Understanding model risk and overcoming model limitations

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Agenda

- Model risk
- Managing Model Risk
- Topics for discussion

Which model?

- *valuing instruments,*

- analyzing business strategies,
- identifying and measuring risks,
- conducting stress testing,
- assessing adequacy of capital,
- managing client assets,
- measuring compliance with internal limits,
- meeting financial or regulatory reporting requirements
- issuing public disclosures.
- …

Definition of Model Risk

"Potential for adverse consequences from decisions based on incorrect or misused model outputs"

Eg.

- Actual cash flows differ from model prediction
- Unexplained Profits and Losses
- Financial losses
- …

Definition of Model Risk

Model risk arises when:

- Use of mathematical models to value and hedge complex financial securities.

- Relatively illiquid markets for which price-discovery mechanisms are inefficient.

Agenda

- Model risk
- ***Managing Model Risk***
- Topics for discussion

Managing Model Risk

- "Effective Challenge of models"
  - —Critical analysis by objective and informed parties
  - —Can identify model limitations and assumptions
  - —Produce appropriate changes
  - —Separation from model development

- Model risk cannot be eliminated
  - —Limits on model use
  - —Monitoring model performance
  - —Adjusting/revising models over time
  - —Informed conservatism (input, model, output)

Managing Model Risk

- Independent reviews of theory underlying models
  - —Financial literature
  - —External audits
- Stress testing models
  - —To alert decision makers on model limitations
  - —Provide range of parameters values for which the model is accurate

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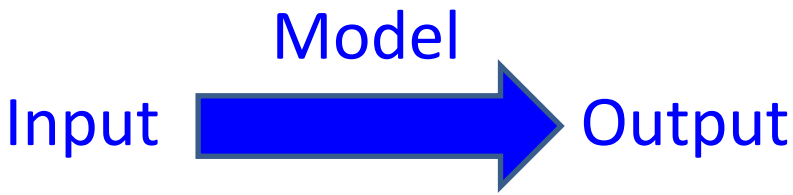
Managing Model Risk

- Model risk reserves
  - —Expected P&L impact of unforeseen inaccuracies in models
  - —Based on assessment of model sophistication

- Impact of model results on other models that rely on those results as input (VaR, PFE…)

What can go wrong?



What can go wrong?

- Input (volatilities, correlations…)

Model

- Model has fundamental errors

Model

What can go wrong?

- Model used incorrectly or inappropriately
- Model is not properly implemented

Model

??

