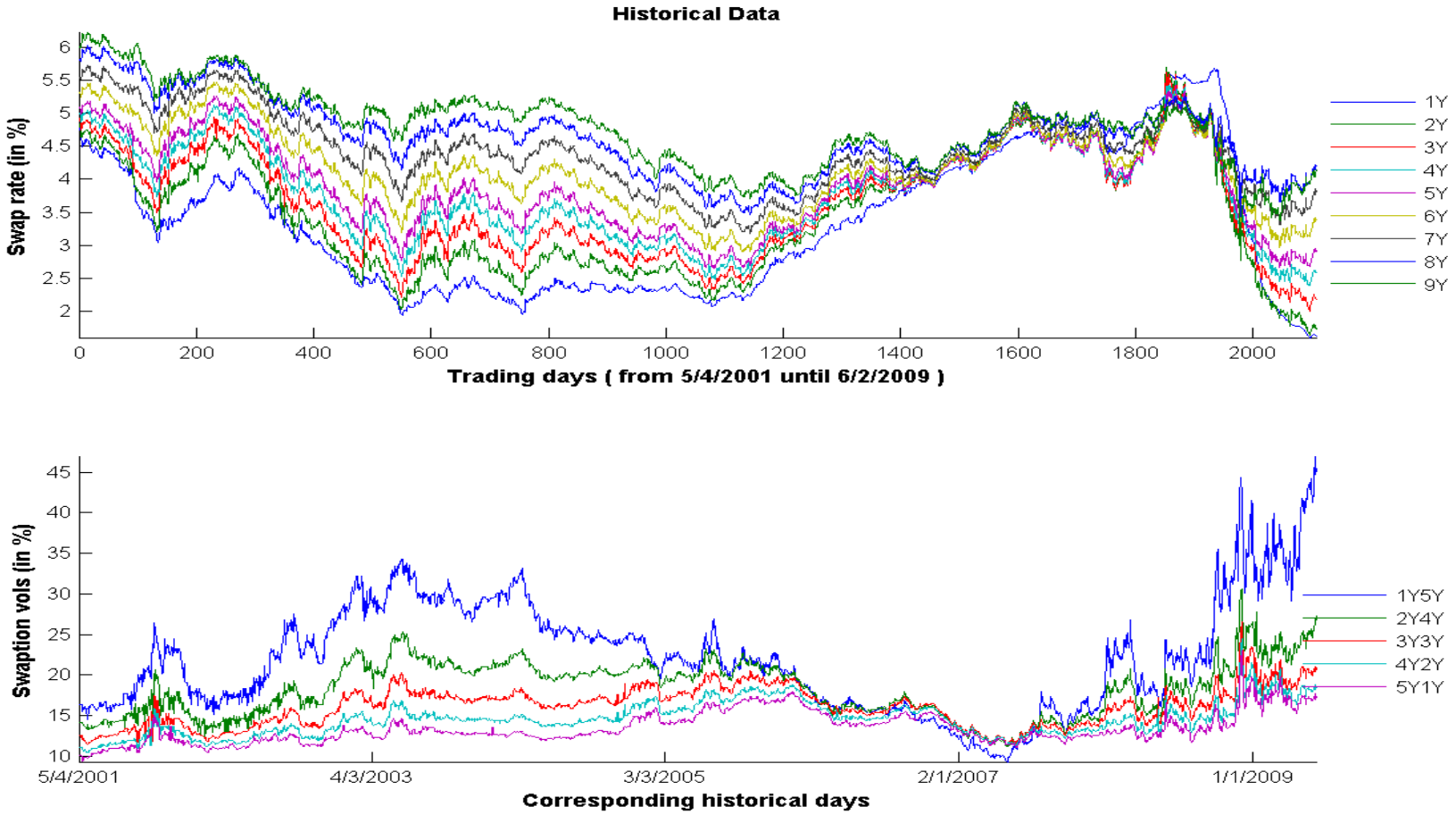
Plain Vanilla Interest Rate Derivatives

European Swaptions

- Gives the holder the right to enter into a swap at future date T
- Parameters of the contract
  - Expiration date T
  - Tenor of the swap
  - Strike of the option
- **Liquid** market in main currencies
  - Modified Black's formula is used to price – let's say to fit to the market
  - Market shows typically strong skews and smiles which change over time



