

CURVES MANUAL

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1 GENERAL PROVISIONS

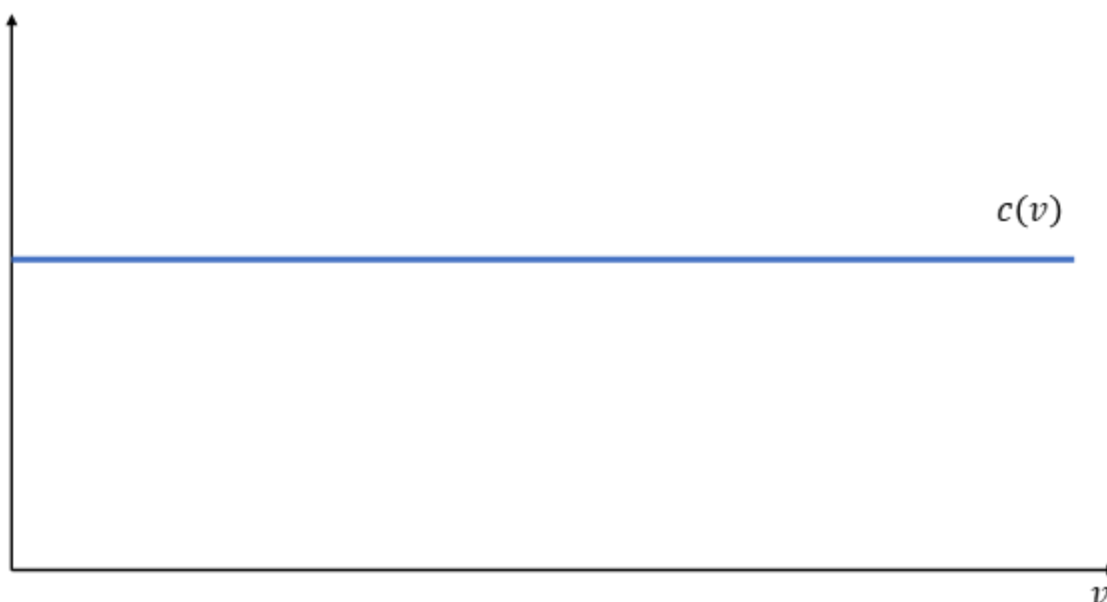
In this Manual, methodologies for the construction of fixed-term structure curves of various economic indicators and financial assets constructed and published by B3 are presented.

To help facilitate comprehension and understanding, each curve is defined individually, what are its numerical characteristics (rate or value, rounded or truncated, number of decimal places, etc.), as well as what is the type of structure (format) of the curve and what are the inputs used.

1.1 Structures

The term structure construction can be classified into five distinct categories relating to its *curvature* trend and construction model: (1) Flat, (2) Additive, (3) Multiplicative, (4) Simple Construction or (5) Complex Construction.

1.1.1 Structure Type 1: Flat



A curve $c(v)$, with a *flat* structure (1), has a constant value for all vertices, v , on the date, t . This value can be fixed or variable for each date, t . Its structure is given by:

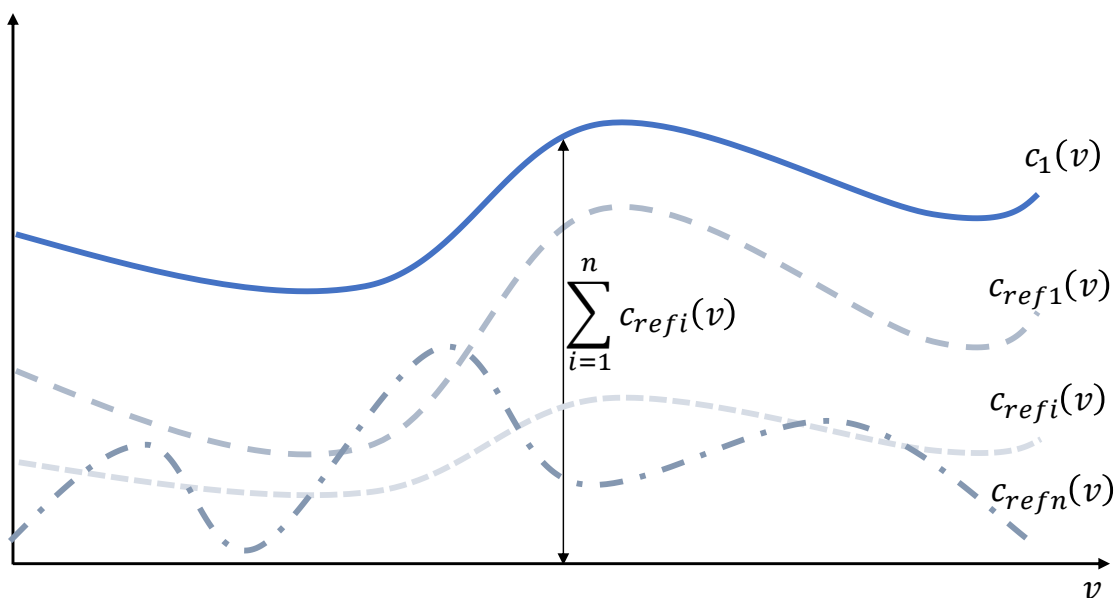
$$c(v)_t = k$$

In which:

$c(v)_t$: the curve on the date t .

k : value corresponding to an economic indicator, the result of a calculation, or a fixed constant for all t .

1.1.2 Structure Type 2: Additive



A Curve $c_1(v)$ with additive structure (2) on date t is constructed from additive operations (addition or subtraction) from other reference curves $c_{refi}(v)$. Since, each curve i can be of a date t_i different or equal to t , its structure is given by the sum of the n curves, according to the equation:

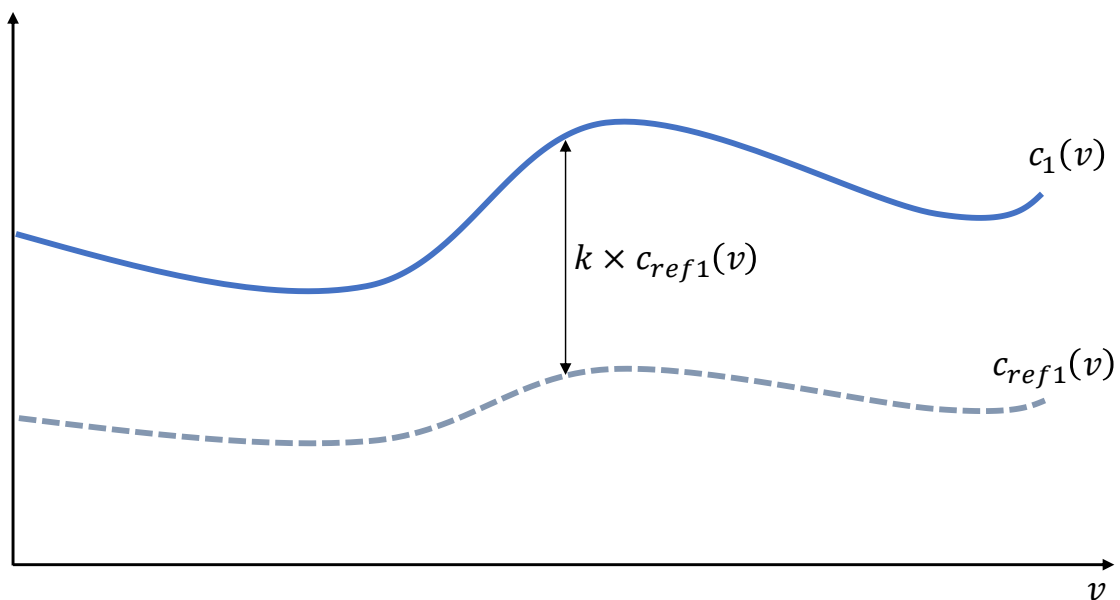
$$c(v)_t = \sum_{i=1}^n c_{refi}(v)_{t_i}$$

Where:

$c(v)_t$: the curve at date t .

$c_{refi}(v)_{t_i}$: referential curve i on date t_i .

1.1.3 Structure Type 3: Multiplicative



A curve $c_1(v)$ with multiplicative structure (3) at date t is constructed from multiplicative operations (multiplication or division) between a value k and a reference curve $c_{ref1}(v)$. Since, each curve i can be of a date t_i different or equal to t , its structure is given by the sum of the n curves, according to the equation:

$$c(v)_t = k^\alpha \times (c_{ref1}(v)_{t_1})^\beta, \alpha, \beta \in \{-1, +1\}$$

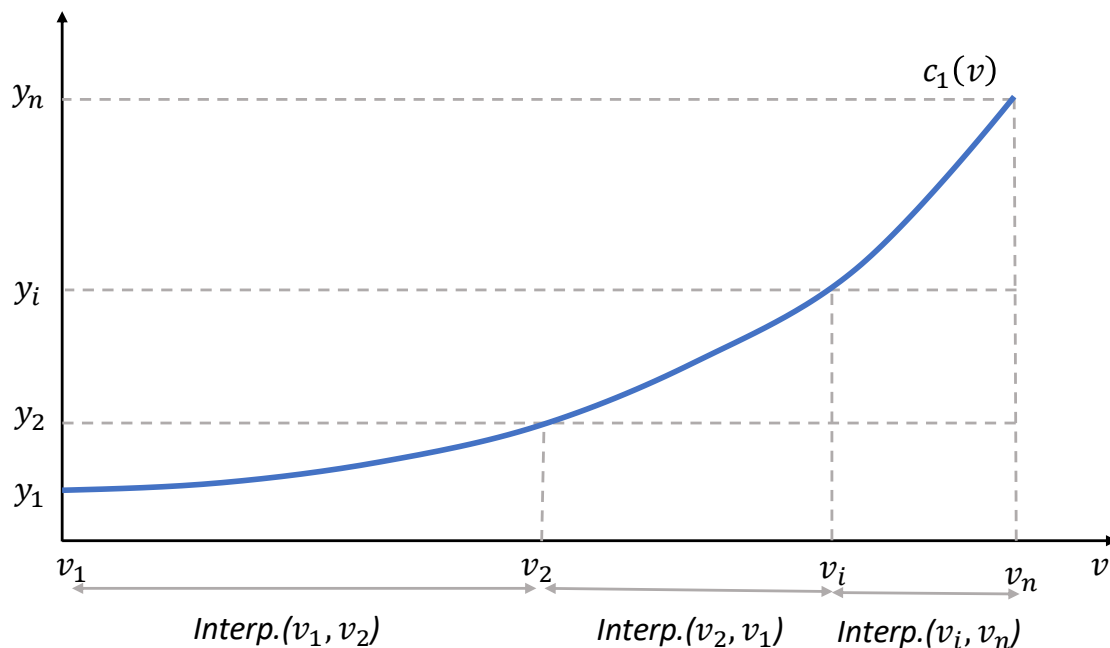
Where:

$c(v)_t$: the curve on date t .

k : value corresponding to an economic indicator, result of a calculation, or a fixed constant for every t .

