Final Report

Guidelines

on criteria for the use of data inputs in the risk-measurement model referred to in Article 325bc of Regulation (EU) No 575/2013 (Capital Requirements Regulation)

Contents

1. Executive Summary

Regulation (EU) No 575/2013, i.e. the Capital Requirements Regulation (CRR), has been amended by Regulation (EU) No 2020/876 (revised CRR), which introduces into EU legislation, *inter alia*, the revised framework for minimum capital requirements for market risk, developed by the Basel Committee and published in their final version in January 2019.

The alternative internal model approach is one of the novelties introduced by the revised CRR. It is designed to capture market risks taking into account tail risks, risk of market illiquidity and default risk through the sum of three components: i) the expected shortfall (ES) risk measure, which determines capital requirements for those risk factors for which a sufficient amount of observable data is available (modellable risk factors); ii) the stress scenario risk measure for risk factors with limited observable data (non-modellable risk factors); and iii) the own funds requirement for default risk associated with credit and equity positions.

Article 325bh(3) of the CRR mandates the EBA to develop guidelines (GL) specifying the criteria for the use of data inputs referred to in Article 325bc of the CRR (i.e. the data inputs used to determine the scenarios of future shocks applied to the modellable risk factors) in calculating the partial expected shortfall measures in accordance with the same article. The GL should clarify the requirements that these data inputs should meet to be used for determining the scenario of future shocks in the institutions' expected shortfall risk measure.

On 12 August 2020, the EBA published a consultation paper[1] on which these GL are based. Three responses were provided on the consultation paper, with two of them being non-confidential and published on the EBA website. A summary of the non-confidential responses, along with the EBA analyses of those responses, is included at the end of this document. The EBA considered the feedback provided by all respondents in finalising these GL.

The GL set out criteria for the accuracy, appropriateness, frequency for updating and completeness of the data inputs used by institutions. The data inputs used in the ES model, in order to be accurate, should be calibrated to historical data reflective of prices observed or quoted in the market. In order to be appropriate, the data inputs should capture, where relevant, both general and specific risks. Those data inputs should also be updated as often as possible, to account for changing market conditions. Finally, those data inputs should prove to be complete, and, in this respect, various aspects are considered, such as the replacement of missing or inconsistent values.

The GL will apply from 1 January 2022.

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[1] https://www.eba.europa.eu/sites/default/documents/files/document_library/Publications/Consultations/2020/EBA-CP-2020-21/923213/EBA-CP-2020-21%20%28CP%20draft%20GL%20on%20criteria%20for%20the%20use%20of%20data%20inputs%20for%20the%20ES%20risk%20measure%20under%20the%20IMA%29.pdf

2. Background and rationale

Regulation (EU) No 2020/876, i.e. the revised Capital Requirements Regulation (revised CRR), implements in EU legislation the revised framework for minimum capital requirements for market risk, also known as Fundamental Review of the Trading Book (FRTB), developed by the Basel Committee and published in its final version in January 2019.

One of the novelties introduced by the FRTB and included in the revised CRR is the alternative internal model approach, specifically revised to overcome the identified drawbacks in the Basel 2.5[2] internal model approach.

The alternative internal model approach comprises three different components. The first component is the ES risk measure, which determines capital requirements for those risk factors with a sufficient amount of available observable market data (i.e. for risk factors identified as modellable). The second component is the stress scenario risk measure (SSRM), for determining capital requirements for risk factors with limited observable market data, i.e. assessed as non-modellable risk factors (NMRF). Finally, credit and equity positions are subject to own funds requirements for the associated default risk.

Under Article 325be of the CRR, institutions are required to assess the modellability of the risk factors of positions assigned to the trading desks included in the scope of the alternative internal model approach. Namely, for a risk factor to be modellable, it should be verified by the institutions that it meets the criteria specified in the relevant RTS ('Draft Regulatory Technical Standards on Criteria for assessing the modellability of risk factors under the Internal Model Approach (IMA) under Article 325be(3) of Regulation (EU) No 575/2013'[3]). Those criteria relate to the identification of a sufficient number of 'verifiable prices', being representative for the risk factor, over the preceding 12-months. Those quantitative criteria are intended to ensure that the risk factors, which institutions include in the calculation of their ES risk measure, are sufficiently liquid and observable.

Once the set of modellable risk factor has been determined in accordance with Article 325be of the CRR, institutions should choose appropriate data inputs for each of those modellable risk factors in order to calculate their ES risk measure. The need for outlining which data inputs are suited for a risk factor to be included in the model used to calculate the partial ES measures referred to in Article 325bc of the CRR ('ES model' throughout the rest of this section) is also underlined by the Basel

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[2] Basel Committee on Banking Supervision, Revisions to the Basel II market risk framework (updated as of 31 December 2010), February 2011, www.bis.org/publ/bcbs193.pdf

[3] https://eba.europa.eu/sites/default/documents/files/document_library//EBA-RTS-2020-03%20Final%20draft%20RTS%20on%20Risk%20factor%20modellability.pdf

Committee when defining Principles[4] for the inclusion of risk factors in the ES model after they have been assessed modellable, i.e. after they have passed the Risk Factor Eligibility Test (RFET).

The data inputs used to determine the scenarios of future shocks applied to the modellable risk factors for the computation of the ES risk measure must, according to Article 325bc of the CRR, be calibrated to historical data, from either the preceding 12-month period or a continuous 12-month period of financial stress. Institutions may use different sources or types of historical data for this purpose. In particular, the EBA acknowledges that the historical data used to calibrate the data inputs referred to in Article 325bc of the CRR do not necessarily need to be obtained from the verifiable prices that were used to assess the modellability of the risk factors under Article 325be of the CRR.

For this reason, once a risk factor has been deemed modellable, the institution should verify that the data inputs for that risk factor are accurate, appropriate, frequently updated and complete, based on the provisions included in these GL, for the drafting of which the EBA is mandated under Article 325bh(3) of the CRR.

In these GL, on top of general provisions that should always apply, specific provisions are included to cover specific cases where the EBA identified the need for addressing particular issues. In particular, specific provisions are included to cover the following specific cases:

(a) data inputs from the current period, i.e. from the preceding 12-month period;

(b) data inputs from the identified period of financial stress;

(c) data inputs used in multifactor models ('Beta approximations' throughout the rest of the GL) and other random data-generating approaches (e.g. Monte Carlo methods) for the purpose of determining the scenarios of future shocks;

(d) data inputs used for combinations of risk factors;

(e) interpolation and extrapolation techniques used for replacing missing or inconsistent values in the data inputs.

Interactions with the CRR and clarification of the notion of data inputs

Article 325bi of the CRR specifies qualitative requirements that an internal risk-measurement model shall satisfy, including the requirement for an institution to conduct an independent review of its internal risk-measurement models. That review is required to assess, in particular, the accuracy and completeness of position data, the accuracy and appropriateness of volatility and correlation assumptions, the accuracy of valuation and risk sensitivity calculations, and the accuracy

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[4] Minimum capital requirements for market risk, January 2019 (rev. February 2019), paragraphs MAR31.25 and MAR31.26

and appropriateness for generating data proxies where the available data are insufficient to meet the requirement set out in Part 3, Title IV, Chapter 1b of the CRR. With this in mind, the criteria set out in these GL relate to the accuracy, appropriateness and completeness, as well as frequent updating of the data inputs used in the ES model.

The mandate in Article 325bh(3) of the CRR explicitly restricts the scope of these GL to data inputs referred to in Article 325bc and used for the ES calculations, where data inputs are mentioned in relation to the determination of the scenarios of future shocks applied to the modellable risk factors.

Paragraphs (2)(c) and (2)(d) of Article 325bc of the CRR require the data inputs used to determine the scenarios of future shocks applied to the values of modellable risk factor and used for calculating PES_t^{RS} and $PES_t^{RS,i}$, to be calibrated to historical data from a continuous 12-month period of financial stress. Paragraph 2(c) also specifies how institutions should identify that period of financial stress. Paragraphs (3)(c) and (4)(c) of that Article require the data inputs used to determine the scenarios of future shocks applied to the values of modellable risk factor and used for calculating PES_t^{RC}, $PES_t^{RC,i}$, PES_t^{FC} and $PES_t^{FC,i}$, to be calibrated to historical data from the preceding 12-month period.[5] In paragraph 3(c), it is also specified that those historical data shall be updated on at least a monthly basis.

Therefore, according to Article 325bc of the CRR, historical data represent the starting point (the 'initial' data) for an institution to calibrate the data inputs, which are ultimately used to determine the shocks in its ES model. Depending on the modelling approach chosen by an institution, this calibration process can be performed either by applying transformations on historical data, or employing directly the historical data as the data inputs used for the determination of the scenarios of future shocks. For the purpose of these GL, the data inputs should be understood as the data that an institution directly uses for determining the scenarios of future shocks.

Before laying down the criteria for the use of data inputs, it is important to further clarify, also by means of examples, what data inputs are in the context of Article 325bc of the CRR, highlighting in particular if and how they differ from historical data.

For example, consider the case of an institution that uses a zero-coupon rate of tenor 'x' as a risk factor and that the value of the risk factor (i.e. the zero-coupon rate of tenor 'x') is calibrated by constructing the zero-coupon yield curve from interest rate swaps (via bootstrapping). Accordingly, the historical data (i.e. the data that are used to calibrate the data inputs in accordance with Article 325bc of the CRR) for that risk factor are the rates in the interest rate swaps and the data inputs are the zero-coupon rates.

In general, where an institution uses a historical simulation approach in its ES model, the institution obtains the data inputs for the risk factor 'x' from the historical data (i.e. the swap rates in the

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[5]Where there is a significant upsurge in the price volatility of a material number of modellable risks factors not in the reduced subset, competent authorities may require an institution to use historical data for a period shorter than the preceding 12-months, but not shorter than the preceding six-months. Competent authorities shall notify and substantiate any such decision to the EBA.

previous example) in the period of financial stress referred to in Article 325bc(2)(c) and in the preceding 12-month period referred to in Article 325bc(4)(c). As a result, the institution builds a time series comprising the values taken by the risk factor (i.e. the zero-coupon rate of tenor 'x' in the previous example) in the two abovementioned periods. The data in that time series – that in the previous example coincide with the values taken by the risk factor 'x' – are the data inputs to which the criteria of these GL are applicable, as such data inputs are those that are finally used for determining the scenarios of future shock.

Differently from the previous example and depending on the modelling approach chosen by an institution, there could be cases where the data inputs coincide with the historical data. For example, consider the case where an institution includes in its risk-measurement model a risk factor being a stock price and uses an historical simulation approach to calculate the ES risk measure. In such a case, the institution may directly use the prices of that stock (these being historical data) as the data inputs from which the scenarios of future shocks are determined.

In the examples provided so far, the data inputs ultimately coincide with the values taken by the risk factor in the periods that are to be considered by the institution for the purpose of calculating the ES risk measure. This conceptual mapping 'data inputs = values of the risk factor in the relevant period', used in the consultation paper (CP), works well for ES models that are based on a historical simulation approach. However, other approaches may be used – e.g. institutions may generate scenarios of future shocks using Monte Carlo simulations. Therefore, the EBA is of the opinion that the notion of data inputs should not be limited to the mapping 'data inputs = values of the risk factor in the relevant period' but should be broader, in order to also encompass the cases where the data inputs are not values of risk factors, as further explained in the example provided in the paragraph below.

