The IASB Insurance Project for life insurance contracts: impact on reserving methods and solvency requirements

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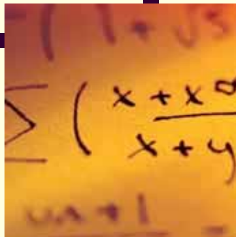


Motivation

- Financial stability of insurance industry affected by increasingly difficult economic climate:
  - Equity market crashes in 2001 and 2002
  - Steady fall in bond yields
  - Increased longevity
- Implication: increased focus of regulators on
  - Accounting rules
    - Comprehensive financial reporting framework
    - Standardization of approaches (where sensible)
    - Improved transparency and comparability of accounting information
  - ➔ IASB Insurance project: IASB & FASB promote a Fair Value based accounting framework
    - Fair Value: amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm's length transaction
  - Solvency
    - Capital requirements
    - Internal models for risk assessment

} ➔ **Solvency II**

Fair value reporting system

- Europe:
  - IFRS 4 (March 2004), in force since January 2005
    - Increased disclosure accounting information
    - Liabilities to be recorded at FV (embedded derivatives)
  - Assets: regulated under IAS 39
    - Available for sale; or Held for trading ➔ M 2 M
    - Held to maturity ➔ amortised cost if able to demonstrate intent to forego future profit opportunities

- Other countries:
  - UK: Twin Peaks/Individual Capital Adequacy Standards (January 2005)
  - Netherlands: Dutch Solvency Review (January 2006)
  - Switzerland: Swiss Solvency Test (January 2006)

➔ Common features: full mark-to-market of assets and liabilities + risk capital assessment

- **Critics of the Fair Value approach**
  - Inconsistent with managing a long-term business such as those of insurance companies
  - High level of subjectivity (measurement of insurance liabilities)
    - Difficult to provide earnings' forecasts
    - Higher cost of capital
  - Increased volatility of reported earnings

Agenda

In the light of these points, we want to analyze the evolution over time of **A & L** originated by a simple participating contract with minimum guarantee

Focus

- Valuation of liabilities
  - Fair Value
  - "Traditional approach" based on the mathematical reserve
- Shortfall probability at maturity
- Redefinition of the premium
- Model and parameter risk
- Capital requirements and solvency profile of the insurer

Working example

- Participating contract with minimum guarantee (r_G)
- Single premium (P_0); ignore lapses, mortality and death benefits or terminal bonus
- Payoff at maturity

$$C(T) = P(T) - D(T), \quad D(T) = \left(P(T) - A(T)\right)^{+}$$

Cumulated benefit — Default option

- Accumulation scheme:

  β = participation rate

  A = equity portfolio backing the policy

$$P(t) = P(t-1)\left(1 + r_P(t)\right), \quad P(0) = P_0$$

$$r_P(t) = \max\left\{ r_G, \beta\left(\frac{A(t) - A(t-1)}{A(t-1)}\right)\right\}$$

Fair Valuation: 1st order basis

- Contract fair value (contingent claim pricing theory)

$$V_C(t) = \mathrm{E}^*\left[e^{-r(T-t)}\left(P(T)-D(T)\right)\middle|\mathcal{F}_t\right] = V_P(t) - V_D(t)$$

- Standard Black-Scholes framework (log-returns normal distributed, constant interest rates, constant volatility)
- Benefit "price"

$$V_P(t) = P(t)\left[e^{-r}(1+r_G) + \beta N(d_1) - e^{-r}(\beta + r_G) N(d_2)\right]^{T-t}$$

$$d_{1,2} = \frac{\ln\frac{\beta}{r_G+\beta} + \left(r \pm \frac{\sigma^2}{2}\right)}{\sigma}$$

- Default option price: via Monte Carlo simulation (due to path dependency)

Market Value Margin (2^{nd} order basis): model risk

- The insurance company uses the Black-Scholes paradigm for pricing (simple to implement)
- The market dynamic of assets though is not log-normal
- What if, for example, the "true" asset in the market is

$$S_t = S_0 e^{L_t}, \quad L_t = at + \gamma W_t + \sum_{k=1}^{N_t} X_k$$

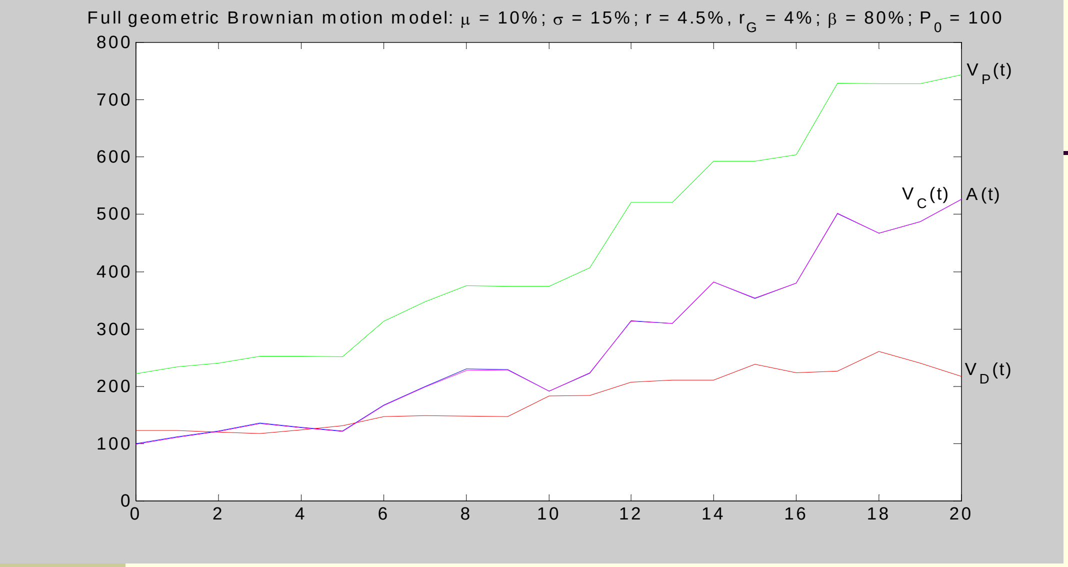
Jumps size Normal distributed

Lévy process   Brownian motion   Compound Poisson process

$$V_P(t) = P(t)\left[e^{-r}(1+r_G) + \beta N(d_1) - e^{-r}(\beta + r_G) N(d_2)\right]^{T-t}$$

- Parameter adjusted to maintain expected rate of growth and total instantaneous volatility constant

