# DEBENTURE PRICING MANUAL

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## INTRODUCTION

This manual presents the calculation methodologies used to generate debentures reference prices and rates disclosed by B3 in the Private Fixed Income segment. Also listed are the characteristics that must be observed in a given bond for it to be eligible for pricing by one of the methods set forth herein.

*Section 1* defines the variables used in pricing models. *Section 2* presents the pricing model for the categories in which the debentures are grouped. *Section 3* provides the economic and financial indices covered by the pricing models and the exceptions. Lastly, *section 4* describes the procedures adopted due to changes in debenture characteristics. The *Annex* shows the methodologies for calculating the parameters used for pricing.

The calculations presented throughout this document are performed without applying any truncation or rounding. Only the PU (present value of contract), the one sent to users, is rounded to the tenth decimal place.

## 1 GLOSSARY OF VARIABLES

Debentures contracts are divided into four groups: (i) Fixed Rate, (ii) Floating Rate with Percentage Spread, (iii) Floating Rate with Multiplicative Spread and (iv) Indexed. The methodology used to calculate the reference price and rate is specific to each group. However, the variables and concepts are common to all. This section presents a glossary of the variables used in fixed income contract pricing methodologies and their descriptions.

| | |
|---|---|
| $\boldsymbol{t}$ | Mark-to-market date. |
| $\boldsymbol{t_{-1}}$ | Business day prior to mark-to-market date. |
| $\boldsymbol{t_0}$ | Bond yield start date. |
| $\boldsymbol{AMT\%(e_i)}$ | Par Value percentage to be paid on payment flow dates $(\boldsymbol{e_i})$. |
| $\boldsymbol{\%Inc(e_i)}$ | Percentage of the future value of the i-th interest rate flow to be incorporated into the issuance par value (VNE). |
| $\boldsymbol{e_i}$ | Payment flow dates, $0 \leq i \leq n$; dates on which the issuer must pay the investor. In the notation used in this document, $e_i$ is the *i*-th payment flow date; $e_0$ is assumed to be the bond yield start date ($t_0$) and $e_n$ is the last payment date. The set of all these dates will be named $E$ and the subset will be named $E_t$, where $e_i \geq t$. |
| $\boldsymbol{N_t}$ | Value in points on the $\boldsymbol{t}$ calculation date of the index correcting the bond issuance par value. |
| $\boldsymbol{N_{t_0}}$ | Value in points on the $\boldsymbol{t_0}$ bond calculation start date of the index correcting the bond issuance par value. |
| $\boldsymbol{r_{e_i}}$ | Interest rate expressed in % per annum (p.a.) that pays the $e_i$ interest rate event. All rates contained in the models presented are expressed in % p.a., on the basis of 252 |

business days (d.u.) capitalized under the compound interest regime. If the interest rates of any bond differ from those mentioned above, they shall be converted to an equivalent rate so that the calculations made are coincident with the characteristics of the bond's issuance.

$\boldsymbol{VNE}$ Bond issuance par value.

$\boldsymbol{VNR}$ Remaining par value, i.e., the amount of the issuance par value that the issuer still owes the investor, minus amortizations already made.

$$VNR(t) = (VNE + \sum_{e_k:e_k \in \mathbb{E}_t} \boldsymbol{F(e_k)} * \%Inc(e_i)) - \sum_{e_k:e_k \leq t} AMT(e_k)$$

$\boldsymbol{TU}$ Single contract discount rate obtained through the bisection method.

The variables below are defined only in $E_t$, that is, in payment flows that occur on dates where $e_i \geq t$.

$\boldsymbol{AMT(e_i)}$ Amortization Cash Value.

