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Eidgenössische Finanzmarktaufsicht FINMA
Autorité fédérale de surveillance des marchés financiers FINMA
Autorità federale di vigilanza sui mercati finanziari FINMA
Swiss Financial Market Supervisory Authority FINMA

Economic Scenario Generators

A regulator's perspective

Falk Tschirschnitz, FINMA
Bahnhofskolloquium

12. November 2012

Motivation

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FINMA has observed:

- Calibrating the interest rate model of choice has become increasingly difficult:
  - High implied volatilities, undulating surface
  - Extremely low nominal interest rates, even negative
- Documentation of the ESG as part of the internal model is usually very limited
  - Choice of particular model is not explained
  - Limitations of the chosen model are not discussed

→ The model risk is considerable.

Agenda

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- Why do we need Economic Scenario Generators (ESGs) ?
- What are the key properties an ESG should fulfil?
- How can you assess the adequacy of your model choice?

Different uses ask for different types of scenario sets

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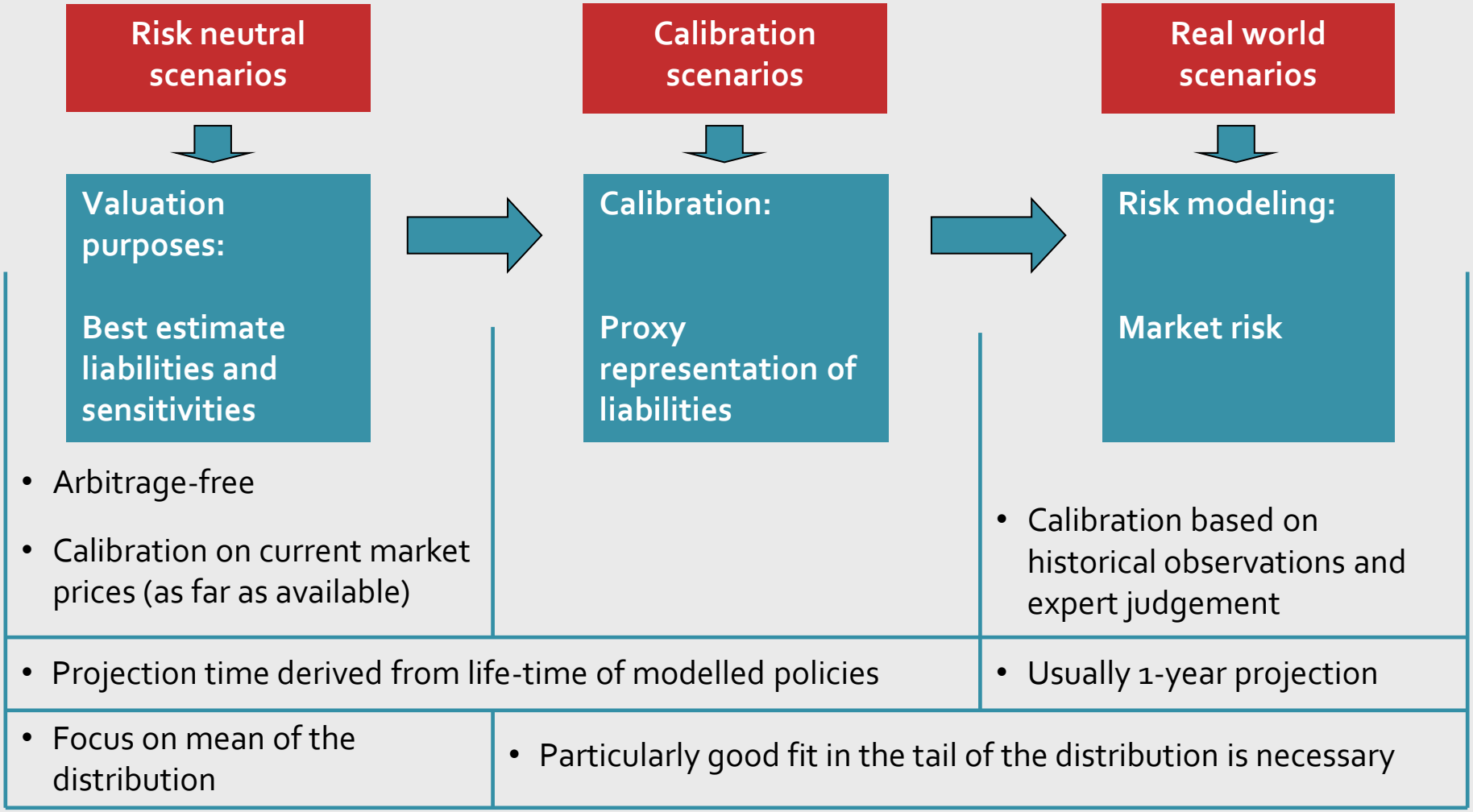

