Market conventions for ZARONIA-based derivatives [Working Draft]

prepared by
The Market Practitioners Group's Derivatives Workstream

SOUTH AFRICAN RESERVE BANK

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1. Background

The highly publicised irregularities relating to the production of interbank offered rates (IBORs) in 2012, see, for example, [Hou and Skeie, 2014], initiated a global regulatory response to reform major interest rate benchmarks. The use of the IBORs within financial markets has subsequently reduced substantially in favour of more robust, alternative reference rates (ARRs), namely, overnight reference rates (ONRRs) which are *near risk-free*.

Derivatives are an integral part of financial markets and are critical to reference rate transition plans in major jurisdictions. The latest Bank for International Settlements (BIS) Report, [BIS, 2022], shows that the gross notional of over-the-counter (OTC) derivatives totalled USD600 trillion globally. Interest rate derivatives form over 50% of global derivatives notional outstanding and the proportion of interest rate derivatives which are centrally cleared stands at 75%.

Given the significant role of interest rate derivatives in financial markets, it is essential that a derivative transition process is managed transparently and consultatively while considering the requirements of clearing houses and other relevant venues. The above will ensure market depth is preserved and potentially enhanced.

2. Derivatives workstream mandate

South Africa has also embarked on the transition journey with the release of the consultative paper [SARB, 2018], prepared by the South African Reserve Bank (SARB), which detailed its initial proposal to reform domestic benchmark and reference rates. The SARB subsequently formed the Market Practitioners Group (MPG) in 2019 to manage the process of adoption and transition to the new interest rate dispensation. The SARB's MPG is a joint public and private sector body, comprising representatives from the SARB, the Financial Sector Conduct Authority (FSCA), and senior professionals from a variety of institutions from different market interest groups active in the domestic money market.

The MPG relies on dedicated workstreams and technical subgroups to carry out its objectives. The workstreams and subgroups have a responsibility of providing technical input and recommendations to the MPG on specific issues that are relevant to the transition from the Johannesburg Interbank Average Rate (Jibar). Members of these workstreams are drawn from a diverse set of market practitioners whose insights and expertise are required to give effect to the mandate of the MPG as well as shape industry opinions on the reform agenda[1].

The Derivatives Workstream (DWS), constituted in 2021, is mandated with making recommendations on the development of derivative markets and contracts that reference the successor rate. More specifically and as set in its terms of reference, the roles and responsibilities of the DWS are as follows:

- *The DWS shall construct an action plan aligned to the objectives set out by the MPG.*
- *In line with the stated functions of the MPG, the DWS will be responsible for:*
  - *consulting widely and making recommendations on the development of derivative markets and contracts that reference the successor rate;*
  - *formulating and implementing strategies to facilitate the market adoption of derivatives that reference the successor rate;*
  - *formulating and recommending strategies to derive term risk free rates from underlying derivatives activity;*
  - *providing input to the finalization and refinement of the transition plan and monitor the progress made in the derivative markets; and*
  - *aligning with progress and recommendations of all workstreams of the MPG.*

[1] For more information, please refer to: SARB Market Practitioners Group.

3. Problem statement

In order for a derivatives market to initiate, market participants need to consider (and agree upon) the numerous conventions that underpin the said derivative. The DWS embarked upon a process to deliberate on and summarise a set of recommended conventions. The results of these deliberations are presented in this white paper together with reasons for the articulated selections. These recommendations should serve as an underpin for on-the-run overnight indexed swap (OIS), which are interest rate swap derivatives that reference the new ARR and will in future be quoted on screens and/or via interbank broking agents.

4. Existing and alternative reference rates

The traditional suite of benchmark rates in South Africa consisted of a set of Jibars (1-, 3-, 6-, 9- and 12-month), see [SARB-MMRR, 2021]. The 3-month Jibar rate is currently the most commonly used benchmark rate for interest rate derivative products denominated in South African rand (ZAR). Alongside the traditional suite of benchmark rates, the South African Futures and Options Exchange (SAFEX) overnight rate (SAFEX ON) is also widely used to remunerate margin balances on Credit Support Annexures (CSAs) as well as margin balances on exchanges and clearing houses, see [SARB-RFRWS, 2020a]. Like the IBORs, Jibar lacks the primary market activity which puts it at risk of being not representative of the underlying market it is meant to measure.

In 2020, the Risk-Free Reference Rate Workstream (RFRWS) published its recommended properties for a viable replacement reference rate for Jibar — please see [SARB-RFRWS, 2020b] for more information. The RFRWS's recommendations are summarised as follows:

Table 1: RFRWS's recommended properties for a viable replacement reference rate.

Theme	General Feature	Definition	Importance
Integrity	Reliability	*Proper governance and administration to safeguard against manipulation or error.*	*Market integrity and functioning.*
	Robustness	*Clear rules for reference rate production, including transparent and well-known fallbacks in periods of market stress.*	*Availability and usability in times of market stress.*
	Representative	*Rate drawn from a representative sample of transactions from the market in question.*	*Correct pricing basis.*
Efficacy	Frequency	*Rates calculated daily to facilitate market functioning.*	*Pricing of new contracts, mark-to-market valuation.*
	Availability	*Published on dedicated sites.*	*Verification of contracts.*
	Transmission	*Market operations ensure functioning markets, liquidity, and price transmission.*	*Monetary policy and financial stability objectives.*
Appropriate	Choice	*Provide a suite of reference rates for different applications.*	*Clear distinction between risk-free and risky secured or unsecured transactions.*

Taking into account the above recommendations, the MPG has designated the South African Overnight Index Average (ZARONIA) as the preferred successor rate to replace Jibar and SAFEX ON. The conceptual design of ZARONIA was rigorously tested, using bona fide transactions data to ensure that it is reliable, robust and sufficiently stable. The designation of ZARONIA as the preferred successor rate forms part of a larger transition roadmap which includes establishing a successor rate, adoption of the successor rate in both derivatives and cash markets, transitioning legacy contracts and eventual cessation of Jibar. See Figure 15 for a snapshot of the transition roadmap.

5. International market conventions

The table below summarises the key market conventions for OISs that trade in the United States (US) (USD-denominated), United Kingdom (UK) (GBP-denominated) and the European Union (EU) (EUR-denominated).

Table 2: Market conventions for USD-, GBP- and EUR-denominated OISs.

Feature	US	UK	EU
Accrual period	1Y	1Y	1Y
Business day calendar	USGS	GBLO	EUTA
Spot lag	2 bd USGS & USNY	0 bd	2 bd
Business day convention	Modified Following	Modified Following	Modified Following
Accrual period date generation	Backward (EOM)	Backward (EOM)	Backward (EOM)
Non-standard first period	Short-stub	Short-stub	Short-stub
Accrual day count convention	ACT/360	ACT/365 Fixed	ACT/360
Floating reference rate	SOFR	SONIA	€STR
Publication/ Calculation lag	1 bd	1 bd	1 bd
Floating rate calculation	Compounded, 0 bd lookback, 0 bd lockout	Compounded, 0 bd lookback, 0 bd lockout	Compounded, 0 bd lookback, 0 bd lockout
Floating rate convention	Simple, 7 decimal places	Simple, 6 decimal places	Simple, 7 decimal places
Payment lag	2 bd USNY	0 bd	1 bd
Fixed rate quotation	Simple, 7 decimal places	Simple, 6 decimal places	Simple, 7 decimal places

6. Derivative design principles

In contemplating an optimal parameter set for an OIS, the DWS adopted the following design principles:

- Support the deepening of financial markets and ease operational complexity.
- Align with major developed markets unless domestic nuances dictate otherwise.
- Ensure that the requirements of major exchanges and clearing houses are observed and satisfied (e.g. settlement requirements).
- Consider the related ZARONIA quotation, timing and application of the rate to derivatives.

In addition to derivative conventions, the DWS have also provided recommendations on certain elements of market micro-structure. It should be noted that the recommendations made within this document should not preclude any derivative user from negotiating a more bespoke derivative to suit individual requirements.

7. Market and convention recommendations

7.1. Spot-starting single-period overnight indexed swaps

The main objective for creating a market in short-term (i.e. tenors less than or equal to 12M) spot-starting single-period OISs, with the recommended conventions below, is to enable the production of term-based reference rates (TBRRs)[2]. Unlike the current suite of Jibars, it should be understood that these OIS rates will provide equivalent term rates that are near risk-free, i.e. they will not constitute term credit and funding spreads.

Table 3: Spot-starting single-period OIS conventions.

Feature	Recommended Convention	Comment	Reference
Swap tenor	$\leq$ 12M	*Suggested standard quote tenors:* 1M, 2M, . . . , 11M *and* 12M.	8.1.
Accrual period	Equal to swap tenor	*For both floating and fixed legs.*	8.1.
Business day calendar	ZAJO	*As published by the relevant government entity.*	8.2.
Forward period	0Y	*Spot-starting swaps have no forward period.*	8.2.
Spot lag	0 bd	*Trade equals settlement and first accrual period start date. This is a common international settlement convention.*	8.2.
Business day convention	Modified Following	*Applied in accrual period date generation.*	8.2.
Accrual period date generation	Backward (EOM)	*Unadjusted backward generation from roll-day plus EOM, then adjusted by Modified Following.*	8.2.
Accrual day count convention	ACT/365 Fixed	*Used for both the calculation of floating and fixed leg interest cash flows.*	8.2.
Floating reference rate	ZARONIA	*As recommended by the SARB's MPG.*	8.3.
Publication/ Calculation lag	1 bd	*To be confirmed by the SARB. Calculated with the sub-accrual period start date as the anchor date.*	8.3.
ACFR calculation	Compounded, 0 bd lookback, 0 bd lockout	*Backward-looking without lookback or lockout period. Payment lag to resolve calculation lag.*	8.4., 8.5.
ACFR convention	Simple, 6 decimal places	*Or 4 decimal places in % format.*	8.5.
Payment lag	1 bd	*Calculated with the last publication/calculation date within the respective accrual period as the anchor date.*	8.5.
Spread	Simple, additive post compounding	*Fixed simple rate added to the compounded ACFR for floating cash flow calculation, if necessary.*	8.5.
Fixed rate quotation	Simple, 6 decimal places	*Or 4 decimal places in % format.*	8.6.
Net Cash Flow Rounding	2 decimal places	*Net unrounded floating and fixed cash flows, then round to the nearest ZAc.*	8.6.

[2]It is strongly recommended that dealers reflect quotes in at least the 1M, 3M, 6M, 9M and 12M tenors. This is to facilitate the build of sufficient liquidity in these tenors for the eventual production of forward-looking TBRR, which is in accordance with [ARRC, 2021].

7.2. Forward-starting single-period overnight indexed swaps

The current forward rate aagreement (FRA) market provides deep hedging and speculation capability. This market also provides a strong underpin for derivative market depth as well as insight into monetary policy expectations. The main objective for creating a market in forward-starting single-period OISs, with the recommended conventions below, is to create a '*replacement*' for the aforementioned FRAs that reference 3-month Jibar.

Table 4: Forward-starting single-period OIS conventions.

Feature	Recommended Convention	Comment	Reference
Swap tenor	1M or 3M	*The two alternatives for the underlying OIS aligns with the market microstructure for SOFR futures.*	8.1., 8.2.
Accrual period	Equal to swap tenor	*For both floating and fixed legs.*	8.1., 8.2.
Business day calendar	ZAJO	*As published by the relevant government entity.*	8.2.
Forward period	<24M	*Suggested standard quote forward periods and tenors:* For 1M: 1M1M, 2M1M, ..., 10M1M *and* 11M1M. For 3M: 1M3M, 2M3M, ..., 8M3M and 9M3M; and 12M3M, 15M3M, 18M3M and 21M3M.	8.2.
Spot lag	0 bd	*Effective equals first accrual period start date. This is a common international settlement convention.*	8.2.
Business day convention	Modified Following	*Applied in accrual period date generation.*	8.2.
Accrual period date generation	Backward (EOM)	*Unadjusted backward generation from roll-day plus EOM, then adjusted by Modified Following.*	8.2.
Accrual day count convention	ACT/365 Fixed	*Used for both the calculation of floating and fixed leg interest cash flows.*	8.2.
Floating reference rate	ZARONIA	*As recommended by the SARB's MPG.*	8.3.
Publication/ Calculation lag	1 bd	*To be confirmed by the SARB. Calculated with the sub-accrual period start date as the anchor date.*	8.3.
ACFR calculation	Compounded, 0 bd lookback, 0 bd lockout	*Backward-looking without lookback or lockout period. Payment lag to resolve calculation lag.*	8.4., 8.5.
ACFR convention	Simple, 6 decimal places	*Or 4 decimal places in % format.*	8.5.
Payment lag	1 bd	*Calculated with the last publication/calculation date within the respective accrual period as the anchor date.*	8.5.
Spread	Simple, additive post compounding	*Fixed simple rate added to the compounded ACFR for floating cash flow calculation, if necessary.*	8.5.
Fixed rate quotation	Simple, 6 decimal places	*Or 4 decimal places in % format.*	8.6.
Net cash flow rounding	2 decimal places	*Net unrounded floating and fixed cash flows, then round to the nearest ZAc.*	8.6.