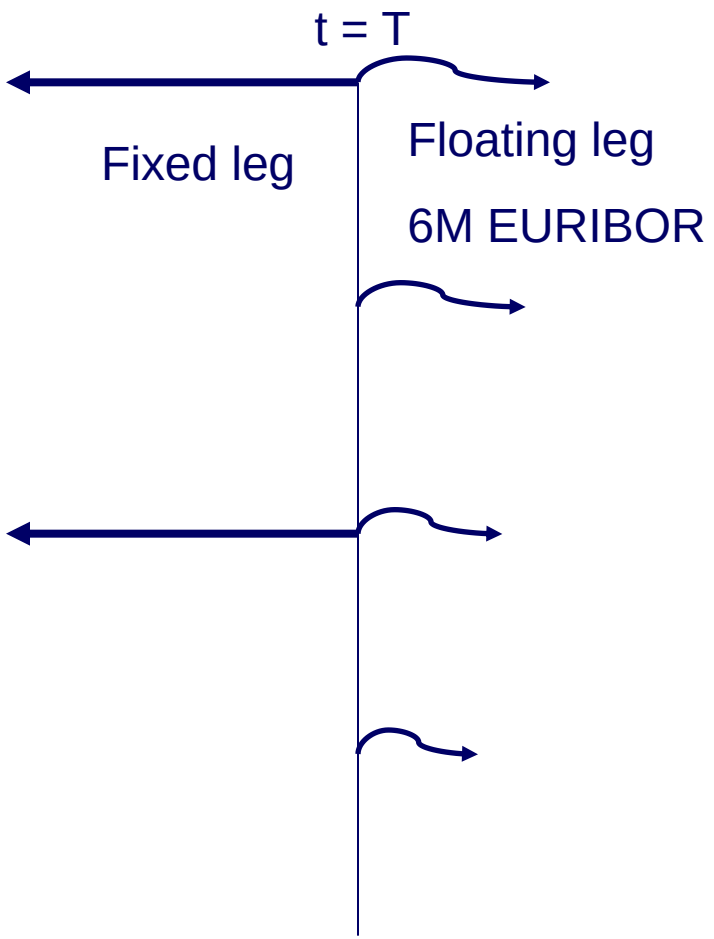
Plain Vanilla Interest Rate Derivatives
Market Data



Exotic Product
Bermudan Swaptions

- The holder has the right to enter into a swap during its life-time

- Premium will depend on
  - Underlying swaps
  - All co-terminal swaptions
  - Joint density of future swap rates spanning the contract



