A Bloomberg Professional Services Offering

BFIX Methodology

FX benchmark solutions

Bloomberg

Version Control:

Material updates from the previous version:

DATE	Update
MAY 2018	As of Sunday May 13, 2018, the data source for 24 currency pairs changed from BGN to BGNE, section 2.2
	Update rules on future 'observed' Christmas and New Year Holidays
NOV 2017	Change to the Time Weighted Average Price ("TWAP") window for all non-G10 spot currencies to 306 seconds. This window was previously only applied to G10 currencies, whereas non-G10 spots carried a 906 second window
	Where a fixing cannot be produced due to inadequate input from the BFIX pricing source, the previous fixing will be carried forward. Previously, in such instances, a fixing was not provided
	Specification of various factors considered in addressing errors and restatements
	Update to governance and oversight section to include certain compliance and audit procedures
	Update to stakeholder engagement procedures to include periodic empaneling of advisory councils
MAY 2016	First version.

Contents

CHAPTER 1 OVERVIEW

1.1   OBJECTIVE

The Bloomberg BFIX, provides Spot, Forward and Non- Deliverable Forward ("NDF") rate fixings for certain currencies and metals, detailed in **Exhibit A** to this methodology. As used in this methodology, the term "fixings" refers only to such Spot, Forward and NDF rates and not to any other rate, calculation or other information that may be related to, or associated with, such fixings that are made available by Bloomberg. Based on pricing provided by the Bloomberg Generic Price ("BGN") and Bloomberg Generic Price Executable ("BGNE") and using Bloomberg's well-known data, technology and distribution platforms, BFIX is made broadly available to the investment community with the objective of providing FX fixings that are reliable, representative, and transparent for the currency and metals markets around the world.

This document describes the BFIX methodology, which undergoes a formal review process at least once each year to ensure its design still promotes a representative and accurate measure of the markets the fixings measure. Any material changes from the previous version will be highlighted in the latest methodology document.

1.2   BFIX ADMINISTRATOR

Bloomberg Index Services Limited ("**BISL**" and, collectively with its affiliates, "**Bloomberg**"), is the "Administrator" (as that term is defined in the Principles for Financial Benchmarks published by the International Organization of Securities Commissions (the "IOSCO Principles")) for the BFIX rates and has overall responsibility for all aspects of the BFIX determination process. This includes the development, determination, dissemination, operation, and governance of the Spot, Forward, and NDF rate services.

CHAPTER 2 INPUT DATA PROCESSES

2.1   BFIX INPUT DATA

Independent and transparent input data is a valued attribute of the BFIX methodology. The Benchmark strives to be reflective of the currency markets they are designed to measure. They therefore favour, consistent with market practice, the following hierarchy of input data:
1) Executed prices
2) Executable prices
3) Indicative prices

BFIX uses Bloomberg's BGN and BGNE as its pricing sources and only accepts quotes that contain both a bid and ask, which are the most appropriate for FX transaction pricing. The BGN is a sophisticated pricing algorithm that produces accurate indications of bid and ask quotes that are derived from hundreds of quality sources, including indicative, executable and executed price quotes from money-centre and regional banks, broker-dealers, inter-dealer brokers, and trading platforms. The BGNE uses purely executable data from Bloomberg's FXGO platform delivering greater transparency into current market liquidity. They are received from a diverse universe of sources who provide them for the primary purpose of soliciting actual FX transactions from the market.

2.2 CLASSIFICATION OF BGNE PRICING SOURCES

As of May 13 2018 the following spot currency pairs employed the BGNE source for the fixing. This applies only to spot fx and not forwards. All other fixings employ the BGN, except for MYR which employs the REGN.

	NAME	ISO
1	EURO	EURUSD
2	BRITISH POUND	GBPUSD
3	SWISS FRANC	USDCHF
4	DANISH KRONE	USDDKK
5	SWEDISH KRONA	USDSEK
6	NORWEGIAN KRONE	USDNOK
7	CZECH KORUNA	USDCZK
8	POLISH ZLOTY	USDPLN
9	HUNGARIAN FORINT	USDHUF
10	ROMANIAN LEU	USDRON
11	RUSSIAN RUBLE	USDRUB
12	TURKISH NEW LIRA	USDTRY
13	ISRAELI SHEKEL	USDILS
14	SOUTH AFRICAN RAND	USDZAR
15	JAPANESE YEN	USDJPY
16	AUSTRALIAN DOLLAR	AUDUSD
17	NEW ZEALAND DOLLAR	NZDUSD
18	CHINESE R. YUAN HK	USDCNH
19	HONG KONG DOLLAR	USDHKD
20	INDIAN RUPEE	USDINR
21	SINGAPORE DOLLAR	USDSGD
22	THAI BAHT	USDTHB
23	CANADIAN DOLLAR	USDCAD
24	MEXICAN PESO	USDMXN

2.3   BGN PRICING SOURCES

BGN prices are designed to track indicative, executable and executed bid and ask input rates from a select subset of Bloomberg's FX price sources, which have met selection criteria such as pricing consistency, frequency, and quality. To resist manipulation by sources, (a) at least executable or indicative price inputs are required, (b) sources are anonymous to users and the sources themselves at each pricing point, and (c) sources change from time-to-time depending on the quality of data they provide. Each source is assigned a quality score based on numerous factors including update frequency and spike frequency. BGN also reduces potential bias in pricing by including quotes from both market makers and market takers. For the currencies of nations with Exchange Controls, primary users of the fixing may require inputs that are local to such nations. Accordingly, for the currencies of these nations, Bloomberg may restrict BGN inputs to only those that are local or otherwise regulated within the subject jurisdiction to enhance relevance to the majority of users and reduce volatility. Any currency restricted to such "local" inputs is identified as such in **Exhibit A** to this methodology.