7.3. Spot-starting multi-period overnight indexed swaps

The current available set of vanilla interest rate swap (IRS) contracts that reference 3-month Jibar provides an important building block for interest curve construction as well as a fundamental underpin to valuation. The main objective for creating a market in spot-starting multi-period OISs, with the recommended conventions below, is to create a '*replacement*' for the aforementioned IRS contracts.

Table 5: Spot-starting multi-period OIS conventions.

Feature	Recommended Convention	Comment	Reference
Swap tenor	$\geq$ 2Y	*Suggested standard quote tenors:* 2Y,3Y,...,10Y,12Y,15Y,20Y,25Y *and* 30Y.	8.1.
Accrual period	1Y	*For both floating and fixed legs.*	8.1.
Business day calendar	ZAJO	*As published by the relevant government entity.*	8.2.
Forward period	0Y	*Spot-starting swaps have no forward period.*	8.2.
Spot lag	0 bd	*Trade equals settlement and first accrual period start date. This is a common international settlement convention.*	8.2.
Business day convention	Modified Following	*Applied in accrual period date generation.*	8.2.
Accrual period date generation	Backward (EOM)	*Unadjusted backward generation from roll-day plus EOM, then adjusted by Modified Following.*	8.2.
Non-standard first period	Short-stub	*Shorter first accrual period, if necessary.*	8.2.
Accrual day count convention	ACT/365 Fixed	*Used for both the calculation of floating and fixed leg interest cash flows.*	8.2.
Floating reference rate	ZARONIA	*As recommended by the SARB's MPG.*	8.3.
Publication/ Calculation lag	1 bd	*To be confirmed by the SARB. Calculated with the sub-accrual period start date as the anchor date.*	8.3.
ACFR calculation	Compounded, 0 bd lookback, 0 bd lockout	*Backward-looking without lookback or lockout period. Payment lag to resolve calculation lag.*	8.4., 8.5.
ACFR convention	Simple, 6 decimal places	*Or 4 decimal places in % format.*	8.5.
Payment lag	1 bd	*Calculated with the last publication/calculation date within the respective accrual period as the anchor date.*	8.5.
Spread	Simple, additive post compounding	*Fixed simple rate added to the compounded ACFR for floating cash flow calculation, if necessary.*	8.5.
Fixed rate quotation	Simple, 6 decimal places	*Or 4 decimal places in % format.*	8.6.
Net cash flow rounding	2 decimal places	*Net unrounded floating and fixed cash flows, then round to the nearest ZAc.*	8.6.

7.4. Cross-currency basis swaps

Table 6: USDZAR Cross-currency basis swap conventions.

Feature	Recommended Convention	Comment	Reference
Swap tenor	$\geq$ 6M	*Suggested standard quote tenors:* 6M,9M,1Y,2Y, . . . ,10Y,12Y,15Y,20Y,25Y *and* 30Y.	9.1.
Accrual period	3M	*Less than 12M to limit excessive collateral consumption and to improve general management thereof.*	9.1.
Business day calendars	ZAJO and USGS	*As published by the relevant government entities. Used for accrual period date generation.*	9.2.
Spot lag	2 bd	*Settlement and first accrual period start date calculated with ZAJO, USGS and USNY calendars.*	9.2.
Business day conventions	Modified Following	*Applied in accrual period date generation using both ZAJO and USGS calendars.*	9.2.
Accrual period date generation	Backward (EOM)	*Unadjusted backward generation from roll-day plus EOM, then adjusted by Modified Following.*	9.2.
USD accrual day count convention	ACT/360	*Aligned with OISs and CCBSs that reference SOFR.*	9.2.
ZAR accrual day count convention	ACT/365 Fixed	*Aligned with OISs that reference ZARONIA.*	9.2.
USD floating reference rate	SOFR	*Aligned with other CCBSs that reference USD.*	9.3.
USD publication/ calculation lag	1 bd	*Aligned with other CCBSs that reference USD.*	9.3.
ZAR floating reference rate	ZARONIA	*As recommended by the SARB's MPG.*	9.3.
ZAR publication/ calculation lag	1 bd	*To be confirmed by the SARB. Calculated with the sub-accrual period start date as the anchor date.*	9.3.
ACFR calculations	Compounded, 0 bd lookback, 0 bd lockout	*Backward-looking without lookback or lockout periods for both USD and ZAR ACFRs. Payment lag to resolve calculation lag for both USD and ZAR legs.*	9.4., 9.5.
USD ACFR conventions	Simple, 7 decimal places	*Or 5 decimal places in % format.*	9.5.
ZAR ACFR conventions	Simple, 6 decimal places	*Or 4 decimal places in % format.*	9.5.
Basis spread	Simple, additive post compounding	*Fixed simple rate added to the compounded ACFR post rounding for floating cash flow calculation.*	9.5.
Basis spread quotation	Simple, 6 decimal places	*Or 4 decimal places in % format.*	9.5.
Floating cash flow rounding	2 decimal places	*To the nearest USc for the USD leg. To the nearest ZAc for the ZAR leg.*	9.5.
USD nominal reset payment lag	0 bd	*Calculated with the last publication/calculation date within the respective accrual period as the anchor date, using both ZAJO and USNY calendars.*	9.2., 9.5.
Payment lag	2 bd	*Calculated with the last publication/calculation date within the respective accrual period as the anchor date, using both ZAJO and USNY calendars.*	9.5.

8. Overnight indexed swap definition and conventions

An OIS is theoretically and structurally equivalent to a vanilla IRS, except that the series of floating cash flows are determined by a TBRR in an IRS and by an averaged ONRR in an OIS. Therefore, the mechanics of the fixed leg of an OIS is theoretically equivalent to that of a corresponding IRS, while the floating legs are fundamentally different. First, the contractual definition of a general OIS is presented using mathematical notation. A general OIS may be theoretically defined via the specification of the following contractual features:

i. nominal, tenor and accrual period;

ii. forward, settlement, accrual period dates and year fractions;

iii. floating reference rates, publication and calculation lags;

iv. averaging, lookback and lockout periods;

v. floating cash flow calculations and payment lags; and

vi. fixed and net cash flow calculations.

Specifications are then discussed for each contractual feature, and a specific convention is recommended.

8.1. Nominal, tenor & accrual period

This category constitutes standard features, which are specified as follows:

- **Swap nominal**: The nominal or notional value of the swap is denoted by N.
- **Swap tenor**: The tenor of the swap may be x_m-months or x_y-years, and is denoted by x_mM or x_yY, respectively, with $x_m = 12x_y$. The parameter x_y may be a whole number or a fraction, for example, using standard spot-starting swap naming convention, a 0.25Y OIS denotes a 3-month spot-starting OIS contract.
- **Interest accrual period**: The length of each interest accrual period may be z_m-months or z_y-years, and is denoted by z_mM or z_yY, respectively, with $z_m = 12z_y$. The parameter z_y may be a whole number or a fraction. The length of both the fixed and floating interest accrual periods will be the same.
- **Number of accrual periods**: The number of accrual periods is denoted by n, with $n = x_m/z_m$, assuming here that n is a whole number, or equivalently, that there are n interest accrual periods of equal length. The case where n is not a whole number will be considered in the next sub-section.

Market convention considerations

There are no material market convention considerations for this category. Rather, parameter choices are made that align with international standards, best practices and market participants' practical requirements.

Recommendations

The following parameters are suggested for spot-starting single-period OISs:

- **Swap tenor**: x_mM, for all $x_m \in \{1, 2, \ldots, 12\}$.
- **Interest accrual period**: $z_m = x_m$, i.e. the length of the accrual period equals the swap tenor, which aligns with international conventions.

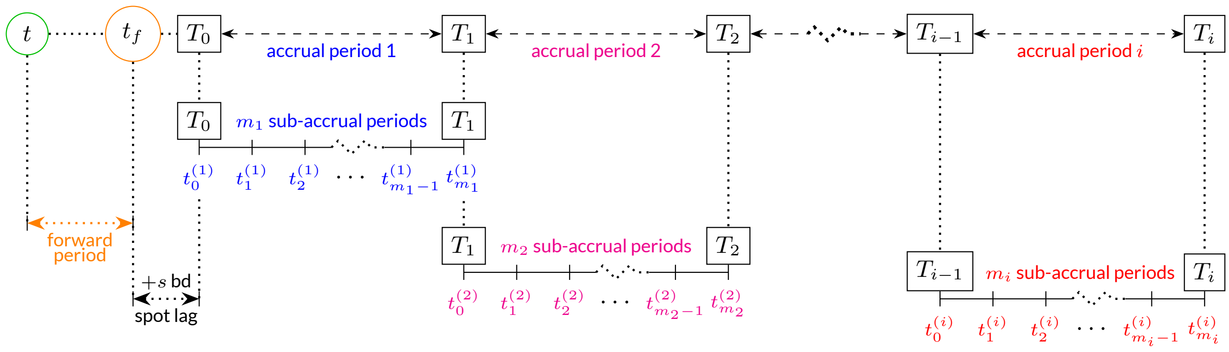
The following parameters are suggested for spot-starting multi-period OISs:

- **Swap tenor**: x_yY, for all $x_y \in \{2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, 30\}$.
- **Interest accrual period**: $z_m = 12$ or $z_y = 1$.

8.2. Forward, settlement, accrual period dates and year fractions

This category leads to the specification of all of the key contractual dates that relate to interest accrual and calculations thereof. Figure 1 below depicts all of the dates and variables that are defined in this sub-section.

Figure 1: Forward, settlement and accrual period dates.



The following are the key features that constitute this category:

- **Trade date**: The trade or transaction date is denoted by t.
- **Forward period and date**: The length of the forward period may be a_m-months or a_y-years, and is denoted by a_mM or a_yY, respectively, with a_m =12a_y. The forward date is denoted and calculated as

$$t_f := \beta(t + a_y\mathsf{Y}) = \beta(t + a_m\mathsf{M}) ,$$

  where the function $\beta(\cdot)$ implements a suitable business day convention algorithm. The parameter a_y may be a whole number or a fraction, for e.g. using standard forward-starting swap naming convention, a 0.25Y1Y or 3M1Y OIS would be a 1-year OIS contract which starts in 3-months from the trade date.
- **Spot lag and settlement/start/effective Date**: The settlement or start or effective date, which also coincides with the first interest accrual period's start date, is denoted and calculated as

$$T_0 := t_f + s\,\mathsf{bd} ,$$

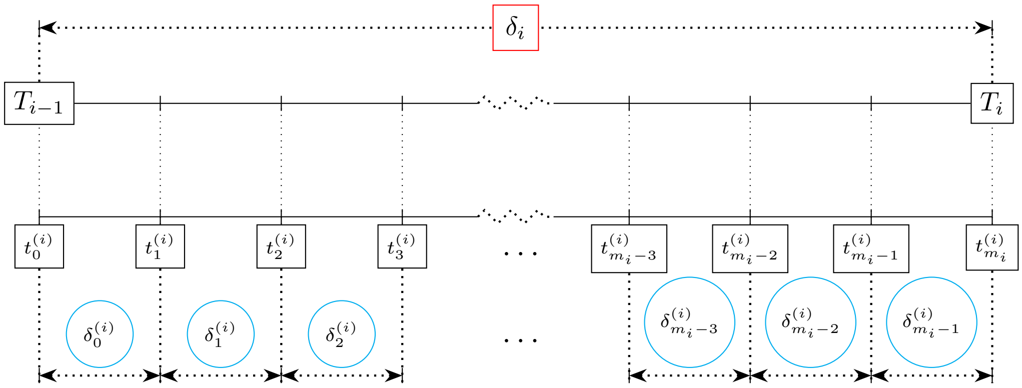
  where s denotes the spot lag and is quantified in valid business days (bd).
- **Interest accrual period start and end dates**: The interest accrual period start and end dates are denoted by the sets $\{T_0, T_1, \dots, T_{n-2}, T_{n-1}\}$ and $\{T_1, T_2, \dots, T_{n-1}, T_n\}$, respectively, such that $[T_{i-1}, T_i]$ is the i-th interest accrual period with tenor z_mM, for $i \in \{1, 2, \dots, n\}$, and $[T_0, T_n]$ is the full swap tenor of length x_yY.
- **Interest accrual period dates**: Valid business dates within the i-th interest accrual period $[T_{i-1}, T_i]$ is denoted by the set:

$$\left\{t_0^{(i)}, t_1^{(i)}, \dots, t_{m_i-1}^{(i)}, t_{m_i}^{(i)}\right\} ,$$

  for $i \in \{1, 2, \dots, n\}$, i.e. it is assumed that $T_{i-1} = t_0^{(i)}$, $T_i = t_{m_i}^{(i)}$ and that the i-th interest accrual period constitutes $m_i + 1$ valid business days, or m_i overnight interest accrual sub-periods.

