Audit, Finance & Control of the Future

TopQuants 2013 Autumn Event

7 November 2013

Building a better working world

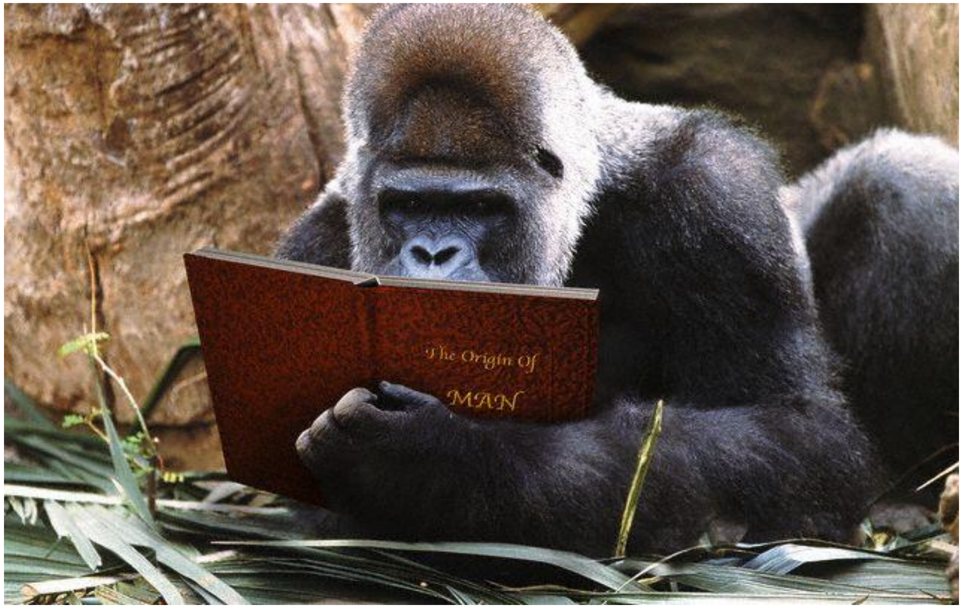
Audit, Finance & Control of the Future
and ‘Model Materiality’ using DVOC

Auditing the Future – a revolution or an evolution?

‘The Origin of Solvency II Audit by Means of

Natural Risk Selection, Or the Preservation

of Favored Cooperation between Auditors and Actuaries in the Struggle for Life’



Agenda

- Introduction
  - Developments
  - Ingredients
- Model Risk Management
- Concept of DVOC
- Examples
  - Life Risk
  - Non-life Risk
  - Market Risk
- Appendix: Using DVOC in Analysis of Change

Introduction, Developments and Ingredients

1

Introduction

For assessing the reasonableness of a model outcome, we want to find a positive answer on the question: **‘Does the model do what it has to do?’**

To be able to answer this question we indirectly split up this question into two questions

- **‘Does the model do what it can?’** and
- **‘Can the model do what it has to do?’**

by dealing with the following criteria:

1. Arithmetical correctness
2. Objective Measurability
3. Fit for Purpose

Ingredients

Judgment for a stand-alone model in consideration to materiality per legal entity.

Avoidable versus unavoidable risk.

Distinction in Tolerable Error between risk models (e.g. for *x*% of SCR) and Market Value models (e.g. for *y*% of MVL/MVA; AFR) – define ‘Tolerable Range’

Define in Tolerable Range boundaries *x* and *y* for valid and invalid for certain error levels, to be determined based on risk appetite for model risk and approved by senior management.

Discussion statements

On the figures: Quality + Acceptance = Effectiveness.

Stochastic modeling: number of runs to be increased to the level that the resulting uncertainty range falls in the financial statement reporting materiality levels (so this could cost a lot of time and money).

Different materiality metrics per model, per risk driver, per usage, per disclosure.

There is need for new materiality measures for audit, finance & control in the future.

And should be aligned to risk appetite.

