Review of the Risk-Based Capital Framework for Insurers in Singapore ("RBC 2 Review")

Second Consultation

Follow-up Response on

Counter-cyclical Adjustments

By

Singapore Actuarial Society

16th January 2015

SINGAPORE ACTUARIAL SOCIETY
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16th January 2015

Ms. Lee Keng Yi

Head, Insurance Department

Monetary Authority of Singapore

10 Shenton Way

MAS Building

Singapore 079117

Dear Ms. Lee

Re: Follow-up Response on Counter-cyclical Adjustments

Review of the Risk-Based Capital Framework for Insurers in Singapore ("RBC 2 Review") – Second Consultation [Consultation Paper P003-2014]

The Singapore Actuarial Society ("the Society") has in July 2014 submitted its response to MAS' second Consultation Paper on the RBC 2 Review. In that response, the Society committed, amongst other things, to conduct further research on counter-cyclical adjustments ("CCA").

This document sets out the research findings by the Society's Life Insurance Committee. It also contains the tentative proposals by the members of CCA Working Party on the scope, design and calibration of CCA under RBC2. These proposals should be further tested in the upcoming QIS2 to confirm their appropriateness and practicality. Views expressed in this document represent a professional standpoint and not those of the employers of, or other parties receiving advice from, the Society's members.

The Society will be publishing this document on its website and it will be available to the public.

If you have any question on this document or wish to discuss its content further, please contact president@actuaries.org.sg or secretary@actuaries.org.sg.

Yours sincerely,

Choo Oi San

President 2014/2015

Singapore Actuarial Society

Raymond Cheung

Chair, RBC 2 Taskforce & Hon. Secretary 2014/2015

Singapore Actuarial Society

About the Singapore Actuarial Society

The Singapore Actuarial Society was formed in 1976. At that time, the profession was little known in Singapore and there were only a handful of qualified actuaries. The adoption of the new Constitution in July 1996 and the Code of Professional Conduct in November 1997 was the fruition of efforts made in the previous two decades to promote the study of actuarial science and professional standards.

The Society is the recognised representative body of the actuarial profession in Singapore, having the final authority in the setting of professional standards. The objectives of the Society are:

- to uphold the highest professional standards among members;
- to serve the public's interest in matters we are uniquely qualified to respond on;
- to promote the study, discussion, publication and research into the application of economic, financial and statistical principles to practical problems, the actuarial, economic and allied aspects of life assurance, non-life insurance, employee retirement benefits, finance and investment with particular reference to Singapore and the ASEAN region;
- to assist students in the course of their actuarial studies;
- to further the professional development of actuaries; and
- to foster and encourage social relationship among the members.

Our office is located at 163 Tras Street, #07-05 Lian Huat Building, Singapore 079024. Please visit our website www.actuaries.org.sg for more information.

Table of Contents

1. Background and Scope

The Monetary Authority of Singapore ("MAS") issued the Second Consultation Paper on RBC2 on 26 March 2014.

A RBC 2 Special Taskforce ("the Taskforce") was set up[1] at the request of the Council of the Singapore Actuarial Society ("the Society") to deliberate on MAS' latest proposal. After gathering the views of the Society's membership, the Society issued a response paper to MAS on 4 July 2014. The Society has committed in that response to conduct further research on several areas of the RBC2 framework, including counter-cyclical adjustments ("CCA") which is the subject matter of this document.

The research on CCA was conducted by the Society's CCA Working Party under the Life Insurance Committee. Views expressed in this document reflect the majority view of the Working Party's members. They are expressed from a professional standpoint and do not represent those of the employers of, or other parties receiving advice from, the Society's members. A summary of the proposals in this document can be found in Appendix 1. The list of members of the Working Party can be found in Appendix 2.

CCA proposed in this document covers both equity risk and credit spread risk. It therefore applies to insurer undertaking life, general, and/or health insurance business; and to insurers acting as direct writers and as reinsurers.

This document is solely directed to the RBC 2 Review and may not necessarily be applicable to other solvency regimes in jurisdictions outside of Singapore.

Proposals on the scope, design and calibration of CCA contained in this document should be viewed as the Working Party's current thinking. These proposals should be further tested in the upcoming QIS2 to confirm their appropriateness and practicality. The Working Party would review its proposals after its members have gained more insights during QIS2.

Section 2 sets out the guiding principles underlying the proposals in this document.

Sections 3 and 4 provide the detailed research and proposals for equity risk and credit spread risk respectively.

[1] A similar Taskforce was set up in June 2012 to respond to the first RBC 2 Consultation Paper issued by MAS on 22 June 2012. The Taskforce has provided a report on the consolidated comments of the RBC 2 Review in August 2012. The report can be found in the following link: http://actuaries.org.sg/?q=node/4361

2. Guiding Principles and Broad Methodology

In the Society's July 2014 response paper, the Society expressed support for introducing CCA in RBC2. Without CCA, insurers will be forced to crystalize losses into a down market in order to maintain their capital ratios while their liabilities may not have fallen due and have no immediate liquidity needs. This reduces the likelihood of insurers recovering naturally after the temporary market stresses. A well-designed CCA is particularly important to life insurers who face predictable cash flows and have investment horizons much longer than the 1 year time horizon assumed under the calibration of RBC2 requirements.

The Society has also made the following comments on the design of CCA:

- CCA should be activated upon significant market movements. The risk requirements just before and after the trigger points should be continuous instead of discrete to prevent any "cliff/jump" behaviour.

- CCA formulae should be pre-determined, developed based on sound technical basis and easily explainable. The Society believes that a clear and transparent CCA mechanism is important for the insurers' capital planning; and supports Enterprise Risk Management and the objective of Own Risk & Solvency Assessment.

- CCA should cover all asset classes and markets where reversion behaviours can be observed and not only be confined to Singapore listed equities. Non-Singapore listed equity should be considered at the minimum. Credit spread should also be considered for inclusion in the CCA framework as its reversion behaviour has historically been stronger than that of equities.

- CCA should seek to reflect the systemic risk component of the price movements. Application of CCA should therefore be independent of how diversified an insurer's actual holdings are. Some appropriate proxies may be used as the reference point for CCA, but there is a need to maintain a balance between the ease of application and the risk sensitivity.

- The extent to which CCA modifies the base RBC2 calibration should reflect the strength of the reversion behaviour in the observed risk type.

Proposals on CCA in this document are developed using the points listed above as guiding principles.

The Working Party reviewed the data on the reversion behaviour of interest rate and found some evidence of reversion tendencies. However, the Working Party noted MAS' proposal to change the definition of interest rate mismatch risk shocks from a fixed number of basis points to a proportionate change in the base valuation interest rate, with a cap on the number of basis points shocked, under RBC2. The Working Party believes that the change in definition is effective in addressing the reversion behaviour seen in interest rate movements. No further CCA is therefore proposed in this document for interest rate mismatch risk.

3. Counter-cyclical Adjustment for Equity Risk

Data

Three equity indices were chosen for the investigation into the reversion behaviour of equity risk; and to calibrate and validate the Working Party's proposal on CCA. The full dataset of each index is used instead of restricting to data from the recent decade. According to a recent survey conducted by Life Insurance Association that was shared with the Society, these indices represent popular equity benchmarks used by insurers in the Singapore life insurance market for their investment management. As RBC2 is based on the concept of change in net asset value over a 1-year time horizon, the indices chosen capture total equity return including gross dividend yield (as opposed to indices that capture only price movements). Analysis and calibration based on these indices should therefore be suitable for use in RBC2.

Index	**Period**	**Bloomberg Ticker**
MSCI Singapore	Dec 1969 – Aug 2014	GDDUSG
MSCI Asia (ex-Japan)	Dec 1987 – Aug 2014	GDUECAXJ
MSCI World	Dec 1969 – Aug 2014	GDDUWI

For each of the chosen indices, the index value on the last day of each month is noted.

The Society has in July 2014 endorsed the use of Straits Times Index as the proxy for the Singapore equity market. The Working Party decided to switch to MSCI Singapore in this study as the MSCI index is float adjusted and more investible in practice.

Limitations

MSCI Asia (ex-Japan) index consists of local country indices (e.g. MSCI Korean and Hong Kong) weighted by their market value. The composite index is usually valued in USD. Index movements observed will therefore reflect not only the equity market performance in the constituent markets, but also changes in exchange rates between Asian currencies versus USD. Magnitude of exchange rate impact is not stable over time, and may sometimes be larger than the movement in equity prices in local currency terms. (Refer to some of the worst hit Asian countries during the 1997 Asian financial crisis.) Currency movements also have influence on the MSCI World index, albeit with a lower magnitude.

Reversion Behaviour Analysis

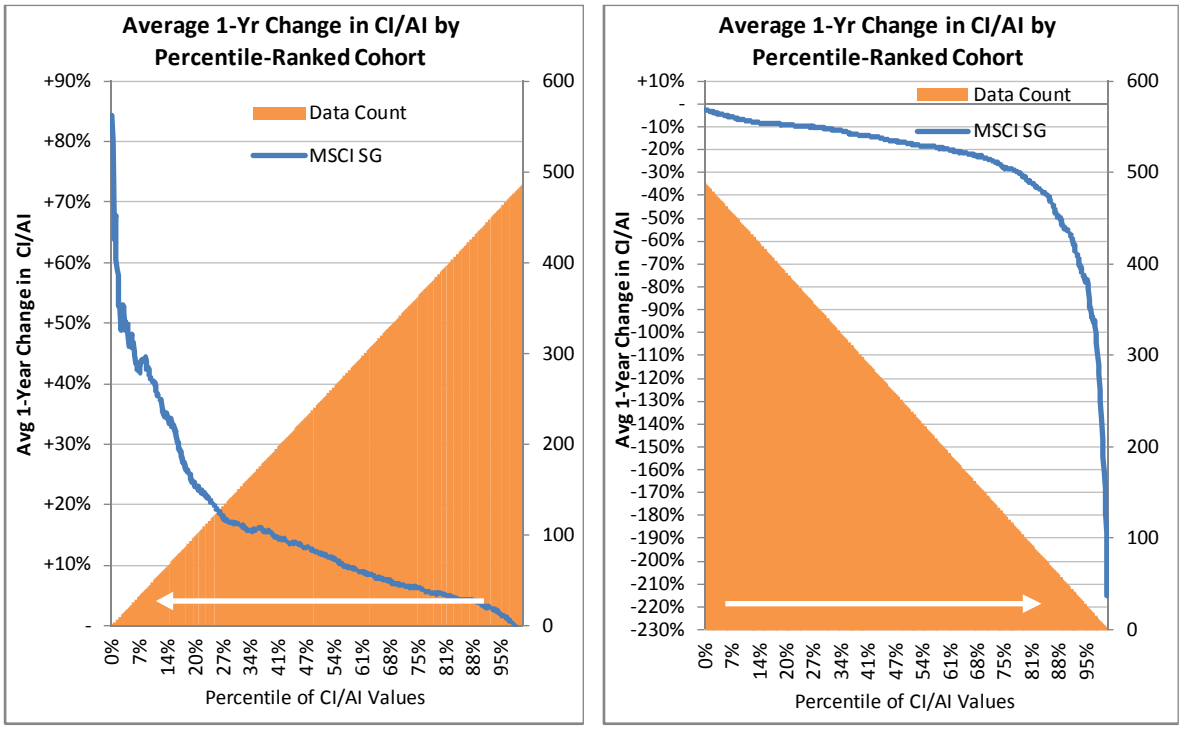
To assess whether reversion behaviour exists for equity risk, the "CI/AI ratios" is calculated for each monthly index value observed. "CI" refers to the current month's index value; while "AI" refers to the rolling 3-year average index value up to and including the current month. The Working Party found the symmetrical adjustment mechanism under Europe's Solvency II a reasonable starting point and have therefore borrowed the "CI/AI ratio" concept in this analysis.

The dataset is then sorted according to the CI/AI ratios.

