LCH.CLEARNET

Understanding the SwapClear Default Fund Sizing Methodology

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1 Executive Summary

1.1 Introduction

The purpose of this document is to present a comprehensive description of how SwapClear has constructed the suite of stress test scenarios used to size the SwapClear Default Fund. The paper will set out the methodologies used to identify historic scenarios and formulate and validate theoretical scenarios.

1.2 Scenario selection overview

SwapClear has collated a combination of historical and theoretical scenarios to form a suite of stress test scenarios. The combination of scenarios ensures a balanced quantitative and qualitative overlay to its approach providing a greater degree of protection within the mutualised layer of LCH.Clearnet's and SwapClear's financial resources

1.3 Default Fund requirements

LCH.Clearnet's risk framework includes a mutualised layer in its waterfall to capture tail market events, which are beyond the 99.7% confidence interval threshold, to protect itself from the default of the largest two members that it has exposure to. This complies with EMIR/Dodd Frank regulatory obligations.

1.4 Document structure

The document sets out the following areas:

- Regulatory background for Default Fund sizing
- Definition of the types of scenarios and methodologies for scenario selection
- Default Fund rebalancing approach
- Stress testing internal governance

To ensure ease of reading, the stress testing paper has been split up into two documents:

- Understanding the SwapClear Default Fund sizing methodology
- Appendix document for the SwapClear Default Fund sizing methodology paper

2 Default Fund Sizing – regulatory background

The sizing of the Default Fund follows standards governing the assessment of financial resources in the LCH.Clearnet Group Risk Financial Adequacy Resource Policy (aligning to the Group Risk Appetite), CPSS-IOSCO recommendations for central counterparties and EMIR/Dodd-Frank regulatory obligations.

The two main functions of the SwapClear Default Fund are:

i) Provide SwapClear with the necessary mutualised resources to manage a default under "extreme and plausible" stressed market conditions over and above any margin held from the defaulter and available LCH.Clearnet Ltd capital and;

ii) Incentivise Clearing Members to participate and bid competitively in the auction, by ensuring members have enough funds at risk, during the Default Management Process.

Group Risk Appetite recognises that in the event of a default during extreme market stress, Initial Margins may be insufficient to cover losses above the market standard 99.7% confidence level covering expected losses in normal market conditions. Therefore, in accordance with CPSS-IOSCO principals and regulatory requirements, SwapClear follows the LCH.Clearnet Limited policy of adopting a "Cover 2" standard for its Default Fund

2.1 CPSS-IOSCO Principal 4: Credit Risk

"An FMI should effectively measure, monitor, and manage its credit exposures to participants and those arising from payment, clearing and settlement processes. An FMI should maintain financial resources to cover its credit exposure to each participant fully with a high degree of confidence. In addition, a CCP that is involved in activities with a more-complex risk profile or that is systemically important in multiple jurisdictions should maintain additional financial resources sufficient to cover a wide range of potential stress scenarios that should include, but not be limited to, the default of the two participants and their affiliates that would potentially cause the largest aggregate credit exposure to the CCP in extreme but plausible market conditions."

2.2 Regulatory Technical Standards on Requirements for Central Counterparties

RTS 49/53/1 - *A CCP's stress-testing programme shall ensure that its combination of margin, default fund contributions and other financial resources are sufficient to cover the default of at least the two clearing members to which it has the largest exposures under extreme but plausible market conditions. The stress testing programme shall also examine potential losses resulting from the default of entities in the same group as the two clearing members to which it has the largest exposures under extreme but plausible market conditions.*

RTS 49/59/7 - *A CCP shall conduct a detailed thorough analysis of testing results at least on a monthly basis in order to ensure its stress testing scenarios, models and liquidity risk management framework, underlying parameters and assumptions are correct. Such analysis shall be conducted more frequently in stressed market conditions, including when the financial instruments cleared or markets served in general display high volatility, become less liquid, or when the size or concentrations of positions held by its clearing members increase significantly or when it is anticipated that a CCP will encounter stressed market conditions.*

2.3 Dodd-Frank Act: 17 CFR – Core Principal B (SIDCOs – §39.33)

"Requires a Subpart C DCO to comply with the Cover Two minimum financial resource standard for all of its activities if the Subpart C DCO: (1) is involved in activities with a more complex risk profile or (2) is systemically important in multiple jurisdictions. This regulation currently applies to SIDCO"

3 Stress Test Scenarios

This section will provide a comprehensive overview of the types of scenarios included in the SwapClear suite of stress test scenarios, providing a breakdown of historical and theoretical scenarios along with the selection methodology for each sub-set.

