Ground Rules

FTSE/JSE Fixed Income Index Series

v1.2

Contents

Section 1

Introduction

1.0 Introduction

1.1 This document sets out the Ground Rules for the construction and management of the FTSE/JSE Fixed Income Index Series. Copies of the Ground Rules are available from FTSE Russell, the Johannesburg Stock Exchange Limited (JSE) and on the websites www.ftserussell.com and www.jse.co.za.

1.2 The FTSE/JSE Fixed Income Index Series is designed to represent the performance of South African bonds, providing investors with a comprehensive and complementary set of indexes.

1.3 The FTSE/JSE All Bond Index (ALBI) Series is designed to represent the performance of fixed-rate bonds denominated in South African Rand (ZAR) and includes the following headline indexes and sub-indexes:

FTSE/JSE All Bond Index (ALBI)

Sector Index	Description
ALBI20	FTSE/JSE All Bond Index
ALBI20G	FTSE/JSE All Bond Government Index
ALBI20O	FTSE/JSE All Bond Other Bond Index
Maturity Index	**Description**
ALBI201	FTSE/JSE All Bond 1-3 Years Index
ALBI203	FTSE/JSE All Bond 3-7 Years Index
ALBI207	FTSE/JSE All Bond 7-12 Years Index
ALBI2012	FTSE/JSE All Bond 12+ Years Index

1.4 The FTSE/JSE Inflation-Linked Index (CILI) Series is designed to represent the performance of inflation-linked bonds denominated in South African Rand (ZAR) and includes the following headline indexes and sub-indexes:

FTSE/JSE Inflation-Linked Index (CILI)

Sector Index	Description
CILI15	FTSE/JSE Inflation-Linked Index

Sector Index	Description
CILI15G	FTSE/JSE Inflation-Linked Government Index
CILI15S	FTSE/JSE Inflation-Linked State-Owned Index
CILI15C	FTSE/JSE Inflation-Linked Corporate Index
Maturity Index	**Description**
CILI151	FTSE/JSE Inflation-Linked 1-3 Years Index
CILI153	FTSE/JSE Inflation-Linked 3-7 Years Index
CILI157	FTSE/JSE Inflation-Linked 7-12 Years Index
CILI1512	FTSE/JSE Inflation-Linked 12+ Years Index

1.5 The base currency of the indexes is South African Rand (ZAR).

1.6 The indexes are calculated for each calendar day, including weekends and holidays.

1.7 The day on which they are calculated is referred to as the "calculation date", which is the business day before in the case of weekend or holiday calculations

1.8 The weekends and holiday valuations and index publishing are done on the prior business day.

1.9 For these calculations, "business day" refers to those days where the JSE is open for bond trading.

1.10 FTSE Russell

1.10.1 FTSE Russell is a trading name of FTSE International Limited, Frank Russell Company, FTSE Global Debt Capital Markets Limited (and its subsidiaries FTSE Global Debt Capital Markets Inc. and MTSNext Limited), Mergent, Inc., FTSE Fixed Income LLC, The Yield Book Inc and Beyond Ratings.

1.11 IOSCO

1.11.1 FTSE Russell considers that the FTSE/JSE Fixed Income Index Series is managed in accordance with the IOSCO Principles for Financial Benchmarks as published in July 2013.

1.12 FTSE Russell hereby notifies users of the index series that it is possible that circumstances, including external events beyond the control of FTSE Russell, may necessitate changes to, or the cessation, of the index series and therefore, any financial contracts or other financial instruments that reference the index series or investment funds which use the index series to measure their performance should be able to withstand, or otherwise address the possibility of changes to, or cessation of, the index series.

1.13 Index users who choose to follow this index or to buy products that claim to follow this index should assess the merits of the index's rules-based methodology and take independent investment advice before investing their own or client funds. No liability, whether as a result of negligence or otherwise, is accepted by FTSE Russell or JSE for any losses, damages, claims and expenses suffered by any person as a result of:

- any reliance on these Ground Rules, and/or
- any errors or inaccuracies in these Ground Rules, and/or
- any non-application or misapplication of the policies or procedures described in these Ground Rules, and/or
- any errors or inaccuracies in the compilation of the Index or any constituent data.

Section 2

Management Responsibilities

2.0 Management Responsibilities

2.1 FTSE International Limited (FTSE)

2.1.1 FTSE is the benchmark administrator of the index series.[1]

2.1.2 FTSE Russell is responsible for the daily calculation and production of the index series and will:

- calculate all the indexes in the FTSE/JSE Fixed Income Index Series and will maintain records of all constituents;
- make changes to the constituents and their weightings in accordance with the Ground Rules;
- publish changes to the constituent weightings resulting from their ongoing maintenance and periodic reviews;
- disseminate the indexes.

2.1.3 The JSE is responsible for the provision of all bond reference, valuation and trading data necessary for FTSE Russell to produce the FTSE/JSE Fixed Income Index Series.