Given the key contractual dates defined above, the next feature that requires definition is the method to be utilised for the calculation of interest accrual year fractions. This, in turn, enables the ultimate computation of floating and fixed cash flows. Figure 2 below depicts all of the notation that is used in this sub-section in order to define the key interest accrual period year fractions.

Figure 2: The interest accrual year fraction for the i-th interest accrual period $[T_{i-1}, T_i]$.



The relevant accrual and sub-accrual period year fractions are defined as follows:

- **Interest accrual period year fractions**: The interest accrual year fraction for the i-th interest accrual period $[T_{i-1}, T_i]$ is denoted by

$$\delta_i := \sum_{j=0}^{m_i-1} \delta_j^{(i)} ,$$

where $\delta_j^{(i)}$ denotes the interest accrual year fraction for the overnight interest sub-accrual period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$, for $j \in \{0, 1, \ldots, m_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.

Market convention considerations

The practical generation of the dates defined above requires:

i. an official and internationally utilised *South African calendar*;

ii. a choice of *business day convention*; and

iii. an *IRS interest accrual period date generation algorithm.*

The appropriate calendar is sourced or referenced from a relevant government authority or an internationally recognised publisher of financial trading and settlement calendars.

A business day convention specifies an algorithm to adjust a date when that date is not a valid business day (i.e. the date is a weekend or public holiday), subject to a specific reference calendar. There are six business day convention algorithms that are prominent in international interest rate derivative markets, namely, *Following*, *Preceding*, *Modified Following*, *Modified Preceding*, *Modified Following Bi-Monthly* and *End-of-Month* (EOM).

Given an IRS with tenor x_yY, interest accrual period z_mM, n accrual periods and spot settlement date T_0, the standard IRS interest accrual period date *Backward* generation algorithm may be presented as follows:

- **Step 1** — calculate the *roll-day*, denoted here by U_n, by adding the swap tenor to the spot settlement date:

$$U_n := T_0 + x_y\text{Y} ,$$

which is the unadjusted (i.e., not adjusted by a business day convention) IRS maturity date.

- **Step 2** — sequentially subtract the interest accrual period from the roll-day:

$$U_i := U_n - (n-i)z_m\text{M} ,$$

for $i \in \{n-1, n-2, \ldots, 1\}$, which creates the set of unadjusted interest accrual period end dates.

- **Step 3** — adjust all of the dates from step 1 and 2 as follows:

$$T_i := \beta(U_i) \ ,$$

for $i \in \{1, 2, \ldots, n\}$, where $\beta(\cdot)$ denotes a function which implements one of the aforementioned business day convention algorithms, which yields all of the required interest accrual period dates.

The *Backward (EOM)* algorithm is identical to the above, except that the EOM algorithm is applied to each unadjusted date in steps 1 and 2. If n is not a whole number, then an additional step before step 1 is required:

- **Step 0** — if n is not a whole number, then set

$$n = \lceil x_m / z_m \rceil = \lceil 12x_y / z_m \rceil \ ,$$

i.e., round-up, for an initial period with tenor shorter than zM, referred to as a *short-stub*, or set

$$n = \lfloor x_m / z_m \rfloor = \lfloor 12x_y / z_m \rfloor \ ,$$

i.e., round-down, for an initial period with tenor longer than zM, referred to as a *long-stub*.

This Backward date generation algorithm ensures that the non-standard interest accrual period is the first one. In turn, this ensures that once that period has passed, the IRS will have the same interest accrual period dates as a directly comparable newly issued IRS. If the non-standard period was the last period, these IRSs will never align.

The practical calculation of the length of interest accrual periods requires a choice of day-count convention.

A day-count convention is a standardised methodology for calculating the number of days between two dates, and then converting this count into a standardised year fraction. There are seven day-count convention methodologies that are prominent in international interest rate derivative markets, viz., *30/360*, *30/360 US*, *30E/360*, *ACT/360*, *ACT/365 Fixed*, *ACT/ACT ISDA* and *Business/252*.

Recommendations

The following conventions are recommended:

- **Calendar**: ZAJO as published by a relevant government authority.
- **Spot lag**: $s =$ 0.
- **Business day convention**: Modified Following.
- **Accrual period date generation**: Backward (EOM) algorithm to determine start and end dates. The sub-accrual periods may then be identified using the ZAJO calendar.
- **Number of accrual periods**: If n is not a whole number then round-up, i.e. set $n = \lceil x_m / z_m \rceil$, which will create an initial period that is a short-stub.
- **Day-count convention**: ACT/365 Fixed.

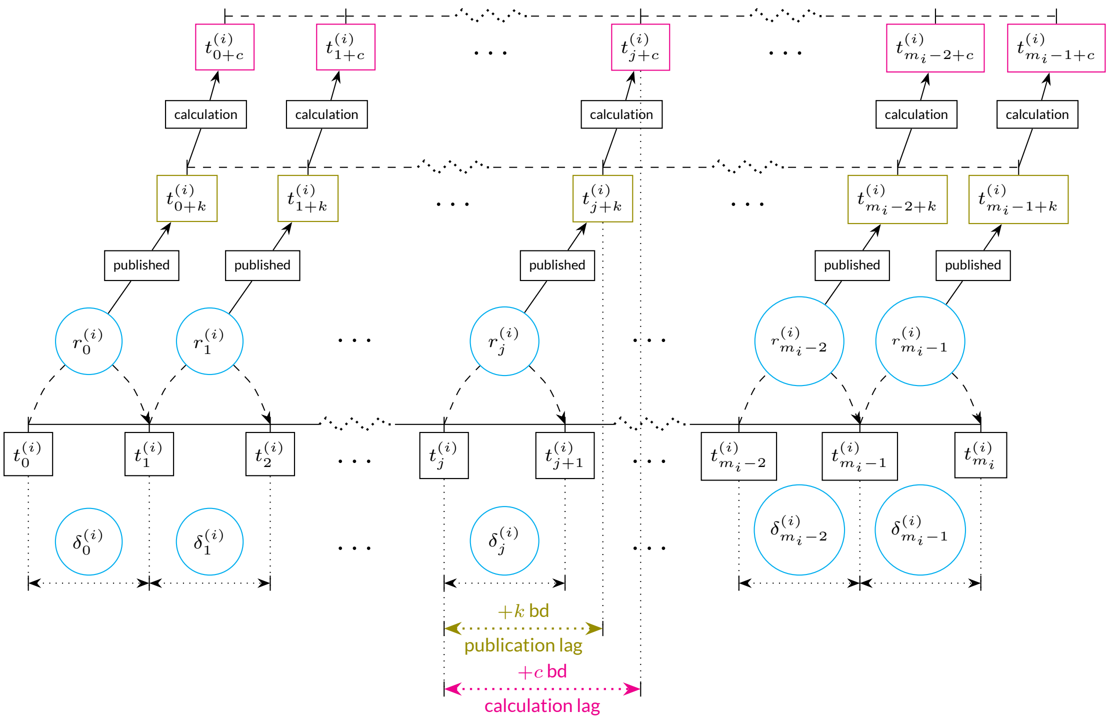
The following parameters are suggested for forward-starting single-period OISs:

- **Swap tenor and interest accrual period**: $z_m = x_m \in \{1,3\}$.
- **Forward period**: a_mM, for all $a_m \in \{1,2,\ldots,11\}$ when $z_m = 1$, and
  a_mM, for all $a_m \in \{1,2,\ldots,9,12,\ldots,21\}$ when $z_m =$3.

8.3. Floating reference rates, publication and calculation lags

The fundamental difference between OISs and vanilla IRSs arises from the specification of the floating cash flows, with the latter using TBRRs and the former using ONRRs. This sub-section introduces this new floating reference rate in a fairly general manner, highlighting nuances in the publication of such a rate and its use in calculations, all of which have a material impact on the eventual computation of floating cash flows. Figure 3 below depicts all of the notation that is utilised in this sub-section.

Figure 3: The floating ONRRs within $[T_{i-1}, T_i]$, with the lags depicted for the j-th ONRR $r_j^{(i)}$.



The key feature here is the ONRR, which is the floating reference rate. The definition of the ONRR enables the description of the publication and calculation lag features. These definitions and descriptions are provided below:

- **Floating reference rate**: The floating reference rate is an ONRR that is applicable over $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$, the arbitrary interest accrual sub-period which will always have a tenor of one business day. This ONRR is denoted by the annualised simple rate $r_j^{(i)}$, for $j \in \{1, 2, \ldots, m_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$. The associated overnight capitalisation factor associated with this arbitrary ONRR is denoted and defined as

$$C_j^{(i)} := 1 + r_j^{(i)} \delta_j^{(i)} ,$$

  again for $j \in \{1, 2, \ldots, m_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$. At the surface, the ONRR defined above is fairly straightforward. However, one of the main differences between the TBRR and ONRR market micro-structures is that the former is based on *quoted rates*, while the latter is based on *transacted rates*. Reference rates derived from quoted rates may therefore be calculated and observed *in-advance*, while those derived from transacted rates may only be calculated and observed *in-arrears*, at best. This nuance necessitates the definition of a feature called a *publication lag*, which is explained next.

- **Publication lag**: While the arbitrary ONRR, $r_j^{(i)}$, has an interest accrual period that starts on $t_j^{(i)}$, the *calculation agent* will only be able to observe relevant transactions during day $t_j^{(i)}$, or mathematically over the period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right)$ and therefore, the earliest that the agent could calculate the relevant ONRR will be at the end of day $t_j^{(i)}$. This means that the rate will be available for use on day $t_{j+1}^{(i)}$. However, operational issues and inefficiencies (potential or otherwise) may preclude the calculation agent from publishing the ONRR on day $t_{j+1}^{(i)}$ consistently. The calculation agent may therefore choose to be prudent and specify a publication lag that is greater than one business day after $t_j^{(i)}$. This publication lag feature is captured here via the date

$$t_{j+k}^{(i)} \geq t_{j+1}^{(i)} ,$$

where k denotes the publication lag and is quantified in valid business days (bd).

- **Calculation lag**: A user of the arbitrary ONRR, $r_j^{(i)}$, may prefer to be more prudent than the calculation agent, for their own operational reasons, and add a lag of their own when using the ONRR for interest accrual calculation purposes. This calculation lag feature is captured here via the date

$$t_{j+c}^{(i)} \geq t_{j+k}^{(i)} ,$$

where c denotes the calculation lag and is quantified in valid business days (bd).

Market convention considerations

The SARB's MPG has recommended that ZARONIA be used as the main ONRR in the South African interest rate derivatives market. The SARB, who is the calculation agent for ZARONIA, has yet to confirm the publication lag.

Recommendations

The following conventions are recommended:

- **Floating reference rate**: South African Overnight Index Average (ZARONIA).
- **Publication/Calculation lag**: The SARB's MPG recommends that the calculation lag be set equal to the SARB's chosen publication lag, i.e. $c = k$.

8.4. Averaging, lookback and lockout periods

Another nuance that arises due to the use of floating ONRRs, as opposed to TBRRs, in the specification of an IRS, is the definition of the *annualised cumulative floating rate* (ACFR) for a given full accrual period based on the floating ONRRs. This requires the notion of *averaging* the ONRRs, for which there are two alternatives, the use of which result in the following types of ACFRs:

- **Simple ACFR**: Based on an *arithmetic average* that is weighted by the length of each sub-accrual period, the simple ACFR for the arbitrary i-th accrual period is denoted and calculated as

$$F_{(i)} := \frac{1}{\delta_i} \sum_{j=0}^{m_i - 1} r_j^{(i)} \delta_j^{(i)} ,$$

where $\delta_j^{(i)}$ and δ_i is defined in sub-section 8.2., and $r_j^{(i)}$ is defined in sub-section 8.3..