2.4   BGNE ALGORITHM

The BGNE is computed as the best bid/offer from a curated list of liquidity providers. The algorithm Operates with a time-weighted top half of the book and a deep pool of contributors to maintain anonymity and ensure no single firm can dominate pricing. BGNE avoids cross markets by incorporating spike filter technology and accepts streams associated only with a bid and an ask, as well as conducting spread analysis logic to avoid market manipulation. The anonymity of pricing feeds is maintained by not attributing prices to price makers and operates an age out parameter to remove stale prices.   BGNE respects local market hours, as per section 5.2.1 "Hours of Local Currencies."

2.5   BGN ALGORITHMS

Inputs are run through a proprietary algorithm to generate better prices, more accurate spreads, and ultimately to create a market reflective bid-ask pair of prices for each currency or metals pair. There are a number of different algorithms, described below, that can be used to calculate BGN tickers. The appropriate algorithm is selected in an automated process based primarily on object type and liquidity, which is recalibrated at least annually.

2.5.1   Median Algorithm

This algorithm separately computes bid and ask prices. The outgoing bid/ask tick is computed as the median of the bid/ask ticks received from sources. If the ticker does not have minimum source prices in the allotted time window, the time window for considering source prices is extended by a factor of an extended multiplier. At the end of the extended time frame, if the minimum number of source ticks are received, the outgoing bid/ask tick is computed as the median of the received ticks. Otherwise, no bid or ask price is computed.

2.5.2   Median Mid Algorithm

This algorithm calculates the bid and ask price together (as a pair). On reception of a tick, if the tick is a bid(ask), the last bid value for the source is updated as the received value and last ask(bid) values are searched. If not available, an outgoing tick is not calculated, and only the last bid(ask) value is updated. When a proper bid/ask pair is available for this source, the spread and mid of bid/ask is computed. This mid/spread value is updated in a map which stored the latest mid/spread value of other sources (a similar time extension logic as in the Median algorithm is used if the minimum number of participants are not available). The median price in this map is selected as the current mid/spread value. Confidence levels in the current mid are also calculated. Depending on the confidence, an outgoing BGN tick is computed as current mid± current spread/2.

2.5.3 Spread Filter Algorithm

This algorithm separately computes bid and ask prices. It functions the same as the Median Algorithm, but has following differences:

a. The source prices under consideration are restricted to ones which do not have a greater spread than the median price.

b. The algorithm then computes the median of the source prices remaining after the first step. Depending on the confidence in the median tick, an outgoing BGN tick is computed as the median price.

2.5.4 Spread Filter and Mode Algorithm

This algorithm separately computes bid and ask prices. It functions the same as the Spread Filter Algorithm, but also computes the mode of the participant prices (after eliminating the ones with spread greater than the spread of median price). If the mode gives a price that has a smaller spread (i.e. in case the bid mode result is greater than the median, and in case the ask mode result is less than median) the mode price is used followed by the median price.

2.5.5 Forward Algorithm

This algorithm calculates the Bid and Ask price together (as a pair). It functions in a manner similar to the Median Mid Algorithm, but after computing the current mid and current spread, it then evaluates the "Standard Score", as defined below, of the current mid against a list (the "Mid List") which maintains a fixed number of previously evaluated BGN Mids (maintained as a queue; if the queue is full, elements are removed from the front). The Standard Score represents how many standard deviations the current mid is above or below. If the Standard Score is 0, only the current mid is recorded in the Mid List and an outgoing tick is not sent. Otherwise, the average mid and standard deviation of the current mid is calculated against the Mid List, and that mid is then added to this Mid List. Spreads are also evaluated against other contemporaneous spreads, applying a smoothing calculation, to arrive at a market reflective spread.

2.6 BGN PUBLICATION HOURS

For currencies or metals that trade 24 hours a day, market trading days and hours are below. Many controlled currencies however have their BGN pricing hours limited to when the local market opens and closes. To obtain the most robust sources of data and thus the most accurate pricing, BGN respects local market trading hours, as sources outside of market trading can be poor. Bloomberg is continuously reviewing and adjusting to these trading hours as needed.

- New York (BGN) which opens and closes at 5pm EST each day
- London (BGNL) which opens and closes at 6pm London time each day
- Tokyo (BGNT) which opens and closes at 8pm Tokyo time each day

The BFIX is set to open at 5.30pm on Sunday EST and it closes 5pm Friday EST.

2.7 DATA INPUT REVIEW

Bloomberg undertakes a periodic review of the appropriateness of specific data used in the calculation and validation of the BFIX rates, including the BGN and BGNE. This review is intended, among other things, (i) to assist in ensuring the BFIX rates are based on reliable and observable market data that reflect the economic reality of a given market, and (ii) to ensure that the BFIX rates themselves are reliable representations of the foreign exchange market.

BFIX does not have "submitters", as that term is defined under the IOSCO Principles, and does not intend to include any in its fixings. There is no solicitation process to obtain underlying data, either by a panel or by polling in the calculation of the BFIX. The BGN and BGNE construction are designed to consistently produce levels without interpolation or extrapolation of input data.

In addition, as noted above, sources are anonymous to users and the sources themselves at each pricing point and the data received is ancillary to the source's primary purpose of soliciting FX transactions from the market. Also, BFIX only establishes fixings for currencies and metals for which it has adequate quality data to produce a snapshot that is representative of the pairing being measured.

CHAPTER 3   BFIX METHODOLOGY

BFIX provides a snapshot of the BGN or BGNE at 30-minute intervals throughout the day and is published on the Bloomberg Professional® service within 15 seconds of the fixing time for USD based spots & Forwards and within 1 minute for all others.

The distribution channels for BFIX are the Bloomberg Professional service, including the Desktop API, Data License, and (for major currencies) the BFIX public website available here:

http://www.bloomberg.com/markets/currencies/fx-fixings.

Each of the fixings is a practical rate capable of replication in a real-world portfolio. The BGN & BGNE inputs used in the fixings are available on the Bloomberg Professional service, including inclusion rules and methodologies.

The Administrator does not use, and does not plan to use, any third parties in data collection, computation or dissemination of the index. In the event it does determine to use such third parties, the Administrator will provide details of their function in the methodology and establish appropriate controls in its internal procedures.

