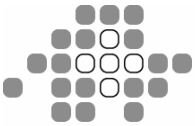

The Swiss Experience with Market Consistent Technical Provisions - the Cost of Capital Approach

Federal Office of Private Insurance, March 28, 2006

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Introduction

This paper describes the concept of market consistent valuation of technical provisions within the Swiss Solvency Test (SST) and how such a valuation is best performed by (re)insurance companies. The paper further outlines the regulatory rationale and reasons of the Federal Office of Private Insurance (FOPI) for its decision in favor of such an approach as compared with a quantile approach. Finally, the paper summarizes the field test experience with a market value type risk margin which is used within the SST. The paper is concluded by a chapter comprising frequently asked questions and four Annexes.

For the SST, all assets and liabilities have to be valued market-consistently. For technical provisions the market consistent value is defined as the best estimate plus the market value margin (MVM). For regulatory purposes, the market value margin is approximated (market to model) by using a cost of capital approach.

The principle behind the calculation of the market value margin within the SST is to give an answer to the question what a rational investor would demand in excess of the best estimate of the liabilities. Many insurance companies take this view when pricing insurance risks themselves.

The concept was tested in two field tests in 2004 and 2005. During the field test in 2004, mainly large companies have participated whereas in the field test 2005, 30 large, mid-sized and small life and nonlife insurance companies participated, covering approximately 90% of the Swiss market in terms of premium or reserve volume.

All companies involved in the field test were both capable and able to calculate the MVM using the cost of capital (CoC) approach. The MVM proved to be risk-sensitive and did distinguish high-risk from low-risk best-estimate provisions. It turned out that the longer the duration of the between best-estimate provisions and the higher the insurance risk, the higher the MVM was. The variability between the MVM of different companies could to a large degree be explained by the difference in risks within the best-estimate provisions. Some errors in calculation of the MVM could be identified by the supervisors and were corrected.

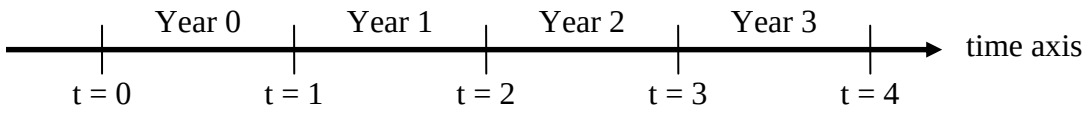
The Swiss Approach to the Market Value Margin

This chapter provides a short description of the Swiss approach of calculating the MVM, using the terminology of the EU Solvency II project in order to facilitate comparability.

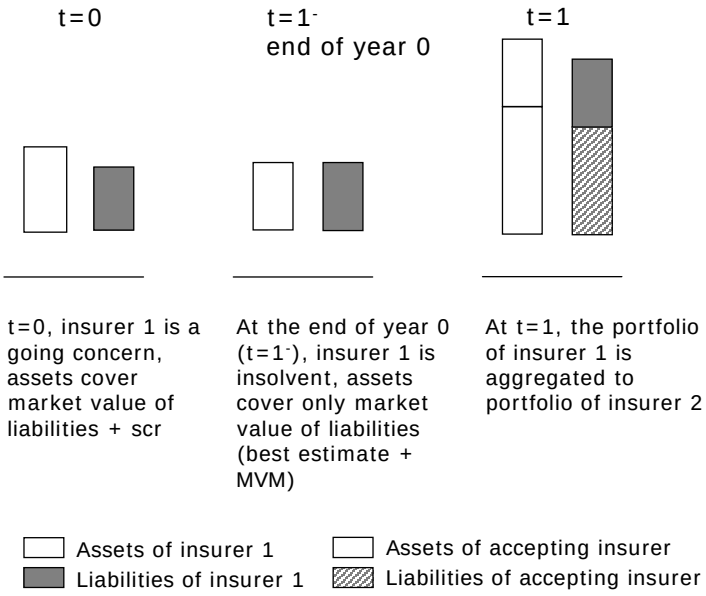
Principles and terms of the Swiss Solvency Test

- The Swiss Solvency Test is based on the market consistent valuation of assets and liabilities.
- The market-consistent value of traded instruments is their market price.
- The market consistent value of technical provisions is defined as the discounted best estimate of technical provisions (taking into account all guarantees, options, administrational and overhead expenses) plus the market value margin.
- Risk bearing capital is defined as market consistent value of assets less market consistent value of liabilities.
- The necessary 1-year risk capital (SCR) at t = 0 is defined as the expected shortfall (TailVaR) of the change of risk bearing capital over one year (year 0).
- Current Year risk is the risk associated of new business in the current year.
- Run-off risk (reserve risk) is the risk associated with the run off of a portfolio.

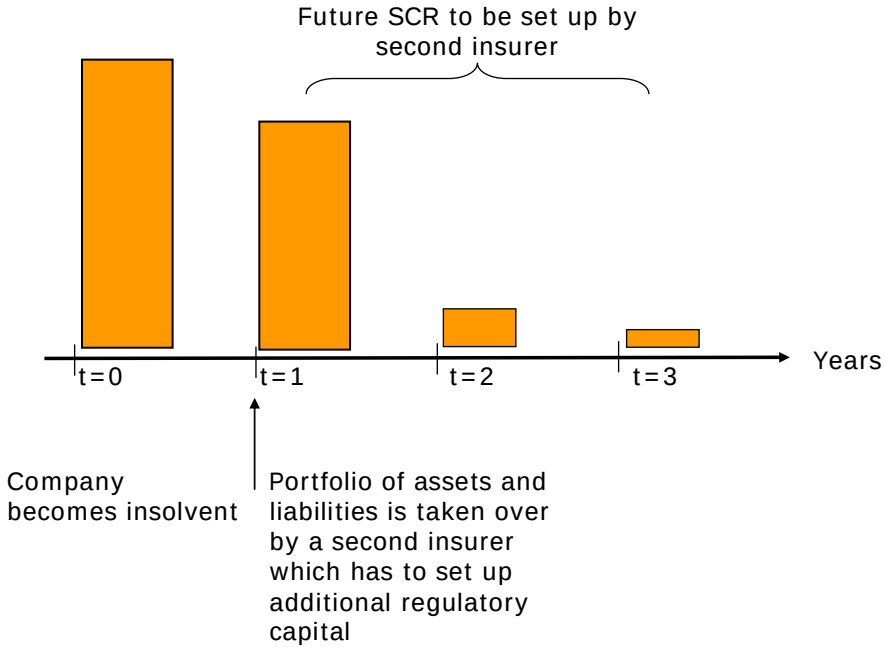
We denote by t=0 the beginning of the current year, by t = 1 the beginning of the next year, etc. Year 0 denotes the current year, year 1 the next year etc.