Model Risk Management

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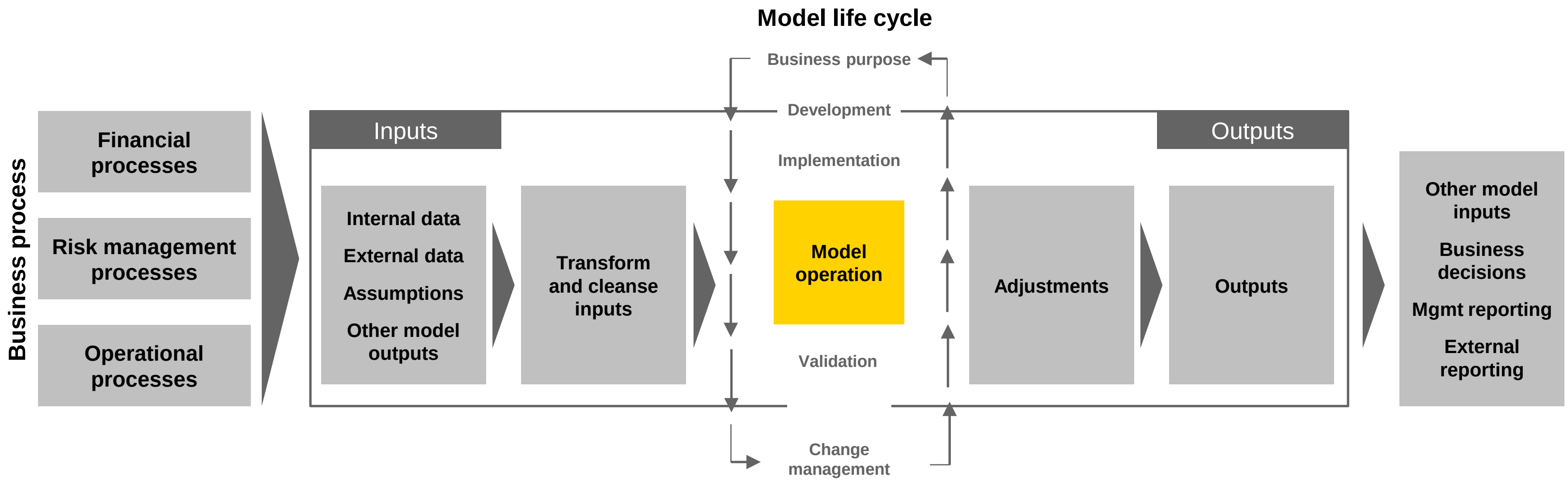
Effective MRM balances process risks with risks associated with the model lifecycle



Many organizations have traditionally concentrated on risks associated with processes themselves and have attached less significance those risks associated with the various stages of the model life cycle, although the latter may represent more serious threats.

Model risk management achieves the rebalancing of risk management activity between both sets of risks (process / model) through bringing the assessment of model risk into the insurer's risk management framework.

Similar approaches are used as for other sources of risk but recognising that there are specific considerations given the complexity of this area and the potential mitigation steps.

Concept of DVOC

3

When is a model ‘good’?

The concept lies in assessing the sensitivities of the outcome of the model relative to the key choices and parameters that drive the (economic or risk) value.

If those choices and parameters are volatile in their own right, it provides the range of possible and/or reasonable outcomes the value should be in.

When is a model ‘good’?