Calibration and Valuation
Hierarchy of Models

Single Factor Short-Rate Model

- Simple and Fast Valuation

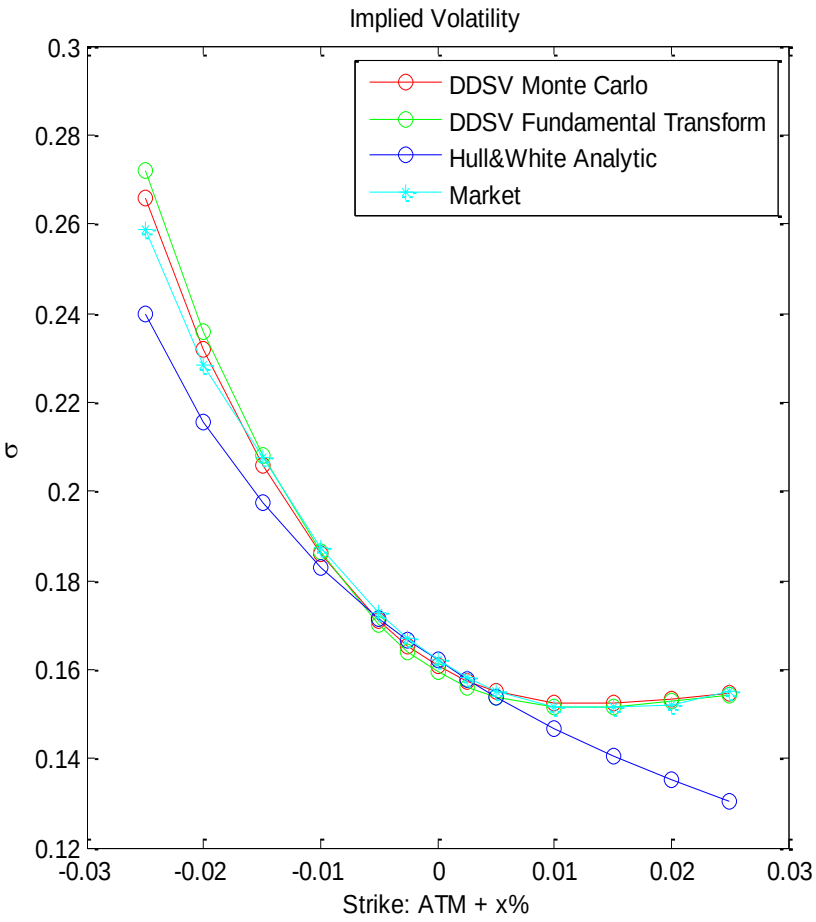
$$dr(t) = a(\phi(t) - r(t))dt + \sigma(t)dW$$

Two Factor Short-Rate Model

- Flexible shape but many more parameters

Stochastic Volatility Cheyette Model

- Flexibility in Calibration of Smile



Model Risk
Background

- Potential losses due to the use of an incorrect model
  - Missing risk factors such as smile
  - Uncertainty in calibration including unobservable parameters
  - Unstable hedge parameters
- Too complex models may not be even useful in practice
  - Additional parameters that are difficult to estimate
  - Traders like simple and intuitive models
- Literature does not treat real exotics nor portfolio effects
- It is of key importance to assess the potential model risk and to have proper reserves in place

Model Risk
Assessment Methodologies

- Distribution of error in P/L due to use of a wrong model
- Model Risk is a specific quantile of this distribution
- How to obtain the error for a scenario
  - Comparison against alternative models
    - Need many different models
    - Even enhanced model may have big uncertainties in choice of parameters
  - Hedging Simulations
    - Fair value is the cost of hedging the claim
    - Realize that at expiry of the claim there is no model dependence!

Model Risk Assessment
Hedging Simulations – The Experiment

Sell Bermudan Swaption @ t=0 and deposit premium in Bank-Account

Repeat for each time-step

1. Liquidate hedge of previous time-step
2. Deposit proceeds in Bank-Account
3. Revalue deal on new time-step
4. Neutralize vega exposue
   - Calculate Vega Sensitivies for each calibration instruments
   - Buy Swaptions to neutralize vega exposure
5. Neutralize remaining delta exposure
   - Calculate Delta Sensitivities to each relevant market instrument
   - Enter into par swaps to neutralize remaining delta exposure
6. Accumulate interest in Bank-Account