The MVM is defined as the cost of the present value (at t = 0) of future SCR which will have to be put up during the run-off of the portfolio of assets and liabilities for the in-force book of business at time t = 1. The SCR absorbs losses up to a certain level but with a very low probability that could happen during a time horizon of one year. The company then might become insolvent at the end of the current year and has no risk bearing capital left. At the beginning of the next year (t = 1), the portfolio of assets and liabilities is assumed to be taken over by another company and that the acquiring or purchasing company needs to be compensated for the additional SCR which it has to put up during the whole run-off of the portfolio.



Another way to see the MVM is that it is the provisions for future capital costs incurred by the business written up to date.



To be able to calculate the MVM reasonably simply and consistently, a number of simplifications were made. The insurer which has to put up the MVM does not know the second insurer which would – hypothetically – take over the portfolio of assets and liabilities in case of insolvency. Hence it is not possible to know the diversification benefit between the portfolio of the defaulting insurer and of the portfolio of the second or acquiring insurer. For the SST it was assumed that the additional SCR for year 1, 2,… are determined solely by the portfolio of the defaulting insurer, i.e. that only the diversification benefit within the considered portfolio is taken into account but no additional diversification effects are granted by the regulator. Thus the MVM calculation is independent of the (hypothetical) insurer taking over the portfolio.

A further assumption is that asset risk at t=1 (i.e. just after the insolvency) equals the asset risk at t = 0. Likely, the value of assets will have been reduced, since otherwise the company would not be insolvent. The reason for this approach is however, that the MVM has to be set up not for the defaulting insurer but for the one taking over the portfolio.

Steps to Calculate the MVM: The insurer calculating the MVM has to do the following steps:

1. Determine the SCR for years 1, 2, until the run-off of the portfolio. The SCR take into account only run-off risks, not current year risks since no new business is assumed. To calculate the future SCR, several possibilities exist:

    a. Do a full SST given the projected assets and liabilities and risks, for each year 1, 2, … Do not take into account any future new business.

    b. Assume that the run-off risk is proportional to the best estimate of technical provisions and project the insurance risk part of the SCR for year 1,2,… given the SCR for year 0 and the best estimate of technical provisions at t = 0.

2. Discount the future SCR for years 1, 2,… using the risk free yield curve to t = 0 and determine the present value.

3. Multiply the present value of future SCR with the Cost of Capital factor, which is currently set to 6%. The result is the MVM.

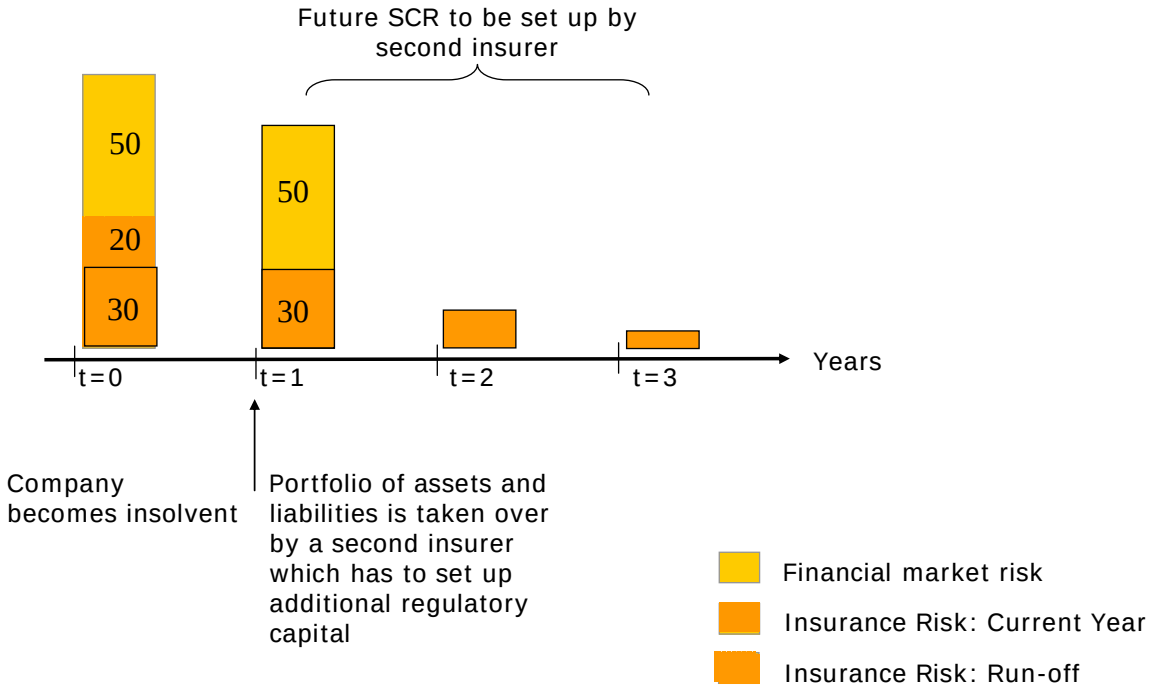
The calculation of the MVM can be done with varying degrees of sophistication. On the one extreme is the full calculation of the SST for each year of the run-off, where only run-off risk is considered for insurance risk. On the other extreme, a company can project the insurance risk SCR calculated for year 0 to years 1, 2,… proportional to the best estimate of technical provisions.

