

Risk Geographies

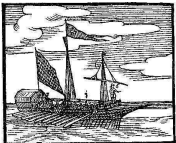
výklad a výpočet rizikového kapitálu

Andrew D Smith

14 listopadu 2006

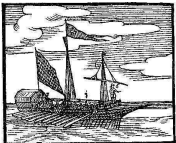
AndrewDSmith8@Deloitte.co.uk

Navigační



Risk Geographies - Themes

- The Model underlying Solvency II
- Most likely ruin event, least solvent likely event
- Visualising risk
 - annuity example
 - Multiple dimensions
- Non-linearity
 - Vineyard example
- Non-normal distributions
- Presenting and Communicating the Answers



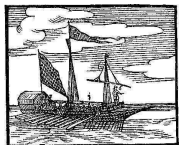
Model Underlying Solvency II

Risk	Capital	Correlation matrix (QIS2 p23)						
market	100	1	0.75	0.25	0.25	0.25	0.25	0.5
credit	50	0.75	1	0.25	0.25	0.5	0.25	0.25
life	60	0.25	0.25	1	0.25	0	0.25	0.25
health	20	0.25	0.25	0.25	1	0	0.25	0.25
non-life	80	0.25	0.5	0	0	1	0.5	0.5
operational	30	0.5	0.25	0.25	0.25	0.5	1	1

Capital available: 245

Input cells in yellow.

Capital (SCR) by risk type represents mean minus 0.5%ile



Solvency II and Correlations

Capital required
independent
correlated
no diversification

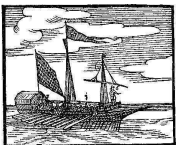
154
231
340

$$\sqrt{\sum_r SCR_r^2} = |SCR|^2$$

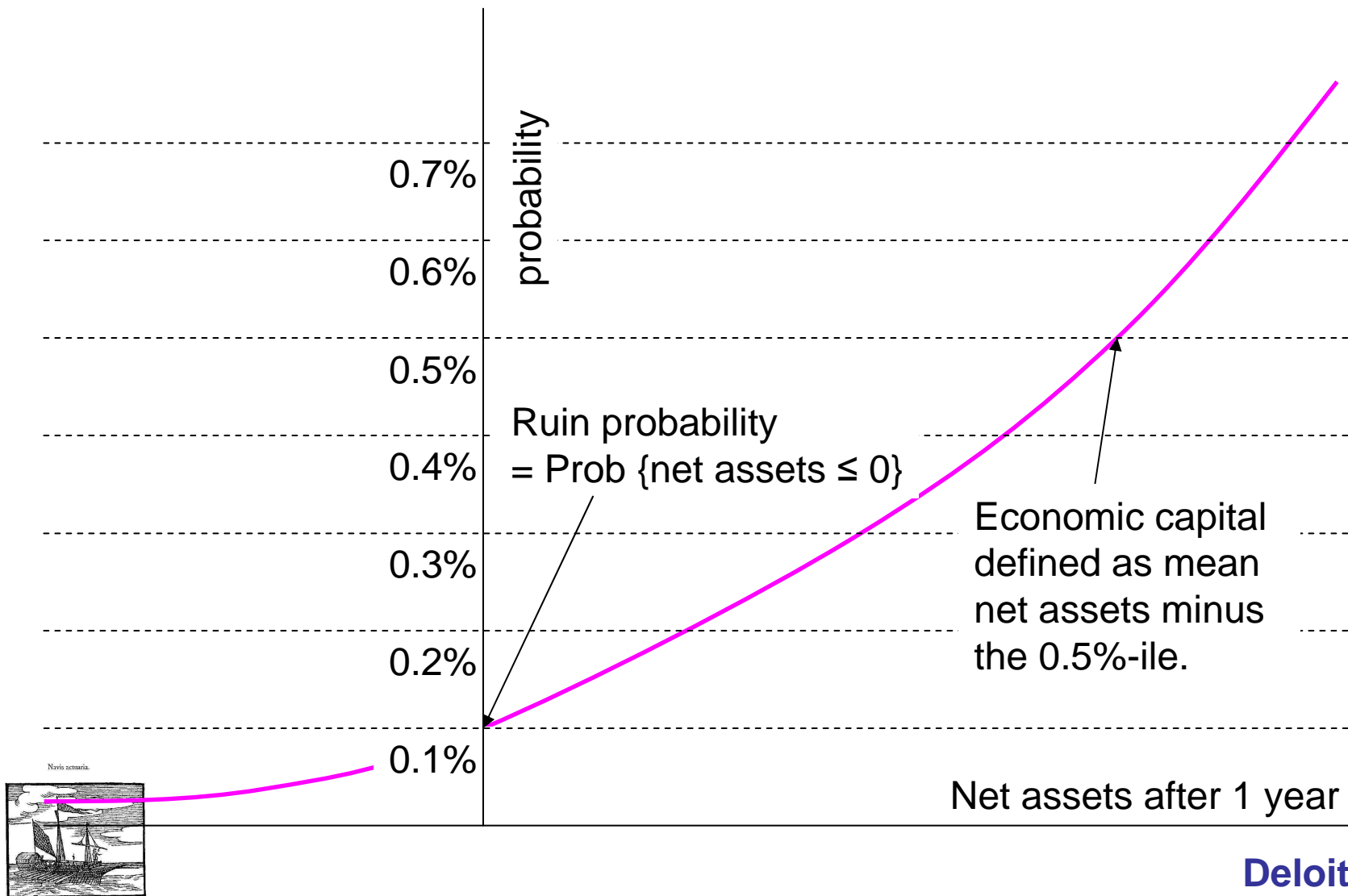
$$\sqrt{\sum_{r \times c} Corr SCR^{r \times c} \cdot SCR_r \cdot SCR_c}$$

$$= \sqrt{SCR^T Corr SCR}$$

$$\sum_r SCR_r = 1^T SCR$$



What Model Underlies Solvency II?



Most Likely Ruin Event (MLRE) & Least Solvent Likely Event (LSLE)

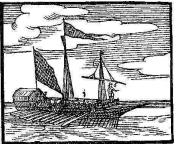
Risk	MLRE	LSLE
market	89	83
credit	44	42
life	30	29
health	7	7
non-life	53	50
operational	21	20
total	245	231

Capital allocation by risk type. Formula is:

$$\frac{Corr\ SCR}{\sqrt{SCR^T\ Corr\ SCR}}$$

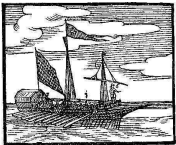
Available capital exhausted

SCR exhausted

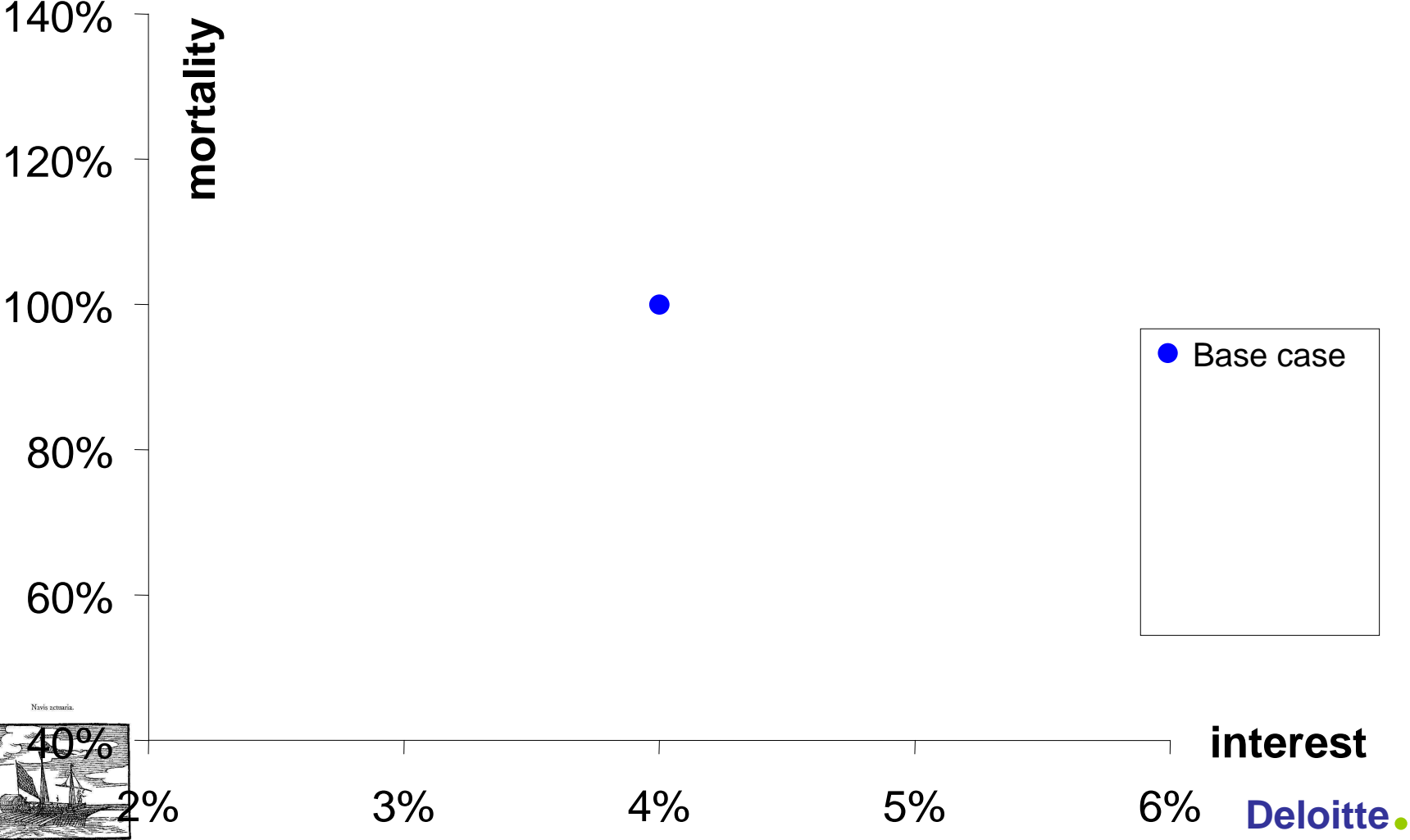


Visualising Risk Annuity Example

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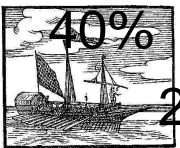
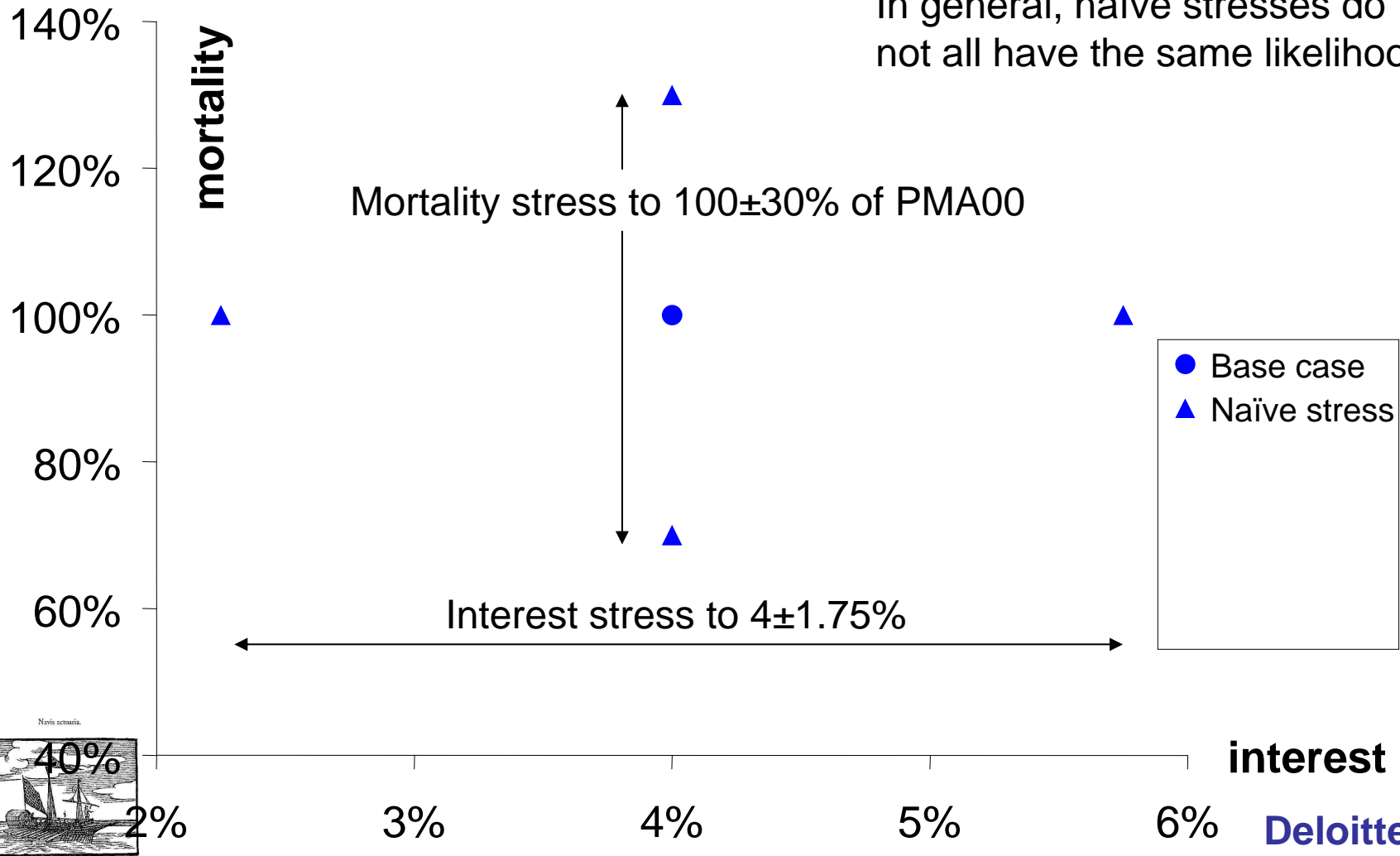