$c_{ref1}(v)_{t_1}$: reference curve at date t_1 .

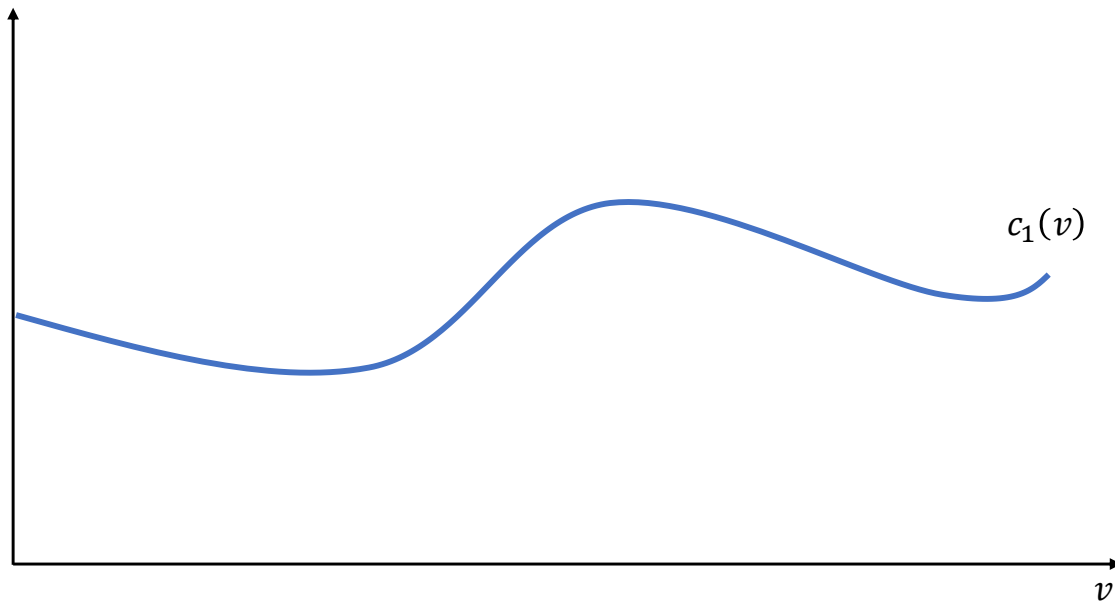
1.1.4 Structure Type 4: simple construction



A curve $c_1(v)$ with a simple structure (4) at time t is built from a template or simple interpolation calculation on the entire curve. The values y_i used in the

interpolation calculation can come from different sources, such as futures contract expirations, economic indicators, a curve $c_i(v)$, result of a calculation, or some constant value.

1.1.5 Structure Type 5: Complex Construction



A curve $c_1(v)$ with a complex structure (5) on date t is built from a variety of structures and/or rules along the vertices v of the curve and may also have different interpolation models along the curve. The values y_i used in the interpolation(s) can come from different sources, such as futures contract expirations, economic indicators, a curve $c_i(v)$, result of a calculation, or some constant value.

1.2 Vertices

Vertices are common to all curves – *standardized vertices*. Their values are defined in pairs $(DC, DU) = (\text{Calendar days}, \text{Business days})$. Business days are based on the market holiday calendar published by ANBIMA. Vertices are defined from fixed vertices and mobile vertices. How values are defined for each vertex can vary within the same curve. Finally, all curves have final values for standardized vertices.

1.3 Values

Curve values can be expressed in price or rate and can be rounded or truncated.

1.4 Interpolation Functions

Below is a list of standard interpolation formulas that can be used repeatedly along curves. Some particular equations used for a specific curve will be defined within the description of the curve calculation model.

1.4.1 Exponential Interpolation 252

$$\left(\left(1 + \frac{i_{previous}}{100} \right) * \left(\frac{\left(1 + \frac{i_{later}}{100} \right)^{\left(\frac{DU_{later} - DU_{previous}}{DU_{later} - DU_{previous}} \right)}}{\left(1 + \frac{i_{previous}}{100} \right)} \right) - 1 \right) * 100$$

1.4.2 Interpolation Flat Forward 252

$$\left(\left(\left(1 + \frac{I_{above}}{100} \right)^{\frac{DU_{previous}}{252}} * \left(\frac{\left(1 + \frac{i_{later}}{100} \right)^{\left(\frac{DU_{later}}{252} \right)}}{\left(1 + \frac{i_{previous}}{100} \right)^{\left(\frac{DU_{previous}}{252} \right)}} \right)^{\left(\frac{DU - DU_{previous}}{DU_{later} - DU_{previous}} \right)^{\left(\frac{252}{DU} \right)}} - 1 \right) * 100$$

1.4.3 Interpolation *Flat Forward 252* with Linear Convention

$$\left(\left(\left(1 + i_{previous} * \frac{DC_{previous}}{36000} \right) * \left(\frac{\left(1 + i_{later} * \frac{DC_{later}}{36000} \right)^{\frac{DU - DU_{previous}}{DU_{later} - DU_{previous}}}}{\left(1 + i_{previous} * \frac{DC_{previous}}{36000} \right)} \right) - 1 \right) * \frac{36\,000}{DC} \right)$$

1.4.4 Interpolation360

$$\left(\left(\left(1 + \frac{I_{above}}{100} \right)^{\frac{DC_{above}}{360}} * \left(\frac{\left(1 + \frac{i_{subsequent}}{100} \right)^{\frac{DC_{later}}{360}}}{\left(1 + \frac{i_{previous}}{100} \right)^{\frac{DC_{previous}}{360}}} \right)^{\frac{DC - DC_{previous}}{DC_{later} - DC_{previous}}} \left(\frac{360}{AD} \right) \right) - 1 \right) * 100$$

1.4.5 Price Interpolation

$$P_{previous} * \left(\left(\frac{P_{later}}{P_{previous}} \right)^{\frac{DU - DU_{previous}}{DU_{later} - DU_{previous}}} \right)$$

1.4.6 Extrapolation *Flat Forward 252* (End)

$$\left(\left(\left(1 + \frac{i_{previous-1}}{100} \right)^{\frac{DU_{previous-1}}{252}} * \left(\frac{\left(1 + \frac{i_{previous}}{100} \right)^{\frac{DU_{previous}}{252}}}{\left(1 + \frac{i_{previous-1}}{100} \right)^{\frac{DU_{previous-1}}{252}}} \right)^{\frac{DU - DU_{previous-1}}{DU_{previous} - DU_{previous-1}}} \left(\frac{252}{DU} \right) \right) - 1 \right) * 100$$

1.4.7 Extrapolation *Flat Forward 252 (Start)*

$$\left(\left(\left(1 + \frac{i_{later}}{100} \right)^{\frac{DU_{later}}{252}} * \left(\frac{\left(1 + \frac{i_{later+1}}{100} \right)^{\left(\frac{DU_{later+1}}{252} \right)}}{\left(1 + \frac{i_{later}}{100} \right)^{\left(\frac{DU_{later}}{252} \right)}} \right)^{\left(\frac{DU - DU_{later}}{DU_{later+1} - DU_{later}} \right)^{\left(\frac{252}{DU} \right)}} - 1 \right) * 100$$

1.4.8 Extrapolation *Flat (End)*

$$i_{DU} = i_{previous}$$

1.4.9 Extrapolation *Flat (Start)*

$$i_{DU} = i_{later}$$

1.4.10 Extrapolation *Flat Forward 252 with Linear Convention (End)*

$$\left(\left(\left(1 + i_{previous-1} * \frac{DC_{previous-1}}{36000} \right) * \left(\frac{\left(1 + i_{previous} * \frac{DC_{previous}}{36000} \right)^{\frac{DU - DU_{previous-1}}{DU_{previous} - DU_{previous-1}}}}{\left(1 + i_{previous-1} * \frac{DC_{previous-1}}{36000} \right)} \right) - 1 \right) * \frac{36000}{DC}$$

2 Local Interest Rate Curves

2.1 Curve DI X PRE (PRE)

Definition

The DI X PRE curve represents an interest rate curve constructed from the settlement prices for the expirations of the Average One-Day Interbank Deposit Rate Futures Contract (DI1) traded at B3.

Values

Rate in % per annum. The percentage rounded to the 3rd decimal place.