In the event of amortization on the issuance par value:

$$AMT(e_i) = (VNE + \sum_{e_k:e_k \in \mathbb{E}_t} \boldsymbol{F(e_i)} * \%Inc(e_i)) \cdot AMT\%(e_i)$$

In the event of amortization on the remaining par value:

$$AMT(e_i) = (VNR \ + \sum_{e_k:e_k \in \mathbb{E}_t} \boldsymbol{F(e_i)} * \%Inc(e_i)) \cdot AMT\%(e_i)$$

$\boldsymbol{DU(e_i)}$ Business days count between $t$ and $e_i$.

$\boldsymbol{DUCupom(e_i)}$ Business days count between $e_{i-1}$ and $e_i$ Payment Flows.

$\boldsymbol{Dur(t)}$ Fixed income contract duration.

$$Dur(t) = \frac{\sum_{e_k:e_k \in \mathbb{E}_t} DU(e_k) \cdot P(e_k)}{PU} \cdot \frac{1}{252}$$

$\boldsymbol{F(e_i)}$ Cash value of the interest rate event to be paid on the $e_i$ date.

$\boldsymbol{I(t)}$ Premiums released and not paid by the issuer.

$\boldsymbol{p}$ Percentage premium, which may be a premium or a discount, applied to the debenture credit spread. The premium is differentiated by debenture and allows incorporating other factors into the price other than the credit profile.

$\boldsymbol{P(e_i)}$ Present value related to the total to be paid at the $F(e_i)$ flow.

$\boldsymbol{PU(t)}$ Present value of contract, reference price (PU = Unit Price).

$$PU(t) = I(t) + \sum_{e_k:e_k \in \mathbb{E}_t} P(e_k)$$

$\boldsymbol{R(e_i)}$ Discount interest rate for the $e_i$ maturity calculated through exponential interpolation. This rate depends on the contract index and will be detailed in the following sections.

$\boldsymbol{S(e_i)}$ Credit spread for the $e_i$ maturity calculated through exponential interpolation. The spread is obtained from the credit spread curves for the debenture credit profile. Each fixed income contract is assigned a credit profile and used to obtain the corresponding credit spread curve.

The characteristics and payment flows of the debentures used in pricing are those defined in the public issuance deeds of debentures and are reflected in B3's securities registration system.

Below, we present the calculation specificities of different debenture groups, using the notation presented herein.

## 2 PRICING MODELS FOR FIXED INCOME CONTRACTS

The reference price for liquid debentures, i.e., those that have a minimum trading frequency over a time window, is the average day's trading prices that meet the maximum dispersion criterion weighted by quantity. For other debentures, the price is determined via the models described below.

The types of fixed income contracts differ depending on the financial index used for indexation, which is reflected in the methodology used for pricing the bond. Fixed income contracts are classified as fixed rate, floating rate (percentage or multiplicative spread) and indexed. The following are formulas for pricing bonds.

### 2.1 Fixed rate contracts

Are contracts characterized for having their interest rate ($r$) and yield known upon issuance.

$$acc_F(e_i) = \left(1 + r_{e_i}\right)^{DUCupom(e_i)/252} - 1$$

$$F(e_i) = VNR(e_{i-1}) * \ acc_F(e_i)$$

$$P(e_i) = \frac{F(e_i) * \%Inc(e_i) + AMT(e_i)}{\left[\left(1 + R(e_i)\right) * \ \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}}$$

$$[(1 + TU)]^{DU(e_i)/252} = \left[\left(1 + R(e_i)\right) * \ \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}$$

## 2.2 Floating rate contracts

Their indexation is based on an index ($Indic(t)$) with an annualized rate on a compound interest basis of 252 business days, such as the CDI (Interbank Certificate of Deposits), which is used for most contracts.

Floating rate contracts may be of two types: percentage spread and multiplicative spread.

### 2.2.1 Floating rate contracts with percentage spread

Percentage spread contracts are traded as a percentage ($\phi_{e_i}$) of the index interest rate defined at the issuance of the contract.