Two key risk drivers facing the firm

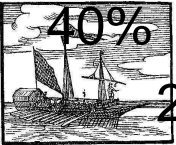
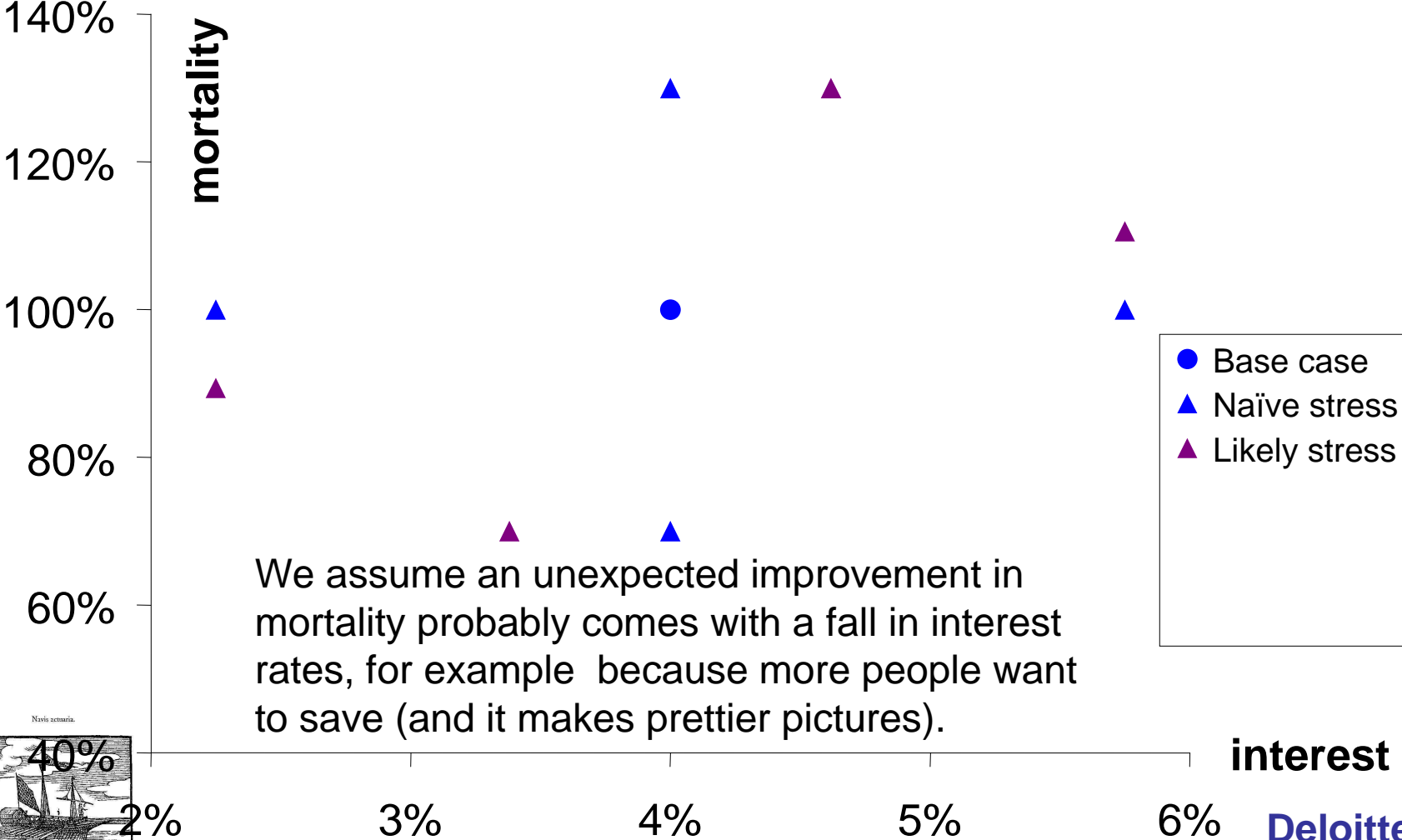


Naïve Stresses

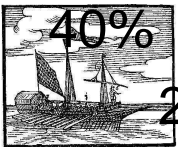
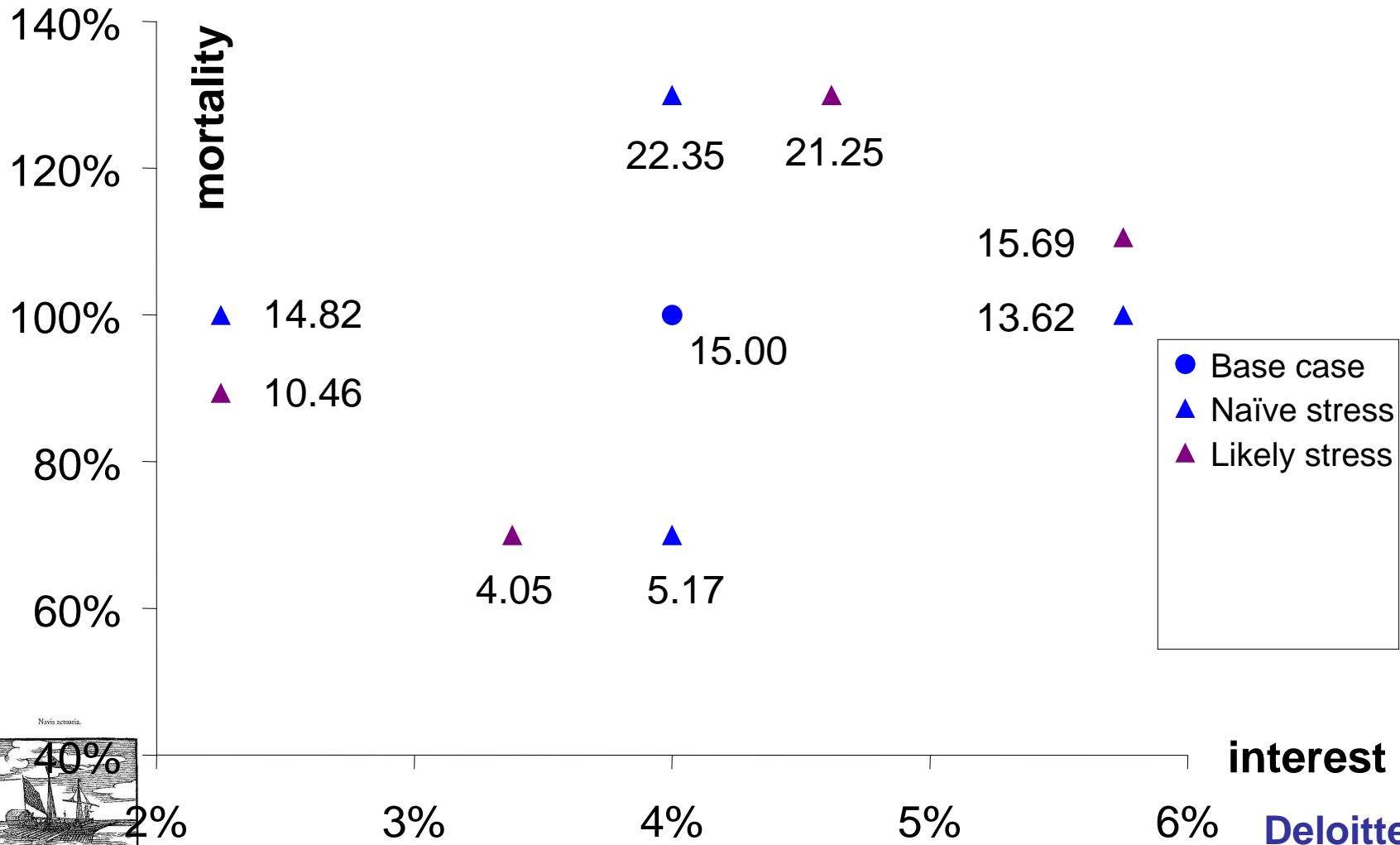
In general, naïve stresses do not all have the same likelihood.