Scenario generation



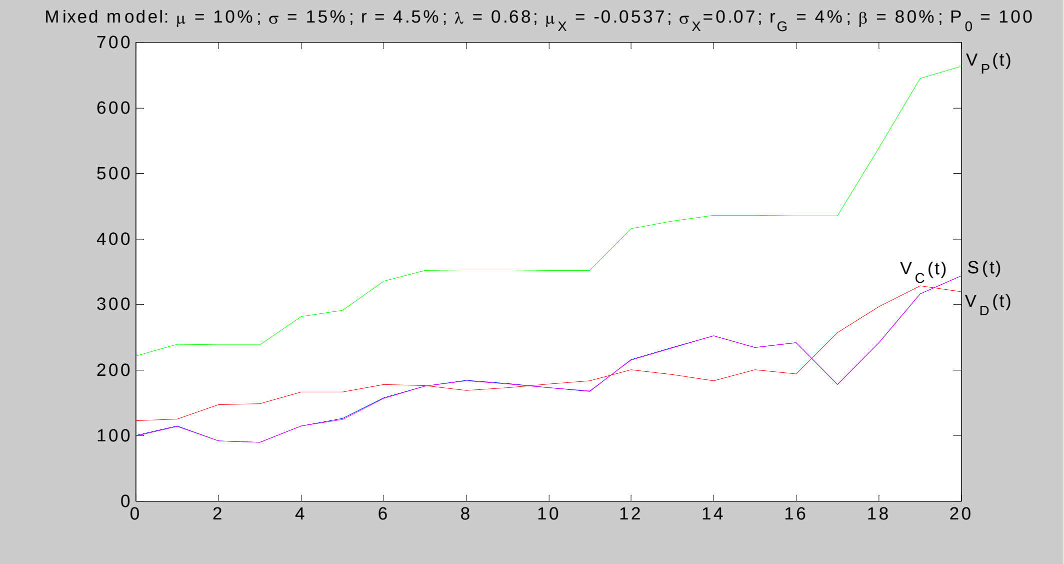
$V_P(0) = 222.73$

$V_D(0) = 122.73$

$V_C(0) = V_P(0) - V_D(0)$

$= 100 = P_0$

➔ no arbitrage ?



$\Pi(P(T) > A(T))$

GBM – model = 74.42%

Mixed model = 81.71%

based on 100,000 scenarios

Hedging likely to fail

Solvency loading: default option premium

- Probability of default at maturity unacceptably high
  - Overall contract sold at fair value
  - Benefit sold too cheaply
  - Default option premium!
- Solvency loading required to clear arbitrage

"Protection" against default

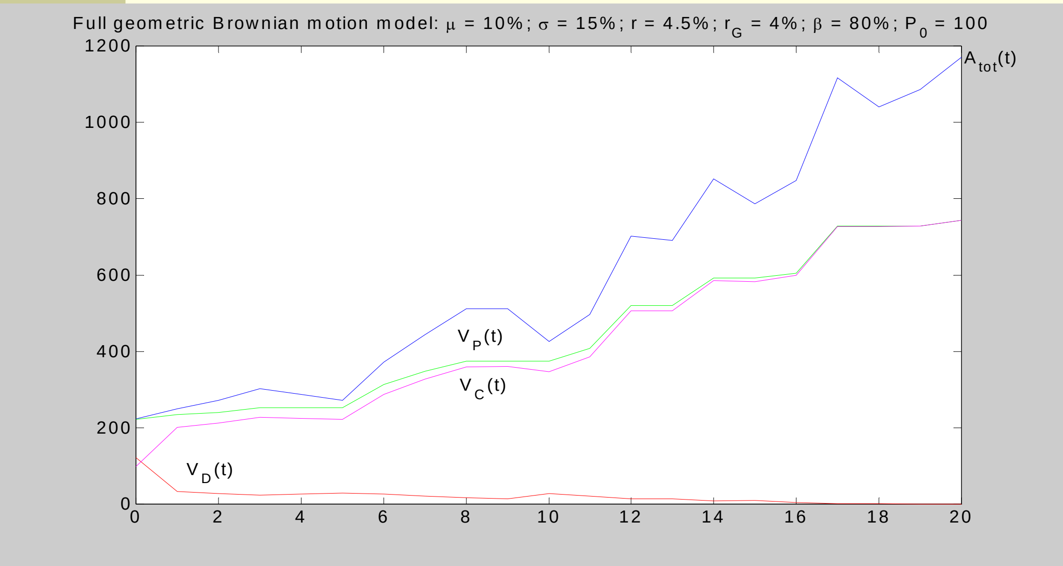
Benefit related premium

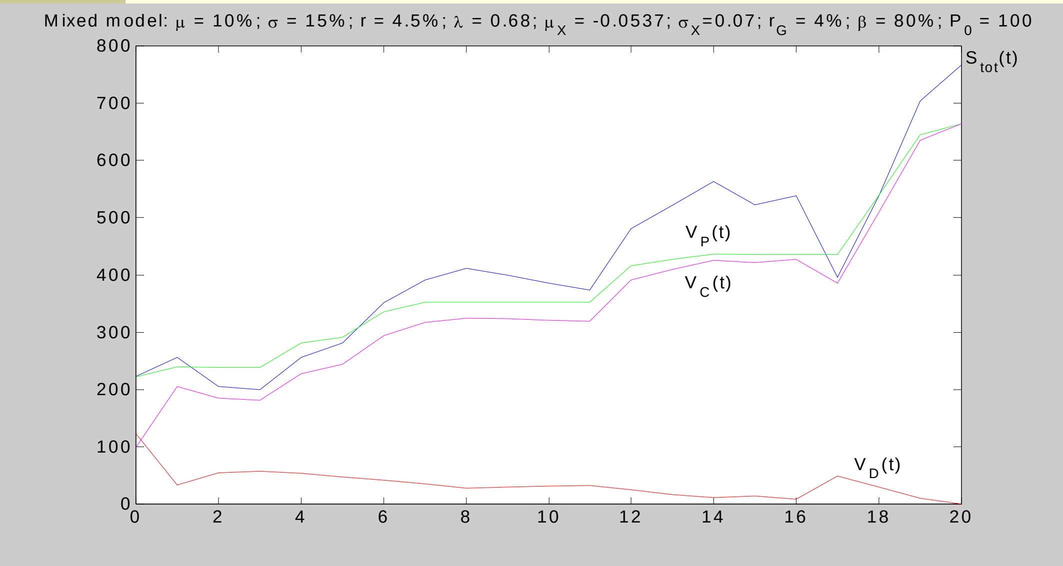
$$P_0 = V_P(0) - V_D(0) \Rightarrow V_P(0) = P_0 + V_D(0) = P_0'$$