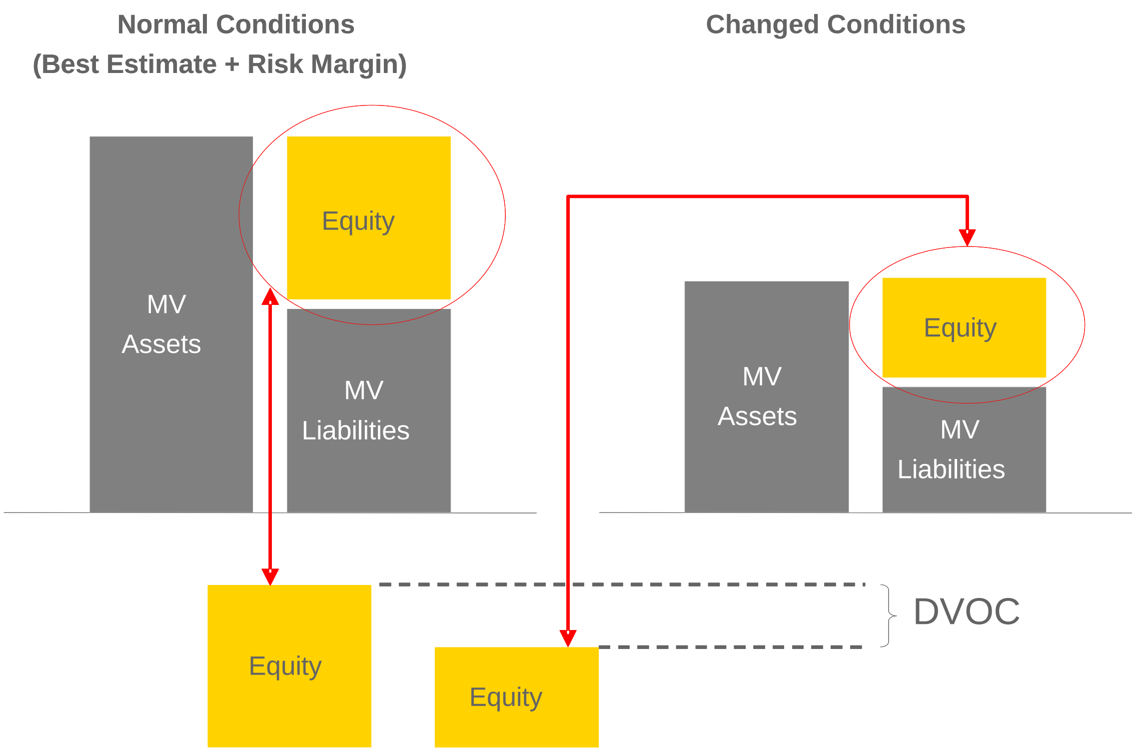
- **DVOC**
  - Delta Value of Change (‘partial derivative of the valuation/risk function’).
- **Generalization of DVO1** – Dollar Value of 1 basis point change in interest rate
  - Used in the Asset Management sector.
  - Deviations are not material when e.g. <3DV01.
  - Already expanded in audits for other risk drivers in auditing derivatives (volatility, dividend yield, inflation, FX etcetera).
- **Assess the ‘first partial derivative of the valuation/risk function’**
  - Key risk drivers – market and non-market related (those that explain eg 95% of EC).
  - ‘normal’ expected fluctuations (e.g. opening vs closing quotes, choice of data vendor, statistical noise, model choices; overall and per parameter).
  - Effect on stand alone valuations and impact on consolidated level.

Assess the key risk drivers

Consider the value of (entries on) the balance sheet in normal and changed situation

Valuation: $MV = f\ (R1, \ldots, Rn)$

With *MV* the market value of an asset, liability, or full surplus, and *Ri* the *i*-th risk driver.



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DVOC: Delta Value of Change (1/2)

Both assets and liabilities are sensitive to changes in key-risk drivers.

First partial derivatives of valuation/risk function are used to evaluate the impact of potential fluctuations on the value.

For assets the DVO1 method is used to calculate the sensitivity of the asset towards a small shock in the underlying market parameters.

For instance, the DVO1 is calculated by applying a 1 basis point shock to the underlying curve (commonly used for interest rate swaps) or the ‘volatility DVO1’ (also known as vega) is calculated by shocking the underlying volatility with 1% (swaptions, equity options).

For liabilities these parameters include not only financial market parameters such as interest rates and volatilities but also include, amongst others, mortality rates and lapse rates.

DVOC: Delta Value of Change (2/2)

For liabilities the key-risk drivers are not only financial input parameters, but also include:

- Shocks in mortality tables.
- Shocks in lapse rates.
- Shocks in expense rates.
- Insurance liabilities can be more sensitive to changes in non-financial parameters than changes in financial parameters.
- Assess inherent fluctuations or uncertainties in non-financial parameters to identify the level to change these.

