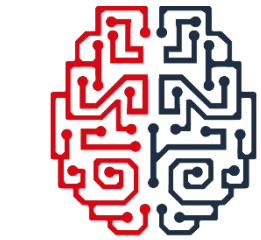

SIREN Benchmark Statement

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NEWCHANGEFX

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Introduction

This benchmark statement is provided by New Change Currency Consultants Ltd ("New Change FX" or "NCFX" or the "Company") as the administrator of the NCFX-MI Family of Benchmarks and in accordance with Article 27 of Regulation (EU) 2016/1011 of the European Parliament and the Council of 8 June 2016 (the "Benchmark Regulation" or "BMR"). The SIREN Benchmark is devised by Raidne Ltd ("Raidne") and produced by NCFX. This statement is intended to meet the requirements of the BMR regulation on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds.

On 27 February 2018, HM Treasury in the UK passed into legislation the Financial Services and Markets Act 2000 (Benchmarks) Regulations 2018, thereby fully adopting the BMR Regulation (EU) 2016/2011. On that date the Financial Conduct Authority (FCA) in the UK granted NCFX permission under Part 4A of the Financial Services and Markets Act 2000 to carry on the regulated activity of administering a benchmark.

The Benchmark Statement below makes reference to Article 27 and 28 of the BMR as well as the technical standards (RTS) accompanying the BMR, published in September 2016, and where applicable makes reference to the specific clause or sub-clause within Articles 27 and 28 of the BMR, or specific Articles and clauses within the RTS relating to disclosure requirements for Benchmark Statements in Section 9.4 of the RTS.

NCFX can be found on the FCA financial services register (https://www.fca.org.uk/firms/financial-services-register) with firm reference number 793983. The FCA is the sole regulatory supervisor for NCFX although the company can also be found on the European Securities and Markets Authority (ESMA) Register of Benchmark Administrators (https://www.esma.europa.eu/databases-library/registers-and-data).

Benchmark Statement

1. General Information:

RTS Section 9.4 Article 7 – Type of Benchmark

- The SIREN Benchmark qualifies as a Non-significant Benchmark in that it does not satisfy the criteria as either a Critical Benchmark or a Significant Benchmark.

BMR Article 27,1,(a) and RTS Section 9.4 Article 1,1 – Rationale and Economic Reality Measured

- SIREN is a fair benchmark designed for settling spot FX transactions at a point in time and to provide an alternative to the 4pm Fix. It is published every 30 minutes during the trading week for all the NCFX-MI benchmark spot pairs (see separate NCFX Mid-Rate Indices Benchmark Statement).
- The SIREN benchmark is devised by Raidne and produced by NCFX using independent mid-rate data provided by NCFX.
- SIREN uses mid-rate spot benchmarks provided by NCFX which allows it to be calculated in real time using live mid-rate spot FX data.
- The SIREN benchmark is harder to manipulate than the 4pm Fix, has a long observation window and can be calculated in real time.
- It seeks to address the excessive market impact that inevitably arises when executing large transactions over a short 5-minute fixing window, where there is more demand for liquidity than the market can absorb.

BMR Article 27,1,(b) and RTS Section 9.4 Article 1,3 – Discretion Used in Calculation

- Contributions to the underlying NCFX-MI data must be relevant, timely and fully automated, there is no data submitted from any manual systems.
- Discretion is neither permitted nor possible in creation of the NCFX-MI benchmarks.
- One of the key characteristics of NCFX benchmarks is the absence of human intervention in determining the mid-rate as it is wholly automated.

2. Methodology and Input Data

BMR Article 27,2,(a),(b) – Definitions and Methodology

- SIREN uses a longer fixing window than current benchmarks which makes it less vulnerable to market impact and also harder to manipulate. Case studies demonstrate that using SIREN leads to cost savings to the client of at least half a basis point for longer fixing windows.
- SIREN uses the concept of optimal execution (first described by Almgren and Chriss in their seminal paper in 2000) to reflect the risks when executing larger trades. The methodology seeks to minimise price risk and market impact.
- The model derives an optimal trading trajectory given a fixed time horizon and is driven by the ratio of the market risk over the market impact, or Omega. The Omega liquidity measure of 3 is established from observing a large set of trade data over a long period of time (see the attached white paper “SIREN: A fair benchmark for FX” by Dr Jamie Walton of Raidne).
- The optimal trajectory provides the weights for the SIREN calculation, which is then applied every second to the observed mid-price over the benchmark window. The weight increases as it approaches the fix.