2.2 FTSE/JSE Fixed Income Advisory Committee

2.2.1 The purpose of the Committee is to consider and advise on matters relating to and proposed amendments to the Ground Rules governing the management of the FTSE/JSE Fixed Income Index Series and to ensure that best practice is used in the construction and ongoing management of the Indexes.

In particular, the Committee will:

- oversee the methodology for the FTSE/JSE Fixed Income Index Series;
- provide guidance on the development and construction of new fixed income indexes for the South Africa market;
- discuss proposed amendments to the index Ground Rules and calculation methodology and make recommendations for enhancements as appropriate.

[1] The term administrator is used in this document in the same sense as it is defined in Regulation (EU) 2016/1011 of the European Parliament and of the Council of 8 June 2016 on indexes used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds (the European Benchmark Regulation).

2.3 Amendments to these Ground Rules

2.3.1 These Ground Rules shall be subject to regular review to ensure that they continue to best reflect the aims of the index series. Any proposals for significant amendments to these Ground Rules will be subject to consultation with the FTSE/JSE Fixed Income Advisory Committee and other stakeholders if appropriate. The feedback from these consultations will be considered by the FTSE Russell Product Governance Board before approval is granted.

2.3.2 As provided for in the Statement of Principles, where FTSE Russell determines that the Ground Rules are silent or do not specifically and unambiguously apply to the subject matter of any decision, any decision shall be based on the Statement of Principles, as far as practical. After making any such determination, FTSE Russell shall advise market participants of its decision at the earliest opportunity. The issue will subsequently be discussed at the FTSE/JSE Fixed Income Advisory Committee and FTSE Russell will decide if a change to these Grounds Rules is warranted. Any changes will be approved by the FTSE Russell Product Governance Board.

Section 3

FTSE Russell Index Policies

3.0 FTSE Russell Index Policies

These Ground Rules should be read in conjunction with the following policy documents which can be accessed using the links below:

3.1 Statement of Principles for FTSE Fixed Income Indexes (the Statement of Principles)

Indexes need to keep abreast of changing markets and the Ground Rules cannot anticipate every eventuality. Where the Ground Rules do not fully cover a specific event or development, FTSE Russell will determine the appropriate treatment by referencing the Statement of Principles, which summarises the ethos underlying FTSE Russell's approach to index construction. The Statement of Principles is reviewed annually, and any changes proposed by FTSE Russell are presented to the FTSE Russell Policy Advisory Board for discussion before approval by the FTSE Russell Product Governance Board.

The Statement of Principles can be accessed using the following link:

Statement_of_Principles_Fixed_Income_Indexes.pdf

3.2 Queries and Complaints

FTSE Russell's complaints procedure can be accessed using the following link:

Benchmark_Determination_Complaints_Handling_Policy.pdf

3.3 Recalculation Policy and Guidelines

3.3.1 The FTSE/JSE Fixed Income Index Series is recalculated whenever errors or distortions occur that are deemed to be significant. Users of the indexes are notified through appropriate media.

The Recalculation Policy and Guidelines can be accessed using the following link:

Recalculation_Policy_and_Guidelines_Fixed Income Indexes.pdf

3.4 Policy for Benchmark Methodology Changes

3.4.1 Details of FTSE Russell's policy for making benchmark methodology changes can be accessed using the following link:

Policy_for_Benchmark_Methodology_Changes.pdf

Section 4

Eligibility Criteria

4.0 Universe Eligibility Criteria and Bond Selection

4.1 Common Criteria

To be eligible for the FTSE/JSE Fixed Income Index Series, a bond must satisfy the following criteria, using bond data as published on the Cut Date:

- Be listed on the JSE and settled electronically;
- Be a "vanilla" fixed-rate or inflation-linked bond: this excludes credit-linked notes, ETFs, commercial paper, perpetuities, amortising and customised instruments;
- Have a remaining term to maturity of greater than one year at any time while an index constituent;
- Have a clean market capitalisation greater than R 100 million, as measured over the averaging period;
- Have either a single maturity date or, for bonds with multiple redemption dates, be priced according to the "mid-redemption" convention. The redemption or mid-redemption[2] date must be a coupon date;
- Redemption date or mid-redemption date must coincide with a coupon date;
- Have been listed for a minimum of 40 trading days prior to the reconstitution Cut Date.

4.2 Additional ALBI Criterion

To be eligible for the ALBI, a bond must be a zero-coupon or fixed-rate bond paying a coupon semi-annually.

4.3 Additional CILI Criterion

To be eligible for the CILI, a bond must be a conventional inflation-linked instrument which has a fixed-rate semi-annual coupon inflated by the four-month lagged headline South Africa Consumer Price Index for all urban areas. This is in line with current market practice for inflation-linked bonds and specifications laid out by the International Swaps and Derivatives Association.

4.4 Bond Selection

Constituent additions and deletions occur quarterly at a reconstitution. The eligible constituents for each index series for the next quarter are ranked according to the Dual Ranking Methodology

[2] In the case of bonds where final redemption has been split into three new bonds with three distinct dates, the mid-redemption date refers to the pricing redemption date of the middle child bond.

described below. The top 20 ranked bonds for the ALBI and top 15 ranked bonds for the CILI form the constituents of the indexes at the next reconstitution.