If $e_i$ is the first event immediately following the $t$ mark-to-market date, then:

$$acc_F(e_i) = fatorIndic * \left\{\left[\left(1 + R(e_i)\right)^{1/252} - 1\right] * \phi_{e_i} + 1\right\}^{DU(t,e_i)}$$

$$fatorIndic = \prod_{k=e_{i-1}}^{t} \left[(1 + Indic_k)^{1/252} - 1\right] * \phi_{e_i} + 1$$

Otherwise:

$$acc_F(e_i) = \left[1 + \left(\left(\left(1 + R(e_i)\right)^{\frac{1}{252}}\right) - 1\right) * \phi_{e_i}\right]^{DU(e_i)}$$

$$F(e_i) = VNR(e_{i-1}) * \left[\frac{acc_F(e_i)}{acc_F(e_{i-1})} - 1\right]$$

$$P(e_i) = \frac{F(e_i) * \%Inc(e_i) + AMT(e_i)}{\left[\left(1 + R(e_i)\right) * \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}}$$

$$\left[\left[\left(1 + R(e_i)\right)^{\frac{1}{252}} - 1\right] * (1 + TU)\right]^{DU_i} = \left[\left(1 + R(e_i)\right) * \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}$$

### 2.2.2 Floating rate contracts with multiplicative spread

Flow payments of floating rate contracts with multiplicative spread consider the composition of the contract coupon rate (r) with the index interest rate for the calculation of the contract's yield. Cash flow discount considers the composition of the market credit spread for the contract and the discount rate ($R(e_i)$) for the index ($Indic$).

If $e_i$ is the first event immediately following the $t$ mark-to-market date, then:

$$acc_F(e_i) = fatorIndic * \left(1 + R(e_i)\right)^{\frac{DU(t,e_i)}{252}} * \left(1 + r_{e_i}\right)^{\frac{DU(e_i)}{252}}$$

$$fatorIndic = \prod_{k=e_{i-1}}^{t} (1 + Indic_k)^{1/252}$$

Otherwise:

$$acc_F(e_i) = \left[\left(1 + R(e_i)\right)\left(1 + r_{e_i}\right)\right]^{\frac{DU(e_i)}{252}}$$

$$F(e_i) = VNR(e_{i-1}) * \left[\frac{acc_F(e_i)}{acc_F(e_{i-1})} - 1\right]$$

$$P(e_i) = \frac{F(e_i) * \%Inc(e_i) + AMT(e_i)}{\left[\left(1 + R(e_i)\right) * \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}}$$

$$\left[\left(1 + R(e_i)\right) * (1 + TU)\right]^{\frac{DU_i}{252}} = \left[\left(1 + R(e_i)\right) * \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}$$

## 2.3 Indexed contracts

Indexed bonds update their issuance par value (VNE) according to the variation of a given $N$ index, which is defined at the contract's issuance, such as the IGP-M (General Market Price Index) or the IPCA (Extended Consumer Price Index).

The contract coupon interest rate ($r_{e_i}$) is then applied over the updated par value to determine the event's cash value to be paid by the issuer.

$$acc_F(e_i) = \left(1 + r_{e_i}\right)^{DUCupom(e_i)/252} - 1$$

$$F(e_i) = VNR(e_{i-1}) * \frac{N_t}{N_{t_0}} * acc_F(e_i)$$

$$P(e_i) = \frac{F(e_i) * \%Inc(e_i) + AMT(e_i) * \frac{N_t}{N_{t_0}}}{\left[\left(1 + R(e_i)\right) * \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}}$$

$$[(1 + TU)]^{DU(e_i)/252} = \left[\left(1 + R(e_i)\right) * \left(1 + S(e_i)\right) * (1 + p)\right]^{DU(e_i)/252}$$

## 3 PRICED DEBENTURES

Public issuances performed through the Brazilian Securities & Exchange Commission (CVM) Normative Instructions No. 400 and No. 476.

