

Session CS-E1

Integrated Risk Management Challenges and Opportunities

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A Broad Classification of Insurer Risk

- Asset Risk
 - Investment
 - Credit
 - Operational
- Liability Risk
 - Reserve
 - Unearned Premium

Define: Economic Capital =

Actuarial Present Value of Assets
minus
Actuarial Present Value of Liabilities

Insurance Notion of Required Capital

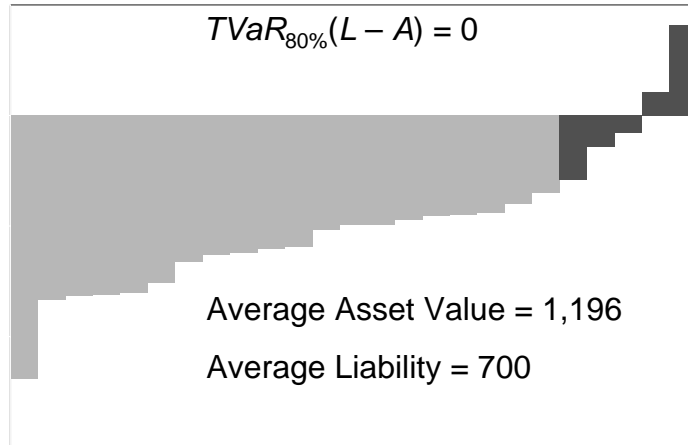
- Needed when costs (e.g. claim payments) exceed premium income.
- Let ρ be a measure of risk – for example:
 - $\rho(X) = E(X) + T \times Std(X)$
 - $\rho(X) = TVaR_\alpha(X)$
 - $TVaR$ means Tail Value-at-Risk
 - $TVaR_\alpha(X)$ = Average of all X 's above α^{th} percentile
- An insurer has sufficient capital if:

$$\rho(L - A) = 0$$

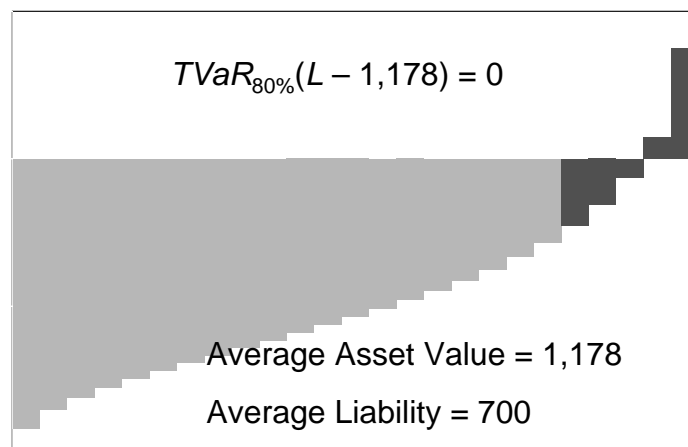
Capital Calculation Example

- Apologies for not using 10,000 scenarios.
- $\rho_{\text{Std}}(L - A)$
 - = Mean + T x Std Dev
 - = (496.18) + 1.536 x 322.97
 - = 0
- $TVaR_{80\%}(L - A)$
 - = Average of top 5 differences
 - = 0

Graphical Representation of *TVaR* Calculation



Graphical Representation of *TVaR* Calculation with Fixed Assets



Capital Management Strategies Move Toward Efficient Frontier

- Risk management strategies
 - Manage concentrations in property catastrophe risk
 - Share investment risk with policyholder
- Correlation strategies
 - Asset/Liability matching
 - Reinsurance
- Other

Challenges and Opportunities

- Parameterization
 - Gather relevant data
 - Fit models
- Implementation
 - Enterprise considerations
- Basel II and UK Internal Capital
 - Opening for new methodologies

Challenge

Quantify Correlation in P/C Insurance

- Formulate model based on parameter uncertainty.
- Test consequences of the model with data from several insurers.

The Common Shock Idea

Multiple Line Parameter Uncertainty

- Select β from a distribution with $E[\beta] = 1$ and $Var[\beta] = b$.
- For each line h , multiply each loss by β .
- Can calculate ρ if desired.

$$Var[X] = E_{\beta}[Var[X|\beta]] + Var_{\beta}[E[X|\beta]]$$

$$Cov[X, Y] = E_{\beta}[Cov[X|\beta, Y|\beta]] + Cov_{\beta}[E[X|\beta], E[Y|\beta]]$$

$$\rho = \frac{Cov[X, Y]}{Std[X] \cdot Std[Y]}$$

Multiple Line Parameter Uncertainty

A simple, but nontrivial example

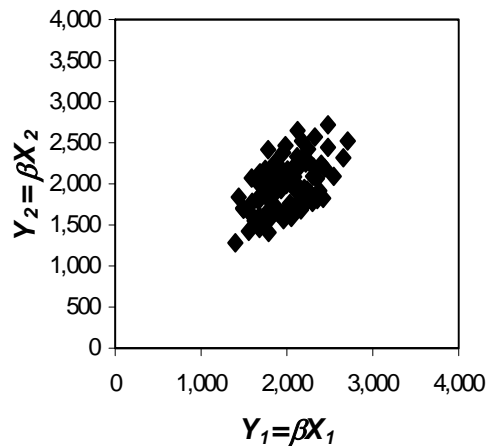
$$\beta_1 = 1 - \sqrt{3b}, \beta_2 = 1, \beta_3 = 1 + \sqrt{3b}$$

$$\Pr\{\beta = \beta_1\} = \Pr\{\beta = \beta_3\} = 1/6 \text{ and } \Pr\{\beta = \beta_2\} = 2/3$$

$$E[\beta] = 1 \text{ and } \text{Var}[\beta] = b$$

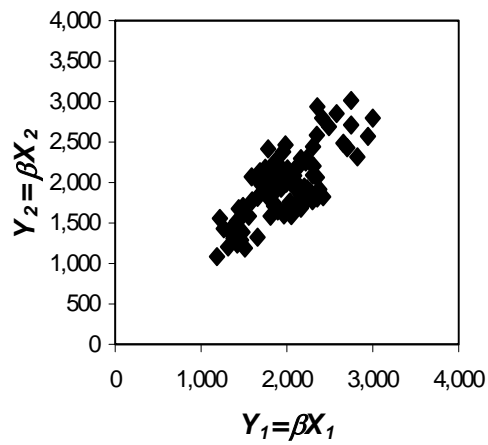
X_1 and X_2 – Low Volatility

$$b = 0.01 \quad r = 0.50$$



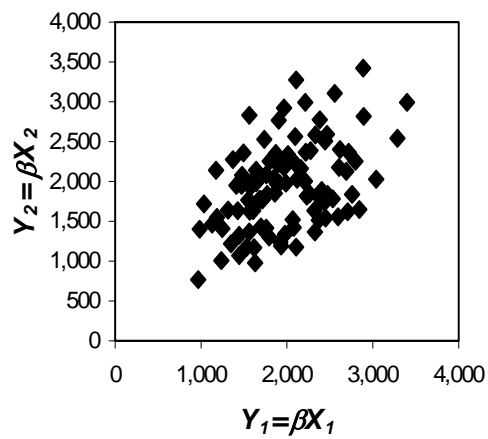
X_1 and X_2 – Low Volatility

$$b = 0.03 \quad r = 0.75$$



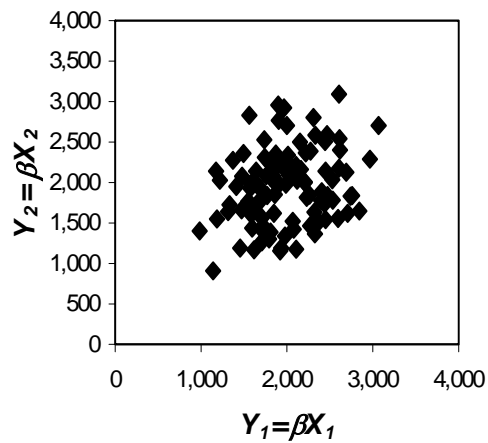
X_1 and X_2 – High Volatility

$$b = 0.03 \quad r = 0.45$$



X_1 and X_2 – High Volatility

$$b = 0.01 \quad r = 0.25$$



Correlation Depends Upon

- The volatility of the common shocks
- The volatility of the lines of insurance
- Which in turn depends upon the
 - Claim severity distribution
 - Claim count distribution and the ***size of the insurer***