To arrive at the future SCR, it is assumed that all hedgeable financial market risk is reduced as far as possible. For this, a portfolio consisting of liquidly traded financial instruments has to be determined which replicates as well as possible the liabilities. This portfolio is called the optimal replicating portfolio (see also Appendix C).

The MVM approach in the SST does not depend purely of insurance risk. It contains a financial market risk component which comes from the fact that the asset portfolio can not be swapped instantaneously into the optimal replicating portfolio. Depending on the liabilities, the optimal replicating portfolio might not hedge all market risk, for instance when the duration of the liabilities is longer than liquidly traded government bonds.

The optimal replicating portfolio can also be determined using different levels of complexity. It can be composed of an optimal mix of liquidly traded financial instruments or it can be composed purely of government bonds.

Example: Assume that a company has an SCR of 100 at t = 0, composed of 50 market and credit risk, 20 current year risk and 30 one-year run-off risk. Its asset portfolio consists of government bonds and shares. The best estimate of technical provisions is 100. The liabilities are assumed to have a reasonable short run-off period.



Note that one-year run-off risk is defined as the risk that the reserves have to be revalued at the end of the year due to new information, different from expected claim experience etc. It is not the risk during the whole run-off period but over a one-year time horizon. The whole horizon is covered by the total of all future one-year run-off risk assessments.

The company has a stable portfolio with new business compensating for business out-flow. Hence it assumes that SCR at t = 1 equals SCR at t = 0. For the MVM calculation, current year risk does not need to be considered. Hence at t = 1, SCR to be set up is 50+30 = 80.

At t = 2, the shares can be converted to government bonds and the whole asset portfolio has converged to the optimal replicating portfolio. After that, we assume that there is no longer market or credit risk for which the (hypothetical) acquiring insurer needs to be compensated, since the liabilities run-off fast and the optimal replicating portfolio is able to hedge all market and credit risk.

Year 0	**Year 1**	**Year 2**	**Year 3**
Financial Market Risk Current Year Risk Run-off risk	Financial Market Risk Run-off Risk	Run-off Risk	Run-off Risk

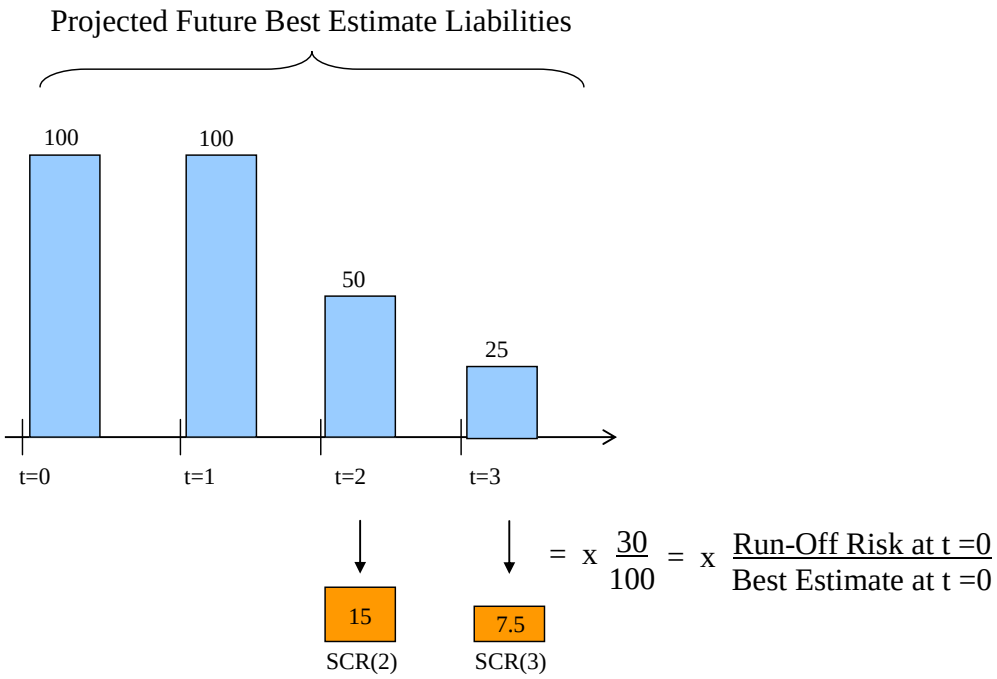
Steps to Calculate the MVM:

1. Projecting future SCR's:
   The assumption on the asset portfolio is that the composition at t=1 corresponds to the composition at t = 0. Therefore the SCR at time t = 1 is given by 80 (see above).

   The SCR's for t = 2 and 3 are projected using above mentioned method 1b), i.e. we assume that run-off risk is proportional to the best estimate.

   The technical provisions are projected to run-off over 3 years with best-estimate at t =

1: 100, at t = 2: 50, at t = 3: 25 and for t>3: 0.
Hence SCR for t = 2 equals 30/100*50 = 15. For t = 3, SCR corresponds to 30/100*25 = 7.5.



2. Assume that the risk-free yield curve is flat with discount rate 4%. The present value of future SCR is therefore $\frac{80}{1.04}+\frac{15}{1.04^2}+\frac{7.5}{1.04^3}=97.5$.