3.1   CALCULATION

The BFIX prices are derived by taking a Time-Weighted Average Price ("TWAP") of the arithmetic mid-rates of BGN or BGNE prices, pre and post the fixing time. Along with other measures such as the anonymity and rotation of sources at any given time, using a TWAP to reach to the fixing value reduces the likelihood of BFIX rates being susceptible to irregular price action in the market around fixing time.

3.2   TIME-WEIGHTED AVERAGE PRICE

The quotes that are fed into the TWAP are the arithmetic mid rates of the BGN or BGNE for bid and ask ticks. Each time slice of the fixing is one second long. The BGN & BGNE can produce multiple prices within one second for a currency or metals pair of which the arithmetic average is taken to produce one price for each second.

The TWAP uses a triangular function with the peak of the triangle on the fix. The peak of the triangle will have 10% weight and linear TWAP around that. The Peak weight is assigned to the quote on the exact fix time. Quotes pre- and post-fix time weigh approximately 88.52% and 1.48% respectively (explained further below).

3.3   TWAP WINDOWS

The time frames for TWAP vary for spots, swaps and outrights and metals as follows:

- For all Spot currencies, the linear TWAP will start three hundred seconds (five minutes) before the fix time and then decay for six seconds after the fix time.
- For all swap points and outrights the linear TWAP will start nine hundred seconds (15 minutes) before the fix time and then decay for six seconds after the fix time.
- For metals the linear TWAP will start six hundred seconds (10 minutes) before the fix time and then decay for six seconds after the fix time.

3.4 ILLUSTRATIVE EXAMPLE OF A SPOT BFIX

Bloomberg BFIX TWAP diagram

Illustrative example of G10 currency with 300 seconds before and 6 seconds after of 10am fix

Each time slice is one second long. The BGN price is the average of BGN ticks in that second. The weighted price at each time slice is the BGN Price * the cumulative weight.

10% weight at time slice 300 seconds.

88.52% weight for 299 seconds

1.48% weight for 6 second decay

09:55:00 AM   10:00:00 am   10:00:06 AM

299 seconds   1 second   6 Seconds
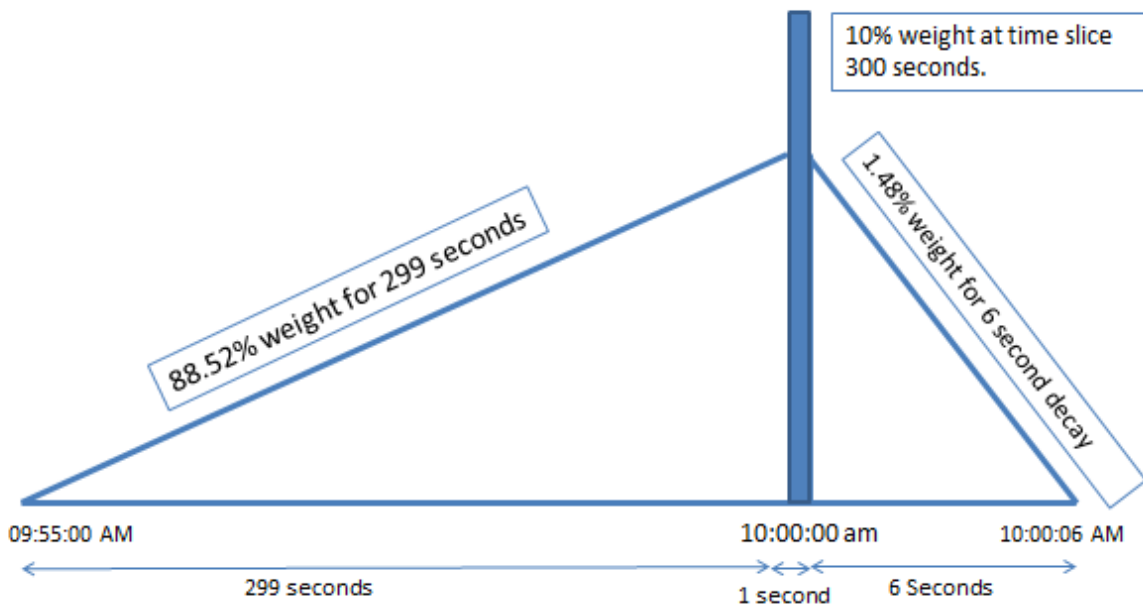
3.5 CALCULATING THE TRIANGLE AREA

Time weights are calculated based on 3 main factors
1. time before,
2. decay after (both considered in seconds) and
3. peak weight based on which following calculations are made

3.6 FORMULA INVOLVED

- Delta Low   = (100/Time Before)
- Delta High   = (-100/Decay)Area   = (0.5*time before*100)+(0.5*decay after*100)-100
- Area Weights   = (1-peak weight)/Area
- Weight   = Previous Time Weight + Delta Low (OR) Delta Hi *Area Weight (Delta high or low is decided as per the time whether its pre fix time or decay)
- The weighted price = Weight * the BGN spot price on that time slice.
- *Final FIX price will be the addition of all the weighted prices.*

> ### Numerical Example: TWAP Calculations for a G10 Currency
>
> Delta Low   = (100/300)
>   = 0.333333333
>
> Delta Hi   = (-100/6)
>   = -16.66666667
>
> Area   = (0.5*300*100) + (0.5*6*100)-100
>   = 15200
>
> Area Weight = (1-(10/100))/15200
>   = 0.0000592105
>
> Considering weight at the 300 second to be zero subsequent weights are
>
> calculated as 0+0.33333 * 0.0000592105 = 0.00002
>
> as the first weight is zero first TWAP will always be 0.

Further detailed examples are provided in Exhibit C.

3.7 CROSS CALCULATION

All the BFIX currencies are fixed against the United States Dollar. Any other currency pair is thus cross calculated, date aligned, as necessary.[1] This calculation takes place on the BFIX rates themselves and not during the BFIX TWAP calculation.