Line of Insurance Volatility The Collective Risk Model

- Select χ from a distribution with mean 1 and variance c .
- Select claim count N from a Poisson distribution with mean $\chi \cdot \lambda$.
- For each claim
- Select a claim size from a distribution with mean μ and standard deviation σ .
- Total loss = Sum of all N claims

Additional Assumptions of the Collective Risk Model

- The size of the risk is proportional to the expected claim count, λ .
- The parameters of the claim severity distribution, μ and σ , are the same for all risk sizes.
- The contagion parameter, c , is the same for all risk sizes.
- *We will test assumptions below.*

Implications of Assumptions

- Behavior of loss ratio as risk size increases

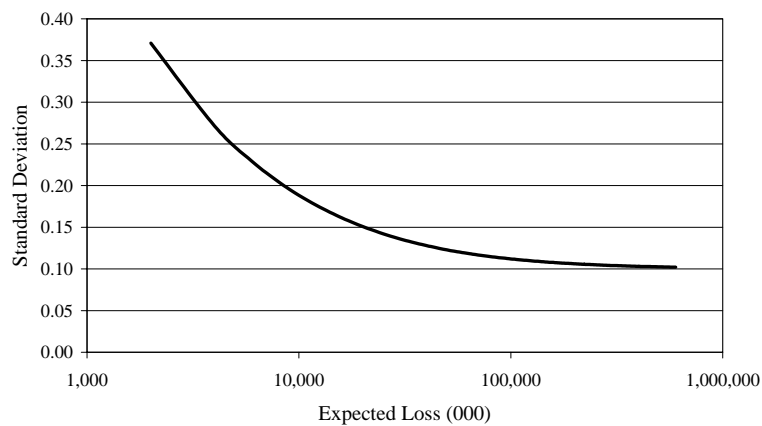
Standard Deviation $[R]$

$$= \frac{\lambda \cdot (\sigma^2 + \mu^2) + c \cdot \lambda^2 \cdot \mu^2}{\lambda \cdot \mu} \xrightarrow{\lambda \rightarrow \infty} c$$

Implications of Assumptions

Loss Ratios for the Collective Risk Model

$\mu = 15,000$ $\sigma = 60,000$ $c = 0.01$

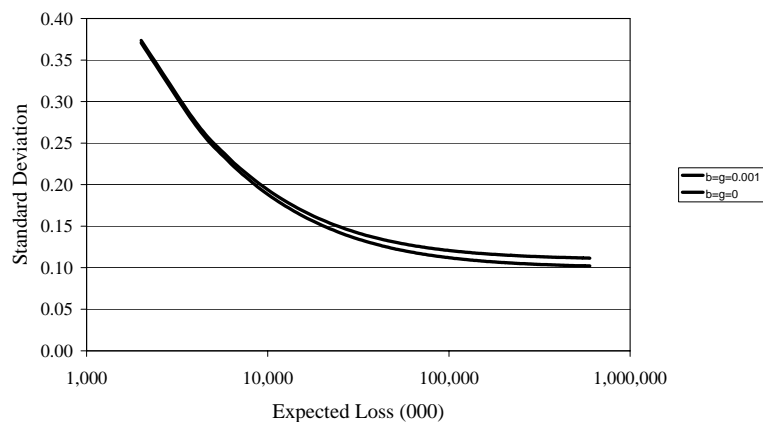


Introduce Common Shocks Across Lines of Insurance

- For claim count
 - α , where $E[\alpha] = 1$ and $\text{Var}[\alpha] = g$
- For claim severity
 - β , where $E[\beta] = 1$ and $\text{Var}[\beta] = b$
- Assume:
 - b and g are the same for all risk sizes
 - b and g are the same for all lines of insurance
 - I back off on this one in general, but I think it is good for the examples that follow.

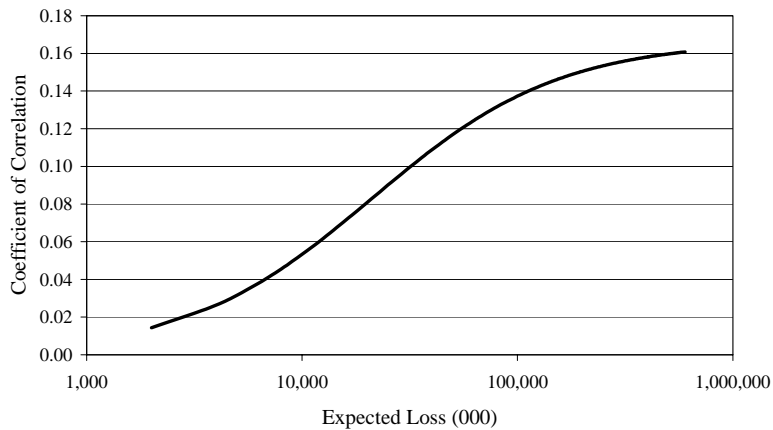
Effect of b and g on loss ratio

Loss Ratios for the Collective Risk Model
 $\mu = 15,000$ $\sigma = 60,000$ $c = 0.01$



Effect of b and g on correlation

Loss Ratios for the Collective Risk Model
 $\mu = 15,000$ $\sigma = 60,000$ $c = 0.01$ $b = g = 0.001$



Does Correlation Matter?

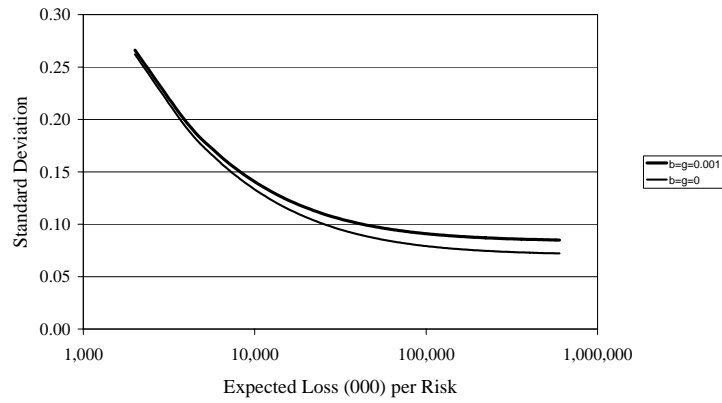
- Consider total loss over n line of insurance
- Look at covariance matrix

$$\begin{pmatrix} \text{Var}[X_1] & \text{Cov}[X_1, X_2] & \dots & \text{Cov}[X_1, X_n] \\ \text{Cov}[X_2, X_1] & \text{Var}[X_2] & \dots & \text{Cov}[X_2, X_n] \\ \dots & \dots & \dots & \dots \\ \text{Cov}[X_n, X_2] & \text{Cov}[X_n, X_2] & \dots & \text{Var}[X_n] \end{pmatrix}$$

- Variance is the sum of n diagonal elements plus $n^2 - n$ off diagonal elements
- For large n , even small correlations matter.