A pair of graphs is plotted for each of the three indices analysed.

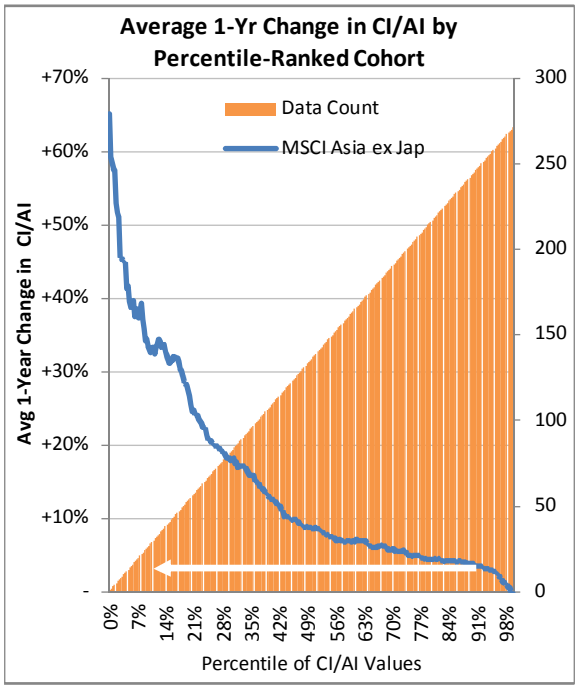
- The coloured line in each graph shows the average 1-year change in CI/AI ratios for a subset of the index data.
- For the graph on the left, and reading it from right to left, data related to the highest CI/AI ratios are progressively excluded from the analysis. If there is reversion behaviour, then the average 1-year movement is expected to trend upwards. An upward trend indicates that when equity level is below the trend line, it is more likely to rebound higher.
- For the graph on the right, and reading it from left to right, data related to the lowest CI/AI ratios are progressively excluded from the analysis. If there is reversion behaviour, then the average 1-year movement is expected to trend downwards. A downward trend indicates that when equity level is above the trend line, it is more likely to revert back to a lower level.

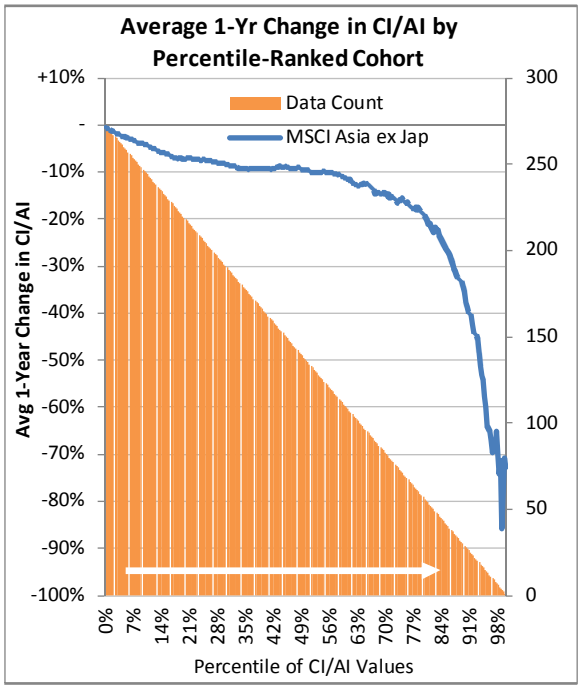
MSCI Singapore



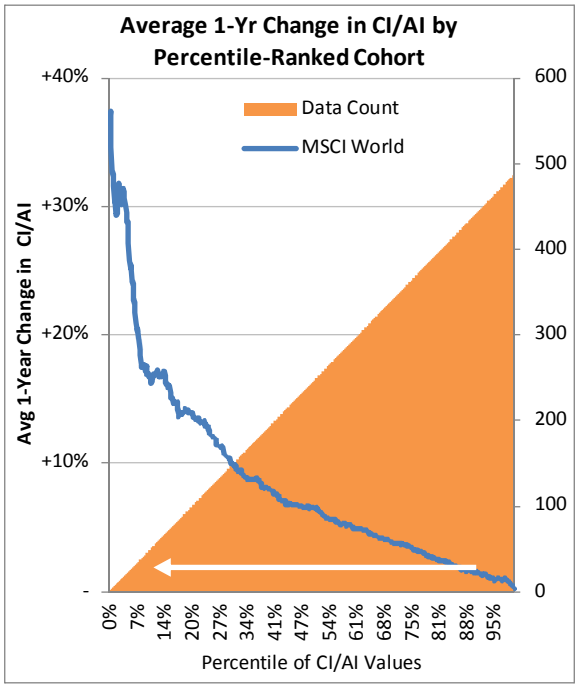
Note: For the graph on the right, the large negative readings mostly relate to 1973 where the index saw a sudden spike, pushing the CI/AI ratio to historical high. While the index came down slowly thereafter, but with AI catching up quickly, the CI/AI ratios recorded large 1-year drop in several months.

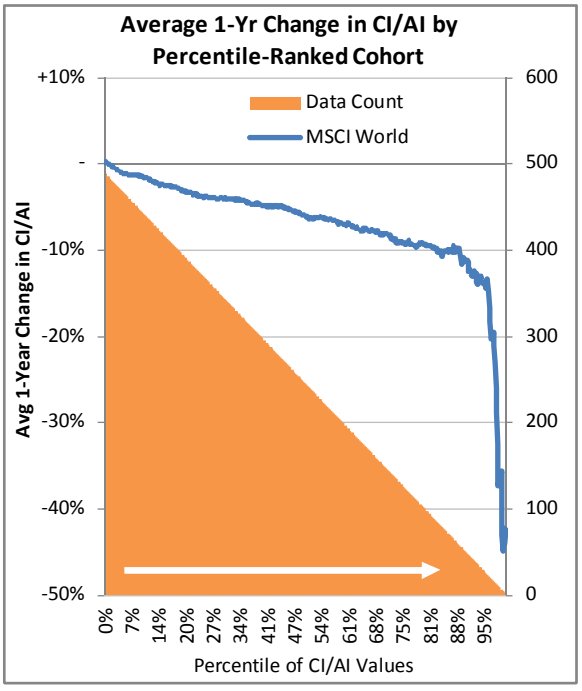
MSCI Asia (ex-Japan)





MSCI World





Observations

A consistent reversion behaviour can be seen from the graphs for the three indices.

- For all the graphs on the left, it is observed that the expected 1-year movement in CI/AI ratios does trend upwards significantly when data points with the lowest starting CI/AI ratios are used. This indicates that when equity level is below the trend line, it is more likely to rebound higher.

- For all the graphs on the right, it is observed that the expected 1-year movement in CI/AI ratios does trend down significantly when data points with the highest starting CI/AI ratios are used. This indicates that when equity level is above the trend line, it is more likely to revert back to a lower level.

These observations support the case for applying a CCA for equity risks, not just for Singapore, but for Asian and global markets in general.

Comparing all the three graphs on the left, one would also observe that the gradient and curvature at which the coloured lines move up when the datasets get smaller is not the same. In the case of Singapore equities, the coloured line moves up in a rather steady pace. As for Asian and global equities, the coloured lines only start to accelerate quickly upwards when there are about 20% of the data points left in the dataset. Similar observations can be made when one compares all the three graphs on the right.

This supports the Society's view that equity CCA should be triggered only after significant market movements because reversion behaviour may not be as strong when prevailing equity level is close to the trend line.

Functional Form and Parameterization

Key Performance Indicators

To assess whether the proposed functional form and parameterization of equity CCA are acceptable, three performance indicators are proposed.

Indicator Name	**Definition**	**Target**
Probability of Adjustment	Number of months where CCA leads to non-zero adjustments to the base calibration *divided by* Total number of months in the dataset.	Less than 20%. This is to ensure that CCA will not be triggered too frequently. This approach is in line with the guiding principles.
Duration Balance	Number of months where upward CCA is triggered *divided by* Number of months where downward CCA is triggered	About 1, so that the adjustments are roughly symmetrical.

Indicator Name	Definition	Target
Magnitude Balance	Sum of magnitude of adjustment from months with upward CCA *divided by* Sum of magnitude of adjustment from months with downward CCA	About 1, so that the adjustments are roughly symmetrical.

There may be many CCA formula/ parameterization combinations that meet all the performance indicators. However, it is not the intent of the Working Party to pursue spurious accuracy and find the "perfect calibration". It would suffice as long as the Working Party finds an intuitive CCA formula with parameterization that can fulfil all three performance indicators.

Functional Form

The Working Party had further debated on what functional form the equity CCA formula should take after the Society submitted its response in July 2014. Given the practical considerations, the Working Party agreed to use the functional form of Europe's Solvency II's Symmetric Adjustment as the starting point. Modification is then made to introduce the concept of trigger level.

This leads the Working Party to propose the following functional form for equity CCA in RBC2:

Condition	Counter-cyclical Adjustment
If $\boldsymbol{ABS}\left[\left(\frac{CI}{AI}\right)-(1+g)\right] \leq Trigger$	0
Else if $\left[\left(\frac{CI}{AI}\right)-(1+g)\right] > Trigger$	$\boldsymbol{MIN}\left[\frac{\left(\frac{CI}{AI}-(1+g+Trigger)\right)}{2}, Upper\ Limit\right]$
Else if $\left[(1+g)-\left(\frac{CI}{AI}\right)\right] > Trigger$	$\boldsymbol{MAX}\left[\frac{\left(\frac{CI}{AI}-(1+g-Trigger)\right)}{2}, Lower\ Limit\right]$

Where

- *CI* refers to the current index level;
- *AI* refers to the average index level in past 36 months;
- *g* is a constant, which can be intuitively interpreted as some "natural trend" of equity growth;

- *Trigger*, which is designed to be symmetrical about *g*, defines the amount of deviation from growth trend required to trigger equity CCA;

- *Upper Limit* and *Lower Limit* help to cap the adjustments that CCA can make to the base equity shock calibration.

The proposed functional form can be explained to layperson by saying that "the CCA model assumes that the natural growth of equities should lead current equity index level to be *g* higher than the 3-year moving average. Should the actual index level deviates from this natural growth trend by a specific trigger threshold, CCA will kick it. However, CCA can only modify the base equity risk shocks by the prescribed limit, be it upwards or downwards."

Parameter Calibration

The Working Party started the calibration process by testing the following set of parameters which, with the exception of *Trigger*, are adopted from the Solvency II calibration. *Trigger* is picked by observing the return volatility of the dataset.

Index	***g***	***Trigger***	***Upper Limit***	***Lower Limit***
MSCI Singapore	8%	35%	10%	-10%
MSCI Asia (ex-Japan)	8%	35%	10%	-10%
MSCI World	8%	35%	10%	-10%

The table below summarizes the performance of this set of parameters in different historical periods (full data set, last 20 years and last 10 years).

Index	**Duration**	***Probability of Adjustment***	***Duration Balance***	***Magnitude Balance***
MSCI Singapore	Dec 1969 – Aug 2014	19.2%	0.37	3.85
	Sep 1994 – Aug 2014	14.2%	1.00	1.00
	Sep 2004 – Aug 2014	16.7%	0.43	2.74
MSCI Asia (ex-Japan)	Dec 1987 - Aug 2014	15.3%	1.13	1.15
	Sep 1994 – Aug 2014	15.0%	0.57	0.56
	Sep 2004 – Aug 2014	14.2%	1.83	2.00
MSCI World	Dec 1969 – Aug 2014	5.4%	2.22	3.71
	Sep 1994 – Aug 2014	3.3%	0.00	0.00
	Sep 2004 – Aug 2014	5.8%	0.00	0.00

From this initial test, the following can be observed:

- Performance indicator reading can vary significantly when one looks at different subset of the data.
- Applying the same set of parameters to all three indices can yield quite diverse performance indicator readings. For the MSCI World index in particular, the initial parameters lead to very infrequent triggering of equity CCA; and whenever equity CCA is triggered in the recent decades, it never increases the equity risk requirement to prepare insurers to bubbles building up.
- The initial set of parameters work reasonably well for the MSCI Asia (ex-Japan) index across different time periods.
- For MSCI Singapore, the initial parameter set triggers equity CCA with acceptable frequency. While downward adjustment to equity risk requirement occurs more frequently than upward adjustments, the magnitude of upward adjustments are much larger.