3.1 Rationale for historical and theoretical scenarios

SwapClear has a defined suite of 124 stress test scenarios (using 5-day returns).

Table 1: chronology of SwapClear stress test scenarios

	Scenario number	Type	Number	Description	Implementation
Tranche 1	1-9	Absolute	9	Original theoretical scenarios	SwapClear Default Fund implementation
	10-35	Absolute	26	Original historical scenarios	SwapClear Default Fund implementation
	36-61	Relative	26	Original historical scenarios	SwapClear Default Fund implementation
Tranche 2	62-82	Absolute	21	LIBOR-OIS historical scenarios	Independent review: Phase 1 implementation
Tranche 3	83-86	Absolute	4	Historical stock market (1987) crash scenarios	BoE direction
Tranche 4	87-88	Absolute	2	Theoretical LIBOR-OIS scenarios	Independent review: Phase 2 implementation
	89-110	Absolute	22	Historical Yield Curve scenarios (steepeners/flatteners)	Independent review: Phase 2 implementation
	111-122	Absolute	12	Theoretical Cross Curve scenarios (narrowers/wideners de-correlation)	Independent review: Phase 2 implementation
	123-124	Absolute	2	Theoretical GBP / JPY specific scenarios	Independent review: Phase 2 implementation

Best market practice incorporates both historical and theoretical scenarios within the stress testing suite. Reliance on only one type potentially devalues and underestimates true risks in the system. One benefit of historical scenarios is that actual market events can be measured against current exposures; however assuming future events will match historical correlations and movements over-relies on the assumption that previous market movements capture all future movements. The addition of theoretical scenarios allows assessment of the impact of de-correlation and implied events, which have not yet occurred, but which are deemed extreme but plausible.

3.2 Scenario categories (historical and theoretical)

The suite of scenarios is sufficiently broad to capture multiple movement types which could impact on the SwapClear yield curves. The current categories include:

- Parallel shifts (and similar moves) that affect all portions of the curve
- De-correlation scenarios (Euro-break up & inter-currency curve narrower/wideners)
- LIBOR-OIS spread scenarios
- Yield curve scenarios (steepeners/flatteners)
- Currency specific scenarios
- Historic events

3.3 Tranche 1 scenarios: SwapClear Default Fund implementation

Theoretical scenarios: 9 theoretical scenarios were employed by SwapClear following the implementation of the SwapClear Default Fund (after the 2012 membership re-strike). These comprised of six purely theoretical scenarios and three based on a hypothetical Eurozone break-up. The additional six theoretical scenarios included a combination of overall curve move scenarios (flatteners, steepeners and parallel shift) and were validated against 20 years of historic data justifying the co-movement of different currencies.

Methodology for the selection of six purely theoretical scenarios

Principal Components Analysis was used to determine the direction and magnitude of moves. Benchmarking the theoretical curves was measured against historical shifts ensuring curve shifts were not

significantly larger than of the average of the largest 5 historical moves in the SwapClear suite. **(SwapClear Stress Test Appendix Document - scenarios 1-6)**.

Methodology for selection of three Eurozone break-up scenarios

Eurozone break-up 1: assumes orderly exit of a peripheral country(s) from the Euro area. SwapClear's interpretation is a positive impact on the remaining Eurozone members, normalization of rates from stressed market conditions are therefore resulting in a sell off. In addition, non-Euro curves rally following asset reallocation from the departing countries to non-EUR currencies.

Eurozone break-up 2: similar to scenario 1, with a parallel shift of the Euro curve as opposed to a more gradual one.

Eurozone break-up 3: disorderly exit from the Euro by a peripheral country(s) leading to systemic issues for Eurozone banks. The scenario assumes the ECB will pump liquidity into the system to counter the immediate crisis with rates dropping as a result of extra liquidity and bleak Eurozone long term growth prospects.

(SwapClear Stress Test Appendix Document - scenarios 7-9).

Historic scenarios: 52 historical scenarios were included in Tranche 1. Both relative and absolute curve movements were included (over a 20-year period dating back to 1992).

Methodology for the selection of historical scenarios

The aggregation of 5-day moves over a 20 year period (1992-2012 - data permitting) in the short, medium, long and whole curve segments[1], generated 26 relative and 26 absolute historic scenarios **(SwapClear Stress Test Appendix Document - scenarios 10-61)**.

3.4 Tranche 2 scenarios: LIBOR-OIS historical spread moves

Historical scenarios capture extreme but plausible widening and narrowing moves for the LIBOR-OIS spreads driven by the major currencies (USD, EUR and GBP). For clarity, a widening move in the LIBOR – OIS spread is where the LIBOR rate moves up relatively more than the OIS and vice versa for LIBOR – OIS narrowing **(SwapClear Stress Test Appendix Document - scenarios 62-82)**.