ESGs
are at the core of stochastic modelling

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- An ESG produces forward-looking scenarios for a specified set of risk factors, e.g.:
  - Interest rate term-structures
  - Inflation
  - Index returns, e.g. for equity, real estate, hedge funds, private equity
  - Exchange rates
- *Assumption:*
  The possible behaviour of risk factors (and their interaction) can be described sufficiently well by certain stochastic models
- Choice of the stochastic model and a set of parameters determines the range of the scenarios produced by ESG

Most life insurers require complex stochastic models for valuation of their liabilities at reference day

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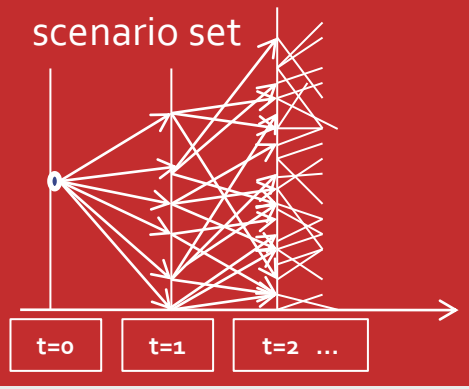
Input data

- Policy data
- Statutory balance sheet (*t=0*)
- …
- Risk-neutral economic scenario set



Best estimate liabilities

Cash flow model

Statutory P&L / Balance sheet

Dynamic management actions e.g. bonus crediting

Fund-based policyholder benefits and fees

Dynamic policyholder actions e.g. lapses

Monte Carlo simulation is currently the only feasible method to value complex (life) liabilities

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- Idea behind Monte Carlo method:
  - Generate sample paths for set of risk factors over the modelling period.
  - Calculate the (discounted) cash flows of the sample paths.
  - Aggregate the results.

- **Key idea & assumptions for market consistent valuation:**
  - → We start in a risk-neutral setting by calibrating the ESG to market prices of options and derivatives from deep and liquid markets. (This setting is free of arbitrage.)
  - → Best estimate for the liabilities is calculated as expectation.
  - → Property of arbitrage-freeness is not affected.
  - → Economically coherent.

Valuation of life liabilities: Survey of Swiss companies

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- All companies with materially sized business allowing for policyholder participation are expected to model stochastically

- Number of risk factors varies
  - between 3 (nominal interest rate / inflation / equity index)
  - and ~15 (multi-economy / various indices / credit spread)

- Two providers dominate the market, hence the choice of models limited
  - for nominal interest rate: Hull-White / 2Factor-Black-Karasinski / LMM(+)

The choice of the ESG poses some key challenges

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- Choice of modelled risk factors
- Choice of ESG-provider

- Choice of complexity of the model
  - Trade-off between simplicity and (perceived) accuracy
- Choice of calibration targets
  - Limited availability / reliability of market prices
  - Limited relevance of historical data for future predictions

→ Actuarial judgement essential that cannot be fully externalised

→ All decisions need to be documented

ESGs need to fulfil some key properties

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- Arbitrage free (for valuation purposes)
- Technically, fit for purpose
  - Theoretical basis
  - Data used is accurate, complete and appropriate
  - Robust calibration process

- **Adequate :**

  "No more complex than necessary,
  given the specific purpose and usage (e.g. product portfolio)"

  (**Parsimonious principle**)

The complexity of the ESG should be adequate to the complexity of the valuation model

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"Too simple"

Big calibration error

Optionality in the liabilities not captured

Model only working for a certain range of interest rates / volatilities

"Just right"

Extremely difficult calibration

"pseudo-accuracy"

ESG as black box

"Too complex"

Required properties for IR-models for risk-neutral valuation (1/5)