4.5 Sub-Index Selection

4.5.1 Of the selected bonds, the issuer class sub-indexes are formed according to the industry classification of each bond made by the JSE.

4.5.2 Each bond in the headline index is allocated to a single sub-index based on this classification. The exact categorisation applied is as follows:

- ALBI20 is split into ALBI20G and ALBI20O sub-indexes. ALBI20G contains ALBI20 constituents ranked 1-10 at the quarterly reconstitution that are issued by the Government of South Africa. ALBI20O contains all other ALBI20 constituents.
- CILI15 is split into three sub-indexes defined by industry classification: government issues, state owned enterprise issues and corporate issues.

4.5.3 Maturity sub-indexes are exclusive of the lower bound and inclusive of the upper bound. Bonds can move at any time from one maturity sub-index to a shorter one based on their remaining times to maturity, not just at reconstitution or reweighting. In the event that a sub-index has no constituents, its index level will remain constant.

4.5.4 When the sub-index has constituents once more, the starting value will be that same constant value.

4.6 Treatment of Bond Split Options in Tradable Indexes

4.6.1 In a small number of instances, bond issuers may split the final redemption of a bond over three distinct dates. In practice, this is done by issuing three new bonds that replace the original bond. The three new bonds would sum to the total nominal value of the original bond, generally split equally three ways, and would redeem sequentially over three years.

4.6.2 When this occurs, the third child of a bond split will automatically replace its parent at the first reconstitution following the final split and will be ranked on its own merit thereafter.

Section 5

Data Sources

5.0 Data Sources

5.1 Bond Prices and Yields

5.1.1 The indexes are calculated using bond prices as published by the JSE.

5.1.2 Please see the JSE methodology for bond pricing and inflation-linked bond pricing for more information.

5.1.3 Distributed yield analytics are calculated by FTSE Russell.

5.2 Bond Reference Data

5.2.1 All bond reference data, including industry classifications, are provided by the JSE.

5.3 Bond Trading Data

Bond trading volumes, are provided by the JSE.

Section 6

Constituent Selection

6.0 Constituent Selection

6.1 Overview

Constituent additions and deletions occur quarterly at a Reconstitution and constituent holdings are updated monthly at a Reweighting.

At each Reconstitution, the process is applied separately for each index as follows:

1. Apply the eligibility criteria in 4.1 to all listed bonds to obtain an eligible universe;
2. Select the constituents of the headline index from this universe, using the Dual-Ranking Methodology;
3. Allocate each selected constituent of the headline index into the relevant Issuer Class or maturity sub-index.

There are no constituent additions and deletions due to a Reweighting. However, the weights for all constituents are updated where their nominal amount in issue has changed.

Cash flows are immediately reinvested across every bond in an index in proportion to their market value within that index. Therefore, the percentage weight and nominal amount of constituents does not change due to reinvestment. Rather, the increase in value is reflected by an increase in the index k-factor.

When a bond moves from one maturity sub-index to a shorter one, which can happen on any day, the sub-index k-factor will change, but the headline index k-factors will not.

6.2 Definitions and Timelines

6.3 Reconstitution

A Reconstitution is performed quarterly in February, May, August and November. At a Reconstitution, the constituents of each index are reevaluated in line with these rules using the Dual Ranking Methodology and set for the subsequent quarter. Reconstitutions are effective as of 12:00 SAST on the first Thursday of the reconstitution month; if this is a non-business day, Rule 6.5 applies. All changes made at each Reconstitution are published in advance no later than the 15th day of the previous calendar month.

The FTSE/JSE All Bond Index and FTSE/JSE Inflation-Linked Index are tradable indexes with listed derivatives products. As such, the index is calculated and published with its pre-reconstituted portfolio shortly after 12:00 SAST, whereas the end of day calculation is done on the reconstituted portfolio.

6.4 Reweighting

A Reweighting is performed monthly in non-Reconstitution months for all indexes in the series. It takes place in January, March, April, June, July, September, October and December. At a Reweighting, the weights of the constituent bonds in an index are adjusted to reflect any updates to their nominal amounts in issue. Reweightings take effect after the close of business of the first Thursday of the Reweighting month, such that the Friday end of day calculation reflects the new weightings, or if this is a non-business day, Rule 6.5 applies. All changes made at each Reweighting are published in advance no later than the 15th day of the previous calendar month. Bonds remaining in the index at reconstitution and where applicable, are also reweighted.

6.5 Non-Trading Days

Where the first Thursday of the Reconstitution or the Reweighting month falls on a non-trading day, the second Thursday of that month will be used to determine the effective date. Where the second Thursday is itself a non-trading day, the previous trading day in that week will be used.

6.6 Cut Date

The Cut Date is the last trading day of the month, two months prior to the Reconstitution or Reweighting month. For example, the Cut Date for the January Reweighting is the last trading day of the previous November, and the Cut Date for the February Reconstitution is the last trading day of the previous December.