### 3.1 Economic and financial indices covered by the models

- CDI with [d-1] business day displacement.
- IPCA with anniversary date on the 15th day and pro-rata capitalization of 252 business days under the compound interest regime.
- IGP-M with anniversary date on the 1st day and pro-rata capitalization of 252 business days under the compound interest regime.

### 3.2 Economic and financial indices not covered by the models

- Indices other than IPCA, DI and IGP-M. If the index update features are equivalent to the IPCA, DI or IGP-M features, the model with the closest features will be used.

- IPCA with anniversary date other than the $15^{th}$ day. Pricing will be performed through the IPCA with anniversary date on the $15^{th}$ day.
- IGPM with anniversary date other than the $1^{st}$ day. Pricing will be performed through the IGP-M with anniversary date on the $1^{st}$ day.
- IPCA with a lag of more than 1 month.
- Assets with amortization events prior to interest payment events with incorporation.
- Perpetual maturity.
- Interest-free amortization: the payment flow comprises amortization only.
- Convertibility into shares or any other asset offered by the issuer as a conversion object.
- Formalization of premium payment by performance (participation event).
- Issuers with defaulted interest flows and amortizations and/or with *restricted confirmed status* in B3's securities system.
- Liquidity-free issuances that are concentrated on few holders
- Issuances made by securitization companies with credit rights-backed payment flow

## 4 PROCEDURES ADOPTED DUE TO CHANGE IN DEBENTURE CHARACTERISTICS

The changes deliberated by the General Meeting of Debenture Holders (AGDs) will be reflected in the pricing following the formalization of the change with B3's Fixed Income Securities. The changes deliberated at the AGDs and treatments applied are listed below.

- Change of event dates (interest rate, amortization, premium, etc): the new dates are updated in the debentures register used for pricing.

- Payment of premium at a future date: the premium's cash value is updated in field ***I(t)*** (premiums due) and incorporated into the reference price according to the unit price (PU) calculation formula available in the glossary of this document.

- Change in the debentures return rate between payment events: the return rate used in the debenture pricing is replaced with the equivalent rate for the period, calculated from the original rate and the changed rate within their respective timeframes.

- Extraordinary amortization with redefinition of future amortization flows: the new amortization flows are updated in the debentures register used for pricing.

- Total early redemption: the debenture redemption date is updated at its maturity date.

- Generic event: the calculated or estimated event value (interest rate, amortization, premium, etc.) is incorporated into the debenture price.

  Change in amortization type (from remaining base amount to issuance base value, or vice versa): debt amortization percentages are updated to reflect the new amortization type.

- Non-payment of event (interest rate, amortization, premium, etc): in this case, the debenture becomes ineligible for pricing.

- Unscheduled amortization without redefining future flows: when the issuer does not deliberate on the redistribution of flows, the unscheduled payment will be debited uniformly in the remaining installments expiring.

- Interest incorporation: in this case, interest amounts are incorporated into the debenture par value as of the date of incorporation.

Changes made through AGDs that are not treated by the available pricing models are not to be incorporated into the debenture reference price.

## ANNEX – METHODOLOGIES

This annex presents the methodologies for estimating the inputs needed for pricing.

# 1 DEBENTURES SPREAD CURVE

## 1.1 Model

The debentures spread curve model uses the Nelson-Siegel approach to adjust the level and slope of the corporate credit curve. These features are observed in stylized interest rate curve facts:

$$r_x(\tau) = \beta_x + \beta_{Crédito}\left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau}\right) + \epsilon(\tau) \qquad (1)$$

Where:

- $x$ is one of the possible credit profiles. For notation purposes, in this manual credit profiles A, B, C and C- are used. Details of the methodology used to define the credit profiles are described in the document **"Methodology for Assigning Debentures Credit Risk Profiles"**;
- $r_x(\tau)$ is the temporal structure of the credit spread for the $x$ credit profile;
- $\tau$ is the annualized curve term;
- $\lambda$ is the $r_x$ speed of decay;
- $\beta_x$ is the long-term rate level of the credit spread curve for the $x$ credit profile;
- $\beta_{Crédito}$ is the slope common to all interest rate curves;
- $\epsilon(\tau)$ is the model's error term.

