**LOCAL MODEL IMPLEMENTATION**

|  |  |
| --- | --- |
| MR: | Market Risk |
| FVAV: | Fair Value Adjustment / Additional Value Adjustment Models |
| XXXX/  XXXX: | **CoC / MPU Bonds & Asset Backed Securities** |
| TI:  ES: | Model Implementation  Spain |
|  |  |

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# INTRODUCTION

This document contains the model implementation for Boadilla SCIB unit, for the Fair Value Adjustments (FVA) and Additional Value Adjustments (AVA) referred to Bonds and Asset Backed Securities (ABS) risk factors, associated to their market price uncertainty (MPU) and close-out costs (CoC).

These Fixed Income securities are normally fair valued through its quoted market price, since securities are issued to provide issuer’s debt liquid making it possible to be exchanged in capital markets. This is a relevant difference with other financial instruments whose fair value might be derived through a theoretical valuation, by applying a valuation technique and using inputs to measure their market risks. This differential factor makes Bond prices more appropriate to determine uncertainty in its valuation.

The model and tool have been defined according to existing Bonds and ABS products and available data in the European market. However, the tools might be used in other circumstances analyzing the particularities of the local market, through developing an intermediate tool (or a manual pathway) to process different sources of information in order to calibrate the bid-ask or uncertainty values finally used by the FVA/AVA calculator.

In particular, the current implementation for SCIB Boadilla considers that a list of committed bid and ask quotes for fixed income products will be available. Also, for MPU purposes it is assumed that the Bank is able to obtain uncertainty information to calculate the fair and prudent levels.

Currently, there are several sources of bid and ask prices for both CoC and MPU purposes of the mentioned fixed income products, such as Bloomberg, Reuters, ICE, etc. If a different source or different format is used, the implementation should be adapted, or a new tool should be developed to preprocess the information from that source obtaining directly the bid-ask spreads to be used in the close-out calculations.

This document details the following list of local aspects of the model:

* Description of local portfolios and scope.
* Details of the inputs currently used, how they are processed, and a brief description of the tools currently used to obtain all the inputs.
* Configuration of the model.
* Details about the local implementation.
* Consistency analysis for certain assumptions.
* Technical implementation.
* Details about limitations and assumptions of the model.
* Test.
* Local monitoring and control.

# Scope and Portfolio Description

This section collects information about the scope of Spain fixed income securities books and type of products and underlyings present in the portfolios.

## Scope

In order to obtain the scope of operations on which the calculation of Bonds/ ABS adjustments should be carried out, the operations whose nominal is categorized as follows are selected:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Unit** | **PNL type** | **Status** | **Family** | **Group** | **Source system**[[1]](#footnote-2) |
| ES | EOD | LIVE  MKT\_OP | IRD | BOND | "Mx3EU" |

*Table 1: Detail of the filter performed at trade level to obtain the Bonds/ABS position*

Additionally, an automatic process is established to obtain the correct scope of portfolios based on the categorization of these portfolios in the Golden Source of this information, GER. The following axes of the categorization will be automatically taken into account to select the calculation scope:

1. Selection of the country over which the perimeter is to be determined, for this purpose the country is chosen in the “*country\_code”* field (“*country\_code=ES*”).
2. The perimeter will be determined by considering only the non-testing operations, therefore only portfolios with this categorization will be included. These can be determined with the selection of the following fields: "*es\_ficticio*" and "*es\_test*" equals to 0.
3. Those portfolios categorized as Fair Value are selected with the following identification: “*tipo\_cartera\_nombre”* field, as "*Negociacion*" or "*Disponible para la venta*" or *"Otros a valor razonable".*
4. The Spain (CIB) perimeter will be selected through the "*frtb\_treatment*", differentiate Trading Book from Banking Book. In the case of the Spain (CIB) unit, the business field is also used to select only the CIB operative (“business*=GCB*”), consequently filtering the ALCO operative. Given the information available with these fields, the tool will distinguish the execution perimeters, allowing to obtain perimeters that are different (and parameterizable) among which no netting will be allowed (perimeters: GCB Trading & GCB Banking).
5. In addition, portfolios registered in official front-end systems are selected, which are currently one of these for the European units: "Mx3EU".

Taking these milestones into account, the perimeter of the unit will be created considering the following filtering:

|  |  |  |
| --- | --- | --- |
| **Data** | **Field** | **Value** |
| Unit | *country\_code* | ES |
| Test flag | *es\_test* | 0 |
| Fictitious flag | *es\_ficticio* | 0 |
| Portfolio type (FV categorization) | *tipo\_cartera\_nombre* | Negociacion | Disponible para la venta | Otros a valor razonable |
| Book classification | *frtb\_treatment* | BB | TB |
| Business classification | *business* | GCB |
| Real source systems | *sistema\_front\_nombre* | "Mx3EU" |

*Table 2: Automatic GER ES filters example to determine unit perimeter*

Apart from the automatic filters already detailed, manual adjustments can also be carried out on the perimeter (in that case, these adjustments to the filters must present a justification by the unit, more government details in the monitoring section). The filters that can be executed will be at the following levels:

1. Book-portfolios: it will be possible to select those books and portfolios to be included and excluded from the perimeter already automatically defined. It is important to highlight that in the case of the Spain unit, the GER “*portfolio\_nombre\_corto*” field is also used as "*book*".
2. Products: it will be possible to indicate which products to exclude from the perimeter.
3. Risk Factors: it will be used to indicate those underlying that are not included in the calculation. No manual filtering is currently being done for these calculators.

It is important to note that there are different types of fixed income securities measured at fair value that bear price risk. Therefore, fixed income positions included in the scope contain Bonds and ABS. To develop the present model and its scope, valuation exposures from the Supra Datalake have been considered, which correspond to Bonds and ABS nominal. Taking this into account the scope of the positions is divided in two, Bonds and ABS, not allowing netting between both perimeters. Currently this distribution is made using the internal categorization of the group available in Asset Control and that can also be exploited in the data lake, SUPRA, specifically this categorization is available in the cd\_sensitivities database and the crd\_buckets table. In the mentioned table there is the "prod\_type" field that allows us to classify the ISINs as “Security” (ABS) and “Bond”. It is important to note that there may be small temporary misalignments between trade\_details (table from which the positions are obtained) and crd\_buckets, so when in the scope definition an ISIN not categorized in crd\_buckets is detected, it is automatically classified as a bond and a control output is generated so that the user can review the classification and re-execute if necessary (this default classification has been defined as such due to the greater exposure in the bond portfolio than in the ABS portfolio).

|  |  |
| --- | --- |
| **id\_ac** | **prod\_type** |
| XS2303066992 | SECURITY |
| ES0L02209093 | BOND |
| ES0L02212097 | BOND |
| ES0L02210075 | BOND |

*Table 3: ABS and Bond classification example*

## Portfolio Description

As mentioned, the scope of fair value portfolios to be considered will include fixed income portfolios containing bonds as well as those containing ABS. Currently, no specific treatment is applied to the book at product level, being possible to collect all the nominals at book- portfolio-ISIN level.

The portfolio data –such as the notional or AC price–, which should be provided, requires no further calculations. In this sense, the portfolios with more position are:

|  |  |  |
| --- | --- | --- |
| **Type** | **Portfolio** | **Notional %** |
| Bond | ESSR\_BASEREPOS | 39% |
| ESSR\_REPOSALES | 19% |
| ESSR\_REPONC | 6% |
| ESACPM\_AFS\_FIN | 5% |
| ABS | ESACPM\_PRIM\_CLO | 69% |
| ESACPM\_INV\_CLO | 16% |
| ESACPM\_INV\_ABS | 7% |
| ESACPM\_PRIM\_ABS | 6% |
| ESCR\_UK\_ABS | 2% |

*Table 4. Top portfolios per notional at 31/03/2022 for Spain*

# Inputs: Description, Collecting and Processing

This section complements the input section contained in the Model Theory document *[1]*  including all the details, sources and processes of raw data.

Therefore, the model inputs involved for Bonds and ABSs securities are the following:

## Positions and trade\_details

“Actual nominal[[2]](#footnote-3)” measures exposure to a specific bond. The use of nominal position for FVA and AVA calculation is compliance with Standards 17 and 22: MPU / CoC calculation (see [4] and [2]), which states that, when computing MPU and CoC adjustments, they should be calculated “by full revaluation or using sensitivities-based approach”.

The nominal required for the adjustment calculation is extracted from Murex (the official platform for bonds deals) and are certified for market risk on a daily basis. These are available in the data lake Supra, specifically in “trade\_details” table which is inside “cd\_gcb\_financial\_formalised\_contracts” database. Then differentiating between the two risk factor types, Bonds and ABS (as explained in section 2.1.), the nominals are sent to the BU FVAs AVAs (SUPRA table: “fva\_trade\_details”).