Where institutions use simulation approaches other than the historical one, scenarios of future shocks are the realisations of a probability distribution whose parameters are determined on the basis of the data inputs that are chosen for the purpose of generating those shocks. For example, where an institution wants to simulate shocks applicable to a risk factor being a stock price, the institution would most probably do so by using a probability distribution whose parameters have been determined to match the observed distribution of the returns of that stock in a specific period. Considering that such returns (i.e. the historically observed returns) are actually those that will be used for determining the probability distribution's parameters and hence the scenarios of future shocks, they are also the data inputs to which the criteria of these GL are applicable (i.e. the data inputs are the observed returns that are used to determine the probability distribution's parameters). It should be noted that the mapping 'data inputs = values of the risk factor in the relevant period' does not hold anymore, since, in this example, the data inputs are returns (and not values of a risk factor).

It is also beneficial to consider an additional example that compiles some features of the previous examples. Consider again the case of an institution that uses the zero-coupon rate of tenor 'x' as a risk factor. Suppose that the value of the risk factor (i.e. the zero-coupon rate of tenor 'x') is derived by constructing the zero-coupon yield curve from interest rate swaps (via bootstrapping). In

addition, the institution uses a simulation approach to derive the scenarios of future shocks applicable to the zero-coupon rate of tenor 'x'. Suppose that, to do so, the parameters of a probability distribution are calibrated on the returns of the zero-coupon rate of tenor 'x' in the relevant periods. In this process, it can be argued that two 'calibrations' are undergone:

(i)   the institution has to transform swap rates into zero-coupon rates;

(ii) the institution has to determine the parameters of the probability distributions by means of the calculated (and not directly observed in the market) zero-coupon rates' returns;

The requirement 'data inputs are to be calibrated on historical data' is interpreted as referring to the first of the two calibration processes, i.e. the swap rates are the historical data that allows the calibration of the zero rate returns. Hence, the calibrated zero-coupon rate returns are the data inputs to which the criteria of these GL are applicable.

For an institution using a Beta approximation to determine the scenario of future shocks, the data inputs should be considered as the data that are used both to set the values of the Beta coefficients, and those that are used to set the values of the variables multiplying those Beta coefficients. Indeed, all those data will have a direct impact on what the scenarios of future shock will be. Also in this case, the EBA acknowledges that a notion of data inputs broader than the one proposed in the CP (i.e. 'data inputs = values of the risk factor in the relevant period') is needed, as often the data used to set the values of the Beta coefficients and of the variables multiplying those Beta coefficients are returns. Hence, as mentioned above, the EBA uses in these GL a notion of data inputs broader than the one proposed in the CP, in order to encompass the cases (e.g. where Beta approximations are used) where the data inputs are not values of risk factors.

2.1   Accuracy of the data inputs

The data inputs used in the ES model, in order to be accurate, should be calibrated to historical data reflective of prices observed or quoted in the market. The EBA considers that the first source of prices observed or quoted in the market is represented by the verifiable prices collected for the purpose of the modellability assessment performed in accordance with Article 325be of the CRR.

Where the data inputs used are not calibrated to verifiable prices collected for the purpose of the modellability assessment, the institution should demonstrate that those data inputs are calibrated to historical data which are reasonably reflective of verifiable prices, i.e. which do not substantially deviate from the verifiable prices, and which are not consistently biased in any fashion.

In addition, the data inputs used in the ES model, in order to be accurate, should reflect the properties of the distributions of the corresponding risk factors and should also reflect the dependency structure between the distributions of corresponding risk factors. In order to do so, institutions should, at a minimum, verify that the volatility of risk factors, as well as the correlations between risk factors, are accurately reflected by the data inputs used. As volatilities and

correlations are main drivers of the output of the risk-measurement model, the data inputs should allow the ES model to accurately reflect the volatility of risk factors included in the scope of the ES model, as well as the correlations between those risk factors. Additionally, other distributional properties (e.g. skewness and kurtosis) should be taken into account, where relevant.

The respondents to the CP called the attention to several points related to the implementation of such requirements (i.e. in relation to paragraphs 12 to 14 of the CP). Firstly, it was remarked that the data used for the purpose of the modellability assessment may not be used by institutions for calibrating the data inputs used in their ES models. Secondly, an issue of comparability was raised between data inputs used in the ES model and those derived from verifiable prices, mainly due to differences in cut-off times and differences between bid/ask values and mid values. Thirdly, it was also highlighted that institutions, which use external data providers for the purpose of the modellability assessment, may not, or only with high effort, be able to derive data inputs from verifiable prices. Fourthly, it was also highlighted that the risk-measurement model may use a different (usually smaller) set of risk factors, compared to the set of factors used for pricing in the front- or back-office systems.

In addition to the points raised by the respondents, the EBA acknowledges that institutions may employ different modelling assumptions, in order to determine the scenarios of future shocks applied to modellable risk factors (e.g. the scenarios of future shocks may be randomly generated using Monte Carlo methods). Similarly, the EBA also carefully considered the cases where the application of Beta approximations could be problematic for the application of such requirements.

With a view to addressing the points mentioned above and having in mind that the notion of data inputs should not be limited to the mapping 'data inputs = values of the risk factor in the relevant period' but should be broader, the EBA revised the approach proposed in the CP.

In relation to the reflection of prices observed or quoted in the market, the approach proposed in paragraph 12 of the CP was based on a reconciliation of values of risk factors used in the ES model with values of risk factors obtained from either verifiable prices or, where verifiable prices are not available, prices based on the institutions' front- or back-office pricing models. In relation to the reflection of volatilities and correlations of risk factors, the approaches proposed in paragraphs 13 and 14 of the CP were based on reconciliations of volatilities and correlations as estimated from the data inputs with volatilities and correlations as estimated from either verifiable prices or, where verifiable prices are not available, values for those risk factors used in the institutions' front- or back-office pricing models.

First of all, the EBA acknowledges that the scope of those reconciliations should be limited to data inputs calibrated to historical data from the current period only (i.e. to data inputs from the preceding 12-month period, as referred to in Article 325bc(3)(c) of the CRR). Indeed, where the period of financial stress identified in accordance with Article 325bc(2)(c) of the CRR does not refer to recent years, there may be limited availability of verifiable prices – typically collected and available from the preceding 12-month period only – and of front- or back-office data.

In addition, in light of the points raised by the respondents to the CP, the EBA considers that unnecessary burden should be avoided in performing such a reconciliation. Therefore, additional flexibility is provided in these GL compared to the CP, in that different alternatives are made available to institutions in order to ensure that historical data (and consequently data inputs) are accurately reflective of prices observed or quoted in the market. In particular, the EBA considers that:

(i) in some cases, it is not possible to perform a reconciliation at the level of data inputs, while it is possible to do so at the level of the historical data used to calibrate those data inputs;

(ii) in some cases, it may be difficult (or not possible) to perform a reconciliation at the level of either the data inputs or the historical data, while it is possible to do so at the level of prices produced by the pricing functions used in risk-measurement model and based on the data inputs or the historical data.

In relation to point (i), consider again the example of an institution that uses a zero-coupon rate tenor 'x' as a risk factor. Suppose that the data inputs, in this case, are the values of the risk factor (i.e. the zero-coupon rate tenor 'x'), calibrated by constructing the fixed-income zero-coupon yield curve from interest rate swaps – hence, in this example, the swap rates are the historical data for that risk factor. Suppose also that the front- or back-office systems directly use swap rates as input data. In this example, it might not be possible to perform a reconciliation at the level of data inputs, since, on the one hand, there could be no verifiable price suitable to directly reconcile the values of the zero-coupon rate of tenor 'x' and, on the other hand, there are no analogous data in the front- or back-office systems. In such an example, however, the reconciliation can be performed at the level of historical data: swap rates can be reconciled with either verifiable prices (i.e. interest rate swap transactions) or with the input data used in the front- or back-office systems.

In relation to point (ii), suppose that a risk factor included in the ES model is different from the factors used for pricing in the front- or back-office systems. In addition, suppose that it is difficult (or not possible) to extract data similar to the data inputs or the historical data from verifiable prices. In such a case, neither data obtained from verifiable prices nor data used in the front- or back-office systems can be used in the reconciliation. In such a case, however, the reconciliation can be performed at the level of prices produced by the pricing functions used in the risk-measurement model and based on data inputs or, where it is not possible to produce prices based on the data inputs, based on historical data. Those 'risk' prices can therefore be reconciled with either verifiable prices or prices produced by the front- or back-office systems.

In addition, the EBA considers that input data used in the front- or back-office systems, mentioned in relation to point (i), or prices produced by the front- or back-office systems, mentioned in relation to point (ii), can be used to perform the reconciliation in the cases where verifiable prices are not widely available, including the cases where verifiable prices are provided by third-party vendors and the values of those verifiable prices are not disclosed.

2.1.1   Data inputs from the current period

Reconciliation of historical data and data inputs with prices observed or quoted in the market

Having in mind the above considerations and with a view to addressing the points flagged by the respondents to the CP, paragraph 16 of these GL requires a reconciliation exercise to be performed at the level of the data inputs from the current period only, in order to ensure that those data inputs are calibrated to historical data reflective of prices observed or quoted in the market. Paragraph 16 requires that one of the two approaches set out in paragraphs 17 and 18 should be applied for performing such a reconciliation.

Under the first approach (paragraph 17 of the GL), institutions should at least quarterly reconcile the data inputs from the preceding 12-month period, with either the corresponding data inferred from verifiable prices or, where verifiable prices are not available, the corresponding data used by the institutions' front- or back-office systems.

Alternatively, under the second approach (paragraph 18 of the GL), institutions should reconcile prices produced by the pricing functions used in their risk-measurement model and based on the data inputs from the preceding 12-month period, with either verifiable prices or, where verifiable prices are not available, prices produced by the institutions' front- or back-office systems.

The second approach mentioned above (i.e. the reconciliation at the level of prices produced by the pricing functions used in the risk-measurement model) is intended to cover those cases where it is difficult to extract data similar to data inputs from verifiable prices and the data used in front- or back-office systems are very different from the data inputs used in the ES model. However, where the reconciliation under the second approach is chosen, institutions should be able to demonstrate that the outcome of that reconciliation (at the level of prices produced by the risk-measurement model) is reasonably aligned with the outcome that would have been obtained by performing the reconciliation under the first approach (directly at the level of data inputs or historical data).

In both the approaches set out in paragraphs 17 and 18, if performing the reconciliations at the level of data inputs is not possible, the historical data used to calibrate those data inputs should be used in place of those data inputs. Institutions should explain how they perform such reconciliations and which data are used. However, while it is acknowledged that, in some cases, the reconciliation may be performed at the level of the historical data instead of at the level of data inputs, the EBA considers that those cases should be adequately documented and justified by institutions. In particular, institutions should document and justify why it is not possible to perform the reconciliation at the level of data inputs.

Assessment of volatilities and correlations stemming from data inputs

In order to verify that the data inputs used in the ES model are reflective of the properties of the distributions of the corresponding risk factors and of the dependency structure between the

distributions of those risk factors, paragraphs 21 and 22 of these GL require two assessments to be performed. Also in this case and for the same reasons described above, the EBA acknowledges that the scope of those assessments should be limited to data inputs calibrated to historical data from the current period only.

Those two assessments focus on volatilities and correlations, which should be accurately reflected by the data inputs used. In particular, paragraphs 21 and 22 require institutions to at least quarterly compare and verify that there is no material difference between the volatilities and the correlations estimated using the data inputs from the preceding 12-month period, and those estimated using verifiable prices. However, where the number of verifiable prices with a value of the price available to the institution is not sufficient to perform those assessments with accuracy, the assessment can be performed using prices used by the institutions' front-office or back-office systems.