Short Examples: Derivates and Life Insurance Liabilities

DV01 – example IRS

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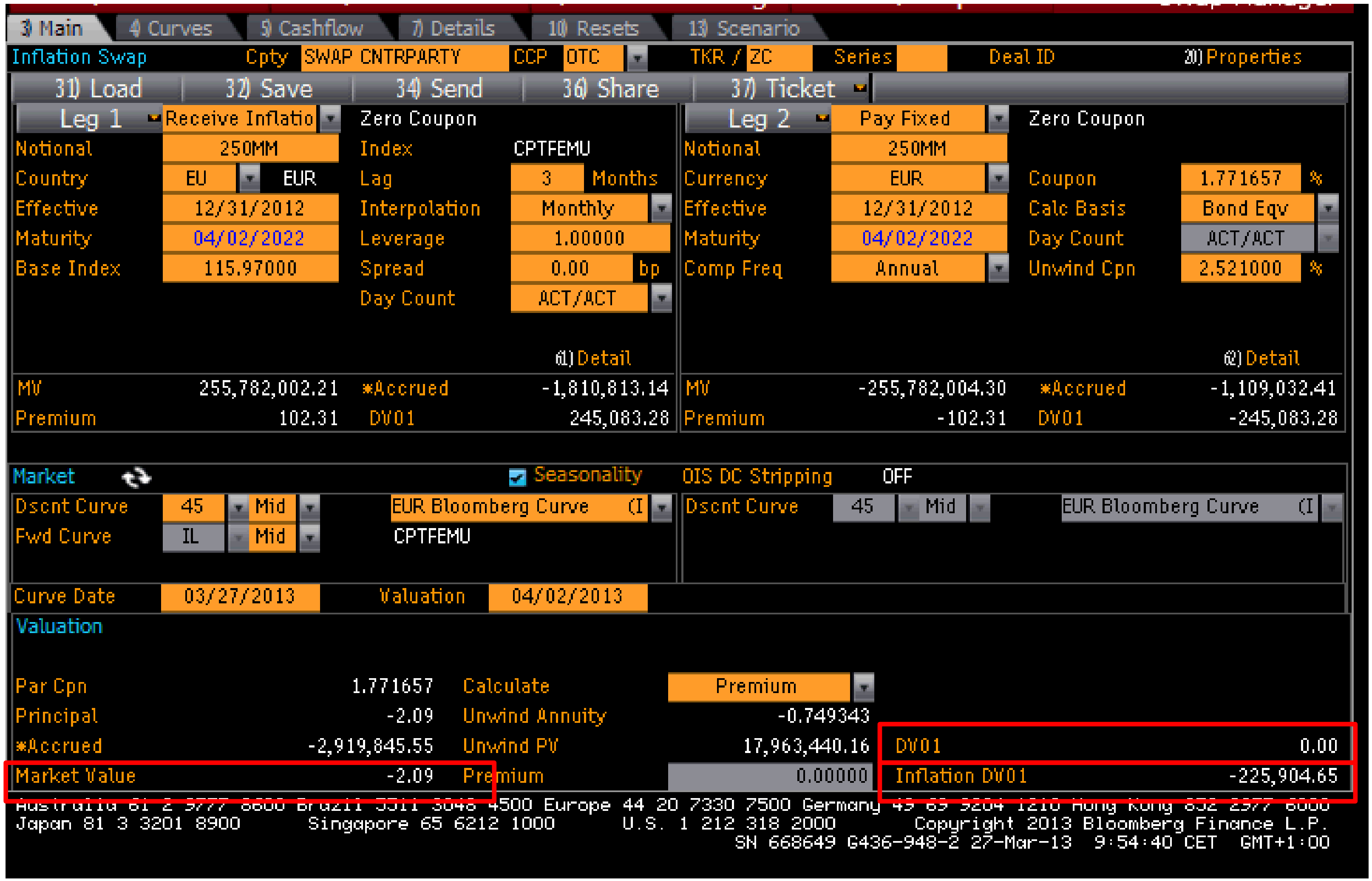
DV01 – example swaption

DV01 – inflation swap



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DVOC – Example Insurance Liability

In this example we show the impact of the shocks of different key-risk drivers for different insurance products. Consider the following products:

- Immediate annuity
- Deferred annuity
- Term assurance (‘overlijdens risico verzekering’)
- Endowment (‘gemengde verzekering’)

The scenario’s are:

- 1 bps shock of the interest rate curve.
- Calculation based on the exclusion of the CCP (1%).
- A relative longevity shock of 10% on the mortality table.
- A relative shock on the expenses of 10%.
- An increase in the assumed lapse rate from 4% to 5%.