3.5 Tranche 3: stock market (1987) crash scenarios

Four additional absolute move scenarios were added to the existing scenario suite in March 2014 to include a number of scenarios replicating the 1987 stock market crash. Interest rate moves were in the region of 10bp-25bp **(SwapClear Stress Test Appendix Document - scenarios 83-86)**.

3.6 Tranche 4 scenarios: Independent review - phase 2

An independent (external) review of the SwapClear suite of stress test scenarios (in line with regulatory requirements) led to the inclusion of additional stress test scenarios:

- Theoretical LIBOR-OIS scenarios
- Historical Yield Curve scenarios (steepners/flatteners)
- Theoretical Cross Curve scenarios (narrower/wideners – de-correlation)
- GBP and JPY specific scenarios

[1] defined as 0-1yr, 1yr+ to 10yr and 10yrs to 50yrs (using extrapolation/interpolation on points where data was not available

3.6.1 Theoretical LIBOR-OIS scenarios

These scenarios capture extreme but plausible widening or narrowing moves between the LIBOR-OIS spreads driven by the major currencies. The theoretical scenarios (for both large general widening and narrowing movements in LIBOR-OIS spreads and where the co-movements are plausible relative to history) compliment the sub-set of historical LIBOR-OIS scenarios.

Methodology for selection of LIBOR-OIS scenarios

For the major currencies, USD, EUR, GBP and JPY, historical analysis was performed for each of the 32 points[2] on the curve. Each individual point's time series was assessed against all other points individually. For each point pair the average of the five largest historical 5-day co-movements was calculated and multiplied by 120% thereby removing dependencies on single historical dates whilst ensuring the shifts remain extreme but plausible **(SwapClear Stress Test Appendix Document - scenarios 87-88)**.

3.6.2 Historical Yield Curve scenarios (steepeners/flatteners)

This sub-set of scenarios capture historical, extreme but plausible, steepening and flattening moves (curve twists) between different sections of the yield curve driven by the major currencies. For clarity a steepening move is where the longer maturity pillar moves up relatively more than the shorter maturity and vice versa for flattening moves.

Methodology for selection of yield curve scenarios

Yield changes were obtained for the major currencies (USD, EUR, GBP and JPY) for the 2y, 5y, 10y and 30y tenors. For each curve segment[3] the largest historical 5 day shifts was obtained and the scenario date compared to the Tranche 1 stress test scenarios. New scenarios were selected when the date did not match the set of scenario dates in Trance 1. An additional 22 scenarios were selected - some dates covered two curve segment drivers **(SwapClear Stress Test Appendix Document - scenarios 89-110)**.

3.6.3 Theoretical Cross Curve scenarios (narrower/wideners – de-correlation)

These scenarios capture extreme but plausible movements between different pairs of the major currencies. Although Tranche 1 scenarios included a wide historical coverage for different currency pairs, the additional scenarios enhance coverage. In particular, some dates in 1992 gave larger moves for countries against GBP (UK ERM exit) that were not incorporated in Tranche 1 **(SwapClear Stress Test Appendix Document - scenarios 111-122)**.

3.6.4 GBP and JPY specific scenarios

Tranche 1 stress tests captured extreme movements for both GBP and JPY historical moves. However, for the sake of completeness two additional theoretical parallel shift scenarios were added with levels chosen to just exceed the 99.7% historical levels **(SwapClear Stress Test Appendix Document - scenarios 123-124)**.

3.7 Inflation Scenarios

3.7.1 Existing Historical Scenarios

Where data is available, existing historical scenarios were backfilled with the relevant inflation shocks, using swap data augmented with linker data to extend the time series history.

[2] For clarity, a point refers to the LIBOR-OIS rates spread for that specific tenor and currency – 3m, 6m, 9m, 12m, 2y, 5y, 10y, 30y (8 tenors across 4 currencies)

[3] So 2s vs 5s is one segment, 2s vs 10s is the second segment and so on

Where time series is unavailable, a regression analysis was performed on interest rates against real rates as the R-square is more significant using real rates as opposed to inflation rates. The R-square for the regression across the curve ranged between 70-90% for EUR HICPx and 30-50% for US CPI, which validates the use of real rates in the regression analysis. Note that actual real rates traded in the market were used, rather than inferring a real rate from nominal and inflation rates. The lookback period used for the regression was August 2007 – August 2009, i.e. the period covering the global financial crisis. The inflation rate shock is then inferred using the Fisher equation, which is:

$$M \approx R + I, \text{ where } M = \text{nominal interest rates; } R = \text{Real interest rates; } I = \text{Inflation rates}$$

3.7.2 New Absolute Historical Scenarios

The following steps are prescriptive of the methodology used to capture the largest/smallest moves over the dataset.