With a view to addressing some of the concerns expressed by the respondents to the CP in terms of operational burden entailed in the specific requirements on the accuracy of data inputs mentioned above (i.e. paragraphs 17, 18, 21 and 22 of these GL), and also with the view to ensuring consistency among those requirements, the EBA clarifies that verifiable prices should be used for all those requirements, only where the number of verifiable prices with a value of the price available to the institution is sufficient to perform the reconciliations and assessments in paragraphs 17, 18, 21 and 22 of the GL with accuracy (i.e. the number of verifiable prices should be sufficient to also compute volatilities and correlations with accuracy). In all other cases, i.e. where no verifiable prices are available or their number is very low, front- or back-office data can be used for all the reconciliations and assessments set out in paragraphs 17, 18, 21 and 22 of the GL. Article 105(8) of the CRR requires institutions to perform an independent price verification (IPV), i.e. a verification of market prices and model inputs. Hence, where front- or back-office data are used for the purpose of the reconciliations and assessments set out in paragraphs 17, 18, 21 and 22 of the GL, institutions should take into account any adjustments to front- or back-office data that have been made as part of the IPV process.

2.1.2 Data inputs from the identified period of financial stress

The data inputs referred to in Article 325bc(2)(c) of the CRR (i.e. those from the identified period of financial stress) should be calibrated to historical data directly sourced from the identified continuous 12-month period of financial stress.

Despite the data inputs from the identified period of financial stress not being included in the scope of the provisions in paragraphs 17, 18, 21 and 22 of these GL, mainly due to the length of historical lookback needed for such provisions, those data inputs should still be calibrated on historical data which are accurately reflective of i) prices observed or quoted in the market, ii) the properties of the distributions of risk factors and iii) the dependency structure between the distributions of those risk factors, in accordance with paragraphs 13, 14 and 15, respectively.

Principle 6 in paragraph MAR31.26 of the Basel text envisages cases where the characteristics of current instruments in the market differ from those in the identified period of financial stress. In such cases, institutions are asked to empirically justify the use of data for the identified period of financial stress that are different from the data actually observed during that period.

The EBA, after assessing the feedback received from respondents to the CP, recognises that there are cases where the characteristics of current instruments have changed so much compared to those that were applicable in the period of financial stress that adjustments to the calibration of data inputs could be warranted.

However, the EBA considers that reflecting the effects of fundamental changes in the characteristics of financial instruments on the calibration of data inputs for the period of financial stress may prove difficult in practice. To that end, such effects should have to be appropriately disentangled and quantified, in particular based on the use of proxy data sourced from the identified period of financial stress. Those proxy data should fulfil in particular the requirements set out in Article 325bc(2)(c), Article 325bc(2)(d) and Article 325bh(1)(g) of the CRR and their use should be justified using analyses based on empirical evidence and on data that objectively characterise the extent to which financial instruments have changed. In addition, institutions should demonstrate that the resulting data inputs accurately reflect changes in prices of similar instruments during the identified period of financial stress and that they do not lead to an underestimation of risks.

2.1.3 Data inputs used in Beta approximations or other random data-generating approaches

Where Beta approximations or other random data-generating approaches are used for the purpose of determining the scenarios of future shocks, the calibration of the coefficients used in the Beta approximations or the parameters of the random data-generating approaches should be empirically based (i.e. determined exclusively on the basis of the data inputs calibrated to historical data) and not determined on a judgmental basis.

According to Principle 7 in paragraph MAR31.26 of the Basel text, in general, institutions should not be allowed to set the coefficients of Beta approximation or the parameters of other random data-generating approaches by judgement. However, paragraph MAR99.22(1) of the Basel text encompasses specific instances where institutions, in derogation to the general principle and under specific conditions, could be allowed to adjust the empirically based coefficients or parameters (i.e. to apply some judgmental considerations when setting such coefficients or parameters). The CRR text is quite clear in requiring institutions to use data inputs calibrated to historical data for determining the scenarios of future shocks (see paragraphs 2(c), 2(d), 3(c) and 4(c) of Article 325bc of the CRR), hence the only cases that could seem to be admissible are those where institutions fine-tune the empirically calibrated coefficients or parameters with additional adjustments.

The EBA considers that such cases should be exceptional, and that any adjustment to the empirically calibrated coefficients should be adequately justified. In particular, institutions should be able to justify the reason why the empirical calibration of the coefficients or parameters cannot be determined exclusively on the basis of the data inputs and they need to be complemented with additional adjustments. In addition, they should describe the methodology used and the adjustments made to the coefficients or parameters empirically calibrated, and demonstrate that the choice of the values for the coefficients or parameters does not underestimate risk.

In order to determine whether such a provision should be maintained in the GL, the EBA sought feedback from the consultation to gather concrete cases where institutions envisage its application, also explaining the reasons why the empirical calibration must be complemented with adjustments. After assessing the feedback received, the EBA recognised that such a provision could be needed in certain instances and therefore such a provision is maintained in these GL.

2.1.4   Data inputs suitable for combination of risk factors

The EBA acknowledges that institutions are free to define the risk factors to be included in their risk-measurement models, as long as those risk factors lead to compliance with the CRR requirements, e.g. the profit and loss attribution requirements and back-testing requirements. The assessment of modellability referred to in Article 325be of the CRR is performed on the basis of the list of risk factors that an institution includes in its risk-measurement model. For each of those risk factors, the institution assesses whether the risk factor is modellable or not.

According to Article 325bb of the CRR, only risk factors that have been assessed to be modellable in accordance with Article 325be can be included in the ES risk-measure calculations.

Once a risk factor has been defined and assessed modellable, an institution should choose the data inputs that will be used to determine the scenarios of future shocks applied to that modellable risk factor. As mentioned above, the EBA acknowledges that the historical data used to calibrate the data inputs does not necessarily need to be the data used to assess the modellability of risk factors.

A given risk factor may be obtained as a combination of other risk factors. According to Principle 1 in paragraph MAR31.26 of the Basel text, combination of data from other modellable risk factors may be used in the ES model. Hence, where a given risk factor is obtained as a combination of other risk factors and the data inputs for the given risk factor are obtained by combining the data inputs of the other risk factors, those other risk factors should be modellable, i.e. those other risk factors have passed the modellability assessment referred to in Article 325be of the CRR.

For example, if a risk factor in the institution's ES model is the zero-coupon rate of tenor 'x', obtained as an interpolation of two other tenors of the zero-coupon rate curve, 'y' and 'z', and the data inputs for that tenor 'x' are obtained by interpolating the data inputs of the two other tenors 'y' and 'z', then those two other risk factors, i.e. the tenors 'y' and 'z', should be modellable in order to use the interpolated data inputs in the ES model.

However, it could be the case that the list of risk factors that an institution include in its risk-measurement model does not contain the other risk factors that are combined. In such a case, the institution should demonstrate that the other risk factors would pass the modellability assessment referred to in Article 325be of the CRR as if those risk factors would be contained in the list of risk factors included in the risk-measurement model.

In addition, where a given risk factor is obtained by means of extrapolation from other risk factors and the data inputs for the given risk factor are obtained by extrapolating from the data inputs of the other risk factors, additional requirements should be met in order to use the extrapolated data inputs in the ES model.

In particular, as also indicated in Principle 1 in paragraph MAR31.26 of the Basel text, the extrapolated data inputs should be used only if the given risk factor is within a reasonable distance from the closest of the modellable risk factors whose data inputs are employed in the extrapolation technique. The distance between two risk factors is considered reasonable if the two risk factors belong to the same bucket of a curve, surface or cube, or if they belong to two adjacent buckets. Additionally, the extrapolated data inputs should not rely solely on data inputs of the closest risk factor, but on data inputs of more than one risk factor, and the data inputs of all those other risk factors should not be obtained by extrapolation themselves.

These requirements should not be applicable only in one-dimensional cases, but should apply also to multidimensional cases, e.g. to volatility surfaces. In those cases, the requirements should be met for each dimension separately, i.e. the extrapolation methodology should rely on the data inputs of more than one modellable risk factor (including the closest risk factor) for each dimension.

In order to better reflect Principle 1 in paragraph MAR31.26 of the Basel text, the EBA has decided to treat the following two cases separately:

(a) the case where a given risk factor is obtained as a combination of other risk factors and the data inputs for the given risk factor are obtained by combining the data inputs from the other risk factors, including by means of interpolation or extrapolation techniques;

(b) the case where data inputs from other risk factors are used in interpolation or extrapolation techniques for the replacement of missing or inconsistent data points in the data inputs for a given risk factor.

As a consequence and for the sake of clarity, different paragraphs have been set out in these GL to cover each of the two cases mentioned above. In particular, paragraphs 27 and 28 of the GL have been addressed to case (a), while paragraphs 42 and 43 have been addressed to case (b), as further explained in Section 2.4.

In the CP, paragraph 31 was addressed to all replacement methodologies, including interpolation or extrapolation techniques, which involve data inputs of other risk factors. That paragraph required institutions to assess the modellability of those other risk factors, before the data inputs of those other risk factors might be used in a replacement methodology. In the feedback received

from consultation, it was highlighted that the replacement of missing or inconsistent values in the data inputs is generally considered as a one-off exercise, and various concerns were expressed around the burden that such a provision introduces.

As mentioned above, the EBA considers that, where a given risk factor is obtained as a combination of other risk factors and the data inputs for the given risk factor are obtained by combining the data inputs from the other risk factors, those other risk factors should be modellable (as set out in the Basel text). In addition, the EBA also considers that the two cases mentioned above, i.e. (a) and (b), while conceptually different, should be treated consistently within these GL, in order to avoid any regulatory arbitrage. Hence, the requirements set out in paragraphs 27, 28, 42 and 43 of these GL reflect these considerations.

2.2   Appropriateness of the data inputs

According to Article 362 of the CRR, general market risk shall encompass the tendency of an instrument's value to change with the change in the value of the broader market, as represented by an appropriate index or indices. Idiosyncratic (or specific) risk, on the other hand, shall encompass the risk associated with changes in an instrument's value due to factors related to its issuer.

The data inputs used for a given risk factor should capture, where relevant, both components of market risk in the ES model, i.e. general and specific risks. To that end, institutions should provide documented analyses supported by convincing empirical evidence, in order to show that the general and specific risks embedded in a given risk factor are captured by the data inputs used in the ES model.

In particular, whenever historical data from indices or other broad factors are used to calibrate the data inputs, with a view to representing the general market risks, the choice of such historical data should be conceptually sound and consistently used across those instruments. Furthermore, in relation to specific risks, the data inputs should allow the capture of material idiosyncratic differences between similar, but not identical, positions.

Beta approximations and other random data-generating approaches

Where Beta approximations or other random data-generating approaches are used for the purpose of determining the scenarios of future shocks, institutions should show with empirical evidence that the methodology applied and the output produced are appropriate to capture both general risk and specific market risks. The analyses performed should be documented as part of the records kept by the institutions to demonstrate their compliance with the requirements of the GL.

In particular, statistical measures, including ones expressing the goodness-of-fit of the Beta approximation or the other random data-generating approaches, should be used to show how general market risks are properly captured by the data inputs included in the ES model. For example, where an index is used in a Beta approximation to capture the risks common to a group of assets, the estimated model should have a sufficient explanatory power and the estimated Beta coefficients should show statistical significance.

In addition, where the remaining specific risks are assumed to be uncorrelated, the residuals of the estimated model should be demonstrably uncorrelated, having analysed their dependence.