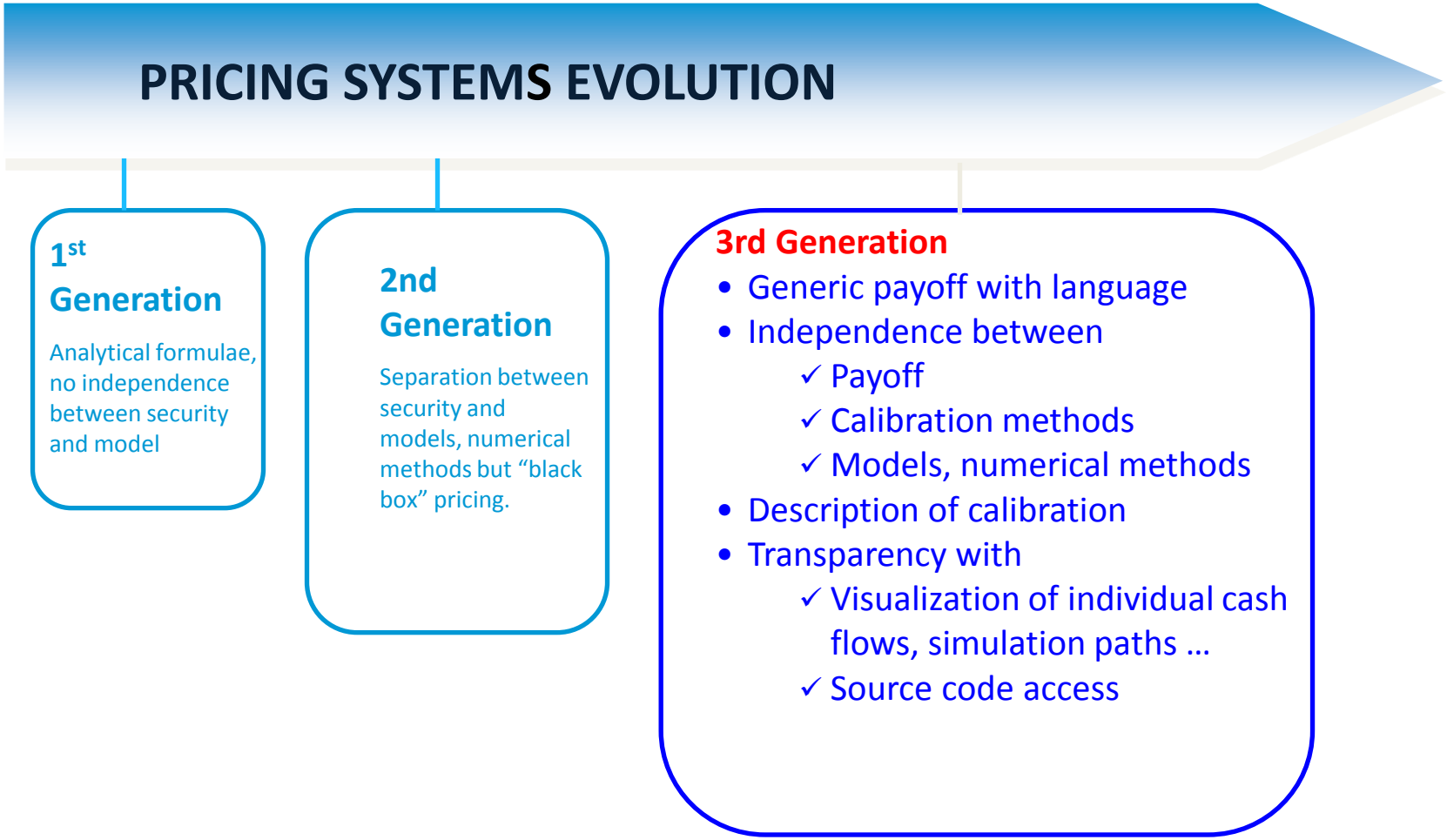
Agenda

- Model risk
- Managing Model Risk
- ***Topics for discussion***

Topics for discussion

1. Latest developments in terms of model implementation
2. Suitability of the models
3. Convergence of the models
4. Stability of the models
5. Consistency of the implemented models

-1- Model implementation: towards flexibility



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-2- Suitability of the model

-A- Availability of market data

-B- Behaviour of the underlyings

-C- Instrument characteristics

-D- Model limitations

-A- Availability of market data

Local Volatility Model (Dupire)

- Diffusion: $$\frac{dS(t)}{S(t)} = \sigma(t, S(t))dW_t$$

Vol. depends on maturity and moneyness

- Drawback: “cannot” be used if we can only get ATM volatilities

-B- Behaviour of the underlying

Gibson-Schwartz Model

- Diffusion:

$$\begin{cases} \dfrac{dS_t}{S_t} = (r_t - y_t)dt + \sigma_1 dW_t^1 \\ dy_t = k(\alpha - y_t)dt + \sigma_2 dW_t^2 \\ d < W^1, W^2 >_t = \rho dt \end{cases}$$

Stochastic Convenience yield

- Advantages :
  - pure commodity model; takes into account the convenience yield behavior
  - As a consequence, pricing is accurate for Commodity products because forward volatility is not implied in the pricing

-C- Instrument characteristics

- Path dependency (Annapurna, Ariane, Binary / Digital call, Comet, Convergence, Range Accrual …)
  - sensitive to smile
  - numerical method must be Monte Carlo

- Early redemption Products ***only*** (Callable, Starlight)
  - numerical method can be AMC, PDE or Tree