To get a sense of how performance indicator readings would change when the parameters change, several other combinations of *g* and *Trigger* are tested. Variations in the *Upper Limit* and *Lower Limit* are not tested because the Working Party agreed that capping the variation from the based calibration by +/-10 percentage points fairly reflects the strength of reversion seen in the reversion behaviour analysis earlier.

As an example, the following set of parameters would be preferred if one aims to improve performance indicator readings when the full history of each of the dataset analysed is used.

Index	***g***	***Trigger***	***Upper Limit***	***Lower Limit***
MSCI Singapore	20%	40%	10%	-10%
MSCI Asia (ex-Japan)	9%	35%	10%	-10%
MSCI World	6%	25%	10%	-10%

The table below summarizes the performance of this set of parameters in different historical periods (full data set, last 20 years and last 10 years).

Index	**Duration**	***Probability of Adjustment***	***Duration Balance***	***Magnitude Balance***
MSCI Singapore	Dec 1969 – Aug 2014	17.4%	0.82	1.05
	Sep 1994 – Aug 2014	15.8%	0.12	0.03
	Sep 2004 – Aug 2014	9.2%	0.57	0.11
MSCI Asia (ex-Japan)	Dec 1987 - Aug 2014	15.3%	1.04	0.92
	Sep 1994 – Aug 2014	15.0%	0.50	0.42

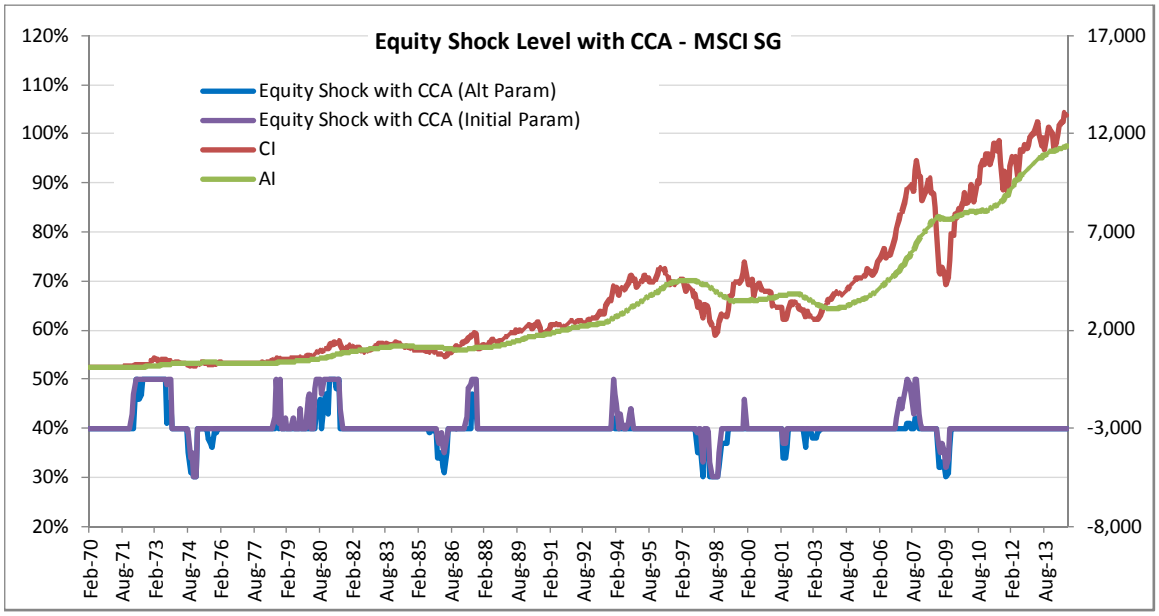
Index	Duration	*Probability of Adjustment*	*Duration Balance*	*Magnitude Balance*
	Sep 2004 – Aug 2014	14.2%	1.83	1.57
MSCI World	Dec 1969 – Aug 2014	11.0%	1.27	0.93
	Sep 1994 – Aug 2014	10.4%	0.19	0.07
	Sep 2004 – Aug 2014	7.5%	0.00	0.00

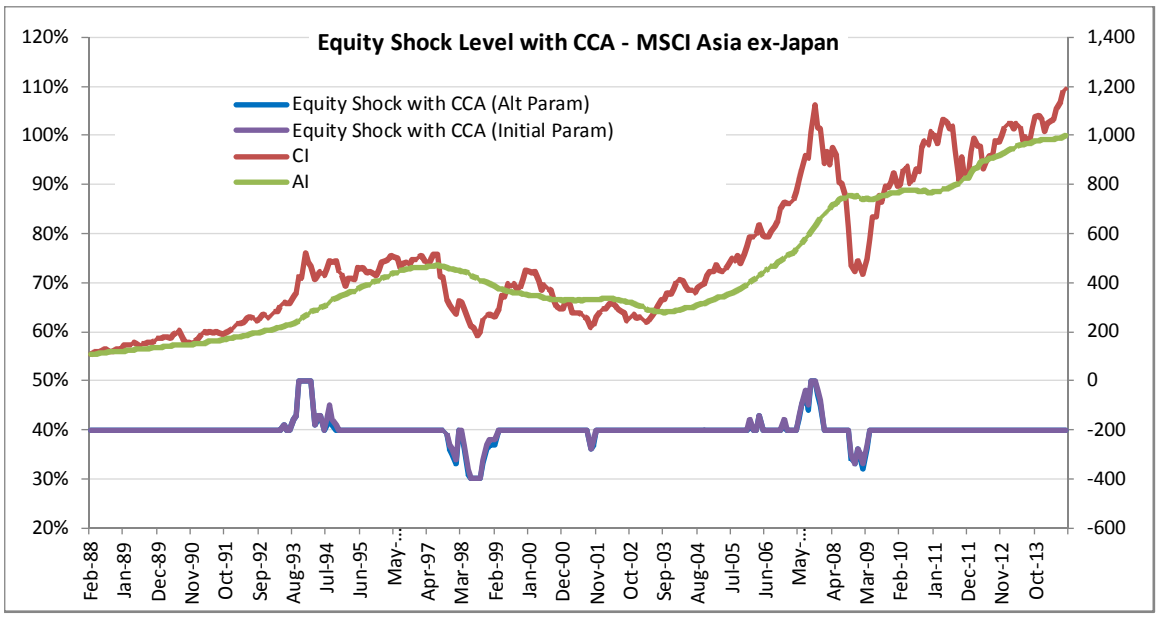
Contrasting the two set of parameters initial test, some additional observations can be made:

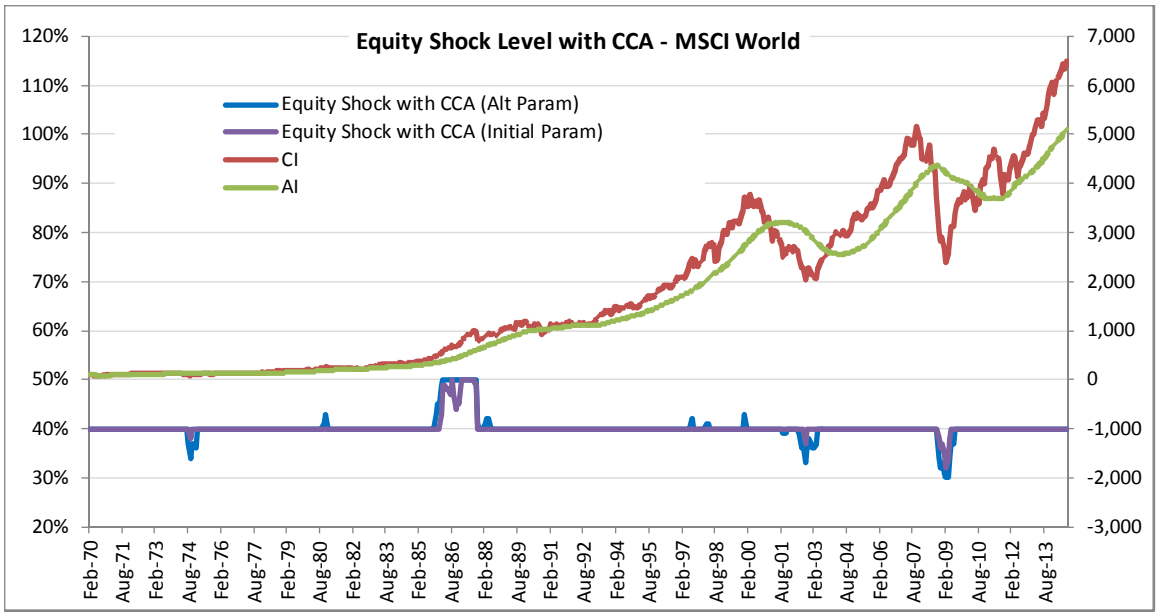
- For MSCI Singapore, targeting to improve the performance when the whole dataset is used leads to poorer performance in the last couple of decades. The alternative calibration would not have prepared insurers well when bubbles were building up before the 1997 Asian financial crisis and the 2008 global financial crisis.

- For MSCI World, lowering *g* and *Trigger* improve the frequency of activating equity CCA. However, CCA in the last two decades are still skewed towards downward adjustments.

The following diagrams show some back-testing results. The lines at the bottom of the diagram show how the equity risk charge, modified by the CCA, would have progressed over time on the various MSCI indices under different parameterization, assuming that the base risk charge is 40%.







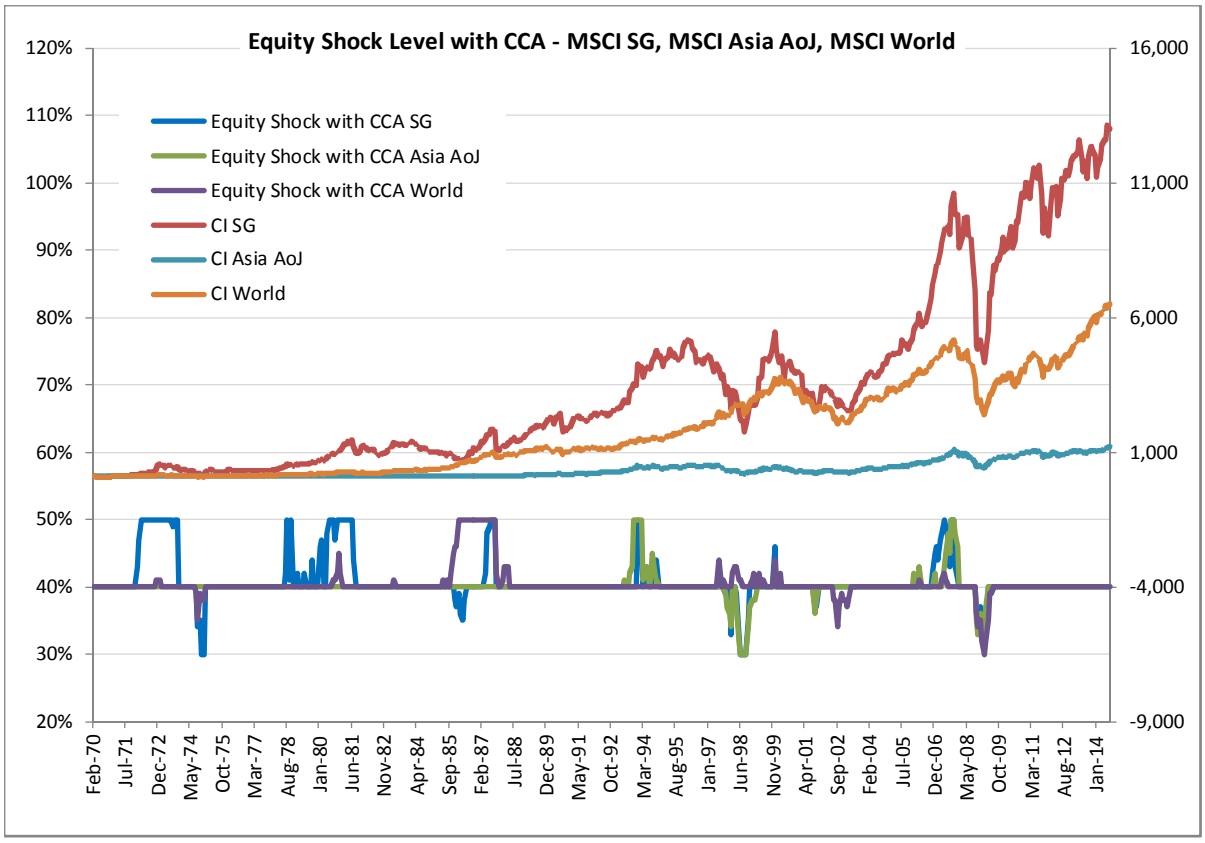
Using information from the two parameter sets above, the Working Party recommends the use of the following parameter set:

Index	***g***	***Trigger***	***Upper Limit***	***Lower Limit***
MSCI Singapore	8%	35%	10%	-10%
MSCI Asia (ex-Japan)	8%	35%	10%	-10%
MSCI World	3%	25%	10%	-10%

The reasons for recommending this parameter set are as follows:

- Singapore's economy has transformed and matured significantly since its independence 50 years ago. In setting the equity CCA parameters for RBC2 for the Singapore market, more reliance should be placed on performance indicator readings in the last two decades.
- For MSCI Asia (ex-Japan), the initial parameter set has performed sufficiently well.
- For MSCI World, since it has more weights on developed and mature economies, slower economic growth, and hence growth in equity prices, is expected going forward. Selecting a lower *g* parameter seems appropriate.

The graph below shows how the equity risk charge, modified by the CCA, would have progressed over time on the various MSCI indices under recommended parameter set, assuming that the base risk charge is 40%. One would observe that CCA is triggered at similar times with similar magnitude for MSCI Singapore and MSCI Asia (ex-Japan) in the past two decades as the performance of these two indices was highly correlated. CCA for the MSCI World behaved somewhat differently, with the most obvious difference being the period before the 2008 global financial crisis where not much upward adjustment was triggered before the crash. Adjusting the *g* parameter up further would have eliminated the upward CCA altogether.



Here are the performance indicator readings corresponding to the recommended set of parameters.

Index	Duration	*Probability of Adjustment*	*Duration Balance*	*Magnitude Balance*
MSCI Singapore	Dec 1969 – Aug 2014	19.2%	2.68	3.85
	Sep 1994 – Aug 2014	14.2%	1.00	1.00
	Sep 2004 – Aug 2014	16.7%	2.33	2.74
MSCI Asia (ex-Japan)	Dec 1987 - Aug 2014	15.3%	1.13	1.15
	Sep 1994 – Aug 2014	15.0%	0.57	0.56
	Sep 2004 – Aug 2014	14.2%	1.83	2.00
MSCI World	Dec 1969 – Aug 2014	15.1%	2.52	2.44
	Sep 1994 – Aug 2014	15.0%	1.00	0.48
	Sep 2004 – Aug 2014	10.8%	0.44	0.10

Sensitivity Testing

The following tables show the sensitivity of the performance indicators to changes in parameters. In general, if the sensitivities produce a less optimal set of indicators, this will serve to confirm that the proposed parameters are reasonable.

Note that change in *Upper Limit* and *Lower Limit* only affects the Magnitude Balance indicator. Change in *Trigger* has the most impact on Probability of Adjustment. If *Trigger* is set too low, equity CCA may be triggered too frequently. Change in *g* tends to have relatively more impact on Duration Balance and Magnitude Balance.

MSCI Singapore (Sep 1994 – Aug 2014)	***Probability of Adjustment***	***Duration Balance***	***Magnitude Balance***
Base	14.2%	1.00	1.00
Change *Upper Limit* and *Lower Limit* to +/- 5%	14.2%	1.00	0.95
Change *Upper Limit* and *Lower Limit* to +/- 15%	14.2%	1.00	0.95
Change *Trigger* to <base +5%>	10.4%	0.92	1.00
Change *Trigger* to <base -5%>	22.1%	0.77	0.91
Change *g* to <base +5%>	17.5%	0.40	0.39
Change *g* to <base -5%>	15.0%	1.77	2.36

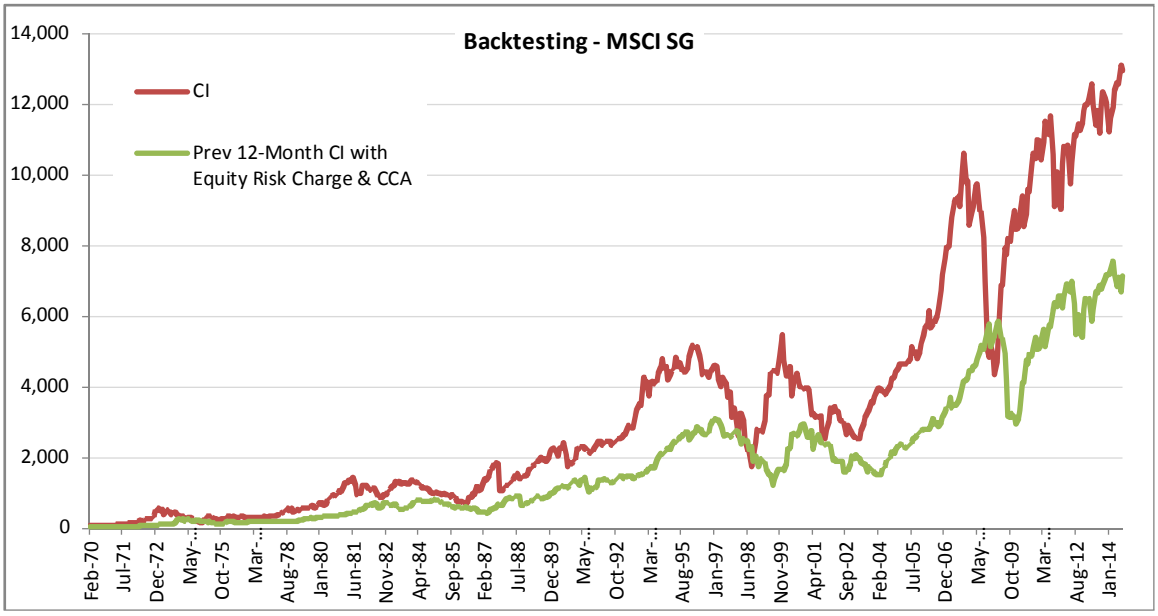
MSCI Asia (ex-Japan) (Dec 1987 - Aug 2014)	***Probability of Adjustment***	***Duration Balance***	***Magnitude Balance***
Base	15.3%	1.13	1.15
Change *Upper Limit* and *Lower Limit* to +/- 5%	15.3%	1.13	1.29
Change *Upper Limit* and *Lower Limit* to +/- 15%	15.3%	1.13	1.42
Change *Trigger* to <base +5%>	10.6%	0.89	1.25
Change *Trigger* to <base -5%>	21.6%	1.56	1.16
Change *g* to <base +5%>	13.4%	0.59	0.52
Change *g* to <base -5%>	18.8%	2.33	2.79

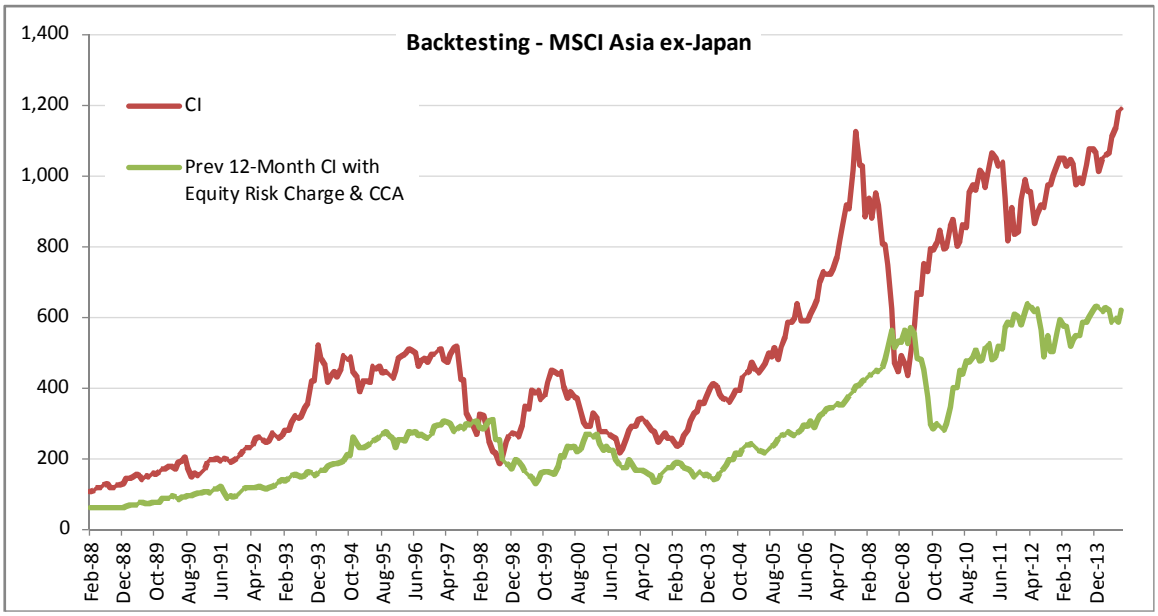
MSCI World (Dec 1969 – Aug 2014)	***Probability of Adjustment***	***Duration Balance***	***Magnitude Balance***
Base	15.1%	2.52	2.44
Change *Upper Limit* and *Lower Limit* to +/- 5%	15.1%	2.52	3.45
Change *Upper Limit* and *Lower Limit* to +/- 15%	15.1%	2.52	4.16
Change *Trigger* to <base +5%>	6.9%	3.11	5.09
Change *Trigger* to <base -5%>	33.4%	5.63	2.69
Change *g* to <base +5%>	10.3%	1.04	0.49
Change *g* to <base -5%>	30.0%	16.89	14.06

Validation

An appropriate CCA calibration should ensure that if the equity market suffers significant drop, the capital set aside a year ago according to the base risk charge, modified by CCA, would have provided the company with sufficient buffer. The validation test is designed with this in mind.

In the following graphs, the red line refers to the index level in a particular month. The green line refers to the index level 12-months ago, adjusted downwards proportionately based on the equity risk charge that has been modified by the CCA. An appropriate calibration would see the red line always staying above the green line.