- **Compounded ACFR**: Splitting the i-th accrual period into m_i sub-accrual periods of equal length Δ_i, it is possible to define the *nominal annual compounded* m_i-times rate

$$f_{(i)} := \frac{1}{\Delta_i} \left[\left(\prod_{j=0}^{m_i - 1} \left[1 + r_j^{(i)} \delta_j^{(i)} \right] \right)^{1/m_i} - 1 \right] ,$$

which is based on a *geometric average*, with $\Delta_i := \delta_i / m_i$. Then, the following

$$F_{(i)} := \frac{1}{\delta_i} \left(\left[1 + f_{(i)} \Delta_i \right]^{m_i} - 1 \right) = \frac{1}{\delta_i} \left(\prod_{j=0}^{m_i - 1} \left[1 + r_j^{(i)} \delta_j^{(i)} \right] - 1 \right) ,$$

yields the compounded ACFR that is applicable for the i-th accrual period.

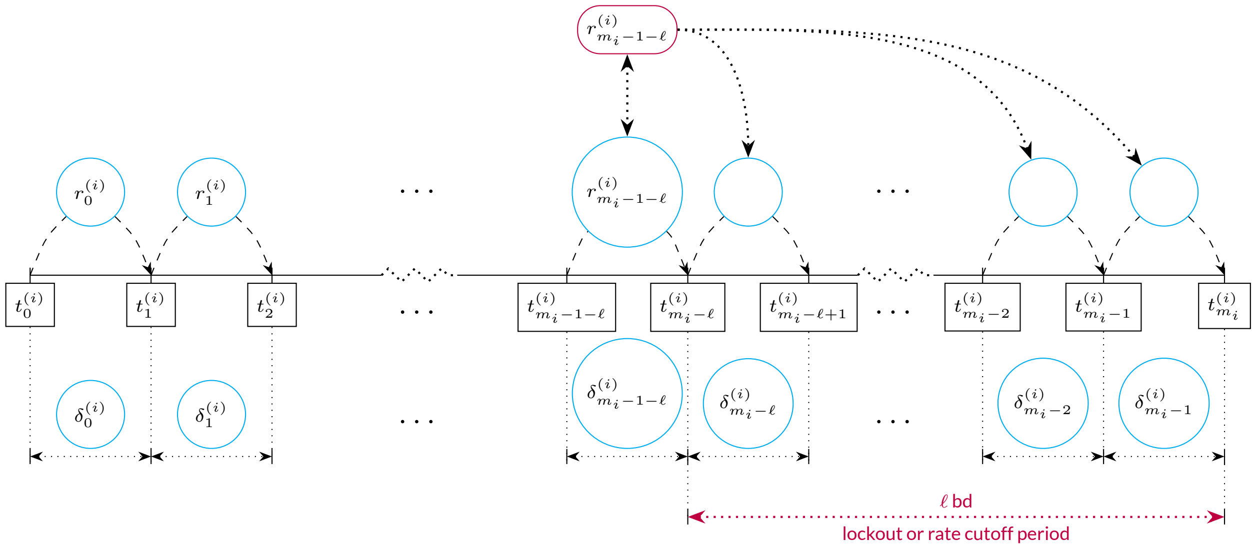
The publication and calculation lags, defined in sub-section 8.3., create non-intuitive payment or settlement issues, since users of the floating reference rate may only know interest cash flows *post in-arrears*. Even in-arrears knowledge of the interest cash flow may be problematic, as same-day settlement may not be possible. In order to resolve these practical timing issues, market practitioners have proposed the following fixing adjustments:

- **Lockout/Rate cutoff period**: Given a *lockout* or *rate cutoff period* value equal to ℓ business days means that

$$r_j^{(i)} = r_{m_i-1-\ell}^{(i)} ,$$

for all $j \in \{m_i-\ell, m_i-\ell+1, \dots, m_i-1\}$. Figure 4 below depicts the practical implications of this adjustment.

Figure 4: A depiction of the lockout or rate cutoff period adjustment.

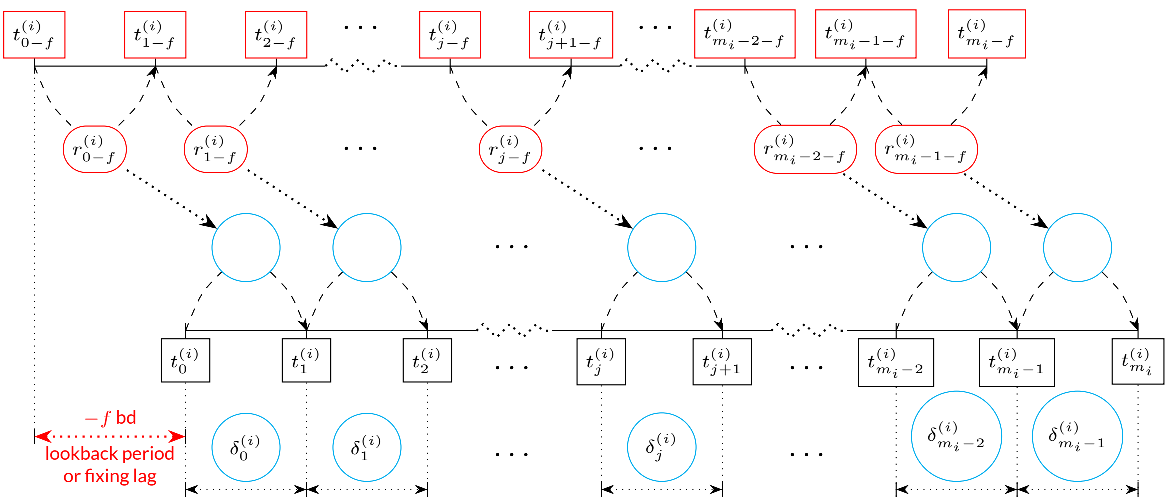


- **Lookback period/fixing lag**: Consider the sub-accrual period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$ and a *lookback period* or *fixing lag* value equal to f business days. Then, the capitalisation factor for this period is calculated as

$$C_j^{(i)} = 1 + r_{j-f}^{(i)}\,\delta_j^{(i)} ,$$

which will be calculable at date $t_{j-f+k}^{(i)}$, where k is the publication lag. Therefore, one can compute interest cash flows in-advance if $f = k$. Figure 5 below depicts the practical implications of this adjustment.

Figure 5: A depiction of the lookback period or fixing lag adjustment.

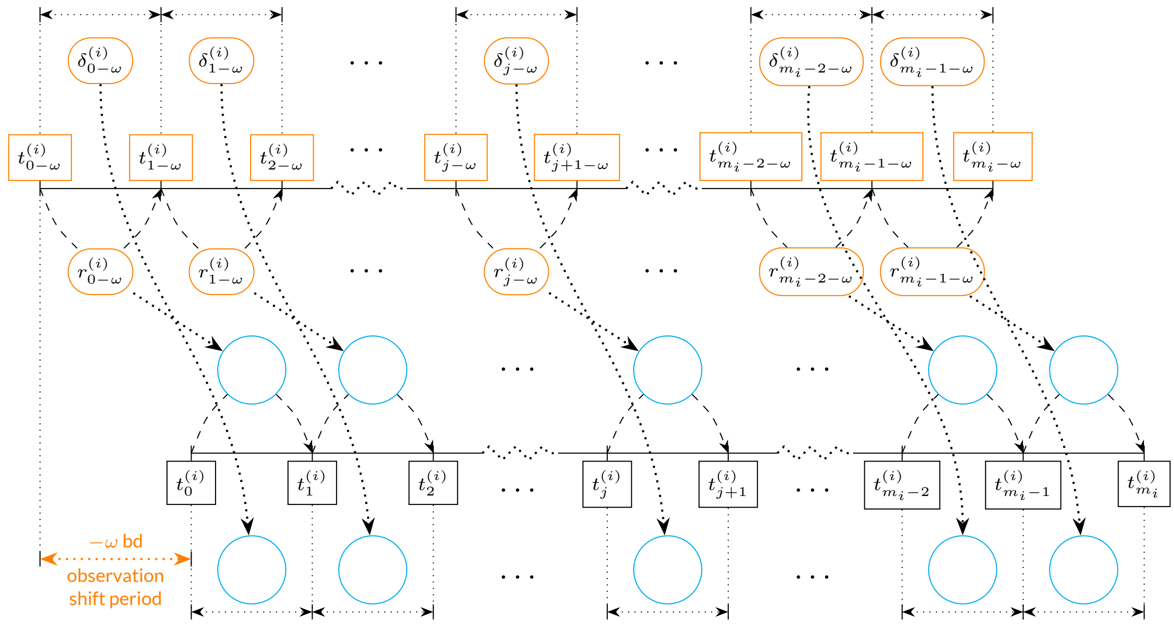


- **Observation shift period**: Consider the sub-accrual period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$ and an *observation shift period* value equal to ω business days, then the capitalisation factor for this period is calculated as

$$C_j^{(i)} = 1 + r_{j-\omega}^{(i)}\,\delta_{j-\omega}^{(i)} = C_{j-\omega}^{(i)}\,,$$

which will be calculable at date $t_{j-\omega+k}^{(i)}$, where k is the publication lag. Therefore, with this adjustment, the capitalisation factor for the past sub-accrual period $\left[t_{j-\omega}^{(i)}, t_{j+1-\omega}^{(i)}\right]$ is used for the actual period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$. Figure 6 below depicts the practical implications of this adjustment.

Figure 6: A depiction of the observation shift period adjustment.



Market convention considerations

Recommendations

The following conventions are recommended:

- **Averaging**: Geometric averaging, resulting in a compounded ACFR.

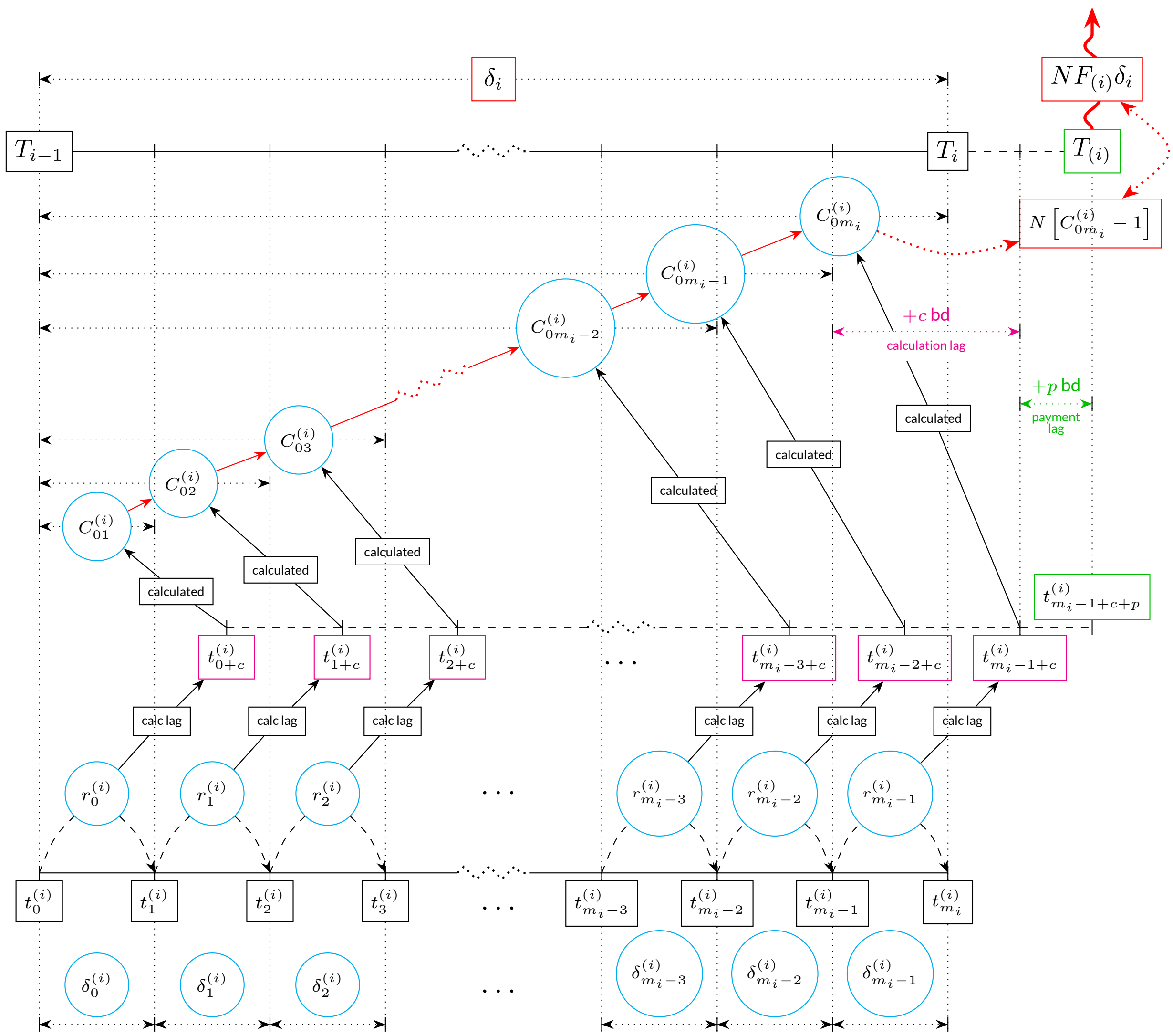
The following adjustments are prominent in cash markets, but have been included here for completeness.