In order to find a homogeneous term structure among debentures, the curve has the $\beta_x$ credit profile level parameter, which is differentiated by credit profile and the $\beta_{Crédito}$ slope factor common to all profiles. This formulation aims to prevent the curves' temporal structure from intersecting.

## 1.2 Model Estimation

### 1.2.1 Optimization method

Since credit spread curves are not directly observable, the estimation problem is to find a discount curve for each credit profile group that minimizes the differential between the theoretical price and the traded price. The weighted least squares method (MQP) is used to jointly estimate all credit curves:

$$\min_{\beta_A, \beta_{Crédito}, \lambda} (1-\rho) \sum_{x \in \{A\}} \sum_{i=1}^{n_x} W_i \left( \left( P_{i,teórico}^{x} - P_{i,mercado} \right) / P_{i,mercado} \right)^2 + \rho \omega_1 \qquad (2)$$

Where:

- $n_x$ is the number of debentures used in $x$ credit profile estimate;
- $P_{i,teórico}^{x} = \sum_{k=1}^{m} FC_{i,k} * DF_{i,k}^{x}$, where $FC_{i,k}$ and $DF_{i,k}^{x}$ are the cash flow and the discount function for the $k$th flow, respectively. The discount function can be broken down as follows:

$$P_{i,teórico}^{x} = \sum_{k=1}^{m} FC_{i,k} * \frac{1}{\left( \left(1+R(\tau_{i,k})\right)\left(1+r_x(\tau_{i,k})\right) \right)^{\tau_{i,k}}}$$

to:

$R(\tau_k)$ is the discount curve (DI or IPCA) and $r_x$ is the credit spread for the $x$ credit profile to which the $i$ debenture belongs, as per equation (1). The $\tau_{i,k}$ term is the maturity of each annualized flow;

- $P_{mercado}$ is the price observed in the market (see section 1.2.4);

- $W_i = {}^{1}/_{Duration_i}$, where Duration is expressed in years:

$$Duration_i = \frac{\sum_{k=1}^{m_i} FC_{i,k} * DF_{i,k}^{x} * \tau_{i,k}}{\sum_{k=1}^{m_i} FC_{i,k} * DF_{i,k}^{x}}$$

- $\omega_1 = \left(\frac{\beta_{A,t} - \beta_{A,t-1}}{\beta_{A,t-1}}\right)^2 + \left(\frac{\beta_{cred,t} - \beta_{cred,t-1}}{\beta_{cred,t-1}}\right)^2 + \left(\frac{\lambda_t - \lambda_{t-1}}{\lambda_{t-1}}\right)^2$

- $\rho \in [0,1]$ is the parameter that defines the weight given to the day's settlement and to the previous day's curve difference.

It should be noted that this estimation is performed daily for A rating curves, as these have sufficient liquidity for robust calculation.

### 1.2.2 Tax Incentives

Debentures with tax incentives tend to exhibit lower spreads than debentures without tax incentives. This characteristic may also distort the effect observed on the issuers' fundamentals (credit profiles). It is therefore justifiable to distinguish between incentivized and non-incentivized debentures when estimating spreads for credit profiles. Thus, for each credit profile group, the spread curve $r_x^{incent}$is estimated for incentivized debentures and the spread curve $r_x^{não-incent}$is estimated for non-incentivized debentures.