Structure

Type 4– Simple Construction

Inputs

- Tx_{Juro} : CDI benchmark rate on day t . Source: B3.
- Tx_{DI1} : Settlement rate of the One-Day Average Rate Interbank Deposit Futures Contract (DI1) on day t . Source: B3

Calculation

- **Vertex 1**: Value of the CDI benchmark rate on day t .
- **Non-interpolated**: settlement rate Tx_{DI1} vertices of each expiration corresponding to the vertex of the curve.
- **Interpolated vertices**: values calculated using the interpolation function 1.4.2 interpolation *Flat Forward 252*.
- **After the last non-interpolated vertex**: 1.4.2. Interpolation *Flat Forward 252*, considering the previous vertex the penultimate vertex of DI1 not interpolated and the next vertex the last vertex of DI1 not interpolated.
- **Interpolation Base**: 252 (business days).

2.2 SELIC x PRE-Curve (SLP)

Definition

The SELIC x PRE curve represents an interest rate curve constructed from the settlement prices for the expirations of the One-Day Repurchase Exchange Rate Futures Contract (OC1) traded at B3.

Values

Rate in % per annum. The percentage rounded to the 3rd decimal place.

Structure

Type 4– Simple Construction

Inputs

- Tx_{Juro} : CDI benchmark rate on day t . Source: B3.
- Tx_{DI1} : Settlement rate of the One-Day Average Rate Interbank Deposit spread Futures Contract (OC1) of day t . Source: B3

Calculation

- **Vertex 1**: Selic rate value on day t .
- **Non-interpolated**: settlement rate Tx_{DI1} vertices of each expiration corresponding to the vertex of the curve.
- **Interpolated vertices**: values calculated using the interpolation function 1.4.2 interpolation *Flat Forward* 252.
- **After the last non-interpolated vertex**: 1.4.2. Interpolation *Flat Forward* 252, considering the previous vertex the penultimate vertex of OC1 not interpolated and the next vertex the last vertex of OC1 not interpolated.
- **Interpolation Base**: 252 (business days).

2.3 TJLP x PRE curve (TJP)

Definition

The TJLP x PRE curve represents the Long-Term Interest Rate.

Values

Rate in % per annum, rounded to the 2nd decimal place.

Structure

Type 1– Flat

Inputs

- TJLP value on day t . Source: BACEN.

Calculation

- All vertices: Value of TJLP on day t .

2.4 TBF x PRE curve (TFP)

Definition

The TBF x PRE curve represents the TBF spread curve.

Values

Rate in % per annum, rounded to the 2nd decimal place.

Structure

Type 4– Simple.

Inputs

- DI X PRE Curve. Source: B3. (item 2.1)
- TBF Rate (Basic Financial Rate). Source: BACEN.

Calculation

To determine the TBF X PRE curve, we need to calculate the TBF factor, as described below:

- Calculation of the TBF factor:

$$TBF_{factor_t} = \frac{\left(\left(\left(1 + \frac{TBF_t}{100} \right)^{\frac{DU_{30}}{DU_{month}}} \right) - 1 \right) * 100}{\left(\left(\left(1 + \frac{PRE_{30}}{100} \right)^{\frac{DU}{252}} \right) - 1 \right) * 100}$$

- TBF_{factor_t} = TBF factor calculated on date t.
- TBF_t = TBF rate on date t.
- PRE_{30} = value of vertex 30 of the curve DI X PRE on date t (item 2.1).
- DU_{30} = business days corresponding to vertex 30 of the curve DI X PRE on date t;

- DU_{month} = business days corresponding to exactly the same day in the following month,
- DU = business days between the calculation date and date t .

After calculating the factor, it is necessary to extract the average of the five business days prior to the calculation date (exclusive).

Calculation of the mean of the TBF factor:

$$\text{Mean } TBF_{factor_t} \left(TBF_{factor_{t-1}}; TBF_{factor_{t-2}}; TBF_{factor_{t-3}}; TBF_{factor_{t-4}}; TBF_{factor_{t-5}} \right)$$

- $TBF_{factor_{t-1}}$ = TBF factor corresponding to 1 business day prior to the calculation date t .
- $TBF_{factor_{t-2}}$ = TBF factor corresponding to 2 business days prior to the calculation date t .
- $TBF_{factor_{t-3}}$ = TBF factor corresponding to 3 business days prior to the calculation date t .
- $TBF_{factor_{t-4}}$ = TBF factor corresponding to 4 business days prior to the calculation date t .
- $TBF_{factor_{t-5}}$ = TBF factor corresponding to 5 business days prior to the calculation date t .

Once the average of the TBF factor for the last five business days is calculated, the TFP curve can be calculated:

- **Curve calculation:**

$$TFP_{i,t} = \left[\left(\left(\left(1 + \frac{PRE_{i+21,t}}{100} \right)^{\frac{21}{252}} - 1 \right) * MeanTBF_{factor_t} + 1 \right)^{\frac{252}{21}} - 1 \right] * 100$$

- $TFP_{i,t}$ = vertex i of the TBF X PRE curve on the calculation date t .
- $PRE_{i,t}$ = value of the curve DI X PRE of the business day i on the calculation date t (item 2.1).
- $MeanTBF_{factor_t}$ = mean value of the TBF factors for the last five business days immediately preceding the calculation date t .

2.5 TR x PRE curve (TP)

Definition

The TR x PRE curve represents the TR factor curve.

Values

Rate in % per annum, rounded to the 2nd decimal place.

Structure

Type 4– Simple.

Inputs

- TBF x PRE curve. Source: B3 (item 2.4).
- Reducer indicator. Source: BACEN.

Calculation

$$TP_{i,t} = \left[\left(\frac{\left(1 + \frac{TFP_{i,t}}{100}\right)^{\frac{1}{12}}}{\left(\left(\left(\left(1 + \frac{TFP_{i,t}}{100}\right)^{\frac{1}{12}} - 1 \right) * b_{TFP_t} \right) + a_{TFP_t} \right)} \right)^{12} - 1 \right] * 100$$

When the value of any vertex is **less than or equal to 0**, we change the respective value to 0.01.

- $TP_{i,t}$ (% per annum) = vertex i of the curve TR x PRE on the calculation date t .
- $TFP_{i,t}$ (% per annum) = vertex i of the curve TBF x PRE corresponding to the calculation date t (item 2.4).
- Factors " $a_{TFP_{i,t}}$ " and " $b_{TFP_{i,t}}$ " defined based on CMN Resolution N^o 5,124 (Bacen).

The values of factors " $a_{TFP_{i,t}}$ " and " $b_{TFP_{i,t}}$ " vary according to the following $TFP_{i,t}^{p.m.}$ (% per month) value ranges:

$TFP_{i,t}^{p.m.}$	$a_{TFP_{i,t}}$	$b_{TFP_{i,t}}$
$TFP_{i,t}^{p.m.} \geq 1,3134\%$	1,00500000	0,48000000
$0,9856\% \leq TFP_{i,t}^{p.m.} < 1,3134\%$	0,99869130	0,96034591
$0,8462\% \leq TFP_{i,t}^{p.m.} < 0,9856\%$	1,00500000	0,32000000
$0,7323\% \leq TFP_{i,t}^{p.m.} < 0,8462\%$	1,00010877	0,89838243
$TFP_{i,t}^{p.m.} \leq 0,7323\%$	1,00500000	0,23000000

Being $TFP_{i,t}^{p.m.}$ the TFP curve rate for the same vertex i and same calculation date t converted to per month percentage rate ($p.m.$), expressed as:

$$TFP_{i,t}^{p.m.} = \left(\left(1 + \frac{TFP_{i,t}}{100} \right)^{\frac{1}{12}} - 1 \right) \times 100$$

2.6 DI x TR curve (TR)

Definition

The DI x TR curve represents the TR spread.

Values

Rate in % per annum, rounded to the 3rd decimal place.

Structure

Type 4– Simple.

Inputs

- DI X PRE curve. Source: B3 (item 2.1).
- TR x PRE curve. Source: B3 (item 2.5).

Calculation

- All vertices

$$TR_t = \left[\frac{\left[1 + \left(\frac{PRE_t}{100} \right) \right]}{\left[1 + \left(\frac{TP_t}{100} \right) \right]} - 1 \right] * 100$$

- $TR_t =$ DI X TR curve on calculation date t.

- PRE_t = vertex of the DI X PRE curve on the calculation date t, curve PRE (item 2.1).
- TP_t = vertex of the TR X PRE curve on the calculation date t (item 2.5).

3 Inflation Curves

3.1 DI X IPCA: Dirty Spread: the “Dirty Spread” as it’s called domestically (DIC).

Definition

The DI X IPCA (DIC) curve represents the term structure curve of the dirty spread of IPCA. Which is constructed from the term structure of the IPCA dirty spread rate calculated from the implicit inflation in the dirty spread values obtained by collecting data points.

Values

The value is expressed as a percentage rate per annum, rounded to 2 decimal places.

Structure

Type 4– Simple Construction

Inputs

- IPCA dissemination calendar of the Brazilian Institute of Geography and Statistics (IBGE).
- *Cparticipants*: DI x IPCA dirty spread for different periods obtained by collecting data points.
- *PRE*: PRE curve (item 2.1).

Calculation

The first step is to determine the vertices i references for calculating the intermediate curve of DI x IPCA. The vertices are defined by the following criteria:

1. First business day of each month.
2. Last business day of each month.
3. 15th business day of each month – adjusted for the next business day, if necessary.
4. 30 calendar day multiples (30, 60, 90, ...).
5. IPCA index official disclosure dates as defined by IBGE.
6. Limit: 5,580 calendar days.

Therefore, the index (k_i) is calculated using the expected number of IPCA disclosures by IBGE up to the date corresponding to vertex i . Thus, each vertex i will be associated with an index k_i .