2.3   Frequency for updating the data inputs

A risk-measurement model requires many data sets. In order for the output of the risk-measurement model to reflect current market conditions, those data sets need to be updated frequently. Institutions should strive to update the data used to calculate the ES risk measure as often as possible (ideally daily) to account for changing market conditions. Additionally, institutions should have a workflow process for updating the sources of data.

According to Article 325bc(3)(c) of the CRR, the data inputs used to determine the scenarios of future shocks for PES_t^{RC}, $PES_t^{RC,i}$, PES_t^{FC} and $PES_t^{FC,i}$, i.e. the data inputs from the current period, must be calibrated to historical data updated at a minimum on a monthly basis. However, whenever needed (i.e. whenever a monthly update lead to an underestimation of the risks), those historical data should be updated on a more frequent basis, typically daily.

Beta approximations and other random data-generating approaches

Where Beta approximations or other random data-generating approaches are used for the purpose of determining the scenarios of future shocks, institutions should also recalibrate the estimated Beta coefficients or parameters of the random data-generating approaches on at least a monthly basis, in order to reflect any potential changes in the relations assumed among the market variables due to changes in the economic environment.

2.4   Completeness of the data inputs

In addition to being accurate, appropriate and frequently updated, the data inputs used in the ES model should prove to be complete.

Firstly, the EBA considers that there could be cases where the historical data used to calibrate the data inputs might not be available, for instance because of malfunctioning of the data provider's

system. In order to ensure that institutions are prepared to handle those cases, procedures should be in place showing how historical data can be obtained from alternative data sources in a timely manner, where the historical data provided by their normally used data sources are not available.

Secondly, institutions are required to have clear policies for the replacement of missing or inconsistent values in the time series of data inputs used to determine the scenarios of future shocks. Such policies should also include how institutions intend to verify that the requirements in paragraphs 13 to 16, 21 and 22 of these GL are satisfied, before such replaced values may be used to determine the scenarios of future shocks.

In addition, institutions should be allowed to filter data or exclude values corresponding to large changes (often referred to as 'outliers') only where the excluded data correspond to erroneous or inconsistent data.

Interpolation and extrapolation techniques used for replacing missing or inconsistent data inputs

With respect to the use of interpolation or extrapolation techniques for the replacement of missing or inconsistent values in the data inputs, the EBA is of the opinion that institutions should be allowed to use those techniques. Nevertheless, given that the data inputs for a given risk factor would, in those cases, depend on the specific techniques used for interpolating and extrapolating, the EBA deems it appropriate to establish conditions under which those techniques can be employed.

In particular, institutions should ensure that the interpolated or extrapolated values appropriately represent the missing values regardless of the interpolation or extrapolation methodology used.

In addition, where data inputs from other risk factors are used in interpolation or extrapolation techniques for the replacement of missing or inconsistent data points in the data inputs for a given risk factor, paragraph 42 of these GL requires that those other risk factors have passed or would pass the modellability assessment referred to in Article 325be of the CRR, depending on whether or not those other risk factors are contained in the list of risk factors included in the institution's risk-measurement model, respectively. In the latter case, the modellability assessment is performed on those other risk factors as if those other risk factors were contained in the list of risk factors included in the institution's risk-measurement model.

With respect to extrapolation techniques, where data inputs from other risk factors are used in extrapolation techniques for the replacement of missing or inconsistent data points in the data inputs for a given risk factor, paragraph 43 of these GL requires that the data inputs from other risk factors used in the extrapolation meet the conditions set out in points (a) to (c) of paragraph 28.

As mentioned in Section 2.1.4, paragraph 31 of the CP was addressed to all replacement methodologies, including interpolation or extrapolation techniques, which involve data inputs of other risk factors, requiring institutions to assess the modellability of those other risk factors. In addition, paragraph 34 of the CP set out additional requirements to be met for the use of

extrapolation techniques involving data inputs of other risk factors. In the feedback received from consultation, it was highlighted that the replacement of missing or inconsistent values in the data inputs is generally considered as a one-off exercise, and that requiring a regular assessment of the modellability of the risk factors involved in replacement methodologies could cause instability in the data inputs, as risk factors previously involved in replacement methodologies may no longer be used, depending on the outcome of the modellability assessment. In addition, some concerns were expressed around the additional requirements on extrapolation techniques. In particular, respondents claimed that some flexibility should be granted to institutions to choose the most appropriate extrapolation techniques, as long as they are able to demonstrate the appropriateness of their choices. However, the EBA considers the requirements in paragraph 31 and 34 of the CP aligned with what prescribed in Principle 1 in paragraph MAR31.26 of the Basel text. Therefore, those requirements have been maintained in paragraphs 42 and 43 of these GL.

3. Guidelines on criteria for the use of data inputs in the risk-measurement model referred to in Article 325bc

EBA/GL/2021/07

13 July 2021

Guidelines

on criteria for the use of data inputs in the risk-measurement model referred to in Article 325bc of Regulation (EU) No 575/2013

1. Compliance and reporting obligations

Status of these guidelines

1. This document contains guidelines issued pursuant to Article 16 of Regulation (EU) No 1093/2010[6]. In accordance with Article 16(3) of Regulation (EU) No 1093/2010, competent authorities and financial institutions must make every effort to comply with the guidelines.

2. Guidelines set the EBA view of appropriate supervisory practices within the European System of Financial Supervision or of how Union law should be applied in a particular area. Competent authorities as defined in Article 4(2) of Regulation (EU) No 1093/2010 to whom guidelines apply should comply by incorporating them into their practices as appropriate (e.g. by amending their legal framework or their supervisory processes), including where guidelines are directed primarily at institutions.

Reporting requirements

3. According to Article 16(3) of Regulation (EU) No 1093/2010, competent authorities must notify the EBA as to whether they comply or intend to comply with these guidelines, or otherwise with reasons for non-compliance, by ([dd.mm.yyyy]). In the absence of any notification by this deadline, competent authorities will be considered by the EBA to be non-compliant. Notifications should be sent by submitting the form available on the EBA website to compliance@eba.europa.eu with the reference 'EBA/GL/2021/07'. Notifications should be submitted by persons with appropriate authority to report compliance on behalf of their competent authorities. Any change in the status of compliance must also be reported to the EBA.

4. Notifications will be published on the EBA website in line with Article 16(3).

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[6] Regulation (EU) No 1093/2010 of the European Parliament and of the Council of 24 November 2010 establishing a European Supervisory Authority (European Banking Authority), amending Decision No 716/2009/EC and repealing Commission Decision 2009/78/EC, (OJ L 331, 15.12.2010, p.12).

2. Subject matter, scope and definitions

Subject matter

5. These guidelines specify criteria for the use of data inputs in the risk-measurement model referred to in Article 325bc according to Article 325bh(3) of Regulation (EU) No 575/2013.

Scope of application

6. These guidelines apply in relation to the permission for institutions to use alternative internal models in accordance with Title IV of Part Three, Chapter 1 of Regulation (EU) No 575/2013, and in particular to compliance with the requirements set out in Articles 325bh of that Regulation.

7. Competent authorities should apply these guidelines in accordance with the level of application set out in Title II of Regulation (EU) No 575/2013.

Addressees

8. These guidelines are addressed to competent authorities as defined in point i-iv of Article 4(2) of Regulation (EU) No 1093/2010 and to financial institutions as defined in Article 4(1) of Regulation No 1093/2010.

Definitions

9. Unless otherwise specified, terms used and defined in Regulation (EU) No 575/2013 have the same meaning in the guidelines.

3. Implementation

Date of application

10. These guidelines apply from 01.01.2022.

4. Criteria for the use of data inputs in the risk-measurement model referred to in Article 325bc of Regulation (EU) No 575/2013

11. The data inputs used by an institution in the risk-measurement model referred to in Article 325bc of Regulation (EU) No 575/2013 should have all of the following characteristics:

    (a) they should be accurate, as further specified in Section 4.1;

    (b) they should be appropriate, as further specified in Section 4.2;

    (c) they should be updated sufficiently frequently, as further specified in Section 4.3;

    (d) they should be complete, as further specified in Section 4.4.

4.1 Accuracy of the data inputs

12. Institutions should meet the requirements in paragraph 13, 14 and 15, in order for the data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 to be accurate. In addition, all of the following should be met, where relevant:

    (a) the requirements for the data inputs from the current period, referred to in Article 325bc(3)(c) of Regulation (EU) No 575/2013, as further specified in Section 4.1.1;

    (b) the requirements for the data inputs from the identified period of financial stress, referred to in Article 325bc(2)(c) of Regulation (EU) No 575/2013, as further specified in Section 4.1.2;

    (c) the requirements for the data inputs used in Beta approximations or other random data-generating approaches for the purpose of determining the scenarios of future shocks, as further specified in Section 4.1.3;

    (d) the requirements for the data inputs used for a given risk factor obtained by combining two or more risk factors that may or may not be incorporated in the institution's internal model, as further specified in Section 4.1.4.

13. The historical data used to calibrate the data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 should be accurately reflective of prices observed or quoted in the market.

14. The data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 should be accurately reflective of the properties of the distribution of the risk factors to which the scenarios of future shocks are applied.

15. The data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 should be accurately reflective of the dependency structure between the distributions of the risk factors to which the scenarios of future shocks are applied.

4.1.1   Data inputs from the current period

16. In order to fulfil the requirement referred to in paragraph 12 for the data inputs from the current period, referred to in 325bc(3)(c) of Regulation (EU) No 575/2013, institutions should comply with either the approach set out in paragraph 17 or the approach set out in paragraph 18.

17. Under the first approach, institutions should reconcile the data inputs from the current period, referred to in Article 325bc(3)(c) of Regulation (EU) No 575/2013, with one of the following:

    (a) the corresponding data inferred from verifiable prices, as defined in the regulatory technical standards to be adopted pursuant to Article 325be of Regulation (EU) No 575/2013;

    (b) the corresponding data used by the institutions' front-office or back-office systems.

18. Under the second approach, institutions should reconcile prices produced by their internal risk-measurement model and based on the data inputs from the current period, referred to in Article 325bc(3)(c) of Regulation (EU) No 575/2013, with one of the following:

    (a) verifiable prices as defined in the regulatory technical standards to be adopted pursuant to Article 325be of Regulation (EU) No 575/2013;

    (b) prices produced by the institutions' front-office or back-office systems.

    In order to perform the reconciliation referred to in this paragraph, the outcome of that reconciliation should be reasonably aligned to the outcome that would have been obtained by performing the reconciliation in paragraph 17.

19. Where it is not possible to perform the reconciliations referred to in paragraphs 17 and 18 using data inputs, institutions should use the historical data used to calibrate those data inputs for the purposes of paragraph 17, and the prices resulting from those historical data for the purposes of paragraph 18.

20. As part of the records kept by the institutions to demonstrate their compliance with the requirements of these Guidelines, institutions should document their approaches to the

reconciliations referred to in paragraphs 17 to 19, including the reasons for applying paragraph 19 where relevant.

21. In order to fulfil the requirement referred to in paragraph 14 for the data inputs from the current period, referred to in 325bc(3)(c) of Regulation (EU) No 575/2013, institutions should assess that there is no material difference between the volatility of a risk factor as estimated on the basis of those data inputs and the volatility of that risk factor as estimated on the basis of one of the following:

   (a) the verifiable prices as defined in the regulatory technical standards to be adopted pursuant to Article 325be of Regulation (EU) No 575/2013;

   (b) the prices used by the institutions' front-office or back-office systems.