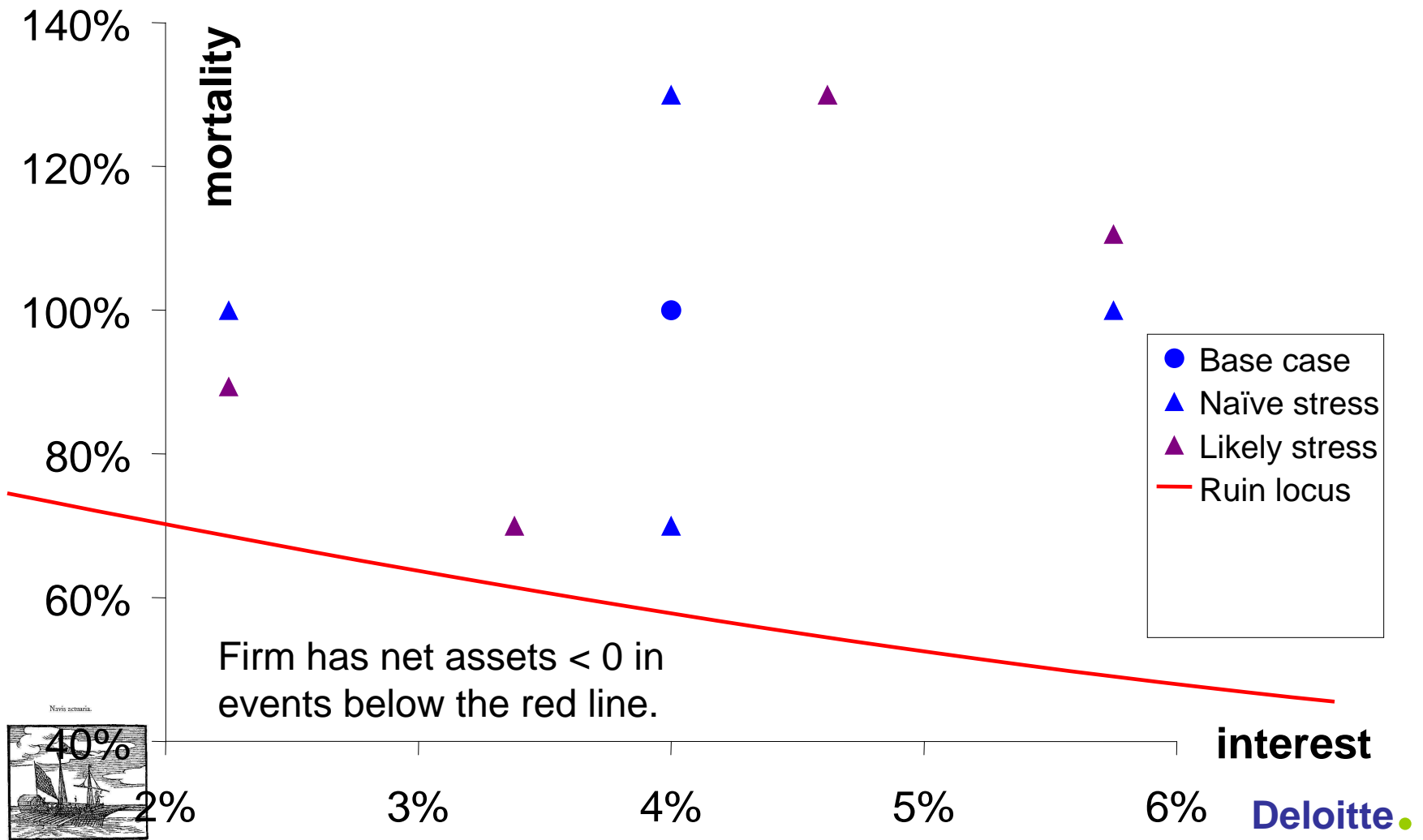
Likely Stresses



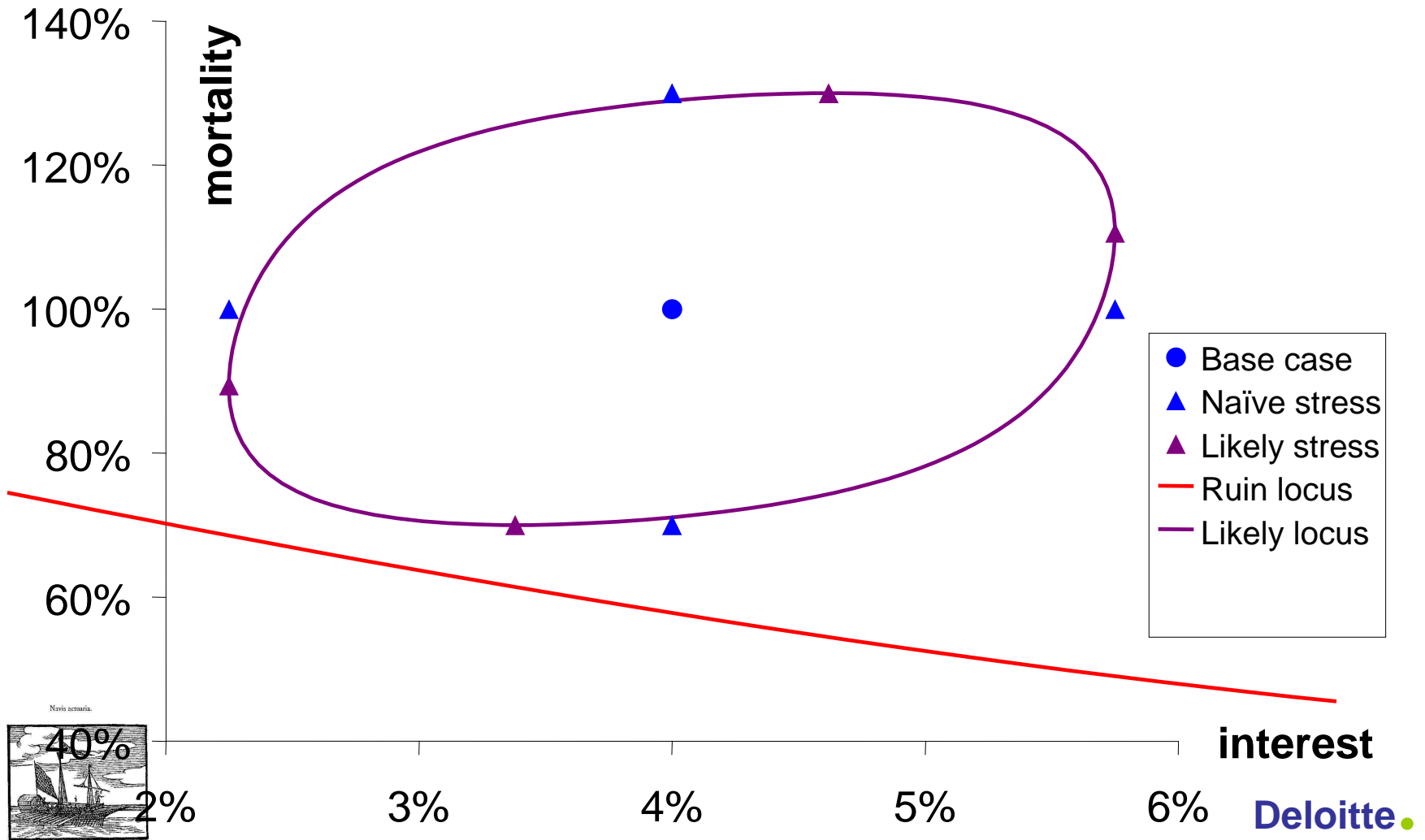
Stressed Net Assets



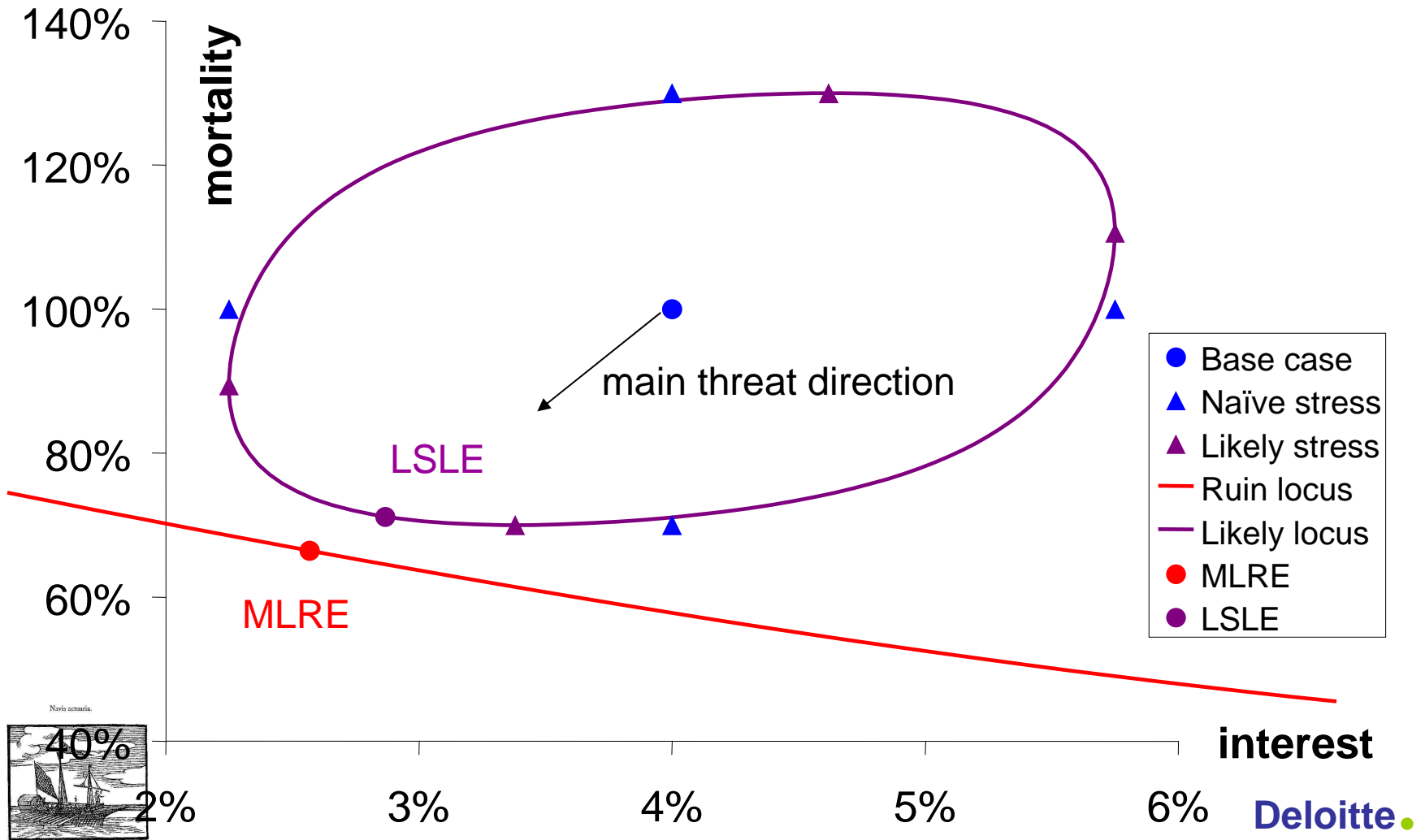
Net Assets and Ruin Region



Likely Stress Locus



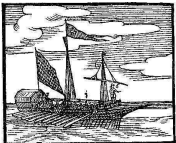
MLRE and LSLE



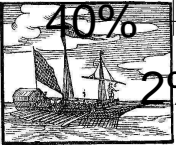
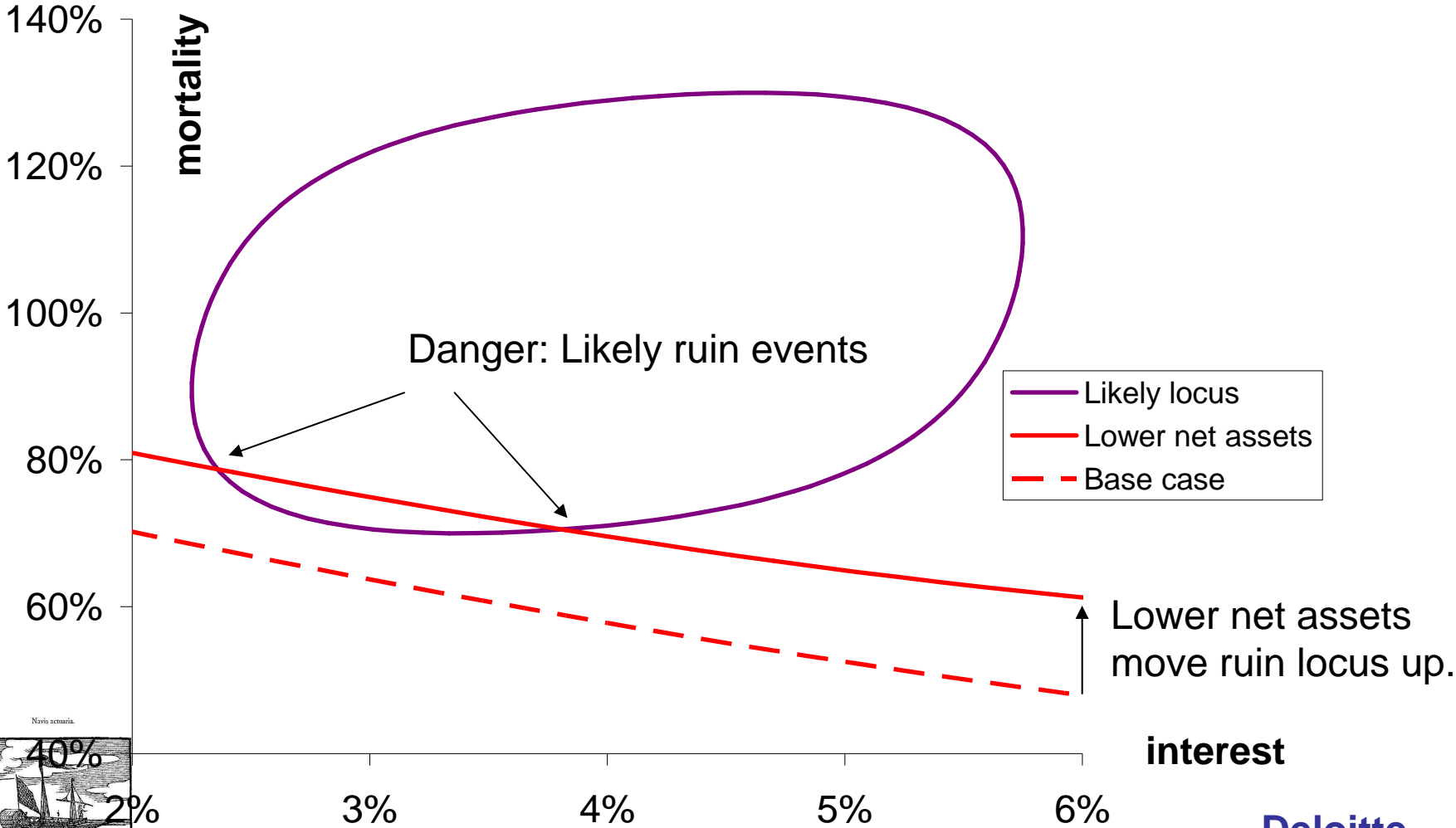
Risk Management

- MLRE is a transparent and powerful summary of the risks facing an organisation as a whole or its constituent business units
- Evaluate internal hedging opportunities by computing MLRE at business unit level and comparing to top level MLRE
- Reduce risk of failure by looking for strategies that mitigate losses in the top level MLRE
 - e.g. hedging
 - reinsurance
 - investment strategy
 - contingent capital
 - then you have to start over and compute a new MLRE!

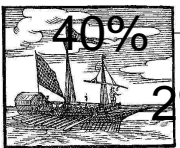
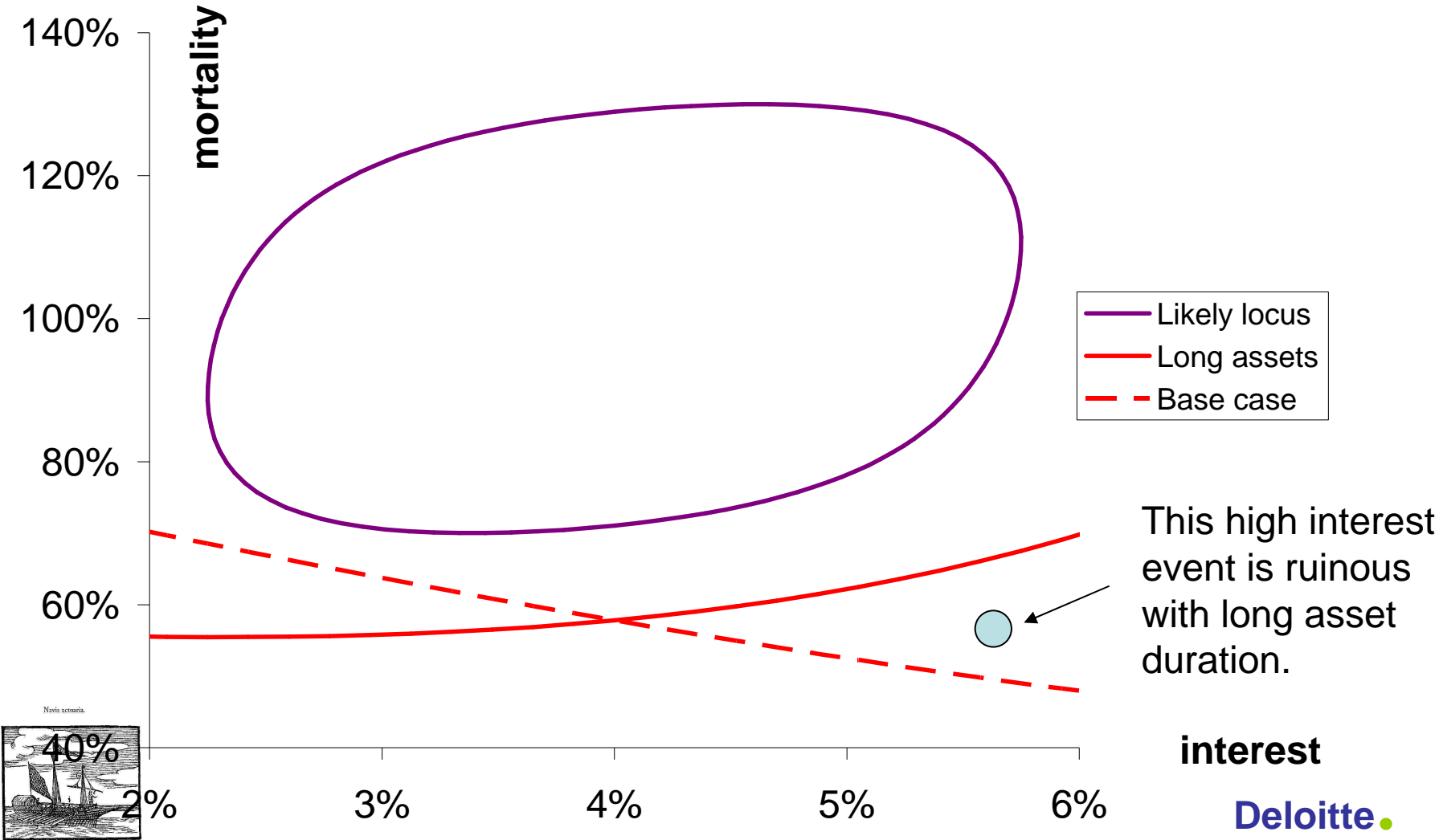
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Effect of Lower Net Assets