6.7 Averaging Period

The Averaging Period is defined for each Reconstitution as the twelve-month period ending on the Cut Date. For new issues, the averaging period for that bond is calculated over the months since it has been issued, excluding the first month of listing. The Averaging Period is not used for a Reweighting.

6.8 Dual Ranking Methodology

The Dual Ranking Methodology is applied at Reconstitution separately for ALBI and CILI, according to the following steps:

1. Using bond data as published on the Cut Date, the eligibility criteria as shown in 4.1 are applied to determine a universe of eligible bonds for a particular index.
2. The Market Capitalisation of each eligible bond is calculated as the product of nominal amount in issue and clean price. This is done as at the end of each month in the Averaging Period and then averaged to get an Average Market Capitalisation per bond.
3. Eligible bonds are ranked in descending order by Average Market Capitalisation and assigned a Market Capitalisation Rank. Ties are broken alphabetically by bond code (JSE local market code equivalent).
4. The Liquidity of each eligible bond represents its monthly median secondary market turnover during the Averaging Period. This value is calculated by FTSE Russell using data supplied by the JSE. Each month's traded value is obtained by aggregating the clean consideration of each eligible trade, where consideration refers to the amount paid for the bond (nominal traded multiplied by price). Trades included are outright purchases and sales of standard and odd lots, traded during that month for settlement on the standard settlement day ("t+3"), or on any non-standard day. Both legs of carries (also known as buy/sell-backs), repos and option exercises are excluded. Liquidity is calculated as the median of the monthly traded values over the Averaging Period to get a Median Monthly Turnover per bond.
5. Eligible bonds are ranked in descending order by Median Monthly Turnover and assigned a Liquidity Rank. Ties are broken alphabetically-in-reverse by bond code.

6. The Dual Rank of a bond is the greater of its Market Capitalisation Rank and its Liquidity Rank. Ties of Dual Rank are broken by Market Capitalisation Rank. This can be achieved by adding 0.5 to the Market Capitalisation Rank of any bond whose Market Capitalisation Rank is greater than or equal to its Liquidity Rank. The Dual Rank is then the greater of this Adjusted Market Capitalisation Rank and the Liquidity Rank.
7. Eligible bonds are sorted by Dual Rank and the first N bonds so listed are selected, where N is 20 for the ALBI and 15 for the CILI.

6.9 Reconstitution of Sub-Indexes

Any change to the constituents of a headline index at a Reconstitution will automatically be applied to all Issuer Class and maturity sub-indexes.

6.10 Weighting Factors

The weighting factors of individual bonds are based on the nominal amount in issue of that bond. While this amount in issue can change from day-to-day, any such change will not be applied in the indexes immediately. Instead, all changes will be rolled up and applied at the next Reweighting or Reconstitution.

All weighting factors are also updated at each Reconstitution, and as such, a Reconstitution includes a full Reweighting.

Section 7

Calculation Guide

7.0 Formulae and Calculation Methods for the FTSE/JSE Fixed Income Index Series

7.1 Time Structure

The index is calculated for every day of the week, including weekends and holidays. For any date, t, the corresponding settlement date, s, is defined as follows:

- If t is a trading day, s is the date of its settlement day according to the prevailing JSE settlement period. Currently bonds settle on "t+3" using the following good business day convention;
- If t is a non-trading day, s is deemed to be the settlement day of the first preceding trading day. For example, if t is a Saturday, s must be the settlement date for Friday (i.e. the next Wednesday, assuming no public holidays).

For calculations on non-trading days, the mark-to-market yields to maturity of the first preceding trading day will be used to determine the discounted clean price and all in price for index calculation.

7.2 Inflation Factor

An inflation index ratio is used to adjust certain values when calculating inflation-linked indexes. The all-in prices for bonds published by the JSE are already adjusted for inflation, however an inflation index ratio is used to create a nominal discount factor from a real discount factor, as well as to calculate the actual cash flow of an ex-coupon.

The inflation index ratio uses the South African Consumer Price Index (CPI), which is the headline CPI for all urban areas. This index is published monthly by Statistics South Africa in document P0141.

$CPI(i,j)$ or the value of the CPI ratio for bond i at time j is calculated as follows:

$$CPI(i,j) = \frac{\frac{1+m-d}{m} CPI_{M-4} + \frac{d-1}{m} CPI_{M-3}}{BaseCPI_i}$$

Where:

d	is the calendar day of the month corresponding to date j
m	is the number of days in the calendar month M
M	is the calendar month of date j

CPI_x is the published CPI value that applies to the first day of calendar month x

$BaseCPI_i$ is the CPI value for the base date of bond i; this is usually the issue date of the bond, but may also be based on a reference bond.

7.3 Initialisation

An index is created as at the end of day on date t_0 with initial value I_{t0}. The ZAR value of the Reference Portfolio at the same time is Z_{t0}. Indexes are usually launched with an initial value of 100, although there is no reason why any other values cannot be used.

The base date for the ALBI20 and its sub-indexes is 1 July 2000, and 1 February 2007 for the CILI15. All the sub-indexes of the CILI15 have a base date of 1 February 2010 with an initial index value of 100, except for the CILI15G (IGOV), which is backdated to 5 February 2010. This ensures that the index levels are somewhat comparable as their levels are identical on 1 February 2010.