1 For each date in the time-series and for each ZCIIS tenor presented for the given date, the 5 day change is computed

2 The dates of the largest upshifts and downshifts for the following benchmark tenors are identified – 5Y / 10Y / 30Y

3 For each of the dates identified, the curve shift on that date is identified. Redundant curve shifts (i.e. the shifts are similar to another date) are discarded.

3.7.3 **Results by currency / index**

Index	Date	Rationale	Overlap existing?
UK-RPI	03/02/2009	Up - dominates the up shifts.	No
UK-RPI	16/01/2013	Up - CPAC (Unprecedented up shifts across the curve).	No
UK-RPI	23/09/1992	Week following UK's exit from ERM	No
UK-RPI	17/05/1990	Large bear steepening of the curve	No
UK-RPI	14/04/1992	Bear steepening of the curve	No
US-CPI	20/10/2008	Front end collapse with back end rallying	No
US-CPI	09/02/2009	Bull flattening of curve	No
US-CPI	22/01/2009	Up - large move in mid-curve.	Yes
US-CPI	22/10/2008	Down - severe shock - sustained across the curve.	Yes
US-CPI	25/11/2008	Down - Sustained negative shock, sustained across the curve.	No
FR-CPI	12/12/2008	Up - Dominates the up shifts.	Yes
FR-CPI	13/01/2009	Up - large shifts between 1 and 8y buckets.	No
FR-CPI	29/10/2008	Down - Dominates the downshifts.	No
FR-CPI	27/11/2008	Down - Sustained negative shifts.	No
EU-HICP	31/05/2005	Up - Dominates the up shifts.	No
EU-HICP	12/12/2008	Up - Dominates the up shifts.	Yes
EU-HICP	31/05/2011	Down - Dominates the down shifts.	No
EU-HICP	26/11/2008	Down – almost parallel downshift of curve	No

The full output (shifts to be applied) is available in the appendix document.

For each new scenario specified in Figure 9 (except for the cases where Overlap existing is set to Yes) – new interest rate shifts will need to be applied.

3.7.4 New Absolute Historical Scenarios

Given the current low interest / inflation rate regime, and the propensity for generating explosive returns when using a relative return measure – it is proposed that no further relative scenarios are to be added.

3.7.5 New Absolute Hypothetical Scenarios

Inflation Only Scenarios

Hypothetical inflation only scenarios were designed to ensure comprehensive coverage of potential inflation events, even if there were no historical precedence.

The inflation curve moves were designed to reflect a typical parallel, steepening and flattening move for each index. Hence, the following scenarios are defined:

- Rally
- Sell off
- Bull steepen
- Bull flatten
- Bear steepen
- Bear flatten

The magnitude of the curve shifts are constrained by the maximum and minimum curve shifts observed over the last 30 years, where data is available, based on the most traded tenor for each respective index. This is to ensure that the scenarios are extreme but plausible. These are:

- UKRPI: 30Y min: -62bps max: +112bps
- USCPI: 5Y min: -115bps max: +70bps
- EU HICPx: 10Y min: -40bps max: +39bps
- EU FRxT: 10Y min: -41bps max: +38bps

The parameters were perturbed such that the curve reaches but does not exceed minimum and maximum levels defined above.

Real Rate Scenarios

Real rate scenarios were developed to cover the potential for de-correlation between inflation and nominal interest rates. Similar to the inflation scenario generation, the largest real rate shifts over the last 30 years were identified based on the most traded tenor of each respective index.

The real rate shifts identified were:

Index	Real rates up	Real rates down
UKRPI	91	(142)
HICPx	40	(74)
FRxT	41	(70)
USCPI	111	(89)

Several approaches were considered to determine the allocation of the real rate shift between inflation and nominal rates.

Historical Data

Index	Real rates up	Inflation	Nominal	Real rates down	Inflation	Nominal
UKRPI	91	(62)	29	(142)	112	(30)
HICPx	40	(7)	34	(74)	26	(48)
FRxT	41	(8)	34	(70)	22	(48)
USCPI	111	(89)	22	(89)	38	(51)

These scenarios are already covered in the suite of historical scenarios, and would not add value in ensuring that the scenarios are comprehensive.

Furthermore, the severity of the HICPx and FRxT shifts appear relatively benign vis a vis the UKRPI and USCPI scenarios.