The filters applied are:

1. Automatic scope filtering according to the type of products, the risk factor type (ABS & Bond) and the portfolios categorization, detailed in the section [2](#_Scope_and_Portfolio).
2. Manual filters that are carried out using the parametric tables that are loaded by PIF to the lake and will be managed by the process administrator in case of user request.
   1. Book-portfolio: no additional manual filters compared to the automatic ones specified in section [2](#_Scope_and_Portfolio).
   2. Product: all products registered for the unit are filtered out except for the bonds (see attached file).



* 1. Risk factor (underlying level): no additional manual filters compared to the automatic ones specified in section [2](#_Scope_and_Portfolio).

Besides the filtering, the process is expected to aggregate the nominal at the necessary level (removing for instance the trade level that it is not necessary in this context). The minimum columns required in this SUPRA table are those shown in the table, although for reasons of traceability new fields could be included in the BU FVA/AVAs:

|  |  |
| --- | --- |
| **Main fields** | |
| asofdate | mgroup |
| country\_code | mtype |
| nominal\_calc | portfolio |
| source\_system | instrument |
| book | maturity |
| security\_code | capital\_factor |
| mfamily | lot\_size |
| quantity\_calc | sens\_value |
| price | prod\_type |

*Table 5. Bonds trade details main fields*

It is important to mention that the Asset Control price of the bond used in the calculation process will be obtained from trade\_details ("price" field). This price does not have to be necessarily taken from the same trade\_details table from which the position is observed, it will be obtained from the trade\_details table that has the same date as the IPV price with which the position is being executed. In case there is exposure to a new bond not available in the trade\_details aligned with the IPV, the AC price of the same trade\_details from which the position is taken will be taken.

It is important to note that the intra-group mark associated with the bond is currently being introduced into the trade\_details table of the FVAs/AVAs BU with the "intragroup" field, which is reported from Stratuss (database available in the CIB lake, S3).

The “sens\_value” field will show the Bond Delta Yield sensitivity or the CDI sensitivity (the type of sensitivity can be distinguished with the “sens\_description" field). It is a necessary data only when quotes are inputted as yields or %CDI, and the methodology based on the duration approximation should be used. Sensitivity is obtained from Murex through Supra Data Lake (sensitivities table). More information on the use of this input may be found in section 5.2.3.

For more information about the fields included in the FVA & AVA trade details BU (“bu\_fva.fva\_trade\_details”) see the document: "SUPRA-Data Structures Template" [10].

It should be noted that the currency conversion of the nominal of this calculator will take place in the calculation engine based on the currency exchange rate obtained automatically via ACX.

## Market data

This section refers to the process of obtaining market quotes (bid, ask, mid or bid-offer spreads) for each available ISIN with an open position in the portfolios under scope.

Due to the different nature of the data capture process between Bonds and ABSs, this section individually analyzes both processes.

* **Bonds**

Bonds are usually traded openly, and, in the case of the most liquid bonds, several contributors continuously quote each specific ISIN. The Bonds prudent prices are reported by IPV, which are obtained through the following process:

1. Every available contributor quote, for every bond registered in AC, is downloaded automatically through AC.
2. Based on the downloaded data, a specific set of contributors is selected. This decision is underpinned by a previous monthly analysis of IPV, for every contributor[[3]](#footnote-4) of interest, in which parameters such as representativeness, transparency or independence, are analyzed. The official price is compared with a centered measure of the sample of qualified contributors. For more information, consult IPV procedures.
3. The outliers, regarding the series of quotes per bond, are cleaned through an interquartile range.
4. The percentiles and standard deviations are calculated, per series of quotes per bond.

Figure 1shows a statistic of the bonds with position in Boadilla SCIB portfolios, attending to the availability of quotes for them:

*Figure 1: Mid-Price at percentile 50 Availability for Bonds in the portfolios at 31/03/2021 (% covered notional)*

If there are not available market quotes, a proxy will be used to obtain the required prudent prices for FVA and AVA calculation. The proxy is based on market quotes from other references with similar characteristics.

Regarding data capture, the main efforts of the present development have focused on improving the quality[[4]](#footnote-5) of the data used as input for the model. In this regard, it would be expected that key market players, such as well-known investment banks and brokerage firms, would provide better quotes, reducing uncertainty. For this purpose, additional contributors have been assessed by including and eliminating some of them. The contributors included are key market players, which are usually more active in certain bond types due to specialization; these key contributors include specialized investment banks and brokerage firms such as Morgan Stanley, Goldman Sachs, Credit Suisse or Jefferies. The eliminated contributors are those that, frequently, present invalid quotes (i.e. quotes with non-existent bid or ask, unexpected 0 bid-offer spread or recurrently considered as outliers), such as exchange contributors.

The effect of the contributor’s selection is tested by analyzing the Close out Cost of four representative securities within Santander’s portfolio. Therefore, the comparison of Close out Cost of the New (including key market players and excluding recurrently invalid contributors) and Original (with no changes with respect to actual contributors used) set of contributors is shown below:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ISIN** | **Date** | **Contributor** | **Contributions** | **SP50** | **SP90** | **FVA COC** | **AVA COC** |
| FR0012278539 | 30/09/2019 | Original | 4 | 0.495 | 93.369 | -3,712 € | -700,269 € |
| 30/09/2019 | New | 6 | 0.49 | 0.97 | -3,675 € | -7,278 € |

*Table 6: New and original contributors for an ISIN*

In most cases, like the example in the table above, it is observed that:

* The number of quotes per ISIN increases, so higher statistical robustness is expected.
* Spread at percentile 50 varies slightly, while spread at percentile 90 is reduced significantly.

Nevertheless, accessing these contributors is not straightforward, and currently, IPV does not have access to all the contributors that would be desirable[[5]](#footnote-6). Some of these contributions are only available under request (through the function “RFE”). It would be necessary to:

1. Obtain access (through Bloomberg “RFE” function) to the contributors considered as key players.
2. Increase the number of contributors and use intraday prices would lead to an improvement in data quality. This is difficult to implement in practice due to both operational and budget constraints by the IPV team.
3. Filter those contributors that systematically offer abnormal data, such as exchanges. This happens because the quoted bid/offer prices are composed of different transactions, often not related. For this reason, it has been concluded that including these contributors leads to a worsening in the data available.

In addition to Bloomberg, other data sources are available to obtain fixed income quotes:

* In this review, Markit prices have been analyzed:
  + Pros: a high number of bond quotes are available, together with statistical information (i.e., standard deviation of the quotes).
  + Cons: this source is not integrated in IPV processes, as it provides aggregated average and standard deviation values instead of the original data (then, no audit trail is available).

After analyzing the data, the conclusion is that no significant improvement in the observability of the references found in Santander portfolios is expected. Thus, this contributor was discarded.

The bank is in the process of incorporating ICE as source for credit curves, so bond quotes are expected to be also obtained. At the date of development of this FVA/AVA model, ICE bond quotes were not available, so no analysis was possible.

**Example**: an example of the Bond percentile calculation is presented. This ISIN has enough bid and bid-ask spread observations as to not apply a proxy for calculating the adjustment.

| **ticker** | **contributor** | **bid** | **ask** | **spread** | **mid** |
| --- | --- | --- | --- | --- | --- |
| AT0000386115 | BVAL | 103.5632 | 103.5868 | 0.0236 | 103.575 |
| FRNK | 103.51 | 103.64 | 0.13 | 103.575 |
| BAYL | 103.426 | 103.726 | 0.3 | 103.576 |
| NOLB | 103.552 | 103.592 | 0.04 | 103.572 |
| HELA | 103.55 | 103.55 | 0 | 103.55 |
| DZBK | 103.532 | 103.612 | 0.08 | 103.572 |
| HVBT | 103.54 | 103.607 | 0.067 | 103.5735 |
| SEND | 103.485 | 103.66 | 0.175 | 103.5725 |
| ICEB | 103.4333 | 103.4533 | 0.02 | 103.4433 |
| EXCH | 103.18 | 103.98 | 0.8 | 103.58 |
| BRLN | 103.51 | 103.64 | 0.13 | 103.575 |
| BAWG | 103.45 | 103.7 | 0.25 | 103.575 |

*Table 7: example of original contributed data*

| **ticker** | **Spread P50** | **Mid P50** | **Std Spread** | **Std Mid** |
| --- | --- | --- | --- | --- |
| AT0000386115 | 0.105 | 103.574 | 0.2198796 | 0.038 |

*Table 8: example prudent prices calculations Bonds*

On the other hand, it is important to note that the spread provided by the Bloomberg BVAL contribution will be used for the calculation of the FVA CoC when available and provided that the score is greater than or equal to 7, instead of the local spread calculated by the IPV at the 50th percentile. This requirement was issued by the local risk user as suggested by the front office.