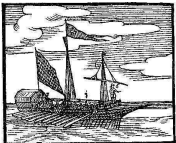


Longer Asset Duration

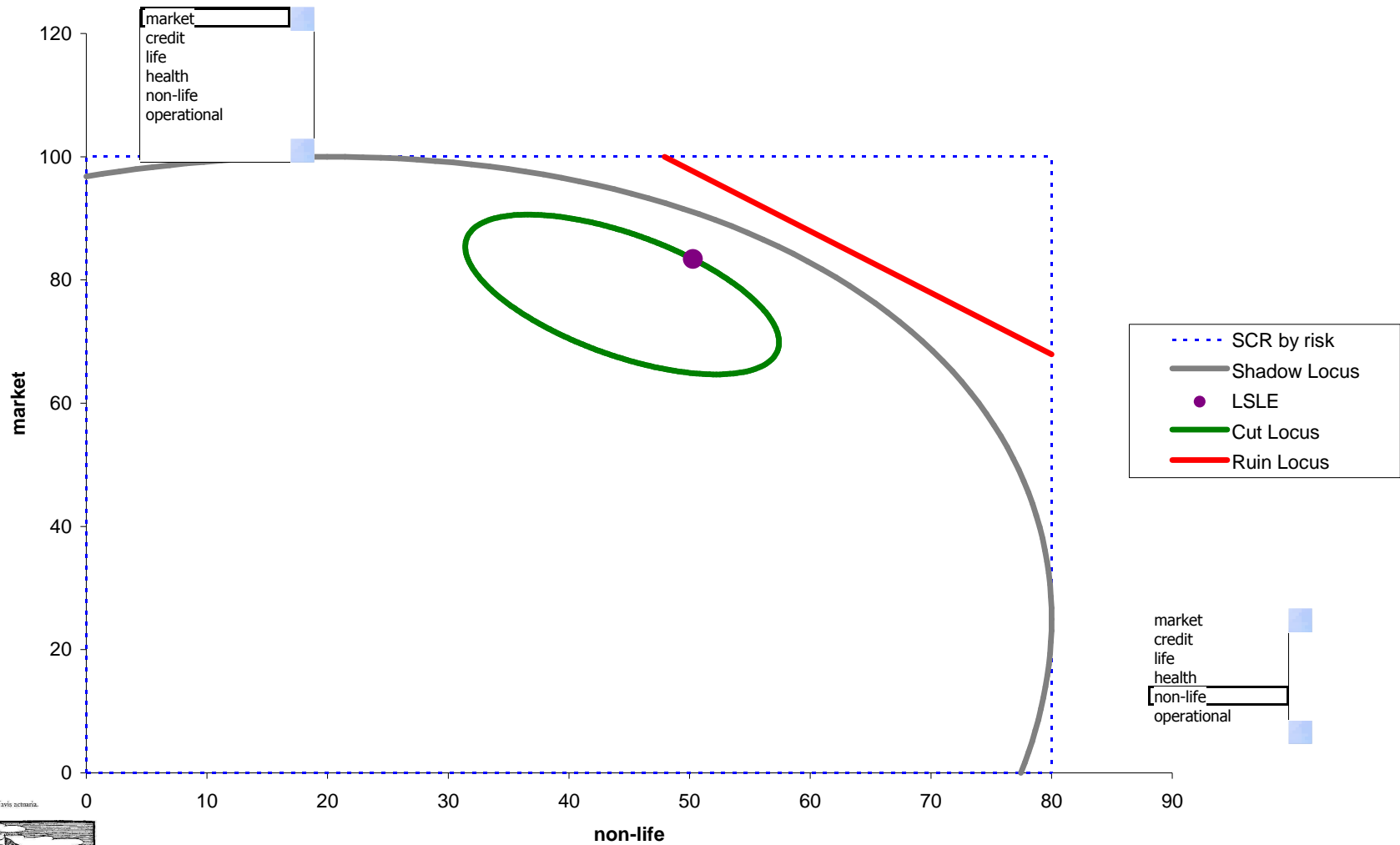


Multi – Dimensional Examples

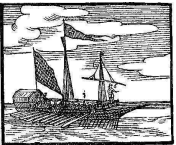
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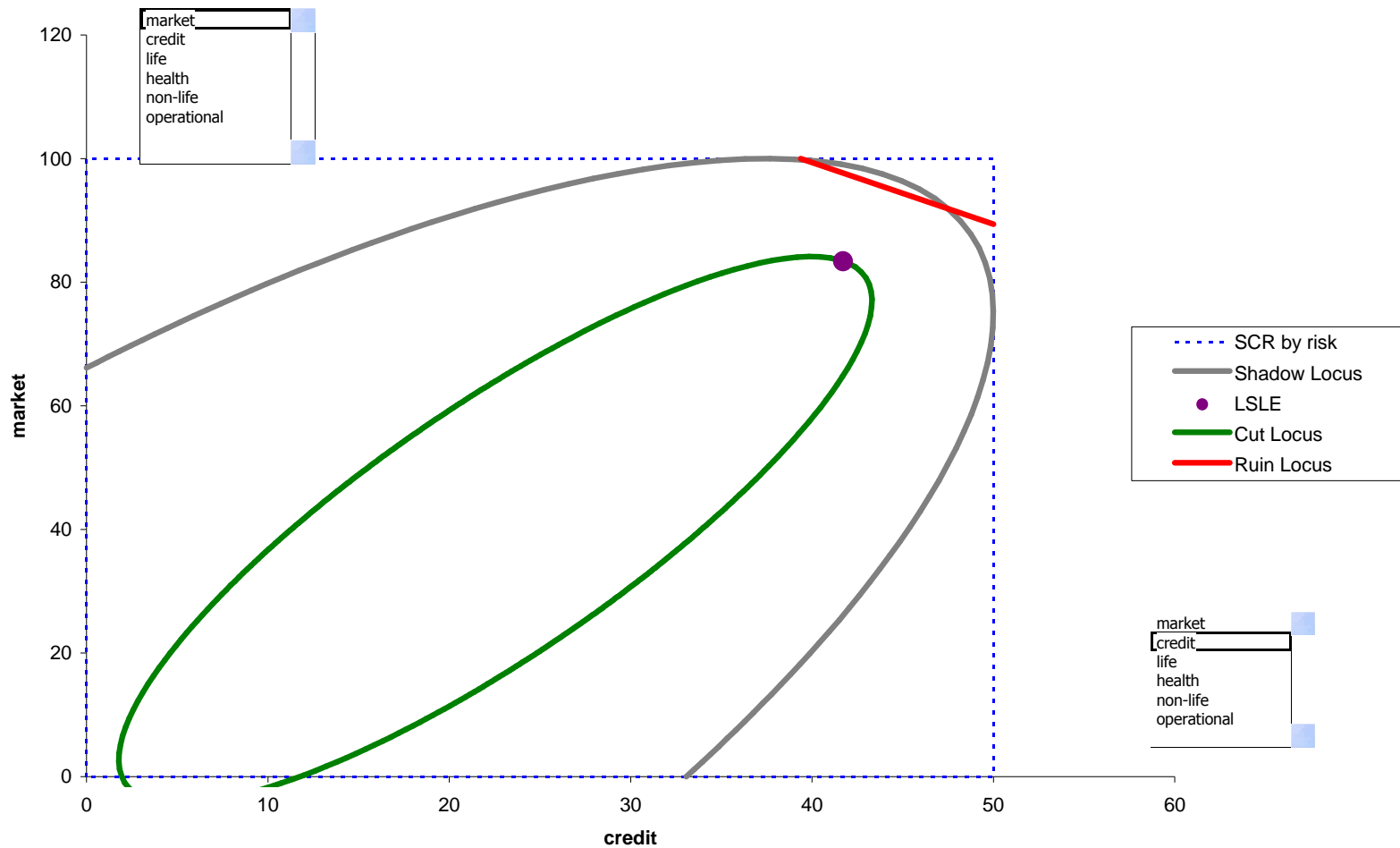
Market and Non-Life



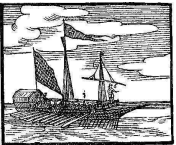
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Market and Credit



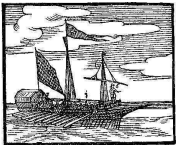
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Non-Linearity

Vineyard Example

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Чорнобиль and წინანდალი



Чорнобиль



წინანდალი



The Nuclear Accident



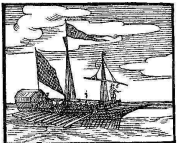
Чорнобиль



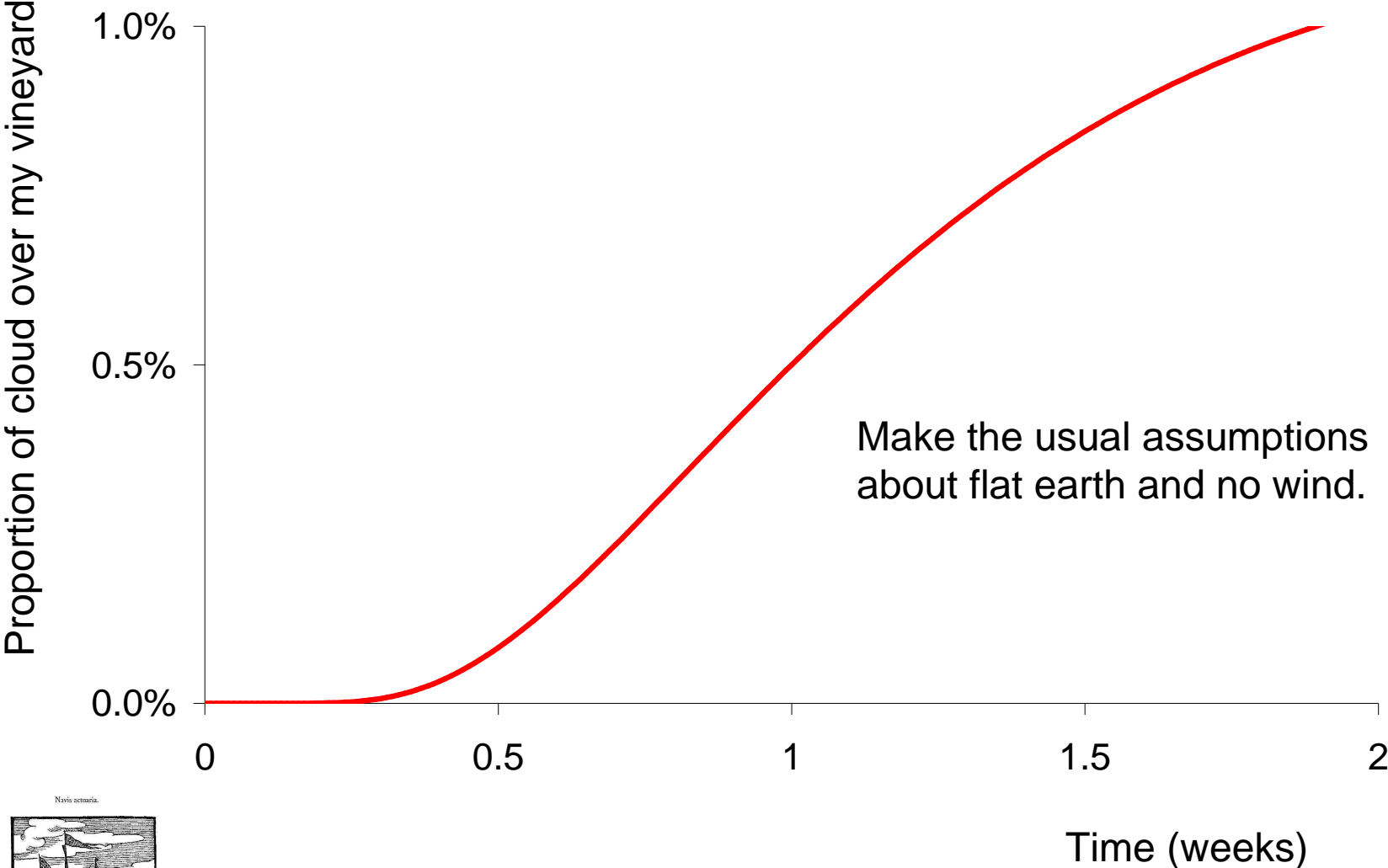
წინანდალი

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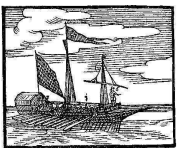
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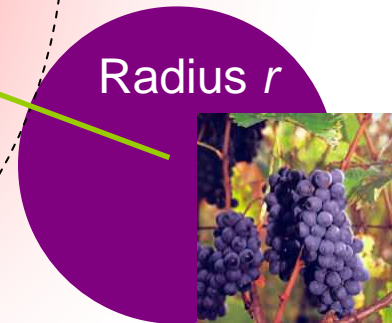
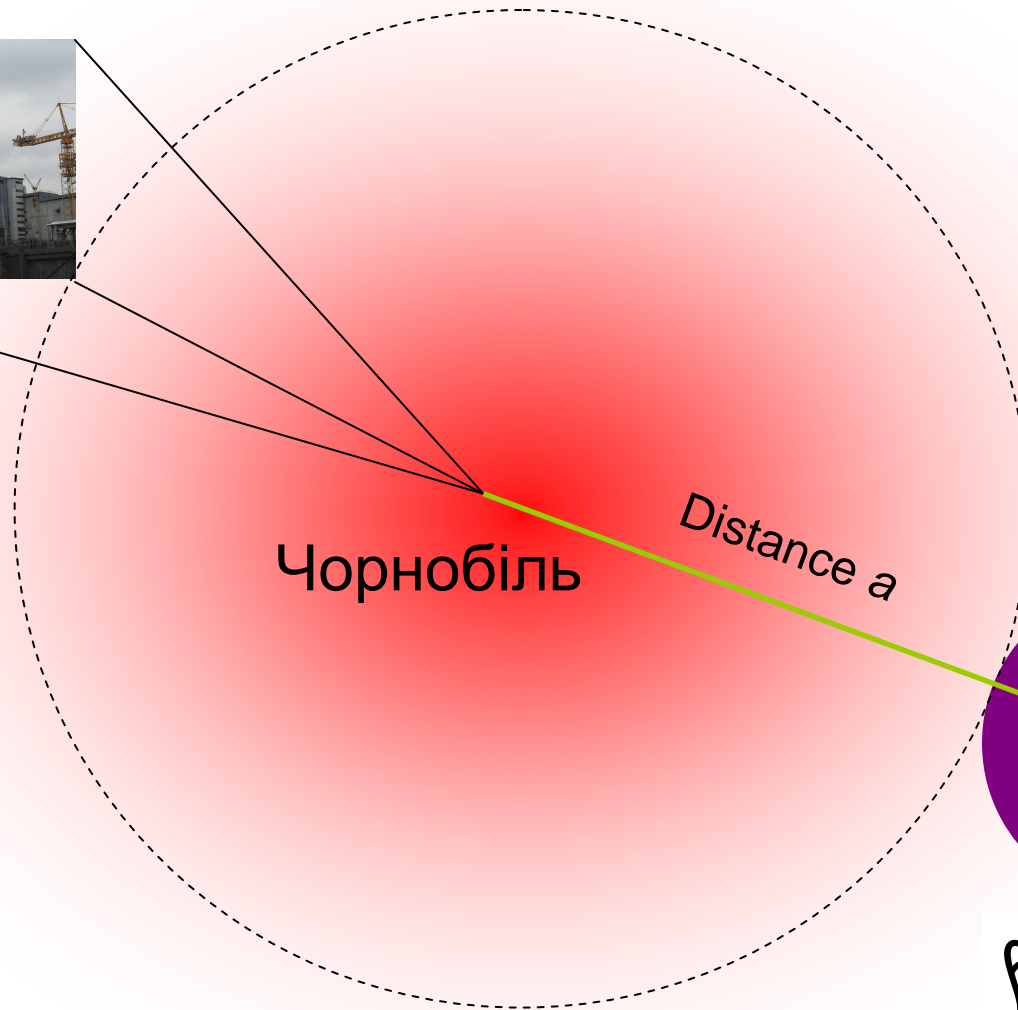
Fallout Impact



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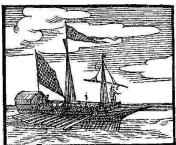