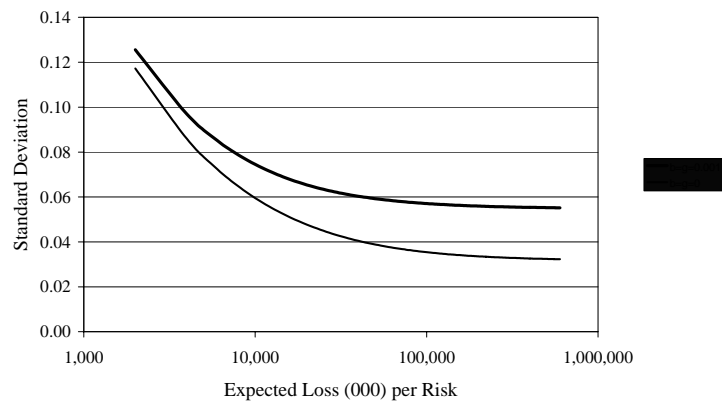
Effect of correlation with two lines

Loss Ratios for the Collective Risk Model for the Sum of Two Risks
 $\mu = 15,000$ $\sigma = 60,000$ $c = 0.01$



Effect of correlation with ten lines

Loss Ratios for the Collective Risk Model for the Sum of Ten Risks
 $\mu = 15,000$ $\sigma = 60,000$ $c = 0.01$

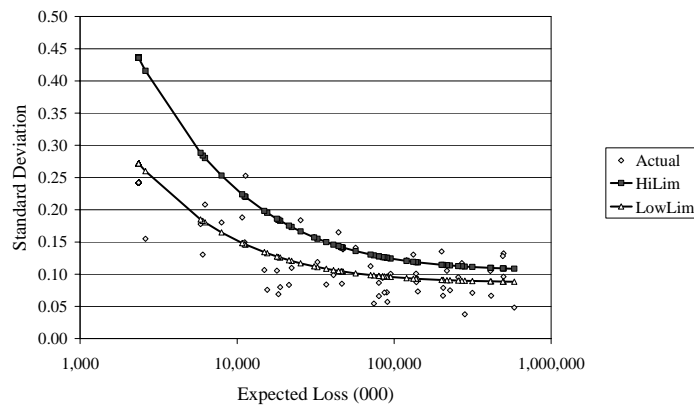


Empirical Tests of Model

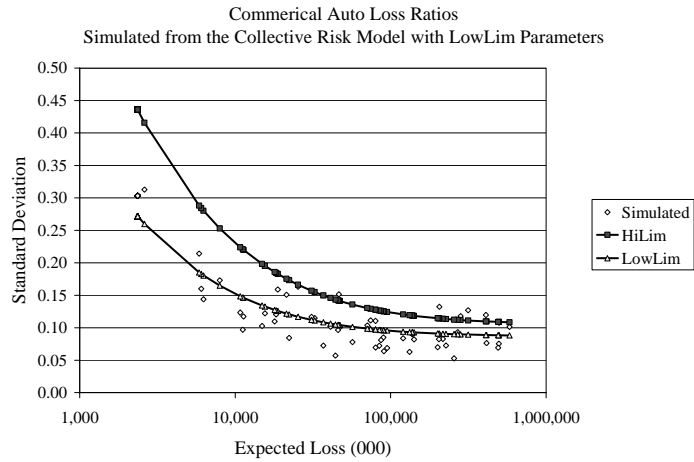
- Schedule P loss ratios for 55 insurers
 - Remove “predictable” changes over time
- Difficulties
 - Catastrophes
 - Loss development understates ultimate variability
 - Reinsurance is probably more prevalent for smaller insurers.
- Used auto (commercial and personal) lines
 - Not as affected as other lines by these difficulties

Model predicts how the standard deviation of the loss ratio decreases with insurer size

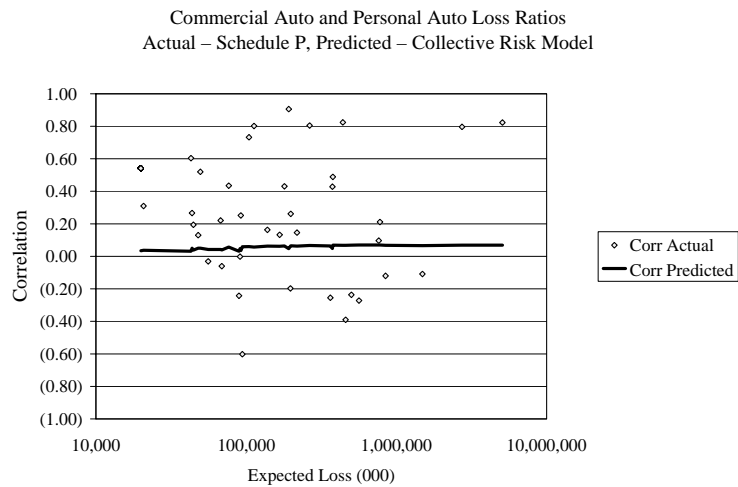
Commercial Auto Loss Ratios
Actual - Schedule P, HiLim and LowLim from Collective Risk Model



Use model to simulate loss ratios based on actual insurer sizes

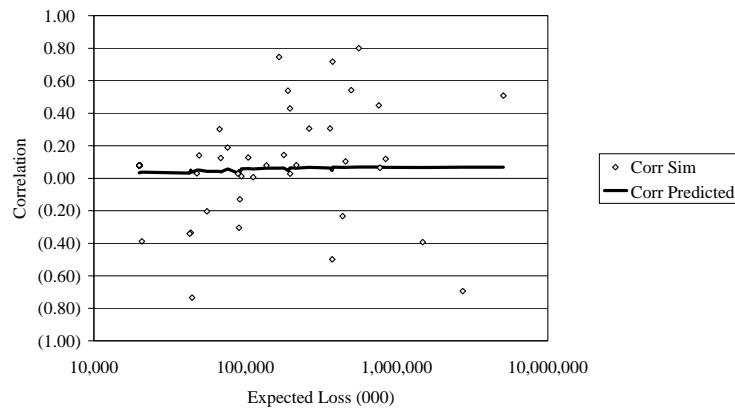


Model predicts that the coefficient of correlation will increase with insurer size



Model predicts that the coefficient of correlation will increase with insurer size

Commercial Auto and Personal Auto Loss Ratios
Simulated and Predicted from the Collective Risk Model



Model predicts that the coefficient of correlation will increase with insurer size

Discussion of the above slides

- The plot of actual vs predicted is at best a weak confirmation.
- The plot of simulated vs predicted shows we should not expect anything more than a weak confirmation.
- Further analysis is necessary.
- Add the assumption that common shocks affect all insurers simultaneously.

Further Analysis

- Let $R=X/E[X]$
- A consequence of the model is that:

$$E[(R_1 - 1) \cdot (R_2 - 1)] = \frac{\text{Cov}[X_1, X_2]}{\lambda_1 \cdot \mu_1 \cdot \lambda_2 \cdot \mu_2} = b + g + b \cdot g$$

- The average of empirical $(R_1 - 1) \cdot (R_2 - 1)$ products is independent of insurer size.

Further Analysis

$$\rho[R_1, R_2] = \frac{E[(R_1 - 1) \cdot (R_2 - 1)]}{\text{Std}[R_1] \cdot \text{Std}[R_2]}$$

- We have already demonstrated that the standard deviation of loss ratios decrease with size.
- We can then conclude that ρ increases with size if the numerator does not also decrease with size.

Further Analysis

- Data gathered
 - r_1 and r_2 and associated expected losses were taken for same year and different insurers
 - 15,790 pairs
- Did a regression of $(r_1 - 1) \cdot (r_2 - 1)$ against average expected loss.
- Slope = 1.95×10^{-10} (not negative)
 - Increasing coefficient of correlation is consistent with Schedule P data.

Estimating $b + g + b \cdot g$

$$E[(R_1 - 1) \cdot (R_2 - 1)] = \frac{\text{Cov}[X_1, X_2]}{\lambda_1 \cdot \mu_1 \cdot \lambda_2 \cdot \mu_2} = b + g + b \cdot g$$

- To estimate $b + g + b \cdot g$, take the average of the 15,790 $(r_1 - 1) \cdot (r_2 - 1)$ products.
- Average = 0.00054

Statistical Significance

- Standard statistical tests of significance do not apply.
 - Non uniform variance of loss ratios
 - Non normality of loss ratios
- Test hypotheses by simulating null hypothesis.
 - Use insurer size (as measured by expected loss) as input
 - Loss ratios have lognormal distribution
 - Did 200 simulations

Results of Hypothesis Test

- H_0 : Slope of regression = 0
- H_1 : Slope of regression < 0
- Did 200 simulations under the null hypothesis
- Slope of 1.95×10^{-10} is out of any critical region for H_1 since it is positive.
- The actual slope was below 49 of the 200 simulated slopes – not that unusual for H_0 .

Results of Hypothesis Test

- $H_0: b + g + b \cdot g = 0$
- $H_1: b + g + b \cdot g > 0$
- Estimate = 0.000540
- Top estimate from a simulation derived from $H_0 = 0.000318$
- Positive correlation consistent with Schedule P data.