22. In order to fulfil the requirement referred to in paragraph 15 for the data inputs from the current period, referred to in 325bc(3)(c) of Regulation (EU) No 575/2013, institutions should assess that there is no material difference between the correlations between risk factors as estimated on the basis of those data inputs and the correlations between those risk factors as estimated on the basis of one of the following:

   (a) the verifiable prices as defined in the regulatory technical standards to be adopted pursuant to Article 325be of Regulation (EU) No 575/2013;

   (b) the prices used by the institutions' front-office or back-office systems.

23. For the purposes of the reconciliations and assessments in paragraphs 17, 18, 21 and 22, institutions should use the data or verifiable prices referred to in point (a) of paragraph 17, point (a) of paragraph 18, point (a) of paragraph 21 and point (a) of paragraph 22, where the number of verifiable prices with a value of the price available to the institution is sufficient to perform those reconciliations and assessments with accuracy. Where no verifiable prices are available, or the number of verifiable prices with a value of the price available to the institution is not sufficient to perform those reconciliations and assessments with accuracy, institutions should use the data or prices used or produced by the institutions' front-office or back-office systems, as referred to in point (b) of paragraph 17, point (b) of paragraph 18, point (b) of paragraph 21 and point (b) of paragraph 22.

24. Institutions should carry out the assessment referred to in paragraph 17, 18, 21 and 22 at least quarterly, or more frequently where extensions and changes to the internal models require to do so.

4.1.2   Data inputs from the identified period of financial stress

25. The data inputs from the identified period of financial stress, referred to in Article 325bc(2)(c) of Regulation (EU) No 575/2013, should be calibrated to historical data from a continuous 12-

month period of financial stress identified by the institution in accordance with that Article.
Where, in exceptional cases, institutions use proxy data from the identified period of financial
stress for the purpose of the calibration of those data inputs, in order to reflect the effect of
fundamental changes that occurred in the characteristics of financial instruments compared to
the characteristics that prevailed during the identified period of financial stress, the data inputs
obtained as a result of this approach should be considered accurate only where all of the
following conditions are met:

(a) this approach is supported by convincing empirical evidence and objective data to
justify the use of proxy data for the calibration of those data inputs;

(b) those data inputs accurately reflect changes in prices of similar instruments during
the identified period of financial stress;

(c) those data inputs do not underestimate risk.

4.1.3   Data inputs used in Beta approximations or other random data-generating approaches

26. Where an institution uses Beta approximations or other random data-generating approaches
for the purpose of determining the scenarios of future shocks, in order for the data inputs used
in those Beta approximations or other random data-generating approaches to be accurate, the
values of the Beta coefficients or the parameters of the random data-generating approaches
should be determined exclusively on the basis of the data inputs calibrated to historical data
referred to in Article 325bc of Regulation (EU) No 575/2013. Where, in exceptional cases, the
institution does not determine the values of the Beta coefficients or the parameters of the
random data-generating approaches exclusively on the basis of those data inputs, but
adjustments are made to the values of those Beta coefficients or parameters, the data inputs
used in those Beta approximations or other random data-generating approaches should be
considered accurate only where all of the following conditions are met:

(a) the Beta coefficients or parameters of the random data-generating approaches cannot
be determined exclusively on the basis of the data inputs calibrated to historical data
referred to in Article 325bc of Regulation (EU) No 575/2013;

(b) the institution describes in its policies the methodology used in this case to obtain the
values of the Beta coefficients or parameters of the random data-generating
approaches, including any adjustments made to the values of the Beta coefficients or
parameters determined exclusively on the basis of the data inputs calibrated to
historical data referred to in Article 325bc of Regulation (EU) No 575/2013;

(c) the choice of the values for the Beta coefficients or parameters of the random data-
generating approaches does not underestimate risk.

4.1.4   Data inputs used for combinations of risk factors

27. Where a given risk factor in the institution's internal model has been obtained by combining two or more risk factors that may or may not be incorporated in the institution's internal model, and the institution combines the data inputs corresponding to those risk factors so as to obtain data inputs that are suitable for the given risk factor in the internal model, the obtained data inputs should be considered accurate only where the data inputs that are combined correspond to risk factors that have passed or would pass the modellability assessment referred to in Article 325be of Regulation (EU) No 575/2013.

28. Where a given risk factor in the institution's internal model has been obtained by extrapolating from risk factors that may or may not be incorporated in the institution's internal model, and the data inputs for the given risk factor in the internal model are obtained by extrapolating from data inputs corresponding to those risk factors, the obtained data inputs should be considered accurate only if all the following conditions are met:

    (a) the extrapolation is based on data inputs of the closest modellable risk factor in each dimension of the given risk factor;

    (b) the extrapolation is based on data inputs of at least two modellable risk factors for each dimension of the given risk factor;

    (c) the data inputs corresponding to the two modellable risk factors referred to in point (b), including the data inputs of the closest modellable risk factor, should not have been obtained by extrapolation themselves.

29. For the purpose of paragraph 28, closest risk factor means a risk factor that is mapped to one of the following buckets, in accordance with the regulatory technical standards to be adopted pursuant to Article 325be of Regulation (EU) No 575/2013:

    (a) the same bucket as the extrapolated risk factor, where the extrapolated risk factor is not the only risk factor in a bucket;

    (b) a bucket adjacent to the bucket of the extrapolated risk factor, where the extrapolated risk factor is the only risk factor in a bucket.

4.2   Appropriateness of the data inputs

30. The data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 should capture both of the following, where relevant:

    (a) general market risks, as further specified in Section 4.2.1;

(b) specific market risks, as further specified in Section 4.2.2.

31. Institutions should perform analyses supported by convincing empirical evidence and objective data to show that the data inputs used for a given risk factor capture all material general and specific market risks embedded in that risk factor, as applicable. As part of the records kept by the institutions to demonstrate their compliance with the requirements of these Guidelines, institutions should document such analyses.

4.2.1   Data inputs capturing general market risks

32. Where historical data from market indices or other historical data representing characteristics shared by different instruments are used to calibrate the data inputs referred to in Article 325bc of Regulation (EU) No 575/2013, with a view to representing general market risks, the choice of such historical data should be conceptually sound and consistently used across those instruments.

33. Where institutions use Beta approximations or other random data-generating approaches for the purpose of determining the scenarios of future shocks, they should show with empirical evidence that general market risks are properly captured by the data inputs used to determine the values of the Beta coefficients or the parameters of the random data-generating approaches. Such empirical evidence should include statistical measures expressing the goodness-of-fit of the Beta approximations or the other random data-generating approaches. As part of the records kept by the institutions to demonstrate their compliance with the requirements of these Guidelines, institutions should document the analyses performed to comply with this paragraph.

4.2.2   Data inputs capturing specific market risks

34. The data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 should allow the capturing of material specific risks, including name-related basis risks and material idiosyncratic differences between similar but not identical positions.

35. Where institutions use Beta approximations or other random data-generating approaches for the purpose of determining the scenarios of future shocks, they should show with empirical evidence that specific market risks are properly captured by the data inputs used to determine the values of the Beta coefficients or the parameters of the random data-generating approaches. Where assumptions are made that residuals from Beta approximations or other random data-generating approaches are uncorrelated to each other, the empirical evidence referred to in the previous sentence should include a justification of those assumptions. As part of the records kept by the institutions to demonstrate their compliance with the requirements

of these Guidelines, institutions should document the analyses performed to comply with this paragraph.

4.3 Frequency for updating the data inputs

36. Institutions should update the historical data used to calibrate the data inputs from the current period, referred to in Article 325bc(3)(c) of Regulation (EU) No 575/2013, more frequently than monthly, as is provided in that Article, where updating those data monthly could lead to an inaccurate estimation of the market risk of the relevant positions.

37. Where institutions use Beta approximations or other random data-generating approaches for the purpose of determining the scenarios of future shocks, they should recalibrate the Beta coefficients or the parameters of the random data-generating approaches on at least a monthly basis.

4.4 Completeness of the data inputs

38. Institutions should have procedures in place for obtaining historical data to calibrate data inputs as referred to in Article 325bc of Regulation (EU) No 575/2013 from alternative data sources in a timely manner, in case historical data provided by their normally used data sources are not available.

39. Institutions should have clear policies and processes for the replacement of missing or inconsistent values in the time series of historical data and data inputs referred to in Article 325bc of Regulation (EU) No 575/2013, including policies for verifying that such replacement of missing or inconsistent values is compatible with the requirements in paragraphs 13 to 16, 21 and 22.

40. Institutions should ensure that data is not filtered and that values corresponding to large changes are not excluded from the time series of historical data and data inputs referred to in Article 325bc of Regulation (EU) No 575/2013, unless the filtered data or excluded values correspond to erroneous or inconsistent data or values.

41. Where interpolated or extrapolated values are used as replacements for missing or inconsistent values in the data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 for a risk factor, the interpolated or extrapolated values should appropriately represent the missing values regardless of the interpolation or extrapolation methodology used.

42. Where interpolated or extrapolated values, based on data inputs corresponding to other risk factors that may or may not be incorporated in the institution's internal model, are used as replacements for missing or inconsistent values in the data inputs referred to in Article 325bc

of Regulation (EU) No 575/2013 for a risk factor, those interpolated or extrapolated values should be based on data inputs corresponding to risk factors that have passed or would pass the modellability assessment referred to in Article 325be of that Regulation.

43. Where extrapolated values, based on data inputs corresponding to other risk factors that may or may not be incorporated in the institution's internal model, are used as replacements for missing or inconsistent values in the data inputs referred to in Article 325bc of Regulation (EU) No 575/2013 for a risk factor, those extrapolated values should be based on data inputs that meet the conditions set out in points (a) to (c) of paragraph 28.

4. Accompanying documents

4.1 Draft cost-benefit analysis / impact assessment

Article 325bc of Regulation (EU) No. 575/2013 (CRR) of the revised CRR requires the EBA to develop guidelines (GL) specifying the criteria for the use of data inputs in calculating the partial expected shortfall. The GL should clarify the qualitative conditions that the data related to modellable risk factors should meet to be used in the institution's internal models calculations.

Article 16(2) of Regulation (EU) No 1093/2010 (EBA Regulation) provides that any GL and recommendations developed by the EBA should be accompanied by an analysis of 'the potential related costs and benefits'. This analysis should provide an overview of the findings regarding the problem to be dealt with, the solutions proposed and the potential impact of these options.

This section presents the cost-benefit analysis of the main policy options included in the GL. Given the nature and the scope of the GL, the analysis is high level and qualitative in nature.

A. Problem identification and Baseline scenario

The revised CRR, introducing the FRTB standards in the EU regulatory framework, introduces an alternative internal model approach. This approach comprises three components: a) the ES risk measure, which determines capital requirements for those risk factors with a sufficient amount of available observable data (i.e. for modellable risk factors); b) the stress scenario risk measure, suitable for determining capital requirements for risk factors with limited observable data (i.e. for non-modellable risk factors); and c) the default risk capital requirement.

An institution must determine which risk factors within its trading desks that fall within the scope of the internal model approach are eligible to be included in the ES risk measure for regulatory purposes. For a risk factor to be classified as modellable, it must meet the criteria specified in the RTS referred to in Article 325be of the CRR. Those criteria relate to the identification of a sufficient number of verifiable prices, being representative for the risk factor over the preceding 12-months. Those quantitative criteria are intended to ensure that the risk factors, which institutions include in their ES risk measure, are sufficiently liquid and observable.