- **Lockout/rate cutoff period**: $\ell = 0$.
- **Lookback period/fixing lag**: $f = 0$.
- **Observation shift period**: $\omega = 0$.

8.5. Floating cash flow calculations and payment lags

Having defined the ACFR in the previous sub-section, this sub-section details the calculation of the floating cash flow. All of the necessary parameters, variables and equations are depicted in Figure 7 below.

Figure 7: Floating cash flow calculation at the arbitrary i-th payment date $T_{(i)}$.



The key quantity here is the computation of the realised capitalisation factor over the interest accrual period. This enables the computation of the compounded ACFR, the eventual floating cash flow and its specific nuances. All of these quantities are defined as follows:

- **Realised capitalisation factors**: Given the i-th interest accrual period and based on the floating ONRRs within this period, the capitalisation factor that is realised over the sub-accrual period $[t^{(i)}_0, t^{(i)}_h]$ is denoted and defined by

$$C^{(i)}_{0h} := \prod_{j=0}^{h-1} C^{(i)}_j = \prod_{j=0}^{h-1} \left[1 + \delta^{(i)}_j r^{(i)}_j\right] ,$$

  and is only calculable at $t^{(i)}_{h-1+c}$, i.e. taking into account the calculation lag of c bd, for $h \in \{1, 2, \ldots, m_i\}$.

- **Floating rate**: The floating rate for the i-th interest accrual period may then be denoted and defined as

$$F_{(i)} := \frac{1}{\delta_i} \left[C^{(i)}_{0m_i} - 1\right] ,$$

which is the compounded ACFR, and is a *backward-looking* or *realised* term rate implied from the corresponding realised capitalisation factor, and is therefore also only calculable at $t^{(i)}_{m_i-1+c}$, for $i \in \{1, 2, \ldots, n\}$.

- **Floating cash flows**: Given the compounded ACFR, the floating cash flow may then be calculated as

$$NF_{(i)}\delta_i \ ,$$

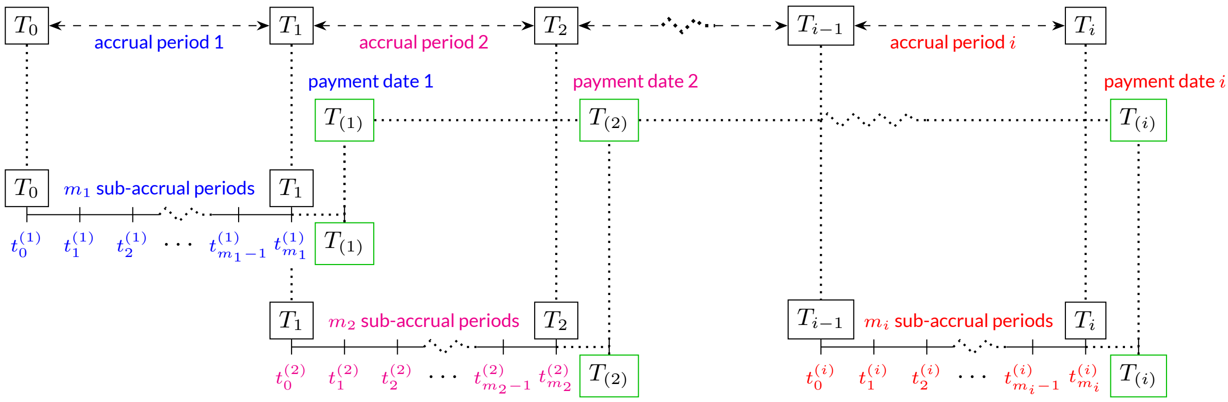
which is also only calculable at $t^{(i)}_{m_i-1+c}$, where N denotes the swap nominal, for $i \in \{1, 2, \ldots, n\}$.

- **Payment lag**: Consider again the arbitrary i-th interest accrual period. Since the floating cash flow is only calculable at date $t^{(i)}_{m_i-1+c}$, which would be the end of the i-th interest accrual period at best if $c = 1$, and the execution or settlement of payments may be subject to delays in practice, it would be naive to assume that same-day settlement is possible consistently. This necessitates the definition of a payment lag, which is captured here via the payment date

$$t^{(i)}_{m_i-1+c+p} := T_{(i)} \ ,$$

where p denotes the payment lag and is quantified in valid business day (bd). In other words, the payment lag is p business days after the last calculation date. These payment dates are depicted in Figure 8 below, which is essentially an update to Figure 1 above.

Figure 8: Accrual period and payment dates.



- **Spread**: For some bespoke transactions involving OISs or components thereof, for example, *par-par asset swaps* or *cross-currency basis swaps*, it may be necessary to add a *fixed spread rate*, denoted here by x, to the floating leg. The i-th floating cash flow for such a swap is then calculated as

$$N\left[F_{(i)} + x\right]\delta_i \ ,$$

i.e. the fixed spread rate is an annualised simple rate that is added to the compounded ACFR.

Market convention considerations

Recommendations

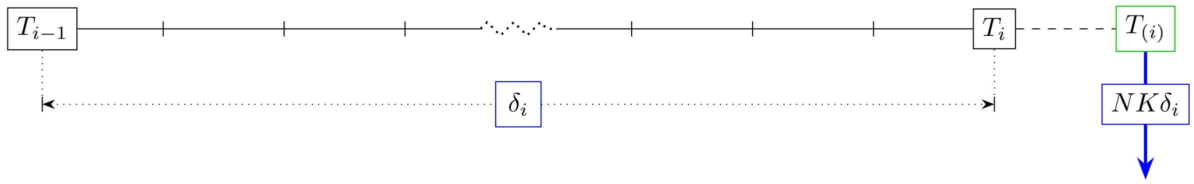
The following conventions are recommended:

- **Floating rate rounding**: $F_{(i)}$ should be rounded to 6 decimal places in numerical format, or 4 decimal places in percentage format. For example, if $F_{(i)}$ =0.07123456, then round to 0.071235 or 7.1235%.
- **Payment lag**: $p = 1$.

8.6. Fixed and net cash flow calculations

The fixed cash flow calculation in an OIS is rather trivial and matches that of vanilla IRSs that are based on TBRRs, modulo the payment lag nuance. Figure 9 depicts all of the notation that is utilised in this sub-section.

Figure 9: Fixed cash flow calculation at the arbitrary i-th payment date $T_{(i)}$.



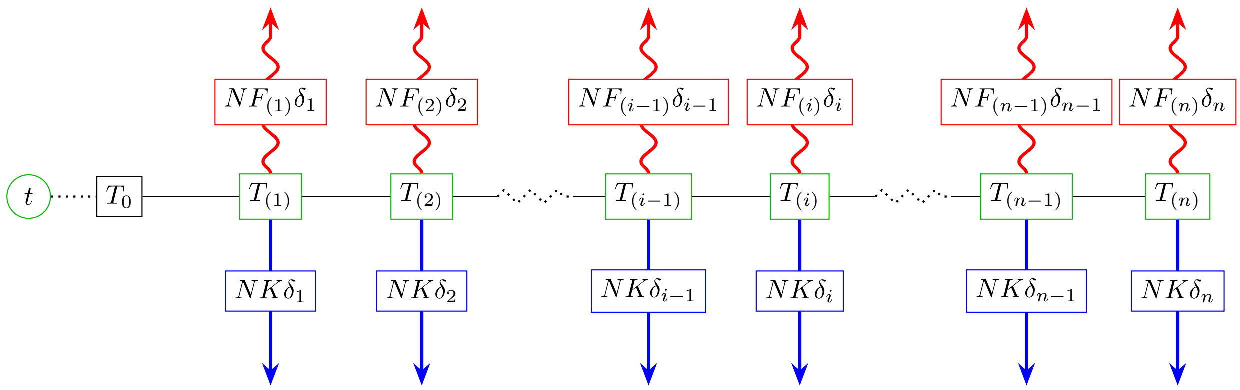
The following describes the key features that constitutes this category:

- **Fixed rate**: The key variable for the purposes of *market-making* which determines the fixed cash flows is the fixed rate, which is denoted here by K and is an annualised simple rate. Given the fixed rate, the fixed cash flow may calculated as

$$NK\delta_i \ ,$$

  which is calculable at date t and applicable for the i-th interest accrual period $[T_{i-1}, T_i]$, for $i \in \{1, 2, \ldots, n\}$. Since interest rate swap floating and fixed cash flows are netted or subject to net settlement, the fixed cash flow payments will also be subject to the payment lag, as defined in sub-section 8.5., and will occur on the set of payment dates $\{T_{(1)}, T_{(2)}, \ldots, T_{(n)}\}$. Figure 10 below depicts the full set of floating and fixed cash flows for a long position in the general OIS that has been defined throughout section 8..

Figure 10: Floating and fixed cash flows for a long position in an Overnight Indexed Swap.



Market convention considerations

Recommendations

The following conventions are recommended:

- **Fixed rate quotation**: K should be rounded to 6 decimal places in numerical format, or 4 decimal places in percentage format. For example, if $K =$ 0.07123456, then round to 0.071235 or 7.1235%.
- **Net cash flow rounding**: For a long OIS, net the unrounded floating and fixed cash flows, i.e. compute $N\left[F_{(i)} - K\right]\delta_i$ for the i-th accrual period, which is denominated in ZAR and then round to 2 decimal places, or to the nearest ZAc.

9. Cross-currency basis swap definition and conventions

The United States Dollar (USD) was established as the world's reserve currency in 1944, following the resolution put forward through the Bretton Woods Agreement and then maintained in the post-Bretton Woods international monetary system, since 1971 — see, for instance, [Eichengreen, 2021] for a historical review and implications thereof. Due to the USD's reserve currency status, it serves as an important benchmark in the foreign exchange and interest rate markets — two significant manifestations of this are:

i. all currencies have an exchange rate that references the USD; and

ii. all foreign currency funding transactions are benchmarked with respect to corresponding USD funding.

Therefore, in order to define the cross-currency basis swap (CCBS) market within the South African context, it is sufficient to specify a USDZAR CCBS. Since CCBSs are naturally linked to the IRSs within the associated interest rate derivative markets, the OISs that were defined in section 8. will feature prominently in what follows.

Using the decompositions of OISs and foreign exchange swaps (FXSs) contracts as combinations of Floating Rate Notes (FRNs) and Fixed Coupon Bonds (FCBs), a long *fair* USDZAR CCBS may be considered as a *portfolio* of:

(1) long *fair* USD OIS $\Longleftrightarrow$ long USD FRN $+$ short USD FCB;

(2) long *fair* USDZAR FXS $\Longleftrightarrow$ long USD FCB $+$ short ZAR FCB; and

(3) short *fair* ZAR OIS $\Longleftrightarrow$ a short ZAR FRN $+$ long ZAR FCB.

By *fair*, it is meant that the respective swap under consideration is priced such that the initial value of the swap is zero (i.e. the key fixed rate is set such that the initial swap value is zero). Then, the following applies:

- The USD FCBs from (1) and (2) cancel each other exactly(i.e. short USD FCB $+$ long USD FCB $= 0$).
- The short ZAR FCB, from (2), incorporates a *risk premium* for exchanging USD for ZAR since it originates within the foreign exchange derivatives market.
- The long ZAR FCB, from (3), originates within the ZAR interest rate derivatives market and therefore agnostic of any *foreign exchange risk premium*.
- Therefore, the ZAR FCBs from (2) and (3) do not cancel each other exactly. While the nominals cancel, the fixed coupons do not (i.e. short ZAR FCB $+$ long ZAR FCB $=$ pay ZAR fixed spread coupons)[3].

Relation between CCBSs and OISs

Based on the arguments above, in general, it follows that:

$$\begin{aligned} \text{long USDZAR CCBS} &= \text{long USD FRN} + \text{short ZAR FRN} + \text{pay ZAR fixed spread coupons} \\ &= \text{receive USD OIS floating leg} \\ &\quad + \text{pay ZAR OIS floating leg} + \text{pay ZAR fixed spread coupons} \\ &\quad + \text{exchange of nominals.} \end{aligned}$$

Therefore, a USDZAR CCBS may be completely defined via the specification of the floating leg of a USD OIS, with zero spread, and the floating leg of a ZAR OIS, with a non-zero spread, i.e. the basis spread.

As a result, in what follows, the definitions, notation and features that were specified and developed in section 8., for a general OIS, are referenced again. Then, specific recommendations for aspects of market micro-structure and conventions for features are provided that are suitable for the specific nuances related to the foreign exchange and US interest rate derivatives markets.