3. The MVM is then 97.5 times CoC (6%): MVM=5.8

	year 0	**year 1**	**year 2**	**year 3**
Liabilities at beginning of year	100	100	50	25
financial market risk	50	50		
one year run-off risk	30	30	15	7.5
current year risk	20			
SCR at beginning of year	100	80	15	7.5
PV(SCR)		$\frac{80}{1.04}$	$\frac{15}{1.04^2}$	$\frac{7.5}{1.04^3}$

Regulatory Considerations

This chapter provides a detailed explanation of the rationale of the Swiss regulator for choosing the MVM approach instead of a quantile approach. It also gives an overview of the discussions while developing the concept.

When developing the Swiss Solvency Test, there were several possibilities for defining a risk margin under discussion. In the end, a Market Value Margin was chosen since it fitted best within a risk based economic framework.

Policy Holder Protection: First, the Swiss regulator sees policy holders' interest best served if the portfolio of an insolvent insurer could be taken over by another insurer. This is not necessarily fulfilled by the quantile approach. The quantile is defined as giving a certain degree of safety over the whole run-off (e.g. 75% probability that the provisions are sufficient). However a given level of tolerance for the reserves to be sufficient does not imply that a second insurer would take the portfolio.

The MVM provides policyholder protection by ensuring that the company has the enough provisions to finance the capital needed to buffer risk on the remaining portfolio even in a run-off situation, e.g. if no accepting insurer could be found to take over the portfolio.

Transparency: It is the stated intention of FOPI to base the SST as far as possible on observable parameters and that there is complete transparency on how parameters are set. This will allow all stakeholders to interpret correctly the results of the SST and functions as a corrective in case parameters might be or become mis-specified. The cost of capital was set as 6% over risk-free for all companies. The reason is that the cost of capital for an accepting insurer is calibrated to the regulatory requirement. The capitalization required under the SST is based on the expected shortfall of change of risk bearing capital over a 1 year time horizon on a 99% confidence level. This corresponds to approximately 99.6% to 99.8% Value at Risk or a strong BBB rating. The observed cost of capital for A or AA rated company is within the range of 3% to 4.5%. FOPI assumed that the cost of capital for BBB companies is higher and 6% was deemed to be a reasonable estimate. For more information, refer also to the Appendix D.

No Double-Counting of Risks: For the SST, it was desired that the different elements of the solvency test fit consistently together. In particular, no double-counting of risks should occur. With the MVM as defined for the SST, this does not take place. The SCR is defined as expected shortfall of the change of risk bearing capital during year 1. The MVM is defined as the cost of the present value of future SCR during years t = 1, 2, etc. Hence the risk considered within the SCR and the MVM are completely separate in time and no double counting of risks occurs by construction.

Possibility of Verification: It is important that supervisors can verify the calculations of the MVM. With the given approach this is easily possible. All companies have to supply the cash flows of the run-off portfolio (derived from loss triangles) as well as the transition of the actual asset portfolio to the optimal replicating one. Given these data, supervisors can

replicate the calculations. It was possible to check the calculations of the MVM after the field test 2005 and identify those companies where the calculations were not compliant with the SST methodology. If a quantile approach would have been chosen, this would not have been possible. Even if a company uses a sophisticated approach for the calculation of the MVM (e.g. by doing a full Solvency Test for each year of the run-off), supervisors can easily calculate the MVM using a simplified method and do a cross-check.

Ease of Calculation: The MVM can be calculated using different levels of sophistication. On the one extreme, companies can project assets and liabilities over the whole run-off period and do a SST for each year of the run-off. However, conservative simplifications are possible which allow the calculation of the MVM using only the spreadsheet supplied by the regulator. This allows also small companies to determine the MVM without having to do a full stochastic calculation over the whole run-off of the liabilities which would be necessary for the quantile approach.

Consistency in Application: The Swiss regulator wanted a method which can be implemented consistently by all life and nonlife companies as well as by reinsurers. The quantile approach does not satisfy this requirement, as FOPI was told by many market participants. In particular, no regulator and no Swiss insurer have implemented a quantile approach for life insurance risks. To determine the quantile of the ultimate of life insurance provisions is highly complex. Actuaries would need to determine the sensitivity of the technical provision to all relevant risk factors over the whole run-off period of the liabilities which are often 40 to 50 years. During this whole period, the sensitivities of embedded options and performance guarantees to market risk factors would have to been modelled. This would at the very least entail the modelling of the future evolution of interest rates as well as other relevant risk factors over the durations of the liabilities. While the expected evolution of market risk factors and the variability of the market risk factors over a one year time horizon can be calculated relatively stable, the probability distribution of market risk factors over a 50 year time horizon depends heavily on assumptions.

For nonlife insurance risk, a small number of companies in Switzerland used the quantile approach. Many companies – also very large and sophisticated ones – use a range within which the actuaries are confident that actual technical provision lie without assigning specific probabilities to the range. This alone would not have been a reason for FOPI to exclude the quantile approach. However, also for nonlife provisions, the quantile is very dependent on actuarial assumptions. A recent study done by APRA also points in the same direction. (see: General Insurance Risk Margins Industry Report 30 June 2004 (issued October 2005), APRA).

Consistency with pricing: The MVM approach is consistent with the pricing approach many (re-)insurance companies use for insurance contracts. The value of the liabilities is related to and not bigger than the technical premium to be charged for the underlying policies. This is not always the case for a percentile-approach (The 75-percentile could be higher than the underlying technical premium) which illustrates why a percentile-approach is not a good approximation for the economic value and cannot be compatible with any future IFRS framework.