The calculation has two steps. First, an inflation expectation curve (IPCA) is calculated implicitly from the informed spread rates. Once the expectation is calculated, the intermediate spread curve for all vertices is calculated. Next, using the intermediate curve, the final curve is calculated for all standardized vertices.

Market Participant Spread:

Rules of the participants pool receipt vertices

1. rates corresponding to the first business day of the month (up to twelve months).
2. Then, month to month until the Swap Agreement deadline (5,580 calendar days).

If there are participants who meet the vertices rule, calculate the median of the informed spread values (*cpInformantes*) for all vertices i in which there was information on the calculation date t .

If $CpInformantes_{i,t} \neq \emptyset \rightarrow MedCpInfo_{i,t} = median(cpInformantes_{i,t})$

Then, do the same for index k_i , for the vertices in which there was information.

$$CpInfo_{k_i,t} = MedCpInfo_{i,t}$$

Finally, if there is $CpInfo_{k_i,t} = \emptyset$ for $i > 0$, an interpolation procedure is performed – to estimate the respective $CpInfo_{k_i,t}$ – from the indexes k_i before (k_a) and after (k_p) with information in t and one-day variations, according to Equation 2.1.1.

$$CpInfo_{k_i,t} = CpInfo_{k_i,t-1} + \Delta_a + \frac{\Delta_p - \Delta_a}{k_p - k_a} \quad (3.1.1)$$

Where:

$$\Delta_a = CpInfo_{k_a,t} - CpInfo_{k_a,t-1}$$

$$\Delta_p = CpInfo_{k_p,t} - CpInfo_{k_p,t-1}$$

Inflation expectation

Defined as $CpInfo_{k_i,t}$, for all vertices, the next step is to calculate the inflation expectation implied in the spread, $E(IPCA)_i$, for every vertex i in which there is information according to Equation 2.1.2.

$$E(IPCA)_{i,t} = Round \left(\frac{\left(1 + \frac{PRE_{i,t}}{100}\right)^{\frac{DU_{i,t}}{252}}}{\left(1 + \frac{CpInfo_{k_i,t}}{100}\right)^{\frac{DU_{i,t}}{252}}} \times 100; 2 \right) \quad (3.1.2)$$

Next, construct the implied inflation curve for the indices k_i so as to cover all vertices i . Considering the following situations:

1. If $k_i = 0 \rightarrow E(IPCA)_{k_i,t} = 0$
2. If $E(IPCA)_{i,t} \neq \emptyset \rightarrow E(IPCA)_{k_i,t} = E(IPCA)_{i,t}$

If there are any $E(IPCA)_{k_i} = \emptyset$, being, that there was no information for any vertex i contained in k_i , then a create a spread estimate for k_i from the pool of participants, according to Equation 3.1.1.

Spread Calculation

Once an implicit inflation curve with valid values for all indexes k_i is obtained, the intermediate IPCA “dirty spread” curve is calculated, for each vertex, according to Equation 3.1.3.

$$Cp_{i,t} = Round \left(\left(\frac{\left(1 + \frac{PRE_{i,t}}{100} \right)^{\frac{DU_{i,t}}{252}}}{\left(1 + \frac{E(IPCA)_{k_i,t}}{100} \right)^{\frac{252}{DU_{i,t}}}} - 1 \right) \times 100; 2 \right) \quad (3.1.3)$$

Final curve of DI x IPCA (DIC)

The final curve of DI x IPCA (DIC) is formed by the standardized vertices (used for all curves). For vertices not contained in the intermediate curve, the IPCA spread is calculated by interpolating the intermediate curve using the formula `Interpolation252Year`.

3.2 DI X IPCA: Clean ID (DPL): The “Clean Spread” as it's known domestically.

Definition

The DI X IPCA (DPL) represents the term structure curve of the IPCA clean spread. Which is constructed from the term structure of the IPCA spread futures contract (DAP) rate calculated from the contract trades and the implicit inflation in the NTN-Bs.

Values

The value is expressed as a percentage rate per annum, rounded to 2 decimal places.

Structure

Type 5– Complex Construction

Inputs

- $IPCA_{ofM}$: official inflation index number for month M . Source IBGE.
- $IPCA_{preview}$: preview of inflation. Source ANBIMA.
- $IPCA_{2nd\ preview}$: preview of inflation for the following month. Source ANBIMA.
- CDI : CDI rate in % per annum. Source B3.
- $IPCA\ Focus\ Expectation$: monthly IPCA expectation, published weekly in the Focus Market Report. Source Central Bank of Brazil (BCB).
- $TaxaAnbima_{NTNB_m}$: NTN-B Indicative Rates published daily. Source ANBIMA.
- PRE : PRE curve (item 2.1).

Calculation

Vertex 1 business day

$$DPL_{0,t} = \left(\left[\frac{\left(1 + \frac{CDI}{100}\right)^{\frac{1}{252}}}{\left(1 + \frac{EIPCA_0}{100}\right)^{\frac{1}{DU_{15a,15p}}}} \right]^{252} \right) - 1$$

Where:

- $DU_{15a,15p}$: number of business days between the 15th of the month immediately preceding (15th) (exclusive) and the 15th immediately following (15p) (inclusive).
- 15a: is the 15th day of the month, immediately before the calculation date, adjusted to the next business day. If the calculation date is the actual 15th, it considers it inclusive.
- 15p: the 15th day, immediately after the calculation date, moved to the next business day if needed. If the calculation date is the corrected 15th, it considers the 15th of the next month.
- $EIPCA_0$: is the monthly variation factor of the IPCA inflation defined as.
 - a) If the IBGE's IPCA Index Number for the current reference month ($IPCAof_{M_0}$) has been released ($DtDisclosure_{15a,15p}$) and the calculation date (t) is before the 15th day of the month immediately afterwards (15p), ie $DtDisclosure_{15a,15p} \leq t < 15p$, the IPCA variation will be given by the variation between the current Index Number and the Index Number of the previous month.

$$EIPCA_0 = \left(\left(\frac{IPCAof_{M_0}}{IPCAof_{M-1}} \right) - 1 \right) \times 100$$

- 15a: is the 15th day of the month, immediately before the calculation date, adjusted to the next business day. If the calculation date is the actual 15th, it considers it inclusive.

- $15p$: the 15th day, immediately after the calculation date, moved to the next business day if needed. If the calculation date is the corrected 15th, it considers the 15th of the next month.
 - $DU_{15a,15p}$: number of business days between the 15th of the month immediately preceding ($15th$) (exclusive) and the 15th immediately following ($15p$) (inclusive).
 - $DtDisclosure_{15a,15p}$: the disclosure date of the published IBGE IPCA index number between the 15th before ($15th$) and the 15th after ($15p$): $15th \leq DtDisclosure_{15a,15p} < 15p$.
- b) Otherwise, the IPCA variation will be given by the last preview for the current reference month, published by ANBIMA

$$EIPCA_0 = IPCA_{predicted}$$

Vertices coinciding with DAP expirations

- a. If the DAP has a price formed by the closing *call* (see the Futures Pricing Manual for more details), the DPL vertex assumes the rate defined in the closing *call*, with the rate as a percentage rounded to 3 decimal places.
- b. Otherwise, the rate obtained by the Fallback DAP/IPCA Clean spread Methodology, described below. The rate $DPL_{Fallback_{n,t}}$, in percentage, is rounded to 6 decimal places.

$$DPL_{n,t} = DPL_{Fallback_{n,t}}$$

Vertices not coinciding with DAP expirations

- First, the implicit inflation in the previous vertices is calculated, that is, for the vertex n defined in the previous steps: $implicit_{n,t} = \frac{(1+Pre_{n,t})}{(1+DPL_{n,t})} - 1$.
- Then the Flat Forward 252 interpolation (item 1.4.2) is applied to obtain the remaining vertices.
- Third, and last step, the vertices of the second step are transformed back into the spread: $DPL_{n,t} = \frac{(1+Pre_{n,t})}{(1+implicit_{n,t})} - 1$ for all vertex n .

Fallback DAP/IPCA Clean Spread Methodology

For vertices coinciding with DAP expirations, the Fallback rate will be obtained by following these steps:

- For the 1st DAP expiration, if it is in the period between the IBGE official inflation disclosure date, inclusive, and the business day prior to the expiration date, the rate for the Fallback of the 1st expiration will be calculated by the following formula:

$$DPL_{Fallback_{1st DAP}} = \left(\left(\left(\left[\frac{\left(\frac{TPré_{DI1}^{1st DAP}}{100} + 1 \right)^{\frac{du}{252}}}{\left(\frac{Inflation}{100} + 1 \right)^{\frac{du}{DU_{15a,15p}}}} \right]^{\frac{252}{du}} \right) - 1 \right) * 100$$

Where:

- $DPL_{1st DAP}$ = settlement price at the rate of the first DAP expiration.
- $TPré_{DI1}^{1st DAP}$ = Pre rate for the vertex coinciding with the first DAP expiration. When the term coincides with “1 business day”, the Pre Rate will be exactly the rate *CDI* reference for the day.
- *Inflation* = rate of change in the official IPCA published by the IBGE (rate of change).