[3] In general, the *risk premium* for exchanging USD for ZAR, also referred to as a *country risk premium*, is non-negative which results in larger ZAR coupons originating in the foreign exchange derivatives market versus the ZAR interest rate derivatives market. However, if this risk premium were to turn negative, then the opposite would of course apply.

A general USDZAR CCBS may be theoretically defined via the specification of the following contractual features:

i. tenor and accrual period;

ii. nominals, forward, settlement, accrual period dates and year fractions;

iii. floating reference rates, publication and calculation lags;

iv. averaging, lookback and lockout periods; and

v. floating cash flow calculations and payment lags.

Below, the specifications are discussed and described for each of the above contractual features, and specific conventions are recommended. The sub-sections below are similar to those presented in section 8., therefore only material differences are highlighted in what follows.

9.1. Tenor and accrual period

The definitions and notation for a general USDZAR CCBS's tenor and accrual period is exactly the same as that of a general OIS, which was presented in sub-section 8.1.. In summary, the following applies:

- **Swap tenor**: x_mM or x_yY;
- **Interest accrual period**: z_mM or z_yY; and
- **Number of accrual periods**: $n = x_m/z_m$.

Market convention considerations

There are no material market convention considerations for this category. Rather, parameter choices are made that align with international standards, best practices and market participants' practical requirements.

Recommendations

The following parameters are suggested for spot-starting USDZAR CCBSs:

- **Swap Tenor**: x_yY, for all $x_y \in \{0.5, 0.75, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, 30\}$.
- **Interest Accrual Period**: $z_m = 3$ or $z_y = 0.25$.

9.2. Nominals, forward, settlement, accrual period dates and year fractions

The key contractual dates associated with a general USDZAR CCBS are exactly the same as that of a general OIS, which was presented in section 8.2., except that one must be cognisant of valid business days within both associated sovereign states. In summary, the following are relevant:

- **Trade date**: t, which is also the transaction date;
- **Forward period**: a_mM or a_yY, where $a_m = 12a_y$;
- **Forward date**: $t_f := \beta\,(t + a_y\text{Y}) = \beta\,(t + a_m\text{M})$, where $\beta(\cdot)$ implements a suitable business day convention algorithm that is cognisant of both ZA and US valid business days;
- **Spot lag**: s bd, quantified in joint ZA and US valid business days;
- **Effective date**: $T_0 := t_f + s$ bd, which is also the start or effective date; and
- **Interest accrual period start and end dates**: $[T_{i-1}, T_i]$, for $i \in \{1, 2, \ldots, n\}$, which are generated with joint consideration for valid business days in both sovereign states.

The first material difference arises with the identification of overnight sub-accrual periods for each currency, which depends on valid business days within each sovereign state, respectively. This leads to the following:

- **ZAR interest accrual period dates**: $\left\{t_0^{(i)}, t_1^{(i)}, \ldots, t_{m_i-1}^{(i)}, t_{m_i}^{(i)}\right\}$, for $i \in \{1, 2, \ldots, n\}$, which matches the definition and notation utilised in sub-section 8.2..

- **USD interest accrual period dates**: It is assumed here that the relevant set of valid US business days within the i-th accrual period is denoted by

$$\left\{t_0^{(\$,i)}, t_1^{(\$,i)}, \ldots, t_{\ell_i-1}^{(\$,i)}, t_{\ell_i}^{(\$,i)}\right\} ,$$

i.e. there are $\ell_i + 1$ valid US business days within the i-th accrual period, for $i \in \{1, 2, \ldots, n\}$. It should be noted, however, that $t_0^{(i)} = t_0^{(\$,i)} = T_{i-1}$ and $t_{m_i}^{(i)} = t_{\ell_i}^{(\$,i)} = T_i$, for $i \in \{1, 2, \ldots, n\}$.

This difference impacts the next feature, which is the calculation of interest accrual year fractions. These depend on the above interest accrual period dates along with the specific day count convention algorithm applied in each sovereign state, respectively. This requires definitions for the following features:

- **ZAR interest accrual period year fractions**: Given the relevant ZAR day count convention algorithm, the year fraction for the i-th accrual period is

$$\delta_i := \sum_{j=0}^{m_i-1} \delta_j^{(i)} ,$$

where $\delta_j^{(i)}$ denotes the interest accrual year fraction for the overnight interest sub-accrual period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$, for $j \in \{0, 1, \ldots, m_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$, as defined in sub-section 8.2..

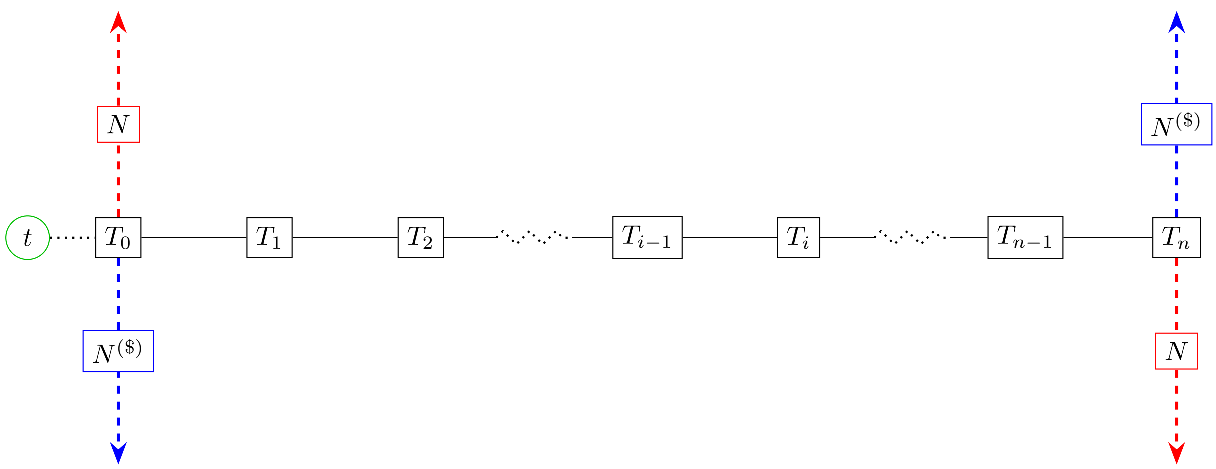
- **USD interest accrual period year fractions**: Given the relevant USD day count convention algorithm, the year fraction for the i-th accrual period is denoted and defined by

$$\delta_i^{(\$)} := \sum_{j=0}^{\ell_i-1} \delta_j^{(\$,i)} ,$$

where $\delta_j^{(\$,i)}$ denotes the year fraction for the overnight interest sub-accrual period $\left[t_j^{(\$,i)}, t_{j+1}^{(\$,i)}\right]$, which is also calculated using the USD day count convention algorithm, for $j \in \{0, 1, \ldots, \ell_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.

The final feature that requires definition are the CCBS's nominals. For a standard spot-starting USDZAR CCBS traded between a *market-maker* and an *end-user client*, namely, a non-interbank USDZAR CCBS, the nominal cash flows have a fixed and standard structure, as depicted in Figure 11 below.

Figure 11: Nominal cash flows for a long position in a non-interbank USDZAR CCBS.



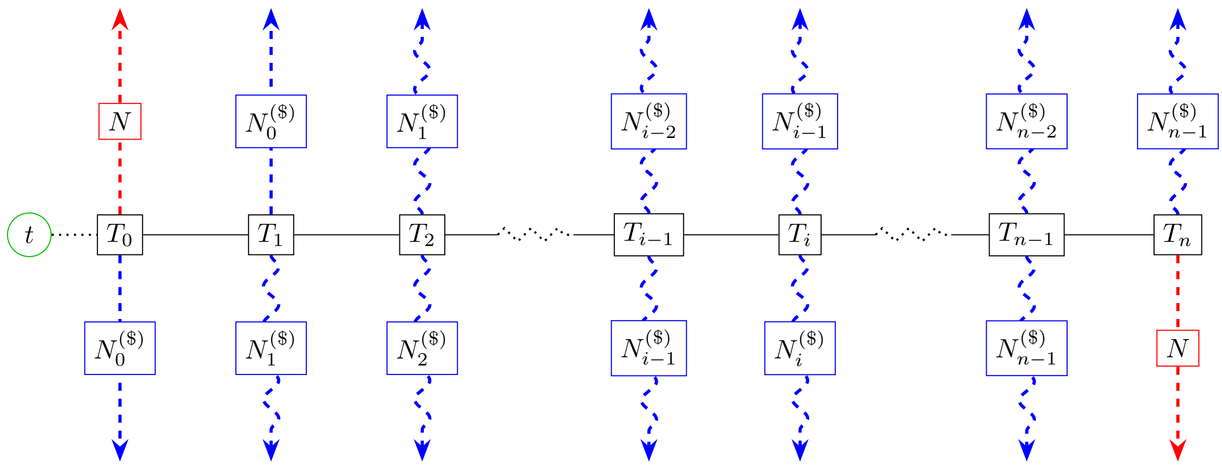
The respective fixed nominals are denoted and defined as follows:

- **ZAR nominal**: N, as defined in sub-section 8.1..
- **USD nominal**: $N^{(\$)} := N/X(t^{(1)}_{0-2}, T_0)$, where $X(t^{(1)}_{0-2}, T_0)$ is the USDZAR spot exchange rate at date $t^{(1)}_{0-2}$, which is also the 2-business day USDZAR forward exchange contract (FEC) rate that is applicable over the period $\left[t^{(1)}_{0-2}, T_0\right]$. To be clear here, $t^{(1)}_{0-2} := t^{(1)}_0 - 2$ bd, quantified with joint ZA and US valid business days.

Take note that Figure 11 depicts a spot-starting CCBS, therefore and $t = t^{(i)}_{0-2} = t^{(i)}_0 - 2$ bd$= T_0 - 2$ bd. This also means that the spot exchange rate $X(t^{(1)}_{0-2}, T_0)$ is known at date t, along with both ZAR and USD nominals.

For a standard spot-starting USDZAR CCBS traded *interbank*, or between two *market-makers*, the nominal on the USD leg is reset at the beginning of each accrual period, using the prevailing and appropriate USDZAR spot exchange rate. This feature is depicted in Figure 12 below.

Figure 12: Nominal cash flows for a long position in an interbank USDZAR CCBS.



While the ZAR nominal maintains its definition above, the USD nominal now varies through the life of the CCBS and is defined as follows:

- **USD Nominal Reset**: The nominal that is applicable for the arbitrary i-th accrual period is

$$N^{(\$)}_{i-1} := N/X(t^{(i)}_{0-2}, T_{i-1}) \ ,$$

  where $X(t^{(i)}_{0-2}, T_{i-1})$ is the USDZAR spot exchange rate at date $t^{(i)}_{0-2}$, for $i \in \{1, 2, \ldots, n\}$. Moreover, the counterparty with the long position will pay/receive the following difference in USD nominals:

$$N^{(\$)}_{i-1} - N^{(\$)}_i \ ,$$

  at each date T_i , for $i \in \{1, 2, \ldots, n-1\}$.

Although the cash flows in Figure 12 is also for a spot-starting CCBS, take note that the net USD nominal cash flows from date T_1 onward are all unknown from the vantage point of the trade date t.

Market convention considerations

The considerations from sub-section 8.2. are all again relevant here, but now the following is required:

i. official and internationally utilised *South African* and *United States* calendars;
ii. ZAR and USD business day conventions;
iii. an interest accrual period date generation algorithm; and

iv. ZAR and USD day count conventions.

The alternatives or choices for (i), (ii) and (iv) are the same as those presented in sub-section 8.2.. The *Backward* algorithm, and its variants, are again applicable here, except that any business day convention-related adjustment, applied within the algorithm, must now be cognisant of joint valid business days within both sovereign states.

Recommendations

The following conventions are recommended:

- **Forward period**: $a_m = a_y = 0$, since standardly quoted CCBSs are all spot-starting.
- **Calendars**: ZAJO and USGS as published by the relevant government entities.
- **Spot lag**: $s = 2$, based on the ZAJO, USNY and USGS calendars. The extra calendar recommendation is based on the ISDA market practice note, [ISDA, 2022]. The magnitude aligns with the 2-business day settlement feature for the USDZAR spot exchange rate and standard SOFR OIS contracts.
- **Business day conventions**: Modified Following using both ZAJO and USGS.
- **Accrual period date generation**: Backward (EOM) algorithm to determine start and end dates, incorporating both the ZAJO and USGS calendars for the EOM algorithm. The ZAR and USD sub-accrual periods may then be identified using the ZAJO and USGS calendars, respectively.
- **Number of accrual periods**: If n is not a whole number then round-up, i.e., set $n = \lceil x_m/z_m \rceil$, which will create an initial period that is a short-stub.
- **Day-count conventions**: ACT/365 Fixed for ZAR and ACT/360 for USD, which align with the recommendation for standard ZARONIA OISs and the convention for standard USD OISs.