Consistency with EEV calculations: Some Swiss companies are applying the CoC approach also for the European Embedded Value calculations. The EEV for those companies is also based on a market consistent valuation so that the EEV calculations and the SST calculations are methodologically consistent

Compatibility to IFRS: Finally, the Swiss regulator intended for the SST to be as consistent as possible for future IFRS valuation. Since the cost of capital approach is a natural approximation of a market value margin which is defined within the IFRS context as

> *The Market Value Margin (MVM) is the additional amount on top of the best estimate which is required by a willing buyer in an arms-length transaction to assume the liabilities the loss reserves are held to meet,*

FOPI deemed the cost of capital approach more compatible with future IFRS valuation rules than for instance a quantile approach or implicit safety margins.

Experiences from the Swiss Field Tests

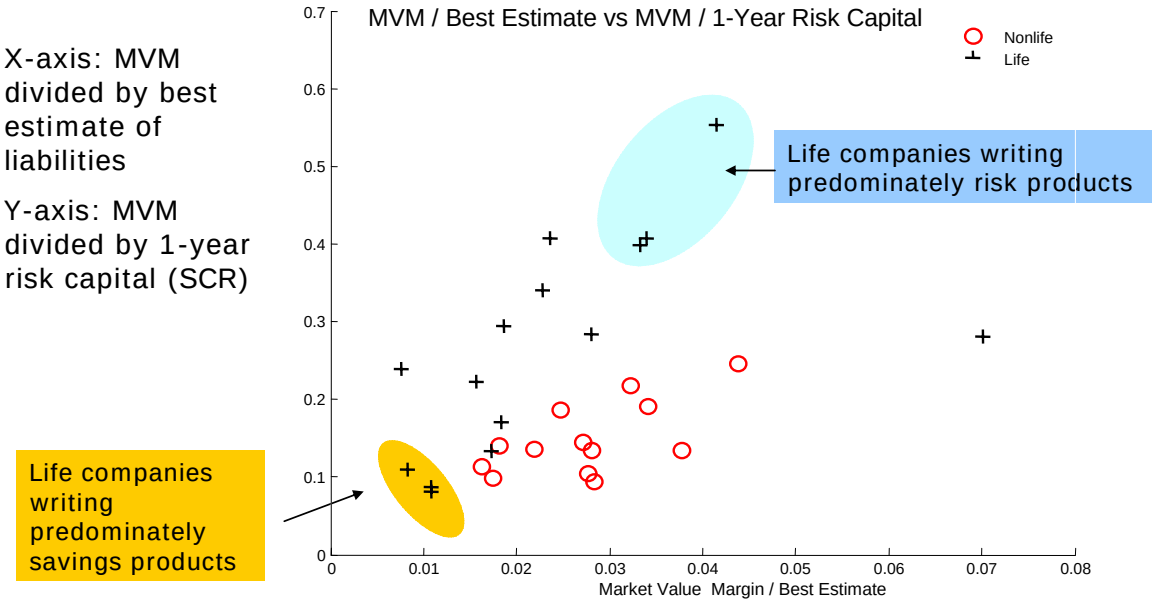
This chapter summarizes the findings of the two field tests performed in 2004 and 2005 in Switzerland.

The market value margin was calculated during the field test 2005 by 15 nonlife companies and 20 life companies (including branches).

The calculation of the MVM during the field test was quite stable. Some companies actually calculated a full solvency test for each year during the run off of the technical provisions, whereas other companies used different levels of simplification. The MVM obtained were sensitive to the risks of the technical provisions. The longer the duration of the technical provisions and the higher the insurance risk, the higher relatively the MVM. This was the case for life companies writing mainly risk products. For short durations of technical provisions or for companies which are mainly exposed to market risks (e.g. life companies writing predominantly savings products), the MVM is relatively low. Nonlife companies had MVM which were falling between the two extremes.

Life insurers writing mainly savings products tend to have relatively small MVM since insurance risk is small compared to market risk. Life insurers writing risk products have large relative MVM since they have a large exposure to biometric risk and a long duration of the run-off portfolio.

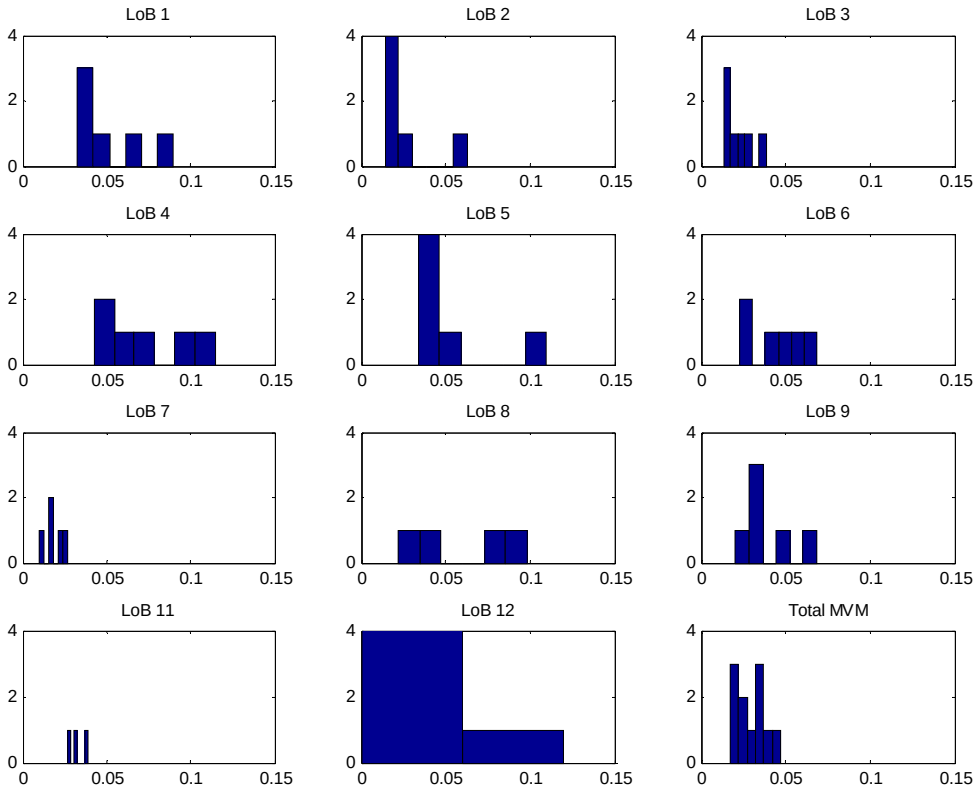
Market Value Margin / Best Estimate vs Market Value Margin / ES[RBC], based on provisional data of Field Test 2005



The x-axis shows the MVM divided by the best estimate of technical provisions. The MVM lies between 1% of best estimate (for a large life insurer dominated mainly by market risk) to 7% of best estimate for a non-life insurer.