BVAL is a synthetic Bloomberg contributor. BVAL contributions are generated internally by Bloomberg, based on available market data, through an internal algorithm. The BVAL contribution is always provided with a score, varying from one to ten, indicating the quality of the market data used to generate the price. If greater than six, it is indicative that observable quotes were used to determine the BVAL price. This contributor was chosen due to the following reasons,

1. Firstly, since BVAL is a contribution generated by Bloomberg, a data provider as well as a trading plataform, it is expected to have much more data than the local IPV team. Therefore, BVAL is expected to be built based on more available information, by requiring less downloads by the IPV team.
2. On the other hand, by considering a score greater o equal than seven, the contributions used to generate the BVAL price are expected to be of enough quality and quantity.
3. Finally, although Bloomberg’s internal methodology used to build the BVAL contribution is private, it is publicly known that the price considers best executable prices, that the bid and ask price are quoted, or the volume linked to the price. Therefore, those contributions issued by the most representative contributors will influence most the BVAL price, while those less representative contributors will not be as significant in the price generation.

By these reasons, the BVAL contributor is considered to be the best available contributor for calculating the FVA CoC adjustment, and this is why the development has been modified to include the information of this contributor with priority for calculating said adjustment.

* **ABSs**

Contrary to bonds, ABSs are mainly traded privately, and although the most premium tranches and instruments are more liquid, it is not possible to obtain quotes for every position daily (i.e., the FVA/AVA calculation date) but there are quotes sporadically available in near time window. Therefore, the prudent prices process of ABSs differs from bonds:

1. The ABSs prices are obtained from Bloomberg through RUNS. RUNS is a private dashboard where brokers and dealers provide quotes. In this platform, some quotes are indicative, and some are executable. The ABS market normally quotes at bid prices, so the number of bid prices available is higher than the number of ask prices and therefore b/o spreads are hardly observed. Due to the lack of data available, a temporal window of one month is applied[[6]](#footnote-7). All the contributions available for Santander portfolio references are extracted from this private dashboard.
2. When a quoted price is not available for a security, the price of the instrument has to be inferred theoretically. Specifically, in the case of Boadilla CIB portfolio, a valuation tool called *Intex* is available. Apart from its valuation engine, *Intex* has the advantage of including all the updated and historical information of the performance of the collateral portfolio, which is necessary for modeling the cash-flows of the structure and how these cash-flows dry down to each tranche of the securitization. *Intex* is well-known and widely used in the ABS market after the sub-prime crises.

It’s worth to mention that the percentiles and uncertainties are not calculated by IPV, but by the tool presented in this document.

For those references without market quotes, the construction of proxy prices is required to calculate FVA and AVA adjustments. The proxies applied for both, standard bonds, and ABS, are discussed in the Model Theory Documentation [1] . The proxy calculation process is out of the scope of IPV.

The dashboard referred is available for trading purposes, nevertheless the Market Data and the IPV departments have also access for valuation and verification purposes respectively.

shows the proportion of ABS in the portfolio with available quotes using a RUNS extraction for a one-month window:

*Figure 2. Price Availability for ABS in the portfolio at 31/12/2020 within a 1-month window (percentage of Notional in €)*

**Example**: RUNS available data is shown for a sample ISIN,

| **ISIN** | **Date** | **Dealer** | **Source** | **Bid Price** | **Ask price** | **Spread** |
| --- | --- | --- | --- | --- | --- | --- |
| XS1751480358 | 02/09/2019 | BAML | MSG | 99.80 | 99.95 | 0.15 |
| 02/09/2019 | BAML | ATT |  | 99.95 |  |
| 03/09/2019 | BAML | ATT |  | 100.00 |  |
| 04/09/2019 | BAML | MSG | 99.80 | 100.00 | 0.20 |
| 04/09/2019 | BAML | ATT |  | 100.00 |  |
| 16/09/2019 | BAML | ATT |  | 100.00 |  |
| 16/09/2019 | BAML | MSG | 99.75 |  |  |
| 16/09/2019 | BNP | MSG | 99.70 | 99.99 | 0.29 |
| 16/09/2019 | BAML | MSG | 99.75 |  |  |
| 16/09/2019 | BNP | MSG | 99.40 | 99.70 | 0.30 |
| 17/09/2019 | BAML | MSG | 99.75 |  |  |
| 17/09/2019 | BNP | MSG | 99.56 | 99.85 | 0.29 |
| 18/09/2019 | BAML | MSG | 99.75 |  |  |
| 19/09/2019 | BNP | MSG | 99.69 | 99.99 | 0.30 |
| 27/09/2019 | BNP | MSG | 99.78 | 100.08 | 0.30 |
| 30/09/2019 | BNP | MSG | 99.76 | 100.06 | 0.30 |

*Table 9: RUN contribution example*

Given the data the previous table, the following statistics may be calculated, which will be used for performing the adjustment calculation.

| **ticker** | **Bid P50** | **Spread P50** | **Spread P90** | **Std Bid** |
| --- | --- | --- | --- | --- |
| XS1751480358 | 99.76 | 0.30 | 0.30 | 0.12 |

*Table 10. ABS prudent price calculation example.*

## FX Spots

The currency exchange rate will be taken directly from ACX (by API), this exchange rate will have the currency exchange rates for any possible pair and the tool will be parameterized so that the calculation can be made in the currency required by the user, in the case of Spain, it will be parameterized in EUR.

|  |  |  |  |
| --- | --- | --- | --- |
| **BASE\_CURRENCY** | **CURRENCY** | **DATE** | **VALUE** |
| EUR | MXN | 29/04/2022 | 2.157056 |
| EUR | NZD | 29/04/2022 | 1.598245 |

*Table 11. FX spot file structure*

## Static Data

In addition to the market quotes, it is necessary to obtain static data at ISIN level that enables to stablish buckets or categories of Bonds/ABS with similar characteristics. This data is usually captured by AC (normally from Bloomberg, but other sources are possible) and certified by the Market Data Team. As proxies will be defined according to those categories, they should be granular enough to identify specific but homogeneous behaviors. On the other hand, the granularity must not be excessive; otherwise, we would not be able to find enough Bonds/ABS (with data available) to populate sufficiently all the categories and therefore, we would not be able to build consistent proxies for each bucket. The information is automatically obtained from AC using the static data extraction circuit defined for FRTB, see detail in "DDR Logical change in FRTB by CRR Regulator and provisioning to Lake v7.0":

Static data for bonds and ABS is storage in three different tables, Bucket Bonds static data related to the bonds, Bucket Sec, static data related to the ABSs and Issuer Global, static data for the issuer of the risk factors.

* For bonds the fields involved in the calculation are the next ones:

|  |  |
| --- | --- |
| **Field** | **Source** |
| **ISIN** | **Buckets\_Bonds** |
| **Maturity**[[7]](#footnote-8) | **trade\_details/ Bucket bonds** |
| **bb\_dx533\_is\_covered** | **Buckets\_Bonds** |
| **Industry\_group** | **issuer global** |
| **country** | **issuer global** |
| **Issuer/ GLCS**7 | **trade\_details/ Bucket bonds** |
| **rating\_external\_normalized** | **Buckets\_Bonds** |
| **RESA\_issue\_normalized** | **Buckets\_Bonds** |
| **bb\_ds530\_defaulted** | **Buckets\_bonds** |

* For ABS the fields involved in the calculation are the next ones:

|  |  |
| --- | --- |
| **Field** | **Source** |
| **ISIN** | **Buckets\_Sec** |
| **Maturity**7 | **trade\_details/ Bucket Sec** |
| **bb\_dx533\_is\_covered** | **Buckets\_ Sec** |
| **Industry\_group** | **issuer global** |
| **country** | **issuer global** |
| **Issuer/ GLCS**7 | **trade\_details/ Bucket Sec** |
| **rating\_external\_normalized** | **Buckets\_ Sec** |
| **RESA\_issue\_normalized** | **Buckets\_ Sec** |
| **bb\_ds530\_defaulted** | **Buckets\_ Sec** |
| **bb\_ds674\_security\_type** | **Buckets\_ Sec** |

The details of this segmentation may be found in the Model Theory Documentation *[1]* , and the details of the format required in section 1.