3.8 ROUNDING

Market convention, as represented by the history of source inputs, dictates the number of decimal places used in a fixing. When the application of algorithms produces an additional decimal place for the bid and/or ask, BFIX will round that number up or down as warranted. To help ensure a measurable bid/ask spread, the bid is always rounded down and the ask is always rounded up.
For example, a bid/ask calculation of 1.10919/1.10921 of a four decimal place currency will be rounded to 1.1091/1.1093.

3.9 FORWARDS

For currencies that are deliverable, the BFIX TWAP looks for SWAP points in each tenor. The resulting OUTRIGHT is the BFIX SPOT plus the SWAP points. For NDF defined currencies, the input sources are from outrights. The BFIX Swap points generated are the result of the BFIX TWAP OUTRIGHT minus the BFIX TWAP SPOT.

If there are no swap point updates in the BFIX window, the function will look back to the previous swap point and roll that fixing forward. For outrights, the spot associated with the BFIX time will always be used.

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[1] For currencies being cross calculated with different settlement dates, BFIX date aligns the rates to account for the cost of funding by taking the swap points difference between the settlement dates and adds them onto the BFIX spot rate of the currency with the earlier settlement date. **Example**: When cross-calculating EUR*CAD, where EUR*USD is T+2 and USD*CAD is T+1, BFIX adds 1day worth of T/N points (Tom/Next swap points) to USD*CAD to acquire a USD*CAD T+2 and then crosses the rates. The T/N points are taken from the BFIX forward curve or, if not available, BFIX interpolates between the spot and the next available tenor (e.g., 1 week).

3.10 CHANGE IN METHODOLOGY

The Administrator will review the benchmark at least annually to validate whether (a) their design continues to measure the intended markets, (b) the input data used remains sufficient, appropriate and faithful to the data hierarchy, and (c) the selection of benchmark currencies continues to meet the goal of measuring only liquid and active markets. More frequent reviews may result from extreme market events, such as those described above under "Stress Events". Any resulting material change to the methodology will be reviewed at regularly scheduled BGOC and BOC meetings, or during emergency meetings in exigent circumstances, pursuant to their terms of reference.

In determining whether a change to a benchmark is material, the following factors shall be taken into account:

• The economic and financial impact of the change;

• Whether the change affects the original purpose of the Benchmark; and/or

• Whether the change is consistent with the overall objective of the Benchmark and the underlying market interest it seeks to measure

The Administrator will also provide stakeholder notice and engagement regarding the proposed chance, the scope and length of which will be informed by the nature of the change and stakeholder impact.

CHAPTER 4.   EXPERT JUDGMENT AND DATA INTEGRITY

The BFIX methodology is a fully automated process designed to produce the most consistent and transparent fixing while reducing the intervention of expert judgments, from attaining input prices to BFIX calculation to publishing. Certain judgments are made by Bloomberg in creating the BGN and BGNE   input to BFIX.

BGN & BGNE pricing is created from a list of eligible sources, which are determined at ticker level, based on a number of factors like liquidity and price quality in the context of the market they are pricing. If pricing or other data are anomalous pursuant to pre-set filters and alerts, Bloomberg evaluators examine the data, and may choose to remove or add sources according to the quality of data provided. Filters, price age-out (typically set to 30 seconds), minimum number of sources (typically set to 2) or other settings of BGN and BGNE may also be adjusted over time according to market conditions to improve pricing.

Expert judgments are also applied to determine the degree of liquidity in a market, or whether there is an active market at any given time for a currency or metal. This may affect the determination of whether to rebuild and publish a fixing that failed to publish at a given snapshot.

BGN and BGNE regularly monitor pricing to help ensure the use of multiple sources for each price. Additional sources are also evaluated if available to add robustness and diversity to pricing. If other sources are not available, BGN and BGNE may discontinue pricing until additional sources can be added. In no event will BFIX take a BGN or BGNE price that is from a single source. Also, BGN or BGNE will not produce a price, and BFIX will not produce a fixing, that can be reverse engineered.

When expert judgment is required, Bloomberg undertakes to be consistent in its application, with recourse to written procedures outlined in this methodology and internal procedures manuals. These procedures detail the steps in decision making and the hierarchy of data to be used. Material exercises of expert judgment are reviewed by senior members of the BGN, BGNE and BFIX teams and
compliance teams. Bloomberg also maintains and enforces a code of ethics to prevent conflicts of interest from inappropriately influencing fixing construction, production, and distribution, including via the use of expert judgment.

Bloomberg maintains an audit trail of any changes done on the BGN and BGNE. The audit trail includes a description of the change, the time and date of the change, the value before and after the change and who made the particular change.

In addition, the audit trail and any changes made to BFIX are maintained on an internal ticketing system for a period of at least 5 years.

CHAPTER 5.   PUBLICATION

5.1   BFIX COVERAGE

The BFIX operates 24 hours a day for all weekdays of the year in line with the following market hours and subject to local currency hours policy and national holidays policy below:

- First BFIX at each week will be Sunday 5:30 PM New York time.
- Last BFIX of each week will be Friday 5PM New York time.

The BFIX will be produced every 30 minutes on the hour and half-hour during these times if an "active market" persists and input minimums are met, subject to the policy on national holidays below.

An active market is one in which (a) BFIX has received from BGN or BGNE at least one bid and ask price in the fixing window, and (b) the bid and ask are within 30 seconds of each other. In no event will BFIX take a BGN or BGNE price that is from a single source. In no event will BGN or BGNE produce a price, or BFIX produce a fixing, that can be reverse engineered. If no qualified BGN or BGNE price can be produced within a fixing window, the previous fix will be carried forward.

5.2.1   HOURS OF LOCAL CURRENCIES

There are some currencies where offshore trading does not occur or is not permitted by that country. The BFIX will be published when the local market is open, and when closed, carry forward the closing price until the market opens again.

This impacts the following currencies with all open and close times in EST with winter and summer hours due to DST.