Distance and Radius

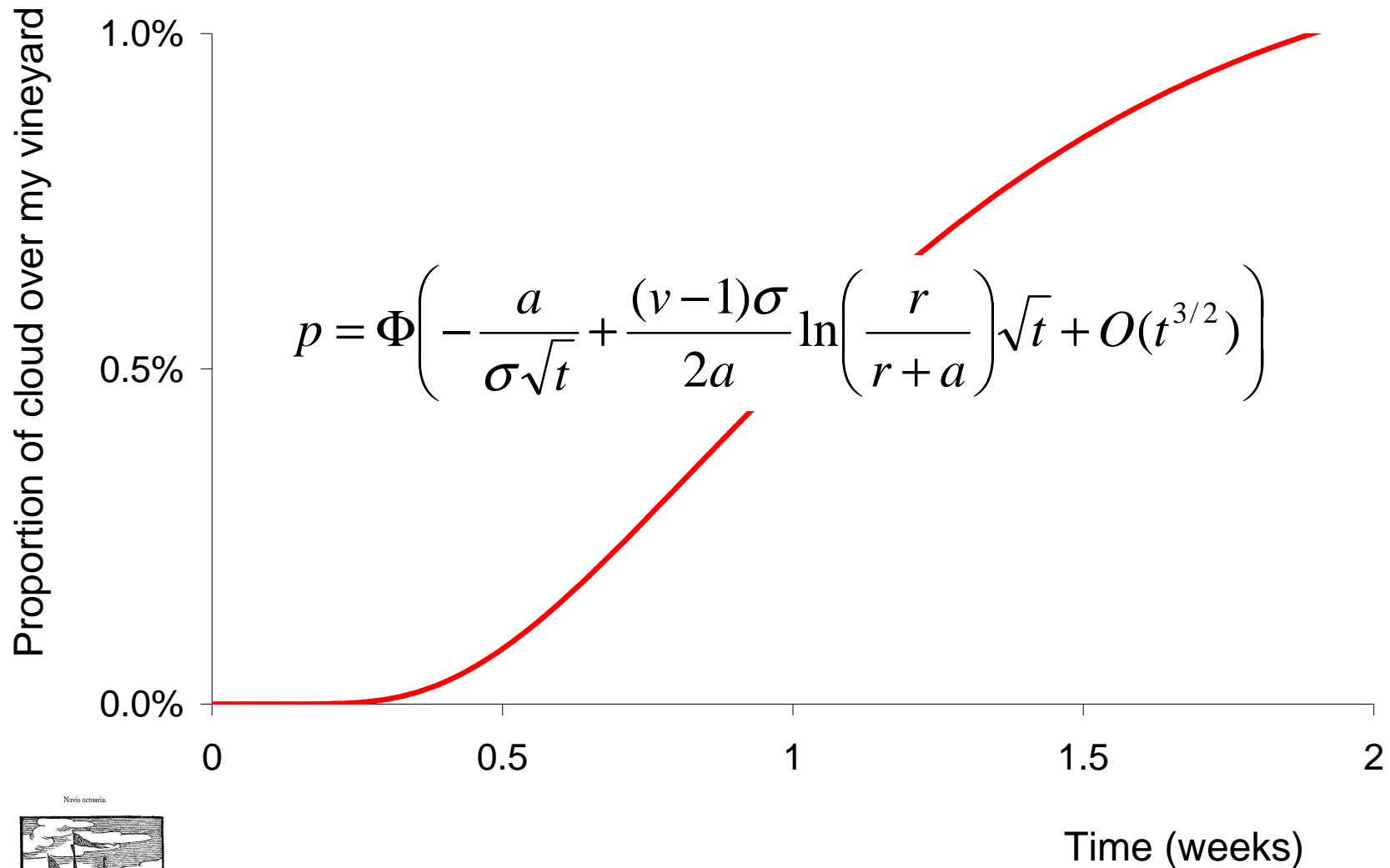


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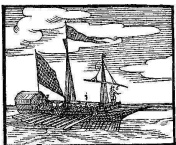
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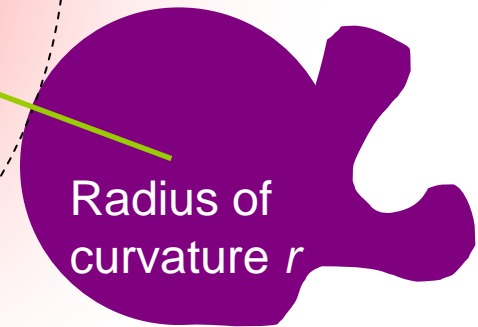
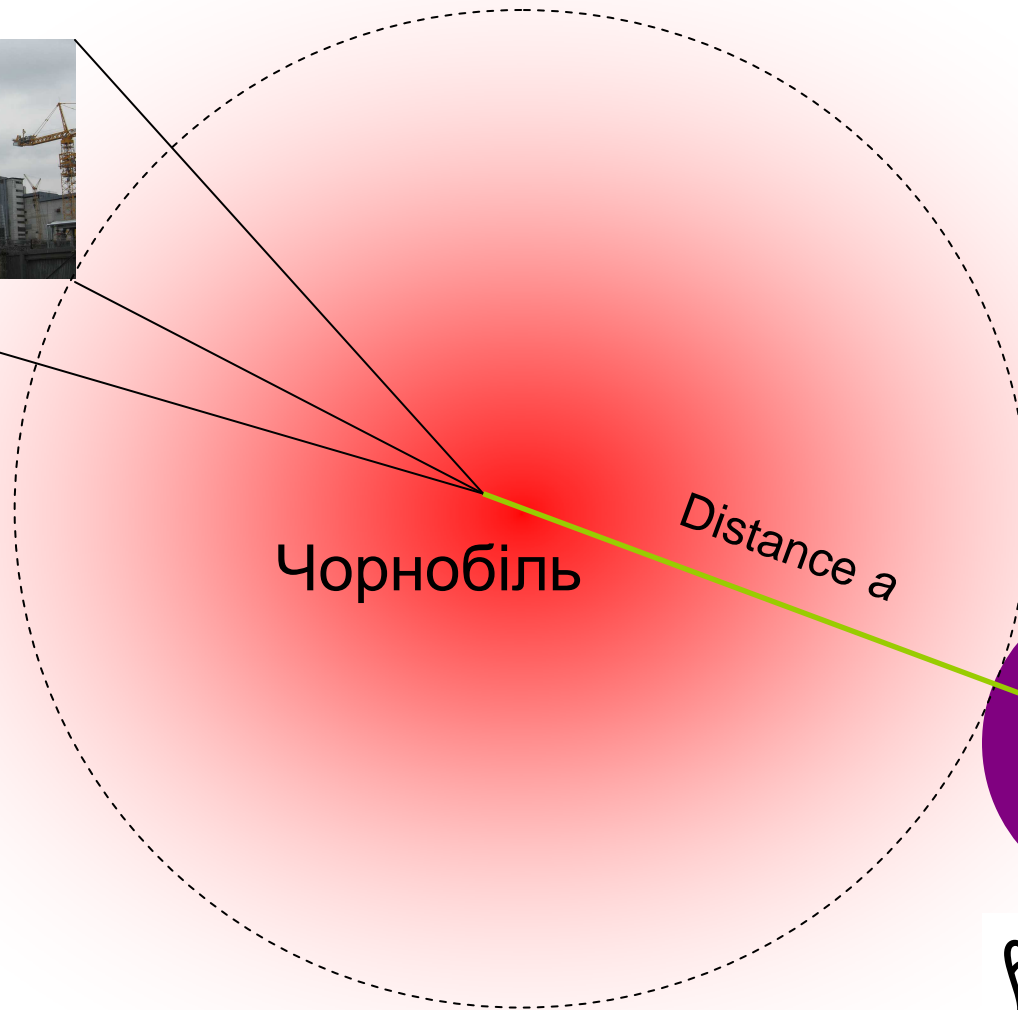
Large Deviation Expansion



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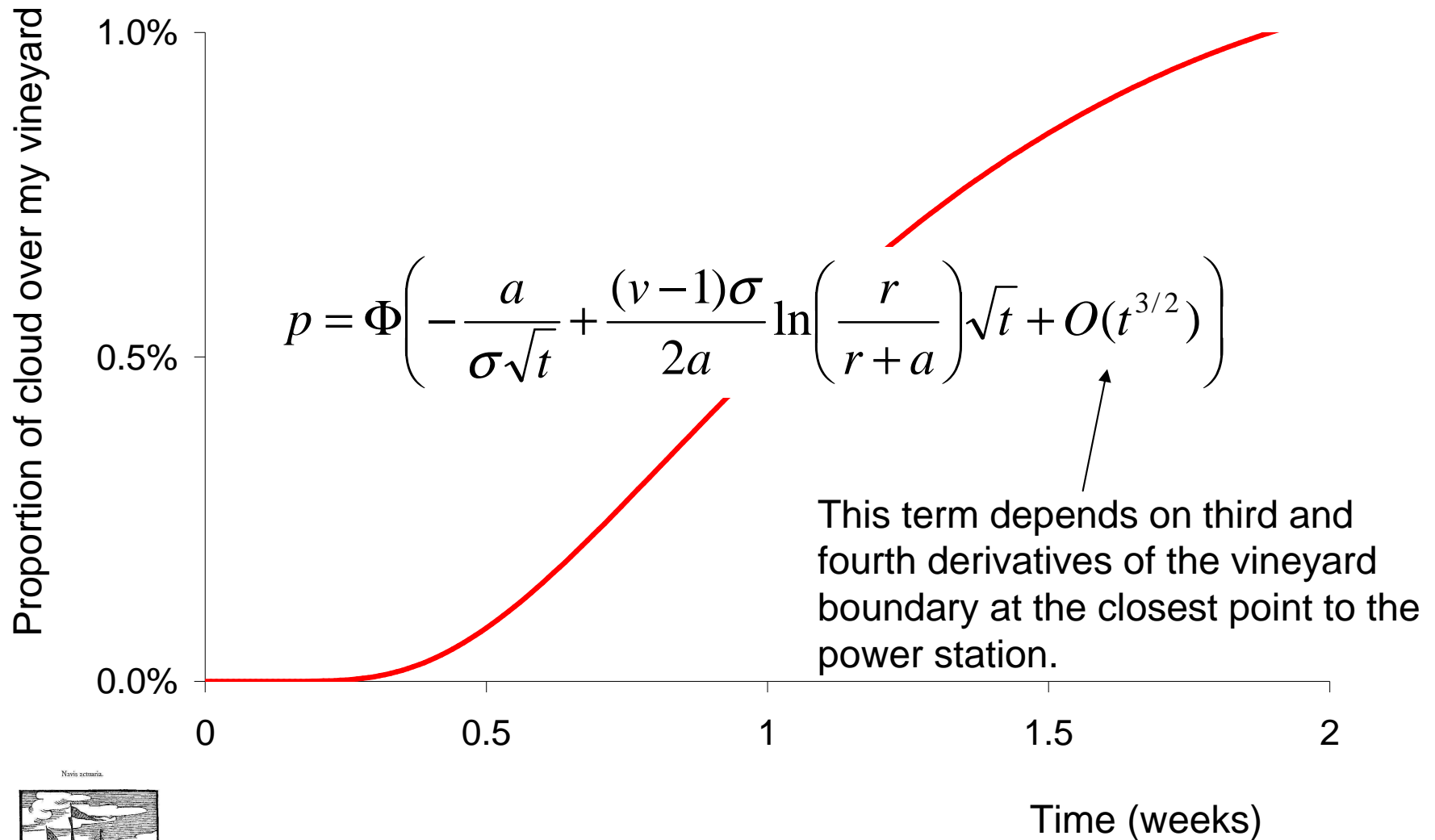


Irregular Vineyard

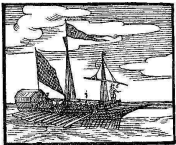


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Same Answer Still Applies

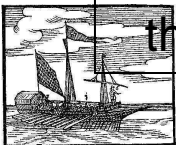


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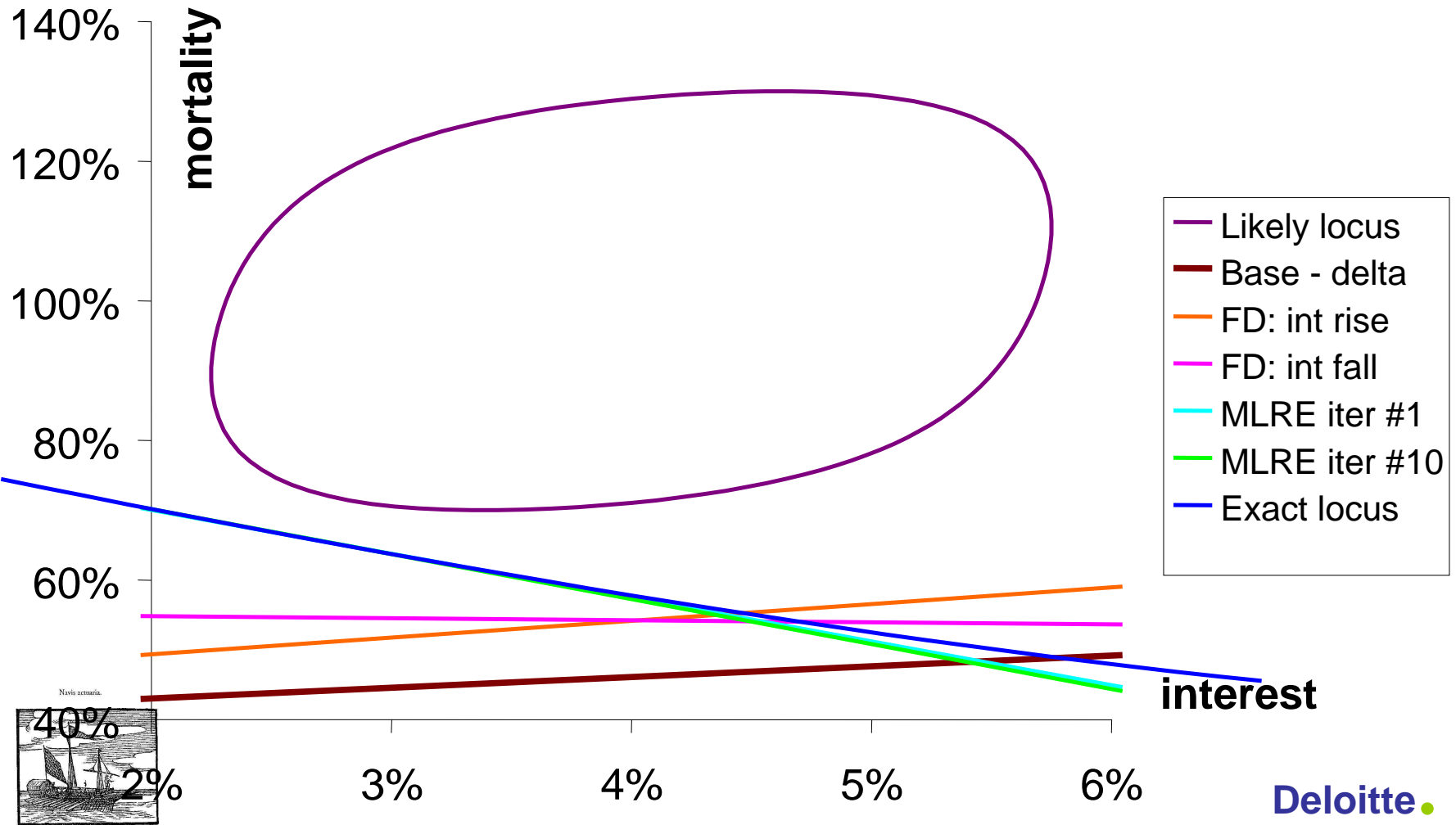


Two Problems – One solution

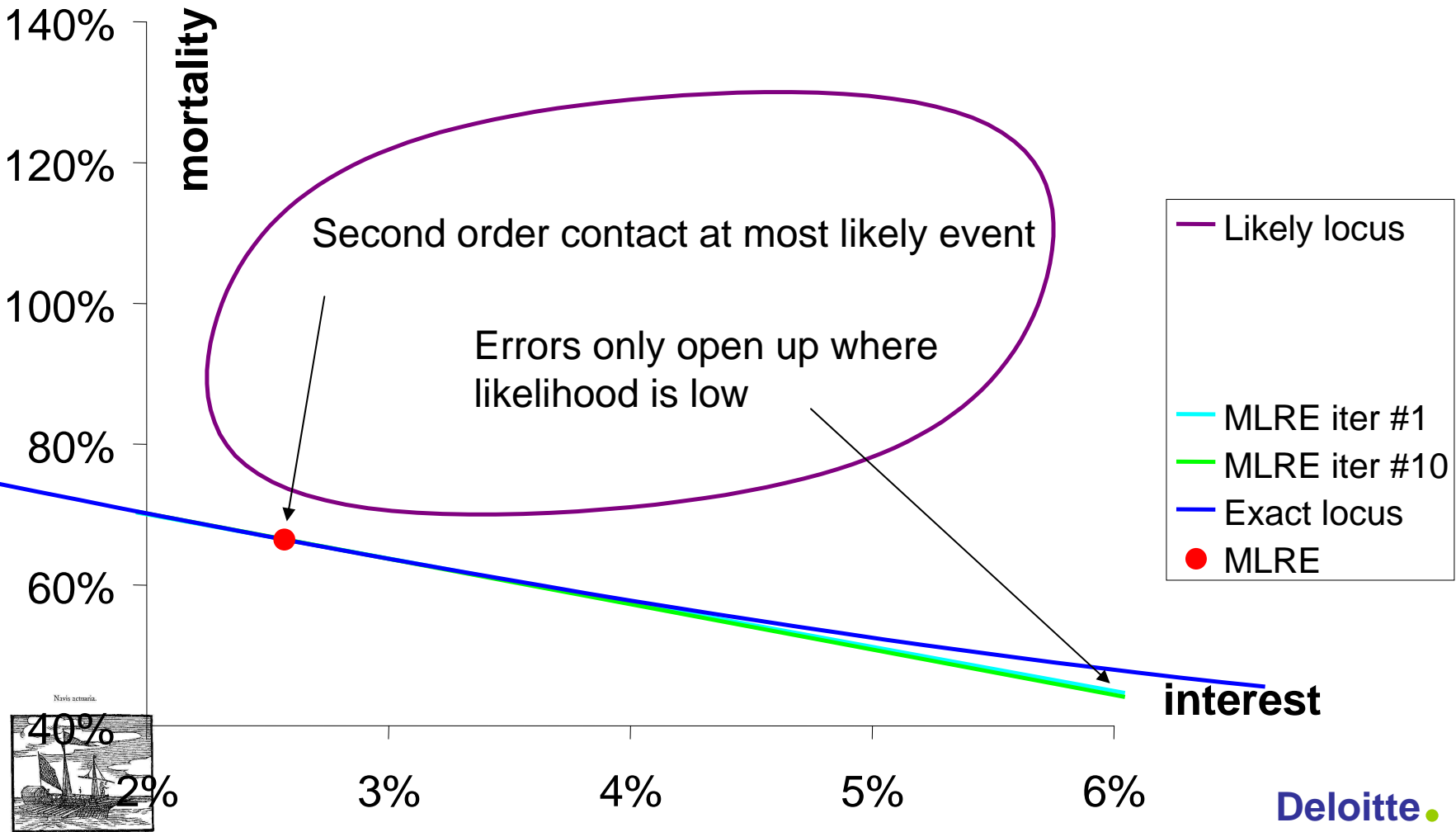
Viticulture / Nuclear Safety	Financial Risk
Position of radioactive particle	Vector of market conditions
Path of particles	Path of market conditions
Чорнобиль power station	Current market conditions
Diffusion speed	Market volatility
წინანდალი vineyard	Conditions leading to ruin
Closest point	Most Likely Ruin Event (MLRE)
Vineyard radius of curvature	Non-linearity / interactions
Proportion of cloud over the vineyard	Probability of ruin