- du = business days between the calculation date (exclusive) to expiration (inclusive).
 - $DU_{15a,15p}$: number of business days between the 15th of the month immediately preceding (15th) (exclusive) and the 15th immediately following (15p) (inclusive).
- b. If it does not follow the previous step, if vertex n also coincides with NTN-B expiration, the vertex will be obtained by adding the IPCA Coupon Match ($Casado_n$), to the NTN-B rate ($NTNB_{n,t}^{Anbima}$) of the day of calculation. We describe how to get the $Casado_n$ in the topic “IPCA Coupon Match” in the sequence.

$$DPL_{Fallback_{n,t}} = NTNB_{n,t}^{Anbima} + Casado_{n,t}$$

- c. If it does not follow the previous steps, the Theoretical DPL curve of the calculation day is used and applied to the spread between the Theoretical DPL and the DAP rate calculated on the previous business day. Obtaining the theoretical DPL is described in the sequence of the DPL.

$$DPL_{Fallback_{n,t}} = DPL_{Theoretical_{n,t}} + Spread_{Theoretical_{n,t-1}}$$

Where:

$$Spread_{Theoretical_{n,t-1}} = DAP_{n,t-1} - DPL_{Theoretical_{n,t-1}}$$

The differential yield $Spread_{Theoretical_{n,t-1}}$, in percentage, to the last day of negotiation, is rounded to 4 decimal places.

IPCA Coupon Match

The “IPCA Coupon Match” ($Casado_{n,t}$) is the differential, for a given date t , between the IPCA Coupon Futures ($DAP_{n,t}$) trading rate and the NTN-B rate ($NTNB_{n,t}$), Brazilian public bonds indexed to the inflation index IPCA, for the same expiration n .

$$Casado_{n,t} = DAP_{n,t} - NTNB_{n,t}$$

The information to the “IPCA Coupon Match” ($Casado_{n,t}$), will be captured through a Pool of Informants, collected on the same calculation date. For more information, see the methodology of the futures pricing model for the IPCA Coupon (DAP) in the **B3 Pricing Manual - Futures**, in chapter 1.8, in the description of the model for P3 (step 3), and in its validation parameters (parameters **Minimum Number of Informants** and **Trading Volume**) contained in “Table 6” of the **Monthly Parameters Annex - Futures**.

When the information meets the above parameters, it will be consolidated by maturity, using the average of each informant i among the M informants.

$$Casado_{n,t} = \frac{\sum_{i=1}^M Casado_{n,t}^i}{M}$$

In the event that only some maturities meet the above parameters (**updated maturities** $Casado_i$), and other maturities do not meet (**non-updated maturities** $Casado_n$), the non-updated maturities ($Casado_n$) will be obtained from the maturities updated ($Casado_i$), considering:

- the Flat Forward interpolation 252 (see *Chapter 1.4.2* of the **General Provisions** Chapter of this manual), in case there is a $Casado_i$ with maturity term DU_i on business days shorter than the interpolated maturity term DU_n in working days, **AND** information $Casado_j$ with maturity term DU_j in working days greater than the interpolated maturity term DU_n in working days, both obtained with information collected according to the parameters above. Both $Casado_i$ and $Casado_j$, to be used, will be the closest in term, before and after $Casado_n$:
- otherwise, the Flat Extrapolation will be used (see *Chapter 1.4.8* and *1.4.9* of the **General Provisions** Chapter of this manual), with the repetition of $Casado_i$, with the maturity term to $Casado_n$, and obtained with the information collected according to the above parameters, with earlier or later maturity, according to the case.

If no maturity meets the parameters, the value of the “IPCA Coupon Match” will be considered the one obtained at the close of the future DAP on the previous day ($Casado_{n,t-1}^{B3}$):

$$Casado_{n,t} = Casado_{n,t-1}^{B3} = DAP_{n,t-1}^{FINAL} - NTN B_{n,t-1}^{Anbima}$$

Where:

$DAP_{n,t-1}^{FINAL}$ is the final settlement of the future DAP contract, obtained at the close of the previous trading day;

$NTNB_{n,t-1}^{Anbima}$ is the government bond rate indexed for inflation index IPCA, obtained at the close of the previous trading day, and published by Anbima.

The differential rate $Casado_{n,t-1}^{B3}$, in percentage, for the previous day, is rounded to 4 decimal places.

Theoretical DPL

a. Vertex for less than 2 years (inclusive):

$$DPL_{Theoretical_{n,t}} = \left(\frac{\left(1 + TPré_{DI1}^n / 100\right)^{\frac{DU_n}{252}}}{\left(1 + Waiver_{NTNB_m} / 100\right)^{\frac{DU_n}{252}} (IPCAFactor_n)} \right)^{\frac{252}{DU_n}} - 1$$

Where:

- n : index corresponding to the expirations of the IPCA spread Futures Contract up to a period of 2 years (inclusive).
- $DPL_{Theoretical_{n,t}}$: IPCA spread extracted from the prices of NTN-Bs for the n th contract month of the IPCA spread Futures Contract.

- $TPré_{DI1}^n$: fixed rate for the term of the nth month of the IPCA Spread Futures Contract, calculated through the exponential interpolation of the PRE curve (item 2.1).
 - $IPCFACTOR_n$: factor corresponding to the monthly IPCA accumulated between the calculation date and the expiration date of the nth contract month of the IPCA Spread Futures Contract, according to the calculation described in the section below “Factor IPCA Monthly Focus/ANBIMA”.
 - DU_n : number of withdrawal days between the calculation date and the expiration date of the nth contract month of the IPCA Spread Futures Contract.
 - $Waiver_{NTNB_m}$: waiver, on an annual basis, between (i) the implicit inflation in the price of the m -th NTN-B expiration (not defined differently for each n vertex, but for each maturity m of NTNBS) and (ii) the market expectation for the IPCA. Premium calculation will be detailed in the section below “NTNB Premium Calculation”. The determination of the NTNBS index m whose premium will be used will be such that:
 - DU_m business days of the NTNBS maturity, whether the term is strictly bigger than DU_n ;
 - When the term DU_n of the vertex is greater than the term DU_M of the highest maturity of $NTNB_M$, such that DU_M is less than 2 years, the waiver to be used in the formula will be the M -th NTNBS.
- b. The remaining vertices are calculated by Flat Forward 252 interpolation (item 1.4.2) and Flat Forward 252 extrapolations (item 1.4.6 and 1.4.7)

The final rate ($DPL_{Theoretical_{n,t}}$), in percentage, is rounded to 7 decimal places.

NTNB Premium Calculation

The waiver, on an annual basis, between the implicit inflation in the price of the M-th of the NTN- B and the market expectation for the IPCA (calculated in the section below “Monthly IPCA Focus/ANBIMA Factor”), is obtained by the following formula:

$$Waiver_{NTNB_m} = \left(\left(\left[\frac{\left(1 + \frac{TPre_{DI1}^m}{100}\right)^{\frac{DU_m}{252}}}{\left(1 + \frac{RateAnbima_{NTNB_m}}{100}\right)^{\frac{DU_m}{252}} * FactorIPCA_m} \right]^{\frac{252}{DU}} \right)^{m-1} \right) * 100$$

Where:

- $Waiver_{NTNB_m}$: waiver on even inflation of M-th NTN-B expiration, published by ANBIMA.
- $RateAnbima_{NTNB_m}$: Indicative rate (spread) of the M-th NTNB expiration, published by ANBIMA.
- $FactorIPCA_m$: Factor corresponding to the accumulated monthly IPCA between the calculation date and the expiration date of the M-th NTN-B expiration, calculated according to the section below “Monthly Focus/ANBIMA IPCA Factor”.
- DU_m : number of withdrawal days between the calculation date (exclusive) and the date of the M-th NTN-B expiration.
- $TPre_{DI1}^m$: prefixed rate for the term of the m-th maturity of NTN-B, calculated by means of the exponential interpolation curve PRE (item 2.1).

IPCA Monthly Focus/ANBIMA

The IPCA Expectation Factor Accumulated monthly will be calculated by the following formula for each month m :

- a. If $m = 0$, that is, for the calculation of the factor considering the expiration of the next 15th day after the calculation date (15p):

$$FatorIPCA_0 = \left(1 + \frac{EIPCA_0}{100}\right)^{\frac{DU_{t,15p}}{DU_{15a,15p}}}$$

- b. If $m \geq 1$, that is, for the calculation of the factor considering the expirations in the following 15th days of next months, up to last month IPCA expectation released by Focus/BACEN:

$$FatorIPCA_m = \left(1 + \frac{EIPCA_0}{100}\right)^{\frac{DU_{t,15p}}{DU_{15a,15p}}} \times \prod_{i=1}^m \left(1 + \frac{EIPCA_i}{100}\right)$$

Where:

- m : is the integer number and represents the number of full months between the calculation date and the expiration to be calculated;
- $EIPCA_0$: IPCA projection released by ANBIMA or inflation for the current month, if disclosed.
- $15a$: is the 15th day of the month, immediately before the calculation date, corrected to the next business day. If the calculation date is the corrected 15th, it considers it inclusive.
- $15p$: it's the 15th day of the month, immediately after the calculation date, corrected to the next business day. If the calculation date is the corrected 15th, it considers the 15th of the next month.
- $DU_{15a,15p}$: number of business days between the 15th of the month immediately preceding (15th) (exclusive) and the 15th immediately following (15p) (inclusive).
- $DU_{t,15p}$: number of business days between the calculation date (t) (exclusive) and the 15th immediately after (15p) (inclusive)
- $EIPCA_i$: market expectation for the IPCA of month i , released by the Central Bank of Brazil in Focus – Market Report

The monthly Accumulated Factor ($FatorIPCA_m$) is rounded to 8 decimal places.

When the ANBIMA IPCA preview of market expectation for the next reference month ($IPCA_{2nd\ preview}$) is released by ANBIMA, it will replace the expectation released by the Central Bank of Brazil in the Focus – Market Report ($EIPCA_{i=1}$). The previous ANBIMA will be used on the business day following publication.

3.3 DI X IGPM (DIM)

Definition

The DI X IGPM (DIM) curve represents the term structure curve of the IGPM dirty spread. Which is constructed from the term structure of the IGPM dirty spread rate calculated from the implicit inflation in the dirty spread values collected from market participants.