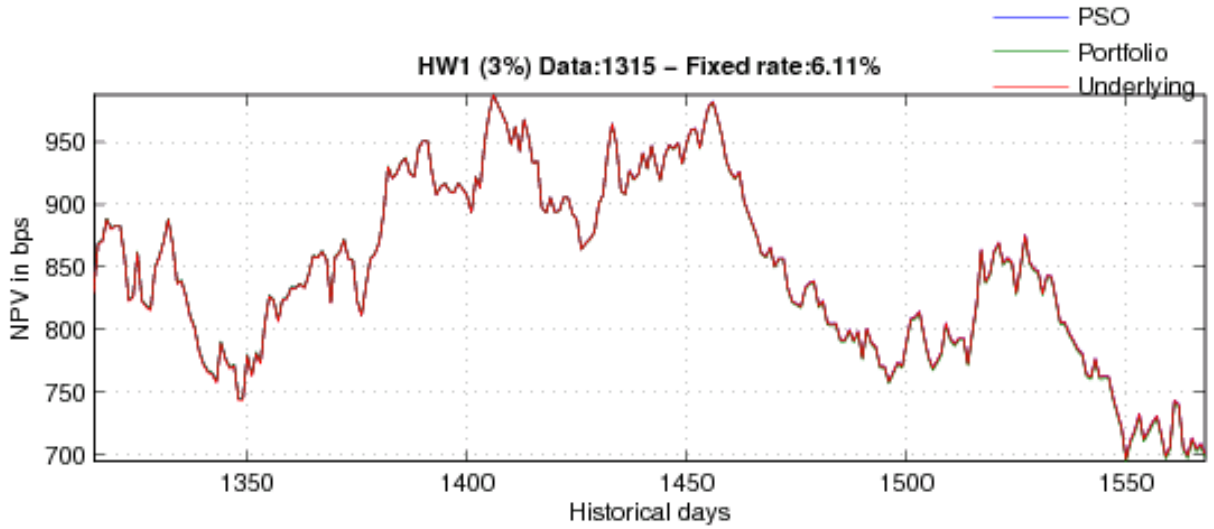
Model Risk Assessment
Hedging Simulations – Low Model Risk Case