### 1.2.3 Spacing between credit curves

Since the liquidity of debentures is concentrated in credit profile A, the parameter for this group ($\beta_A$) is used as a reference to obtain the $\beta s$ for the other credit ratings denoted by $\beta_x$. More specifically, in order to preserve the economic sense of the parameters for the levels of the credit curves over time, the spacing between the curves is estimated in two steps. In the first step, the objective function of equation (2) brings sample heterogeneity by adding the function $Q(n_x^{inc})$:

$$\min_{\beta_x, \beta_{Crédito}, \lambda} (1-\rho) \sum_x \sum_{i=1}^{n_x} Q(n_x^{inc}) W_i \left( \left( P_{i,teórico}^{x} - P_{i,mercado} \right) / P_{i,mercado} \right)^2 + \rho \omega_1 \qquad (3)$$

With $Q(n_x^{inc}) = \frac{1}{n_x^{inc}}$, for $n_x^{inc}$ as the number of debentures for the rating $x$ priced at the market on the date, even where a single parameter is estimated for debentures with and without tax incentives, the two types are segregated for each rating and weighted with the function $Q(n_x^{inc})$.

Having estimated the parameters of the model and minimized the objective function of equation (3) for the $x$ credit profiles, in conjunction with the day's trades, the next step is to obtain $\beta_x$ by finding the difference between one credit profile and all others ($\beta_{x,dif} = \beta_x - \beta_A$) and to apply this parallel displacement to the A rating curve for the corresponding type of tax incentive. Thus, after the A rating curve is estimated, the curve is obtained for each of the other ratings by equation (1) and these parameters:

$$\beta_x^{incent} = \beta_{x,dif} + \beta_A^{incent}$$

$$\beta_x^{não-incent} = \beta_{x,dif} + \beta_A^{não-incent}$$

If the difference for any rating is less than the difference for a higher credit rating, both ratings use the difference for the higher rating. This avoids certain economic inconsistencies in the estimation due to heterogeneous liquidity across groups, which is common in this market.

### 1.2.4 Treatment of outliers

In traded prices, it is common to find some values that present an implied rate of return in the trade that does not match the spreads observed for other debentures of the same credit profile. These outliers in the implied spreads on debenture prices can be explained for several reasons. Some of them are listed below.

- Credit profiles may be lagged due to the time lag between the market's perception and the updating and disclosure of economic and financial information that allows the credit profile to be adjusted.

- Inconsistencies in the $(FC_k)$ cash flow, existence of premium events, amortization, or interest rate extended or canceled.

- The liquidity of a debenture may generate distorted traded prices from its fundamentals (credit profile).

An outlier filter is therefore applied. The filter considers an outlier if the debenture meets the criterion of the following standardized statistics:

$$\left|\frac{\varepsilon_i - med(\varepsilon_1, \cdots, \varepsilon_n)}{\sigma(\varepsilon_1, \cdots, \varepsilon_n)}\right| > 1{,}5 \qquad (4)$$

Where:

- $\varepsilon_i = \left(W_i\left(P_{teórico} - P_{negócio}\right)/P_{negócio}\right)^2$ is the residual resulting from the adjustment process of the $i$th debenture;

- $P_{mercado}$ and $P_{teórico}$, as described in equation (2);

- $med(\varepsilon_1, \cdots, \varepsilon_n)$ is the residual median of all debentures traded on the reference date;

- $n$ is the number of debentures traded on the reference date;

- $\sigma(\varepsilon_1, \cdots, \varepsilon_n)$ is the residual sample standard deviation on the reference date;

- The $|\cdots| > 1{,}5$ criterion is justified as an adjustment of the empirical residual distribution to a normal distribution.

### 1.2.5 Market price

For estimation of the average traded price, the prices used are those informed in type 52 or 552, the final buy and sell trades registered on the B3 system and duly settled on T+0 (hereinafter referred to as **trades**). A minimum volume filter and a filter for the implicit spread in the price of each trade is applied with the purpose of removing those trades with spreads that are not compatible with the issuance trading profile. If the implied spread of the *j* trade on the *t* date is expressed by $\rho_{t,j}$, it is obtained by numerically solving the following equality:

$$P_{t,j} = \sum_{k=1}^{m} \frac{FC_k}{\left(\left(1 + R_t(\tau_k)\right)\left(1 + \rho_{t,j}\right)\right)^{\tau_k}}$$

Where:

- $P_{t,j}$ is the *j* trade price on the $t$ date;
- $FC_k$ are the debenture's cash flows;
- $\tau_k$ is the time in business days to the $k$ flow;
- $R_t$ is the discount curve.