Fair value condition for the contract

Fair value condition for the benefit

Adjusted scenario





$\Pi(P(T) > A_{tot}(T))$

GBM – model = 6.97%

Mixed model = 12.74%

based on 100,000 scenarios

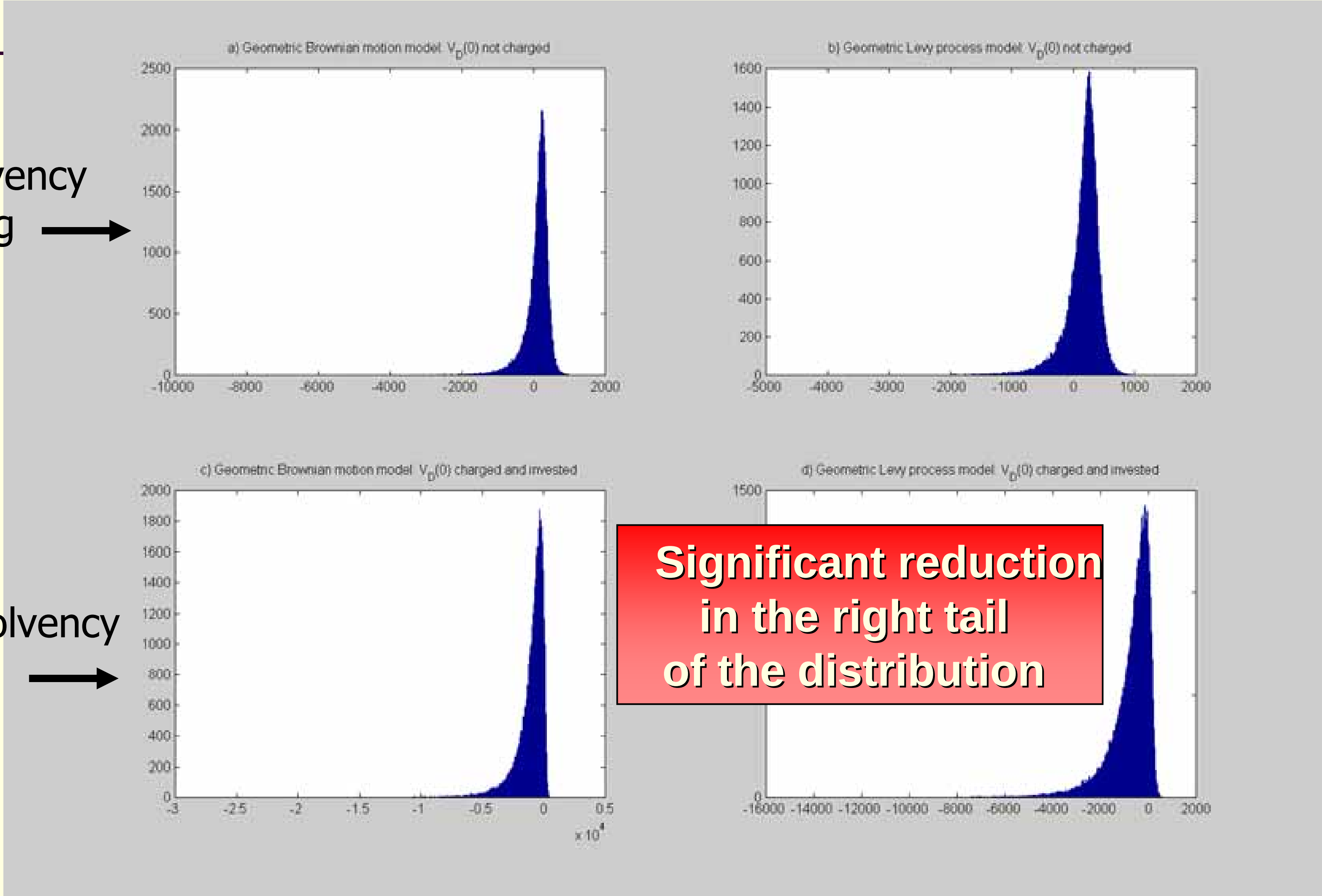
Any hedging strategy we can think of, has a higher chance of success

Shortfall distribution

GBM model | Mixed model

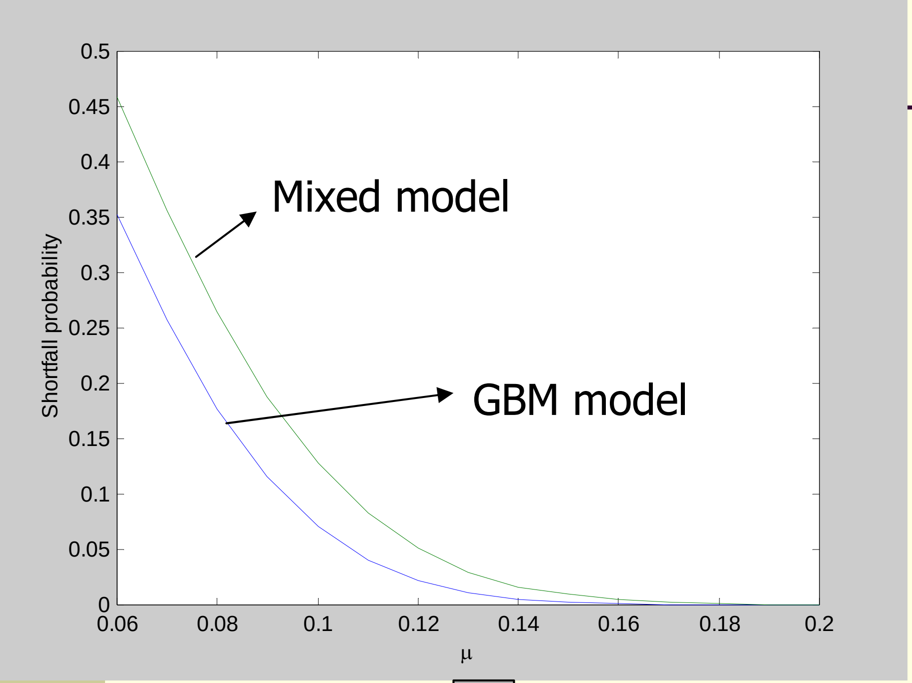
No solvency loading →

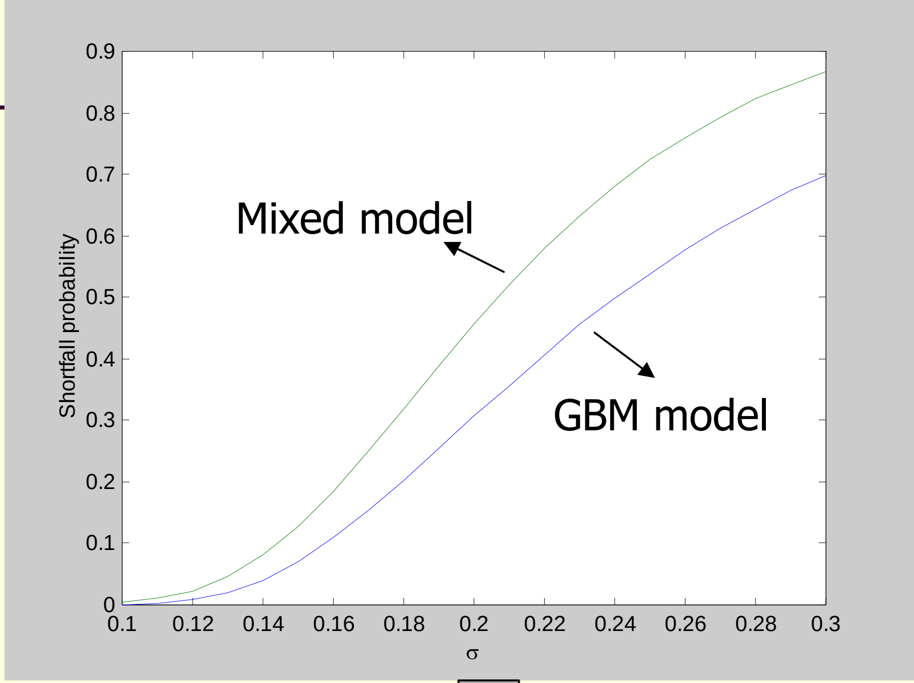
With solvency loading →



Significant reduction in the right tail of the distribution

Parameter risk





The higher the expected return on asset, the lower the probability of default (assets grow more than liabilities)

The higher the volatility, the higher the shortfall probability (assets effect only)

Alternative reporting system: mathematical reserve

- Starting point: the contract is issued at a "fair premium", i.e. there is a solvency loading equal to $V_D(0)$, which is invested in the equity fund
- Reserve value (equivalence principle)

$$V_R(t) = P_R(T)\, e^{-r(T-t)}$$

Discount rate = risk free rate of interest

Best estimate of the benefit at maturity

- The "fictitious account" $P_R(T)$?