## Other Inputs

Other necessary inputs for the calculator are:

* **Exemptions:** this file will be common to indicate both bond exemptions and ABS exemptions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Fill** | **Value** | **FVA MPU** | **AVA MPU Gross** | **FVA CoC** | **AVA CoC Gross** |
| ISSUER | BESP | None | None | Market Maker | Market Maker |
| ISSUER | BPKM | None | None | Market Maker | Market Maker |
| ISSUER | EIBU | None | None | Market Maker | Market Maker |
| ISSUER | GXI1 | None | None | Market Maker | Market Maker |
| ISSUER | H6JT | None | None | Market Maker | Market Maker |
| ISSUER | KREW | None | None | Market Maker | Market Maker |
| ISSUER | REPT | None | None | Market Maker | Market Maker |
| ISSUER | TSIT | None | None | Market Maker | Market Maker |
| ISSUER | V35N | None | None | Market Maker | Market Maker |

*Table 12: Spain exemption 31/03/2022*

To fill in the exemptions, the following criteria must be followed:

1. **Fill:**

* Indicates the type of value to be filled in the *"Value"* field, and it is possible to indicate any of the following values: "*ISSUER*", "*STRING*", "*ISIN*", "*INSTRUMENT*".

1. **Value:** depending on the value of the Fill field we have to fill in according to the following criteria:

* If "*Fill= ISSUER*" we should fill the field with the names of the issuers to be exempted.
* If "*Fill= STRING*" we must fill the field with the first string of the ISINs that we want to exempt, for example, if "*Value= BRN*" we will exempt all bonds whose code begins with "*BRN*".
* If "*Fill= ISIN*" we should fill the "*Value*" field with the ISINs we want to indicate as exempt.
* If "*Fill= INSTRUMENT*" we must fill in the "*Value*" field with the instrument we want to indicate as exempt.

1. **FVA MPU, FVA CoC, AVA MPU Gross & AVA CoC Gross:** in case of exemption, it should be filled in as "NONE" and in case of exemption, it can be filled in with any literal explaining the reason of the exemption.

* **Region parametric**: this table allows us to parameterize and relate each Country with its region. This table will be managed by the administrator of the process and it will only be necessary to request its update in case new countries are added.
* **Bucket proxy manual adjustments**: this is an input that will function as a contingency measure in case any anomaly or discrepancy is detected in the calculation of the proxy bucket, it will allow us to indicate exactly the value of the generated buckets. For example:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Buckets** | **sp50\_proxy** | **STD\_sp90\_proxy** | **STD\_MID10\_proxy** | **STD\_MID90\_proxy** |
| AAA to A-t < 3Y-Governments-Others | 0.0031 | 0.045500916 | 0.022734572 | 0.022734572 |
| AAA to A-t < 3Y-Financial Institutions-Others | 0.0031 | 0.045500916 | 0.022734572 | 0.022734572 |
| AAA to A-t < 3Y-Others-Others | 0.0031 | 0.045500916 | 0.022734572 | 0.022734572 |

*Table 13: bucket proxy manual adjustments example*

In the case of Spain, this file is not used at implementation date.

* **Issuer proxy manual adjustments:** works in the same way as the bucket proxy, but in this case the value of the issuer proxy is indicated. In the case of Spain, no use is made of this file at the implementation date.
* **Theoretical price ABS valuation**: theoretical valuation of those ABSs with no prices available in the different sources. These theoretical prices will be obtained from an internal pricing tool and will be provided by IPV in an Excel file. The file should include a column with bid, mid and ask prices. More information can be found in 5.2.2.
* **Manual Adjustments**: this input has been established as a contingency plan to be used in case any of the ISIN or instrument data is not correct at source or is not being reported in the automatic data flow. The data we will be able to report are the following (in case the reported bond exists the data reported here will replace the automatic one, but in case it does not exist it will be considered as additional information)

|  |  |
| --- | --- |
| **Type** | Indicates if it is bond, abs, cds or another |
| **Issuer/ISIN** | To be filled in with the value "ISSUER" or "ISIN" depending on the data to be reported |
| **ID** | You will have the Murex ID code of the bond/ABS or the Issuer ID (GLCS code) |
| **Price\_quotation** | To correct the basis of the bonds whose prices are not correct in the price\_quotation file |
| **Nominal\_ISIN** | It will be used to include/adjust nominals. In case the nominal adjustment is due to a quality error at source, it should be reported to the corresponding team |
| **Precio AC** | To adjust those Asset control prices that are not correctly at origin |
| **lot\_size\_ISIN** | Field used to include/replace lot size data |
| **Capital\_factor\_ISIN** | Field used to include/replace capital factor data |
| **intragroup\_flag\_issuer** | Field for setting/including static data |
| **is\_covered** | Field for setting/including static data |
| **industry** | Field for setting/including static data |
| **country** | Field for setting/including static data |
| **parent\_company** | Field for setting/including static data |
| **region** | Field for setting/including static data |
| **ISIN rating** | Field for setting/including static data |
| **issuer\_rating** | Field for setting/including static data |
| **instrument\_type** | Field for setting/including static data |
| **Flag Default** | Field for setting/including static data |
| **Issuer** | Field to be filled in case you want to include/change the Issuer associated to an ISIN |
| **Traded volumen** | N/A |
| **Market porcentaje** | N/A |
| **Currency** | N/A |
| **Portfolio** | N/A |
| **Book** | N/A |
| **Desk** | N/A |
| **Entity** | N/A |
| **Maturity** | N/A |

*Table 14: data available for manual adjustment*

* **Price quotation**: indicates the quotation (flat or percentage) for each bond. This information is available in Murex and obtained through Trade Details SQL (table in SUPRA).
* **Isin without associated price\_quotation:** no price adjustment
* **“Price\_quotation = 1”:** no price adjustment
* **“Price\_quotation = 2”:** the price (AC & IPV prices) is adjusted as follows

More information on the use of this input may be found in 5.2.2.

To make use of these inputs you must assign the format, form and name of each file as indicated in the user's guide.

## Parameters

For executing the tool need some parameters to determine the performance:

The tool needs some parametrization:

* **Marginal distribution**: marks if marginal distribution has to be applied. %. In the case of Spain *“****marginal distribution =*** *True”*
* **Distribution group**: level at which the distribution will be applied. In the case of Spain *“****distribution group =*** *desk”*
* **Price corrections**: identifier for bonds whose price basis has to be corrected 10%. In the case of Spain *“****Price corrections=*** *BRSTNCLF”*
* **Bucket worst proxy**: default fallback rating value for proxying bonds without price and without static data, in case this value is not informed, worst rating will be used by default. In the case of Spain *“****Bucket worst proxy*** *= BBB to B”*
* **Yield**: indicates if the execution uses prices or yields, in case this value is not informed, the tool will consider the execution is with prices. In the case of Spain, the following has been indicated as *“False”*.
* **Pivot price**: indicates the price on which the MPU calculation is based, it can be "Mid P50" or "AC Price", in the case of ES the "AC Price" is used. If nothing is specified for this parameter, the model assumes the pivot price as "AC Price".
* **Number of contributors**: minimum number of contributors for considering the ipv values, in case this value is not informed, 5 contributors will be considered by default. In the case of Spain *“****Number of contributors*** *= 5”*
* **Number of observations for bucket proxy**: minimum number of observations for considering the buckets of the bucket proxy, in case this value is not informed, 5 observations will be considered by default. In the case of Spain “**Number of observations for bucket proxy***= 5”*
* **Number of observations for issuer proxy**: minimum number of observations for considering the buckets of the issuer proxy, in case this value is not informed, 5 observations will be considered by default. In the case of Spain “**Number of observations for issuer proxy** *= 5”*
* **Issuer proxy order:** fields for bucketing the issuer proxy, in case this value is not informed, the order [*issuer, maturity, currency*] will be considered by default. In the case of Spain the order [*issuer, maturity, currency*] will be considered.
* **Bucket proxy order**: fields for bucketing the bucket proxy, in case this value is not informed, the order [*rating, maturity, industry, area*] will be considered by default. In the case of Spain the order [*rating, maturity, industry, area*] will be considered.
* **Industry parametrization**: industry mapping for bucket proxy, in case this value is not informed, the parametrization in the table below will be considered by default.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Financial Institutions** | Diversified Finan Serv | Savings&Loans | Insurance | REITS | Investment Companies | Private Equity | Banks |
| **Governments** | Sovereign | Municipal | Regional (state/provnc) |  |  |  |  |

*Table 13: Default & Spain industry parametrization*

# MODEL IMPLEMENTATION

This section contains all the technical information about the implementation and the exact treatment of specific functional details as interpolations in market data, proxy calculation and the algorithm to apply calendars.