COUNTRY	ISO	LOCAL TIMES		DAYLIGHT SAVING DIFFERENCE	
		OPEN	CLOSE	OPEN	CLOSE
ARGENTINE PESO	ARS	10:00am	3:00pm		
BAHRAIN DINAR	BHD	9:00am	1:30pm		
BRAZILIAN REAL	BRL	9:00am	6:00pm		
CHILEAN PESO	CLP	8:30am	1:30pm		
COLOMBIAN PESO	COP	8:00am	1:00pm		
EGYPTIAN POUND	EGP	8:30am	2:30pm		
INDIAN RUPEE	INR	8:30am	4:30pm		
INDONESIAN RUPIAH	IDR	8:00am	4:00pm		
ISRAELI SHEKEL	ILS	8:00am	10:30pm	9:00am	11:30pm
KENYAN SHILLING	KES	8:00am	6:00pm		
MALAYSIAN RINGGIT	MYR	8:00am	5:00pm		
OMANI RIAL	OMR	8:00am	2:00pm		
PAKISTANI RUPEE	PKR	9:30am	5:30pm	9:00am	3:00pm
PERU NEW SOL	PEN	9:00am	1:30pm		
PHILIPPINE PESO	PHP	9:00am	4:00pm		
QATAR RIAL	QAR	8:00am	1:30pm		
SAUDI ARABIAN RIYAL	SAR	9:00am	5:00pm		
SOUTH KOREAN WON	KRW	9:00am	3:00pm		
TAIWAN DOLLAR	TWD	9:00am	4:00pm		
UAE DIRHAM	AED	9:00am	3:00pm		
URUGUAY PESO	UYU	9:00am	3:00pm		
BHUTAN NGULTRUM	BTN	9:30am	5:30pm		
KUWAITI DINAR	KWD	9:00am	2:00pm		

5.3   POLICY ON NATIONAL HOLIDAYS

The FX market is a global 24 hour a day market. A public holiday in a country does not necessarily mean the FX market is closed. The BFIX operates on all days as long as an active market is open. However, liquidity on such holidays in the currency in question may be considerably lower, potentially failing to qualify as an active market, meaning the BFIX will not publish for that currency and the last fix will be carried forward. In some of the less liquid currencies or where currency trading offshore is not allowed, it is likely the BFIX will have significantly reduced coverage on national holidays. In addition, the BFIX will not publish on the following days where liquidity is known to be significantly impacted: Easter Friday, Christmas Day and New Year's Day. Please see a list in **Exhibit D** that lists these dates over the next 5 years.

5.4   DELIVERY METHODS

Absent a disruption or failure, the BFIX will be published on the Bloomberg Professional service within 15 seconds of the fixing time for USD based spots & Forwards and within 1 minute for all others. The rates can be consumed as a source in many Bloomberg functions and API.

A select number of currencies and times for the spot price only will be available free on the Bloomberg website under a delay of 5 minutes. http://www.bloomberg.com/markets/currencies/fx-fixings

Those select currencies and times are listed in **Exhibit E**.

5.5   DISRUPTION TO SERVICE/RESTATEMENTS

Periods of inability to provide a fixing are generally dictated by anticipated periods where there is no active market, such as holidays or off-trading hours for less frequently traded currencies. Bloomberg has robust controls and procedures in place to minimize unanticipated fixing failures and their impact. In the event of such an unanticipated failure, BFIX would determine whether the event occurred during an active market. If so, BFIX will endeavor to publish the fixing or revised fixing as soon as practicable. If no qualified BGN or BGNE price can be produced within a fixing window, the previous fix will be carried forward.
Bloomberg makes every effort to provide accurate calculation of BFIX Fixings. However, to the extent a material error in a fixing is uncovered following its publication and dissemination, a notification will be sent to BFIX clients alerting them of such error and the expected date of a revised publication, if warranted. Bloomberg considers the following factors to determine whether to restate. Not all conditions need to be present to warrant a restatement, and certain factors may be more determinative that others depending on the circumstances of the given error.

A. The relative importance of the data field impacted by the error;
B. When the error occurred and when it was discovered;
C. The number of fixings affected;
D. Whether the impacted fixings are linked to tradable products;
E. The magnitude of the error;
F. The burden of restatement on client re-processing relative to the impact of the error;
G. The impact of the restatement on analytical tools.

Any decisions to amend and/or republish a BFIX rate will be reviewed by the Benchmark Governance Committee after implementation.

Bloomberg reserves the right not to amend or republish any BFIX rate after the publication of the rate for the same currency on the following business day in the United States of America.

Bloomberg will retain records relating to any amendment to or republication of a BFIX rate for a minimum period of 5 years.

CHAPTER 6.   BENCHMARK OVERSIGHT AND GOVERNANCE

6.1   BENCHMARK OVERSIGHT COMMITTEE

Bloomberg has established a robust governance and audit structure in order to monitor, manage and/or improve the objectivity, reliability, consistency, transparency and management and implementation of the benchmark rules. The Benchmark Oversight Committee (BOC) is the uppermost governance body and consists of senior representatives from various Bloomberg business units. Voting members of the BOC do not participate in the index business.

The purpose of the BOC, with respect to the BFIX, is to discuss, review and challenge all aspects of the determination process of the fixing. The BOC meets on a quarterly basis to review matters such as material risks, conflicts of interest, industry developments, client complaints and material index errors and restatements.

BFIX is subject to Bloomberg's internal compliance function which periodically reviews various aspects of Bloomberg's businesses in order to determine whether such businesses are adhering to applicable firm-wide policies and procedures, and assess whether applicable internal controls are functioning properly. In addition to the compliance function, Bloomberg may from time to time appoint an independent external auditor with appropriate experience and capability to periodically review and report on its adherence to the IOSCO Principles for Financial Benchmarks. The frequency of such external reviews will depend on the size and complexity of the operations and the breadth and depth of the benchmark use by stakeholders.