Allocation of real rate shocks between inflation and nominal

The historical analysis above was inconclusive as to how a real rate shock might be split between inflation and nominal rates, as different historic situations have behaved differently. A regression analysis was performed to try and ascertain a rule that could be used. However this was also inconclusive (results are below). It was therefore decided that the real rate move would be divided evenly (i.e. 50:50) between the inflation and nominal rates.

Index	Real rates up	Inflation	Nominal	Real rates down	Inflation	Nominal
UKRPI	91	(28)	63	(142)	44	(98)
HICPx	40	(25)	15	(74)	46	(28)
FRxT	41	(20)	21	(70)	34	(36)
USCPI	111	(60)	51	(83)	45	(38)

Size of scenarios

Rather than replicate the historic shocks, we calibrated the hypothetical scenario shock to be consistent across the inflation indices under consideration, and to be conservative with respect to most of the historic events observed. We therefore decided on a shock size for real rates of 100bp, which is more conservative than the most severe events in US, French and European inflation in the historic dataset. The UK example shows us that a more extreme scenario could occur in the other rates; hence we have up-sized the shock to the 100bp level. We do, however, believe that any further increase would be excessively conservative, given the unique events surrounding the UK's membership and exit from the European Exchange Rate Mechanism (ERM) which led to that move in real rates. Hence, although we model this scenario with respect to UK rates, we have not applied it to the other currencies.

The scenarios have therefore been defined as:

- Inflation/interest rate decorrelation 1: Inflation +50bp, Interest Rates -50bp
- Inflation/interest rate decorrelation 2: Inflation -50bp, Interest Rates +50bp

The above shocks are to be applied to each inflation index (and the corresponding interest rate) individually. The table below illustrates the behaviour of real rates and inflation during the recent financial crisis and resulting global recession. It demonstrates that a scenario of this severity covering all relevant inflation and interest rates and occurring at the same time would not be plausible.

	Real Rates			Inflation Rates			Nominal Rates		
	5Y	10Y	30Y	5Y	10Y	30Y	5Y	10Y	30Y
October 2008 - US enters recession									
USCPI (27 October)	89	31	11	(93)	(40)	(49)	(4)	(9)	(38)
HICPx (29 October)	31	24	(10)	(44)	(27)	(14)	(14)	(3)	(24)
FRXt (29 October)	27	20	(10)	(40)	(23)	(14)	(14)	(3)	(24)
UKRPI (27 October)	(19)	(17)	(9)	(9)	(2)	0	(28)	(19)	(9)
Global Recession November 2008									
USCPI	32	(11)	38	(49)	(32)	(86)	(16)	(42)	(48)
HICPx	16	11	(30)	(39)	(37)	(36)	(23)	(26)	(67)
FRXt	14	7	(29)	(36)	(33)	(37)	(23)	(26)	(67)
UKRPI	50	15	(20)	(69)	(39)	(26)	(20)	(25)	(46)
February 2009 - Stimulus package									
USCPI	(30)	4	(10)	51	24	23	20	28	13
HICPx	16	12	9	(15)	(6)	(7)	1	6	2
FRXt	2	7	1	(1)	(0)	1	1	6	2
UKRPI	37	33	46	(28)	(25)	(34)	9	8	12

3.8 MXN Scenarios

3.8.1 Time Series

Swap time series was available dating back to 2003. The OTC interest rate market started trading in 1998. Prior to 2003, weekly CETES (Mexican treasury bills) data is available dating back to 1994 but only for maturities up to 1 year.

The analysis will be split into 2 parts:

- Pre-2003: where CETES data is used, with focus on the tequila crisis in 1995.
- Post-2003: interest rate swap data is available.

3.8.2 Pre-2003: CETES time series

The tequila crisis resulted in 28 day t-bill rates going beyond 80% in early 1995 when markets started pricing in a Mexican default. Using available data, the largest weekly moves in that crisis (using the 1m point as a point of reference as it is the most liquid tenor) were:

	Max yield move	Price	Min yield move	Price
1m	24.39%	93.98	(10.26%)	96.40
3m	0.41%	94.20	(0.49%)	94.99
6m	(0.79%)	90.02	0.21%	90.00
1y	0.00%	93.74	0.02%	93.74
Date	16 March 1995		25 May 1995	

Evidently, the curve experienced a severe bear flattening because it was driven by a price shock, rather than a rate shock. When a bond is trading as distressed debt, the market trades at recovery value, i.e. price rather than rate moves. This can be observed by the prices of CETES converging to 94 with the exception of the 6m bill. This is more a function of illiquidity of the 6m note than any useful information on price behaviour.

Conversely, when the curve normalises, the curve bull steepens. It is useful to note that the yield equivalent move is immaterial at the 1y maturity, and thus we would expect almost no movement on longer dated tenors if any data existed.