7.4 Valuation Date Discount Factors

The calculations for day t start with the pricing of the constituent bonds in the Reference Portfolio for settlement on day s. Similarly, any ex-coupons will be discounted from their receipt date to give a value on s.

These values for s will then be further discounted from s to the valuation date t. The discounting of each value (i.e. bond price or ex-coupon belonging to the bond) will be at each bond's yield to maturity, including an inflation adjustment for inflation-linked bonds.

The effect of this further discounting will often be the same as if the bond itself had been valued for settlement on t and not on s, using the same yield to maturity. In order to make this statement as true as possible, the discounting method applied from s to t must be consistent with the JSE Bond Pricing Formula. The specifications below describe the calculation of discount factors, $D_{i,t}$, for bond i on day t, which fulfil this condition.

The inputs are:

t is the valuation date

s is the settlement date corresponding to t (see Rule 7.1)

$c_{i,t}$ is the next coupon payment date for bond i which is on or after t

$c^-_{i,t}$ is the previous coupon payment date for bond i which is before $c_{i,t}$

$c^+_{i,t}$ is the coupon payment date for bond i which comes after $c_{i,t}$

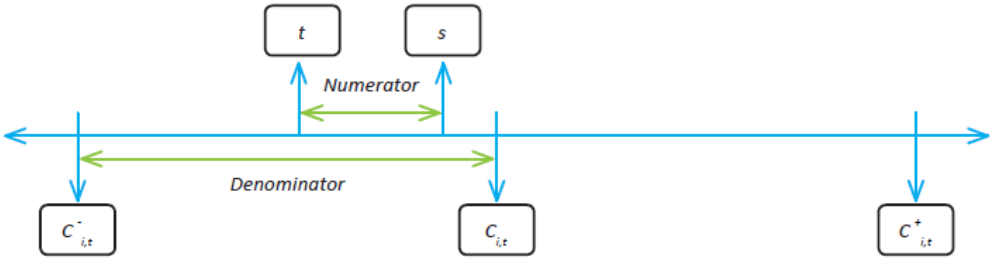
$Y_{i,t}$ is the yield to maturity of bond i applicable to the valuation date t, expressed as a percentage. This figure will be the nominal yield to maturity for fixed-rate bonds and the real yield to maturity for inflation-linked bonds .

The first step is to determine the exact size of the period, $H_{i,t}$ over which discounting is performed for bond i on day t. This is measured in the same units as the coupon frequency of the bond, namely half-years for the fixed rate and inflation-linked indexes. This period size will correspond to the period between the previous and the next coupon dates and can vary in its actual number of days.

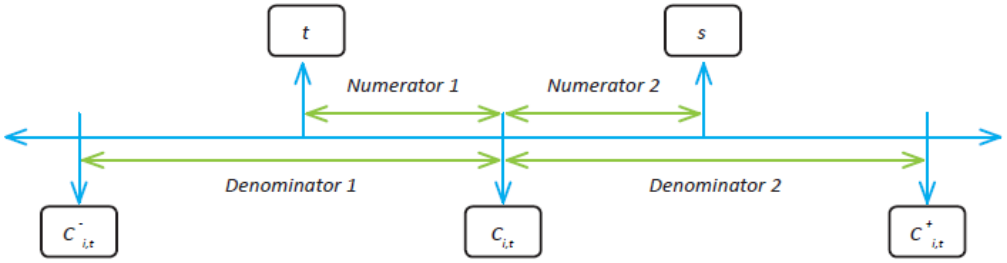
The period from s to t is then measured as a fraction of a half-year or a fraction of a quarter, rather than a fixed number of days. $H_{i,t}$ is used in conjunction with the bond's yield to maturity to determine a discount factor applicable from s to t.

If the period between s and t does not contain a coupon payment date, then $H_{i,t}$ is simply the number of days from t to s divided by the number of days in the current coupon period. However, if a coupon payment date does fall before the settlement date, allowance is made for two coupon periods of different lengths. These two cases are illustrated below:

a. No coupon between *s* and *t* (i.e. $s \leq c_{i,t}$) :



b. Coupon between *s* and *t* (i.e. $t \leq c_{i,t} < s$):



Hence from the above, the formula for $H_{i,t}$ is as follows:

$$H_{i,t} = \frac{s-t}{c_{i,t} - c^-_{i,t}} \qquad \text{if } c_{i,t} \geq s$$

$$H_{i,t} = \frac{s-c_{i,t}}{c^+_{i,t} - c_{i,t}} + \frac{c_{i,t}-t}{c_{i,t} - c^-_{i,t}} \qquad \text{if } c_{i,t} < s$$

Given $H_{i,t}$ above, the discount factor $D_{i,t}$, applicable from s back to t is:

For fixed-coupon bonds: $$D_{i,t} = \left(\frac{1}{1+\frac{Y_{i,t}}{200}}\right)^{H_{i,t}}$$

For inflation-linked bonds: $$D_{i,t} = \left(\frac{1}{1+\frac{Y_{i,t}}{200}}\right)^{H_{i,t}} \times \frac{CPI(i,t)}{CPI(i,s)}$$

7.5 The Bond Portion of the Portfolio

The index portfolio is valued in two separate portions: the Bond Portion and the Ex-Coupon Portion. This section deals with the former.