6.2   STAKEHOLDER ENGAGEMENT

BFIX Advisory Councils ("BAC") are composed of key market participants and other influential individuals to assist Bloomberg in setting BFIX priorities, to discuss potential rules changes and to provide ideas for new products. BACs are generally constituted on an annual basis. While potential changes are discussed through this process, all feedback received is non-binding and all final decisions on benchmark index rules are made by the BOC review after the review period has ended. Bloomberg is also in constant and ongoing engagement with its users through various channels, including via help desks, sales personnel and direct communication with product personnel. To help ensure BFIX remains an accurate representation of currency and metals markets, it endeavors to meaningfully incorporate these engagements into improvements in processes and service. Prior to any material change that might meaningfully impact users, BFIX consults more broadly with stakeholders, where appropriate, before a recommendation is presented to the BOC for approval. This concept of shared ownership enables Bloomberg to produce the most relevant fixings and helps ensure responsiveness to user requirements.

6.3   CHANGES TO METHODOLOGY

Over time, Bloomberg may be required to change the methodology to help ensure representativeness, accuracy, or integrity. Such changes could include adjustments to coverage, the time window or TWAP calculation, and are in response to internal needs or engagement with stakeholders through Bloomberg personnel. Material changes to the BFIX methodology are reviewed and approved by the BOC.

Bloomberg will provide reasonable notice to its clients of any planned change with the rationale for the change. Bloomberg will also publish a revised version of its methodology document on its website.

CHAPTER 7.   RISKS ASSOCIATED WITH THE BFIX

The following is a summary of certain risks associated with the BFIX but is not meant to be an exhaustive list of all risks associated with using BFIX, an investment in currencies or metals, or   investments measured against BFIX. Though the fixings are designed to be representative of the markets they measure, they may not be representative of every use case. There is also inherent,   though transparent, judgment in their construction, as outlined in this methodology. They are also   designed for general applicability and not to address the individual needs of users. Bloomberg does not advise as to the usefulness of BFIX to a particular circumstance, and users are therefore encouraged to seek their own counsel for such matters.

This methodology is subject to change, which may impact its usefulness to users. Though efforts will be made to alert users of this change, not every individual user may be aware of them. Such   changes may also significantly impact the usefulness of BFIX.

Bloomberg may also determine to cease publication of BFIX or a particular fixing provided by BFIX. Bloomberg maintains internal policies regarding user transitions, but there is no guarantee an   adequate alternative is available generally or for a particular use case.

Markets for currencies and metals, as with all markets, can be volatile.   As BFIX is designed to measure those markets, its fixings could be materially impacted by market movements, thus significantly impacting the use or usefulness of the fixings for some or all users. Also, certain currency and metals markets are less liquid than others, and even the most liquid markets may   suffer periods of illiquidity. Illiquidity can have an impact on the quality or amount of data available to BFIX for calculation, and may cause BFIX to produce unpredictable results.

BFIX is based on indicative bid and ask rates which are supplied by source institutions in their discretion. While they reflect where those institutions would be willing to transact, they may not be reflective of where they actually transacted. Also, while BFIX will not accept pricing from BGN that is derived from a single source, the number of source rates with respect to a particular fixing may be relatively few at any given snapshot. However, in no event will BGN produce a price, or BFIX produce a fixing, that can be reverse engineered.

CHAPTER 8.   LIMITATIONS OF THE BENCHMARK

The following is a summary of certain limitations associated with the Bloomberg BFIX Benchmarks but is not meant to be an exhaustive list of all risks and limitations associated with using these Benchmarks. Though the Benchmarks are designed to be representative of the markets they measure, they may not be representative of every use case. They are designed and calculated strictly to follow the rules of this methodology, and any benchmark level or other output is limited in its usefulness to such design and calculation.

There is inherent, though transparent, judgment in benchmark construction, as outlined in this methodology. They are also designed for general applicability and not to address the individual needs of users. Bloomberg does not advise as to the usefulness of Bloomberg BFIX benchmarks to a particular circumstance, and users are therefore encouraged to seek their own counsel for such matters. This methodology is subject to change, which may impact its usefulness to users. Though efforts will be made to alert users of this change, not every individual user may be aware of them. Such changes may also significantly impact the usefulness of Bloomberg BFIX Benchmarks. Bloomberg may also determine to cease publication of Bloomberg BFIX benchmarks or a particular BFIX provided by Bloomberg. Bloomberg maintains internal policies regarding user transitions, but there is no guarantee an adequate alternative is available generally or for a particular use case. Markets for currencies, as with all markets, can be volatile. As Bloomberg BFIX benchmarks are

designed to measure those markets, its benchmarks could be materially impacted by market movements, thus significantly impacting the use or usefulness of the fixings for some or all users. Also, certain currency markets are less liquid than others, and even the most liquid markets may suffer periods of illiquidity. Illiquidity can have an impact on the quality or amount of data available to Bloomberg BFIX for calculation, and may cause Bloomberg BFIX benchmarks to produce unpredictable results.