For a historical window calibrated based on debenture's liquidity, the implied spreads on extragroup trade prices are collected for each debenture. In this history the following is obtained:

- The $\rho_{med}$ median of the last days' debenture trades. The window size is configurable and short to capture the debenture trend change, for example 3 days.
- The standard deviation of implicit spreads in the $\sigma$. historical window.

With them, the following spreads are defined:

$$\rho_\alpha = \rho_{med} + \sigma * d$$
$$\rho_{1-\alpha} = \rho_{med} - \sigma * d$$

Where $d$ is a weighting factor of the standard deviation. Finally, the price interval is defined.

$$P_{min} = \sum_{k=1}^{m} \frac{FC_k}{\left((1+R_t(\tau_k))(1+\rho_\alpha)\right)^{\tau_k}} \text{ and } P_{max} = \sum_{k=1}^{m} \frac{FC_k}{\left((1+R_t(\tau_k))(1+\rho_{1-\alpha})\right)^{\tau_k}}$$

Therefore, for the calculation day all trades within this interval are considered. The weighted average number of trades in the interval defines the $P_{mercado}$ market price of the debenture on the calculation date. For debentures that had extragroup trades and no trade passed through the filter, the market price is the weighted average of all the day's extragroup trades.

An extragroup trade is understood as the trade which the buyer's economic group (indicated in the institution's registration on the B3 system) differs from the seller's economic group.

For executed trades involving investment funds, the economic group considered for the purpose of classifying the trade will be the one indicated in the fund manager's registration.

Trades executed between fund managers owned by the same economic group and intermediated by the same institution are considered intragroup trades, provided that the debenture's transferred amount is the same at both legs of the trade.

### 1.3 Estimation algorithm

The estimation of all spread curves for credit profiles is performed in two phases.

**I) Daily procedure** – T+0 estimation of the A profile incentivized curve parameters and the non-incentivized A profile parameters, and use of the parameters estimated periodically to obtain other profile curves.

**II) Periodical procedure** – Estimation of spacing between credit profile curves.

**Daily procedure**

- **1st Step:** The market price of the debentures traded on the reference date is calculated based on trade prices (according to section 1.2.4), by grouping them by credit profile and classifying them as incentivized or non-incentivized debentures.

- **2nd Step:** The $(W_i)$ Duration for each traded debenture is calculated.
- **3rd Step:** The Nelson-Siegel model is estimated by weighted least squares for (A) reference credit profile with incentivized and non-incentivized debentures.
- **4th Step:** The estimated model residuals are used to generate the standardized statistics (see item 1.2.3).
- **5th Step:** The outliers filter is applied. For the endogenous outliers model, debentures with standardized statistics greater than 1.5 are excluded. The model is estimated again and a second analysis of endogenous outliers is applied.
- **6th Step:** The $(\beta_A)$ level and $(\beta_{crédito})$ slope estimated parameters are collected.
- **7th Step:** The $(\beta_{x,dif})$ spacing parameters are collected.
- **8th Step:** The curve level for the other credit profiles is calculated on the basis of the level estimated for the A rating.
- **9th Step:** The Nelson-Siegel formula is used with the estimated $\beta_{x,t}^{não-incent}, \beta_x^{incent}, \beta_{Crédito}$ parameters to generate the $r_x^{incent}$ $r_x^{não-incent}$ curves in the vertices for calculation.

**Periodic procedure**

- **1st Step:** For each $t$ day within an $h$ day window, steps 1 through 6 of the **daily procedure** are performed using all the incentivized and non-incentivized debentures credit profiles.