The Bond Portion of the portfolio is a portfolio of bonds held in nominal amounts. The nominal amount $N_{i,t}$ of bond i on day t is proportional to that bond's weighting factor on the same day:

$$N_{i,t} = K_t \times w_{i,t}$$

Where:

$w_{i,t}$ is the weighting factor of bond i on day t and is defined as the nominal (face value) amount in issue of bond i included in the index at the last reweighting or

reconstitution. It remains fixed for the subsequent month and is measured in ZAR millions;

K_t represents the proportionality constant or "k-factor" for the entire portfolio. This acts as a rebasing factor for the index value and is set at an index level. It is subject to change when a rebasing event occurs (a reconstitution, reweighting or a cashflow reinvestment), however its initial value is given by the requirement that the index portfolio's initial value at time t_0 is the required base value of 100, denoted Z_{t0}.

Thus:

$$K_{t0} = \frac{Z_{t0}}{\sum_{i=1..n}(w_{i,t0} \times p_{i,t0} \times D_{i,t0})}$$

Where:

$p_{i,t}$ is the all-in price of bond i on day t , quoted per ZAR 100 nominal

The value of the Bond Portion for a single bond, $B_{i,t}$, at close on day *t* is then given by:

$$B_{i,t} = N_{i,t} \times p_{i,t} \times D_{i,t}$$

The total value of the Bond Portion of the index portfolio on day t is the sum of $B_{i,t}$, across all bonds in the index:

$$B_t = \sum_{i=1..n} B_{i,t}$$

7.6 The Ex-Period

The Ex-Period of a bond is the period which occurs directly before each of its coupon payment dates when it is trading for settlement ex-coupon. An investor who purchases a bond in its ex-period is not entitled to receive the next coupon payable.

The Ex-Period begins on the first day on which a bond is trading for ex-settlement (i.e. the first trading day whose settlement date is on or after the bond's books-closed date).

The Ex-Period ends on the day on which the received coupon can be reinvested (i.e. the first trading day whose settlement is on or after the bond's coupon payment date, if necessary, adjusted for non-business days). On this day, the Ex-Period ends at the notional close of business: the rebasing time for the day.

7.6.1 The Ex-Coupon of an Individual Bond

The Ex-Coupon portion of the portfolio on valuation date t is the value of coupons which have vested in the portfolio, based on holdings in the bonds at the start of their ex-periods, but have not yet been received and reinvested.

The Ex-Coupon amount, $X_{i,t}$ relating to bond i on day t can be defined as follows:

For bonds not in their ex-period: $X_{i,t} = 0$

Otherwise:

For fixed-coupon bonds: $X_{i,t} = N_{i,t}^{x} \times \frac{g_{i,t}}{200}$

For inflation-linked bonds: $X_{i,t} = N_{i,t}^{x} \times \frac{g_{i,t}}{200} \times CPI(i, c_{i,t})$

Where:

$N_{i,t}^{x}$ is the nominal amount of the bond in the portfolio on the first day of its ex-period and before any rebasing for that day. This value remains constant throughout the ex-period;

$g_{i,t}$ is the coupon rate of the bond at time t expressed as a percentage. This will be a nominal coupon rate for fixed-rate bonds and a real coupon rate for inflation-linked bonds;

$CPI(i, c_{i,t})$ is the CPI index ratio for the bond for the coupon date $c_{i,t}$.

Note: it is possible for a bond to be included in the ex-coupon portion when it is no longer a constituent of the Bond Portion of the index portfolio if it was deleted from the index during its ex-period.

7.6.2 The Value of the Ex-Coupon Portion

The value of each bond's ex-coupon, $V_{i,t}$, on any day t in its ex-period, is the present value of that coupon payment discounted in two parts: first from coupon payment date to s and then from s to t. In the event that the coupon payment date falls between t and s, there is only a single level of discounting: from coupon payment date to t. Using notation as before:

For fixed-coupon bonds: $$V_{i,t} = X_{i,t} \times D_{i,t} \times \left(\frac{1}{1+\frac{Y_{i,t}}{200}}\right)^{\frac{\max(c_{i,t}-s,0)}{c_{i,t}-c^{-}_{i,t}}}$$

For inflation-linked bonds: $$V_{i,t} = X_{i,t} \times D_{i,t} \times \left(\frac{1}{1+\frac{Y_{i,t}}{200}}\right)^{\frac{\max(c_{i,t}-s,0)}{c_{i,t}-c^{-}_{i,t}}} \times \frac{CPI(i,s)}{CPI(i,c_{i,t})}$$

The total value of the Ex-Coupon portion of the index portfolio is the sum of $V_{i,t}$ across all bonds:

$$C_t = \sum_{i=1..n} V_{i,t}$$

7.7 Reinvestment of Coupons

The ex-coupon amount $X_{i,t}$ is received on its payment date and reinvested at the first opportunity thereafter (i.e. on the first trading date whose settlement date is on or after receipt date, or the last day of the ex-period).