Once a risk factor has been deemed modellable under Article 325be of the CRR, the institution should choose the most appropriate data inputs to calibrate its ES model. The CRR asks EBA to develop GL specifying the criteria for the use of data inputs in calculating the ES risk measure. The provisions in the GL follow the spirit of the set of principles[7] defined by the Basel Committee for the inclusion of risk factors in the ES model after they have passed the Risk Factor Eligibility Test (RFET).

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[7] Minimum capital requirements for market risk, January 2019 (rev. February 2019), paragraphs 31.25 and 31.26

The lack of common criteria could result in an inconsistent use of data inputs across banks and undermine the calibration of the internal risk-measurement models. Given that institutions may use many different types of models, and for any given model many different sources or types of data inputs, it is important that a set of minimum criteria is determined.

B. Policy objectives

The specific objective of the GL is to establish common principles on the data inputs used to determine the scenarios of future shocks applied to the modellable risk factors. These principles aim to ensure that those data inputs are accurate, appropriate, frequently updated, complete and their use in the internal risk-measurement model is overall consistent.

Generally, the GL aim to create a level playing field, promote convergence of institutions' practices and enhance comparability of own funds requirements across the EU.

C. Options considered, Cost-Benefit Analysis and Preferred Options

This section presents the main policy options discussed during the development of the GL, the costs and benefits of these options, as well as the preferred options retained in the GL.

Scope of the Guidelines

The EBA is mandated, according to Article 325bh(3) of the CRR, to draft specific GL on the criteria for the use of data inputs in the risk-measurement model referred to in Article 325bc. The last part of the sentence, despite no explicit risk-measurement model is mentioned in Article 325bc (but only partial expected shortfall measures), clearly restrict the scope of the present GL to the data inputs that are used to calibrate the internal risk-measurement model for those risk factors deemed modellable (in accordance with Article 325be and the relative RTS), i.e. to those data inputs used to determine the scenarios of future shocks applied to the modellable risk factors.

Notion of data inputs

According to Article 325bc of the CRR, the data inputs used to determine the scenarios of future shocks applied to the modellable risk factor and used for calculating the partial ES measures shall be calibrated to historical data. Hence, the historical data represent the starting point to calibrate the data inputs, which are ultimately used to determine the shocks in its ES model. Depending on the modelling approach chosen by an institution, this calibration process can be performed either by applying transformations on historical data, or employing directly the historical data as the data inputs used for the determination of the scenarios of future shocks. For the purpose of these GL, the data inputs should be understood as the data that an institution directly uses for determining the scenarios of future shocks.

Regarding the notion of data inputs, in the consultation paper (CP) the conceptual mapping 'data inputs = values of the risk factor in the relevant period' was used, as that approach works well for

ES models that are based on a historical simulation approach. However, the EBA acknowledges that
other approaches may be used – e.g. Monte Carlo simulations, and in such approaches the data
inputs used may not be values of risk factors. Therefore, the EBA is of the opinion that the notion
of data inputs should not be limited to the mapping 'data inputs = values of the risk factor in the
relevant period' but should be broader.

In the present GL, a notion of data inputs broader than the one proposed in the CP is used, in order
to also encompass the cases where the data inputs are not values of risk factors. Hence, the data
inputs should be understood as the data that an institution directly uses for determining the
scenarios of future shocks.

Reconciliation of data inputs with verifiable prices or front- or back-office system data

Principle 4 in paragraph MAR31.26 of the Basel text specifies that the data used must be reflective
of prices observed and/or quoted in the market. Where data used are not derived from verifiable
prices, the institution should demonstrate that the data used are reasonably representative of
verifiable prices. To that end, the institution should periodically reconcile price data used in a risk
model with front-office and back-office prices, where verifiable prices are not available. In addition,
Principle 3 of the Basel text specifies that the data used must allow the model to reflect volatility
and correlations of the risk positions. To that end, institutions should periodically reconcile the
volatility and correlations estimated from the data used in the ES model with the volatility and
correlations estimated from verifiable prices, where available, or from front-office or back-office
data.

In the CP, the EBA proposed three separate conditions for determining whether verifiable prices or
front- or back-office system data should be used in each of the reconciliations mentioned in the
Basel text – i.e. reconciliations of data inputs, of volatilities and of correlations, included in
paragraphs 12 to 14 of the CP.

The respondent to the CP proposed to relax the conditions in paragraphs 12 to 14 of the CP. In
particular, it was argued that it should be sufficient to conduct reconciliation exercises between the
data inputs and either the risk factors obtained from front/back office systems or verifiable prices
– independently of the number of verifiable prices available. However, the EBA is of the opinion
that a complete removal of any conditions for using front- or back-office data in the reconciliations
set out in paragraphs 12 to 14 of the CP would be non-compliant with the requirements set out in
the Basel text.

The EBA considered two options regarding the conditions for determining whether verifiable prices
or front- or back-office system data should be used in such reconciliations.

Option 1a: Three separate conditions for determining whether verifiable prices or front- or back-
office system data should be used in each of the three reconciliations.

Option 1b: One condition for determining whether verifiable prices or front- or back-office system
data should be used for all the three reconciliations.

While both options are compliant with the requirements set out in Basel, Option 1b ensures that such reconciliations of data inputs, volatilities and correlations will be performed consistently, using the same time series in each of the three assessments.

Option 1b has been retained.

Frequency of the reconciliation of data inputs with verifiable prices

The EBA considered two options regarding the frequency of the reconciliations of data inputs, of volatilities and of correlations – i.e. the reconciliations set out in Principles 3 and 4 in paragraph MAR31.26 of the Basel text.

Option 2a: Specify that the frequency of the reconciliations should be at least quarterly.

Option 2b: Do not explicitly specify the frequency of the reconciliations.

Option 2a ensures that such reconciliations will be performed at least every quarter. As such, it provides for common minimum criteria across institutions and avoids infrequent reconciliations. The quarterly frequency matches with the frequency of the risk factor modellability assessment, making it easier for institutions to synchronise the two processes. On the other hand, Option 2b provides a greater flexibility to institutions but at the same time can create inconsistent practices across the EU.

Option 2a has been retained.

Adjustments in Beta approximations or other random data-generating approaches

The Basel text specifies, in Principle 7 in paragraph MAR31.26, that the coefficients ('Betas') of a multifactor model (indicated as 'Beta approximation' in these GL) must be empirically based and must not be determined based on judgment. According to the Basel text, in general, risk factors where the parameters are set by judgement should be considered as non-modellable. However, paragraph MAR99.22(1) appears to encompass certain cases where institutions, in derogation to the general principle and under specific conditions, could be allowed to apply some level of judgement when setting such parameters.

The CRR requires institutions to determine the scenarios of future shocks applied to modellable risk factors using the data inputs calibrated to historical data (see paragraphs 2(c), 3(c) and 4(c) of Article 325bc). Therefore, where Beta approximations or other random data-generating approaches are used for the purpose of determining the scenarios of future shocks, the CRR rules out any instances where the coefficients or parameters of those Beta approximations or random data-generating approaches are purely judgement-based. The only cases that could seem to be admissible under the CRR are those where the empirically calibrated coefficients or parameters are additionally fine-tuned with some adjustments.

The EBA considers that such cases should be exceptional, and that any adjustment to the empirically calibrated coefficients or parameters should be adequately justified. The following

options have been considered to assess the accuracy of the data inputs used in Beta approximations or other random data-generating approaches:

Option 3a: The Beta coefficients or parameters of the random data-generating approaches should be determined exclusively on the basis of the data inputs calibrated to historical data, i.e. where adjustments have been made to the coefficients or parameters determined exclusively on the basis of the data inputs calibrated to historical data, those data inputs are automatically considered as inaccurate.

Option 3b: In exceptional case, adjustments can be made to the values of the Beta coefficients or parameters of the random data-generating approaches determined exclusively on the basis of the data inputs calibrated to historical data, i.e. where adjustments have been made to the coefficients or parameters determined exclusively on the basis of the data inputs calibrated to historical data, those data inputs can be considered accurate if certain conditions are met.

Option 3a is stricter and would result in all data inputs used in Beta approximations or other random data-generating approaches where some adjustments have been applied as inaccurate. However, there may be cases where such adjustments may be warranted.

In order to determine whether such a provision, included in paragraph 16 of the CP, should have been maintained in the final GL, the EBA sought feedback from the consultation to gather concrete cases where institutions envisage its application, explaining also the reasons why the coefficients cannot be empirically calibrated only.

Respondents to the CP agree with maintaining such a provision in the final GL. In particular, one respondent provided some cases where such provisions can be applicable. These include cases where there are not enough historical data to get fully empirical estimates and some adjustments can be used to stabilise or improve the accuracy of the estimates.

Following the feedback, the EBA recognises that paragraph 16 of the CP could be needed in certain instances and therefore is of the opinion that such provision should be maintained in the GL.

Option 3b is retained.

Adjustments to the data inputs used for the period of financial stress

The Basel text specifies, in Principle 6 in paragraph MAR31.26, that the data used to determine the stressed expected shortfall should be sourced directly from the historical period of financial stress whenever possible. However, there may be cases where the characteristics of current instruments in the market differ from those in the period of financial stress. In these cases, the Basel text allows institutions to use data that reflect such differences, as long as they can empirically justify them.

Reflecting the effects of fundamental changes in the characteristics of financial instruments or in the characteristics of markets on the calibration of data inputs for the period of financial stress may prove difficult in practice. Such effects would have to be appropriately disentangled and quantified,

in particular based on the use of additional data. Institutions would have to motivate any use of such additional data to objectively characterise the extent to which financial instruments or market structures have altered and to verify that the resulting data inputs do not lead to an underestimation of risks.

The EBA has thus considered the following options regarding the data inputs used to determine the scenarios of future shocks for the purposes of points (c) and (d) of Article 325bc(2) of the CRR.

Option 4a: The data inputs must be calibrated to historical data sourced from the identified period of financial stress only.

Option 4b: In exceptional cases and under specific conditions, the data inputs can be calibrated using historical data sourced from a more recent period in addition to the historical data sourced from the identified period of financial stress, in order to reflect fundamental changes in the characteristics of financial instruments or markets across the two periods.

Option 4c: In exceptional cases and under specific conditions, the data inputs can be calibrated using proxy data sourced from the identified period of financial stress, in order to reflect fundamental changes in the characteristics of financial instruments across the two periods.

Option 4a is stricter as it will allow only historical data from the identified period of financial stress to be used. However, there may be cases where the use of additional data may be warranted.

The EBA sought precise feedback in the CP on whether there could be cases where the characteristics of current instruments or the characteristics of the market have changed so much compared to those that were applicable in the period of financial stress that adjustments to the above calibration could be warranted, and on whether institutions could envisage the application of such a provision. In particular, the CP set out Option 4b under paragraph 17 in the CP, and clarified that such a provision should have been reassessed in light of the feedback received and having regard to the harmonised application of CRR requirements in the EU.

All respondents to the CP highlighted the need to reflect fundamental changes in the characteristics of financial instruments in specific cases. In particular, one respondent provided some examples of situations where the need to augment data from the identified period of financial stress may arise. These include cases where the instrument had significantly different characteristics in the period of financial stress compared to now (e.g. the issuer of a security changed its business model).