Exhibit A: List of BFIX Currencies and Metals Offered

BFIX Europe	ISO	BFIX AFRICA & GULF	ISO	BFIX ASIA-PACIFIC	ISO	BFIX AMERICAS	ISO
Albanian Lek	ALL	Algerian Dinar	DZD	Australian Dollar	AUD	Argentine Peso	ARS
Belarus Ruble	BYR	Angola Kwanza	AOA	Azerbaijan Manat	AZN	Brazilian Real	BRL
British Pound	GBP	Bahrain Dinar	BHD	Bhutan Ngultrum	BTN	Canadian Dollar	CAD
Bulgarian Lev	BGN	Botswana Pula	BWP	Chinese R. Yuan	CNY	Chilean Peso	CLP
Croatian Kuna	CZK	Central African Franc	XAF	Georgia Lari	GEL	Mexican Peso	MXN
Danish Krone	DKK	Egyptian Pound	EGP	Hong Kong Dollar	HKD	Peru New Sol	PEN
Estonian Kroon	EEK	Ghana Cedi	GHS	Indonesian Rupiah	IDR	Uruguay Peso	UYU
Euro	EUR	Israeli Shekel	ILS	Japanese Yen	JPY		
Finnish Markka	FIM	Jordanian Dinar	JOD	Kazakhstan Tenge	KZT		
Hungarian Forint	HUF	Lesotho Loti	LSL	Malaysian Ringgit **	MYR		
Iceland Krona	ISK	Kenyan Shilling	KES	Mongolia Tugrik	MNT		
Italian Lira	ITL	Kuwaiti Dinar	KWD	New Zealand Dollar	NZD		
Latvian Lat	LVL	Mauritius Rupee	MUR	Pakistani Rupee	PKR		
Lithuanian Litas	LTL	Moroccan Dirham	MAD	Philippine Peso	PHP		
Macedonia Denar	MKD	Namibia Naira	NAD	Singapore Dollar	SGD		
Norwegian Krone	NOK	New Zambian Kwacha	ZMW	South Korean Won	KRW	**BFIX METALS**	**ISO**
Polish Zloty	PLN	Nigerian Naira	NGN	Sri Lanka Rupee	LKR	Gold Spot $/Oz	XAU
Romanian Leu	RON	Omani Rial	OMR	Taiwan Dollar	TWD	Palladium Spot $/Oz	XPD
Russian Ruble	RUB	Qatar Rial	QAR	Thai Baht	THB	Platinum Spot $/Oz	XPT
Serbian Dinar	RSD	Saudi Arabian Riyal	SAR	Vietnam Dong	VND	Silver Spot $/Oz	XAG
Solvakian Koruna	SKK	Seychelles Rupee	SCR				
Solvenian Tolar	SIT	Sierra Leone Leone	SLL				
Swedish Krona	SEK	South African Rand	ZAR				
Swiss Franc	CHF	Swaziland lilangeni	SZL				
Turkish New Lira	TRY	Tanzania Shilling	TZS				
Ukraine Hryvnia	UAH	Tunisian Dinar	TND				
ECU	XEU	UAE Dirham	AED				
		Ugandan Shilling	UGX				
				**local BGN inputs only			

EXHIBIT B: GLOSSARY

- **Active Market -** An active market is one in which (a) Bloomberg has received at least one bid and ask price in the fixing window, and (b) the bid and ask are within 30 seconds of each other.
- **Ask -** The rate at which a market maker is willing to sell the base currency or metal. Also known as an offer.
- **Bid -** The price at which the market maker is willing to buy the base currency or metal.
- **Bloomberg Generic Price (BGN) -** A representative price based on indicative rates only sourced from participants in the applicable market.
- **Exchange Controls –** Various legal or regulatory controls restricting the purchase or sale of currencies, such as the banning of the use or possession of foreign currencies within the subject country, restrictions on currency exchange to government-approved exchangers, fixed exchange rates and restrictions on the amount of a currency that may be imported or exported.
- **Executable -** As opposed to an indicative quote, an executable quote can be dealt on.
- **Forward** - The foreign exchange rate on a date in the future.
- **FX -** Foreign Exchange
- **G10 Currencies –** AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, NZD, and SEK.
- **Indicative** – A market maker's provided quote indicating where it would be willing to transact, but is not obliged to transact at the price. Also known as 'not firm'.
- **Local market trading hours** - The timeframe or hours a market is defined as open.
- **Market Maker -** A firm or trader that is making a bid and an ask price to the market to trade on and take on the risk associated with the trade.
- **Market Taker -** Anyone who is trading on prices and will hit the bid or offer in the market but not provide bid/ask prices.
- **NDF** – means 'non-deliverable forwards', which are contracts that involve no exchange of principal, are fixed at a pre-determined price, and are typically settled in USD (or sometimes, in the case of Eastern Europe, in EUR) at the prevailing spot exchange rate taken from an agreed source, at an agreed time, on an agreed future date.
- **Outrights -** A forward that locks in the price at which a currency can be bought or sold on a future date. Also known as 'Forward Outright'. Also appears as 'FX Outrights'.
- **Peak weight** – The weight at the top of a time weighted average price defined in BFIX calculation as 10%.
- **Spot rate** - The foreign exchange rate on the settlement date.
- **Swap Points -** The annualized percentage premium or discount that the forward outright (all-in rate) represents over the current spot rate.
- **Tick –** The minimum upward or downward movement in the currency is called a tick. For example, a movement in EUR*USD from 1.1028 to 1.1029 is defined as the price has moved up by 1 tick. In USD*JPY if the price moves from 110.25 to 110.20 the price has moved down by 5 ticks.
- **Tickers –** Each BGN price that can be populated resides in a unique 'ticker' on the Bloomberg Professional service that can be called. 'EG GBP Curncy <GO>' is a ticker and BGN is a source to use on such ticker.
- **TWAP** – Time-Weighted Average Price. A method of calculating an average price over a specified period of time.

Exhibit C – Further Calculation Examples

BFIX CALCULATION

Curncy	EUR
DATE	01/19/16
START TIME	9:55:00 AM
END TIME	10:00:06 AM
TIME BEFORE	300
DECAY AFTER	6
PEAK WEIGHT	10%

DELTA LOW	(100/ TIME BEFORE)	= 0.3333
DELTA HI	(-100/ DECAY)	= -16.6667
AREA	(0.5 * TIME BEFORE * 100) + (0.5 * DECAY	= 15199
AREA WEIGHT	(1 - PEAK WEIGHT%) / AREA	= 0.0000592105