Hence, as the rate shocks at the longer end of the curve were relatively insignificant, and the large shifts in the front end of the curve contain an element of sovereign credit risk, we propose to exclude this period in the analysis for defining the stress framework.

3.8.3 Post-2003: Swap time series

The largest 5 day moves in the swap time series out to 10y maturities were identified:

	2Y	5Y	10Y
Min	(1.39%)	(2.09%)	(2.77%)
Max	1.70%	2.19%	2.62%
Min date	31-Oct-08	31-Oct-08	31-Oct-08
Max date	24-Oct-08	24-Oct-08	24-Oct-08
Standard deviation	0.17%	0.19%	0.22%

The largest volatility in the curve occurred in the weeks following the Lehman default. Maturities beyond 10y were not analysed, as the most liquid tenors are concentrated in the 2, 5 and 10y maturities, according to an independent research source.

The swap time series would be a more pertinent data set with respect to the current market liquidity and dynamics in assessing an extreme but plausible scenario. Furthermore, shifts beyond 1y exist, and are beyond 10 standard deviations, which, if we use a normal Gaussian distribution, statistically imply a probability of less than 1 in 1 billion.

3.8.4 Discounting Risk

Discounting risk is not incorporated in the current stress testing framework. However, the MXN TIIE swap curve is constructed differently to the majors with respect to discounting. The MXN TIIE discounting curve is dependent on USD FedFunds and USDMXN cross-currency basis, rather than an OIS curve in its native currency. Hence, we examine the potential impact of discounting risk on the portfolio.

We use the following zero rates and corresponding discount factors since this is the period of the most extreme market moves over the last decade:

	Zero Rates			Discount Factors		
	2Y	5Y	10Y	2Y DF	5Y DF	10Y DF
24/10/2008	8.89%	9.89%	10.97%	0.8434	0.6239	0.3531
31/10/2008	7.60%	7.88%	8.21%	0.8637	0.6844	0.4544

Now consider 3 bullet portfolios where the cashflows are positive, neutral, and negative and we apply the above discount factors to obtain NPV:

	Bullet cashflow	NPV		Change in NPV
		24/10/2008	31/10/2008	
Positive	100,000,000	84,338,224	72,845,856	(11,492,368)
Flat	0	0	0	0
Negative	(100,000,000)	(84,338,224)	(72,845,856)	11,492,368

As demonstrated above, the same shift in the discount rates could result in different P&L outcomes, which does not necessarily result in a larger loss, or a more conservative measure. In other words, the effect of discounting is entirely dependent on the 'moneyness' of the portfolio in question, which is a 2nd order effect. The main driver is therefore the forecasting risk of the portfolio.

Consequently, we propose to capture the discounting risk via the basis risk add-on under the IM framework, as that model uses a VaR model to capture the potential loss, and is more suited towards accounting for the various permutations of the shape portfolio.

3.8.5 Proposed Scenarios

1 Historical Absolute Shift Scenarios

As the most extreme moves of the MXN TIIE curve occurred on 24 and 31 October 2008, we propose to add these 2 dates to SwapClear's suite of historical scenarios.

See SwapClear Stress Test Appendix Document for details on the shifts.

2 Hypothetical Absolute Shift Scenarios

As MXN is a relatively nascent swaps market, there is insufficient data to assess how the swaps market would perform in a sovereign credit crisis, e.g. the tequila crisis.

Thus, we examined several options for a suitable alternative, namely:

- Mexican Brady bond yields – no data was available
- USD swap rates in 1985 when the USA was close to default – available swap data only went back as far as October 1987. Generic US treasury yields were used as a proxy. Maximum 5 day move during that period was 82bps, which is less extreme than the proposed stresses below
- Recent oil shocks, given that PEMEX is a significant contributor to Mexico's GDP. The MXN TIIE market has moved c. 20bps over one month, and thus the events noted below are more extreme
- The RUB swap market was also examined as its economy is also sensitive to oil prices. Whilst the market shocks during the recent months were more severe, i.e. c. 300bps, this is driven more by the trade sanctions placed on Russia following its involvement in the Ukraine crisis, therefore causing a capital flight and the Russian Central Bank raising interest rates by 7.5% in December 2014, rather than the collapse in oil prices.

Hence, we propose using HUF as a proxy to examine any potential scenarios that could be developed.

HUF is proposed for the following reasons:

- HUF has a relatively weak correlation with the majors, but its economy is heavily dependent on its neighbour states, vis a vis Mexico being dependent on the USA; and
- Hungary has suffered a credit crisis between late 2011 and early 2012, where all 3 major credit rating agencies downgraded Hungarian debt to "junk".