It is important to note that due to the lag between trade and settlement, the reinvestment of coupons takes place before the actual receipt date. Reinvestment occurs at the end of the day generally, or at midday on reconstitution days. Until this happens, it is still part of the ex-coupon portion, C_t. After the rebasing, it falls out of this portion.

The value of the ex-coupon portion that is to be reinvested on settlement date s is defined as $R_{i,t}$, and will thus only have a value on the last day of the ex-period, being 0 elsewhere:

$R_{i,t} = V_{i,t}$ if t is the last day of the ex-period,

$R_{i,t} = 0$ otherwise.

The total value of the coupons being reinvested across the index portfolio is:

$$R_t = \sum_{i=1..n} R_{i,t}$$

Coupons are reinvested across the index in each bond in proportion to its market value, thereby preserving the percentage market value of each bond in the index. The effect of the reinvestment is

thus captured entirely in an increase in the k-factor for the index. Each index has its own k-factor. For example, when a coupon is reinvested in the ALBI, it affects that index's k-factor, but if the cashflow does not originate from a bond in the 1-3 year sub-index, the k-factor for that maturity sub-index is unaffected.

7.8 Recalculation of the k-factor

The recalculation of K_t takes place whenever there is a rebasing event (a reconstitution, reweighting or reinvestment), at the rebasing time at the close-of-business. The new k-factor, K'_t will hold thereafter.

K'_t is calculated such that the value of the index portfolio immediately before and after the rebasing is the same. The k-factor is thus used to maintain a continuous index value.

The k-factor is calculated as follows:

Portfolio value after rebasing changes = Portfolio value before rebasing changes

$$\sum_{i=1..n} K'_t w'_{i,t} p_{i,t} D_{i,t} + C'_t = \sum_{i=1...n} K_t w_{i,t} p_{i,t} D_{i,t} + C_t$$

$$K'_t = \begin{cases} \dfrac{B_t + R_t}{\left(\sum_i w_{i,t} p_{i,t} D_{i,t}\right)} & If\ only\ reinvestment \\ \dfrac{B_t + R_t}{\left(\sum_i w'_{i,t} p_{i,t} D_{i,t}\right)} & If\ reweighting\ and\ or\ reconstitution \end{cases}$$

Where:

K'_t is the new k-factor, applicable from time t;

$w'_{i,t}$ is the new notional weight (face value) of bond i after rebasing, applicable from time t;

C'_t is the new value of the ex-coupon portion after rebasing, applicable from time t.

Other notation as before.

7.9 Total Return Index

The Total Return Index value of the Index Portfolio at the close of day t is given by:

$$Z_t = B_t + C_t$$

Index levels are calculated every day, including weekends and holidays. When calculating Total Return Index values on non-business days, t moves forward but s remains as at the preceding business day.

7.10 Clean Price Index

The price index is a representation of the capital value of the bond portfolio without regard for the interest accrued or coupons paid. This index is "clean" and is calculated as follows:

$$I_t^C = \frac{K_t^C \sum_{i=1..n} T0CP_{i,t} \times w_{i,t}}{\sum_{i=1..n} w_{i,t}}$$

Where:

I_t^C is the value of the Clean Price Index at time t;

$T0CP_{i,t}$ is the clean price for $t + 0$ settlement at time t

K_t^C is the constant chosen to base the index at the published starting value as on the starting date of the index. This "k-factor" changes whenever index constituents or weightings change so that the index level is continuous. Thus, the new constant k' is calculated such that $I_t^C = I'^C_t$. Note that each index has a distinct k-factor and that the K_t^C used in the Clean Price Index is not the same as the K_t used in the Total Return Index;

Other notation as before.

7.11 All-In Price Index

The all-in (dirty) price index is identical to the Clean Price Index, save for the fact that the all-in price is used. This should reflect performance similar to that of a bond portfolio which does not reinvest its coupons but rather pays them out to the investor:

$$I_t^A = \frac{K_t^A \sum_{i=1..n} T0P_{i,t} \times w_{i,t}}{\sum_{i=1..n} w_{i,t}}$$

Where:

I_t^A is the value of the All-in Price Index at time t;

$T0P_{i,t}$ is the all-in (dirty) price for settlement at time t (the T+0 price) per R100 nominal value of constituent i at time t

K_t^A is the constant chosen to base the index at the published starting value as on the starting date of the index. This "k-factor" changes whenever index constituents or weightings change so that the index level is continuous. Thus, the new constant k' is calculated such that $I_t^A = I'^A_t$. Note that each index has a distinct k-factor and that the K_t^A used in the All-In Price Index is not the same as the K_t or K_t^C used in the Total Return or Clean Price Indexes;

Other notation as before.

7.12 Coupon Yield

The coupon yield provides a running yield estimate and is defined as the annual interest yield on the price index (i.e. the interest receivable over a full year divided by the market capitalisation).