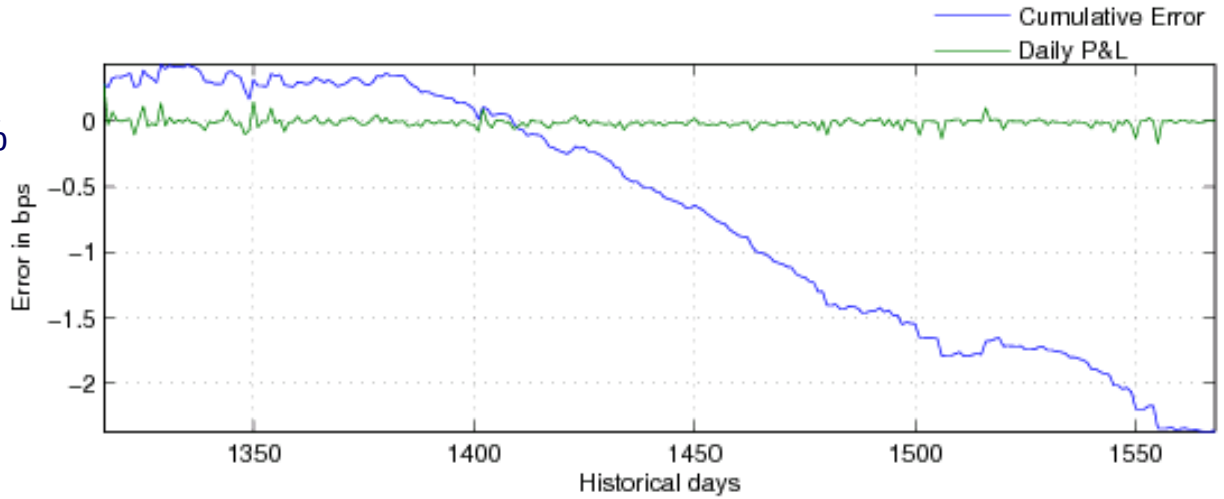
In-the-Money Deal

Low Model Risk

Bermudan

- Strike 6.11%
- Maturity 5Y
- Mean-Reversion of 3%





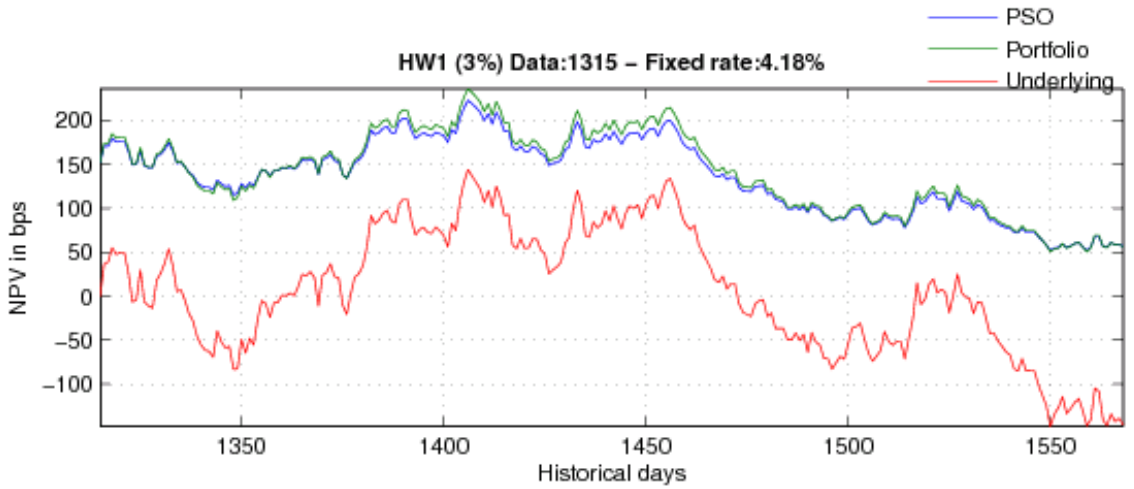
Model Risk Assessment
Hedging Simulations – High Model Risk Case

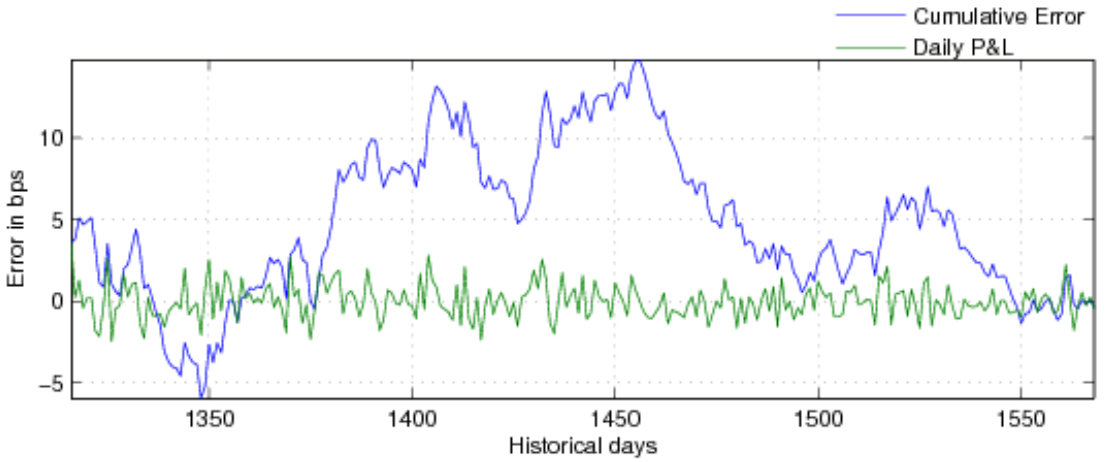
At-the-Money Deal

High Model Risk

Bermudan

- Strike 4.18%
- Maturity 5Y
- Mean-Reversion of 3%





Model Risk Assessment
Summary

Model Risk Estimation

- Generate P&L Distribution (e.g. many scenarios)
- Estimate quantile that you like and charge your trader and impose limits ☺

Pitfalls

- Relevant risk factor not present in market scenarios (e.g. basis or curve inversion)
- History too short
- Market Friction and Transaction Cost
- How to express impact into something that your Product Control team can calculate
- Name it …

Final Remark

Acknowledgements

- Panos Nikoupoulos, Norbert Hari and Bart Hoorens