Mathematical reserves

- 6 possible alternatives for the projection method of expected liabilities
  - Static method
  - Dynamic method (4 alternative schemes)
  - Retrospective method

- Comparison with FV technique to assess
  - Adequacy in terms of covering of the liability
  - Cost of implementation
  - Volatility of the balance sheet
  - Cost of capital
  - Solvency profile

P_R(T)

- Static: $P_R(T) = P_0(1+r_R)^T \; ; r_R = 8.5\%$
- Dynamic: $P_R(T) = P(t_k)(1+r_R(t_k))^{T-t_k} \; ; k = n, 2n, \ldots, \left[\frac{T}{n}\right]; n = 1,3,4,5$

• 1 $r_R(t_k) = \max\{r_R, \beta\overline{\mu}_n(t_k)\}$

• 2 $r_R(t_k) = \max\{r_G, \beta\overline{\mu}_n(t_k)\}$

$$\overline{\mu}_n(t_k) = \frac{1}{n}\sum_{k=1}^{n}\frac{A_{tot}(t_k) - A_{tot}(t_{k-1})}{A_{tot}(t_{k-1})}; \beta = 80\%; r_R = 8.5\%; r_G = 4\%$$

• 3 $r_R(t_k) = \max\{r_G, \overline{\mu}_n^{(P)}(t_k)\}$

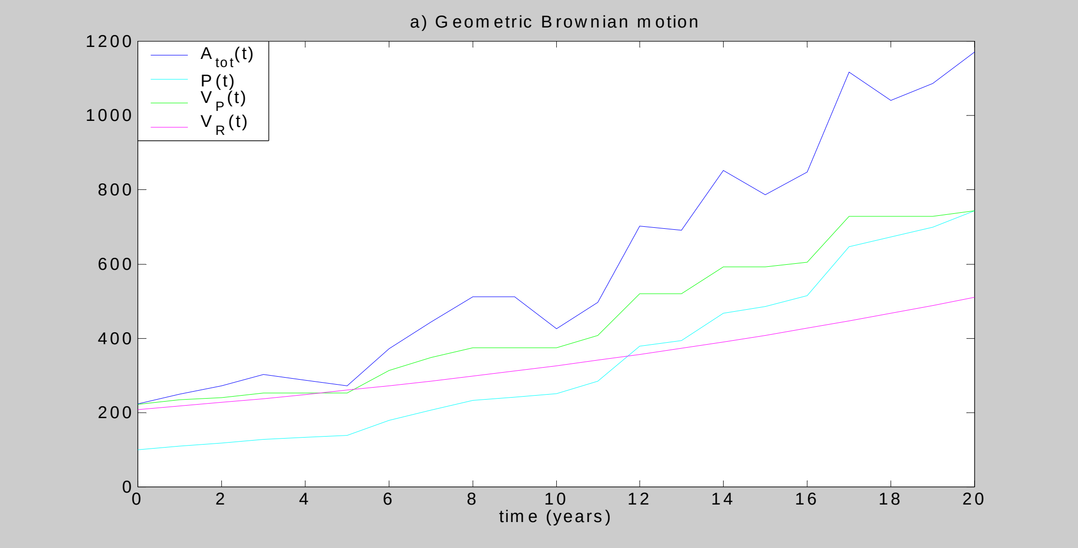
$$\overline{\mu}_n^{(P)}(t_k) = \frac{1}{n}\sum_{k=1}^{n}\frac{P(t_k) - P(t_{k-1})}{P(t_{k-1})}$$

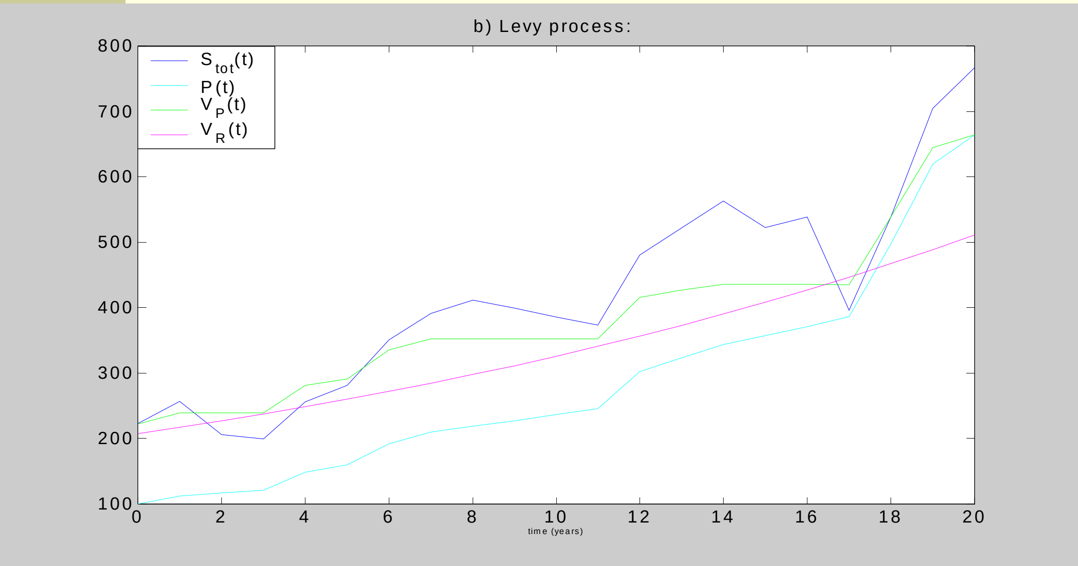
• 4 $r_R(t_k) = r_R + \alpha\left(\overline{\mu}_n(t_k) - \mu\right)$

$$\mu = 10\%$$

$$\alpha = \begin{cases} \beta & \text{if } s_n(t_k) > 0 \\ b < \beta & \text{if } s_n(t_k) < 0 \end{cases}$$