Using swaps data covering the period where Hungary was downgraded, we observe the following moves across the main tenors:

	2y	5y	10y
Min	(0.58%)	(0.48%)	(0.44%)
Max	0.76%	0.54%	0.33%
Min date	30-Apr-12	10-Oct-11	10-Oct-11
Max date	04-Jan-12	04-Jan-12	04-Jan-12
Standard deviation	0.30%	0.23%	0.21%

We therefore propose to use the HUF market moves of 4 January and 30 April 2012 as a proxy for the MXN curve. The shocks will be scaled by 1.5 and rounded to the nearest 5bps due to the nascent nature of this product in the market. The moves dated 10 October 2011 are excluded as this pre-dated the credit downgrade. Furthermore, we propose to shock only the MXN curve, to reflect a country specific stress event, which also breaks the inter-market correlation.

The hypothetical stress proposed for MXN is therefore:

	2y	5y	10y
Curve down	(0.90%)	(0.75%)	(0.70%)

Curve up	1.15%	0.80%	0.50%
Min date	30-Apr-12	30-Apr-12	30-Apr-12
Max date	04-Jan-12	04-Jan-12	04-Jan-12

Note that these scenarios are also complementary to the proposed historical stresses. See appendix **Error! Reference source not found.**for the shifts to all the tenors on the MXN curve.

3 Hypothetical MXN devaluation

We consider the scenario of a repeat of the Mexican Peso devaluation at the end of December 1994, where MXN depreciated by 45% against USD.

The relevant CETES yield moves during that period were:

Tenor	Yield shock
1m	15.00%
3m	1.18%
6m	(0.12%)
1y	0.00%

However, the CETES yield move incorporates a large element of credit risk. If we return to the HUF example in 2, on 4 January, HUF 5y debt moved almost double that of the interest rate swap move when the sovereign was downgraded to junk. Hence, we propose to use 50% of the CETES yield curve move to define a hypothetical scenario on MXN devaluation. The stress is therefore:

	FX	1m	3m	6m	1y	2y
MXN rates curve up	45%	7.50%	0.6%	0.00%	0.00%	0.00%

3.8.6 Existing Scenarios

1 Historical Scenarios

If data is available, historical dates will be backfilled with the relevant MXN interest rate shifts. If data is not available, we will utilise the HUF proxy method as described in section 3.8.52.

2 Hypothetical Scenarios

As discussed in 3.8.52, we propose to proxy the MXN stresses in the existing hypothetical scenarios to HUF with the 1.5 scalar.

4 Default Fund Sizing/Rebalancing

The sizing approach uses the Taylor expansion to apply basis point moves to the delta and gamma strips for all currencies (for all tenors within the relevant SwapClear yield curve), within the portfolio, to calculate stress losses above initial margin at an aggregated portfolio level.

Stress Test Exposure above Initial Margin ("STLOIM") = (Stress Loss Exposure) + Initial Margin

Step 1: aggregation of stress losses at the House/Client level within an entity

The size of the Default Fund is the combined aggregate theoretical losses from the House exposure and Client exposures at the Group level. However, the first stage is calculation of theoretical losses at the entity level where House/Client portfolios are separately stressed against every historical and theoretical scenario. As part of the aggregation process, a Client's theoretical profit cannot be used to offset either i) another Client's theoretical loss or ii) one Client's theoretical profit cannot offset a House theoretical loss:

Example 1a

- DEF (H): (£30m) STLOIM (theoretical loss)
- DEF (C1): (£15m) STLOIM (theoretical loss)
- DEF (C2): £5m STLOIM (theoretical profit)
- DEF (C3): (£12m) STLOIM (theoretical loss)
- DEF (C4): (£7m) STLOIM (theoretical loss)
- Member DEF STLOIM: (£64m)

Example 1b

- GHI (H): (£25m) STLOIM (theoretical loss)
- GHI (C1): (£15m) STLOIM (theoretical loss)
- GHI (C2): (£14m) STLOIM (theoretical loss)
- GHI (C3): £18m STLOIM (theoretical profit)
- GHI (C4): (£3m) STLOIM (theoretical loss)
- Member DEF STLOIM: (£57m)

Step 2: aggregation of stress losses at the Group level

Where a group structure exists, any member, within that structure, will have their respective theoretical losses (above initial margin) added together for each scenario. The same House/Client offset logic applies for Groups where if one/multiple members (within the group) have theoretical profits from the stress event, profits are not allowed to offset losses between legal entities:

Example 2

- ABC1: (£50m) STLOIM (theoretical loss)
- ABC2: £25m STLOIM (theoretical profit)
- ABC3: (£48m) STLOIM (theoretical loss)
- ABC4: £10m STLOIM (theoretical profit)
- Group ABC STLOIM: (£98m)

Step 3: day with the largest two combined losses (from the same scenario) is identified

Over the 60-day look-back period, the largest two STLOIMs are selected. The selection process uses the day which provides the largest two members STLOIMs, from the same scenario, as the basis for sizing the Default Fund.