The objective from this section is to be able to calculate the following adjustments.

* **FVA CoC:**

|  |
| --- |
|  |

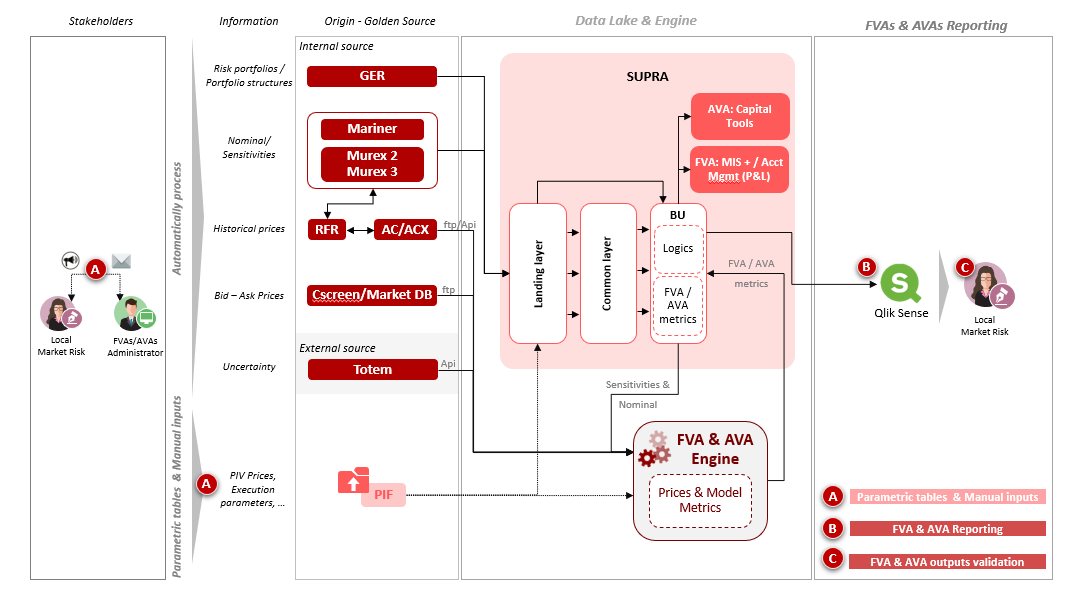
* **AVA CoC** (Gross):
* **FVA MPU**
* **AVA MPU** (Gross):

|  |
| --- |
|  |

* **AVA MPU** (Net):

## Model Architecture

The functional architecture of the interest rate FVAs and AVAs model is presented in the figure below:



*Figure 3: Functional architecture of FVAs and AVAs model.*

As shown in the previous figure, the main parts of the architecture are the following:

1. **Sources**: the main original data sources are: Murex, Mariner, Asset Control, GER and other manual inputs, such as parametrization files (more details in the Target Operating Model):
   1. Murex: it is the main source where market operations. Nominals are sent to SUPRA data lake where any necessary exceptional adjustment will be made in order to consolidate the data lake as the official nominals golden source.
   2. Asset Control: an internal software application that among others, is the golden source for instrument prices and market data in general, used by Santander Bank. The underlyings are identified by a unique code called ISIN.
2. **SUPRA:** collection process of the data available in the data lake (SUPRA). In this case Bonds/ABS nominals, which are treated as specified in previous sections and stored in the FVAs/AVAs BU.
3. **FVAs and AVAs calculation engine**: this is the core of FVAs and AVAs calculations. The engine performs different steps details in the next section.
4. **Reporting layer**: includes the intermediate or final reports generated by the engine and available for exploitation in QlikSense.

In the following section, further details of the technical implementation needed to build each part are described.

## Technical implementation

This section has been divided into five different sub-sections that enables the understanding of the logics behind the implementation:

1. Relevant information on the calculation process
2. Market quotes feeding
3. Proxy construction
4. Proxy application
5. Adjustment calculation

### Relevant information on the calculation process

**Number contributors**

The market data file, provided by IPV, should provide the number of contributors for mid-prices and for bid-offer spread quotes, more details in section 5.2.3.1. From this file only data with over a minimum number of contributors will be used to calculate the empirical adjustments. The number of minimum contributors may be parametrized by parameter (section 3).

If an ISIN has more contributions than the minimum value, the empirical percentiles will be generated from the data provided for performing the adjustment calculation. If it has less contributions than the minimum value, the observations will not be enough for an empirical percentile determination, and a parametric calculation or a proxy will be preferred.

**Proxy order**

The buckets are created following the hierarchical order indicated in the parameters of section 3.

The proposed proxy hierarchy has been defined to this order. However, the proxy bucket key order may be modified by the user. In addition, the user has the possibility to replace one of the proposed categories by any of the available static data. Note that the rating is required during the proxy execution, so it should be included as any of the bucket keys. An example in the following table:

| **proxy 1** | **proxy 2** | **proxy 3** | **proxy 4** |
| --- | --- | --- | --- |
| Rating | YEAR\_BUCKET | COMB\_IND | Area |

*Table 16. Proxy order tab example*

The proxy keys chosen are not expected to change.

**Bucket sector**

Key “COM\_IND” for the proxy may be parametrized by the user, where the different industries are to be grouped in less granular values. The following table contains a bucket sector parametrization example for the bucket bond proxy:

| **Financial Institutions** | **Governments** |
| --- | --- |
| Diversified Finan Serv | Sovereign |
| Savings&Loans | Municipal |
| Insurance | Regional(state/provnc) |
| REITS |  |
| Investment Companies |  |
| Private Equity |  |

*Table 26. Bucket sector parametrization example*

For this example, the sub-sectors defined in the column “Financial Institutions” will be assigned to the sector category “Financial Institutions”, and the same happens with “Governments”. Also, the user may input more columns, creating new sectors. Non-defined sub-sectors will be assigned to the category “Others”.

**Bucket proxy manual adjustments**

The user may manually input data to be used for each bucket through the file “Bucket proxy manual adjustments” as follows:

| **Bucket** | **sp50\_proxy** | **…** |
| --- | --- | --- |
| BBB to B-3Y <= t <= 7Y-Financial Institutions-Others | 0.34 | … |

| **…** | **STD\_sp90\_proxy** | **STD\_MID10\_proxy** | **STD\_MID90\_proxy** |
| --- | --- | --- | --- |
| … | 0.25 | 0.2 | 0.3 |

*Table 18. Bucket proxy gaps example*

The columns should be filled as follows:

1. Bucket: The bucket to be modified on the bucket proxy should be introduced in this column. The user may include only buckets that are observed in the tool, this is, combinations of the provided static data (please refer to 3.2) in the defined order (please refer to *Table 26*). The bucket should include all the categories that make up the proxy in the order defined in the *Proxy order* tab from the Control Code file.
2. Sp50\_proxy: The spread percentile 50 to be assigned for the bucket selected. The spread is a numeric field and expressed in 100-base term.
3. STD\_sp90\_proxy: The percentile 90 of the standard deviation of the spread to be assigned for the bucket selected. The standard deviation has been calculated from spreads, so it is a numeric field and expressed in 100-base term.
4. STD\_MID10\_proxy: The percentile 10 of the standard deviation of the mid-price to be assigned for the bucket selected. The standard deviation has been calculated from prices, so it is a numeric field and expressed in 100-base term.
5. STD\_MID90\_proxy: The percentile 90 of the standard deviation of the mid-price to be assigned for the bucket selected. The standard deviation has been calculated from prices, so it is a numeric field and expressed in 100-base term.

When proxying the non-informed values through the bucket-proxy, one additional bucket (from hereinafter, the bucket worst) is created.

The values in this bucket will be applied to those bonds which would use the fallback bucket specified in the parameter when cannot be created, guaranteeing that a value may be inferred for every bond/security.

For generating the prices for the bucket worst bucket, the most punitive value for each metric (i.e., the most punitive spread p50, the most punitive spread p90, the most punitive uncertainty short, etc.) among the least granular buckets will be used to populate the bucket worst metric.