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- Arbitrage free

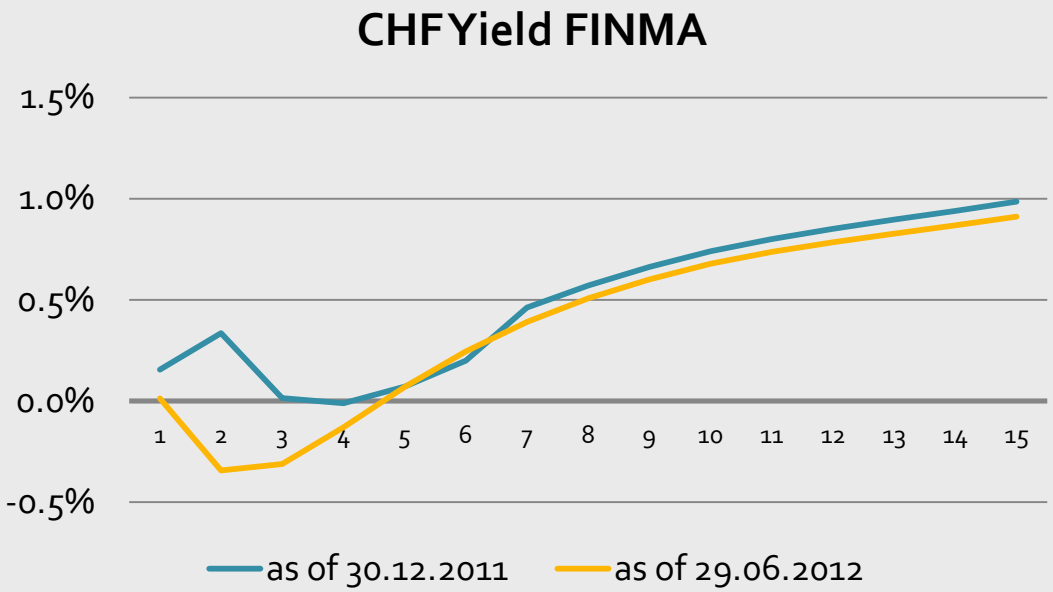
Relevant criteria:

- Martingale test:
  all asset classes achieve the same average return

- Leakage test:
  starting market value of assets (MVA) should be equal to the present value of all future cash flows plus the present value of the residual MVA

Required properties for IR-models for risk-neutral valuation (2/5)

- Can be calibrated to initial term structure



Relevant criteria:

Initial bond prices are perfectly matched.

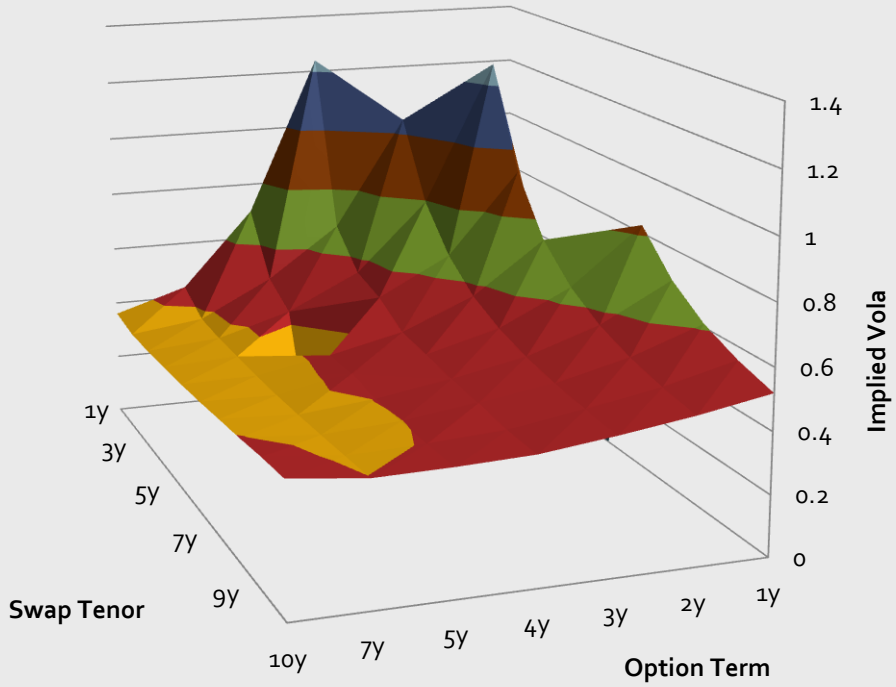
Required properties for IR-models for risk-neutral valuation (3/5)