Backtesting - MSCI SG
CI
Prev 12-Month CI with Equity Risk Charge & CCA
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Feb-70
Jul-71
Dec-72
May-...
Oct-75
Mar-...
Aug-78
Jan-80
Jun-81
Nov-82
Apr-84
Sep-85
Feb-87
Jul-88
Dec-89
May-...
Oct-92
Mar-...
Aug-95
Jan-97
Jun-98
Nov-99
Apr-01
Sep-02
Feb-04
Jul-05
Dec-06
May-...
Oct-09
Mar-...
Aug-12
Jan-14


Backtesting - MSCI Asia ex-Japan
CI
Prev 12-Month CI with Equity Risk Charge & CCA
1,400
1,200
1,000
800
600
400
200
0
Feb-88
Dec-88
Oct-89
Aug-90
Jun-91
Apr-92
Feb-93
Dec-93
Oct-94
Aug-95
Jun-96
Apr-97
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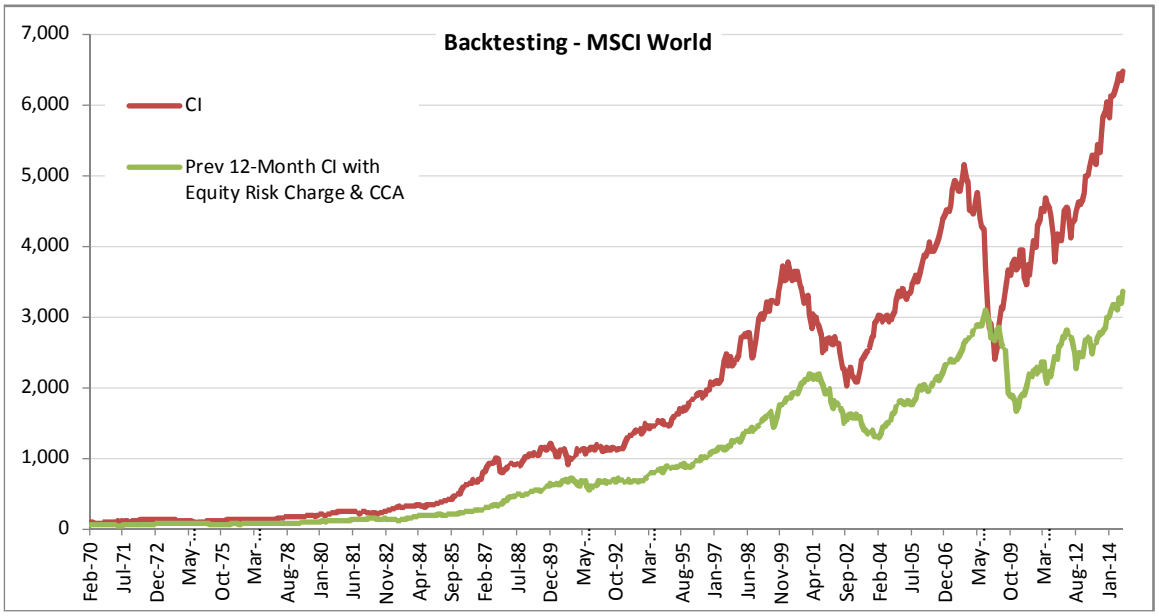


The validation test appeared to have failed for all indices during the 2008 global financial crisis and, for Singapore and Asia (ex-Japan), during the 1997 Asian financial crisis. However, out of a total of 46 months across all indices when the test failed (which in turn comes from close to 1400 months tested) none of those months had the failure been caused by the proposed equity CCA calibration. In other words, all the failures are linked to the base calibration. Therefore, the CCA proposals have not be invalidated.

Implementation Methods

The Working Party envisages that the proposed equity CCA formula and calibration be implemented as follows in RBC2:

- Equity CCA should be applied to all equity holdings, regardless of geography and listing status. It should not be restricted to Singapore listed equities. Analysis in this Section has shown that reversion behaviour exists not only in the Singapore equity markets, but also in Asian and global equity markets in general. In addition, even when an equity investment is not listed, its value will, to a greater or lesser extent, be influenced by general market movements. Unless MAS observes that a specific insurer's equity holdings are highly concentrated, equity should apply to insurers' entire equity portfolio even if some of the securities are not listed. The Working Party also noted that insurers tend to hold a diversified equity portfolio given the penalty from RBC's C3 (concentration) risk requirement calibration.

- Equity CCA should also apply to equity exposures held via collective investment schemes.

- Insurers are to allocate their equity exposures into three market groupings. All Singapore equities will be grouped under "Singapore". All non-Singapore equities but relate to Asia (ex-Japan) are grouped under "Asia (ex-Japan)". All remaining exposures are grouped

under “Rest of the World”. MSCI Singapore, MSCI Asia (ex-Japan) and MSCI World should be chosen as the proxies, which correspond to the three market groupings. When equity CCA is triggered for each of the three groups of exposures will then depend on the CI/AI ratios of its corresponding proxy. This means that equity CCA can be triggered at different times for equity exposures allocated to different groupings.

- The calibration of equity CCA should be reviewed once every three years using the methodology described in this document. Where the prevailing calibration no longer meets the performance indicators, they should be adjusted. Insurers should be given 12 months to roll out the new calibration so that it would not lead to excessive disruption in insurer’s capital planning process.

4. Counter-cyclical Adjustment for Credit Spread Risk

Data

Three historical spread datasets were chosen for the investigation into the reversion behaviour of credit risk; and to calibrate and validate the Working Party's proposal on CCA. The full dataset of each is used instead of restricting to data from the recent decade.

Dataset	**Period**
US Long-term Corporate Bonds (Moody's) – split by broad rating classes for investment-grade credits	Jan 1919 – Dec 2013
US Intermediate-term Corporate Bonds (Moody's) – split by broad rating classes for investment-grade credits	Jun 1994 – Dec 2011
J.P. Morgan Asia Credit Index Singapore	Sept 2005 – Jun 2012

For each of the chosen dataset, the spread level on the last day of each month is noted.

Limitations

Credit spread data is relatively scarce compared to data on the equity markets. Among the datasets chosen, the history of spread data for Singapore and US intermediate-term bonds are also significantly shorter than that for US long-term bonds. This document tends to place greater reliance on the US long-term bond data since it provides more credibility in the analysis of reversion behaviour over time.

The three datasets chosen relate only to dollar-denominated issues. While that covers a significant portion of the part of insurers' bond holdings that are subject to credit risk requirements, applying it to issues denominated in other currencies, especially in Singapore Dollars, should be tested in QIS2.

Each dataset chosen deals with around 100 issues. The investible universe is much wider; and insurers generally do not seek to replicate bond indices in their investment process due to liquidity and return considerations. It is recognized that there would be some basis risk between the behaviour observed using the selected dataset and the actual behaviour of insurer's credit portfolio.

Spread data can be influenced by embedded options, e.g. call option given to the issuer. The extent of influence is in turn dependent on the relationship between prevailing interest rate and the yield of specific issues. Where the impact of embedded options is significant, an issue is often excluded from the dataset. How credit spread CCA should be applied to callable bonds which embedded options are nearly at- or in-the-money is out of scope of this document. It should be dealt with consistently together with the interest rate mismatch risk requirement discussion.

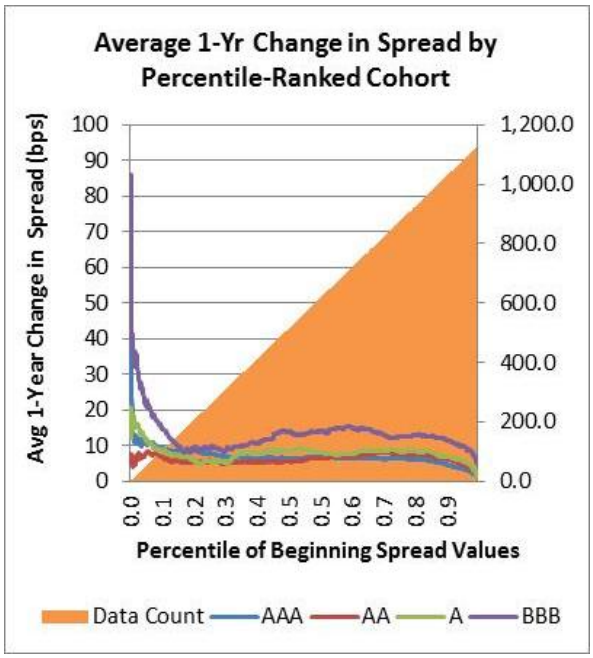
Reversion Behaviour Analysis

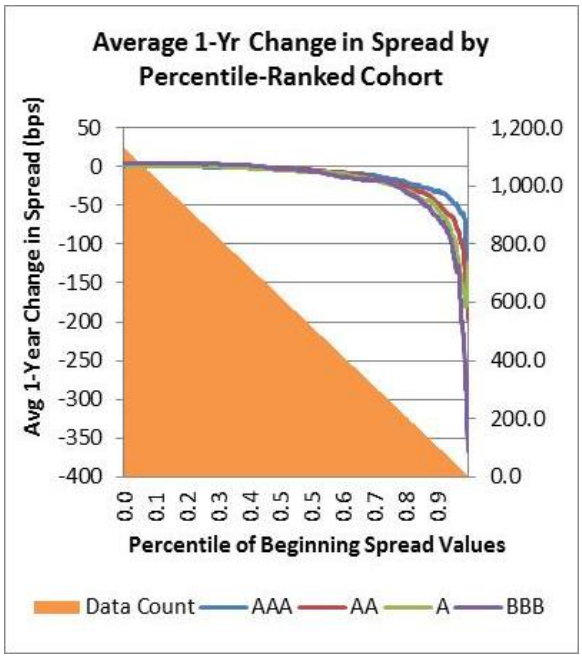
To assess whether reversion behaviour exists for spread risk, 1-year movement in the spread level is calculated. Spread movements are calculated for each broad rating class (AAA/AA/A/BBB) separately where the data permit. The spread movement data are then sorted according to the starting spread level.

A pair of graphs is plotted for each of the three datasets analysed.

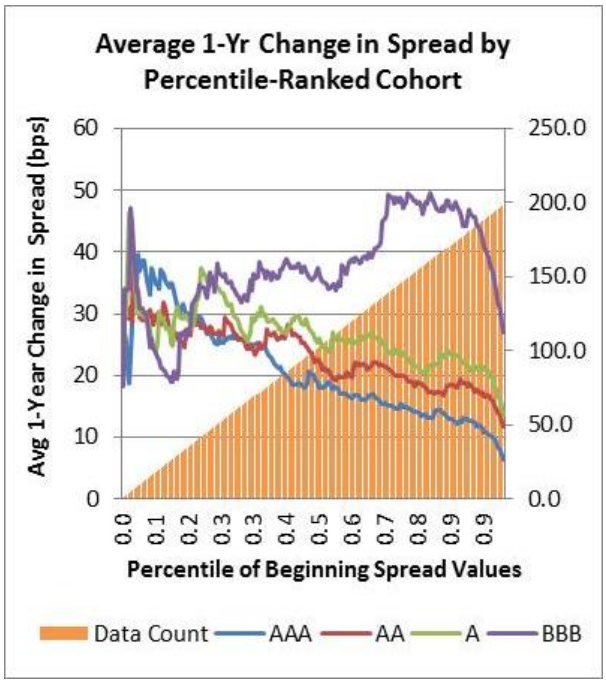
- The coloured line in each graph shows the average 1-year spread movement for a subset of the dataset.
- For the graph on the left, and reading it from right to left, data related to the highest starting spread are progressively excluded from the analysis. If there is reversion behaviour, then the average 1-year movement is expected to trend upwards. An upward trend indicates that when spread level is low relative to historical average, it is more likely to rebound higher.
- For the graph on the right, and reading it from left to right, data related to the lowest starting spread are progressively excluded from the analysis. If there is reversion behaviour, then the average 1-year movement is expected to trend downwards. A downward trend indicatesthat when spread level is high relative to historical average, it is more likely to revert back to a lower level.