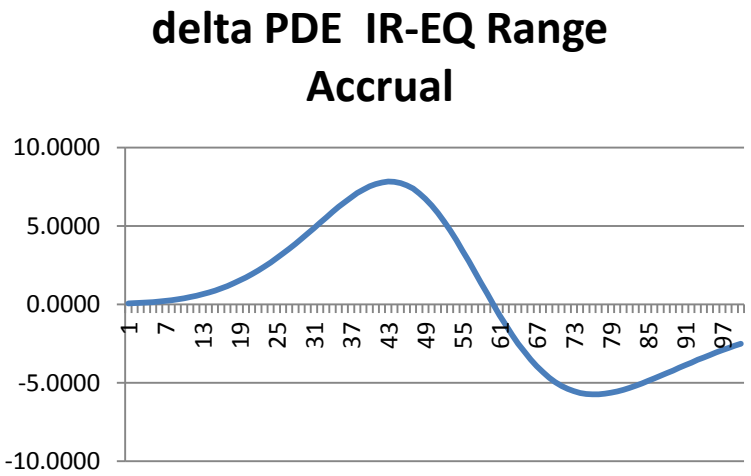
-D- Model limitations

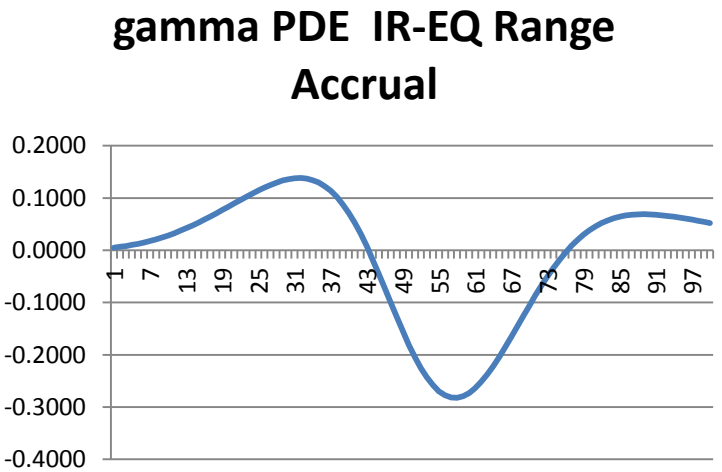
- **Black Scholes**
  - no volatility smile in the model
- **Local vol. Dupire**
  - Forward smile flattens with time
  - Inappropriate for very short dated options, where the underlying can jump.
  - E.g. problem in cliquet pricing
- **Heston** (Stochastic vol)
  - Calibration can fail on short maturities
- **Gibson-Schwartz**
  - no volatility smile in the model
  - no term structure as parameters are constant

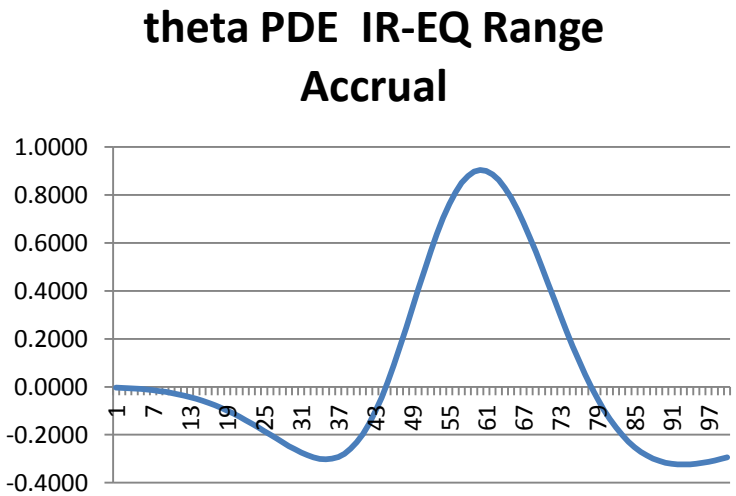
-3- Model convergence

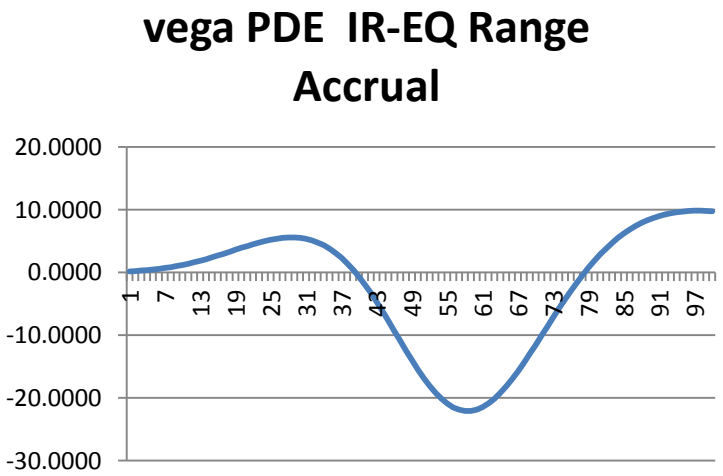
- Convergence of MC
  - Enough scenarios
  - Appropriate parameters (time steps…)
  - Ability to audit scenarios to construct the prices
  - Track cumulative price => stability regardless of the numbers of scenarios
- Convergence of the calibration algorithm
  - Monitor “Calibration residual”(i.e. difference between volatility surface given by market data and the one produced by model)