Re-estimated MLRE: Annuity Example



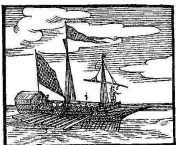
Small Non-linearity Effect



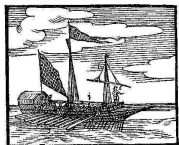
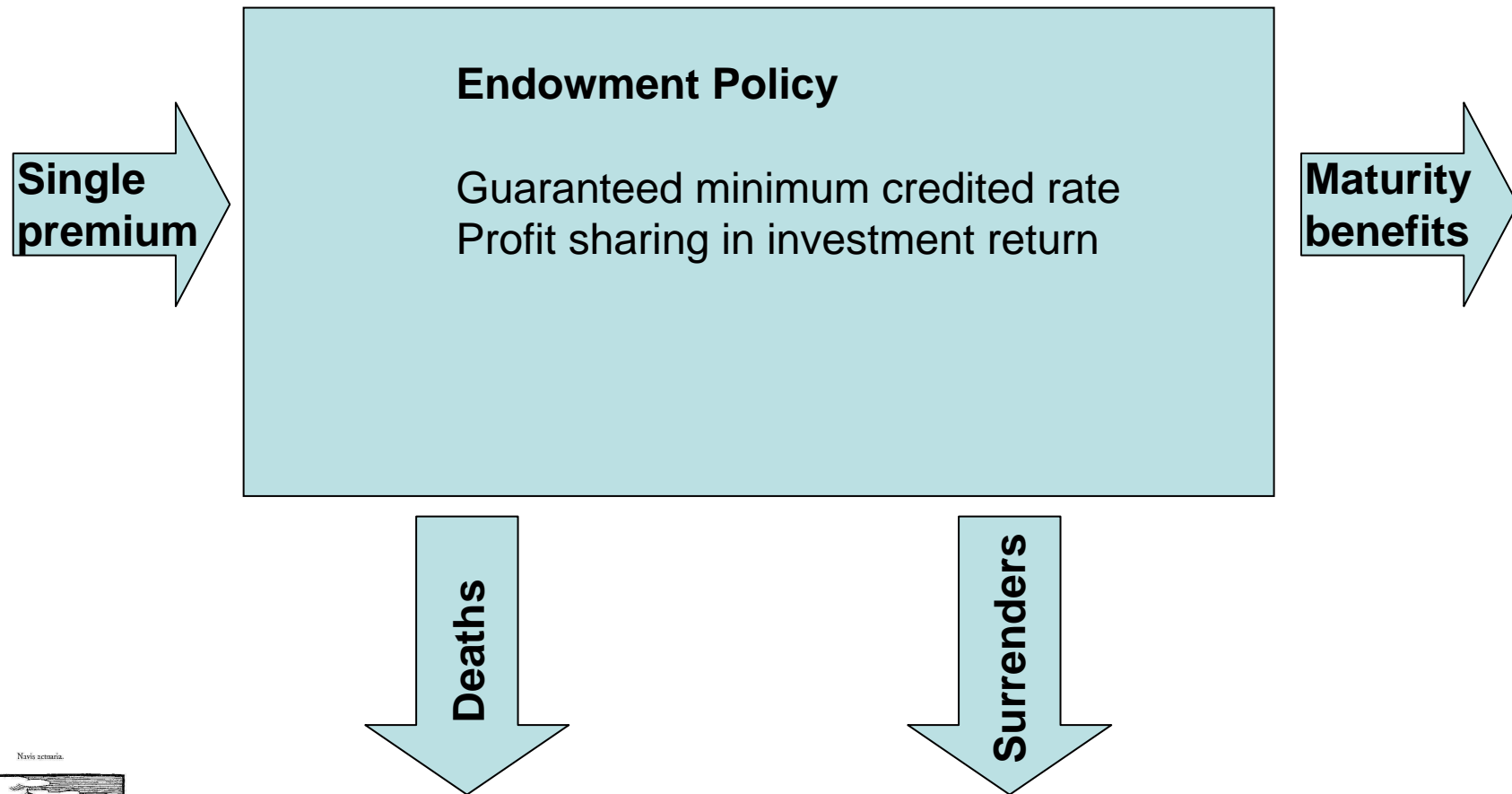
Non-Normal Distributions

Endowment Example

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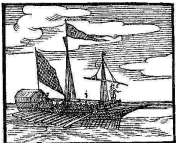
Endowment Example



Possible Risks

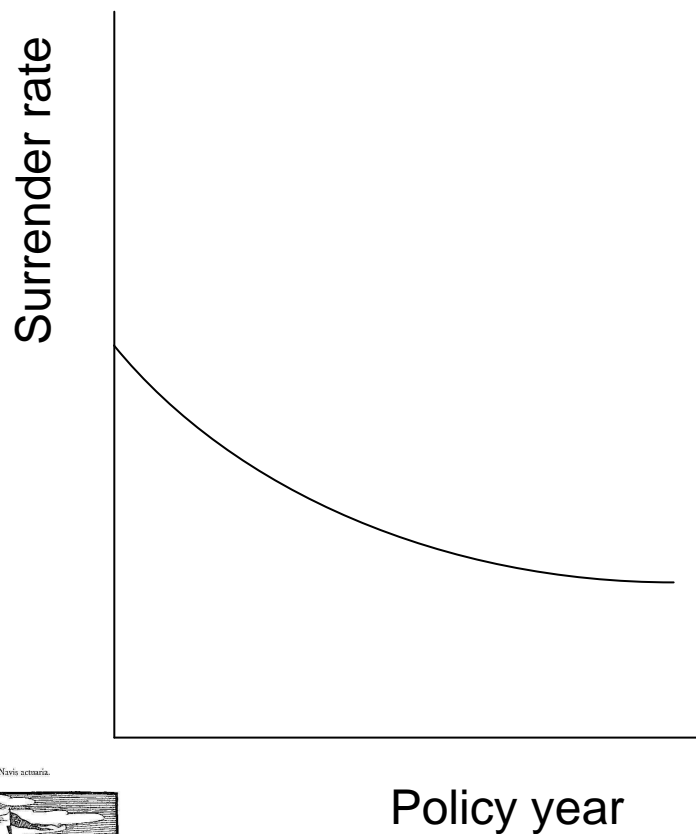
- Risk-Free Interest Rates
- Asset defaults
- Surrender behaviour
- Market volatility
- Mortality expectations
- Operational failures

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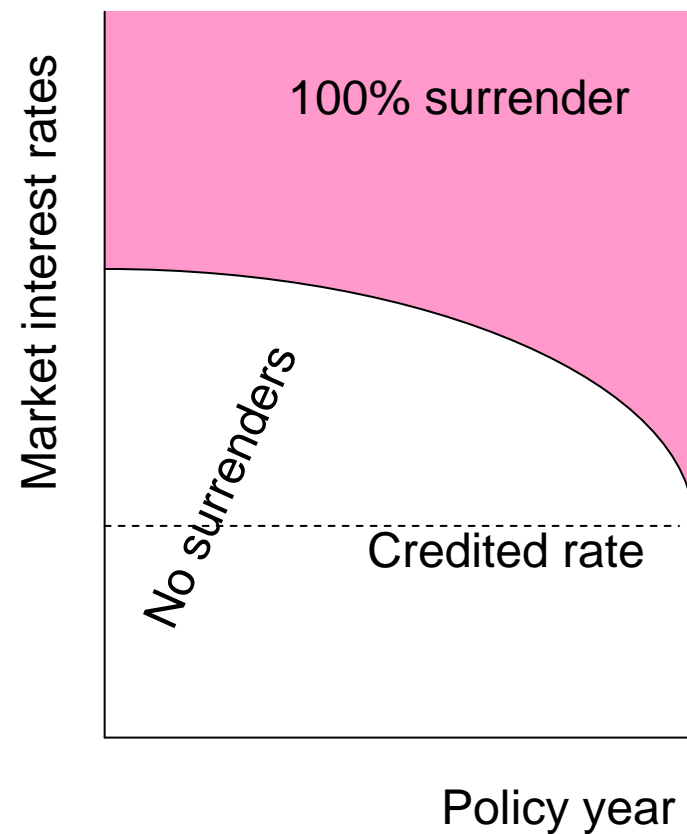


Passive and Rational Policyholders

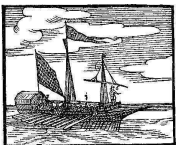
Passive Policyholders



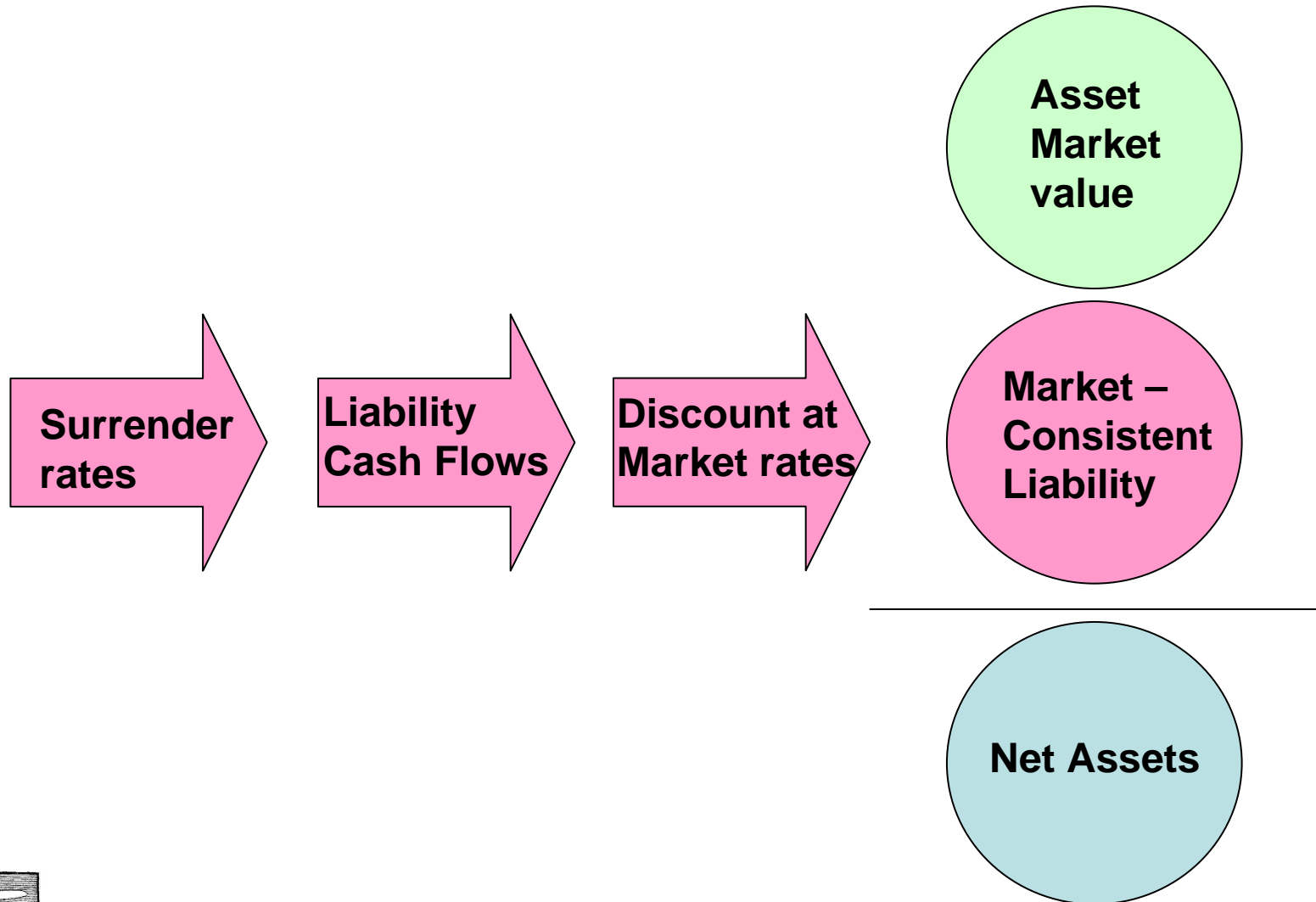
Rational Policyholders



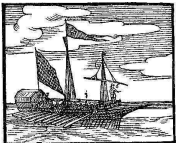
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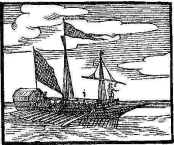
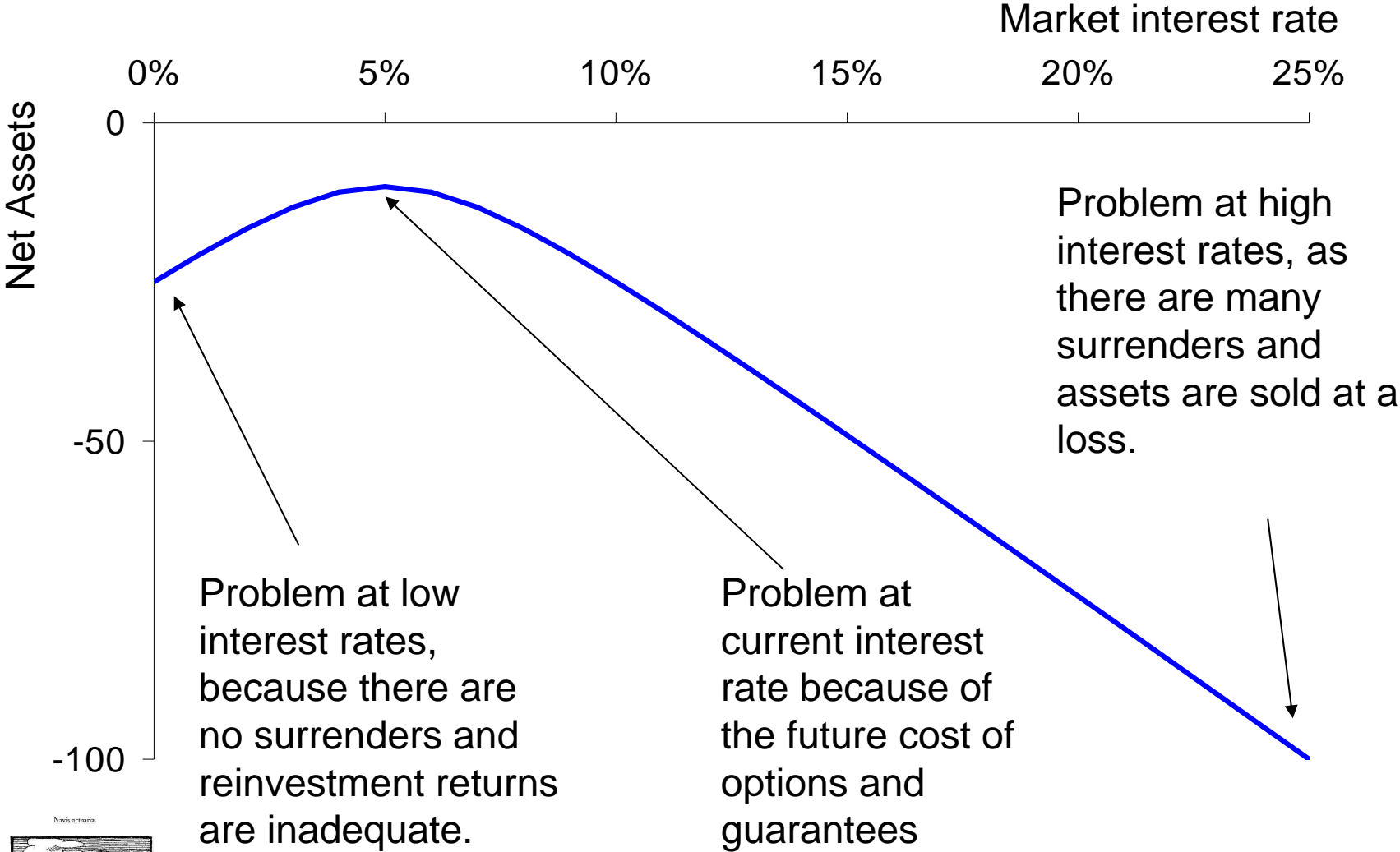
Market Valuation: Passive Case