After assessing the feedback received, the EBA recognises the need to reflect fundamental changes in the characteristics of financial instruments in specific cases. However, the EBA considers that Option 4b may create issues 1) due to the reference to fundamental changes in the characteristics of 'financial markets', which is potentially opening the door to transformations of data inputs that may end up being difficult to justify and 2) when read in conjunction with the provisions set out in Article 325bc(2)(c) and (d), which require the historical data and data inputs used to calculate the partial expected shortfall measures PES_t^{RS} and $PES_t^{RS,i}$ to be sourced from the identified continuous 12-month period of financial stress. Hence, the EBA considers that the provision should

be limited to changes in financial instruments (not markets) and that, in order to reflect fundamental changes in the characteristics of financial instruments, proxy data sourced from the identified period of financial stress should be used.

Option 4c is retained.

Combination of risk factors

Principle 1 in paragraph MAR31.26 of the Basel text specifies that combination of data from other modellable risk factors may be used in the ES model. The Basel text also specifies that a risk factor obtained as a combination of modellable risk factors is modellable and that a risk factor obtained as a combination of modellable and non-modellable risk factors is non-modellable. In addition, point (b) in Principle 1 sets out additional requirements for risk factors obtained by means of extrapolation from other risk factors.

With a view to transposing Principle 1 of the Basel text in these GL, the EBA has decided to treat the following two cases in these GL separately:

(a) the case where a given risk factor is obtained as a combination of other risk factors and the data inputs for the given risk factor are obtained by combining the data inputs from the other risk factors, including by means of interpolation or extrapolation techniques;

(b) the case where data inputs from other risk factors are used in interpolation or extrapolation techniques for the replacement of missing data points in the data inputs for a given risk factor.

On the one hand, paragraphs 27 and 28 of these GL are addressed to the case (a) above, setting out general requirements for the data inputs used for risk factors obtained as a combination of other risk factors (paragraph 27), and specific requirements for risk factors obtained by means of extrapolation from other risk factors (paragraph 28). On the other hand, paragraphs 42 and 43 of these GL are addressed to the case (b) above, setting out general requirements for interpolation or extrapolation techniques used for the replacement of missing data points in the data inputs for a given risk factor (paragraph 42), and specific requirements for extrapolation techniques used for the replacement of missing data points in the data inputs for a given risk factor (paragraph 43).

With respect to extrapolation, point (b) of Principle 1 of the Basel text states that institutions may extrapolate up to a reasonable distance from the closest modellable risk factor. However, the notion of 'reasonable distance' is not clearly defined therein.

The EBA, adopting Principle 1, has considered the following options on the notion of 'reasonable distance'.

Option 5a: Specify further how banks can assess the distance between two risk factors as reasonable.

Option 5b: Do not further specify the notion of reasonable distance.

Option 5a sets additional criteria on what can be considered as reasonable distance. In particular, a risk factor is considered to be within a reasonable distance from the closest of these modellable risk factors, which is not derived by extrapolation itself, if the closest modellable risk factor is mapped to the same bucket as the extrapolated risk factor and the extrapolated risk factor is not the only risk factor in a bucket, or to an adjacent bucket otherwise. This ensures some level of harmonisation across institutions. On the other hand, Option 5b is more flexible allowing institutions to assess differently what is reasonable distance. However, this could create inconsistencies around the notion of 'reasonable distance' across institutions, undermining the level playing field for institutions across the EU.

The EBA put forward Option 5a for consultation. One respondent found the provision as too prescriptive and suggested to allow banks flexibility when choosing the most appropriate extrapolation methodologies, as long as they are able to demonstrate the appropriateness of their choice.

After assessing the feedback received, the EBA considers that the introduction of more flexibility or the removal of such a provision would not be compliant with point (b) of Principle 1 in paragraph MAR31.26 of the Basel text.

For these reasons, the EBA decided not to amend or to remove the provision proposed in paragraph 34 of the CP from the final GL.

Option 5a has been retained.

Interpolation and extrapolation techniques used as replacement methodologies

Once a given risk factor has passed the modellability assessment, institutions should fulfil the conditions in this GL, to ensure that the data inputs used for that risk factor are complete. For that purpose, institutions could employ, among others, interpolated or extrapolated data, for the replacement of missing or inconsistent data points in the data inputs. Interpolation or extrapolation techniques can be divided into two types. The first type of techniques produces the interpolated or extrapolated values starting from the values of the given risk factor observed on previous and subsequent dates. The second type of techniques produces the interpolated or extrapolated values starting from the values of other risk factors (e.g. neighbouring grid points of an interest rate curve) observed on the same date. Figure 1 below provides two examples of the first type of techniques, while Figure 2 provides two examples of the second type of techniques.

Figure 1: interpolated value starting from the values of the given risk factor observed on previous and subsequent dates (left figure) and extrapolated value starting from the values of the given risk factor observed on previous dates (right figure)
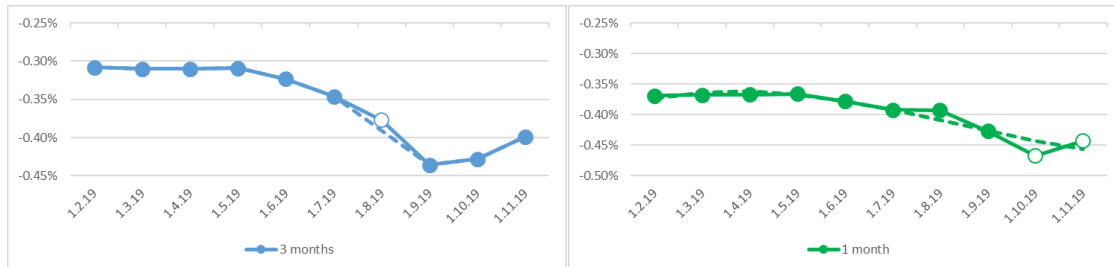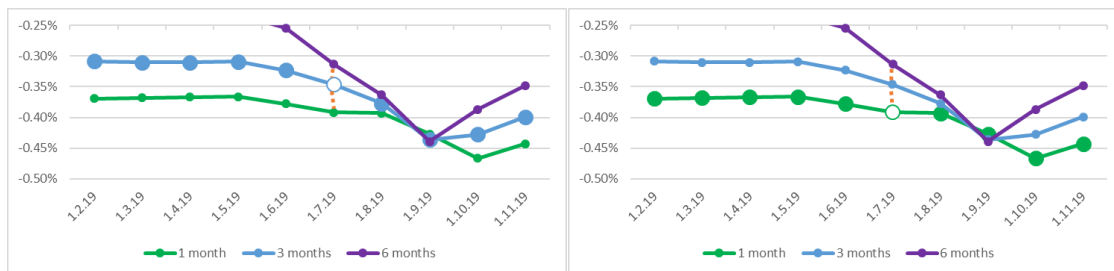

Figure 2: interpolated value starting from the values of other risk factors observed on the same date (left figure) and extrapolated value starting from the values of other risk factors observed on the same date (right figure)

Paragraph 31 of the CP was addressed to all replacement methodologies, including interpolation or extrapolation techniques, which involve data inputs of other risk factors (i.e. it was addressed to the second type of techniques). That paragraph required institutions to assess the modellability of those other risk factors, before the data inputs of those other risk factors might be used in a replacement methodology. In the feedback received from consultation, it was highlighted that the replacement of missing or inconsistent values in the data inputs is generally considered as a one-off exercise, and various concerns were expressed around the burden that such a provision introduce. In addition, paragraph 34 of the CP set out additional requirements to be met for the use of extrapolation techniques involving data inputs of other risk factors. In the feedback received from consultation, some concerns were expressed around the additional requirements on extrapolation techniques. In particular, respondents claimed that some flexibility should be granted to institutions, to choose the most appropriate extrapolation techniques, as long as they are able to demonstrate the appropriateness of their choices.

Hence, the EBA considered the following options:

Option 6a: Maintain in the GL the requirements on interpolation or extrapolation techniques involving data inputs from other risk factors (i.e. second type of interpolation and extrapolation techniques mentioned above) and used for the replacement of missing or inconsistent data points in the data inputs for a given risk factor.

Option 6b: Remove from the GL the requirements on interpolation or extrapolation techniques involving data inputs from other risk factors and used for the replacement of missing or inconsistent data points in the data inputs for a given risk factor.

Option 6a was the one that the EBA put forward for consultation. It ensures full alignment with what was prescribed in Principle 1 of the Basel text and consistency with the requirements set out in paragraph 27 and 28 of the GL (i.e. consistency of treatment with cases where a given risk factor is obtained as a combination of other risk factors and the data inputs for the given risk factor are obtained by combining the data inputs from the other risk factors, including by means of interpolation or extrapolation techniques). In addition, it ensures that harmonised treatments are used across the EU institutions. As mentioned above, respondents expressed a preference for Option 6b. However, the EBA considers that Option 6b would be non-compliant with Principle 1 in paragraph MAR31.26 of the Basel text.

Option 6a has been retained.

4.2   Feedback on the public consultation

The EBA publicly consulted on the guidelines contained in this paper.

The consultation period lasted for 3 months and ended on 12 November 2020. Three responses were received, of which two were published on the EBA website.

This paper presents a summary of the key points and other comments arising from the consultation, the analysis and discussion triggered by these comments and the actions taken to address them if deemed necessary.

In a number of cases, several industry bodies made similar comments or the same body repeated its comments in the response to different questions. In such cases, the comments, and EBA analysis are included in the section of this paper where EBA considers them most appropriate.

Changes to the guidelines have been incorporated as a result of the responses received during the public consultation.

Summary of key issues and the EBA's response

In the feedback table that follows, the EBA has summarised the comments received and explains which responses have and have not led to changes and the reasons for this.

As part of the general comments, one respondent voiced concerns regarding the three reconciliations proposed in paragraphs 12 to 14 of the CP. The respondents highlighted several points which may create issues, including 1) the fact that verifiable prices may not be used for the calibration of the ES model; 2) differences between data used in the ES model and data extracted from verifiable prices, due to intraday movements, bid/ask quotation and valuation adjustments; 3) unavailability of information needed to extract data from verifiable prices, especially where verifiable prices are provided by third-party vendors; and 4) differences between the set of risk factors used in the risk-measurement model and the set of risk factors used in front-office systems. The EBA, considering some of the points mentioned by the respondent, and in light of additional considerations (including the fact that a notion of data inputs broader than the one proposed in the CP should be used), revised the three reconciliations proposed in paragraphs 12 to 14 of the CP.

With respect to the provisions in paragraph 16 of the CP (on conditions to apply additional adjustments to the empirically calibrated coefficients of Beta approximations) and paragraph 17 of the CP (on conditions to reflect the effects of fundamental changes in the characteristics of financial instruments, when calibrating the data inputs for the period of financial stress), respondents were supportive for maintaining those provisions in the GL. The EBA, recognising that those provisions could be needed in certain instances, maintained them in the GL.

Regarding the replacement of missing or inconsistent data, one respondent expressed concerns on both paragraph 29 of the CP (prohibiting old and unchanged data as replacement of missing or

inconsistent values) and paragraph 33 of the CP (requiring that the volatility of extrapolated values be equal to or higher than the volatility of the data it is extrapolated from). The EBA, taking into account the feedback received, removed those two provisions from the GL.

Regarding the use of replacement methodologies, including interpolation or extrapolation techniques, which involve data inputs of other risk factors, and the relative requirement on the modellability of those other risk factors, as set out in paragraph 31 of the CP, respondents expressed concerns. In particular, it was mentioned that requiring a regular assessment of the modellability of the risk factors involved in replacement methodologies could cause instability in the data inputs, as risk factors previously involved in replacement methodologies may no longer be used, depending on the outcome of the modellability assessment. The EBA, after having analysed the concerns flagged by the respondents, decided to broadly maintain in the GL the provision included in paragraph 31 of the CP, that provision being aligned with that prescribed in the Basel text. However, the structure of the GL and the wording used have been revised.