**Issuer proxy manual adjustments**

The user has the possibility of completing the issuer proxy bucket values. As a way of example, if there is no data for an issuer, the price, standard deviation, and spreads may be inputted manually from the file “Issuer proxy manual adjustments” as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **issuer** | **P50\_MID** | **STD\_MID** | **P50\_SP** | **STD\_SP** |
| REPT | 89 | 0.21 | 0.15 | 0.1 |

*Table 19: Issuer proxy gaps example*

The columns should be filled as follows:

1. Issuer: The issuer to be modified or completed on the issuer proxy should be introduced in this column. Here, the user should include the GLCS code of the issuer. Note how the issuer should be already included in the tool.
2. P50\_MID: The percentile 50 of the mid-price to be assigned for the bucket selected. The percentile has been calculated from prices, so it is a numeric field and expressed in 100-base term.
3. STD\_MID: The standard deviation of the mid-price to be assigned for the bucket selected. The standard deviation has been calculated from prices, so it is a numeric field and expressed in 100-base term.
4. P50\_SP: The spread at percentile 50 to be assigned for the bucket selected. The spread is a numeric field and is to be expressed in 100-base term.
5. STD\_SP: The standard deviation of the spread to be assigned for the bucket selected. The standard deviation has been calculated from spreads, so it is a numeric field and expressed in 100-base term.

**Price quotation**

The price quotation correction is applied, to convert all prudent prices and spreads, in the IPV file, to percentage base unit quotes. The calculation engine converts the flat quoted bond prices to percentage prices and spreads. The price quotation per ISIN is to be inputted to the tool. Resulting prices will be used during the execution. The following table presents the format in which the quotation is to be inputted.

| **ISIN** | **NUM\_VALUE** |
| --- | --- |
| ES0377990009 | 1 |
| ES0378641023 | 1 |
| ES0378641072 | 1 |
| ES0378641031 | 1 |

*Table 20. Price quotation.*

For this correction, the tool assigns unitary quotation to those bonds with NUM\_VALUE equal to 0, percentage quotation to those bonds with NUM\_VALUE equal to 1 and flat quotation those bonds with NUM\_VALUE equal to 2. By default, if not informed the quotation will be assumed to be “Percentage”.

For flat bonds, to obtain the price in base 100, the following formula is applied:

### Market quotes feeding

* + - 1. MID-prices (bonds)

For Bonds, the market data is provided by IPV through an Excel file*,* including percentiles, standard deviations and the number of contributors used for calculating the prudent prices. The Bonds Excel file has the following structure:

| **ISIN** | **number\_contributors\_mid** | **p50\_mid** | **p5\_mid** | **p10\_mid** | **p90\_mid** | **p95\_mid** | **…** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ARARGE3209S6 | 3 | 39.80 | 39.70 | 39.70 | 40.23 | 40.24 | … |
| ARARGE3209T4 | 3 | 35.97 | 35.56 | 35.66 | 36.00 | 36.00 | … |
| ARARGE3209Y4 | 3 | 41.19 | 40.84 | 40.93 | 41.60 | 41.67 | … |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **…** | **std\_mid** | **number\_contributors\_spread** | **p50\_sp** | **p5\_sp** | **p10\_sp** | **…** |
| … | 0.25 | 4 | 0.57 | 0.51 | 0.53 | **…** |
| … | 0.24 | 4 | 0.5 | 0.48 | 0.48 | **…** |
| … | 0.36 | 4 | 0.53 | 0.51 | 0.51 | **…** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **…** | **p90\_sp** | **p95\_sp** | **std\_sp** | **…** |
| … | 0.63 | 0.64 | 0.06 | **…** |
| … | 1.17 | 1.2 | 0.35 | **…** |
| … | 2.27 | 2.56 | 0.97 | **…** |

*Table 37. Prices reported by IPV*

For the provided data prudent price data, base price corrections shown in 5.2.2 for Trade Details prices should be applied. Those instruments not quoted as percentage will be modified to percentage base quotes, and those with non-informed quote consensus will be treated as percentage by default.

**Yield to price transformation**

As mentioned in the model theory document (*[1])*, the prudent prices may be provided in yields or prices. If provided in yields, prudent yield values must be transformed to prudent prices to both perform the proxy and calculate the adjustments.

If the prudent values inputs are in yield prices, the user should parametrize the tool as explained before. The tool transforms these prudent values to percentage price units through the bond delta yield (BDY for short) sensitivity. To carry out this transformation the murex yield should also be provided with prudent yield values.

The following structure is expected when providing yields:

| **ISIN** | **number\_contributors\_mid** | **MPU\_P5** | **MPU\_P10** | **MPU\_P50** | **MPU\_P90** | **…** |
| --- | --- | --- | --- | --- | --- | --- |
| MX0SGO0000H6 | 3 | 3.323 | 3.327 | 3.365 | 3.413 | … |
| MX0SGO0000E3 | 3 | 3.322 | 3.324 | 3.355 | 3.390 | … |

| **…** | **MPU\_P95** | **number\_contributors\_spread** | **COC\_P5** | **COC\_P10** | **…** |
| --- | --- | --- | --- | --- | --- |
| … | 3.417 | 3 | 0.020 | 0.025 | … |
| … | 3.420 | 3 | 0.030 | 0.037 | … |

| **…** | **COC\_P50** | **COC\_P90** | **COC\_P95** | **Yield\_Murex** |
| --- | --- | --- | --- | --- |
| … | 0.030 | 0.209 | 0.210 | 3.380 |
| … | 0.040 | 0.276 | 0.280 | 3.355 |

*Table 22. Prudent prices in yield format.*

In this case, the parameter "Yield = YES" indicates that the prudential values are in yield format. As mentioned, to transform to percentage prices the Approximate Modified Duration for each bond must be obtained using the BDY (Bond Delta Yield). This data can be obtained in the trade\_details file.

* + - 1. Bid-ask prices (ABS)

For ABS the market data is provided by IPV through an Excel file. The prices collected from the RUNS function (from the Bloomberg platform), are reported as follows,

| **ISIN** | **Fch** | **Dealer** | **Fuente** | **Prec Bid** | **Prec Ask** |
| --- | --- | --- | --- | --- | --- |
| BE0002493683 | 05/09/2019 | JPM | RUN | 100.38 |  |
| BE0002493683 | 03/09/2019 | JPM | RUN | 100.39 |  |
| BE0002493683 | 25/09/2019 | JPM | RUN | 100.298 |  |
| BE0002493683 | 13/09/2019 | JPM | RUN | 100.27 |  |

*Table 23. Structure of RUNS prices*

Additionally, IPV reports the theoretical prices. Boadilla SCIB uses a valuation tool called Intex. The expected format of the file is:

| **ISIN** | **bid\_theorical** | **ask\_theorical** | **intex\_theorical** |
| --- | --- | --- | --- |
| ES0305370001 | 99.821 | 99.935 | 99.878 |
| ES0305442008 | 100.117 | 100.263 | 100.19 |
| ES0312282009 | 99.444 | 100.023 | 99.7335 |
| ES0312887013 | 97.104 | 98.068 | 97.586 |
| ES0313814065 | 96.784 | 98.25 | 97.517 |

*Table 24. Theorical prices*

### Proxy construction

* + - 1. MID-prices (bonds)

For bonds two proxies have been developed, an issuer proxy and a bucket proxy.

The information required for the modelling of both proxies is based on the data downloads from the different sources (e.g., Bloomberg). Specifically, IPV files and statics dataare needed.

**Issuer Proxy**

Data involved

The static features of each bond are an input of the model, static data information. This information is obtaining from AC (see section 3).

The calculation of the issuer proxy is carried out using the prices provided by IPV and the static data following the steps detailed below.

Building the proxy

This proxy is defined for each category, where a category is given by a combination of the following keys, the issuer and the maturity bucket. First, it is to highlight how the maturity considered will be bucketed among less than 3Y maturity, between 3Y and 7Y maturity and over 7Y maturity buckets. This will allow to avoid excessive granularity.

1. Issuer – Issuer of the security, equivalent to the GLCS code
2. Maturity tranche – Maturity date bucketed as *short term* (under 3Y maturity), *medium term* (over 3Y but under 7Y maturity) and *long term* (over 7Y maturity) tranches.
3. Currency – Currency in which the currency is issued (sec\_currency of trade\_details).

For each ISIN within the category with at least one observation of bid-ask spread, the P50 of those observations is considered. The proxy-spread-P50 considered for the category is calculated as the 50th percentile of those spreads P50 calculated for all the ISINs in the category with data available.

For ISINs with at least three observations of bid-ask spread, the standard deviation of those bid-ask spreads is considered. The proxy bid-ask-spread-standard-deviation built for the category is obtained as the 50th percentile of the standard deviations calculated for all the ISINs in the category with enough bid-ask spreads available.

Finally, for each ISIN with at least three observations of mid-prices, the standard deviation of those mid-prices is calculated. The proxy mid-price-standard-deviation built for the category is obtained as the 50th percentile of the standard deviations calculated for all the ISINs in the category with enough mids available.

The result of the issuer proxy is linked to their correspondent ISINs through the field issuer.