- **2nd Step:** Estimates are obtained for the $(\beta_x)$ level parameters and spacing between all credit profiles and the benchmark profile as formalized in item 1.2.2.

## 2 SYSTEMATIC BIAS CORRECTION MODEL FOR TRADED DEBENTURES

The systematic bias correction premium is modeled to better adjust the debenture trade prices by capturing its own and individual characteristics. The premium comes as a shock applied to the spread curve for the debenture credit profile.

The premium is estimated when the debenture has a minimum of trades within the calculation period. For these debentures, the $P_{mercado}$ day's market price (calculated according to section 1.2.4) allows calculation of the implied premium by the equation

$$P_{mercado} = \sum_{k=1}^{m} \frac{FC_k}{\left((1+R(\tau_k))(1+r_x(\tau_k))(1+premium)\right)^{\tau_k}} \quad (5)$$

On the dates when the debentures are not traded, the following sequence of procedures is applied to calculate the premium (the first procedure is the one given by equation (5)).

P2: debentures considered liquid within the calculation period use the last calculated premium.

P3: illiquid debentures that (when possible) receive the average premium for liquid debentures with the same issuer, with possible grouping criteria being the federal taxpayer number (CNPJ), tax incentive indicator, remuneration index, and duration.

P4: debentures that do not fit the previous methods will have their premium estimated according to an individual issuance analysis and the respective trading profile.

P5: newly issued debentures, which have not yet had a defined trading profile, have their premium defined based on the first deals observed, which may be the primary market price for issues that do not have deals immediately after issuance or are in a lock-up period, with this premium being maintained until the security becomes eligible for one of the liquidity-based methods.

P0: debentures that do not correspond to any of the previous methods receive a premium equal to zero.

The premium methodology can be verified for systematic bias correction used for each debenture priced through the information provided on UP2DATA.

## CHANGE LOG

**Effective**: July 1st, 2019

**1st version**: July 1st, 2019

### Areas in charge of this document at B3:

| Responsible | Area |
|---|---|
| Draft | Fixed Income Pricing and Pricing Modeling |
| Review | Pricing |
| Approval | Risk Management |

### Updates

| Version | Change | Reason | Date |
|---|---|---|---|
| 1 | Original Version | - | July 1st, 2019 |
| 2 | Sections 1 and 2 | Addition of treatment to incorporate interest into the calculation of reference price. | September 1st, 2019 |
| 3 | Section 2 – Annex | Addition of estimate for debentures premium with little liquidity. | September 12, 2019 |
| 4 | Section 1 - Annex | Reference to document describing the methodology for assigning credit risk profiles. | October 24, 2019 |
| 5 | Sections 1.2.2 and 1.3 - Annex | Spread curves for non-incentivized debenture issuances are now generated from trades executed for those issuances. | March 31st, 2020 |
| 6 | Section 1.2.1 - Annex | Addition of a component to the objective function to estimate the credit | September 6, 2020 |

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|---|---|---|---|
| | | spread curves, equation (2) | |
| 7 | Section 1.2.4 | Change to the definition methodology of the trade acceptance tunnel | October 1st, 2020 |
| 8 | Sections 1.2.4 and 2 - Annex | Detailing of the methodology for classifying intragroup and extragroup trades, as well as premium types assigned to debentures | August 4, 2021 |
| 9 | Sections 1.2.1. 1.2.2, 1.2.3, 1.2.4, 1.2.5 and 2 of Annex | Credit curve spacing methodology changed. Minimum volume filter for market price included. P3 premium changed. | March 14, 2022 |
| 10 | Introduction<br><br>Section 2 - Annex | Change in decimal precision<br><br>Included of theP5 Method | January 08, 2025 |
| 1 | Sections 1 and 2 | Simplification of the formula that incorporates interest into the calculation of reference price. | July 04, 2025 |