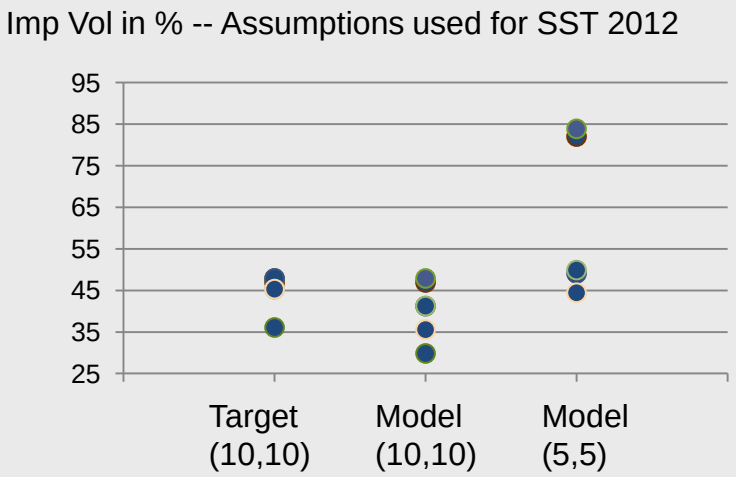
- Can be calibrated to initial derivative prices

Relevant criteria:

- Clear acceptance criteria
- Robust calibration process

CHF implied swaption vol as of 30.06.12
Source: Bloomberg





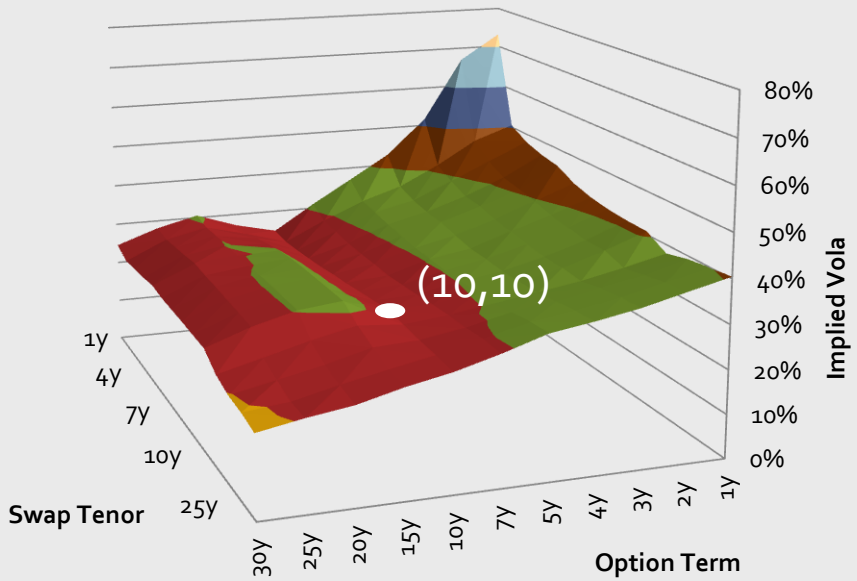
Required properties for IR-models for risk-neutral valuation (3/5)