**Bucket Proxy**

Data involved

The static features of each bond are an input of the model, static data information. This information is obtaining from AC (see section 3).The buckets will be different from those in the Issuer proxy.

Building the proxy

Through the function rating\_builder, the algorithm generates the categories in which all the ISINs will be classified. All the available ISINs in Asset Control are taken into consideration, labeling each bond depending on Region, Industry, Rating, Maturity. The buckets for each axis are:

1. Rating – Rating bucketed as *AAA to A*, *BBB to B* or *CCC to D*.
2. Maturity tranche – Maturity date bucketed as *short term* (under 3Y maturity), *medium term* (over 3Y but under 7Y maturity) and *long term* (over 7Y maturity) tranches.
3. Sector – Financial Institutions, Governments, Covered Bond. The sectors may be parametrized by the user as is shown in Table 27. Although *Covered Bonds* are not an industry, due to the special observed behavior are treated as an independent industry.
4. Region – Region in which the security is issued, bucketed in *Europe*, *LATAM*, *North America* and *Others*. More details about the country mapping in Appendix II: Region classification.

The algorithm builds a table:

| **ISIN** | **bucket\_rating** | **covered\_bond** | **bucket\_industry** | **Year\_bucket** | **bucket\_region** |
| --- | --- | --- | --- | --- | --- |
| CH0029008809 | AAA to A | N | Financial Institutions | t<3Y | Others |

*Table 44. Issuer proxy output example*

For that ISINs with no rating informed the user fallback will be applied, more details in 5.2.1.

* + - 1. Bid-ask prices (ABS)

As in bonds proxies, a set of static data from the securities is loaded, in this case, the fields involved in the process are:

| **ISIN** | **maturity** | **bb\_dx533\_is\_covered** | **rating\_external\_normalized** | | | **RESA\_issue\_normalized** | **bb\_ds530\_defaulted** | | **GLCS** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ES0313270045 | 17/07/2049 | N | | BB- | AA | | N | BA13D1 | |
| US3138XC3H31 | 01/11/2028 | N | |  | B | | N | 3T65 | |
| US3140H5BA86 | 01/01/2048 | N | | A+ | CCC | | N | 00FMQA | |

*Table 26. Static data for ABS example*

The detail of how the static data are input is given in section 3.

As in bonds proxies, a set of issuer static data from the securities is loaded, the fields involved in the process are:

| **GLCS** | **Industry\_group** | **country** |
| --- | --- | --- |
| 1VV3 | Other ABS | IT |
| DW20A1 | Automobile ABS | GB |
| NFMIPX | Credit Card ABS | ES |

*Table 27. Issuer static data for ABS*

The target of this part of the process is to obtain the 50th percentile and the 10th percentile of the bid prices used to compute the adjustments. These will be calculated from the information of RUNS prices for ABS instruments.

Data Formatting

Information of rating, instrument\_type and industry type given in RUNS (first table in 4.2.3.2 section) are mapped to the buckets defined of each category. A table as the one presented below should be obtained for each ISIN,

| **ISIN** | **instrument\_type** | **industry** | **rating** | **…** |
| --- | --- | --- | --- | --- |
| ES0305192009 | Whole Loan | WL Collateral CMO | AA | … |

| **…** | **product\_type** | **Bucket\_1** | **Bucket\_2** | **Bucket\_3** |
| --- | --- | --- | --- | --- |
| … | ABS | AA-Whole Loan-WL Collateral CMO | AA-Whole Loan | AA |

*Table 47. Bucketing of features*

Some observations could appear duplicated in the RUNS extraction (more detail in first table in 4.2.3.2 section). In this step, duplicated prices for the same date and contributor are removed. Additionally, observations with ask price lower or equal than bid price are considered erroneous and are removed[[8]](#footnote-9).

Once the available data is filtered, the engine calculates the bid-ask spreads as the difference between the ask and the bid in the same date and same contributor. This will be one of the fields to be proxied.

Building the proxy

As for bonds, the ABS proxy will be based on a series of defined keys which will build each proxy bucket. The considered keys for ABS are presented below,

1. Rating – Rating bucketed as *AAA to A*, *BBB to B* or *CCC to D*.
2. Instrument type – Type of ABS instrument.
3. Industry – Industry to which the ABS applies to.

All the final variables used for the FVA/AVA are calculated. The result obtained assorted by ISIN and Date is shown in an intermediate output (see user guide).

While, when sorting by all the ISIN window, the following data has been obtained:

Note how the percentile 50 bid will not be proxied.

Proxy output

Once all the bid percentiles, spread percentiles and standard deviations percentiles are obtained. Percentiles are obtained considering observations for different days. The next step is the proxy construction using the three segmentation variables. For each bucket the following is calculated:

* Number of ISIN observations for both bid prices and spreads conforming the bucket
* Percentile 50 of Spreads P50, P90 and P95.
* Percentile 50 of bid standard deviations

For buckets with less than three observations, a bucket with a lower granularity but with over three observations will be used.

The following table show an example of the buckets with the highest level of granularity:

| **Bucket** | **spreadP50\_bucket** | **spreadP90\_bucket** | **…** |
| --- | --- | --- | --- |
| A-Whole Loan-WL Collateral CMO | 0.36 | 0.38 | … |
| AA-ABS-Automobile ABS | 0.11 | 0.13 | … |
| AA-ABS-WL Collateral CMO | 0.45 | 0.51 | … |

| **…** | **spreadP95\_bucket** | **Std50\_bucket** | **Std10\_bucket** | **Std05\_bucket** |
| --- | --- | --- | --- | --- |
| … | 0.39 | 0.11 | 0.21 | 0.27 |
| … | 0.13 | 0.03 | 0.05 | 0.06 |
| … | 0.53 | 0.03 | 0.06 | 0.07 |

*Table 29.* *Spreads and dispersion for different buckets*

In this table, spreads and standard deviations percentiles are shown for different buckets. Again, the user may parametrize the fallback to be used for that ABS with no rating available.

### Proxy application

* + - 1. MID-prices (bonds)

Once the proxy has been generated it will be used to fill those instruments with no market prices available. As mentioned in 5.2.4.1, if there is a bond with no market prices available but there are market prices for its issuer, the issuer proxy will be the first one applied.

Depending on the static data available for the bond, the bucket used will have a different level of granularity. When there is no spread data, but rating, maturity, industry, and area information/data is available, the bucket with the highest granularity level will be applied. However, if there is no region data, only rating, maturity and industry will be used. Also, if the industry data is not available, following the hierarchy presented in 5.2.4.1, only rating and maturity will be applied for the bucket. Finally, if there is only information available about the rating, the less granular proxy will be used.

According to the parameterization indicated before, when the number of observations is greater or equal to 5 the empirical approach will be applied, this is, the percentiles reported within the IPV file will be considered for the AVA adjustment.

If the number of observations is lower than 5 but greater to 3, the IPV price certified will be used, but the prudent prices will be generated by assuming a normal distribution with the ISIN’s own data (as seen in section 6.4 of the Model Theory documentation *[1]* ). The standard deviation will be retrieved from the ISIN quotes available.

Lastly, if the number of observations is lower than 3, a proxy approach based on normality approach assuming normality on spreads will be applied (as seen in 6.4 of the Model Theory documentation *[1]* ). The standard deviation of the security will be obtained via proxy through the processes/methodologies described in previous sections.

Percentile 50 mid prices and Bid Offer spreads follow a different approach. If a price is provided by IPV, this will be the preferred one. Else, the mid-price at percentile 50 will be assumed to be the Santander internal price, and a proxy approach based on assuming normality on spreads will be applied to generate the percentile 50 spread (as seen in section 6.4 of the Model Theory documentation *[1]* ).

* + - 1. Bid-ask prices (ABS)

Once the proxy has been generated it will be used to fill those instruments with no bid-ask prices available. To start off, the issuer proxy will be used to fill gaps, as mentioned in 5.2.4.2, if there is an instrument with no data available but there is data for its issuer, the issuer proxy will be applied. For cases that cannot be filled with the issuer proxy, the buckets contained in Table 29 will be used. The most granular proxy (rating-maturity-instrument type-industry) that will be applied when all static data is available includes rating, instrument type and industry. On the other hand, for ABS the less granular proxy only includes rating, as in bonds. Note that, if there is no Industry, and an intermediate level of granularity exists, only rating and instrument type will be used for the bucket.