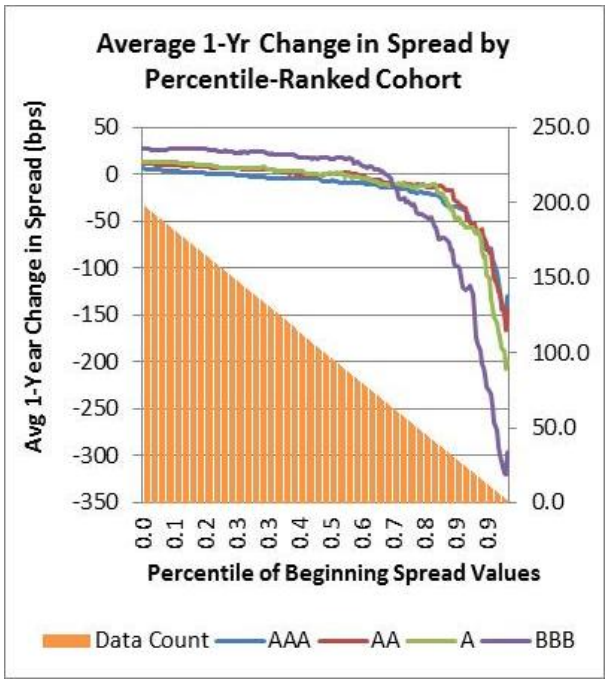
US Long-term Corporate Bonds



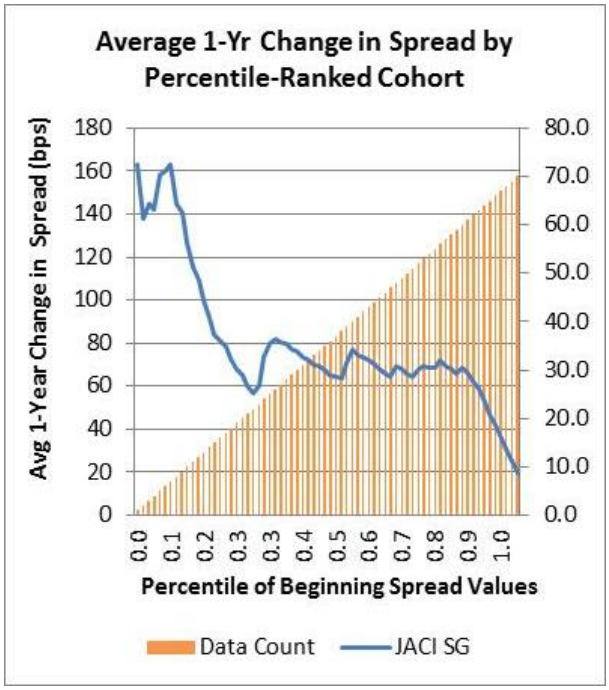


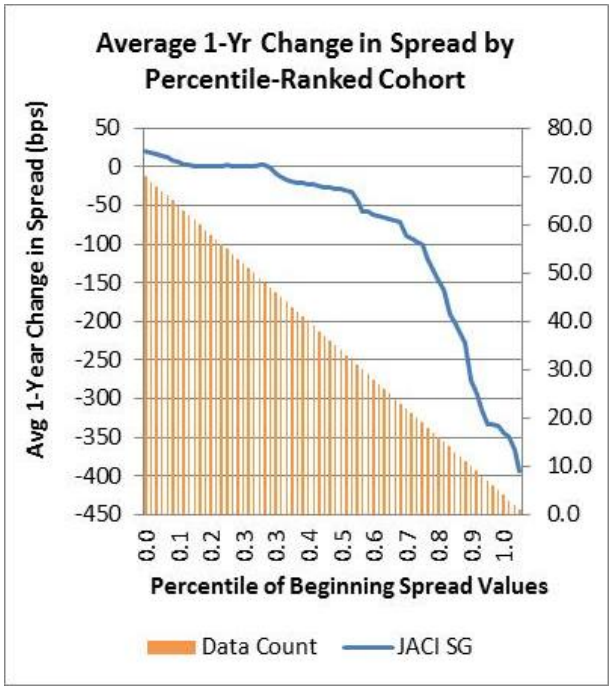
US Intermediate-term Corporate Bonds





JACI Singapore





Observations

The following observations can be made from these graphs for about the reversion behaviour of credit spread in these three datasets.

- For all the graphs on the right, it is observed that the expected 1-year movement in spread does trend down significantly when data points with the highest starting spreads are used. This indicates that when spread level is high relative to historical average, it is more likely to revert back to a lower level.

- Behaviour shown in the graphs on the left are less consistent. For the JACI Singapore dataset which has a shortest history, it is observed that the expected 1-year movement in spread does trend upwards significantly when data points with the lowest starting spreads are used. This indicates that when spread level is below the trend line, it is more likely to rebound higher. However, such reversion behaviour is much weaker or non-existent when one looks at the results from different rating classes in the US intermediate- and long-term bond data.

Unlike equity CCA where data suggest bi-directional adjustments, the credit spread data suggest that credit spread CCA should be applied only when spread is high relative to historical average. CCA is not necessary when spreads are compressed.

The datasets cover investment-grade credits. As such, the datasets supports application of CCA not only to Singapore investment-grade credits, but investment-grade credit exposure worldwide. Non-investment grade credits were not analysed in this study. While the Working Party expects similar reversion behaviour in the spread data of non-investment grade credit, it also expects that "survival bias" would have an increasing contribution to the observed reversion as one goes down the rating scale. (e.g. Some reversion is contributed by downgraded/ defaulted issues leaving the rating class.) The Working Party would therefore recommend more detailed analysis before applying CCA to non-investment grade credits.

Comparing all the three graphs on the right, one would also observe that the gradient and curvature at which the coloured lines move down when the datasets get smaller is not the same. For both the JACI Singapore dataset and the US long-term bond dataset, the coloured lines start to accelerate quickly downwards when there are about 20-30% of the data points left in the dataset. For the US intermediate-term bond dataset, the coloured lines start to accelerate downwards only when there are about 10% of data points left in the dataset.

This supports the Society's view that credit spread CCA should be triggered only after significant spread movements because reversion behaviour may not be as strong when prevailing spread level is close to historical average.

Functional Form and Parameterization

Key Performance Indicators

To assess whether the proposed functional form and parameterization of credit spread CCA are acceptable, the Working Party proposes to use the probability of triggering CCA as the performance indicator. Indicators about balance between upward and downward adjustments used for equity CCA is not applicable here as the proposed credit spread CCA only deals with spread widening beyond historical average.

Indicator Name	Definition	Target
Probability of Adjustment	Number of months where CCA leads to non-zero adjustments to the base calibration *divided by* Total number of months in the dataset.	Less than 20%. This is to ensure that CCA will not be triggered too frequently. This approach is in line with the guiding principles.

There may be many CCA formula/ parameterization combinations that meet the performance indicator. However, it is not the intent of the Working Party to pursue spurious accuracy and find the "perfect calibration". It would suffice as long as the Working Party finds an intuitive CCA formula with parameterization that can fulfil the performance indicator.

Functional Form

Europe's Solvency II does not have a CCA feature for credit spread risk. This leads the Working Party to develop the CCA formula from first principles.

First, a hypothesis is made that spread change over a 1-year period can be represented by the following process:

$$\boldsymbol{LN}(X+S) = \boldsymbol{LN}[A \times \boldsymbol{MAX}(S-L, \boldsymbol{0}) + S] + B \times Z$$

where

- *S* is the beginning spread
- *X* is the spread change over the next 1 year
- (*X* + *S*) is the spread at the end of 1 year
- *L* is the spread level where reversion behaviour starts
- *A* is a parameter governing the speed of reversion
- *B* is the volatility of the spread change
- *Z* is a standard normal random variable

This can be explained to layperson by saying that "the CCA model for credit spread assumes that reversion behaviour starts from spread level *L*. The speed at which spread gets pulled back towards level *L* after significant widening is proportional to how far spread is above level *L*. Use of the logarithm function ensures that spread at the end of 1 year will not be negative.

Once the parameters *A* and *L* are determined, credit spread CCA can be written as:

$$\boldsymbol{MAX}[A \times \boldsymbol{MAX}(S - L, \boldsymbol{0}), -Base\ Stress]$$

where *Base* Stress refers to the base RBC2 calibration for credit spread risk requirement. As the sign of *A* is generally negative, credit spread CCA would be a deduction from the base RBC2 requirement for credit spread risk. The magnitude of the adjustment is capped at the base RBC2 calibration.

Parameter Calibration and Sensitivity Testing

Calibration of credit spread CCA parameters start with calculating the estimates for parameters A, B and L for each dataset and, where the data permit, for each board rating class using the maximum likelihood method.

The following key statistics are observed for the datasets analysed:

(bps)	**AAA**		**AA**		**A**		**BBB**		
	US LT	**US IT**	**US LT**	**US IT**	**US LT**	**US IT**	**US LT**	**US IT**	**JACI(S)**
Average Spread	71	89	96	113	128	141	185	197	206
Volatility	40	46	50	57	67	76	92	117	128

Note: Dataset for JACI Singapore is not split by broad rating class, but its constituents are assessed to be rated BBB on average.

The table below summarizes the model parameters derived using the maximum likelihood method.

	AAA		**AA**		**A**		**BBB**		
	US LT	**US IT**	**US LT**	**US IT**	**US LT**	**US IT**	**US LT**	**US IT**	**JACI(S)**
L	103	124	144	169	191	211	277	302	279
A	-0.88	-0.98	-1.13	-1.04	-0.93	-0.90	-0.80	-1.00	-1.39
B	0.42	0.50	0.32	0.46	0.30	0.43	0.29	0.44	0.53

Several observations can be made:

- The average spread level on the US intermediate-term bonds is higher than that of the US long-term bonds. The *L* parameter (reversion trigger level) is also higher for US intermediate-term bonds by a similar quantum. Note that the US intermediate-term bonds dataset has a shorter history, which did not cover a period of low spreads in the US during the 1940s-1960s.

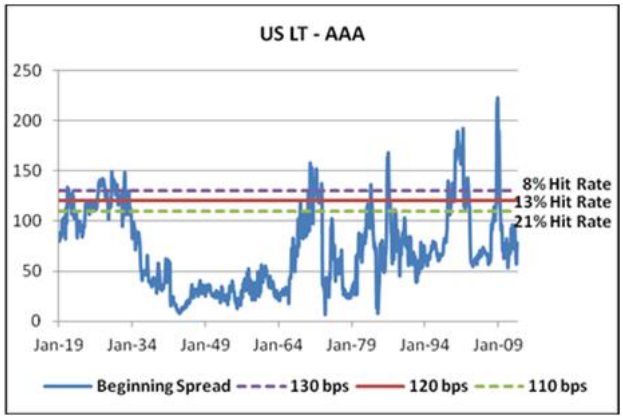
- Most of the *A* parameters (speed of reversion) fall between -0.8 and -1.1.

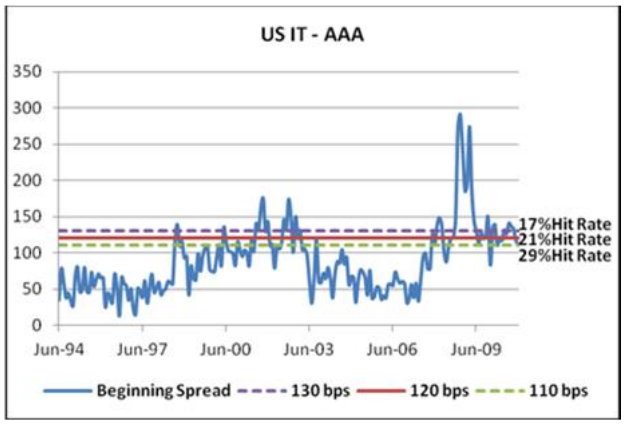
- The *B* parameters (volatility of residual term of spread change process) are in line with the volatility of spread in the datasets; with the intermediate-term bonds seeing more volatility.

The performance indicator reading is influenced solely by the parameter *L*. The following table summarizes the sensitivity of performance indicator readings to *L*. Indicator readings that are underlined and in bold represent the levels of *L* closest to the maximum likelihood

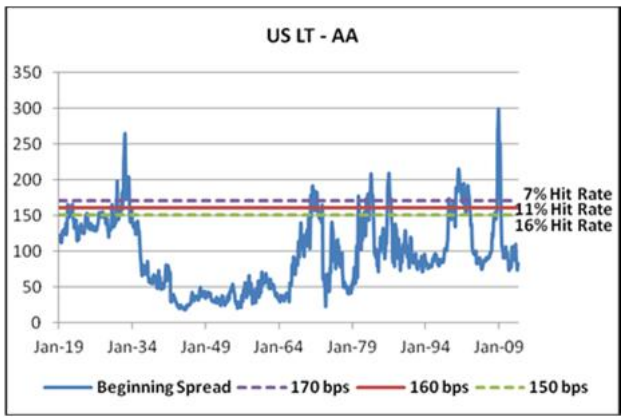
estimates. Also included are graphs showing when CCA could have been triggered historically at various levels of *L*.