Scenario generation: static case

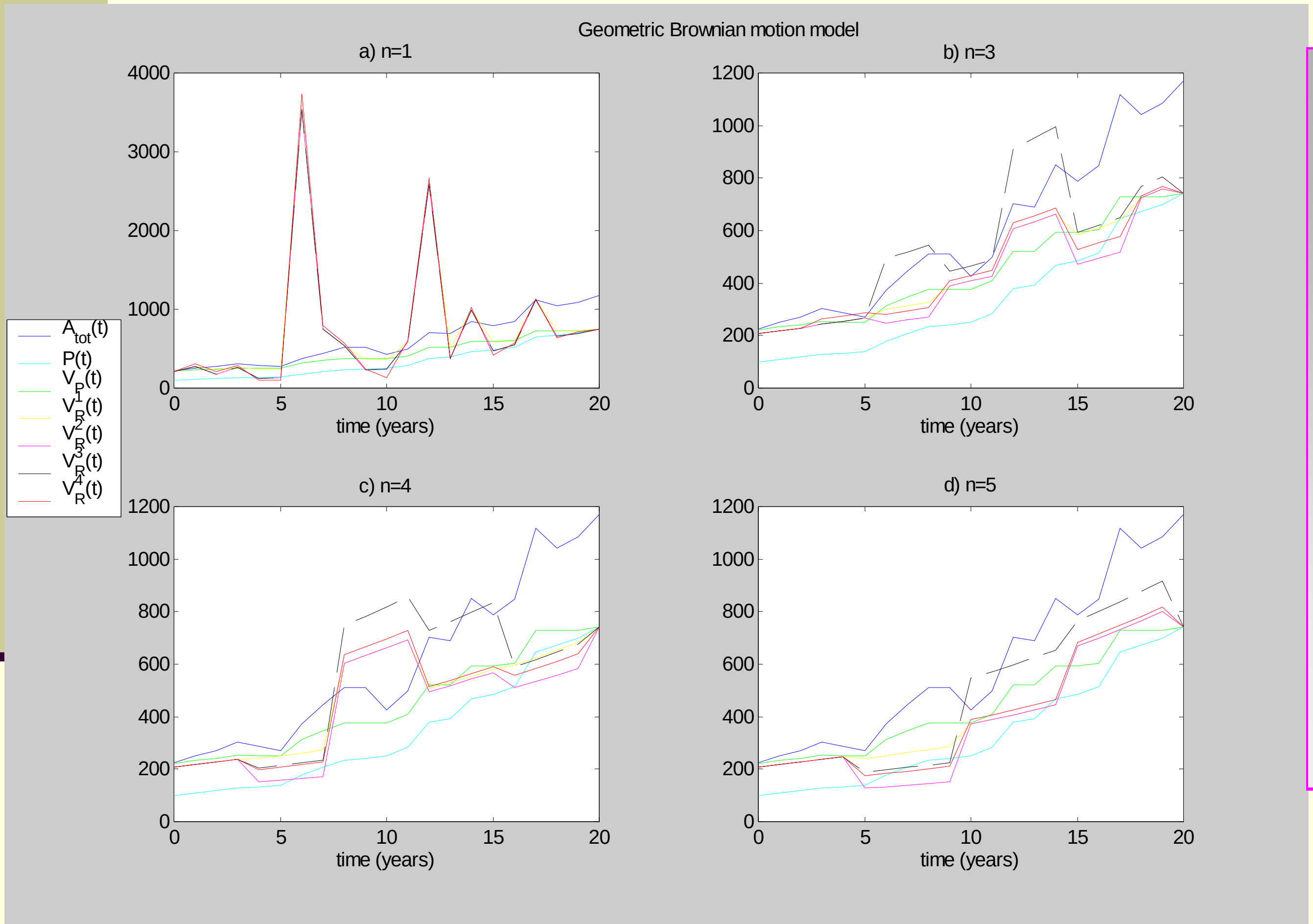




- The **static reserves** are always below the fair value
- At maturity the reserves are clearly insufficient to cover the liability

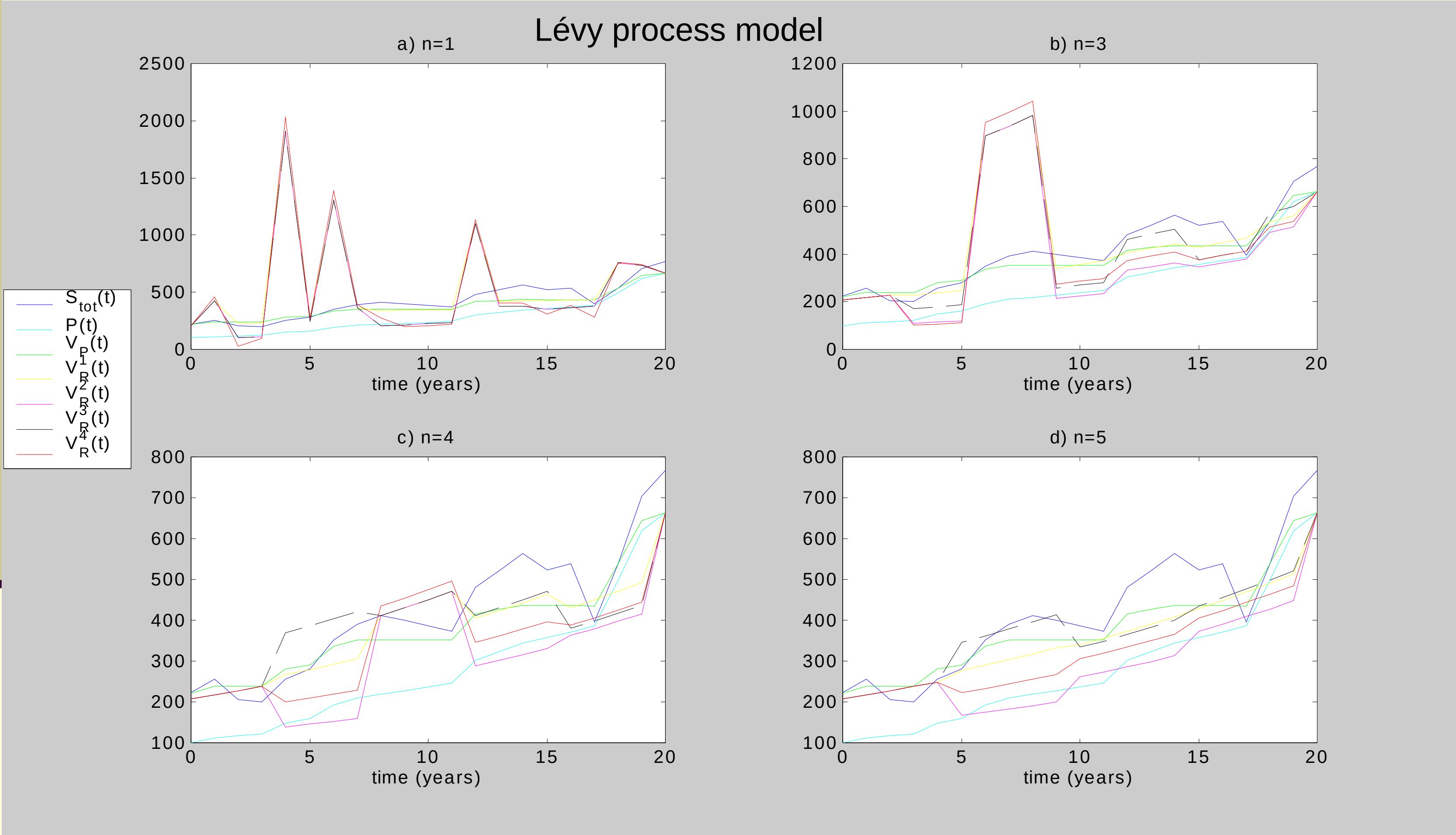
- The **retrospective reserve** is, as expected, always below the fair value of the liability; however, at maturity it converges to the benefit due