Values

The value is expressed as a percentage rate per annum, rounded to 2 decimal places.

Structure

Type 4– Simple Construction

Inputs

- IGPM dissemination Calendar from the Getulio Vargas Foundation (FGV).
- *cpInformantes*: DI x IGPM dirty spread with diverse terms collected from market participants.
- *PRE*: PRE curve (item 2.1).

Fallback

- If there is no verified information collected from the pool of market participants, the expected IGP-M inflation, calculated by Equation 3.3.2,

will be obtained in the FOCUS Report released by BACEN, through the query Series of Consolidated Statistics.

Calculation

The first step is to determine the vertices i reference for calculating the intermediate curve of DI x IGPM. The vertices are defined by the following criteria:

7. First business day of each month.
8. Last business day of each month.
9. 15th business day of each month – adjusted for the next business day, if necessary.
10. Multiples of 30 calendar days (30, 60, 90, ...).
11. Official release dates of the IGPM index by FGV.
12. Limit: 5,580 calendar days.

Next, estimate an index (k_i) that represents the expected number of IGPM disclosures by FGV up to the date corresponding to vertex i . Thus, each vertex i will be associated with an index k_i .

The calculation consists of two steps. First, an inflation expectation curve (IGPM) is calculated implicitly from the informed spread rates. Once the expectation is calculated, the intermediate spread curve for all vertices is calculated. Then, from the intermediate curve, the final curve is calculated for all standardized vertices.

Market Participant Spread:

Rule of the market participant pool receipt vertices

3. rates corresponding to the first business day of the month (up to twelve months).
4. Then, month by month until the Swap Agreement registration limit (5,580 calendar days).

If there are participants who meet the vertices rule, the median of the informed spread values ($cpInformantes$) is for all vertices i in which there was information on the calculation date t .

$$\text{If } cpInformantes_{i,t} \neq \emptyset \rightarrow MedCpInfo_{i,t} = \text{median}(cpInformantes_{i,t})$$

Then, making the correspondence for index k_i , for the vertices in which there was information.

$$CpInfo_{k_i,t} = MedCpInfo_{i,t}$$

Finally, if there is $CpInfo_{k_i,t} = \emptyset$ for $i > 0$, an interpolation procedure is performed – to estimate the respective $CpInfo_{k_i,t}$ – from the indexes k_i before (k_a) and after (k_p) with information in t and one-day variations, according to Equation 3.3.1.

$$CpInfo_{k_i,t} = CpInfo_{k_i,t-1} + \Delta_a + \frac{\Delta_p - \Delta_{in}}{k_p - k_a} \quad (3.3.1)$$

Where:

$$\Delta_a = CpInfo_{k_a,t} - CpInfo_{k_a,t-1}$$

$$\Delta_p = CpInfo_{k_p,t} - CpInfo_{k_p,t-1}$$

Inflation expectation

Defined as $CpInfo_{k_i,t}$ for all vertices, the next step is to calculate the inflation expectation implied in the spread, $E(IGPM)_i$, for every vertex i in which there is information, according to Equation 2.2.2.

$$E(IGPM)_{i,t} = \text{Round} \left(\frac{\left(1 + \frac{PRE_{i,t}}{100}\right)^{\frac{DU_{i,t}}{252}}}{\left(1 + \frac{CpInfo_{k_i,t}}{100}\right)^{\frac{DU_{i,t}}{252}}} \times 100; 2 \right) \quad (3.3.2)$$

Next, construct the implied inflation curve for indices k_i so as to cover all vertices i . Considering the following situations:

3. If $k_i = 0 \rightarrow E(IGPM)_{k_i,t} = 0$
4. If $E(IGPM)_{i,t} \neq \emptyset \rightarrow E(IGPM)_{k_i,t} = E(IGPM)_{i,t}$

If there are any $E(IGPM)_{k_i} = \emptyset$, that is there was no information for any vertex i contained in k_i , then a spread estimate for k_i , is obtained from the market participants pool, according to Equation 3.3.1.

Spread Calculation

Once an implicit inflation curve with valid values for all indexes k_i , is obtained the intermediate curve of IGPM dirty spread is calculated, for each vertex, according to Equation 3.3.3.

$$Cp_{i,t} = \text{Round} \left(\left(\frac{\left(1 + \frac{PRE_{i,t}}{100} \right)^{\frac{DU_{i,t}}{252}}}{\left(1 + \frac{E(IGPM)_{k_i,t}}{100} \right)^{\frac{252}{DU_{i,t}}}} - 1 \right) \times 100; 2 \right) \quad (3.3.3)$$

Final curve of DI x IGPM (DIM)

The final curve of DI x IGPM (DIM) is formed by the standardized vertices (used for all curves). For vertices not contained in the intermediate curve, the IGPM spread is calculated by interpolating the intermediate curve using the formula `Interpolation252Year`.

4 Currency Curves

4.1 Real x Dollar Forward (PTX)

Definition

Fixed-term structure of the ratio of the Real exchange rate to Dollar.

Values

Price value with 7 decimal places, truncated at the 7th.

Structure

Type 4 - Simple Construction

Inputs

- **Prefix Interest Curve (PRE)** = Interest curve disclosed daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*.
- **Ptax t0** = Ptax Sales exchange rate disclosed by the Central Bank for the date (t0).
- **Ptax t-1** = Ptax Sales exchange of Sale disclosed by the Central Bank in t-1.
- **Dirty Dollar spread Curve (DOL)** = Published daily by B3, according to the calculation model in item 4.4.

Calculation

- **Vertex 1:**
Ptax 800 Sales exchange rate disclosed by the Central Bank for the date (t0).
- **Other Vertices:**
The formula below is used to define the other vertices of the curve:

$$TC_n = \left(\frac{\left(1 + \left(\frac{PRE_n}{100} \right)^{\frac{DU_n}{252}} \right)}{1 + \left(CD_n * \frac{DC_n}{36.000} \right)} \right) * ptax_{t-1}$$

TC_n = Real x Dollar Exchange Rate at vertex n.

PRE_n = Pre-fixed rate at vertex n, captured from the PRE curve (item 2.1).

CD_n = Dirty Dollar spread at vertex n, captured from the DOL curve (item 4.4).

$ptax_{t-1}$ = Sales Ptax exchange rate published by the Central Bank at t-1.

DU_n = Working days of vertex n.

DC_n = calendar days from vertex n.

4.2 Real x Euro Forward (EUR)

Definition

Term structure of the ratio between the real exchange rate taxa per Euro.

Values

Value in price with 7 decimal places, truncated in the 7th position.

Structure

Type 4 - Simple Construction

Inputs

- **Fixed Interest Curve (PRE)** = Interest curve disclosed daily by B3 (item 2.1).
- **Dollar Spot per Euro** = Exchange Rate of Dollars per Euro captured from Refinitiv at 16:00 hours, Brazilian official time.
- **Dollar Clean spread = Real Exchange** Rate per Dollar calculated by B3 from 15:30 hours, Brazilian official time, with pool of participants, according to the Reference Rate for US Dollar Technical Note available at B3 website.
- **Euro spread Curve (EUC)** = **Disclosed** daily by B3, according to the calculation model indicated in item 4.6.

Calculation

- **All Vertices:**

The formula below is used to define all the vertices of the curve:

$$TC_n = \left(\frac{\left(1 + \left(\frac{PRE_n}{100} \right)^{\frac{DU_n}{252}} \right)}{1 + \left(CE_n * \frac{DC_n}{36.000} \right)} \right) * Reais \times Euro$$

TC_n = Exchange Rate of Reais x Euro at vertex n.

PRE_n = Pre-fixed rate at vertex n, captured from the PRE curve (item 2.1).

CE_n = Euro spread at vertex n, captured from the EUC curve (item 4.6).

$Tx Reais \times Euro$ = Exchange parity of Reais per Euro, calculated by B3 (Spot Dollar per Euro X Dollar Clean Coupon) on date t0.

DU_n = Working days of vertex n.

DC_n = calendar days from vertex n.

4.3 Real x JPY Forward (JPY)

Definition

Fixed-term structure of the ratio of the Exchange Rate Real per Yen.

Values

Price value with 7 decimal places, truncated in the 7th house.

Structure

Type 4 - Simple Construction

Inputs

- **Prefix Interest Curve (PRE)** = Interest curve disclosed daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps (item 2.1)*.
- **Yen X Dollar Spot** = Yen per Dollar Exchange Rate captured from Refinitiv at 16:00 hours, Brazilian official time.

- **Dollar Clean spread = Real Exchange** Rate per Dollar calculated by B3 from 15:30 hours, Brazilian official time with pool of participants, according to the Reference Rate for US Dollar Technical Note available at B3 website.
- **Yen spread Curve (YCL)=Disclosed** daily by B3, according to the calculation model indicated in item 4.7.

Calculation

- **All Vertices:**

The formula below is used to define all the vertices of the curve:

$$TC_n = \left(\frac{\left(1 + \left(\frac{PRE_n}{100} \right)^{\frac{DU_n}{252}} \right)}{1 + \left(CI_n * \frac{DC_n}{36.000} \right)} \right) * Tx \text{ Reais } x \text{ Yen}$$

TC_n = Exchange Rate of Reais x Yen at vertex n.

PRE_n = Pre-fixed rate at vertex n, captured from the PRE curve (item 2.1).

CI_n = Yen spread at vertex n, captured from the YCL curve (item 4.7).

$Tx \text{ Reais } x \text{ Yen}$ = Reais per Yen exchange parity, calculated by B3 (Clean spread Dollar / Spot Yen x Dollar) on date t0.