Example 3

Scenario 10 (largest – day 32)

Member 1: STLOIM - £1.0bn

Member 2: STLOIM - £0.8bn

Member3: STLOIM - £0.6bn

.....

Member 60: STLOIM - £0.1bn

Combined STLOIM: £1.8b

Scenario 83 (second largest – day 13)

Member 1: STLOIM - £0.9bn

Member 2: STLOIM - £0.7bn

Member3: STLOIM - £0.6bn

.....

Member 60: STLOIM - £0.2bn

Combined STLOIM: £1.6b

.....

.....

.....

.....

.....

.....

.....

.....

Scenario 10 (smallest – day 57)

Member 1: STLOIM - £0.5bn

Member 2: STLOIM - £0.4bn

Member3: STLOIM - £0.3bn

.....

Member 60: STLOIM - £0.1bn

Combined STLOIM: £0.9b

Step 4: 10% buffer applied to largest aggregate STLOIMs

10% buffer is applied to determine the Default Fund size.

Example 4

If scenario 10 gives the largest aggregate exposure:

Scenario 10 (largest – day 32)

Member 1: STLOIM- £1.0bn

Member 2: STLOIM - £0.8bn

Member3: STLOIM - £0.6bn

.....

Member 60: STLOIM - £0.1bn

Unadjusted Default Fund size = (£1.0bn + £0.8bn) * 110% = £1.98bn

The default fund size is re-balanced monthly and SwapClear monitors STLOIMs for all members on a daily basis and additional margin is called intra-month where required.

Step 5: calculation of monthly Default Fund Additional Margin (DFAM) and adjusted Default Fund size

Monthly DFAM is usually charged to the largest group driving the Default Fund size (monthly DFAM will not be charged to the largest group where they are not outsized relative to the second largest group who are also driving the Default Fund size). This is charged to prevent the largest group's stress exposures being outsized and driving up the size of the Default Fund via mutualisation of the exposure.

The unadjusted Default Fund size (step 4) has the monthly DFAM deducted from it thereby reducing the mutualised layer and charging the corresponding amount to the largest group in the form of un-mutualised initial margin. The monthly DFAM is calculated against a 45% threshold of the unadjusted Default Fund size in relation to the largest STLOIM (for the largest group driving the Default Fund size) over the 60-day look back period (Note: the date and scenario do not have to match those used in step 4).

To ensure the adjusted Default Fund (i.e. after monthly DFAM has been deducted) covers the EMIR requirement that the Default Fund covers the second and third largest groups simultaneously defaulting, monthly DFAM will be adjusted (reduced) as required.

Example 5

If scenario 10 gives the largest aggregate exposure:

Scenario 10 (largest – day 32)

Member 1: STLOIM - £1.0bn

Member 2: STLOIM - £0.8bn

Member3: STLOIM - £0.6bn

.....

Member 60: STLOIM - £0.1bn

Unadjusted Default Fund = £1.98b

Scenario 61 (largest in look back period – day 40)

Member 1: STLOIM - £1.1bn

45% of unadjusted Default Fund size

45% * £1.98b = £0.891bn

Monthly DFAM

£1.1b - £0.891b = £0.209bn

Adjusted Default Fund size = £1.98bn - £0.209bn = £1.771bbn

5 Stress Testing Governance Framework

The stress testing governance framework consists of internal monthly reviews and an annual independent review.

5.1 SwapClear Monthly Review

SwapClear's stress tests scenarios are reviewed on a monthly basis. The aim of this working group is:

- Review driving factors behind the latest monthly Default Fund rebalancing;
- Discuss potential market events that could be appropriate for inclusion into the stress test given the current economic environment;
- Identify plausible scenarios (e.g. using a distribution led stress tool) that could have a larger stress test loss than the current scenario driving the default fund size.
- Any changes are taken through the governance cycle for approval by the LCH.Clearnet Risk Committee and the Bank of England.

5.2 Independent Annual Review

An annual review is conducted by an independent validator on the completeness of the suite of stress test scenarios, and methodology used to generate the stress test scenarios.

The two most recent independent reviews have respectively resulted in SwapClear implementing:

- LIBOR-OIS stress and currency de-correlation scenarios;
- Development of the additional stress testing tools