- The SIREN benchmark uses a 20-minute window which allows for most of the benefits associated with optimal execution and reduced exposure to market impact.

BMR Article 27,2,(c) – Input Data

- Input date is derived automatically from the FX marketplaces (ECNs) connected to NCFX.
- Input data is collected at 4 pm local time in London, capturing the prevailing executable market mid-rates available in spot and forwards at that time.
- All input data feeds are from the top of the contributor's books for 1 million units of the base currency.

3. Limitations and Errors

BMR Article 27,2,(e),(f),(g) and RTS Section 9.4 Article 1,2 – Limitations and Unreliable Data

- NCFX does not offer NCFX-MI benchmarks in currency pairs that exhibit limitations in terms of contributing feeds.
- Each member of the underlying NCFX-MI family of benchmarks requires a minimum of two independent contributing marketplaces (ECNs) to be accepted for use in calculation of the SIREN benchmarks.
- Where, for whatever reason, at least two independent marketplaces are not able to furnish a rate, NCFX will not publish the underlying NCFX-MI benchmark. This will mean that the SIREN benchmark for the related currency pair will not be available either. In the absence of the underlying data, the SIREN Benchmark would not be available to users, for valuation purposes, until such time as normal conditions resume and at least two independent marketplaces are able to resume publication of prices in real-time. Users would be notified accordingly.
- In the event of an adverse change of circumstances for a given member of a family of benchmarks, clients would be notified, and the benchmark withdrawn until such time as the underlying NCFX-MI data became available again.
- Given the fully automated nature of the index and its calculation, we have not knowingly had an error in the calculation of the index over the years for which the index values have been available. If an error was identified, we would check the inputs that created the error and check the nature of the error. If the error were deemed to indeed be an error, for example one of the underlying inputs being quoted to the wrong decimal place, the error would be corrected, and the value of the index revised.

4. Changes and Cessation

BMR Article 27,1,(c),(d), BMR Article 28 and RTS Section 9.4 Article 1,4 – Benchmark Changes or Cessation

- Although considered extremely unlikely, there may be circumstances in or beyond the control of the administrator that would lead to either a change in the methodology or the cessation of the production of the NCFX-BI family of benchmarks.
- Changes to the methodology in calculating the NCFX-BI benchmarks may lead to changes in the financial contracts and financial instruments that are referenced to them.
- Where it is a change of methodology benchmark users would be given three months' advanced warning ahead of a change in methodology.
- Where the administrator is obliged to stop providing a benchmark for whatever reason, benchmark users would be given three months' notice and the administrator would suggest any credible alternative benchmarks if possible.

A Note on Methodology – Optimal Execution and SIREN Calculation Methodology

The concept of optimal execution in economics determines the optimal trading trajectory when considering the opposing concepts of market risk and market impact. These are related as follows:

Low market risk ↔ Faster execution ↔ High Market Impact

Low Market Impact ↔ Slower execution ↔ Higher market risk

The classic optimal execution model for market orders was first described by **Almgren and Chriss** in their seminal 2000 paper. In their model they constructed an exact solution for the trade trajectory given a fixed time horizon T:

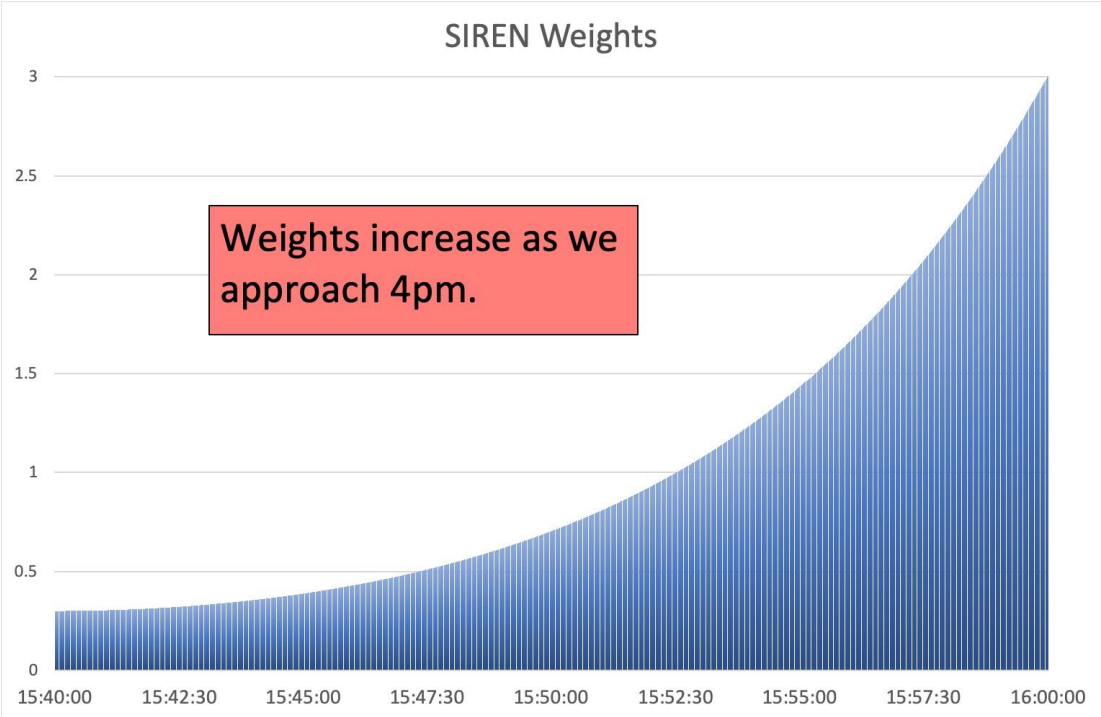
$$\frac{Q(t)}{Q(0)} = \frac{\sinh(\Omega(1-\tau))}{\sinh\Omega}, \qquad \Omega = T\sqrt{\frac{\lambda\sigma^2}{a+b}}, \quad \tau = \frac{t}{T}$$

Here, “sigma” is the volatility of the underlying and “a” and “b” are the temporary and permanent price impact caused by trading. “Q(t)” represents the quantity of the trade held at any time “t” over the trading horizon “T”.

The trajectory is driven by Omega which is a ratio of the market risk over the market impact. This can be determined for a given asset using market data. Generally, the more liquid a currency is, the higher the omega, implying more execution can happen closer to the fix.

For our benchmark we are considering the opposite problem of executing a given notional by time T. This is analogous to the related problem in equities of executing an algorithm to hit the close and is known as a Market-On-Close (MOC) algorithm. Using the Almgren-Chriss framework we can simply reverse time to generate this trajectory.

The optimal trajectory is used to determine the weights for our SIREN calculation. The liquidity measure omega is chosen optimally from observed market impact across a large number of trades. We apply the SIREN weight to the observed mid- price every second over the benchmark window. The weights increase as we approach the benchmark as shown in the example below:



An important element of this methodology is that market impact is a function of the volume to be traded at the benchmark. To reduce the market impact for larger notionals, we have chosen a 20-minute window for the benchmark calculation. In the case study we show the potential savings from trading this longer window for a set of fixing trades.

The SIREN fix can be calculated in real-time using live mid-market spot data as the weights are known in advance.

New Change FX benchmark mid-market spot rates are snapped every second in the price construction. New Change FX is the benchmark administrator for the SIREN benchmark.

The SIREN benchmark is published twice an hour for all standard FX trading hours and is available for 71 currency pairs as listed in the appendix.