-4-Greek Stability*

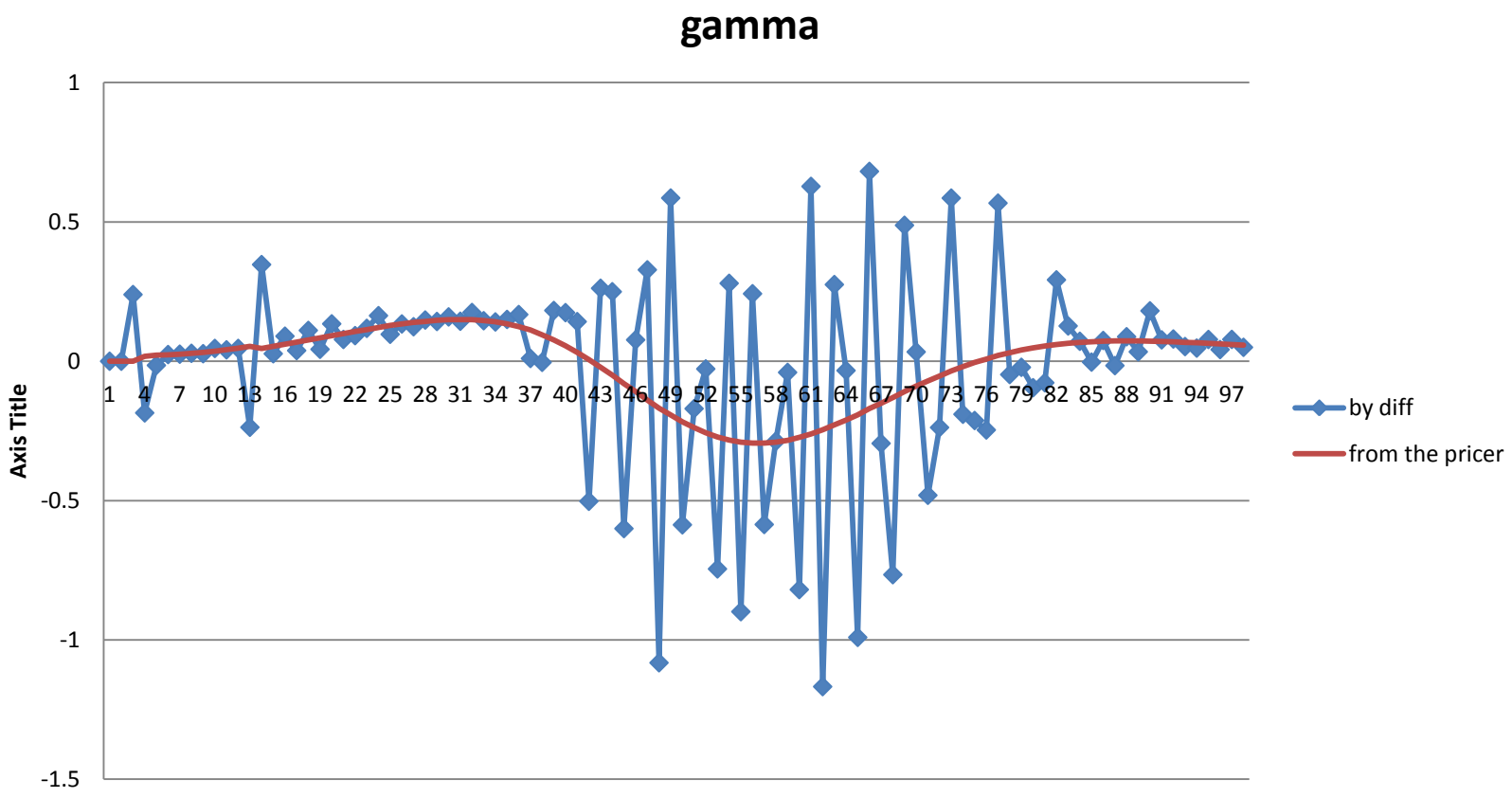








-4- Greek UNstability



* Not real life example; for illustration purposes only.

-4- Sensitivity to model parameters

- Mean reversion
- Implied volatility
- Correlation
- Shift
- Tenor
- Jump size
- Jump vol
- …

-5- Model consistency*

	PDE	MC	TREE
HW1F	100.123	100.230	N/A
HW2F	100.050	**103.124**	N/A
LMM	100.353	**98.256**	N/A
CEV	**97.567**	100.278	N/A

* Not real life example; for illustration purposes only.

Conclusion

- Using models triggers a new kind of risk
- Monitoring model risk includes
  - Managing input of the model
  - Choosing the “right model”
    - Available Market data
    - Instruments
    - Model limitations
  - Validating the model
    - Convergence, calibration, stability, consistency

THANK YOU

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