Scenario generation: dynamic case

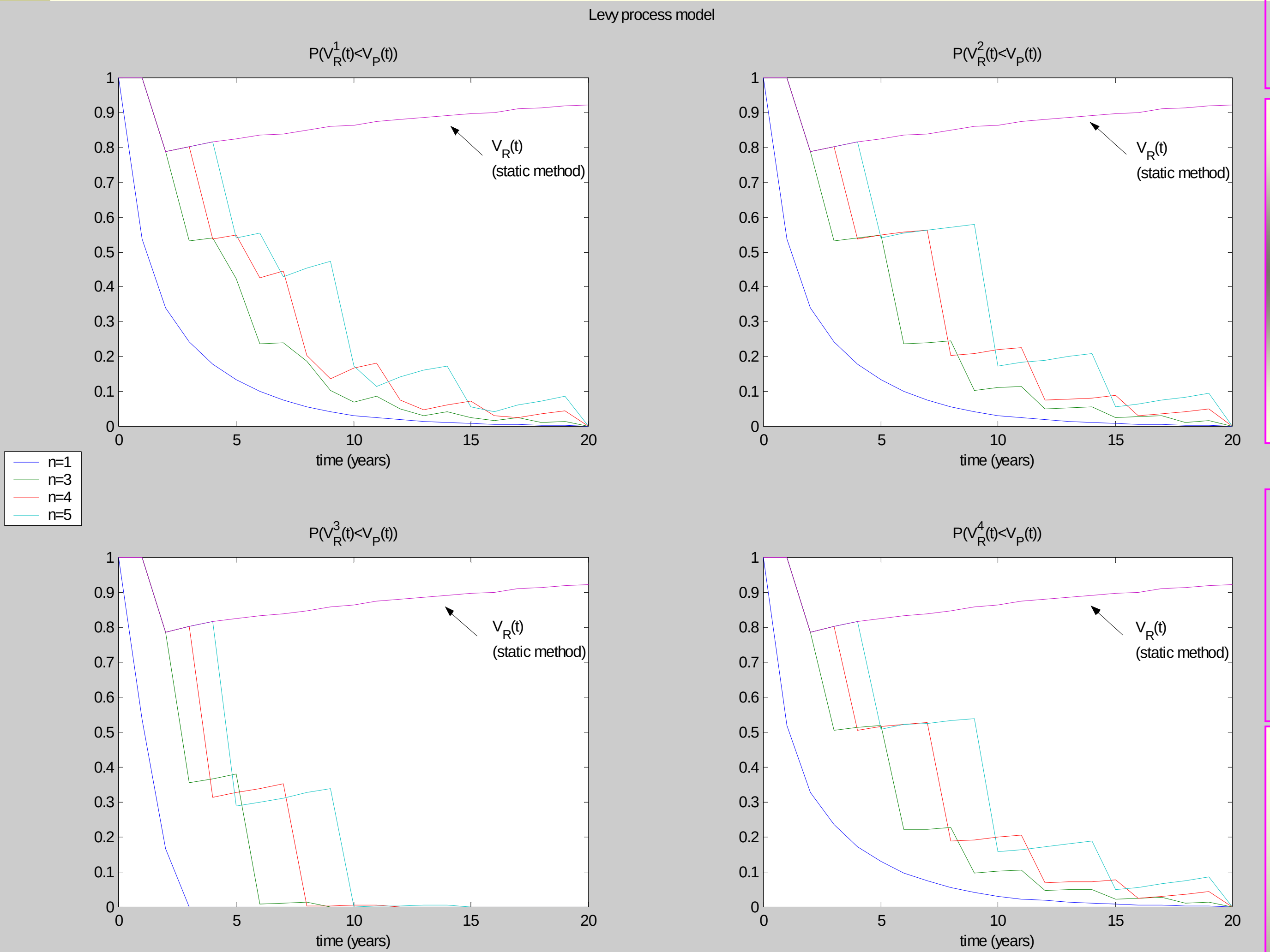


- **The evolution of reserves is very unstable and volatile**
- **As *n* increases, the smoothing effect becomes stronger and the peaks reduce in terms of frequency and magnitude**

Scenario generation: dynamic case



Adequate reserves? $\Pi(V_R(t)<V_P(t))$



At maturity

Static method:

$\Pi(V_R(T)<P(T))=92\%$

Dynamic method:
$V_R(T)=P(T)$

During the lifetime of the contract

The dynamic reserves are consistently above the Fair Value ➔ more expensive to implement

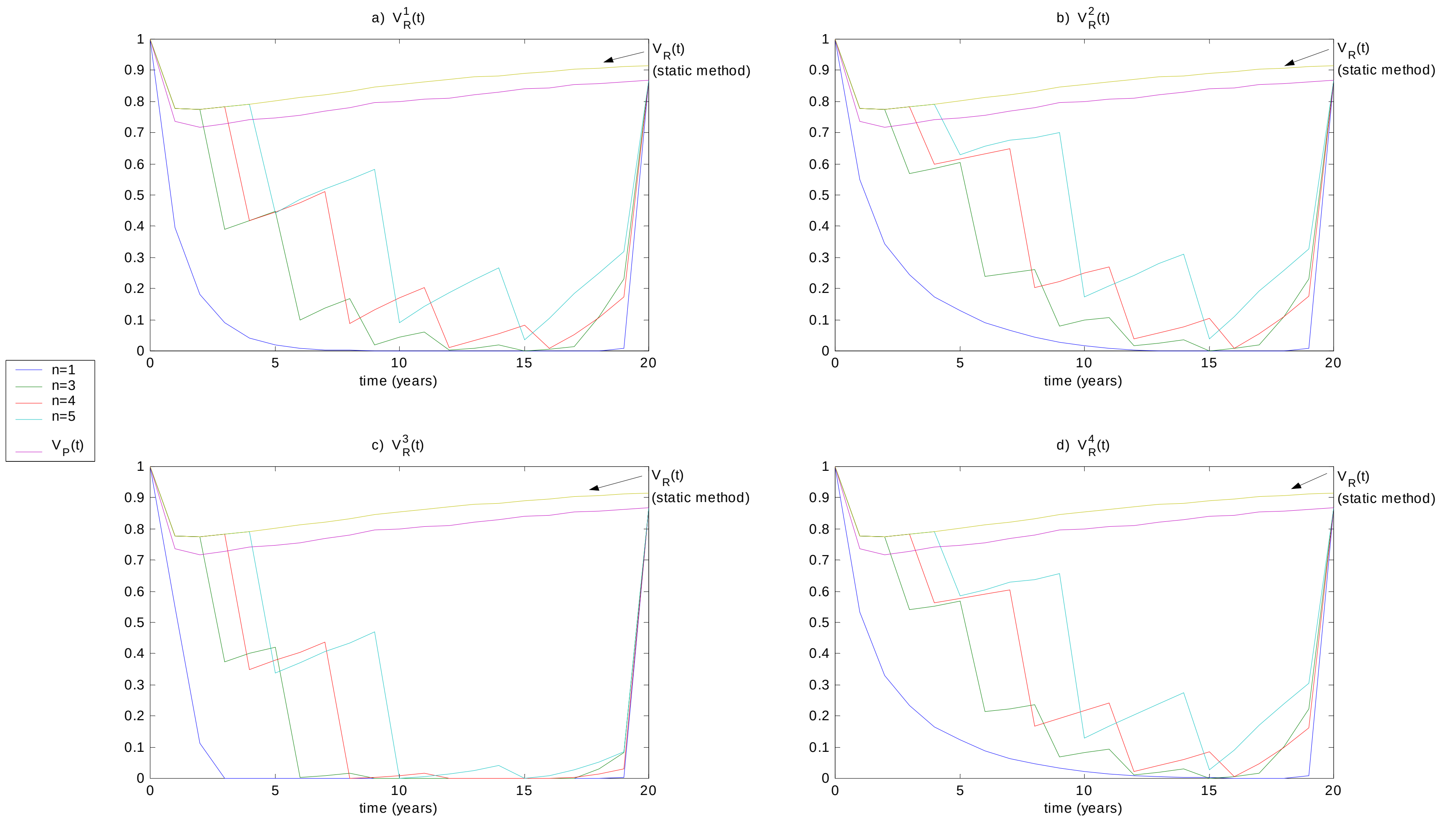
An important aspect of Solvency II project: Target capital