For fixed-rate indexes:

$$CpnYld_{idx,t} = \frac{\sum_{i=1..n} ACpnR_{i,t} \times w_{i,t}}{\sum_{i=1..n} T0CP_{i,t} \times w_{i,t}}$$

For inflation-linked indexes:

$$CpnYld_{idx,t} = \frac{\sum_{i=1..n} ACpnR_{i,t} \times T0CP_{i,t} \times w_{i,t}}{\sum_{i=1..n} T0CP_{i,t} \times w_{i,t}}$$

Where:

$CpnYld_{idx,t}$ is the coupon yield of the index on transaction day t;

$ACpnR_{i,t}$ is the annual coupon rate of bond i on transaction day t. For fixed rate bonds it is the nominal coupon rate, whereas for inflation-linked bonds it is the real coupon rate.

$T0CP_{i,t}$ is the clean price with a settlement of $t + 0$ of bond i on transaction day t.

Other notation as before.

7.13 Modified Duration

This is given by:

$$MD_t = \sum_{i=1..n} (N'_{i,t} \times P_{i,t} \times D_{i,t}) \times \frac{\left\{ dMod_{i,t} + \frac{H_{i,t}}{2(1 + \frac{Y_{i,t}}{200})} \right\}}{Z_t}$$

Where:

MD_t is the modified duration of the index at time t;

$dMod_{i,t}$ is the modified duration of bond i at time t;

$N'_{i,t}$ is the nominal amount of bond i in the portfolio at time t, once any rebasing for the day has been applied;

Other notation as before.

7.14 Convexity

This is given by:

$$IConv_t = \sum_{i=1..n} (N'_{i,t} \times P_{i,t} \times D_{i,t}) \times \frac{\left\{ Conv_{i,t} + \frac{H_{i,t} \times dMod_{i,t}}{(1 + \frac{Y_{i,t}}{200})} + \frac{H_{i,t} \times (2H_{i,t} + 1)}{4(1 + \frac{Y_{i,t}}{200})^2} \right\}}{Z_t}$$

Where:

$IConv_t$ is the convexity of the index at time t;

$Conv_{i,t}$ is the convexity of bond i at time t;

Other notation as before.

7.15 Average Index Yield

The calculation of index yield at time t, IY_t, is shown below. This is the yield that when used to value every bond in the index, produces the same index level.

$$IY_t = \frac{\sum_i Y_{i,t} \times P_{i,t} \times w_{i,t} \times ModDur_{i,t}}{\sum_i P_{i,t} \times w_{i,t} \times ModDur_{i,t}}$$

Notation as before.

7.16 Constituent Contribution Calculations

To calculate the contribution of the bond, the opening value of the ex-coupon on the first day of the ex-coupon period is calculated and then subtracted from the opening bond portion. The formula for the opening ex-coupon and bond portions, and the respective contributions are shown below.

Bond Portion

The opening bond portion, $B'_{i,t}$, of the current transaction day t is calculated using the following formula:

$$B'_{i,t} = N_{i,t} \times P_{i,t-1} \times D_{i,t-1}$$

Notation as before.

Ex-Coupon Value

The opening ex-coupon value, $V'_{i,t}$, to determine the bond contribution to the Total Return Index is calculated for the current transaction day t using the following formula:

For fixed-rate bonds:

$$V'_{i,t} = X_{i,t} \times D_{i,t-1} \times \left(\frac{1}{1 + \frac{Y_{i,t-1}}{200}} \right)^{\frac{max(c_{i,t}-(s-1),0)}{c_{i,t}-\bar{c}_{i,t}}}$$

For inflation-linked bonds:

$$V'_{i,t} = X_{i,t} \times D_{i,t-1} \times \left(\frac{1}{1 + \frac{Y_{i,t-1}}{200}} \right)^{\frac{max\,(c_{i,t}-(s-1),0)}{c_{i,t}-\bar{c}_{i,t}}} \times \frac{CPI_{i,s-1}}{CPI_{i,c_{i,t-1}}}$$

Where:

$V'_{i,t}$ is the opening ex-coupon value of bond i as at open on the current transaction day t.

$Y_{i,t-1}$ is the yield to maturity of bond i on the previous transaction day $t-1$.

All other notation as before.

Bond Contribution

To calculate the contribution of individual bonds in the index portfolio to the Total Return Index performance, the opening bond portion and ex-coupon values are used as input to the bond and cash portion contributions respectively.

The bond portion contribution is calculated using the following formula:

$$BondContrib_{i,t} = B_{i,t} - B'_{i,t}$$

The cash portion contribution is calculated using the following formula:

$$CashContrib_{i,t} = V_{i,t} - V'_{i,t}$$

All other notation as before.

Appendix A: Further Information

Further information on the FTSE/JSE Fixed Income Index Series is available from FTSE Russell.

For contact details please visit the FTSE Russell website or contact FTSE Russell client services at info@ftserussell.com.

Website: www.ftserussell.com.

For JSE enquiries, please contact indices@jse.co.za.

Website: www. jse.co.za