Summary of Results

This version of the collective risk model

- c is the same for all risk sizes
- b and g generate correlation

is consistent with Schedule P data.

- I think of this as a first order approximation. I would not be surprised to see more refined versions.
- But – It takes a lot of data to test statistically.
- And – The results do have consequences!

Relevance

- IAA Solvency Subcommittee and “Blue Book”
 - Standard conservative formula for capital requirements.
 - Optional use of *internal model* for capital. This model will be subject to regulator standards and audit. Standing of judgmental correlations?
- Progress on new capitalization standards
 - Swiss are well on their way
 - EU is also moving in this direction
 - US is uncertain
 - More on this from Dan

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Agenda

- “ERM by regulation” – new regulatory regimes
 - Basel II; UK ICA, Swiss Solvency Test, Dutch Adequacy Test
- Basel II and bancassurance
 - case study: large European bancassurer
- Case study: the Internal Capital Assessment of UK life insurers
 - the imperative of stochastic risk modelling
 - the challenge – and benefit – of risk aggregation
- Implementation challenges – learning from banks

New regulatory regimes – challenges and opportunities

Basel II refresher

- For the first time:
 - credit risk can be assessed with internal models
 - operational risk needs to be assessed
 - market, credit and operational risks are assessed *together*
- It's not only for banks: insurance companies get mentioned, too – albeit in relation to banks
- There is more for insurance in Basel II!
- Trillion euro question: who should regulate occupational pension funds?

UK Internal Capital Assessment

- First assessments due at the end of 2004
- Risk capital is to be assessed internally by each insurer
- Internal stochastic models are encouraged
- Risk diversification is rewarded with reduced capital requirement
- The Financial Services Authority reviews all assessments
- Assessments that are judged not to be of a sufficient theoretical and empirical standard are subject to an Individual Capital Guidance issued by the FSA
- The time horizon of the assessment is one year or three to five years, as appropriate for the business

Swiss Solvency Test

- Market-consistent valuation of assets and liabilities, including all embedded options and financial guarantees
- Standard model + ability to override it with an internal model if the supervisor is satisfied that this is more suitable than the standard model for assessing company's risk capital
- Compatible with the principles of Solvency II in allowing the use of internal models
- Expected shortfall is the risk measure
- The time horizon is one year

Dutch Adequacy Test

- A suite of tests:
 - a Minimum Test: at the time of testing, technical provisions must exceed the actual value of liabilities
 - a Solvency Test: that there is an adequate probability of enough capital being available to absorb risks over a period of one year
 - a Continuity Test: that over the long term, risk capital falls within a range that allows an institution to absorb financial setbacks without major changes to its strategic investment policy
- The Dutch Adequacy Test is work in progress

Banking and insurance in Europe

- Many banks have tried to add value by adding insurance products to their offering, but only some have succeeded

Proportion of group profits/revenue derived from insurance activities

Banking group	Total	Insurance contribution	
		amount	percent
RBS	£ 8,101m	£ 862m	11%
HBoS	£ 4,770m	£ 1,067m	22%
Credit Agricole*	€ 13,510m	€ 2,800m	21%
Santander	€ 4,609m	€ 2,102m	46%
Fortis	€ 3,358m	€ 1,599m	48%
Credit Suisse*	CHF 12,241m	CHF 6,120m	50%

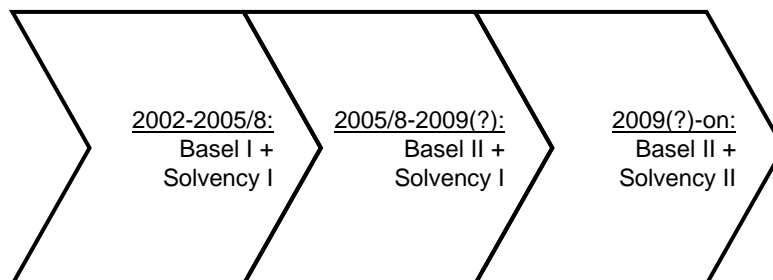
* revenue rather than profits

Basel II challenge to bancassurance

- Bancassurers will have to separate their banking- and insurance-linked capital
 - so far, double counting of capital has been technically permitted, insurance reserves counting as group (risk) capital
- The bancassurance model has led in many cases to rapid expansion of group activities
 - some groups may find themselves under-capitalized under the new rules
- Recognising capital utilisation at divisional level can lead to a reorganisation of insurance business:
 - create an insurance joint venture and find a partner
 - sell off some businesses, retain others – but which?
 - what is the time scale of the re-organisation process?

Europe-wide regulatory regimes

- Bancassurers are subject to a dual regulatory regime
- Internal models of risk capital are permitted in the “new” regimes, Basel II and Solvency II
 - VaR has been allowed since Basel I got amended in 1996
 - Solvency II is very much work in progress!



Case study: a large European bancassurer

Calculation assumptions

- RegK is calculated first as prescribed by current regulation
 - no diversification credit allowed
 - internal models – 10-day VaR – for market risk
 - Advanced Internal Ratings Based Approach for credit risk
 - Standardised Approach for operational risk
 - Solvency I for P/C and Life insurance
- The alternative method for Life insurance
 - calculates 10-day market VaR of the asset portfolio, with two alternative volatility assumptions:
 - unhedged portfolio, with full income and “market” volatility
 - hedged portfolio, with reduced income and volatility as in the Trading Book
 - assumes negligible credit (default) risk
 - uses the Basel II Standardised Approach for operational risk
 - calculates the longevity risk capital according to Solvency I, as a percentage of technical reserves

Calculation parameters

	Calculation parameters					
	PD	R (pool correlation)	LGD	b (maturity adjustment)	M /y (effective maturity)	β
Retail Banking	0.10%	0.04	50%			12%
Retail Mortgages	0.10%	0.15	5%			12%
Commercial Banking	0.06%	0.24	50%	0.28	1.0	15%
Asset Management						12%
	confidence level		annual volatility		horizon /d	
Trading & Sales	99%		5%		10	18%
P/C Insurance						
Life Insurance						
alternative 1	99%		10%		10	15%
alternative 2	99%		5%		10	15%

Capital utilisation

	Commission and fees	Interest or transaction income	Technical reserves	Risky Assets	Regulatory Capital				Total RegK	Income /RegK
					Mkt.	Credit	Op.	Ins.		
Retail Banking		218		8,500		20	26		47	4.7
Retail Mortgages		1,430		55,860		53	172		225	6.4
Commercial Banking		2,683		104,800		1,229	402		1,631	1.6
Asset Management	1,521			128,000			182		182	8.3
Trading & Sales	279	884		23,500	545		209		754	1.5
	Tech. result									
P/C Insurance	620		10,209					408	408	1.5
Life Insurance*	820	3,470	69,080					2,763	2,763	1.6
alternative 1	820	3,470	15,080	54,000	2,502		644	603	3,749	1.1
alternative 2	820	2,031	15,080	54,000	1,251		428	603	2,282	1.2

Figures in EUR millions (except Income/RegK)

* assuming no pensions and annuity business, and hence no longevity risk

Case study conclusions

- The new regulatory regimes facilitate a clear analysis of capital utilisation
- Changing the calculation method changes the result (regulatory capital, and hence Income/RegK)
 - in our case study, Life insurance is more capital-efficient under Solvency I than under a Basel II - like regime
 - under Solvency I P/C insurance seems relatively less efficient and would be a candidate for disposal or reorganisation
 - under Solvency II Life insurance seems the least capital-efficient business
 - corporate action is not the only way: notice the sensitivity of risk capital to the market parameters; portfolio re-engineering could be the solution