DU_n = Working days of vertex n.

DC_n = calendar days from vertex n.

4.4 Dirty Dollar Spread Curve (DOL)

Definition

Dirty Exchange Spread Rate Curve based on DDI contracts traded at B3.

Values

Value in rate, rounded to the 3rd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Foreign Exchange spread Futures (DDI)** = Futures Contracts of Exchange spread traded at their maturities in B3.
- **Ptax t0** = Ptax Sales exchange rate disclosed by the Central Bank for the date (t0).
- **Ptax t-1** = Ptax sell exchange rate disclosed by the Central Bank in t-1.
- **CDI rate** = CDI rate disclosed daily by B3 in % aa.

Calculation

- **Vertex 1:**

$$TC_n = \left(\left(\frac{\left(1 + \frac{(CDI_{t0})}{100} \right)^{\frac{DU_n}{252}}}{\frac{ptax_{t0}}{ptax_{t-1}}} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = Dirty Exchange spread Rate at vertex n.

CDI_{t0} = CDI rate published by B3 on date t0.

$ptax_{t0}$ = Sales Ptax exchange rate published by the Central Bank in t0.

$ptax_{t-1}$ = Sales Ptax exchange rate published by the Central Bank at t-1.

DU_n = Working days of vertex n.

DC_n = calendar days from vertex n.

- **Mobile Vertices:**

The rates of DDI futures contracts at their respective vertices are used to define the movable vertices of the DOL curve.

- **Intermediate Vertices:**

You use the Interpolation formula checked in item 1.4.3 to find the values between the DDI maturities.

Long Vertices:

The Interpolation formula verified in item 1.4.10 is used to extrapolate the vertices after the last known maturity of DDI futures.

4.5 Clean Dollar Spread Curve (DOC)

Definition

Clean Exchange spread Rate Curve based on DDI contracts traded on B3.

Values

Value in rate, with 2 decimal places, rounded in the 2nd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Foreign Exchange spread Futures (DDI)** = Exchange spread Futures Contracts traded at maturity in B3.
- **Ptax t-1** = Taxa of Ptax exchange of Sale disclosed by the Central Bank in t-1.
- **CDI rate** = CDI rate disclosed daily by B3 in % a year.
- **Dollar Clean spread = Real Exchange** Rate per Dollar calculated by B3 after 15:30 hours, Brazilian official time, from the pool of participants, to the Reference Rate for US Dollar Technical Note available at B3 website

Calculation

- **Vertex 1:**

$$TC_n = \left(\left(\frac{\left(1 + \frac{CDI_{t0}}{100} \right)^{\frac{DU_n}{252}}}{\frac{ptax_{t-1}}{Dol CL_{t-0}}} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = Clean Exchange spread Rate at vertex n.

CDI_{t0} = CDI rate published by B3 on date t0.

$ptax_{t-1}$ = Sales Ptax exchange rate published by the Central Bank in t-1.

$Dol CL_{t0}$ = Exchange Rate Dollar Clean spread calculated by B3 from 15:30 hours, Brazilian official time, with a market participant pool, according to the Reference Rate for US Dollar Technical Note available at B3 website

DU_n = Working days of vertex n.

DC_n = calendar days from vertex n.

- **Moving Vertices:**

The rates of DDI futures contracts at their respective vertices are used to define the movable vertices of the DOC curve, from the use of the equation below:

$$TC_n = \left(\left(1 + \frac{DDI_n}{36.000} * DC_n \right) * \left(\frac{DOL CL_{t0}}{Ptax_{t-1}} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = Clean Exchange spread Rate at vertex n.

CDI_{t0} = CDI rate published by B3 on date t0.

$ptax_{t-1}$ = Sales Ptax exchange rate published by the Central Bank in t-1.

$Dol CL_{t-0}$ = Exchange Rate Dollar Clean spread calculated by B3 from 15:30 hours, Brazilian official time, with a market participant pool, according to the Reference Rate for US Dollar Technical Note available at B3 website

DDI_n = DDI Future Contracts rate published by B3.

DC_n = calendar days from vertex n.

- **Intermediate Vertices:**

The Interpolation formula checked in item 1.4 is used. 3 to find the values of the intermediate vertices.

- **Long Vertices:**

The Interpolation formula checked in item 1.4.3 is used to extrapolate the vertices after the last known expiration of clean DDI futures.

4.6 Clean Dollar Spread Curve (DCL)

Definition

Clean Exchange spread Rate Curve based on DDI contracts traded on B3.

Values

Value in rate, with 2 decimal places, rounded in the 2nd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Foreign Exchange spread Futures (DDI)** = Exchange spread Futures Contracts traded at maturity in B3.
- **Ptax t0** = Ptax Sales exchange rate disclosed by the Central Bank for the date (t0).
- **Ptax t-1** = Taxa of Ptax exchange of Sale disclosed by the Central Bank in t-1.
- **CDI rate** = CDI rate disclosed daily by B3 in % a year.
- **Dollar Clean spread = Real Exchange** Rate per Dollar calculated by B3 after 15:30 hours, Brazilian official time, from the pool of participants, according to the Reference Rate for US Dollar Technical Note available at B3 website.

Calculation

- **Vertex 1:**

$$TC_n = \left(\left(\frac{\left(1 + \frac{CDI_{t0}}{100} \right)^{\frac{DU_n}{252}}}{\frac{ptax_{t0}}{DolCL_{t-0}}} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = Clean Exchange spread Rate at vertex n.

CDI_{t0} = CDI rate published by B3 on date t0.

$ptax_{t0}$ = Sales Ptax exchange rate published by the Central Bank in t-1.

$DolCL_{t0}$ = Exchange Rate Dollar Clean spread calculated by B3 from 15:30 hours, Brazilian official time, with a market participant pool, according to the Reference Rate for US Dollar Technical Note available at B3 website.

DU_n = Working days of vertex n.

DC_n = calendar days from vertex n.

- **Moving Vertices:**

The rates of DDI futures contracts at their respective vertices are used to define the movable vertices of the DOC curve, from the use of the equation below:

$$TC_n = \left(\left(1 + \frac{DDI_n}{36.000} * DC_n \right) * \left(\frac{DOL CL_{t0}}{Ptax_{t-1}} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = Clean Exchange spread Rate at vertex n.

CDI_{t0} = CDI rate published by B3 on date t0.

$ptax_{t-1}$ = Sales Ptax exchange rate published by the Central Bank in t-1.

$Dol CL_{t-0}$ = Exchange Rate Dollar Clean spread calculated by B3 from 15:30 hours, Brazilian official time, with a market participant pool, according to the Reference Rate for US Dollar Technical Note available at B3 website.

DDI_n = DDI Future Contracts rate published by B3.

DC_n = calendar days from vertex n.

- **Intermediate Vertices:**

The Interpolation formula checked in item 1.4 is used. 3 to find the values of the intermediate vertices.

- **Long Vertices:**

The Interpolation formula checked in item 1.4.3 is used to extrapolate the vertices after the last known expiration of clean DDI futures.

4.7 Euro Spread Curve (EUC)

Definition

Euro Spread Rate Curve.

Values

Value in rate, with 4 decimal places, rounded to the 4th decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Clean Dollar Spread Curve (DOC)** = Clean Dollar Spread Curve (item 4.5), released daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*, with the CODE DOC.
- **Euro Spread Curve (SDE)** = U.S. Dollar x Euro Interest Rate Differential Curve (item 4.8), released daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*, with the code SDE.

Calculation

- **All Vertices of the EUC Curve:**

$$TC_n = \left(\left(1 + DOC_n * \frac{DC_n}{36.000} \right) * \left(1 + SDE_n * \frac{DC_n}{36.000} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = Euro Coupon Rate at vertex n.

DOC_n = Clean Dollar Coupon Rate (DOC) at vertex n (item 4.5).

SDE_n = Euro Spread Rate (SDE) at vertex n (item 4.9).

DC_n = calendar days from vertex n.

4.8 JPY spread Curve (YCL)**Definition**

JPY spread Rate Curve.

Values

Price, rounded to the 7th decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Clean Dollar spread Curve (DOC)** = Clean Dollar spread Curve (item 4.5), released daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*, with the CODE DOC.
- **JPY Spread Curve (SYD)** = U.S. Dollar x JPY Interest Rate Differential Curve (item 4.9), released daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*, with the code SYD.

Calculation

- **All Vertices of the YCL Curve:**

$$TC_n = \left(\left(1 + DOC_n * \frac{DC_n}{36.000} \right) * \left(1 + SYD_n * \frac{DC_n}{36.000} \right) - 1 \right) * \frac{36.000}{DC_n}$$

TC_n = JPY Coupon Rate at vertex n.

DOC_n = Clean Dollar Coupon Rate (DOC) at vertex n (item 4.5).

SYD_n = JPY Spread Rate (SYD) at vertex n (item 4.12).

DC_n = calendar days from vertex n.

4.9 Euro Spread Curve (SDE)

Definition

Interest rate differential curve between EUR (TEU) and USD (TUS),

Values

Value and price (*spread*), rounded to the 2nd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Interest Rate Curve in USD (TUS)** = USD Interest Rate Curve of 16:00 hours, Brazilian official time, daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*, with the code LUS.
- **Interest Rate Curve in EUR (TEU)** = EUR Interest Rate Curve from 16:00 hours, Brazilian official time, disclosed daily by B3 in the publication *Mercado Derivativos – Taxas de Mercado para Swaps*, with the code TEU.

Calculation

- **All Vertices of the SDE Curve:**

$$TC_n = (TEU_n - TUS_n)$$

TC_n = EUR Spread Rate at vertex n.

TEU_n = EUR Interest Rate (TEU) at vertex n.