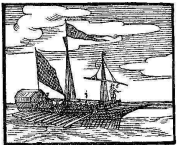
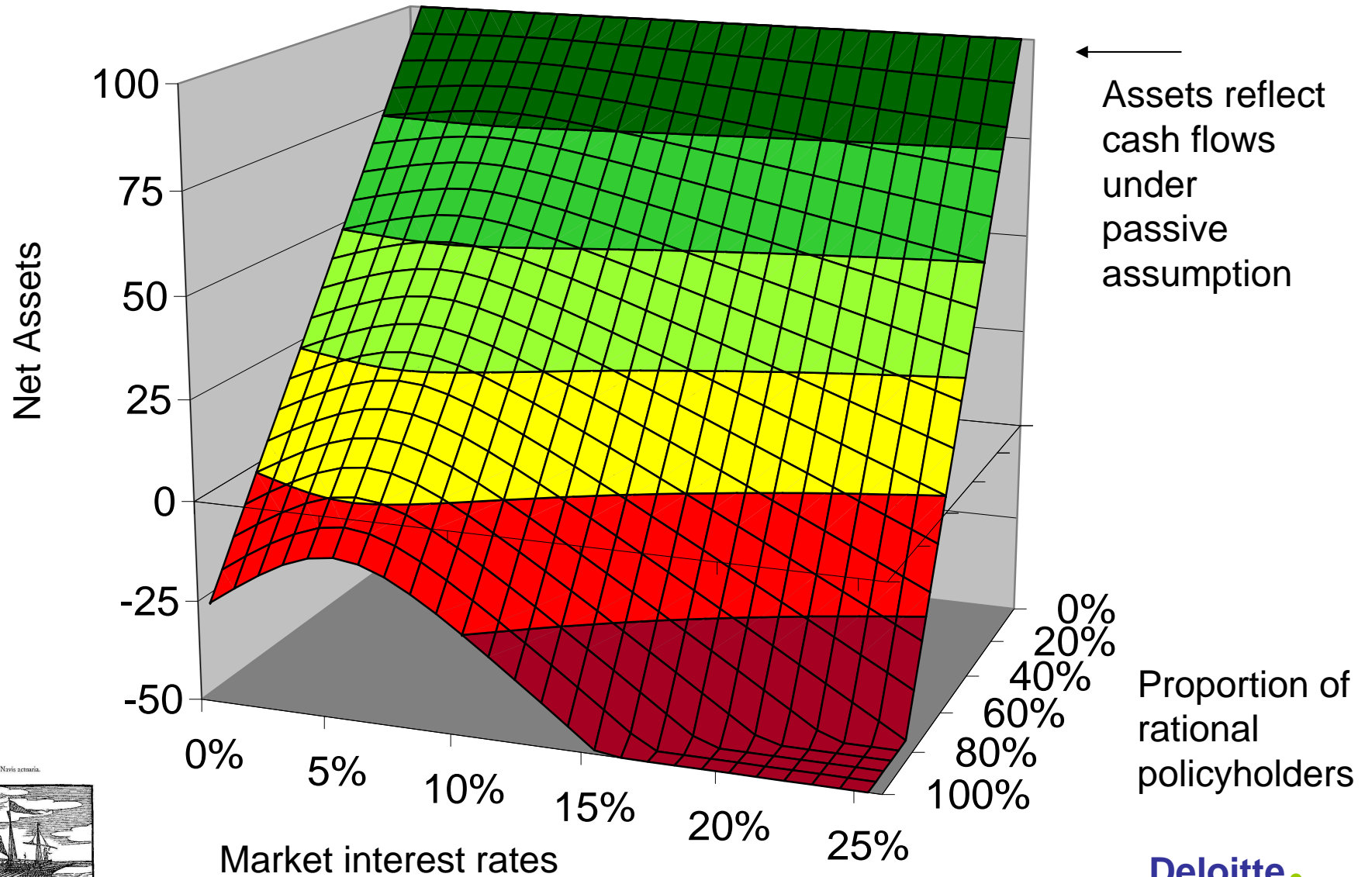
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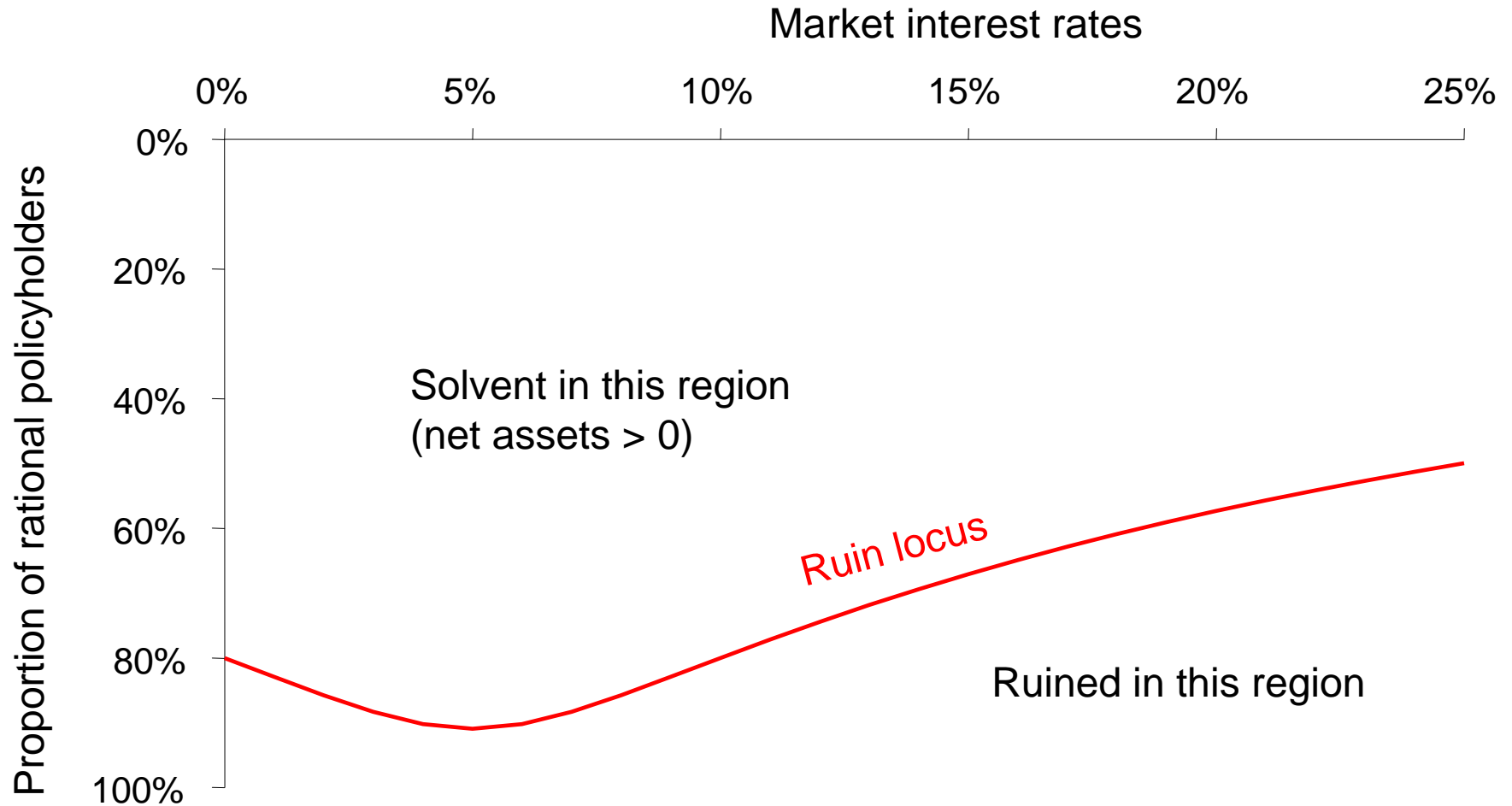
Market Valuation: Rational Case



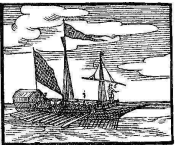
Market Valuation



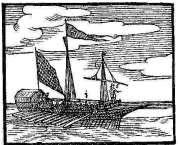
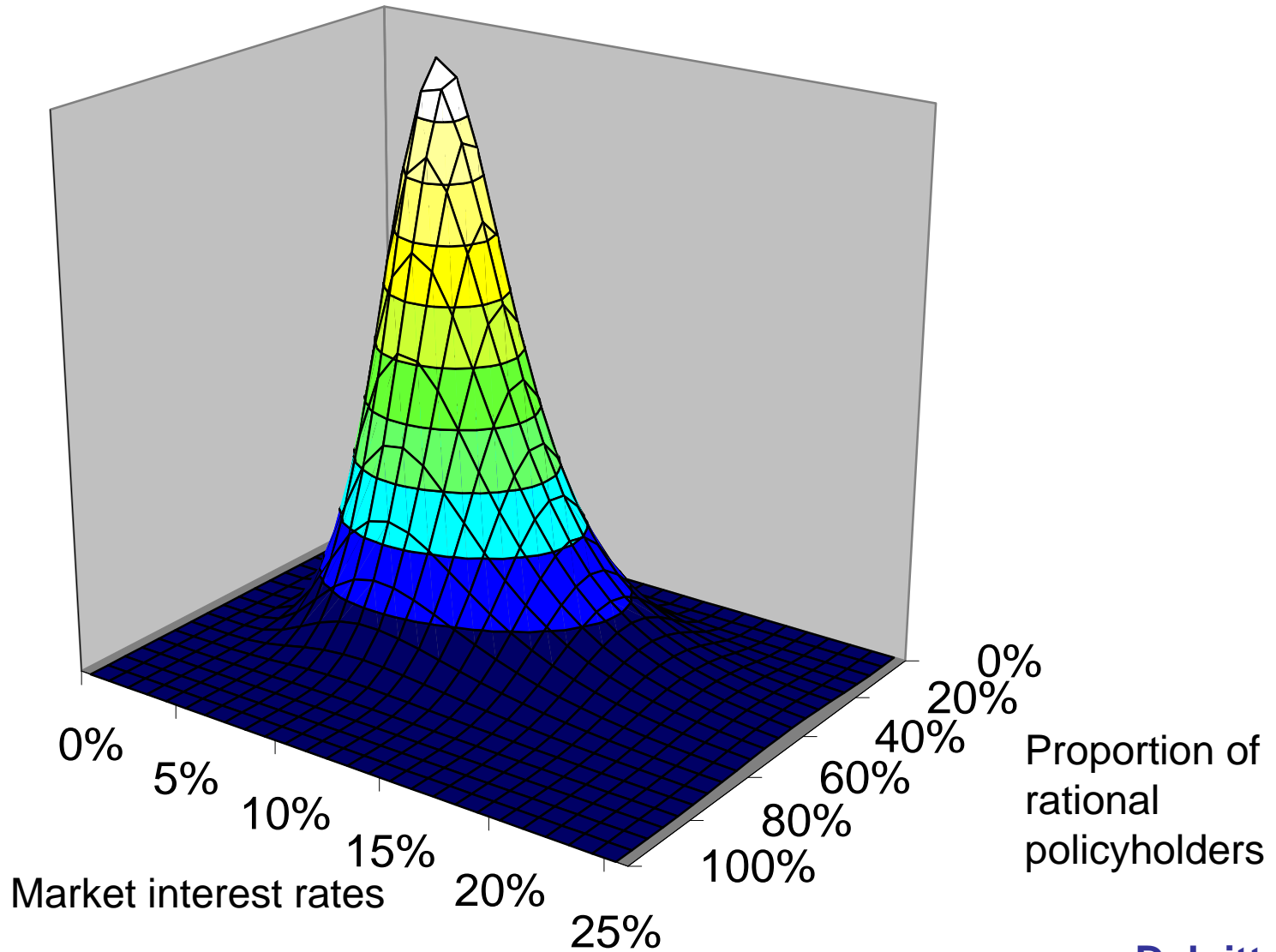
The Ruin Locus