- Can be calibrated to initial derivative prices

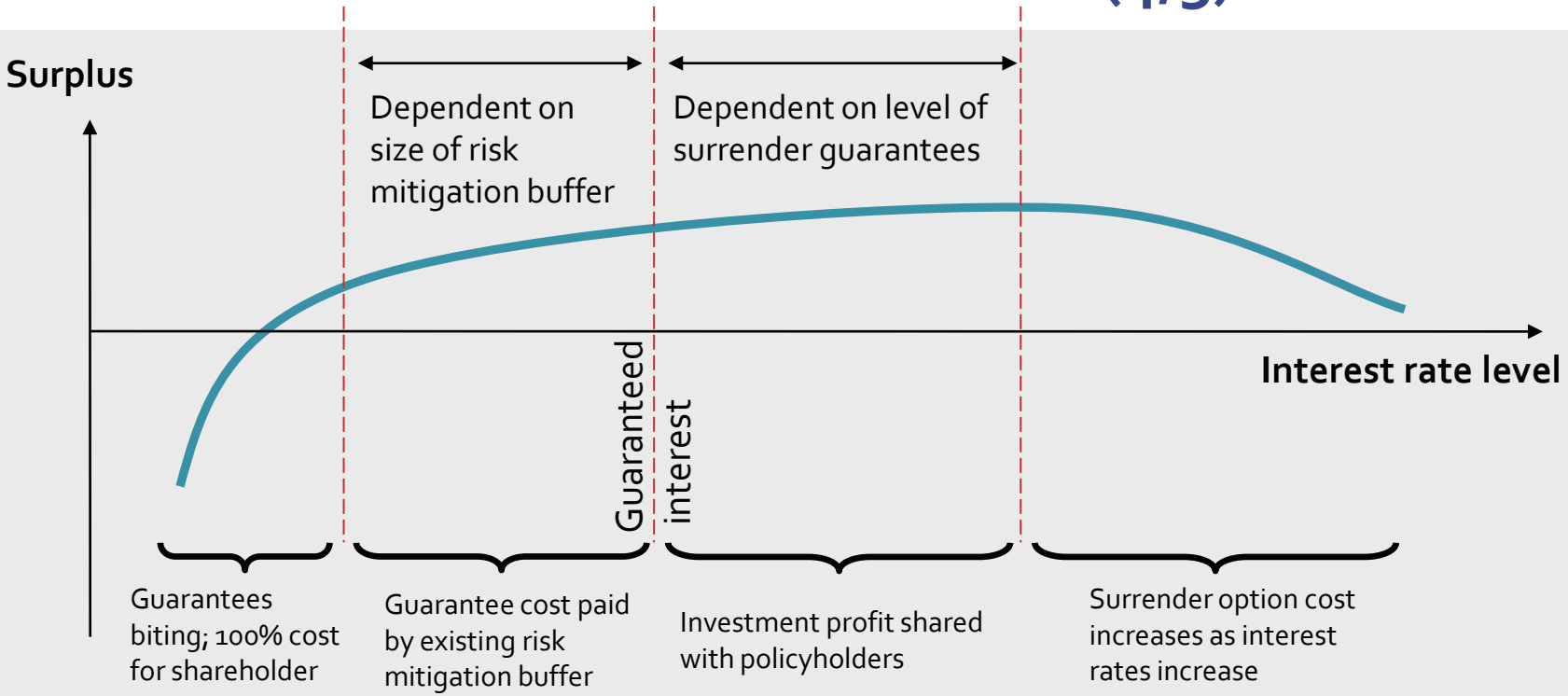
Relevant criteria:

- Clear acceptance criteria
- Robust calibration process
- Well chosen calibration targets

EUR implied swaption vol as of 30.06.12
Source: Bloomberg



Required properties for IR-models for risk-neutral valuation (4/5)



- Produces sufficiently rich set of yield curve movements

Relevant criteria:

TVOG not underestimated by choice of interest rate model
(e.g. path-dependencies likely to be mispriced by 1-factor model)

Required properties for IR-models for risk-neutral valuation (5/5)

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- Theoretically sound, numerically stable

- Valuation model and ESG have to be seen as "package"
  - "Sensible" interpretation of extreme scenarios
  - Ability to price options & guarantees by ESG must be sufficient for the options & guarantees intrinsic to the liabilities
  - A bad valuation model cannot be saved by a good ESG
  - Dependency on particular ESG should be minimized

Relevant criteria:

Confirmation by Appointed Actuary

FINMAs attempt at testing the adequacy of the interest rate model

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- Test 1: What are the relevant market prices to calibrate to?
  - Using a simplified replicating portfolio approach: asset universe restricted to swaps and (liquid) swaptions
  - "Weights" assigned to swaptions indication for "relevance"

- Challenges:
  - Big fitting error expected
  - Results dependent on scenario set used
  - Solution might not be very robust; high offsetting positions
  - Big effort

- However,
  - RP not used for (re-) valuations, so quality of fit not so much of an issue
  - Should be run with IR that can fit IR-vol surface well
  - Interested in an indication of region to calibrate to
  - Particularly suitable for companies already using an RP-approach

FINMAs attempt at testing the adequacy of the interest rate model

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- Test 2: What impact has a change of the interest rate model?

- Challenges:
  - Change of IR-model not without implications on asset model
  - Impact might not be attributable to a specific characteristic

- However,
  - Use for both valuations simplified asset model (e.g. following Brownian motion)
  - Change IR-model only gradually
    - 1-factor to 2-factor, keeping distribution
    - normal vs. lognormal, keeping # of factors
    - consistent calibration approach, using results of test 1

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