Basel II challenges to banking

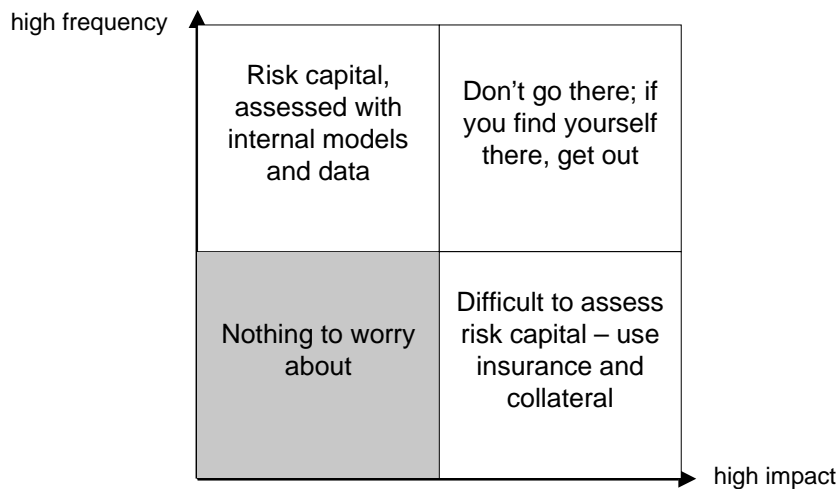
- Banks may find some lending too “costly” in terms of risk capital
 - commodity and project finance
 - high-volatility commercial real estate
 - low- or un-rated borrowers, including emerging countries
- In order to use their own models (IRBA to credit risk, AMA to operational risk), banks will need insurance against one-off losses from:
 - political action
 - large scale fraud, technical failures
 - legal action
 - damages to physical collateral due to fire, storm, etc

Basel II opportunities for insurance

- Risk mitigation permitted under the Accord:
 - collateral
 - netting
 - guarantees and insurance
- Insurers can offer banks protection against a variety of low frequency, high impact risks:
 - P/C insurance to physical collateral, making it eligible as a credit risk mitigant
 - insurance against certain business risks – insurrection, legal action, etc – allowing banks to focus on low impact, high frequency risks that can be priced with bank's own statistical models and data
- Insurers will be for banks what reinsurers are for insurers today

Dividing the risks

From the bank's point of view...



Assessing the opportunity

- Assume that a bank lends 100m to a credit-unrated commodity trader
 - the loan is used to purchase inventory, which is offered as collateral
 - assume that marking to market the collateral yields a 40% risk weighting for this transaction, or 40m of risk-weighted assets
 - the capital charge to the bank is $8\% \times 40\text{m} = 3.2\text{m}$
- An alternative to holding this capital is to purchase insurance
 - assume that the bank insures 30m of the total loan
 - the risk weighting for this AA- rated insurer is 20%
 - the total capital charge to the bank is
$$8\% \times (40\% \times 100\text{m} - 30\text{m}) + 8\% \times 20\% \times 30 = 0.8\text{m} + 0.48\text{m} = 1.28\text{m}$$
- The bank has to “rent” 1.92m capital from the insurer

Case study: the Internal Capital Assessment of UK life insurers

Aggregating risks for a UK life insurer

- Risks involved:
 - mortality
 - lapse
 - economic (taken as largely equity risk, and represented by the changes in the FTSE100)
- Risks ignored:
 - operational risks
 - default risk on ceded reinsurance
- Estimating the correlations
 - pair-wise correlations calculated between data series
 - t-test applied to each result at 95% confidence level
 - each data point represents one degree of freedom
 - if t-test result $> |\rho|$, $\rho = 0$ otherwise

Statistical results on lapse risk

Type of product	Lapse rate statistics					
	Mean	Variability % p.a.		Correlation with FTSE100 returns, ρ	t-test	ρ
		$\sqrt{\text{variance}}$	STDEV			
Life WP	5.0%	1.4%	1.4%	51%	0.42	51%
Life UWP	19.1%	10.0%	10.1%	51%	0.42	51%
Pensions WP	2.9%	1.5%	1.6%	-26%	0.48	0
Pensions UWP	6.9%	3.3%	3.4%	25%	0.48	0
Investment UL	8.3%	2.2%	2.2%	8%	0.49	0

Statistical results on longevity risk

Population	Death rate			Amounts death rate versus lives death rate		
	Mean	Variability, % p.a.		Mean	Variability, % p.a.	
		$\sqrt{\text{variance}}$	STDEV		$\sqrt{\text{variance}}$	STDEV
Portfolio1 – All lives	3.0%	0.2%	0.2%	98%	6.6%	6.8%
Portfolio1 – Males	3.2%	0.1%	0.1%	89%	5.0%	5.1%
Portfolio1 – Females	2.0%	0.4%	0.5%	152%	31%	32%
Portfolio2 – All lives	2.0%	0.6%	0.7%	88%	8.8%	9.4%

Model life insurance firm

- Risk factors included:
 - changes in equity prices
 - changes in property prices
 - default risk on ceded reinsurance
 - settling misselling claims
- Risk factors ignored:
 - fixed interest factors: risk-free rates, credit spreads
 - many types of operational risk
 - underwriting risks: mortality, morbidity, lapse, property and casualty risks

Risk definitions

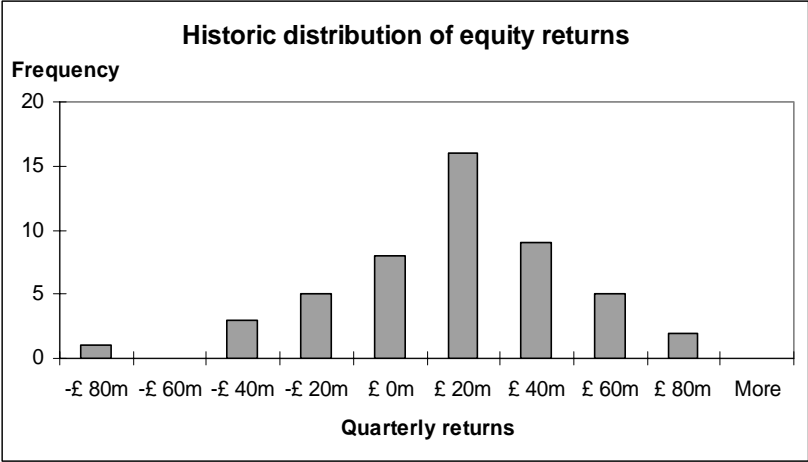
- **Equity risk:**
 - exposure equals the market value of the equity portfolio at the beginning of the period
 - risk factor period return equals that of FTSE 100
- **Property risk:**
 - exposure equals the market value of the property portfolio at the beginning of the period
 - risk factor period return equals that of Halifax HPI
- **Default risk on ceded reinsurance**
 - exposure equals ceded reinsurance
 - probability of default x recovery rate approximately equals the spread on the bonds issued by the reinsurer
- **Legal risk: having to settle misselling claims**
 - exposure is defined as total sales across the product range
 - loss is defined as exposure x industry average misselling rate x the average amount of compensation per claim settled

Model firm exposure to different risks

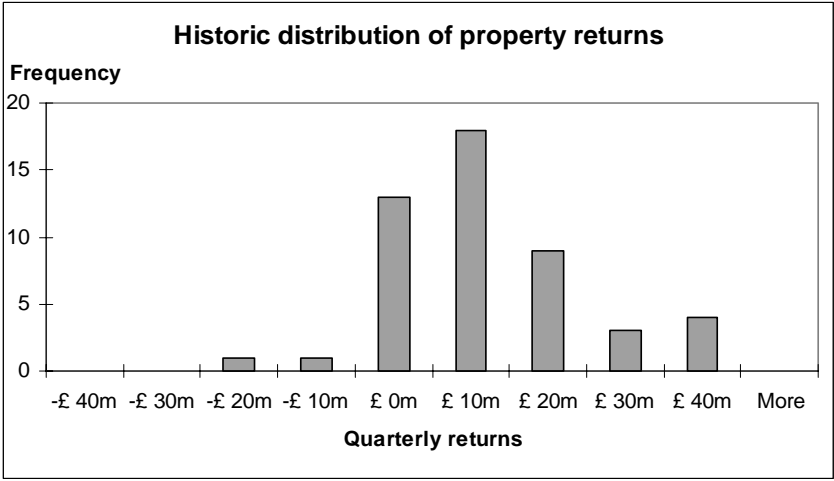
Risk factor	Equity risk	Property risk	Reinsurer default	Misselling compensation
Exposure (2003)	£ 400 m	£ 500 m	£ 300 m	£ 570 m