The following cases are distinguished, applied with the following preference order (as detailed in section 6.3 of the Model Theory documentation *[1]* ),

1. Over 5 quotes on the same date for an ISIN – Empirical calculation considering data of the most recent date with most observations
2. Over 3 quotes on the same date for an ISIN – Parametrical approach considering data of the most recent date with most observations
3. Over 5 quotes in the whole window for an ISIN – Empirical calculation considering all the data available
4. Over 3 quotes in the whole window for an ISIN – Parametrical calculation considering all the data available
5. Under 3 quotes in the whole window for an ISIN – Parametrical calculation by inferring the standard deviation through the defined proxy

If there are no bid prices available in the market data provided but there is at least one ask price for an ISIN, the ask observations will be used, as seen in section 6.3 of the Model Theory documentation *[1]* . For short positions, if there are no ask prices available in market data, bid price will be used. More details in the 6.3 section of the Model Theory document *[1]* .

If there are not market quotes for a particular ISIN, but there is a theoretical price, this will be considered.

If for a particular ISIN there are no quotes available, nor a theoretical price, the Santander price will be used as reference point. This price will be considered as a fallback solution, even though it is expected to be an infrequent case. More details about this subsection may be found in section 6.3 of Model Theory *[1]* .

### Adjustment calculation

**Bonds & ABS**

This section explains how the adjustments are being calculated. Note that adjustments will not be calculated for all bonds and ABS, there can be exemptions for different reasons. For those to which an adjustment is calculated, the formulas may be consulted in Model Theory *[1]* .

The output file shows the calculated adjustments and the values used to calculate them. The following file shows an example of the output file with more details:



*Table 30. Example of FVA & AVA adjustments output*

See details on how to exploit and interpret each field in the user's guide.

It is important to note that over the final calculation obtained for the bond calculator **the double counting will be eliminated with the Delta IR calculator** (making use of the adjustments obtained through the special bond execution). About this process the following points are relevant:

1. Non-application of exemptions

1. In the IR Delta bond calculator, the exemptions made for IR Delta will not be taken into account, so that the adjustment associated with exempt curves in delta ir will be removed in the elimination of double counting.
2. In the IR Delta bond calculator, exemptions on bonds that are exempt in the bond calculator will not be applied, but if a bond is exempt in the price bond calculation, double counting will not be eliminated (thus avoiding negative adjustments).

2. For negative CoC adjustments when double counting is removed, in this case the bonds adjustment (in the bonds calculator) will be capped at 0.

3. For MPU adjustments the double counting of FVA MPU is not eliminated and in the case of AVA MPU the IR Delta Net AVA MPU will be eliminated from the bond Gross AVA MPU.

Where,

* *“bond final”* is the final adjustment after removing the double counting
* *“bond”* is the adjustment of bond calculator without take into account double counting
* “ir delta” is the adjustment of ir delta bond calculator

4. For the ABS calculator, double counting will not be removed due to the expected low materiality of the Delta IR ABS adjustment.

See the detail about this process in the theoretical model.

### Output

The details of the different output outputs are detailed in the user's guide.

## User guide

All the information about how to use the tool, how to load the files and the rest of the information about the execution is detailed in the User Guide [5].

This guide includes all information about the necessary files for the execution, the format in which they must be loaded and the way to do it through the PIF platform.

# MODEL Monitoring

The aim of the model monitoring and control implementation is to detect in advance the existence of potentially risky behaviors and thus be able to take the necessary measures in advance, in addition to reviewing and calibrating the parameters used in the model periodically and verifying that are still adequate or if not, make an adaptation of them.

* **Global monitoring**

The global monitoring process will be carried out by the administrators' team and will be common for all the group units, the details of which can be found in the FVAs AVAs Target Operating Model. The details of the global detail of the controls and FVA/AVA standards and policies are described in the theoretical model.

* **Local monitoring**

Once the values are updated, figures are inserted in MIS via adjustment, sent to Cristine II as the consolidated official number of P&L monthly basis and reported via e-mail to the following areas:

1. Accounting
2. Finance
3. Middle Office
4. Global Market Risk SCIB

In addition, a daily sign off by Front Office of the P&L report takes place, and numbers are also reviewed monthly in the “Meeting ACPM Tesoreria Boadilla”

The market risk team sent the numbers to Cristine II and reports on a quarterly basis on the amount of the prudential value adjustment (AVA) with a breakdown by business, as well as the main drivers of changes to the following areas:

1. Corporate market risks
2. Capital Corporation

Results are presented and discussed on a quarterly basis at the Meeting ACPM Tesoreria Boadilla and in the Regulatory Internal Model Working Group (RIMWG).

It should be noted that as part of the governance and monitoring of the FVA/AVA calculation process, it is established that all changes in the parameterization of the tools must be communicated to the corporation in order to communicate and analyze minor or significant changes with Model Risk:

1. Change in scope: request for manual exclusion of books, portfolios, products or underlyings
2. Changes in the parametrization of the tool

# References

*[1] FVA\_AVA\_Bonds\_ABS\_ModelTheory, Methodological Standards, April 2021*

*[2] Additional Value Adjustments (AVA) \_ Methodological Standards, Market Risk Methodology, Nov 2018*

*[3]* *“Guia\_IPV\_V5.6.docx”, IPV Team, April 2021*

*[4] Fair\_Value\_Adjustments\_Methodological Standards\_v3, Market Risk Methodology, May 2018*

# Change Control

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Version** | **Owner** | **Changed by** | **Date of change** | **Validated by** | **Committee approval** | **Approval date** | **Scheduled review date** |
| 1 | Pablo Blanco | Ignacio Hoyos | 05/05/2021 | Elena Lopez |  | 15/07/2021 |  |
| 2 | Pablo Blanco | Ignacio Hoyos | 10/05/2021 |  |  |  |  |

|  |  |
| --- | --- |
| **Version** | **Description of change** |
| 1 | Initial version |
| 2 | 1. Intragroup bonds identification automated through using DataLake information 2. ABS and bonds segregation incorporated through using DataLake information 3. Modification of the scope filtering parametrization 4. Marginal distribution module modified to allow different levels of distribution 5. Market Making module modified to allow the user to apply the condition individually per adjustment 6. Parametrization of the results of the issuer proxy and bucket proxy to be applied allowed 7. The option of modifying the bucket proxy bucket’s order and fields, and possibility of using the currency in the bucket proxy incorporated 8. Parametrization of the Industry field categories of the bucket proxy included 9. Parametrization of the Industry categories of the bucket proxy allowed 10. Basis price corrections included in the tool and automated through using DataLake information 11. The labeling of the output report renamed |

1. Regarding the MX3EQ source system, it contains all bonds with exoticity in the payoff contractual condition. This is, all bonds with any kind of optionality, convertibility or such will be loaded from this source. When pricing these bonds, the price of the implicit optionality must be subtracted (or added) to the bond price. Since the optionality risk is assessed in their own models (Vega EQ or Vega IR VA models), these bonds are excluded from the scope of the Bonds/ABS VA models. These will later be assessed in the different newly developed VA models after each underlying risk factor. This will guarantee a consistency among the data used in this model, and therefore all the proxies and FVA/AVA final adjustment calculation will be performed with consistent, comparable data. [↑](#footnote-ref-2)
2. Defined as the Live Nominal (i.e., deducting any amortization of principal) [↑](#footnote-ref-3)
3. If the bond has a position under scope, every available contribution out of 13 chosen contributors are considered. Else, only the quote of a contributor is downloaded [↑](#footnote-ref-4)
4. Quality understood as at what point the price reflects the reality of the market, when a trader wants to close certain position. [↑](#footnote-ref-5)
5. The exposed examples have quotes of the available key players, but not of every key player, due to the lack of access. [↑](#footnote-ref-6)
6. This is considered appropriate since prices from ABS are very stable in a short period of time. This is due to the fact that ABS are normally referenced to a floating interest rate, so its prices are not very sensible to interest rate levels since both ABS cash-flows and discount factors are proportionally affected by changes in market interest rates, mainly senior tranches where the fixed spread of the coupon is small. Regarding other factors that influence the price of the ABS: the default rate responds to changes in the status of the collateral, and it is not updated more often than quarterly and only affects to junior and mezzanine tranches; the prepayment on the other side, mostly affects to bonds with high par premiums or par discounts and is also not updated more often than quarterly. The discount margin is the variable that is more reactive to the market expectations, but it doesn’t change dramatically except for in stress periods [↑](#footnote-ref-7)
7. This field is obtained through the trade details file, because in this table is where the data is certified, and if we do not have information here, we look for it in the Bucket bonds file. [↑](#footnote-ref-8)
8. If bid id equal to ask price, those prices could be considered a correct observation of a mid-price. However, in the case of ABS, we focus on the bid-prices and bid-ask spreads. Therefore, observations with zero spread will be discarded. [↑](#footnote-ref-9)