- The target capital is the amount needed to ensure that the probability of ruin of the insurance company, within a given period, is low
- Likely recommendations:
  - 0.5% ruin probability
  - 1 year time horizon
- We consider the Risk Bearing Capital (SST)

$$\frac{\text{Market value of assets - Best estimate of liability}}{\text{Best estimate of liability}}$$

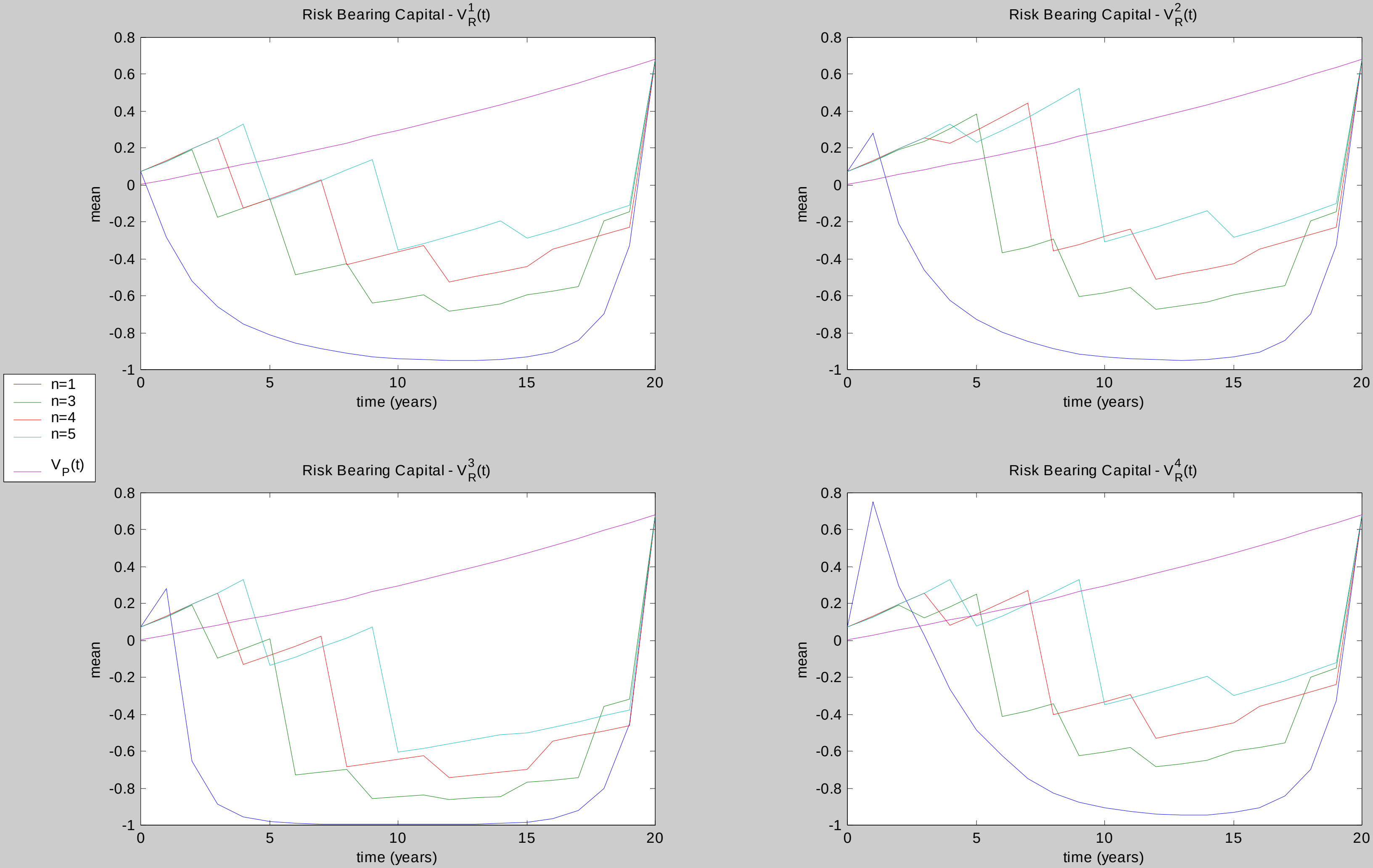
  - The best estimate of liabilities is given by both the FV approach and the mathematical reserves approach