- The company sold 8,100 pension contracts in 2003
- Average compensation (industry-wide) has recently been £4,000 per claim
- The probability of a successful claim for this product is taken to be 50%
- Company's pension sales varies from year to year and is assumed to be a fixed share of the industry-wide life sales
 - hence exposure to misselling claims varies with industry-wide life sales

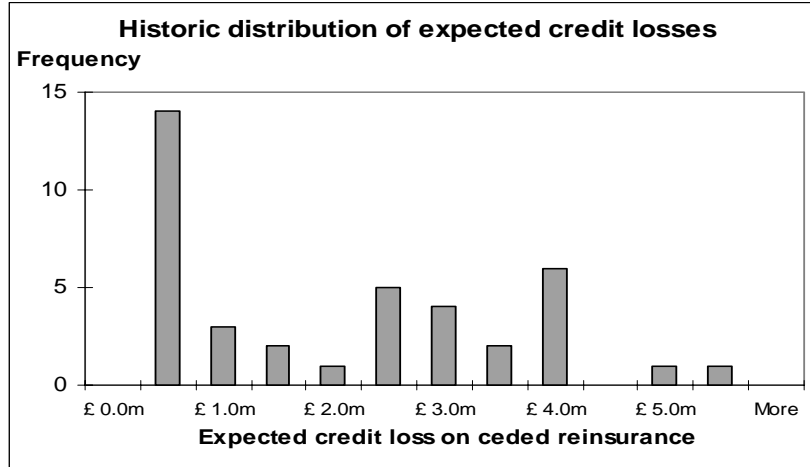
Distribution of equity returns



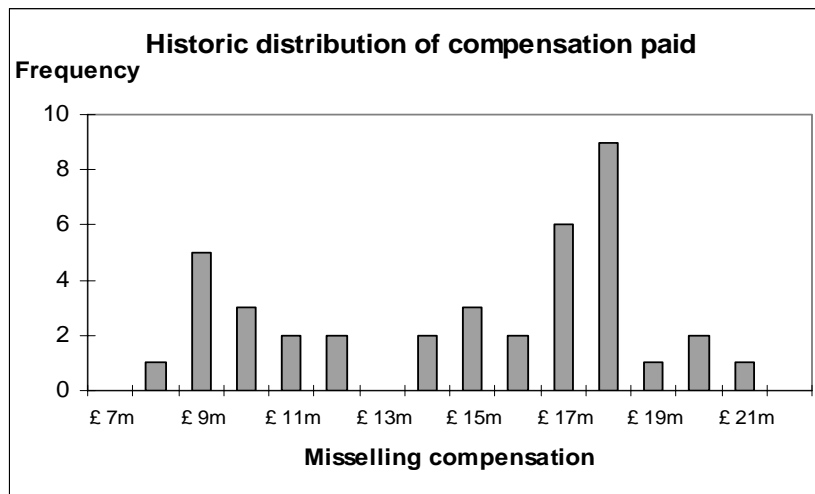
Distribution of property returns



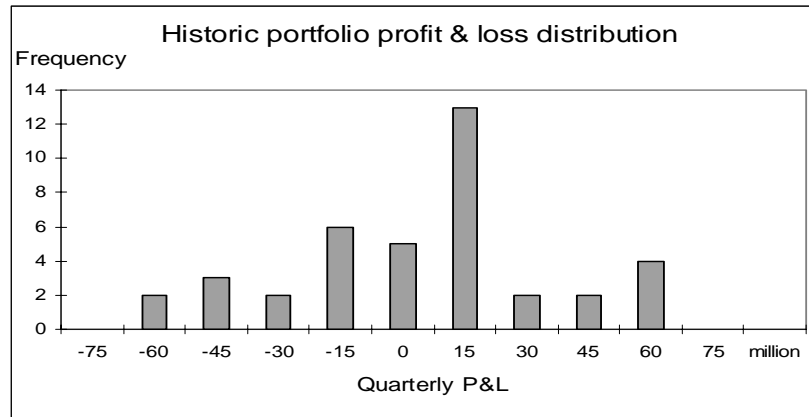
Distribution of default risk



Distribution of misselling losses



Distribution of firm's total P&L



Total P&L for each period is the sum of all losses incurred during that period across all risk factors

Portfolio risk capital

- Gaussian *conditional* distributions of risk factor returns with *dynamic* variances and covariances
- Variance and covariance are forecast as exponentially-weighted moving averages, rather than their long-term simple averages
- Main advantages:
 - method copes well with fat tails
 - ease of implementation
 - other forecasting models are possible: simple moving averages, GARCH, stochastic volatility
- Limitations:
 - risk capital is sensitive to the business cycle, which is not necessarily agreeable to regulators
 - distributions are still assumed to be symmetric: tolerable for most asset returns, not so for default risk and some operational risks

Time-stability of risk measures

Period	Annual return volatilities			Return correlations		
	Equity	Property	Credit	Eq.-Prop.	Eq.-Cr.	Prop.-Cr.
Sep'91 – Mar'94	12.9%	3.7%	n/a	-22%	n/a	n/a
Apr'94 – Dec'96	6.7%	2.9%	1.0%	-35%	-3%	-9%
Jan'97 – Jun'99	17.5%	3.4%	1.0%	-22%	45%	-58%
Jul'99 – Dec'01	15.0%	3.5%	0.9%	10%	18%	-39%
Jan'02 – Sep'03	20.3%	3.5%	0.8%	-10%	10%	-57%
Overall	15.6%	5.0%	1.0%	-26%	23%	-44%
Forecast in Sep'03	21.4%	7.6%	0.9%	n/a	n/a	n/a

Correlation of losses

- Only negative returns considered
- Correlation is calculated only for periods where there are negative returns in both series
- FTSE100 and HPI: correlation between losses ('91-'04) is -97.7%
- FTSE100 and several overseas equity markets: EU, CH, US, HK
 - daily returns, not quarterly as throughout this study
- Correlation can actually drop during periods of loss, rather than rise

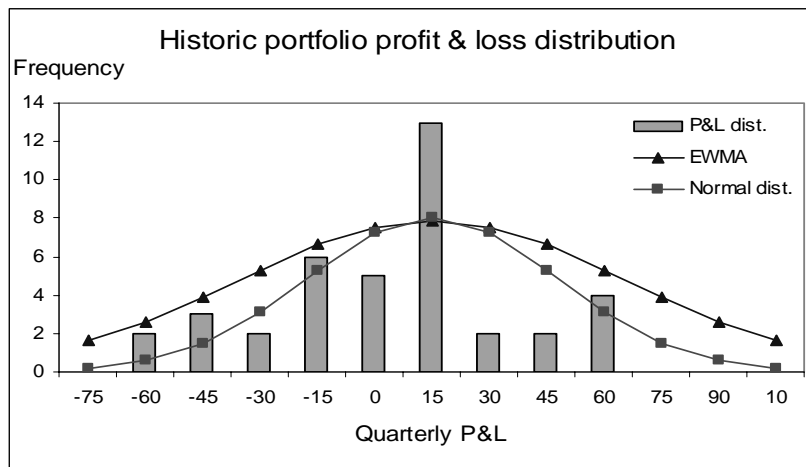
FTSE100 and	Correlation between indices	
	All returns	Losses
STOXX 50	66%	47%
SMI	61%	10%
S&P 500	26%	-21%
HSI	33%	50%

Back testing results

- Past forecasts of risk capital are compared with actual P&L result
- Worst quarter (annualised loss) in 40 ('94 to '04) ~ 97.5% confidence

Method and correlation assumption	Worst loss
-26% correlation equity-property (last 10 years' average)	£ 137 m
-10% correlation equity-property (last 2 years' average)	£ 143 m
50% correlated risks (arbitrary, "conservative" choice)	£ 172 m
100% correlated risks (arbitrary, "safe" choice)	£ 220 m
Dynamic variances, undiversified risk	£ 277 m
Dynamic variances and covariances, diversified risk	£ 258 m
Historic profit and loss distribution	£ 263 m

Tail fit



- "Naive" methods – that assume the volatility and correlation are constant – underestimate tail risk significantly