The y-axis shows the MVM divided by SCR. Here the values range from 10% (for life insurers with mainly market risk exposure) up to 60% for life insurers writing mainly risk products.

MVM for different lines of business in nonlife insurance: The MVM can additionally be calculated on a line of business level. The differences in calculation can be explained by differences in assumptions on parameter risk, the amount of stochastic risk which depends on the size of the portfolio and the run-off pattern.



The figure shows histograms of the MVM divided by the best estimate of technical provisions for different lines of business (LoB 1 - LoB 12) as well as for the aggregated portfolio of technical provisions.

LoB 1	Motor Liability	LoB 2	Motor Hull
LoB 3	Property	LoB 4	General Liability
LoB 5	Accident (mandatory)	LoB 6	Accident (supplementary)
LoB 7	Health (collective)	LoB 8	Health (individual)
LoB 9	Transport	LoB 10	Aviation
LoB 11	Credit&Surety	LoB 12	Others

Aviation was relevant to only one company and is excluded from the analysis.

Frequently Asked Questions

Our company has a lower cost of capital than 6% since we have a high rating. Can we replace the cost of capital of 6% by our cost of capital?

No, the cost of capital does not depend on the insurer setting up the MVM but compensates the insurer taking over the portfolio for future capital requirements. Since the insurer taking over the portfolio is not known by the company setting up the MVM, a cost of capital determined by the regulator has to be used. This is the main difference between MVM used by insurers which generally are set as the cost of future economic capital for the company itself. The MVM which has to be calculated for regulatory purposes is the cost of future capital of the (unknown) company taking over the portfolio.

How was the cost of capital of 6% determined?

The risk measure of the SST is expected shortfall on a 99% level of confidence. This corresponds approximately to a 99.6% to 99.8% Value at Risk which implies a strong BBB rating. For A or AA rated companies, cost of capital is in the range of 3% to 4.5% over risk-free. For a BBB company, the cost is slightly higher, so that 6% over risk-free was chosen. See also Appendix D.

How does the MVM compare to the quantile approach quantitatively?

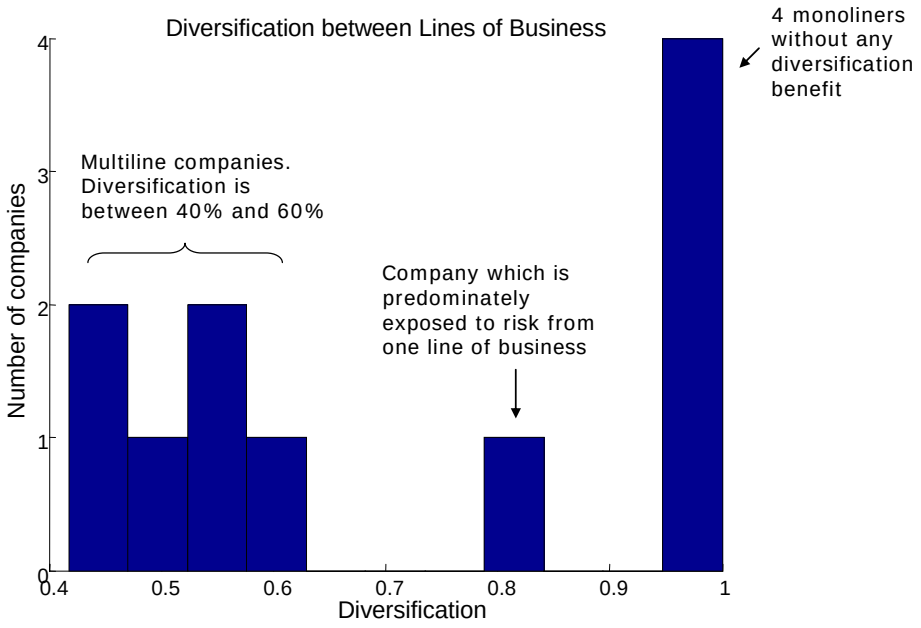
FOPI was informed by a number of companies that the MVM compared to a quantile on a confidence level of between 65% and 90%, differing between companies and between life and nonlife risks.

Should the component of the run-off risk modelling the stochastic risk be taken into account, or should it be considered to be hedgeable?

Stochastic risk is taken into account for the MVM. While it could be argued that stochastic risk diversifies, this is only true if a portfolio were aggregated with a comparatively large portfolio. Since this can not be assumed in reality (i.e. the insurer taking over the portfolio can be of similar size as the defaulting one), it is reasonable to not take diversification of stochastic risk into account. For most companies, the contribution of stochastic risk to SCR is much smaller than parameter risk so that neglecting diversification effects is not relevant.

Should the MVM be calculated on the total portfolio or on different lines of business?

An insurer becomes insolvent as a whole. The underlying assumption of the MVM is that the total portfolio is taken over by a second insurer, therefore the MVM has to be calculated on the total portfolio. FOPI did analyze the MVM on a line of business level given data from P&C companies which participated in the field test 2005.