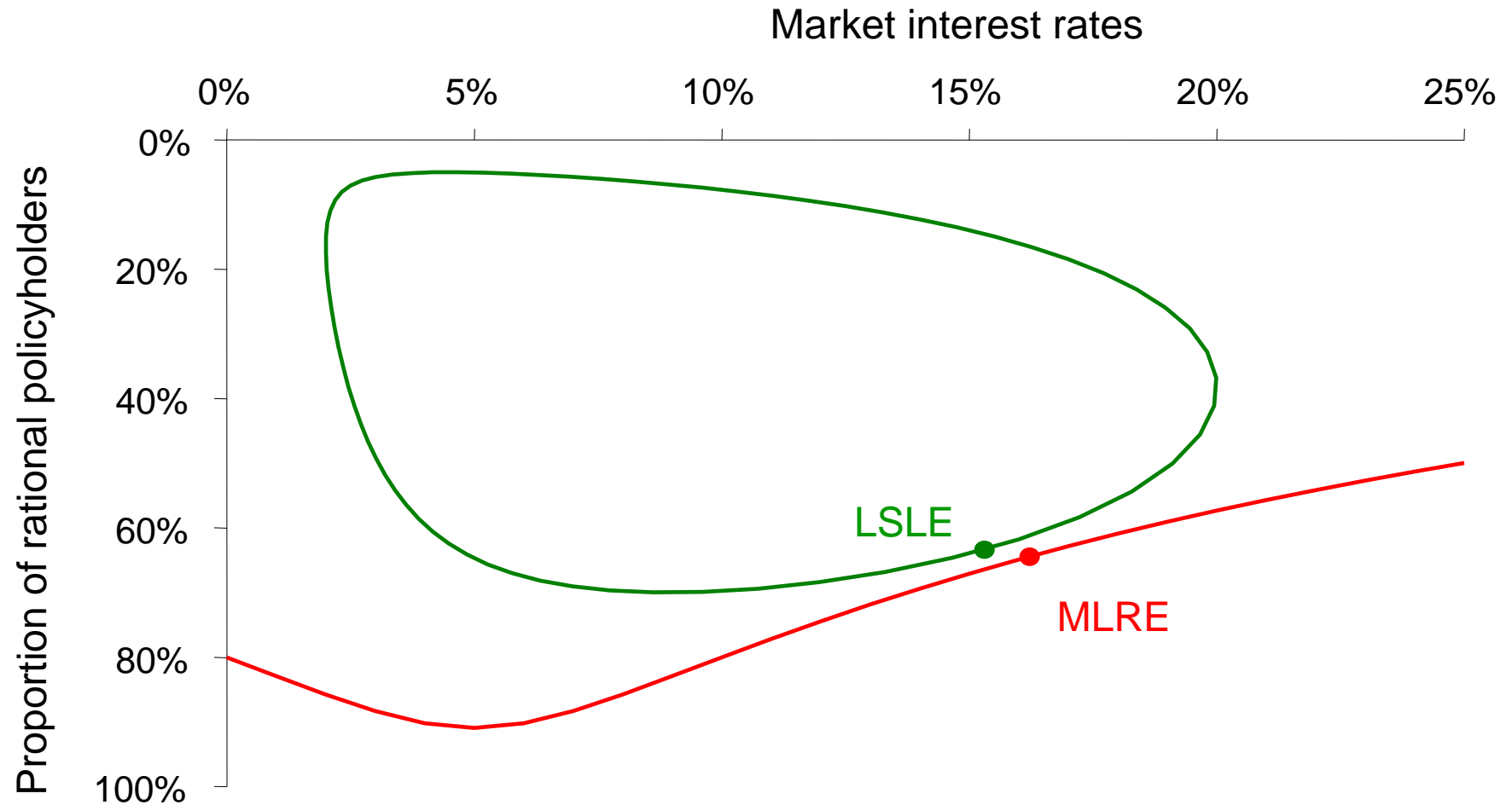
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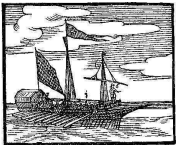
Probability Density Estimate



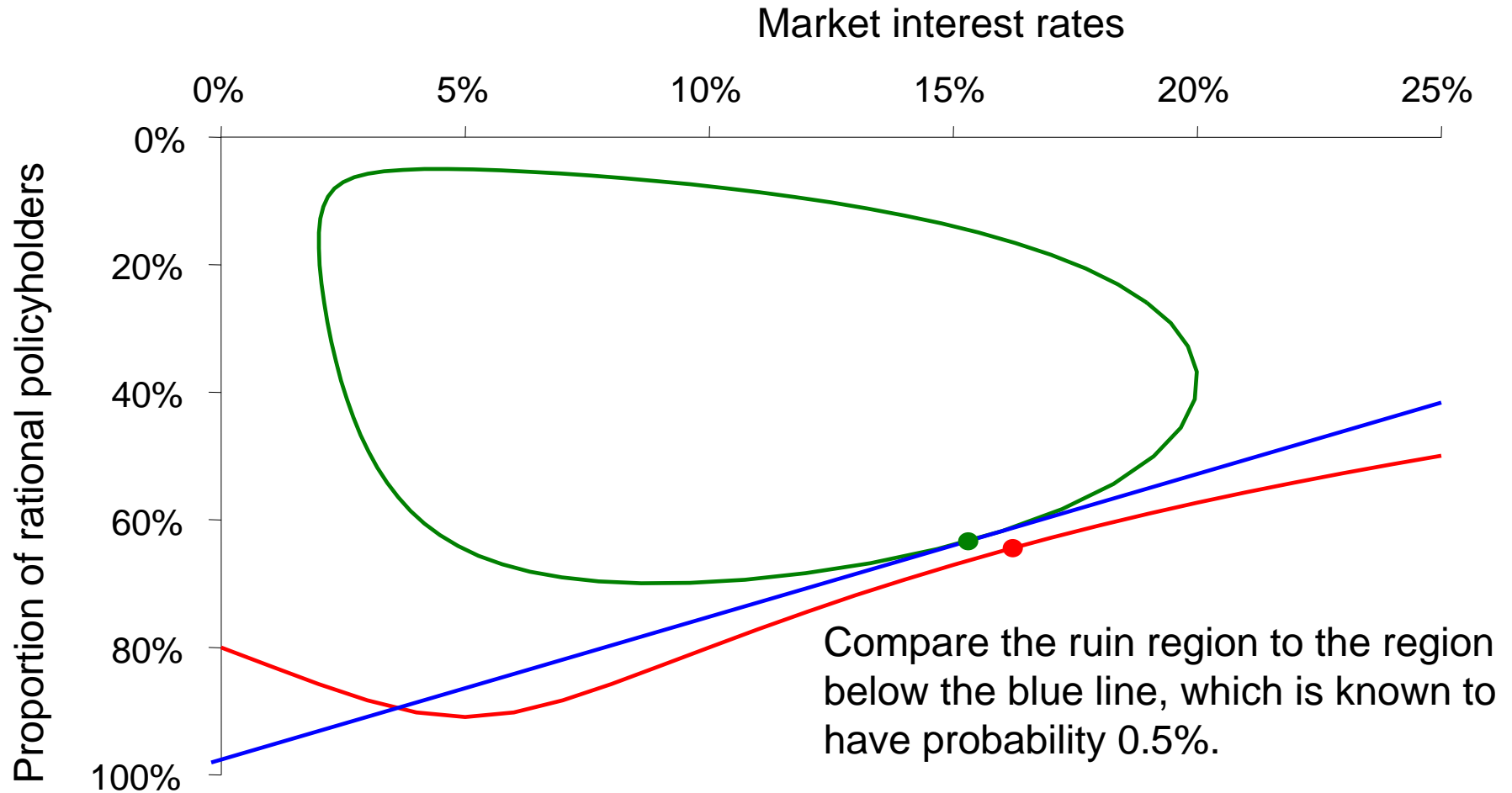
MLRE and LSLE



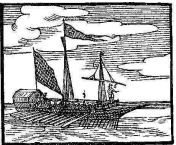
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Estimating Ruin Probability



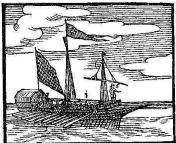
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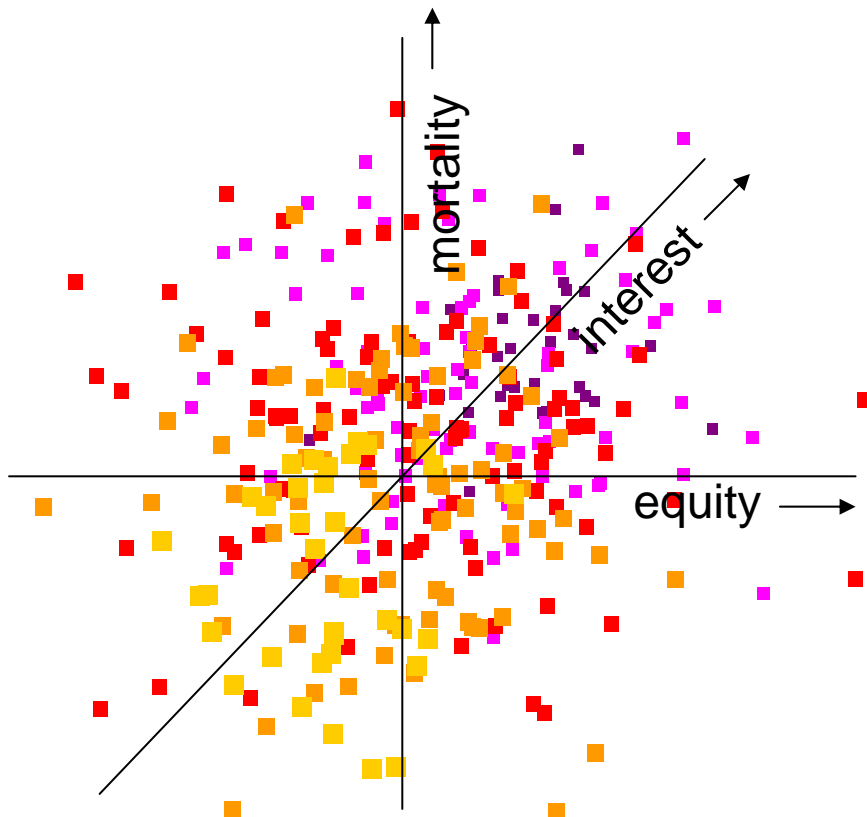
Conclusion

Business Benefits

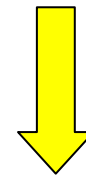
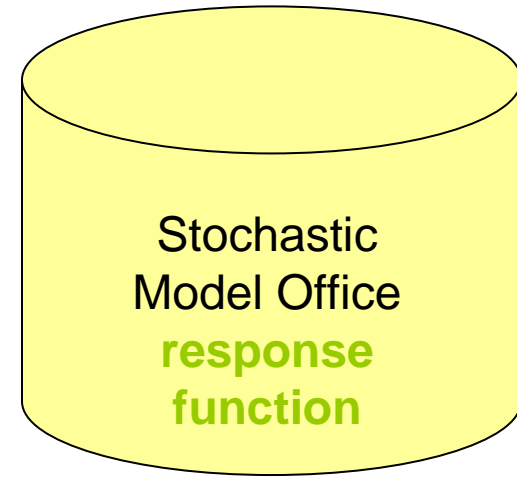
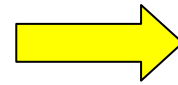
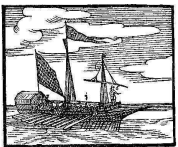
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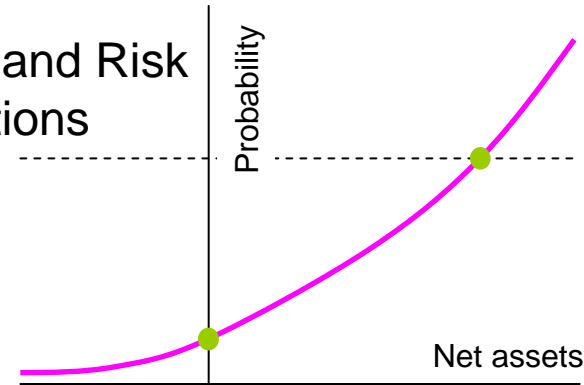
Solvency Model



Stochastically generated
drivers



Capital and Risk
calculations



Computation Approaches

Analytical

Risk metrics approach
Driver distribution is multivariate normal
Response function is linear (or quadratic)
Analytical capital and risk calculations

Risk Geographies

Numerical probability density integration, focusing on the **driver values** with high probability and adverse **response function**.

Monte Carlo

Simulate **driver values** from **driver distribution**
Apply the **response function** to compute net assets for each simulated vector of **driver values**
Analyse the simulated distribution of net assets.

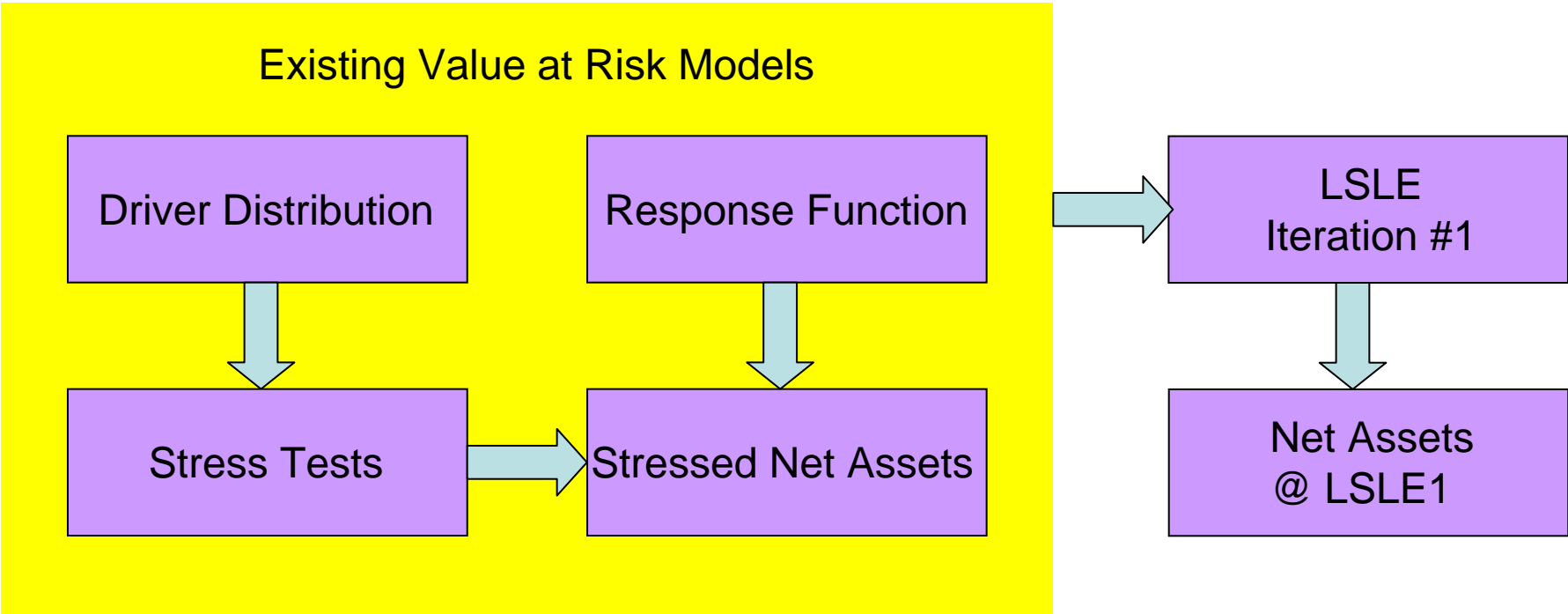


Techniques Comparison

	Risk metrics	Risk Geographies	Monte Carlo ²
Fast run time	●	●	●
Convex response	●	●	●
Add extra drivers	●	●	●
Mid-year effects	●	●	●
Lumpy response	●	●	●
Heavy tails	●	●	●
Copulas	●	●	●
Parameter error	●	●	●
Sampling error	●	●	●



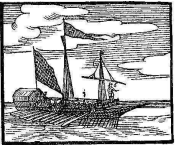
Project Steps



Review
Driver Distribution

Graphical
Explanation

Further
Sensitivities



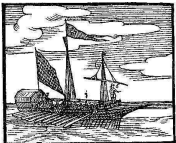
Review
Response Function

Iterate to
LSLE 2

User Benefits

- Accurate assessment of ruin probability.
- Robust calculations of economic capital
- Interactive desktop tool illuminates key assumptions and their importance.
- Clear analysis of costs and benefits of hedging, reinsurance and other risk management initiatives, extending existing cash flow and valuation models.
- Intuitive scenario-based risk communication.
- Respond confidently to questions about operational risk, heavy tails and correlations under stressed situations.
- Step-by-step transition from the correlation approach to the Risk Geographies approach.

Navis zentaria.



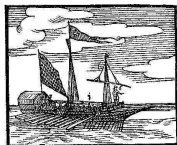
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Risk Geographies

výklad a výpočet rizikového kapitálu

Andrew D Smith

14 listopadu 2006

AndrewDSmith8@Deloitte.co.uk

Navigační