9.3. Floating reference rates, publication and calculation lags

The descriptions of the floating reference rate and its associated publication and calculation lag features that were provided for OISs in sub-section 8.3. are directly transferable to the two floating reference rates that are required for the definition of a general USDZAR CCBS. In summary, the following features are relevant here for the ZAR leg of the general USDZAR CCBS:

- **ZAR floating reference rate**: $r_j^{(i)}$ denotes the ZAR floating reference rate for the period $\left[t_j^{(i)}, t_{j+1}^{(i)}\right]$ and enables the definition of the overnight capitalisation factor

  $$C_j^{(i)} := 1 + r_j^{(i)}\delta_j^{(i)} \ ,$$

  for $j \in \{1, 2, \ldots, m_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.
- **ZAR publication lag**: $t_{j+k}^{(i)}$ is the publication date for the rate $r_j^{(i)}$, where k is the publication lag quantified in valid ZA business days.
- **ZAR calculation lag**: $t_{j+c}^{(i)}$ is the calculation date for the rate $r_j^{(i)}$, where c is the calculation lag quantified in valid ZA business days.

Accordingly, similar features are also relevant for the USD leg of the general USDZAR CCBS:

- **USD floating reference rate**: $r_j^{(\$,i)}$ denotes the USD floating reference rate for the period $\left[t_j^{(\$,i)}, t_{j+1}^{(\$,i)}\right]$ and enables the definition of the overnight capitalisation factor

  $$C_j^{(\$,i)} := 1 + r_j^{(\$,i)}\delta_j^{(\$,i)} \ ,$$

  for $j \in \{1, 2, \ldots, \ell_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.

- **USD publication lag**: $t^{(\$,i)}_{j+k^{(\$)}}$ is the publication date for the rate $r^{(\$,i)}_j$, where $k^{(\$)}$ is the publication lag quantified in valid US business days.
- **USD calculation lag**: $t^{(\$,i)}_{j+c^{(\$)}}$ is the calculation date for the rate $r^{(\$,i)}_j$, where $c^{(\$)}$ is the calculation lag quantified in valid US business days.

Market convention considerations

Recommendations
The following conventions are recommended:

- **ZAR floating reference rate**: South African Overnight Index Average (ZARONIA).
- **ZAR publication/calculation Lag**: The SARB's MPG recommends that the calculation lag be set equal to the SARB's chosen publication lag, expected to be one business day, i.e. $c = k = 1$.
- **USD floating reference rate**: Secured Overnight Financing Rate (SOFR).
- **USD publication/calculation Lag**: $c^{(\$)} = k^{(\$)} = 1$, which is the convention that is used in standard USD OISs and other CCBS's that reference the USD.

9.4. Averaging, lookback and lockout periods

The choice between arithmetic or geometric averaging of the floating ONRRs in order to create an ACFR, along with potential fixing adjustments (i.e., lockout, lookback and observation shift periods) to cater for discrepancies between calculation and settlement times, that were presented in sub-section 8.4., is again relevant for the definition of the two legs of the general USDZAR CCBS. In summary, the following features should be considered for the ZAR leg of the general USDZAR CCBS:

- **ZAR simple ACFR**: The ZAR simple ACFR for the i-th accrual period is denoted and calculated as

$$F_{(i)} := \frac{1}{\delta_i} \sum_{j=0}^{m_i-1} r^{(i)}_j \delta^{(i)}_j \ ,$$

  for $i \in \{1, 2, \dots, n\}$, which is based on arithmetic averaging.

- **ZAR compounded ACFR**: The ZAR compounded ACFR for the i-th accrual period is denoted and calculated as

$$F_{(i)} := \frac{1}{\delta_i} \left(\prod_{j=0}^{m_i-1} \left[1 + r^{(i)}_j \delta^{(i)}_j \right] - 1 \right) = \frac{1}{\delta_i} \left(\prod_{j=0}^{m_i-1} C^{(i)}_j - 1 \right) \ ,$$

  for $i \in \{1, 2, \dots, n\}$, which is based on geometric averaging.

- **ZAR lockout period**: Given a lockout period of ℓ ZA business days means that

$$r^{(i)}_j = r^{(i)}_{m_i-1-\ell} \ ,$$

  for all $j \in \{m_i - \ell, m_i - \ell + 1, \dots, m_i - 1\}$ and $i \in \{1, 2, \dots, n\}$.

- **ZAR lookback period**: Given a lookback period of f ZA business days means that

$$C^{(i)}_j = 1 + r^{(i)}_{j-f} \delta^{(i)}_j \ ,$$

  for all $j \in \{0, 1, \dots, m_i - 1\}$ and $i \in \{1, 2, \dots, n\}$.

- **ZAR observation shift period**: Given an observation shift period of ω ZA business days means that

$$C^{(i)}_j = 1 + r^{(i)}_{j-\omega} \delta^{(i)}_{j-\omega} \ ,$$

  for all $j \in \{0, 1, \dots, m_i - 1\}$ and $i \in \{1, 2, \dots, n\}$.

Accordingly, similar features should be considered for the USD leg of the general USDZAR CCBS:

- **USD simple ACFR**: The USD simple ACFR for the i-th accrual period is denoted and calculated as

$$F_{(i)}^{(\$)} := \frac{1}{\delta_i^{(\$)}} \sum_{j=0}^{\ell_i - 1} r_j^{(\$,i)} \delta_j^{(\$,i)} ,$$

  for $i \in \{1, 2, \ldots, n\}$, which is based on arithmetic averaging.

- **USD compounded ACFR**: The USD compounded ACFR for the i-th accrual period is denoted and calculated as

$$F_{(i)}^{(\$)} := \frac{1}{\delta_i^{(\$)}} \left(\prod_{j=0}^{\ell_i - 1} \left[1 + r_j^{(\$,i)} \delta_j^{(\$,i)} \right] - 1 \right) = \frac{1}{\delta_i^{(\$)}} \left(\prod_{j=0}^{\ell_i - 1} C_j^{(\$,i)} - 1 \right) ,$$

  for $i \in \{1, 2, \ldots, n\}$, which is based on geometric averaging.

- **USD lockout period**: Given a lockout period of $\ell^{(\$)}$ US business days means that

$$r_j^{(\$,i)} = r_{\ell_i - 1 - \ell^{(\$)}}^{(\$,i)} ,$$

  for all $j \in \{\ell_i - \ell^{(\$)}, \ell_i - \ell^{(\$)} + 1, \ldots, \ell_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.

- **USD lookback period**: Given a lookback period of $f^{(\$)}$ US business days means that

$$C_j^{(\$,i)} = 1 + r_{j - f^{(\$)}}^{(\$,i)} \delta_j^{(\$,i)} ,$$

  for all $j \in \{0, 1, \ldots, \ell_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.

- **USD observation shift period**: Given an observation shift period of $\omega^{(\$)}$ US business days means that

$$C_j^{(\$,i)} = 1 + r_{j - \omega^{(\$)}}^{(\$,i)} \delta_{j - \omega^{(\$)}}^{(\$,i)} ,$$

  for all $j \in \{0, 1, \ldots, \ell_i - 1\}$ and $i \in \{1, 2, \ldots, n\}$.

Market convention considerations

Recommendations

The following conventions are recommended:

- **ZAR averaging**: Geometric averaging, resulting in a compounded ACFR.
- **USD averaging**: Geometric averaging, resulting in a compounded ACFR.

The following adjustments are prominent in cash markets, but have been included here for completeness.

- **ZAR lockout/rate cutoff period**: $\ell = 0$.
- **ZAR lookback period/fixing lag**: $f = 0$.
- **ZAR observation shift period**: $\omega = 0$.
- **USD lockout/rate cutoff period**: $\ell^{(\$)} = 0$.
- **USD lookback period/fixing lag**: $f^{(\$)} = 0$.
- **USD observation shift period**: $\omega^{(\$)} = 0$.

9.5. Floating cash flow calculations and payment lags

Given the recommendation for compounded USD and ZAR ACFRs, respectively, the calculation methodologies mirrors that which was presented in sub-section 8.5. for the floating cash flow of a general OIS.

In particular, the analogous quantities and definitions for the USD leg of the general CCBS are:

- **USD floating rate**: The ZAR ACFR for the i-the interest accrual period is

  $$F_{(i)}^{(\$)} := \frac{1}{\delta_i^{(\$)}} \left[C_{0\ell_i}^{(\$,i)} - 1 \right] ,$$

  where $C_{0\ell_i}^{(\$,i)}$ is the realised USD capitalisation factor for the period $\left[t_0^{\$,i}, t_{\ell_i}^{\$,i} \right]$, and is defined as

  $$C_{0\ell_i}^{(\$,i)} := \prod_{j=0}^{\ell_i - 1} C_j^{(\$,i)} = \prod_{j=0}^{\ell_i - 1} \left[1 + \delta_j^{(\$,i)} r_j^{(\$,i)} \right] ,$$

  and is only calculable at $t_{\ell_i - 1 + c^{(\$)}}^{(\$,i)}$, i.e., taking into account the calculation lag of $c^{(\$)}$ bd, for $i \in \{1, 2, \ldots, n\}$.

- **USD floating cash flows**: Given the compounded ACFR above, the i-th USD floating cash flow may be calculated as

  $$N^{(\$)} F_{(i)}^{(\$)} \delta_{(i)}^{(\$)} ,$$

  for a non-interbank CCBS, and as

  $$N_{i-1}^{(\$)} F_{(i)}^{(\$)} \delta_{(i)}^{(\$)} ,$$

  for an interbank CCBS, both of which are also only calculable at $t_{\ell_i - 1 + c^{(\$)}}^{(\$,i)}$, for $i \in \{1, 2, \ldots, n\}$.

The calculations for the ZAR leg of the general CCBS are similar, except that one has to incorporate the *basis spread*. The relevant quantities are defined below:

- **ZAR floating rate**: The ZAR floating rate for the i-the interest accrual period is

  $$F_{(i)} := \frac{1}{\delta_i} \left[C_{0m_i}^{(i)} - 1 \right] ,$$

  where $C_{0m_i}^{(i)}$ is the realised ZAR capitalisation factor for the period $\left[t_0^{\$,i}, t_{m_i}^{\$,i} \right]$, and is defined as

  $$C_{0m_i}^{(i)} := \prod_{j=0}^{m_i - 1} C_j^{(i)} = \prod_{j=0}^{m_i - 1} \left[1 + \delta_j^{(i)} r_j^{(i)} \right] ,$$

  and is only calculable at $t_{m_i - 1 + c}^{(i)}$, i.e., taking into account the calculation lag of c bd, for $i \in \{1, 2, \ldots, n\}$.

- **ZAR floating cash flows**: Given the compounded ACFR above, along with the relevant basis spread x, the i-th ZAR floating cash flow may be calculated as

  $$N \left[F_{(i)} + x \right] \delta_{(i)} ,$$

  which is also only calculable at $t_{m_i - 1 + c}^{(i)}$, for $i \in \{1, 2, \ldots, n\}$.

The final feature that requires definition is the payment lag. In general, this feature is complicated in a CCBS, since one must be cognisant of potentially different sub-accrual periods and publication/calculation lags in the respective underlying currencies. Below is the definition of this feature for a general USDZAR CCBS:

- **Payment lag**: The payment date for the arbitrary i-th interest accrual period is denoted and defined as

$$T_{(i)} := \max\left\{t^{(i)}_{m_i-1+c+p}\,, t^{(\$,i)}_{\ell_i-1+c^{(\$)}+p}\right\}\,,$$

where p denotes the payment lag and is quantified in joint US and ZA valid business days. In most practical circumstances, $t^{(i)}_{m_i-1+c} = t^{(i)}_{m_i}$ and $t^{(\$,i)}_{\ell_i-1+c^{(\$)}} = t^{(\$,i)}_{\ell_i}$, and since $t^{(i)}_{m_i} = t^{(\$,i)}_{\ell_i} = T_i$, from sub-section 9.2., it follows that

$$T_{(i)} := T_i + p\,\text{bd}\,,$$

which is far more intuitive, from a practical perspective.

Figure 13 below depicts the full set of USD and ZAR floating cash flows for a long position in a non-interbank spot-starting USDZAR CCBS that has been defined throughout section 9..

Figure 13: USD and ZAR cash flows for a long position in a non-interbank USDZAR CCBS.