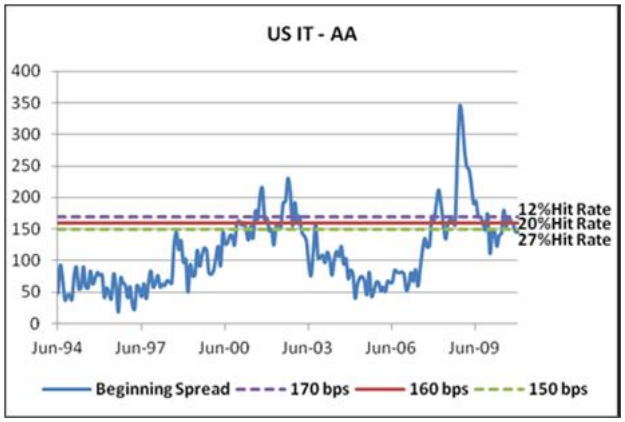
	AAA	
	US LT	**US IT**
90	31%	44%
100	**26%**	39%
110	21%	29%
120	13%	**21%**
130	8%	17%
140	5%	10%
150	3%	6%



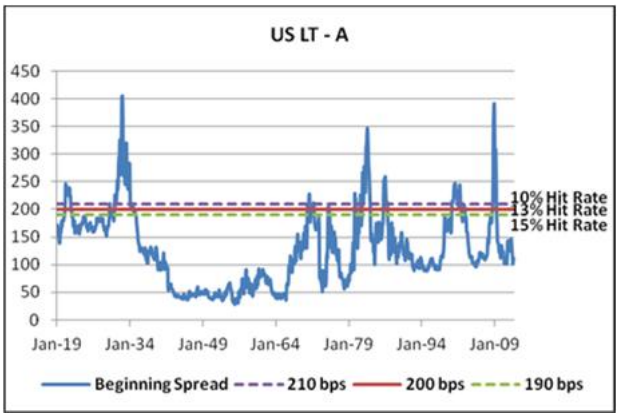


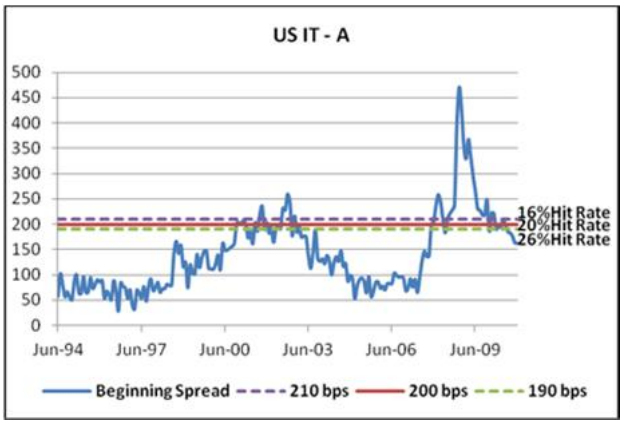
	AA	
	US LT	**US IT**
130	28%	37%
140	**21%**	33%
150	16%	27%
160	11%	20%
170	8%	**12%**
180	5%	10%
190	3%	9%



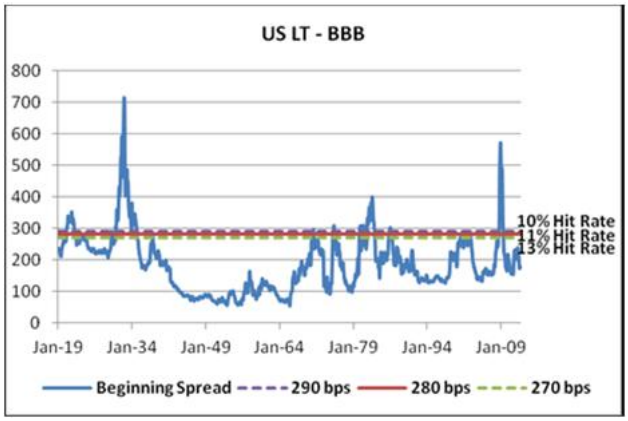


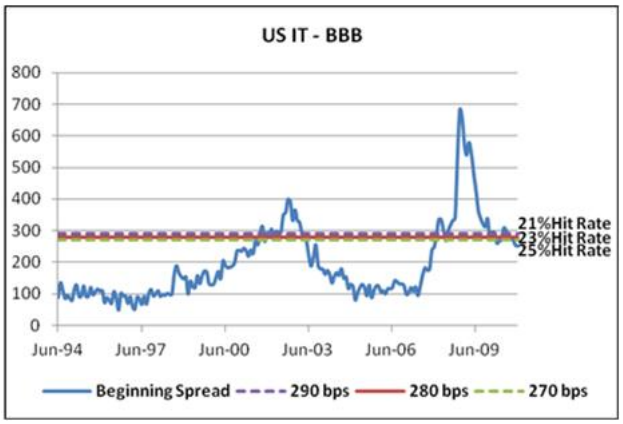
	A	
	US LT	**US IT**
170	26%	33%
180	20%	30%
190	**15%**	26%
200	13%	20%
210	10%	**16%**
220	9%	13%
230	7%	10%

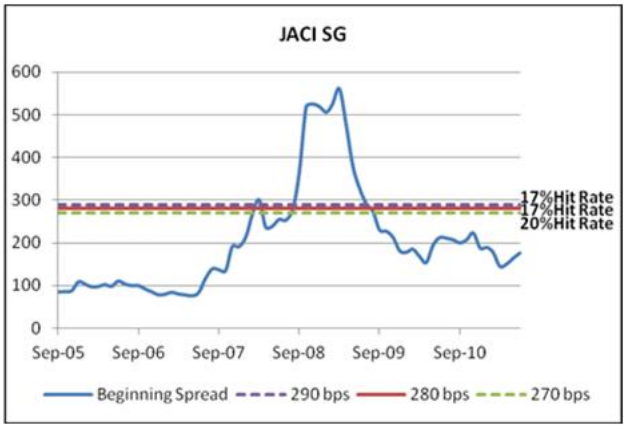




	BBB		
	US LT	**US IT**	**JACI(S)**
250	20%	30%	24%
260	17%	28%	21%
270	13%	25%	20%
280	**11%**	23%	**17%**
290	10%	21%	17%
300	9%	**16%**	16%
310	8%	14%	14%







Several observations can be made:

- For the same trigger level *L*, performance indicator readings for long-term and intermediate-term bonds varies quite significantly. If credit spread CCA uses the same trigger level for all bonds, it may cause "over-activation" of CCA for intermediate-term credit or "under-activation" of CCA for long-term credit. Neither situation is desirable based on the guiding principles.

- For AAA-rated credits and long-term AA-rated credits, using the maximum likelihood estimates of *L* lead to a breach of performance target. A higher trigger level should be selected.

The following set of *L* parameters, differentiated by rating class and term-to-maturity, are therefore proposed for credit spread CCA. Term-to-maturity buckets are aligned to MAS' credit spread risk proposals in the second consultation paper. The Working Party has restricted itself to proposing parameters for investment grade credits only.

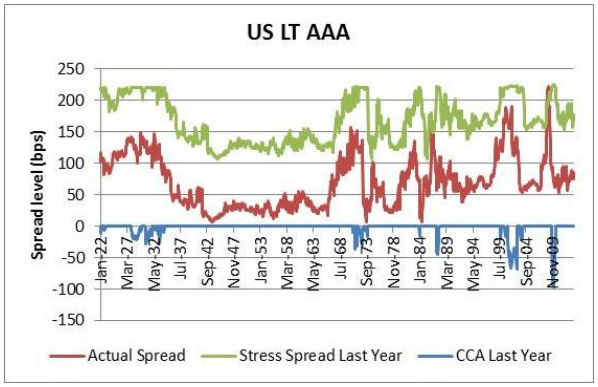
Term	**AAA**	**From AA- to AA+**	**From A- to A+**	**From BBB- to BBB+**
Up to 10 years	140	180	210	310
More than 10 years	120	150	200	290

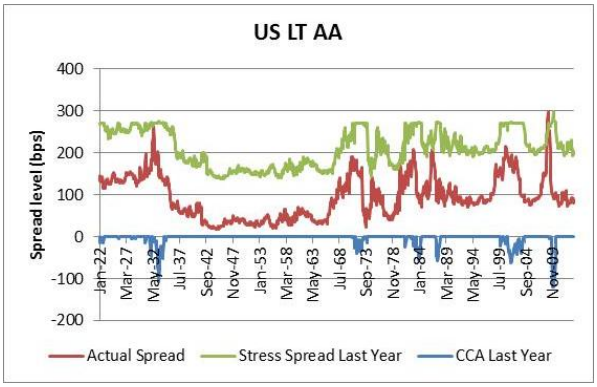
As for the parameter *A*, the Working Party deems it practical to adopt the same parameter regardless of rating class and term-to-maturity as the analysis showed no observable pattern along those dimensions. An *A* parameter of (-0.95), approximately the median among the different dataset is recommended.

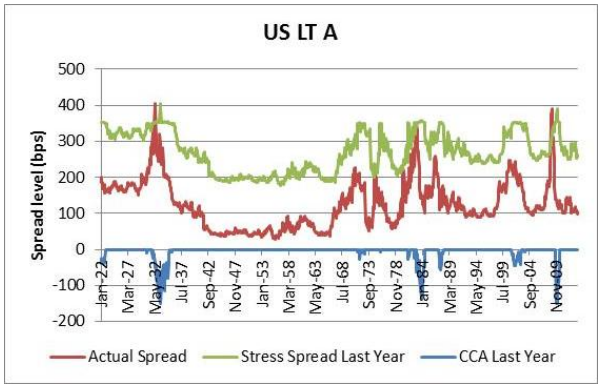
Validation

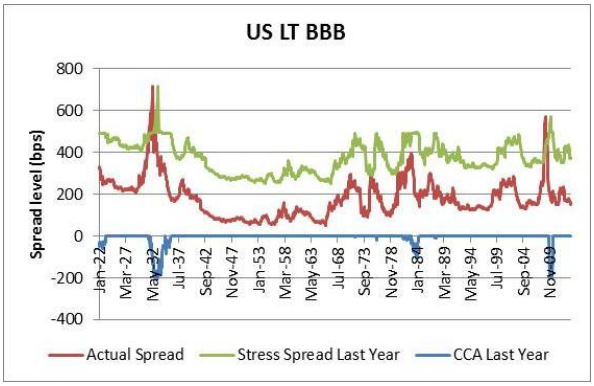
An appropriate CCA calibration should ensure that if there is a significant spike in spread, the capital set aside a year ago according to the base risk charge, modified by CCA, would have provided the company with sufficient buffer. The validation test is designed with this in mind.

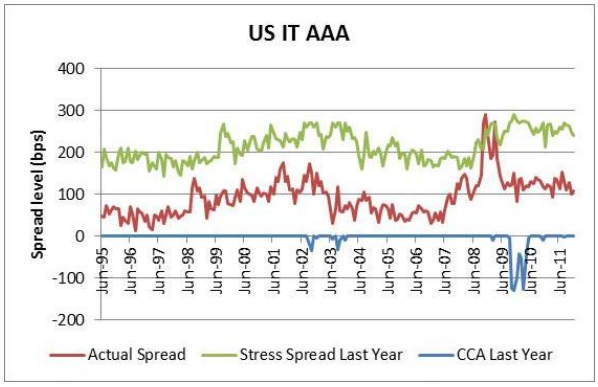
In the following graphs, the red line refers to the spread level in a particular month. The green line refers to the spread level 12-months ago, adjusted upwards based on the credit spread risk charge that has been modified by the CCA. (The base risk charge is taken from the RBC2 QIS1 calibration. Base risk charge for ">10 years" is used for validating US long-term bond data. Base risk charge for "between 5 years to 10 years" is used for validating US intermediate term bond data and data for JACI Singapore. Risk charge for BBB-rated credits is used to validate JACI Singapore data. An appropriate calibration would see the red line always staying below the green line.