DVOC – Output Example

Overview				
	Immediate annuity	Deferred annuity	Term insurance	Endowment
BE	€ 394.867.057	€ 305.577.521	€ 59.218.810	€ 33.604.987
IR shock	€ 394.510.153	€ 305.033.334	€ 59.146.805	€ 33.522.610
CCP shock	€ 429.914.651	€ 351.980.880	€ 66.672.258	€ 41.268.535
Longevity shock	€ 399.710.363	€ 307.116.212	€ 56.131.280	€ 33.662.456
Expense shock	€ 395.207.529	€ 306.049.947	€ 59.392.264	€ 33.850.495
Lapse shock	€ 394.867.057	€ 305.577.521	€ 59.218.810	€ 37.847.669

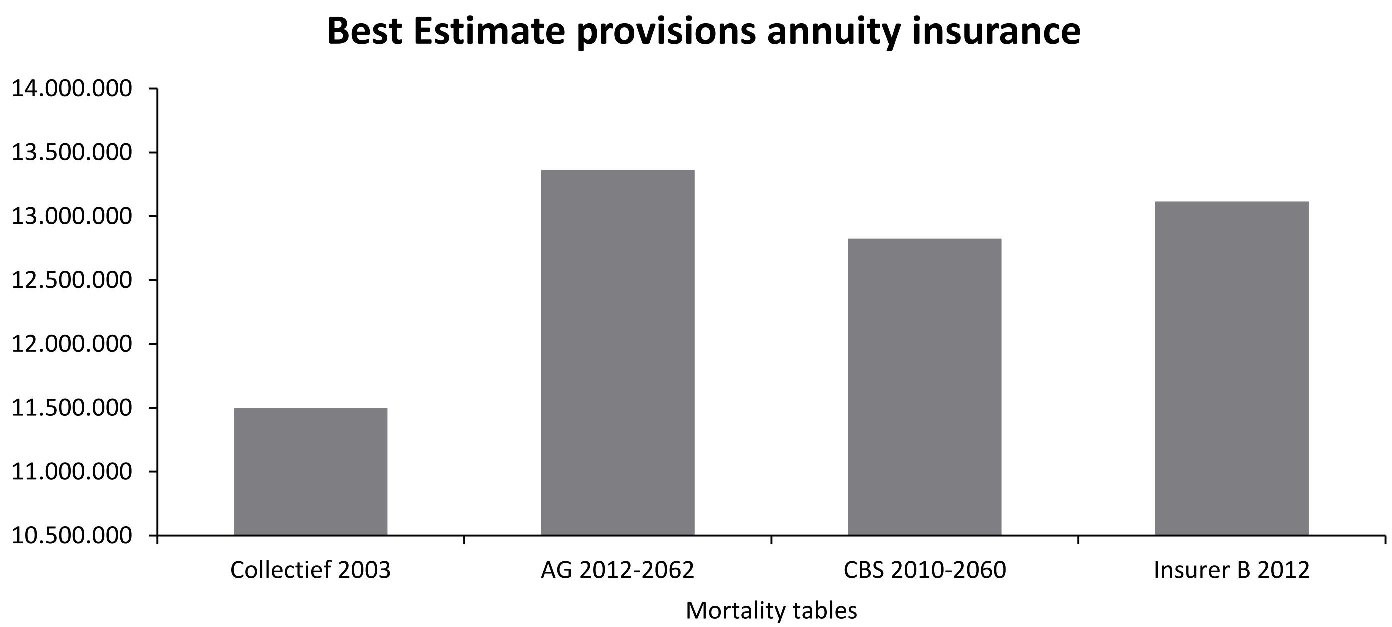
Impact				
	Immediate annuity	Deferred annuity	Term insurance	Endowment
IR shock	-€ 356.903	-€ 544.188	-€ 72.005	-€ 82.377
CCP shock	€ 35.047.595	€ 46.403.358	€ 7.453.448	€ 7.663.547
Longevity shock	€ 4.843.306	€ 1.538.690	-€ 3.087.529	€ 57.469
Expense shock	€ 340.472	€ 472.425	€ 173.454	€ 245.508
Lapse shock	€ 0	€ 0	€ 0	€ 4.242.682