TUS_n = USD Interest Rate (TUS) at vertex n.

4.10 GBP Spread Curve (SGP)

Definition

Interest rate differential curve between Pound Sterling (TGB) and USD (TUS),

Values

Value and price (*spread*), rounded to the 2nd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Interest Rate Curve in USD (TUS)** = USD Interest Rate Curve of 16:00 hours, Brazilian official time, daily by B3 in the publication Mercado Derivativos – Taxas de Mercado para Swaps, with the code LUS.
- **Interest Rate Curve in GBP (TBP)** = GBP Interest Rate Curve from 16:00 hours, Brazilian official time, disclosed daily by B3 in the publication Mercado Derivativos – Taxas de Mercado para Swaps, with the code TEU.

Calculation

- **All Vertices of the SDE Curve:**

$$TC_n = (TBP_n - TUS_n)$$

TC_n = GBP Spread Rate at vertex n.

TBP_n = GBP Interest Rate (TBP) at vertex n.

TUS_n = USD Interest Rate (TUS) at vertex n.

4.11 MXN Spread Curve (SMX)

Definition

Interest rate differential curve between Mexican Peso (TMX) and USD (TUS),

Values

Value and price (*spread*), rounded to the 2nd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Interest Rate Curve in USD (TUS)** = USD Interest Rate Curve of 16:00 hours, Brazilian official time, daily by B3 in the publication Mercado Derivativos – Taxas de Mercado para Swaps, with the code LUS.
- **Interest Rate Curve in MXN (TMX)** = MXN Interest Rate Curve from 16:00 hours, Brazilian official time, disclosed daily by B3 in the publication Mercado Derivativos – Taxas de Mercado para Swaps, with the code TMX.

Calculation

- **All Vertices of the SDE Curve:**

$$TC_n = (TMX_n - TUS_n)$$

TC_n = MXN Spread Rate at vertex n.

TMX_n = MXN Interest Rate (TMX) at vertex n.

TUS_n = USD Interest Rate (TUS) at vertex n.

4.12 JPY Spread Curve (SYD)**Definition**

Interest rate differential curve between JPY (TJP) and USD (TUS).

Values

Value and price (*spread*), rounded to the 2nd decimal place.

Structure

Type 4 - Simple Construction

Inputs

- **Interest Rate Curve in USD (TUS)** = USD Interest Rate Curve at 16:00 hours, Brazilian official time, published daily by B3 in the Mercado Derivativos – Taxas de Mercado para Swaps, with the code LUS.
- **Interest Rate Curve in JPY (TJP)** = JPY Interest Rate Curve at 16:00 hours, Brazilian official time, published daily by B3 in the

Mercado Derivativos – Taxas de Mercado para Swaps, with the code LJP.

Calculation

- **All Vertices of the SYD Curve:**

$$TC_n = (TJP_n - TUS_n)$$

TC_n = EUR Spread Rate at vertex n.

TJP_n = JPY Interest Rate (TJP) at vertex n.

TUS_n = USD Interest Rate (TUS) at vertex n.

5 Index Curves

5.1 Curve IBrX50 X PRE (BRP)

Definition

The Curve IBrX50 X PRE corresponds to the index curve constructed from the prices of adjustments of the maturities of the Brazilian Index Futures Contract 50 (BRI) traded in B3.

Values

Index points.

Structure

Type 4 - Simple Construction

Inputs

- *Índice IBrX_{50t}*: Brazil-50 index day t closing .
Source: B3.
- *BRI_t*: value in adjustment points of the Brazil-50 Index Futures Contract on day *t*.
Source: B3

Calculation

- **Vertex 1:** Brazil-50 index day t closing value.
- **Non-interpolated vertices:** Corresponds to the expirations of the Brazil-50 Index futures contract (IBrX-50).
- **Interpolated vertices:** values calculated with interpolation function 1.4.1 Exponential Interpolation 252.
- **After the last uninterpolated vertices:** Repeats to the last uninterpolated vertex.
- **Interpolation Base:** 252 (business days).

5.2 Bovespa Index Curve (INP)

Definition

The Bovespa index curve corresponds to the index curve constructed from the settlement prices of the Ibovespa Futures Contract expirations (IND).

Values

Index points.

Structure

Type 4 - Simple Construction

Inputs

- *Índice Ibovespa_t*: Ibovespa index closing on day *t*.
Source: B3.
- *IND_t*: value in adjustment points of the Ibovespa Index Futures Contract for the day *t*.
Source: B3

Calculation

- **Vertex 1**: value of the Ibovespa index at closing on day *t*.
- **Uninterpolated vertexes**: corresponding to Ibovespa futures contract expirations.
- **Vertexes prior to the first maturity**: values calculated by interpolation function 1.4.5 Price Interpolation with the following changes:

$$\text{Índice Ibovespa}_t * \left(\left(\frac{IND_{1st}}{\text{Índice Ibovespa}_t} \right)^{\left(\frac{DU_v}{DU_{1st}} \right)} \right)$$

- *Índice Ibovespa_t*: Ibovespa index closing on day *t*.
Source: B3.
- *DU_v*: business days of the vertex.

- DU_{1st} : business days of the first maturity.
- IND_{1st} : value in adjustment points of the first maturity of the Ibovespa Index Futures Contract.
- **Interpolated vertexes**: values calculated by interpolation function 1.4.5 Price Interpolation.
- **After the last uninterpolated vertex**: repeats to the last uninterpolated vertex.
- **Base Interpolation**: 252 (Working days).

5.3 Small Caps Index Curve (SML)

Definition

The Small Caps index curve corresponds to the index curve constructed from the settlement prices of the Small Caps Futures Contract expirations (SML).

Values

Index points.

Structure

Type 4 - Simple Construction

Inputs

- $\acute{I}ndice\ Small\ Caps_t$: Small Caps index closing on day t .
Source: B3.
- SML_t : value in adjustment points of the Small Caps Index Futures Contract for the day t .
Source: B3

Calculation

- **Vertex 1**: value of the Small Caps index at closing on day t .

- **Uninterpolated vertexes:** corresponding to Small Caps futures contract (SML) expirations.
- **Vertexes prior to the first maturity:** values calculated by interpolation function 1.4.5 Price Interpolation with the following changes:

$$\acute{I}ndice\ Small\ Caps_t * \left(\left(\frac{SML_{1st}}{\acute{I}ndice\ Small\ Caps_t} \right)^{\left(\frac{DU_v}{DU_{1st}} \right)} \right)$$

- $\acute{I}ndice\ Small\ Caps_t$: Small Caps index closing on day t . Source: B3.
 - DU_v : business days of the vertex.
 - DU_{1st} : business days of the first maturity.
 - SML_{1st} : value in adjustment points of the first maturity of the Small Caps Index Futures Contract.
- **Interpolated vertexes:** values calculated by interpolation function 1.4.5 Price Interpolation.
 - **After the last uninterpolated vertex:** repeats to the last uninterpolated vertex.
 - **Base Interpolation:** 252 (Working days).

5.4 Ibovespa Futures Carrying Cost (Convenience Yield) Curve (CYI)

Definition

The Ibovespa Futures Carrying Cost curve corresponds to implied curve from the settlement prices of the Ibovespa Futures Contract expirations (IND).

Values

The value is expressed as a rate, rounded to 4 decimal places.

Structure

Type 4 - Simple Construction

Inputs

- *Índice Ibovespa_t*: Ibovespa index closing on day *t*.
Source: B3.
- *INP_t*: INP curve (item 5.2) in *n* vertex.
Source: B3
- *Interest rate Curve (PRE)*: interest rate *t*.
Source: B3

Calculation

- **Vertex 1:** DI index economic indicator value
- **All vertices:**

$$TxCYI_n = \left(\left(\text{Índice Ibovespa} * \frac{\left(1 + \frac{PRE_n}{100}\right)^{\frac{DU_n}{252}}}{INP_n} \right)^{\frac{252}{DU_n}} - 1 \right) * 100$$

6 FINAL DISPOSITIONS

Beginning of validity of the 1st version: 05/20/2022

1st version: 05/20/2022

Change Log:

Version	Modified Itens	Changes	Reason	Date
1	First Release	First Release	Transparency on calculation methods and development of forward curves published and made by B3.	05/20/2022
2	Section 2.1, 2.4 and 3.2	Notation improvement	To facilitate understanding	06/08/2022
3	Section 4.6	DCL Curve Included	Inclusion of DCL curve method due to the change in the formula of 1 st vertex of DOC curve.	07/01/2022
4	Sections 4.2 and 4.3 Section 4.7 to 4.10	Spot rate provider change Terminology change	Refinitiv is the provider Libor term exclusion	01/06/2023
5	Section 3.2 Section 4	Change methodology Inclusion	IPCA Coupon Match Curve SGP and SMX	07/31/2023
6	Section 3.2	Correction and number places to rounded	Correction point of the DPL Curve, and inclusion the number places to rounded	09/11/2023

7	Sections 2.4 and 2.5	Change	Change on methodology of the curves TFP and TP and the reducer indicator (REDv)	12/11/2023
8	Sections 3.2	Correction	Correction in the DPL Theoretical equation	07/05/2024
9	Section 5.3 Section 5.4	Inclusion Inclusion	Small caps Index Curve inclusion Ibovespa Futures Carrying cost Curve inclusion	11/18/2024
10	Section 2.5	Change methodology	Change on methodology of the curve TP	01/03/2025
11	Section 1.4 Section 4.4	Inclusion Revision	Extrapolation formula inclusion Reference to the extrapolation formula (long vertices) of the Dirty Dollar Spread Curve	02/05/2025
12	Section 5.2 Section 5.3	Correction	Reference to the Price Interpolation Formula	03/20/2025