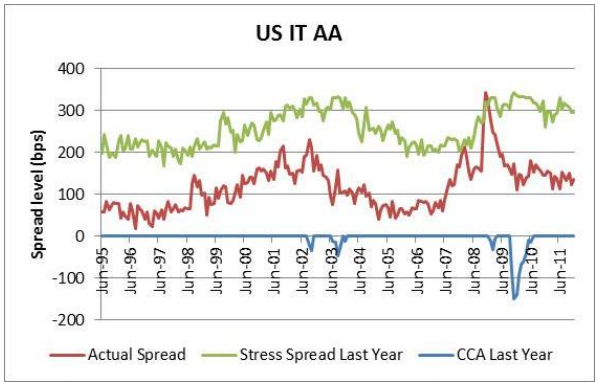


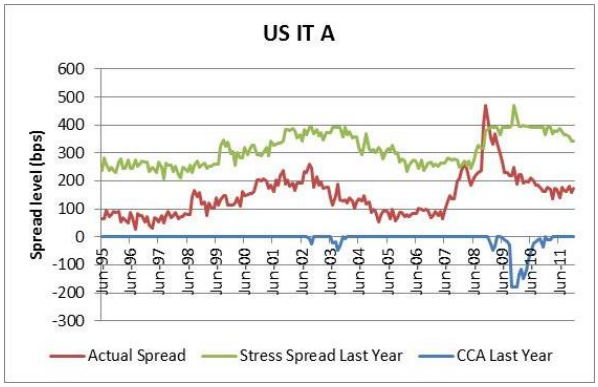


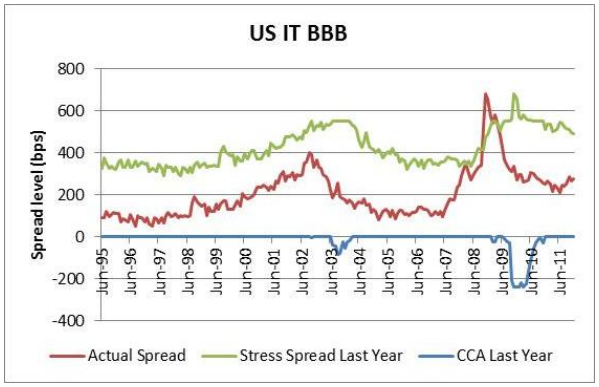


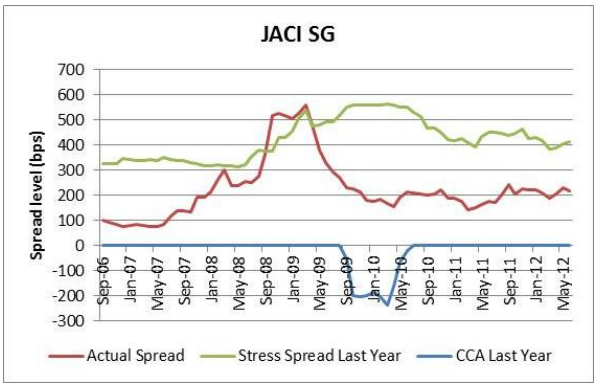












The following were observed in those instances where the red lines go above the green lines:

- The validation test appeared to have failed for all datasets and across all rating classes during the 2008 global financial crisis. However, in all but one instance (BBB-rated US intermediate-term bonds), the red line goes above the green line when CCA was not in operation. (i.e. when the base risk charge was not adjusted downwards) The chosen CCA parameters are not invalidated in these instances.

- There were other instances when CCA is in operation and the red line goes above the green line. These instances are (i) Oct-Dec 1931, for BBB-rated US long-term bonds; (ii) Apr-Jul 1932, for A-rated and BBB-rated US long-term bonds; and (iii) Mar 2009, for BBB-rated US intermediate-term bonds. In all these instances, removing the effects of CCA would have no impact on the validation test results. Each of these instances lasted for 1 to 4 months. Noting that cash flows arising from life insurance liabilities are fairly predictable, the validation test for the selected CCA parameters can be considered a

borderline pass. Whether the calibration is appropriate for non-life business is more nuanced. It would depend on an insurer's reinsurance management strategy which has significant influence on the predictability of an insurer's cash flows. Temporary reduction in value of bond holdings would matter less for insurers with better cash flow predictability.

Implementation Methods

The Working Party envisages that the proposed credit spread CCA formula and calibration be implemented as follows in RBC2:

- Credit spread CCA should be applied to all investment grade credits that are subjected to the credit spread risk module in RBC2, regardless of geography. "Investment grade" refers not only to credits that are rated by rating agencies. The Society has in its July 2014 response recommended recognizing internal credit rating models under RBC2 to the extent that these models meet the criteria specified by MAS. Credits that are deemed investment grade by admissible model should be eligible for CCA. Non-investment grade credits are exposed to greater rating transition/ default risk and spread may therefore not revert. To what extent should non-investment grade credits be eligible for CCA requires further investigation.

- Credit spread CCA should also apply to credits held via collective investment schemes.

- Unlike equity CCA, no proxy will be used for credit spread CCA. Instead, reliance is placed on the yield of each instrument held. The prevailing spread of each instrument needs to be derived as it is a necessary input to the CCA formula. Spread for each instrument is derived by deducting the relevant sovereign yield from the total yield of the instrument. For an instrument denominated in the currency of Country X, "relevant sovereign yield" refers to the yield curve on sovereign bonds issued by Country X in its own currency. In another words, all USD-denominated and SGD-denominated bonds will make reference to US Treasury and Singapore Government Securities yield curves respectively, regardless of the domicile of the bond issuer. In the case of EUR-denominated bonds, the best rated Eurozone country should be chosen as the reference point (i.e. German Bund yield curve becomes the likely candidate). Based on the same logic, Argentinian government bonds denominated in USD will still use US Treasury yield curve as reference point. This methodology means that credit spread CCA can be triggered at different times for different instruments individually depending on each instrument's current spread.

- Credit spread CCA should also apply to assets earmarked in Matching Adjustment calculations or assets that are part of the reference portfolio in Volatility Adjustment calculations. The Society has in its July 2014 response suggested granting more flexibility to the Matching Adjustment rules, and introducing Volatility Adjustment (/illiquidity premium), in the valuation of insurance liabilities under RBC2.

- The calibration of credit spread CCA should be reviewed once every three years using the methodology described in this document. Where the prevailing calibration no longer meets the performance indicators, they should be adjusted. Insurers should be given 12 months to roll out the new calibration so that it would not lead to excessive disruption in insurer's capital planning process.

Appendix 1 – Summary of Proposals

Equity CCA

Functional form for equity CCA:

Condition	Counter-cyclical Adjustment
If $$\boldsymbol{ABS}\left[\left(\frac{CI}{AI}\right)-(1+g)\right] \leq Trigger$$	0
Else if $$\left[\left(\frac{CI}{AI}\right)-(1+g)\right] > Trigger$$	$$\boldsymbol{MIN}\left[\frac{\left(\frac{CI}{AI}-(1+g+Trigger)\right)}{2}, Upper\ Limit\right]$$
Else if $$\left[(1+g)-\left(\frac{CI}{AI}\right)\right] > Trigger$$	$$\boldsymbol{MAX}\left[\frac{\left(\frac{CI}{AI}-(1+g-Trigger)\right)}{2}, Lower\ Limit\right]$$

Where

- *CI* refers to the current index level;
- *AI* refers to the average index level in past 36 months;
- *g* is a constant, which can be intuitively interpreted as some "natural trend" of equity growth;
- *Trigger*, which is designed to be symmetrical about *g*, defines the amount of deviation from growth trend required to trigger equity CCA;
- *Upper Limit* and *Lower Limit* help to cap the adjustments that CCA can make to the base equity shock calibration.

Proposed parameters:

Index	*g*	*Trigger*	*Upper Limit*	*Lower Limit*
MSCI Singapore	8%	35%	10%	-10%
MSCI Asia (ex-Japan)	8%	35%	10%	-10%
MSCI World	3%	25%	10%	-10%

Proposed operational rules:

- Equity CCA should be applied to all equity holdings, regardless of geography and listing status.
- Equity CCA should also apply to equity exposures held via collective investment schemes.
- Insurers are to allocate their equity exposures into three market groupings. All Singapore equities will be grouped under "Singapore". All non-Singapore equities but relate to Asia (ex-Japan) are grouped under "Asia (ex-Japan)". All remaining exposures are grouped under "Rest of the World". MSCI Singapore, MSCI Asia (ex-Japan) and MSCI World should be chosen as the proxies, which correspond to the three market groupings. When equity CCA is triggered for each of the three groups of exposures will then depend on the CI/AI ratios of its corresponding proxy. This means that equity CCA can be triggered at different times for equity exposures allocated to different groupings.
- The calibration of equity CCA should be reviewed once every three years using the methodology described in this document. Where the prevailing calibration no longer meets the performance indicators, they should be adjusted. Insurers should be given 12 months to roll out the new calibration so that it would not lead to excessive disruption in insurer's capital planning process.

Credit Spread CCA

Functional form of credit spread CCA:

$$\boldsymbol{MAX}[A \times \boldsymbol{MAX}(S - L, \mathbf{0}), -Base\ Stress]$$

where

- *S* is the beginning spread;
- *L* is the spread level where reversion behaviour starts;
- *A* is a parameter governing the speed of reversion;
- *Base* Stress refers to the base RBC2 calibration for credit spread risk requirement.

Proposed parameters for *L*:

Term	**AAA**	**From AA- to AA+**	**From A- to A+**	**From BBB- to BBB+**
Up to 10 years	140	180	210	310
More than 10 years	120	150	200	290

Proposed parameter *A* = (-0.95).

Proposed operational rules:

- Credit spread CCA should be applied to all investment grade credits that are subjected to the credit spread risk module in RBC2, regardless of geography. "Investment grade" refers to credits that are rated investment grade by rating agencies or admissible internal credit rating models.

- Credit spread CCA should also apply to credits held via collective investment schemes.

- The prevailing spread of each instrument needs to be derived by deducting the relevant sovereign yield from the total yield of the instrument. For an instrument denominated in the currency of Country X, "relevant sovereign yield" refers to the yield curve on sovereign bonds issued by Country X in its own currency. In another words, all USD-denominated and SGD-denominated bonds will make reference to US Treasury and Singapore Government Securities yield curves respectively, regardless of the domicile of the bond issuer. In the case of EUR-denominated bonds, the best rated Eurozone country should be chosen as the reference point (i.e. German Bund yield curve becomes the likely candidate). This methodology means that credit spread CCA can be triggered at different times for different instruments individually depending on each instrument's current spread.

- Credit spread CCA should also apply to assets earmarked in Matching Adjustment calculations or assets that are part of the reference portfolio in Volatility Adjustment calculations.

- The calibration of credit spread CCA should be reviewed once every three years using the methodology described in this document. Where the prevailing calibration no longer meets the performance indicators, they should be adjusted. Insurers should be given 12 months to roll out the new calibration so that it would not lead to excessive disruption in insurer's capital planning process.

Appendix 2 – CCA Working Party Members

Cheung Kwok Kei (Chairperson of Life Insurance Committee)
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Jess Kang
Alex Lee
Harry Lee
Ng Kok G
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Also, a big thank you to other members of the Society who have contributed in the research.

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