Implementation – Learning from Banks

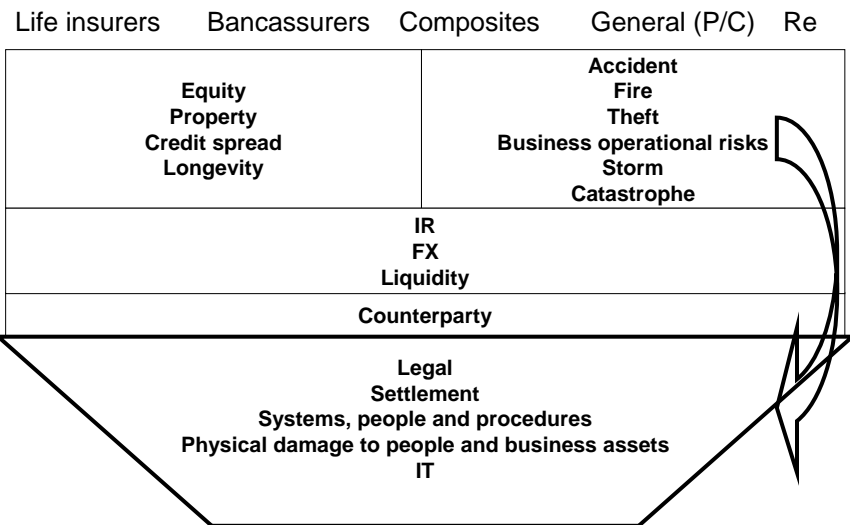
Enterprise Risk Management

ALM	Profitability	FTP
Liquidity Balance Sheet Risk • Interest rate risk • Exchange rates • Liquidity	Risk Management Platform Scenarios, Simulation & Stress Testing • Markets & economics • Customer Behaviour • New Business	Exposure Transaction Risks • Market Risk • Operational Risk • Underwriting Risk
IAS	Compliance	Solvency I/II

Enterprise-Wide Risk



Risk exposure

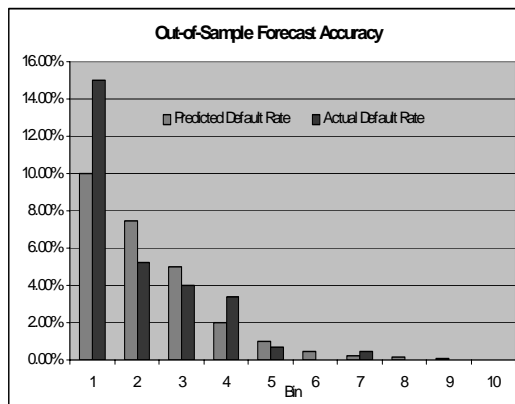


Model Validation Process

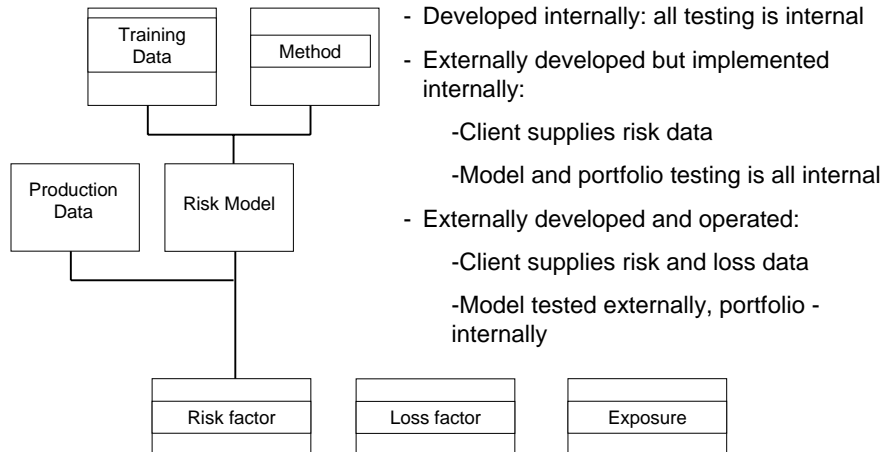
- *Dedicated* validation database is key
- *Validation* of model(s) supported by
 - methodology papers available for review & critique
 - dedicated model validation intranet web site
- *Verification* of statistical results supported by
 - clear documentation of data sources
 - well-designed information systems facilitating replication trials by 3rd parties (regulators??)
- *Ongoing* model re-validation process
- Modelling needs to be done at the same standard across risks

Example output of model validation

Middle-Market Estimation Results			
Logit Model			
Variable	Parameter Estimate	Standard Error	Wald Chi-Square
Intercept	-2.1144	0.0914	534.7040
CFDD	-0.4863	0.0402	146.1575
BSDD	-0.0985	0.0149	43.4494
res_flag	0.6520	0.1191	29.9553
Year_2001	-1.3169	0.1682	61.3314
Year_2000	-0.7762	0.1456	-5.3310
Year_1999	-0.0043	0.1244	-0.0346
Year_1998	0.3421	0.1201	2.8485
Year_1997	0.1123	0.1198	0.9374
Year_1996	0.0237	0.1233	0.1922
Year_1995	0.0196	0.1107	0.0314



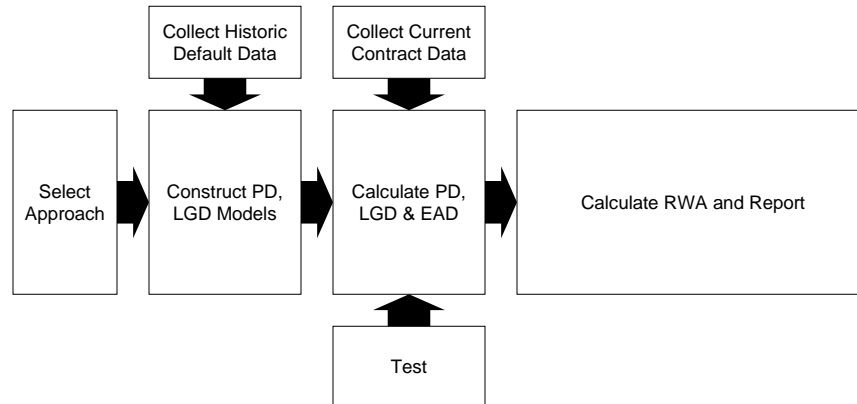
Model stress testing



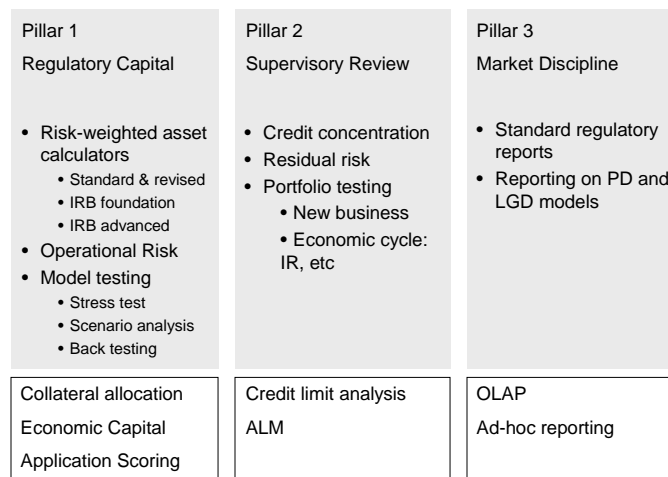
Scenario Analysis

- New business simulation
 - portfolio growth according to strategic and economic criteria
 - capture the business cycle
- Behaviour scenarios
 - customer behaviour models to forecast lapse risk
- Cash flow modelling
 - Interest rate and FX risk
- Exposures forecasting
- Risk scenarios
 - forecast Exposures, as well as Probability and Loss distributions for each risk factor and class of exposure
- The specific needs of insurers:
 - the time horizon and term structure of their liabilities
 - the limitations of (regulatory) point-in-time risk measures