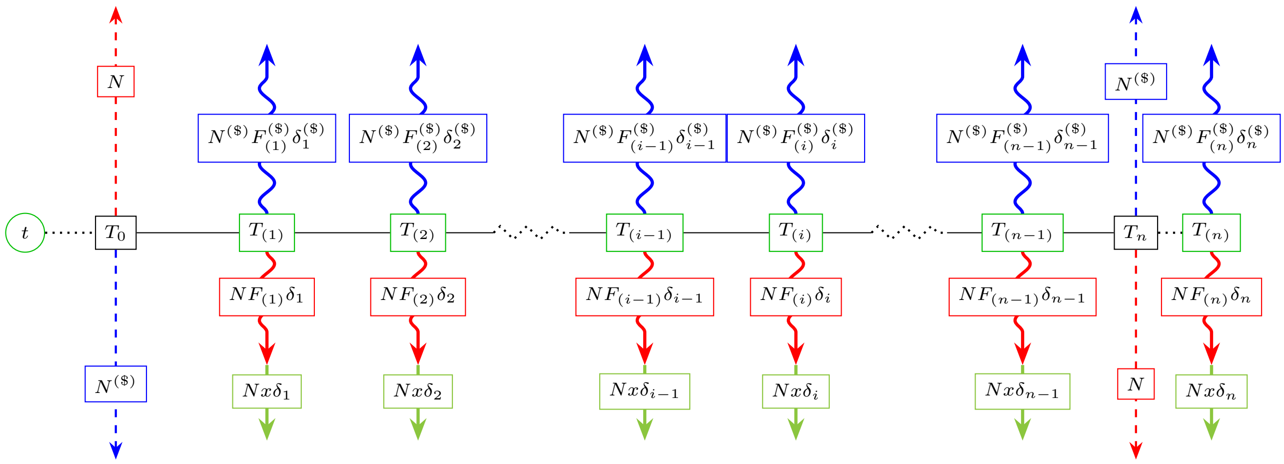
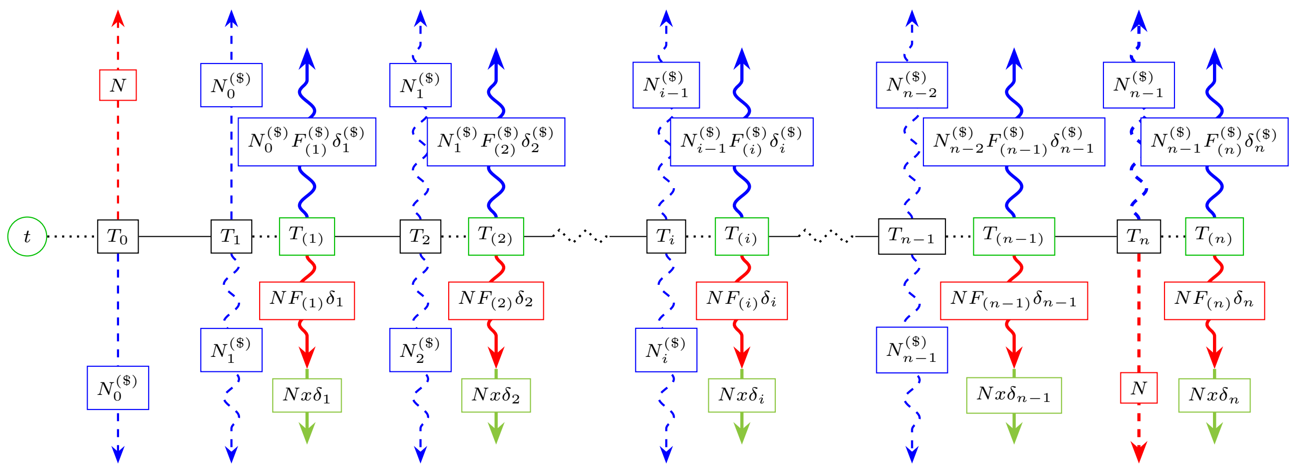


Figure 14 below depicts the full set of USD and ZAR floating cash flows for a long position in an interbank spot-starting USDZAR CCBS, which has also been defined throughout section 9..

Figure 14: USD and ZAR cash flows for a long position in an interbank USDZAR CCBS.



Market convention considerations

Recommendations

The following conventions are recommended:

- **USD floating rate rounding**: $F_{(i)}^{(\$)}$ should be rounded to 7 decimal places in numerical format, or 5 decimal places in percentage format. For example, if $F_{(i)}^{(\$)} =$ 0.04123456, then round to 0.0412346 or 4.12346%.
- **USD floating cash flow rounding**: The floating cash flow, $N^{(\$)}F_{(i)}^{(\$)}\delta_i^{(\$)}$, which is denominated in USD should be rounded to 2 decimal places, or to the nearest USc.
- **Basis spread quotation**: x should be rounded to 6 decimal places in numerical format, or 4 decimal places in percentage format. For example, if $x =$ 0.01123456, then round to 0.011235 or 1.1235%.
- **ZAR floating rate rounding**: $F_{(i)}$ should be rounded to 6 decimal places in numerical format, or 4 decimal places in percentage format. For example, if $F_{(i)} =$ 0.0712345, then round to 0.071235 or 7.1235%.
- **ZAR floating cash flow rounding**: The floating cash flow, $\left[NF_{(i)} + x\right]\delta_i$, which is denominated in ZAR should be rounded to 2 decimal places, or to the nearest ZAc.
- **Payment lag**: $p =$ 2, based on the ZAJO and USNY calendars. The removal of the USGS calendar, when compared to the spot lag, is market convention for standard SOFR OIS contracts.

10. Numerical examples

In order to demonstrate the recommended conventions for ZAR OISs and USDZAR CCBSs practically, a couple of Microsoft Excel workbooks have been created with specific examples, scenarios, actual market data and supporting calculations. These workbooks may be accessed via the following hyperlinks:

- for a working model that demonstrates the calculation of the respective floating leg cash flows, see: ZARONIA_Model; and
- for various relevant examples and scenarios, see: ZARONIA_Examples.

Take note that the provided examples and scenarios highlight features and nuances of the specific conventions that are recommended rather than an exhaustive presentation of all possible conventions, in general.

Glossary

List of acronyms

ACFR annualised cumulative floating rate. 7, 8, 9, 10, 16, 18, 19, 20, 27, 28, 29

ARR alternative reference rate. 4, 5

bd business day(s). 6, 7, 8, 9, 10, 12, 16, 19, 20, 23, 25, 29

BIS Bank for International Settlements. 4

CCBS cross-currency basis swap. 3, 10, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31

CSA Credit Support Annexure. 5

DWS Derivatives Workstream. 4, 5, 6, 35

EOM End-of-Month (business day convention). 6, 7, 8, 9, 10, 13, 14, 26

€STR Euro short-term rate. 6

EU European Union. 6

EUR euro. 6

EUTA Europe TARGET Calendar - TARGET Financial Center. 6

FCB fixed coupon bond. 22

FEC forward exchange contract. 25

FSCA Financial Sector Conduct Authority. 4

FRA forward rate agreement. 8

FRN floating rate note. 22

FXS foreign exchange swap. 22

GBLO London banking calendar - London Financial Center. 6

GBP British pound. 6

IBOR interbank offered rates. 4, 5

IRS interest rate swap. 9, 11, 13, 14, 15, 16, 21, 22

ISDA International Swaps and Derivatives Association. 26

Jibar Johannesburg Interbank Average Rate. 2, 4, 5, 7, 8, 9, 35

MPG Market Practitioners Group. 3, 4, 5, 7, 8, 9, 10, 16, 27, 35

ONRR overnight reference rate. 4, 11, 15, 16, 19, 27

OIS overnight indexed swap. 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 20, 21, 22, 23, 26, 27, 29, 31

OTC over-the-counter. 4

RFRWS Risk-Free Reference Rate Workstream. 3, 5

SAFEX South African Futures & Options Exchange. 5

SAFEX ON SAFEX Overnight Rate. 5

SARB South African Reserve Bank. 3, 4, 7, 8, 9, 10, 16, 27, 35

SOFR secured overnight financing rate. 6, 8, 10, 26, 27, 31

SONIA Sterling Overnight Index Average. 6

TBRR term-based reference rate. 7, 11, 15, 16, 21

UK United Kingdom. 6

US United States of America. 6, 23, 24, 25, 27, 28, 30

USc United States cent. 10, 31

USD United States dollar. 3, 4, 6, 10, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31

USGS United States Government Securities business days, also referred to as the Securities Industry and Financial Markets Association (SIFMA) Calendar. 6, 10, 26, 31

USNY United States banking calendar - New York Financial Center. 6, 10, 26, 31

ZA Republic of South Africa. 23, 25, 26, 27, 30

ZAJO South African calendar - Johannesburg Financial Center. 7, 8, 9, 10, 14, 26, 31

ZAc South African cent. 7, 8, 9, 10, 21, 31

ZAR South African rand. 3, 5, 10, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31

ZARONIA South African Overnight Index Average. 2, 5, 6, 7, 8, 9, 10, 16, 26, 27, 35

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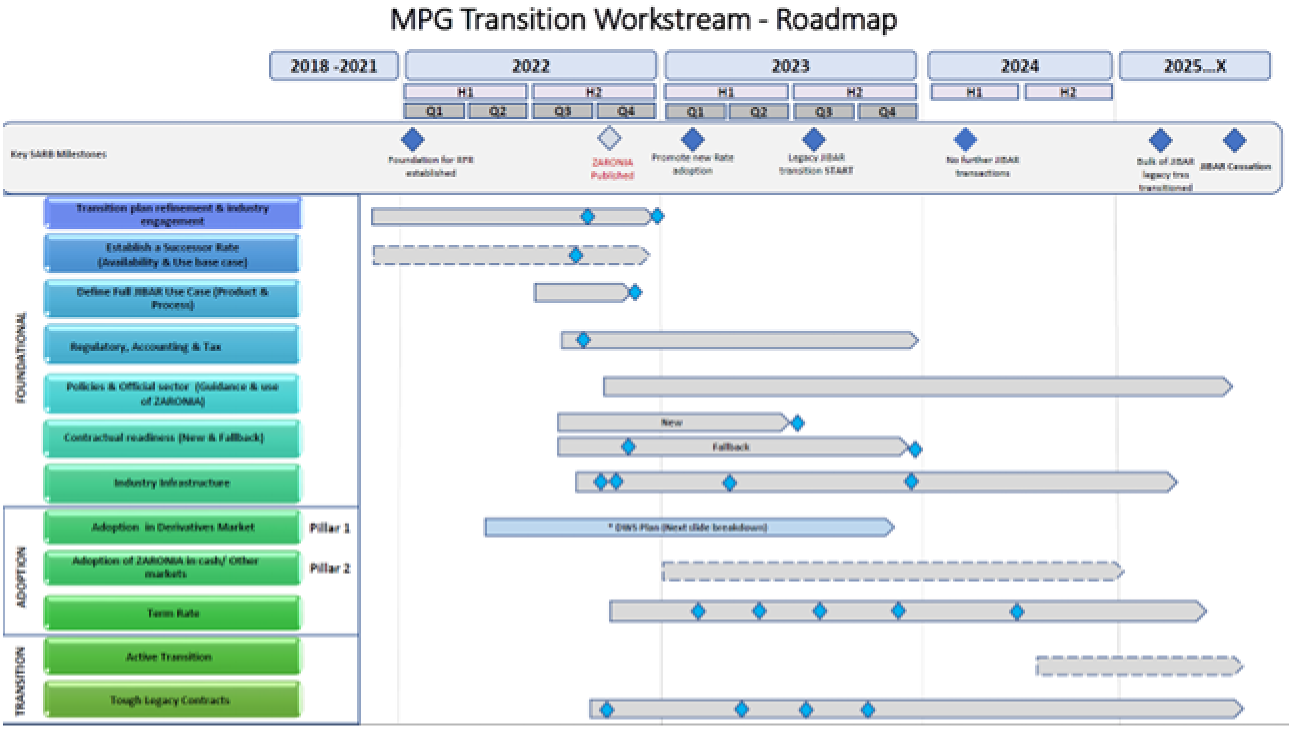
A SARB MPG's transition roadmap

Figure 15: The SARB MPG's transition roadmap.



B Tenor basis — Jibar versus ZARONIA

The scope of this document aims to define the recommended conventions for derivatives referencing ZARONIA. It is likely that legacy interest rate derivative portfolios will eventually be converted to ZARONIA prior to the eventual cessation of Jibar. While the timing and details of portfolio conversions are outside the scope of this document, the DWS would like to highlight that a Jibar versus ZARONIA basis swap could assist the market in facilitating these portfolio conversions via transfers of risk. It is therefore recommended that conventions for a Jibar versus ZARONIA derivative be defined and added to a later version of this document.