Examples

4

Example: Life Insurance

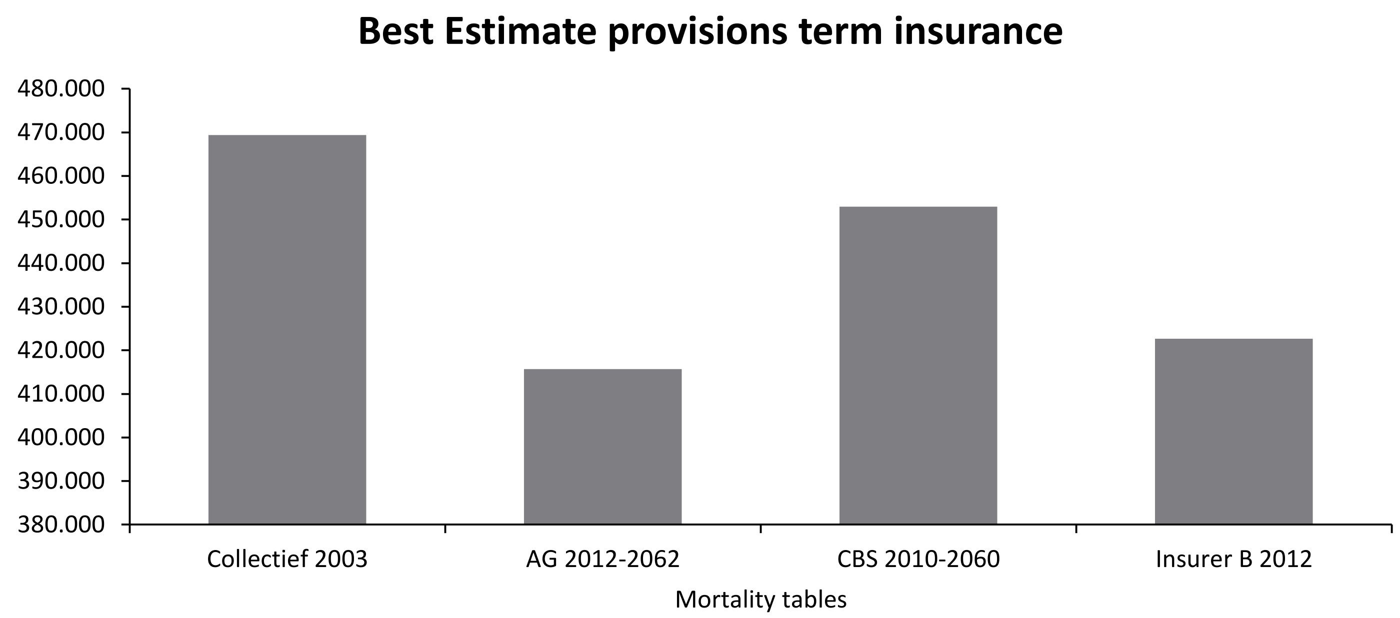
Annuity Insurance – Results



Impact of using different mortality tables on provisions compared to Collectief 2003:

- AG 2012-2062: +16%
- CBS 2010-2060: +12%
- Insurer B specific mortality table 2012: +14%

Term Insurance – Results



Impact of using different mortality tables on provisions compared to Collectief 2003:

- AG 2012-2062: -11%
- CBS 2010-2060: -3%
- Insurer B specific mortality table 2012: -9%

Example: Non-life insurance

Arithmetical correctness (1/2)

1. Arithmetical correctness

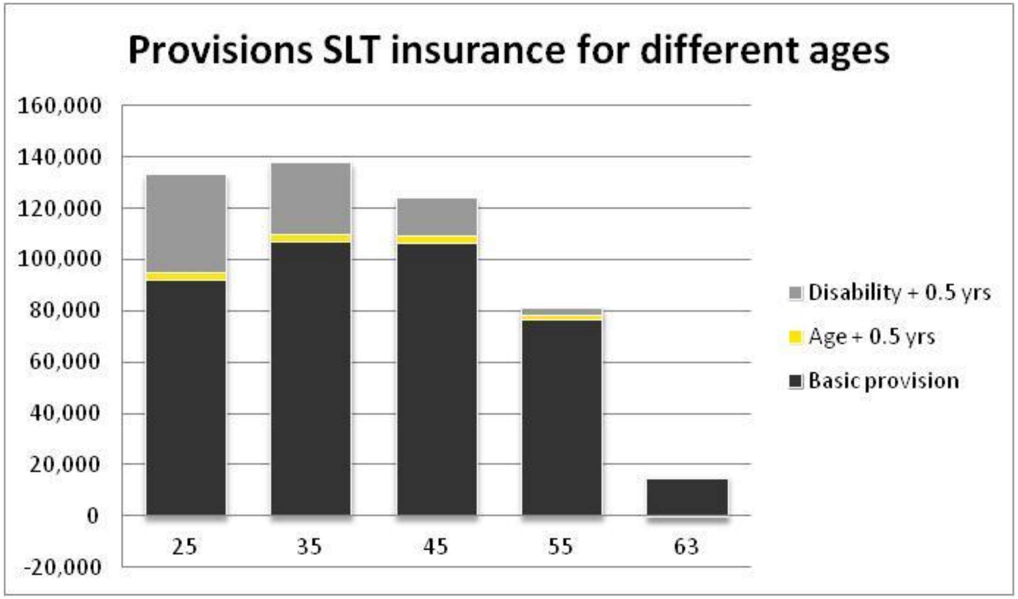
"Valid" modeling result differences can be caused by:

- Approximation of current age, retirement age and disability inception date to full months or full years
- Use of recovery rate assumptions which are constant per full year
- Rounding or approximation of yield curves

What is a valid deviation?

- 0.5 yrs deviation in age
- 0.5 yrs deviation in disability history
- 1 week of data timelag

Individual results show deviations up to 43% for young individuals



Arithmetical correctness

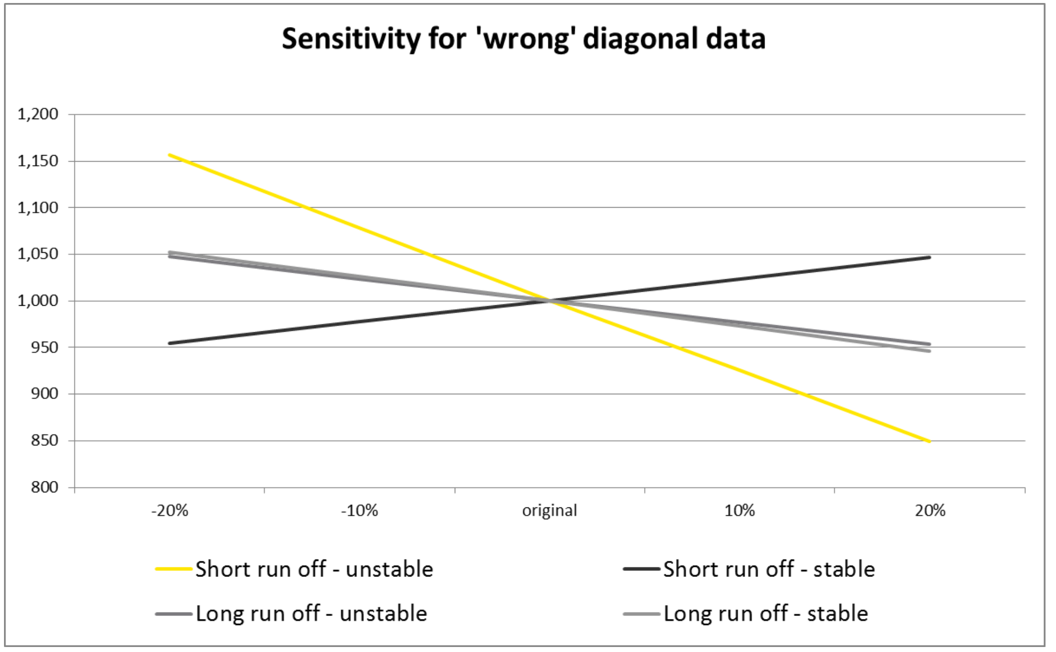
1. Arithmetical correctness

Quantitative modeling result differences can be caused by:

- Data issues: we see this as the larges cause of deviations

We have tested the sensitivity for data errors:

- X % of deviation in new diagonal data
- Crude results given in graph
- Results move linearly with deviations
- Materiality depends on Line of Business characteristics



Asset Examples

Market data, derivatives and fixed income instruments

- Market data
  - Interest rates
  - Interest rate volatility
  - Equity prices
  - Equity volatilities
  - FX rates
  - Inflation rates
  - Credit spreads
- Derivatives
  - Interest rate swaps
  - Swaptions
  - Equity options
  - FX forwards / swaps
  - Inflation-linked swaps
  - Credit default swaps
- Fixed income
  - Private loans
  - Asset-backed securities
- Other similar products…