The Basel II “minimum action” map

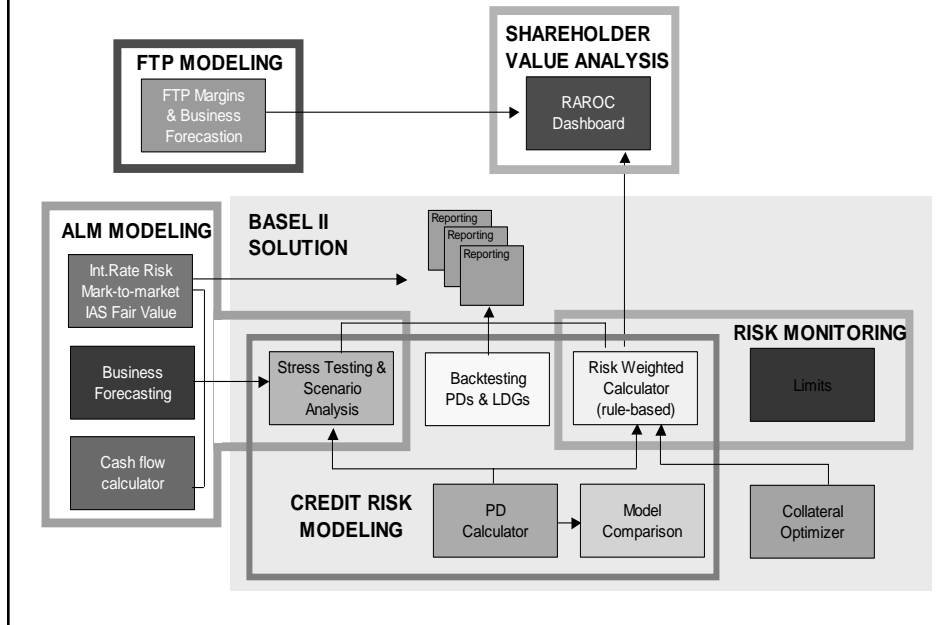


Compliance and Added Value (I)

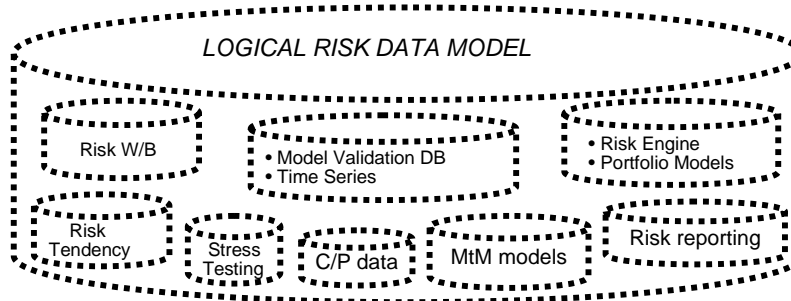


The Almonde Risk Management Platform

Compliance and Added Value (II)

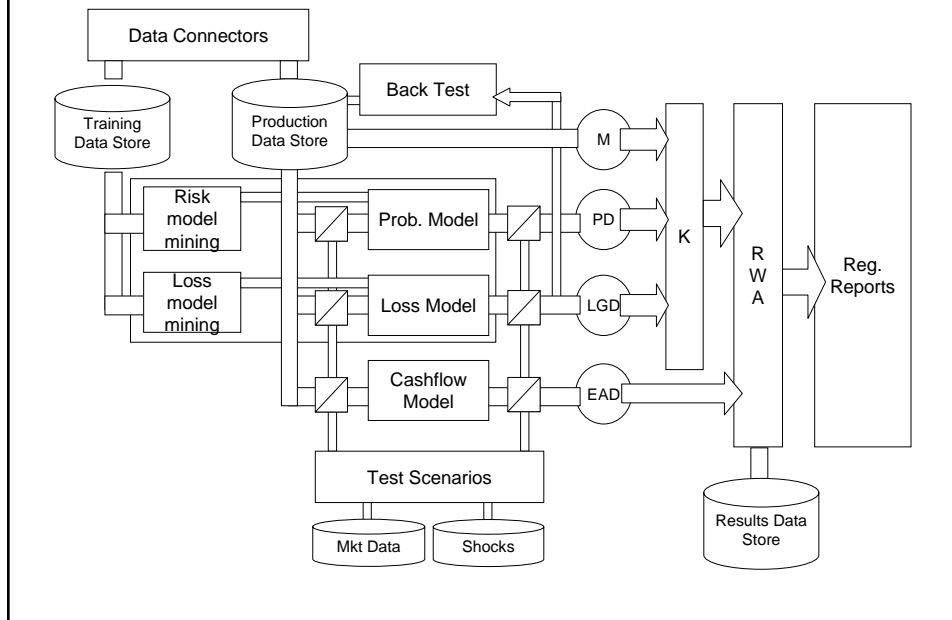


Technology & Integration



- An ERM solution is readily connected to, and loads data from, a wide range of sources
 - Flat files, ODBC databases, etc
 - Disparate data are mapped to the single internal data model
 - Data are validated and cleansed as they are loaded
- Results are passed to downstream reporting systems and processes
 - Excel, flat files, HTML/XML/pdf, ODBC databases
 - Output is configured for each client and reporting needs (executive, management, regulators, etc)

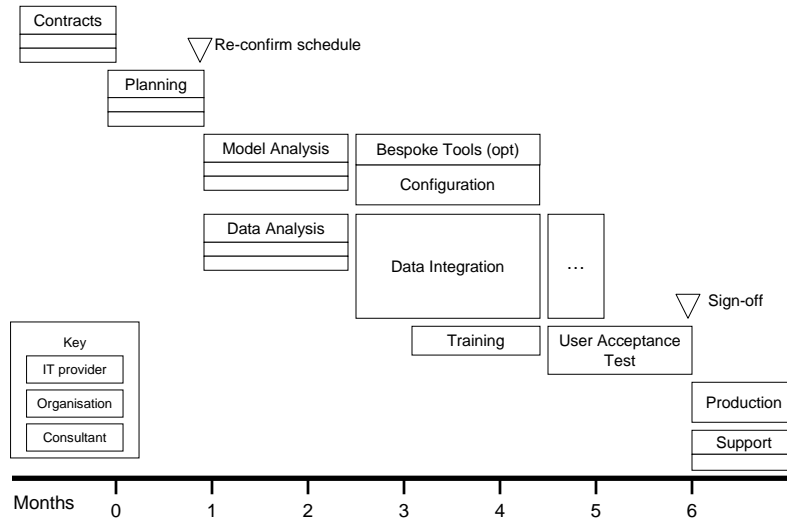
A packaged solution



Implementation Plan

- Implementation organisation
 - Software provider
 - Project supervision, application software with standard models, bespoke analytic modules
 - Local distribution or systems integration partner
 - Physical equipment, 3rd party software, data mapping, configuration, training, ongoing support
 - Client
 - Source data formats, internal policies and analytic requirements, acceptance test and sign-off
- Implementation schedule
 - Key phases: discovery, analysis, configuration/integration, UAT
 - Discovery: 3-4 weeks including working proof-of-concept
 - Implementation: 4-9 months depending on the number and complexity of the data sources, risk portfolio and corporate structure

Implementation Timeline



Experience - *Regional Retail Bank*

- The client: middle tier bank, equivalent to a monoline insurer
 - Systems are a mix of standard applications and in-house development, diverse data sources
- Needs:
 - Full Basel II IRBA compliance for Credit Risk, STDA for Operational Risk – equivalent with the “new” regulation of insurers
 - Integration with internal risk models
 - Optimisation of Credit Approval process – equivalent with optimising underwriting process
 - Risk Management and portfolio analysis
- Solution:
 - Integrated risk models for lending (underwriting) and compliance calculations
 - Integrated risk management, industrialised stress-testing and back-testing
 - Full regulatory reporting
- Project cost: EUR 500,000; 8 month from contract to production

Compliance with new regulation – learning from Basel II

- It is as much about “forward-looking” business benefits as it is about supporting regulatory objectives
- It is at least 85.283% about getting the data right!!
- “Use Test Requirement” = Single Data Architecture
- Secular + Cyclical + Migration drivers = chance to review risk models
- Organising for Success = Research + IT + Portfolio Management + Finance + Group + Senior Management + Underwriting + Business Units + Operations