PAIRS

LCH.Clearnet SwapClear

Version 5.0
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Version History

This version of the PAIRS document (Version 5.0) replaces the last version (Version 4.3), which outlined the previous PAIRS model based on relative returns and a 5 year lookback period. Version 5.0 details the updated PAIRS model which uses absolute returns and a 10 year lookback period.

Contents

1 Introduction

This document is the technical specification of the LCH.Clearnet SwapClear Initial Margining model, PAIRS "Portfolio Approach to Interest Rate Scenarios", which calculates the SwapClear initial margin requirement of member and client portfolios. PAIRS is a filtered historical model, i.e. it looks at historical events that occurred within the look-back period and from these infers a suitable initial margin in line with regulatory requirements and LCH.Clearnet SwapClear Risk Policy. This technical specification provides full details of the Initial Margin calculation, enabling the algorithm to be replicated.
It should be noted that the PAIRS methodology produces IM, which is the first of a number of safety mechanisms employed by SwapClear. Others include the Initial Margin Multiplier, tenor basis risk add-on, credit multiplier and the default fund which is calculated using stress tests.

2 Theoretical Framework

This section describes the IM framework in detail such that the IM numbers can be replicated.
The portfolio is exposed to scaled historical market moves and Initial Margin is calculated as the Expected Shortfall (ES) of the portfolio. The historical moves are sampled over a fixed grid in zero space. The length of the history consists of 2500 five day overlapping scenarios. In this document a day or date refers to a valid SwapClear date which is a non-weekend and non SwapClear holiday as defined in the official SwapClear documentation. Each historical scenario is applied to today using a scaling mechanism involving both the dispersions on the scenario's date and today's date.

2.1 Input data

The IM Model operates on the history of interest rate data, in the form of zero curve data linearly interpolated between fixed grid points. The history extends back to 2505 days. In addition to the zero rate data, FX rates are needed for the same duration of time for each local curve currency expressed in the base currency, which is the currency in which IM is calculated. The

dispersion, or volatility, of the time series considered is calculated using an iterative approach (EWMA), and therefore the seed of the time series has to be provided at the start of the model.
The interest rate time series in this document will be denoted as $\mathbf{Z}^s = \{Z_t^s : t \in T\}$, where Z is the zero curve rate indexed by the super script s that runs over all tenor points of all curves, and by the subscript t for time, and where T is the set of days in the history of zero curve data. The bold typeface of the variable indicates that it is a time series. FX rate time series will be denoted as $\mathbf{FX}^{ccy} = \{FX_t^{ccy} : t \in T\}$ where FX is the exchange rate from the base currency to the local, or counter, currency CCY.

2.2 Market returns

The time series of the absolute returns of the zero rates are calculated as

$$\mathbf{R}^s = \{Z_t^s - Z_{t-5}^s : t \in T\}, \tag{1}$$

and the time series for the relative returns of the FX rates are calculated as

$$\mathbf{R}^{ccy} = \left\{ \frac{FX_t^{ccy} - FX_{t-5}^{ccy}}{FX_{t-5}^{ccy}} : t \in T \right\}. \tag{2}$$

One can note that from the original time series of length 2505, we have now created a returns time series that is of length 2500 days. For ease of notation, we use T to denote the length of the history we need in order to perform our calculations.

2.3 Dispersion measurement

The PAIRS model calculates the dispersion of the return series as an iterative estimation of the standard deviation. The EWMA implementation of standard deviation (STD) is the recursive expression

$$\sigma_{t+1} = \sqrt{\sigma_t^2 \cdot \lambda_{STD} + {R_{t+1}}^2 \cdot (1 - \lambda_{STD})}, \tag{3}$$

where σ_n is the dispersion at position n, R is one of the FX or zero curve interest rate series of which we are estimating the volatility, and λ_{STD} is the decay factor of the EWMA process. The starting seed of the recursive expression is set only once when the IM process is started. Thereafter, the current dispersion will be automatically generated from the previous day's dispersion.

2.4 Scaling of historical scenarios

In order to apply a historical scenario to today's market environment, both absolute zero interest rates returns and relative FX rates returns are scaled. The level of scaling of a point in a specific return series is determined by both the dispersion at that point in time and also the dispersion today.
Each historical return time series is scaled according to the following equation,

$$\mathbf{S}_N = \left\{ R_t \cdot \left(\frac{\sigma_N}{\sigma_t} + 1 \right) \Big/ 2 : t \in T \right\}. \tag{4}$$

Here $\mathbf{S}_N$ denotes the set of scaled returns of a return time series - either scaled absolute interest rate return or relative FX return - for the scenario t with respect to the day N for which IM is calculated. σ_t and σ_N represent the dispersion of the corresponding time series at time t and time N respectively. We can note that all time series that are subscripted with N will have to be recalculated each time IM is calculated for a new date. Conversely, time series that are not subscripted with N will only change on a day to day basis with regards to the latest piece of information in the time series.