The Risk Bearing Capital: $\Pi(RBC > 0)$



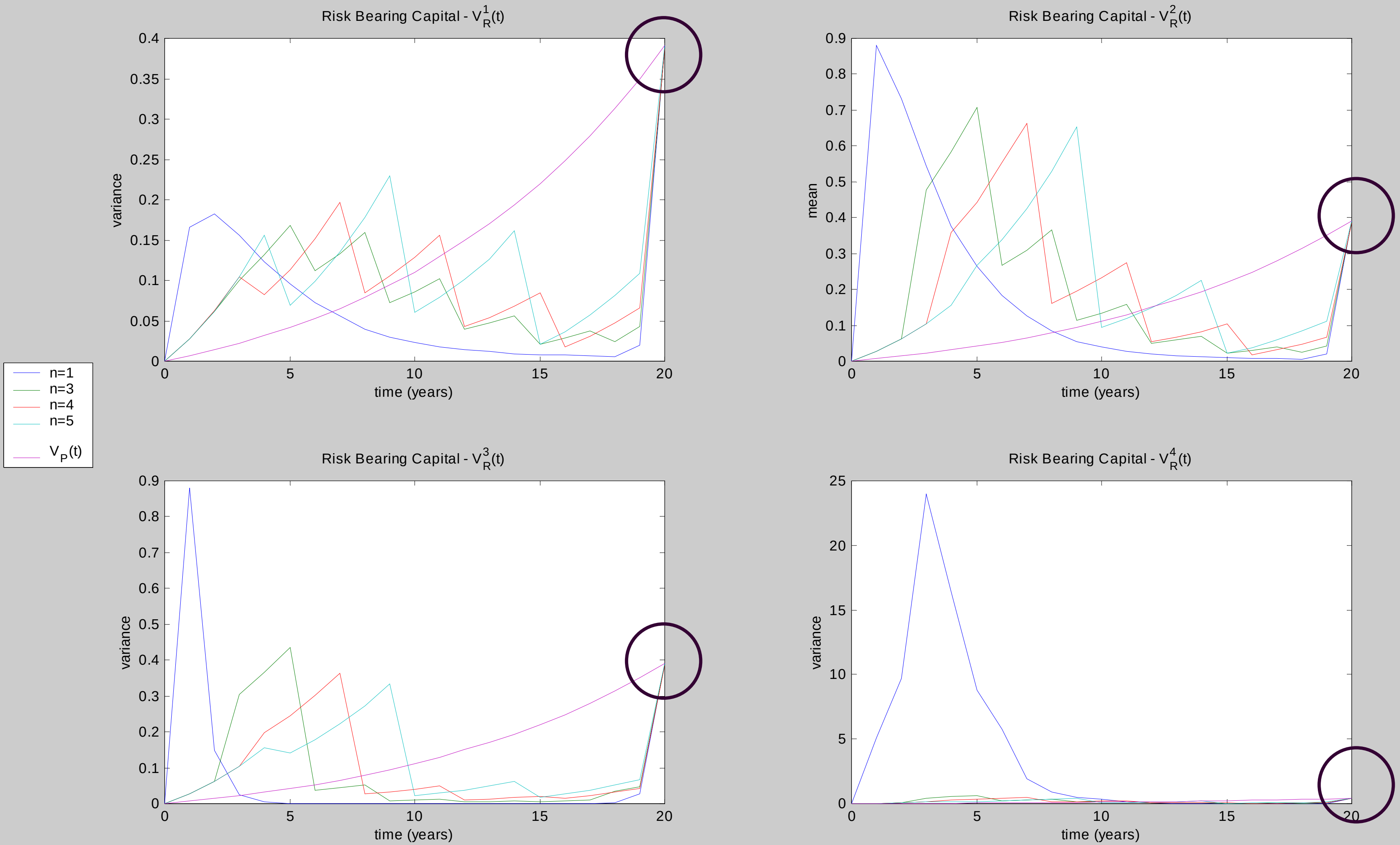
The fair value approach generates the lowest shortfall probability and the more stable RBC

Mean of Risk Bearing Capital



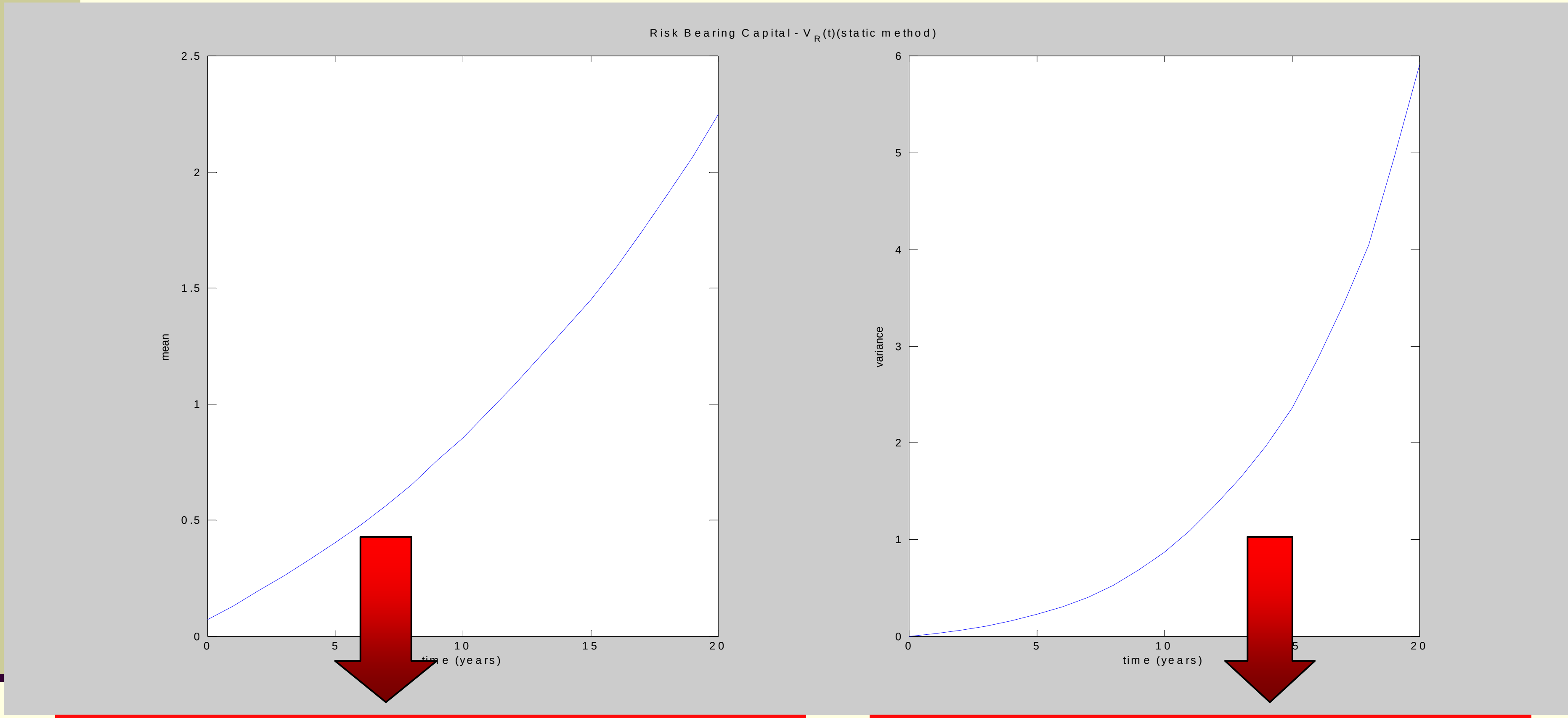
<u>The mean of RBC is always positive by using the fair value</u>

Variance of Risk Bearing Capital



Irregular pattern of the annual variance of the dynamic reserves

Moments of Risk Bearing Capital for static method of calculating reserves



This result is affected by the low level of static reserves (which are unable to cover the actual amount)

This result is due to the fact that the reserves are completely uncorrelated with the trend of assets

Conclusions

- The example shows
  - The market-based valuation approach provides awareness of default risk and suggests possible rule for the redefinition of the premia charged
  - Reserving systems need to be consistent with, and appropriate for, the nature of the liabilities

- More specific guidelines needed for fair valuation of insurance liabilities
  - Target accounting model (impact on MVM, shortfall probability, solvency capital requirements) …➔ work in progress

- The fair value approach can guarantee
  - Effective and cost efficient ALM policy
  - Stable solvency profile