- Note: focus is on level 2 and level 3 valuations

Market data – objective measurability

Examples

- Interest rates: measure of 3 bps for interest rates reasonable to test objective measurability
- Interest rate volatility: measure strongly depends on option expiry and swap tenor to test objective measurability
- Equity volatilities: measure of 350 bps – 500 bps for equity volatility reasonable to test objective measurability
- FX rates: Rate of client must be between high and low rate for that specific day
- Inflation rates: measure of 3 bps inflation movement to test objective measurability. Note that seasonality can have a large impact on the inflation rates.
- Credit spreads: measure of daily change in credit spread to test objective measurability

Derivatives – objective measureability

- For every derivative, evaluate the difference between the ‘parallel model’ value and the ‘audit object’ value to the applicable DVOC measure.

Using DVOC in Analysis of Change

6

Example – case study

At January 1, 2013 the portfolio "value" includes 50,000 death benefit contracts with the following characteristics:

- *Maturity: December 31, 2022*
- *Annual premium, payable January 1, per contract: € 1,250*
- *Acquisition costs per contract, paid January 1, 2013: € 1,000*
- *Death benefit (on occurrence of death), payable December 31, per contract: € 100,000*
- *Required capital for risk margin purposes: € 12,500,000. (The risk margin is calculated by determining the cost of providing an amount of eligible own funds equal to the Solvency Capital Requirement necessary to support the insurance obligations over their lifetime.)*

- Assume Cost of Capital rate of 6%
- Assume (flat) Risk Free rate (curve) of 3%
- Assume Best Estimate Mortality Rate: 1% for all future years

Example – qualitative insights

*At t=0 the Basic Own Funds (BOF * € 1.000) for this portfolio equals* € 61.219

After one year, the BOF equals € 58.498. Analyze the change between year *t*=0 and *t*=1.

We can make a movement analysis by using the knowledge of the portfolio at *t*=0:

1. *BOF will make a return in the best estimate assumption equal to the risk free return*
2. *BOF will increase with the release of the risk margin (+risk free interest)*

Variances in period (0,1)

3. BOF will change due to difference between best estimate mortality and realized mortality
4. BOF will change due to delta in investment return

Assumption changes after t=1

5. BOF will change due to change in mortality assumption
6. BOF will change due to change in interest rate curve

1 and 2 are fixed, 3-6 can be estimated by using DVOC's on *t*=0 and apply parameter changes known on *t*=1. No additional 'full B/S and/or P&L' calculations are needed!

Example – quantitative insights

At t=0 the Basic Own Funds for this portfolio equals € 61.219. at t=1: BOF equals € 58.498

1. *BOF will make a return in the best estimate assumption equal to the risk free return:* € 1.836,57
2. *BOF will increase with the release of the risk margin for Y0 (+risk free interest):* € 772,50
3. DVOC death benefits: € 100,00 per individual
4. DVOC investment return: € 1,25 per basis point increase in return
5. DVOC mortality assumption: € 3.747,52- per basis point increase in mortality rate
6. DVOC interest rate: € 0,60- per basis point increase in interest rate

Changes (variances and assumption changes) known on t=1:

20 more individuals died in year 1

Investment return 3% above risk free

Mortality assumption increased by 1bp (hence: 1,01% per year instead of 1,00%)

Interest rate (curve) increased by 50bp (hence: 3,5% flat rate as of year 1 onwards)

Analyses of Change - results

At t=0 the Basic Own Funds for this portfolio equals € 61.219. A t=1: BOF equals € 58.498

t=0 calculated BOF	**€ 61.219,07**	% delta BOF
20 additional deaths	€ 2.000,00-	72%
0,50% change interest rate	€ 30,00-	1%
3% additional investment return	€ 375,00	13%
1 bp increase mortality rates	€ 3.747,52-	134%
risk free change BOF	€ 1.836,57	66%
release risk margin Y1	€ 772,50	28%
t=1 estimated BOF	**€ 58.425,62**	**estimation using the DVOC's**
calculated BOF	€ 58.497,88	
unexplained	**€ 72,26**	3%

The unexplained is due interest rate convexity and to the non-linear effect between change in both mortality rates and interest rate movement.

Thank you

For more information please contact

drs Paul W.P. de Beus

partner EY Actuaries

paul.de.beus@nl.ey.com

+31 6 2908 4266

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