2.5 Applying the scaled historical scenarios to today

In the PAIRS model, each of the scaled historical returns in the time series is viewed as a likely potential outcome for how the markets are going to move over the next five market days. Each potential market outcome is called a scenario and there are 2500 distinct sets of scenarios.

2.5.1 The set of potential scenarios

The potential scenarios are created on an individual tenor point basis and currency basis, i.e. there is no interaction between tenor points on the same

curve etc. The absolute returns of the zero rates are reflected in the calculation of the scenarios. They are calculated as the sum of the rate today and the rate return time series, $\mathbf{Z}_N^i = Z_N^i + \mathbf{S}_N^i$.
The relative returns of the FX rates are reflected in the calculation of the scenarios. They are calculated as $\mathbf{FX}_N^{ccy} = FX_N^{ccy} \cdot (1 + \mathbf{S}_N^{ccy})$. Here it is worth stressing that there are 2500 scenarios, each scenario defined by one date in the time series of every currency.

2.5.2 Portfolio valuation

In order to proceed with the IM calculation we first introduce some notation with regards to valuation of a portfolio. Let us denote the portfolio of which we wish to calculate the IM as P. We then denote the part of portfolio P denoted in currency ccy as P^{ccy}. A set of tenor points belonging to a specific currency ccy can then be written as $\{Z^i : CCY(i) = ccy\}$, where $CCY(\cdot)$ is a function taking a tenor point index of a particular currency and returning the currency. The valuation, $NPV(\cdot)$, of P^{ccy} on the set of tenor points on curves belonging to currency ccy is written as

$$NPV_N^{ccy} = NPV(P^{ccy}, \{Z_N^i : CCY(i) = ccy\}), \tag{5}$$

where we use N as subscript of NPV to indicate that the valuation is for date N.
We proceed by valuing the portfolio P^{ccy} on the time series of scaled returns as

$$\mathbf{NPV}_N^{ccy} = NPV(P^{ccy}, \{Z_N^i + \mathbf{S}_N^i : CCY(i) = ccy\}). \tag{6}$$

Note that there is a difference between valuation of the sub currency portfolio at the time of IM calculation, NPV_N^{ccy}, and the valuation of the sub currency portfolio over the time series of perturbed historical scenarios, $\mathbf{NPV}_N^{ccy}$.
The next step is to value the PnL of the portfolio in the (potentially several) local currencies:

$$\mathbf{PnL}_N^{ccy} = \mathbf{NPV}_N^{ccy} - NPV_N^{ccy}. \tag{7}$$

Here, for each currency ccy, $\mathbf{PnL}_N^{ccy}$ is the set of PnLs for each of the 2500 scenarios.

The next step is to convert the local currency PnL numbers into the base currency.

$$\mathbf{PnL}_N = \sum_{ccy} \mathbf{PnL}_N^{ccy} / \mathbf{FX}_N^{ccy}, \tag{8}$$

Here $\mathbf{PnL}_N$ is the set of PnLs for each of the 2500 scenarios all expressed in the base currency.

2.6 Expected Shortfall calculation

The IM of a portfolio is calculated as the expected shortfall of the top q scenario losses over the total 2500 scenarios. In detail, $\mathbf{PnL}_N$ is sorted to give $\mathbf{PnL}_N^{SORT}$, and the smallest q numbers (i.e. largest q losses, where q is set equal to 6) are used to create the average:

$$IM_N = \left| \frac{1}{q} \cdot \sum_{t=0}^{q-1} PnL_{t,N}^{SORT} \right|. \tag{9}$$

IM_N is then the IM of the portfolio on today's date.
For clients of members, IM is calculated as:

$$IM_N = \sqrt{\frac{7}{5}} \cdot \left| \frac{1}{q} \cdot \sum_{t=0}^{q-1} PnL_{t,N}^{SORT} \right|, \tag{10}$$

where a scaling factor of $\sqrt{\frac{7}{5}}$ is applied due to an assumption of a longer holding period (7 days as opposed to 5 days) in the event of a default, where 2 extra days are added to allow for the porting of clients.

3 Summary

This document provided details of the PAIRS model on a level such that, together with the "SwapClear Zero Coupon Rate Curve Construction Methodology" and "SwapClear Risk Analytics" documents, one can build the model and replicate IM. Table 1 summarizes the main attributes of the PAIRS model.

Table 1: PAIRS Attributes

Attribute	PAIRS Value
IR Change Measure	Absolute
EWMA estimation of IR Dispersion Measure	Standard Deviation
IR Dispersion EWMA λ	0.992
Holding Period	5 days
Number of Scenarios	2500
FX Change Measure	Relative
EWMA estimation of FX Dispersion Measure	Standard Deviation
FX Dispersion EWMA λ	0.992
Confidence Methodology	Expected Shortfall, Average of worst 6 losses