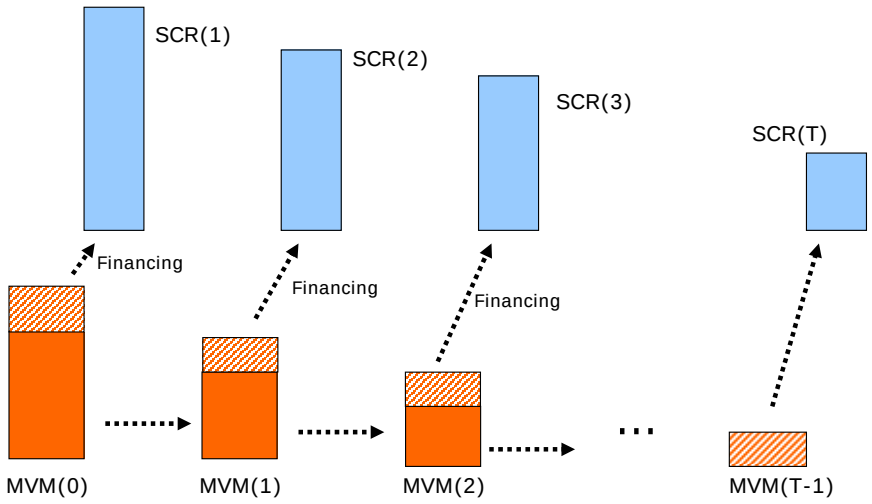


For multiline companies, the diversification between the lines of business was approximately 40% to 60%.

Has the MVM a run-off or portfolio transfer view?

The MVM is set such that a second insurer can take over the portfolio, hence it has a portfolio transfer view. However, the arguments for the approach also go through with a run-off view. Since the MVM does not take into account diversification benefits between the portfolio of the defaulting insurer and the portfolio of the insurer, a run-off would be possible under the assumption that the cost of capital of the run-off company would not exceed 6%. The MVM is exactly sufficient to compensate the run-off company to set up SCR for years t=1, 2, until the run-off of the technical provisions.

The initial MVM (MVM(0)) can be decomposed into parts financing future SCR necessary during the whole run-off (t=1,…,T) of the portfolio of assets and liabilities



What was the contribution of the illiquidity of assets to the MVM?

On average, the contribution was about 20% to 25%. FOPI is considering whether to simplify the approach and assume that the asset portfolio can be assumed to be the optimal replicating portfolio from t = 1 as it can be argued that illiquidity is already priced in the value of the assets.

Is there any market risk when the asset portfolio has converged to the optimal replicating portfolio?

There can still be unhedgeable market risk, for instance if the duration of the liabilities is longer than the one of government bonds. The optimal replicating portfolio can only be composed of liquidly traded financial instruments.

Does the CoC approach take into account stochastic (volatility) risk?

Yes, in the SST CoC approach, stochastic risk enters the future SCR and consequently the MVM. The argument for this is that in practice an insurer taking over the portfolio of a defaulting insurer has itself a portfolio of finite size, so that stochastic risk can not be completely diversified away by aggregating the portfolios of the defaulting and of the accepting insurer. Stochastic risk is for most companies anyway not a large part of SCR, so that the effect also on the MVM is small.

Is the CoC calculation circular, in the sense that to determine the MVM, the MVM itself needs to be known?

No, this is not the case. The future SCR entering the calculation are independent on the MVM. The SCR are purely the necessary amount of risk bearing capital to survive at the end of one year, quantified by the expected shortfall of the change of risk bearing capital during one year. While the absolute level of risk bearing capital depends on the MVM, the change of risk-bearing capital does not. The underlying assumption has been made that the MVM at the end of the year equals the MVM at the beginning of the year, or equivalently, that the portfolio is stable over a one year time horizon.

Does the MVM contain the insurance risk during the whole run-off of the liabilities?

Yes, the MVM depends on the insurance risks during the whole run-off of the liabilities. Technically, the MVM is a function of a sequence of 1-year risk measures given current information. If R_t denotes the reserves at time t, the MVM is a function of:

$$MVM=f(R_2-R_1, R_3-R_2,\ldots, R_T-R_{T-1} \mid \mathcal{F}_0).$$

In contrast, the quantile is a function of: $Q=g(R_1 \mid \mathcal{F}_0)$ (or R_0, depending on the definition). Hence, both the CoC approach and the Quantile approach make use of the same information.

The CoC approach works well for companies using an internal model. But for a simple factor model CoC is difficult to determine.

The CoC method is independent of the model used to calculate the SCR. Indeed for a factor model calculating the CoC becomes very easy.

The CoC approach works well for big and highly capitalized companies. But for a small and less capitalized company it is difficult to apply.

The CoC works well also for small companies. During the field test in 2005, a number of small and mid-sized companies participated and all were able to determine the MVM. The CoC approach leads itself well to different levels of (conservative) simplifications which can be used by companies. It should however be noted that not all small companies used these simplifications but were able to apply also the more complex ways of calculating the MVM.

Does the MVM take into account group diversification?

Yes, in the sense that for the calculation of the MVM, all formal capital and risk transfer instrument can be taken into account. If there are instruments from the groups (i.e. from legal entities of a group) to a legal entity LE, which affect the future regulatory capital requirements SCR for years 1, 2,… of LE, then the MVM of LE can profit from being part of the group. Note however, that for this to be possible the capital and risk transfer instruments need to have durations longer than one year. For instance, a guarantee which can be cancelled within one year would not affect future SCR for years 1, 2,… Analogously, a guarantee with a duration of 3 years would affect SCR for years 1 and 2 but not for years 3, 4,…

Appendix A: Liquidity Considerations of the Asset Portfolio

There were in addition two principles which determined the calculation method:

1. The insurer setting up the MVM should not be penalized if, after the transfer, the insurer taking over the portfolio does not minimize the regulatory risk capital requirements as fast as possible.