TIME	weight	BID QUOTE	WEIGHTED PRICE	ASK QUOTE	WEIGHTED PRICE
0	0.00000	1.0898	0.00000	1.0899	0.00000
1	0.00002	1.0898	0.00002	1.0899	0.00002
2	0.00004	1.0898	0.00004	1.0899	0.00004
3	0.00006	1.0898	0.00006	1.0899	0.00006
4	0.00008	1.0898	0.00009	1.0899	0.00009
5	0.00010	1.0898	0.00011	1.0899	0.00011
6	0.00012	1.0898	0.00013	1.0899	0.00013
7	0.00014	1.0897	0.00015	1.0898	0.00015
8					0.00017
9					0.00019
10					0.00022
11					0.00024
12					0.00026
13					0.00028
14					0.00030
15	0.00030	1.0898	0.00032	1.0899	0.00032
16	0.00032	1.0898	0.00034	1.0899	0.00034
17	0.00034	1.0898	0.00037	1.0899	0.00037
18	0.00036	1.0898	0.00039	1.0899	0.00039
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
291	0.00574	1.0892	0.00626	1.0893	0.00626
292	0.00576	1.0892	0.00628	1.0893	0.00628
293	0.00578	1.0892	0.00630	1.0893	0.00630
294				1.0893	0.00632
295				1.0892	0.00634
296	0.00584	1.0891	0.00636	1.0892	0.00636
297	0.00586	1.0891	0.00638	1.0892	0.00638
298	0.00588	1.0891	0.00641	1.0893	0.00641
299	0.00590	1.0891	0.00643	1.0892	0.00643
300	0.00592 0.10000	1.0891	0.10891	1.0892	0.10892
301	0.00493	1.0891	0.00537	1.0892	0.00537
302	0.00395	1.0892	0.00430	1.0893	0.00430
303	0.00296	1.0891	0.00322	1.0892	0.00322
304	0.00197	1.0891	0.00215	1.0892	0.00215
305	0.00099	1.0891	0.00107	1.0892	0.00107
306	0.00000	1.0891	0.00000	1.0892	0.00000
	100.0%	BFIX BID	1.08951	BFIX ASK	1.08961

*Weight at second 1= (delta low * area weight).*

*This is cumulative so the weight at second 2 = (delta low * area weight)+weight of second 1.*

Repeated down to second 300

*The Weighted price is the weight*BGN price*

*The weight at second 301 = Delta HIGH * Area*

*The weighted price at second 300 is the peak weight 10% * the BGN price*

The Bfix price is the sum of the 306 weighted prices

The weights add up to 100% by summing all the weights and including the 10% peak

The weights at second 0 and second 306 are zero.

Exhibit D - Schedule of Days BFIX will not operate

The BFIX will not price on three specific business days of the year due to lack of liquidity.

Good Friday, and the observed market days for Christmas day and New years day as per the open days of the Fedwire services from the Federal reserve.

Where Dec 25 and Jan 1 fall on a Saturday, the National observed holiday will be on the Friday but there is no close of the Fedwire and markets will be open on Friday.

If those holidays fall on a Sunday then the holiday is observed on the Monday and in addition Fedwire is closed.

Please note 2021 as an example of Christmas day falling on a Saturday but BFIX will be open on the Friday before.

The below is a table of days where the BFIX will be closed.

DATE	DAY	HOLIDAY
25-DEC-18	TUESDAY	CHRISTMAS DAY
2019		
01-JAN-19	TUESDAY	NEW YEARS DAY
19-APR-19	FRIDAY	GOOD FRIDAY
25-DEC-19	WEDNESDAY	CHRISTMAS DAY
2020		
01-JAN-20	WEDNESDAY	NEW YEARS DAY
10-APR-20	FRIDAY	GOOD FRIDAY
25-DEC-20	FRIDAY	CHRISTMAS DAY
2021		
01-JAN-21	FRIDAY	NEW YEARS DAY
02-APR-21	FRIDAY	GOOD FRIDAY
2022		
15-APR-22	FRIDAY	GOOD FRIDAY
26-DEC-22	MONDAY	CHRISTMAS DAY
2023		
02-JAN-23	MONDAY	NEW YEARS DAY
07-APR-23	FRIDAY	GOOD FRIDAY
25-DEC-23	MONDAY	CHRISTMAS DAY
2024		
01-JAN-24	MONDAY	NEW YEARS DAY
29-MAR-24	FRIDAY	GOOD FRIDAY
25-DEC-24	WEDNESDAY	CHRISTMAS DAY

Exhibit E – Currencies Available on Public Website

Currency against the EUR		Currency against the CAD		Currency Against the USD
EUR-JPY		MXN-CAD		USD-DKK
EUR-BGN		GBP-CAD		XAU-USD
EUR-CZK		THB-CAD		USD-MXN
EUR-DKK		BRL-CAD		USD-JPY
EUR-GBP		ZAR-CAD		USD-CNH
EUR-HUF		PEN-CAD		USD-ILS
EUR-PLN		CHF-CAD		USD-SGD
EUR-RON		TRY-CAD		USD-ZAR
EUR-SEK		NOK-CAD		USD-THB
EUR-CHF		SAR-CAD		USD-CHF
EUR-NOK		INR-CAD		USD-CZK
EUR-HRK		MYR-CAD		USD-SEK
EUR-RUB (T+1)		RUB-CAD		USD-PLN
EUR-TRY		HKD-CAD		GBP-USD
EUR-AUD		AUD-CAD		USD-HUF
EUR-BRL		CNY-CAD		NZD-USD
EUR-CAD		KRW-CAD		AUD-USD
EUR-CNY		SGD-CAD		USD-TRY
EUR-HKD		NZD-CAD		USD-HKD
EUR-ILS		JPY-CAD		EUR-USD
EUR-MXN		TWD-CAD		USD-CAD
EUR-NZD		IDR-CAD		
EUR-SGD		SEK-CAD		
EUR-THB				
EUR-ZAR		TIMES AVAILABLE		
EUR-IDR		Beijing 9.30am		
EUR-INR		Singapore/Kuala Lumpur 11.00am		
EUR-KRW		Manila 11.30am		
EUR-MYR		Jakarta/Bangkok 11.00am		
EUR-PHP		Seoul 2.00pm		
		Tokyo 3.00pm		
		Mumbai 12.00pm		
		Frankfurt 2.00pm		
		London 4.00pm		
		Ottawa 12.00pm		
		New York 12.30pm		
		New York 5.00pm		

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