2. The insurer taking over the portfolio of assets and liabilities should be compensated if the insurer setting up the market value margin invested in an illiquid asset portfolio.

From rule 1 follows that the insurer calculating the MVM can assume that assets are rebalanced to liabilities as fast as possible (giving liquidity constrains) to an optimal replicating portfolio, i.e. a portfolio of assets which minimize the Asset-Liability mismatch.

From rule 2 follows that the insurer setting up the MVM has to take into account the limited liquidity of its assets. It takes longer to sell real estate and buy government bonds than to sell liquid shares.

Liquidity Assumptions: For the standard model of the SST, the duration how long given classes of assets can be changed into government bonds are specified:

- Publicly traded shares, liquid bonds: <1 year
- Illiquid shares and bonds 1-2 years
- Real estate: 3 years
- Hedge funds, private equity: Not specified, has to be determined by insurers

The rule for the duration is that within the time period specified, the asset has to be able to be sold without losing value.

Appendix B: Further Methods to Determine Future SCR

There are further possibilities to determine the SCR for years 1, 2, … in addition to those given in the text. Here we mention another two:

a. Do not split the insurance SCR in run-off risk and current year risk. Project SCR for year 1,2,… given the proportion of total insurance risk at t = 0 and technical provisions at t = 0. This is conservative since also current year risk scenarios would be taken into account.

b. Do not split the insurance SCR in run-off risk and current year risk. Project SCR for years1,2,… given the proportion of total insurance risk for year 0 and technical provisions at t = 0. Assume that the asset portfolio is rebalanced into one composed of government bonds given the liquidity constrains of the asset portfolio at t = 0.

Appendix C: The Optimal Replicating Portfolio

A replicating portfolio is defined as a portfolio which replicates the expected cash flows of the liabilities under financial market risk scenarios. It is composed of liquidly traded financial instruments. The optimal replicating portfolio is defined as a replicating portfolio which best replicated the expected cash flows in the sense that market and credit risk are minimized, i.e. which replicates the expected cash flows under all financial market risk scenarios.
The optimal replicating portfolio immunizes the liability cash flows against all changes in the underlying market risk factors.

If a replicating portfolio were to replicate the cash flows perfectly, the market consistent value of the liabilities would equal the market value of the replicating portfolio. This can however only be achieved if the optimal replicating portfolio replicates the liability cash flows under all possible future states of the world, i.e. if the cash flows are immunized not only against all changes in the underlying market risk factors but also against changes in all other risk factors.

Since in most cases, the optimal replicating portfolio immunizes only against market risk factors, basis risk remains and the market consistent value of the liabilities consists of the market value of the replicating portfolio plus a margin for the basis risk.

For purposes of the MVM calculation in the SST, companies can replicate the liability cash flows using different levels of sophistication. It is possible to use only government bonds for the replicating portfolio. In that case, likely not all market risk has been hedged and the future required SCR would increase. Hence the simplification is conservative.

For life companies which sell products with embedded options, the optimal replicating portfolio should contain traded derivatives which can replicate the liability cash flows, and in particular the value of the options and the exercise of the policyholders under different market risk factors. In these cases the determination of an optimal replicating portfolio can be complex. For the MVM calculation, it is however sufficient to find a good approximation as residual market risk will be captured within the future SCR and leads to a conservative estimate of the MVM.

Appendix D: The Estimation of the Cost of Capital

The observed cost of capital for A or AA rated company is within the range of 3% to 4.5%. FOPI assumed that the cost of capital for BBB companies is higher and 6% was deemed to be a reasonable estimate.

Higher rated companies have lower capital requirements but also have higher economic capital requirements. FOPI estimates that the two effects more or less cancel out, i.e. that a CoC of 6% on a BBB economic requirement is approximately in the range of a CoC of 4.5% on a A requirement or a CoC of 3% on a AA requirement. Using published default probabilities for different rating classes and normality assumptions, it is possible to roughly calculate the different MVM so obtained.

FOPI did an analysis based on the actual distribution functions of life and nonlife companies participating in the field test 2005.

The figure below shows the calculation for 18 life and nonlife companies which participated in the field test 2005. The distribution function for the economic profit and loss was used to obtain a Value at Risk for the default probabilities for BBB, A, AA and AAA rated companies (0.003 for BBB, 0.0011 for A, 0.0003 for AA and 0.0001 for AAA). These Value at Risk numbers were then multiplied with the cost of capital assumed for the different rating classes (6%, 4.5%, 3% and 2.5%). The values obtained for A, AA and AAA ratings were put in relation to the value for the BBB rating. These relative numbers give an indication on how the MVM relate for differently rated companies.

The average relative values so obtained were: 89% for A, 71% for AA and 67% for AAA ratings. This means that for instance the average MVM for a A rated company is about 89% of the average MVM of a BBB company if the SCR is based on a Value at Risk measure.

FOPI did the same calculation for a SCR which is based on a TailVaR measure, as is the case for the SST. The average relative values obtained were: 86% for A, 66% for AA and 60% for AAA ratings.

Finally the same calculations were made assuming that the distribution functions follow the normal law.

			MVM (Normalized)		
Rating	Default Probability	CoC	Normality Asumption	Empirical with VaR SCR	Empirical with TailVaR SCR
BBB	0.30%	0.060	1.00	1.00	1.00
A	0.11%	0.045	0.74	0.89	0.86
AA	0.03%	0.030	0.62	0.71	0.66
AAA	0.01%	0.025	0.56	0.67	0.60

The MVM of highly rated companies are relatively lower than for less highly rated. However, the cost of capital is not based on the capitalization of the company setting up the company but on the capitalization of an average, hypothetical assuming company. Since it is feasible that no accepting insurer can be found to transfer the portfolio, a run-off should still be possible. This is the case by choosing a cost of capital associated with the regulatory capital requirement.