With respect to the specific requirements addressed to extrapolation techniques, used for the replacement of missing or inconsistent values and involving data inputs of other risk factors, as set out in paragraph 34 of the CP, respondents expressed concerns. In particular, respondents claimed that some flexibility should be granted to institutions, to choose the most appropriate extrapolation techniques, as long as they are able to demonstrate the appropriateness of their choices. The EBA, after having analysed the concerns flagged by the respondents, decided to maintain in the GL the provision included in paragraph 34 of the CP, that provision being aligned with that prescribed in the Basel text. However, the structure of the GL and the wording used have been revised.

Summary of responses to the consultation and the EBA's analysis

Comments	Summary of responses received	EBA analysis	Amendments to the proposals
General comments			
Concerns that the GL are too prescriptive and hamper level playing field.	One respondent is of the opinion that the GL are too prescriptive, in particular on the allowance of appropriate extrapolation techniques (see also question 4). The respondent fears that this might lead to different, restricted modelling options for European banks compared to banks in other jurisdictions and emphasises the importance of an alignment of European legislation to global standards.	The EBA considers these GL in alignment with the Basel text. In addition and consequently, the EBA is not aware at the moment of any level playing field issues with other jurisdictions implementing the FRTB framework.	No amendments are needed.
Concerns regarding paragraphs 12 to 14 of the CP on the requirement to reconcile values of risk-factors used in the ES model with those derived from verifiable prices.	One respondent expresses concerns regarding the feasibility and usefulness of the reconciliation between values of risk factors used in the ES model and values of risk factors derived from verifiable prices. The respondent names the following reasons: 1. The Basel FRTB rules (paragraph 31.22) do not explicitly require verifiable prices to be used for calibration of the ES model. Furthermore, as part of question 14 of the consultation of the RTS on the risk factor modellability assessment, the EBA took note of the fact that the data used in the modellability assessment will typically not be used by institutions for calibrating their internal models.	Firstly, while not mentioned by respondents, the EBA considers that a notion of data inputs broader than the one proposed in the CP (i.e. 'data inputs = values of the risk factor in the relevant period') is needed, as in some cases the data inputs are not values of risk factors. Hence, the amendments introduced in the GL are underpinned by the above consideration. On point 1 raised by respondents, the EBA considers these GL fully aligned to the Basel text. Principle 4 in paragraph MAR31.26 states: *The comparison of front or back office prices with risk prices should consist of comparisons of risk prices with real price observations, but front office and back office prices can be used where real price observations are not widely available.*	Amendments to Section 4.1.

Comments	Summary of responses received	EBA analysis	Amendments to the proposals
	2. There is a lack of comparability between risk factors used in the ES model and those derived from verifiable prices due to differences in: a. cut-off times. Whereas verifiable prices are generated intraday, risk factor values in the time series for ES calibration are normalised to a certain cut-off time. Significant intraday moves in verifiable prices could hamper a mechanical reconciliation of level, volatility and correlation between risk factors used in the ES model and those derived from verifiable prices; b. bid/ask vs mid values and valuation adjustments. Whereas verifiable prices are quoted using bid/ask spreads and might include valuation adjustments, risk factor values for ES calibration are expected to provide a mid/fair value. 3. Firms which use an external data provider for the modellability assessment might not, or only with high effort, be able to derive the risk factors' values corresponding to the verifiable price observations counted to show modellability. This is due to the fact that	On point 2, the EBA acknowledges that there are natural reasons for observing differences between the values of risk factors as estimated from different data sources. In order to reflect that, the wording proposed in paragraph 12 of the CP has been softened. On point 3, the EBA acknowledges that the use of external data providers would be of high relevance for many institutions implementing the FRTB IMA. In addition, the EBA is of the opinion that the CP already encompassed such cases (i.e. verifiable prices are supposed to be used only where an institution has the value of the price available). However, having in mind the high importance of this point, and recognising that there may be limited availability of verifiable prices and of front- or back-office data from the period of financial stress, the EBA amended the scope of the reconciliations set out in paragraphs 12 to 14 of the CP, which in the GL is limited to data inputs calibrated to historical data from the current period only. On point 4, the EBA recognises that some risk factors may be included in the front-office pricing models while not in the risk-measurement model, and vice versa. Having in mind that some implementation issues could arise, the EBA considers to provide additional flexibility in the approach proposed in the GL. In particular, the approach proposed in paragraph 12 of the CP has been extended, in order to include: 1. the possibility to perform such an assessment also at the level of historical data, to be	

Comments	Summary of responses received	EBA analysis	Amendments to the proposals
	firms might not have access to the prices and/or the full information needed to extract the corresponding risk factors' values of the trades counted for the modellability assessment. 4. The ES model might use a smaller set of risk factors compared to the set of factors used for pricing. The respondent proposes to relax the requirements in paragraphs 12 to 14 of the CP such that it is sufficient to conduct a quarterly reconciliation exercise between the risk factors used in the ES model and either the risk factors obtained from front/back office systems or verifiable prices – independently of the number of verifiable prices available.	reconciled with either verifiable prices or similar data used in the front- or back-office systems; 2. the possibility to perform such an assessment also at the level of prices produced by the risk-measurement model, and based on either the data inputs or the historical data used to calibrate those data inputs, to be reconciled with either verifiable prices or prices produced by the front- or back-office systems. On the amending suggestion proposed by one respondent, the EBA is of the opinion that a complete removal of any condition for using front- or back-office data in the reconciliations set out in paragraphs 12 to 14 of the CP would be against the Basel text (see again Principle 4 in paragraph MAR31.26). However, in order to ensure consistency among the three reconciliations set out in paragraphs 12 to 14 of the CP and with a view to removing any unnecessary burden when performing those reconciliations, the EBA replaced the three separate conditions for accessing point (b) in paragraphs 12 to 14 of the CP with a unique, general condition (set out in paragraph 22 of the GL). In this way, the same time series is used for all the three reconciliations.	
Concerns regarding the requirements on replacement of missing or inconsistent values in paragraph 29 of the CP.	One respondent is of the view that paragraph 29 of the CP, prohibiting old and unchanged data as a replacement for missing or inconsistent values, unnecessarily forces firms to implement more complex filling techniques. The respondent hence proposes to delete paragraph 29 and consider that	The EBA acknowledges the concerns raised by the respondent and removed paragraph 29 of the CP from the GL.	Removal of paragraph 29 of the CP from the GL.

Comments	Summary of responses received	EBA analysis	Amendments to the proposals
	the specific replacement methodologies used should be the choice of each individual firm, subject to the requirements in paragraph 28 of the CP to have in place 'clear policies for replacement of missing or inconsistent values'.		
	The respondent further raises concerns that a risk factor would have to be capitalised under the stress scenario risk measure if on a single day in the data history a missing or inconsistent value cannot be replaced in a way that meets the GLs. The respondent hence proposes a level of tolerance whereby if less than a certain percentage of values is replaced in a way that does not meet the GLs, this would still be acceptable and the risk factor may still be eligible to be capitalised in the ES model.		
Concerns with paragraph 33 of the CP requiring that the volatility of extrapolated values is equal to or higher than the volatility of the data it is extrapolated from.	One respondent proposes to delete paragraph 33 of the CP requiring that where extrapolated values are used as replacement for missing or inconsistent values in the historical time series of a risk factor, the volatility as estimated from the extrapolated values should be equal to or higher than the volatility as estimated from the data used for extrapolating. The respondent argues that if there is only a single day with a missing or inconsistent value this volatility comparison would lack robustness due to a lack of data. The respondent considers a justification of extrapolated values to not lead to a systemic bias toward volatility underestimation via paragraph 28 of the CP as sufficient in this regard.	The EBA acknowledges that there could be some instances where the current drafting of paragraph 33 of the CP could pose some problems to institutions in its application. Therefore, the EBA removed paragraph 33 of the CP and aligned the requirements for extrapolation techniques to the ones for interpolation techniques, set out in paragraph 32 of the CP.	Removal of paragraph 33 of the CP from the GL and amendments to paragraph 32 of the CP (paragraph 41 of the GL).

Comments	Summary of responses received	EBA analysis	Amendments to the proposals
Responses to questions in Consultation Paper EBA/CP/2020/21			
Question 1. To which extent do you intend to apply paragraph 16 of the CP? Please provide concrete examples that could fall under the scope of paragraph 16 of the CP and explain why the coefficients cannot be calibrated to the historical data only.	All respondents agree with the proposal. One respondent considers the proposal reasonable and suggests including paragraph 16 of the CP as proposed. One respondent does not use beta approximations, but the respondent agrees with the proposal. The respondent also sets out their alternative approach to determine scenarios of future shocks to obtain PES_t^{FC} and $PES_t^{FC,i}$ via the collection of historical time series which are augmented through proxies. One respondent states that the type of situation where this paragraph can be applicable is where there is not enough historical data under which to make a fully empirical estimate or the estimates can be stabilised and accuracy improved by incorporating a level of judgement.	The EBA recognises that paragraph 16 of the CP could be needed in certain instances and therefore is of the opinion that such a provision can be maintained.	No amendments are needed.
Question 2. To which extent do you intend to apply paragraph 17 of the CP? Please provide concrete examples that could fall under the scope of paragraph 17 of the CP.	All respondents agree with the proposal. One respondent currently has no case that requires the use of historical data more recent than the chosen 12-month period of financial stress. In addition, one respondent provides examples of situations where the need to augment data from the period of financial stress may arise: • if the instrument did not exist in the period of financial stress;	The EBA recognises that there are instances where reflecting the effect of fundamental changes in the characteristics of instruments is needed. However, the EBA recognises that the provision set out in paragraph 17 of the CP could create issues 1) due to the reference to fundamental changes in the characteristics of 'financial markets', which is potentially opening the door to transformations of data inputs that may end up being difficult to justify; and 2) when read in conjunction with Article	Amendments to paragraph 17 of the CP (paragraph 25 of the GL).

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	• if the instrument had significantly different characteristics in the period of financial stress compared to now (e.g. the issuer of a security changed its business model or the risk factor has an absolute maturity).	325bc(2)(c) and (d) of the CRR. Hence, the EBA considers that the provision should be limited to changes in financial instruments (not markets) and that such a provision should be reassessed and that proxy data sourced from the identified period of financial stress should be used to reflect the effects of fundamental changes in the characteristics of financial instruments.	
Question 3. Do you agree with the inclusion of paragraph 31 of the CP in the GL? Do you envisage any issues that could be associated with paragraph 31 of the CP?	All respondents suggest to remove paragraph 31 of the CP from the GL. All respondents have concerns that requiring a regular modellability monitoring of risk factors, which are used in data remediation, could cause periodic changes of shocks in the historical time series. In particular, if a regular revision deems a risk factor used for replacing as non-modellable, and if this happens on a regular basis, this could cause instability in the historical time series (and as a consequence in the risk measures). Vice versa, a risk factor might be a valid alternative for data remediation today, but could not be used at the time when the remediation took place, because it was non-modellable at that time. One respondent acknowledges that instability issues depend on the type of risk factor.	In order to better reflect Principle 1 in paragraph MAR31.26 of the Basel text, the EBA considers treating the following two cases separately: (a) the case where a given risk factor is obtained as a combination of other risk factors and the data inputs for the given risk factor are obtained by combining the data inputs from the other risk factors, including by means of interpolation or extrapolation techniques (treated in paragraphs 27 and 28 of the GL); (b) the case where data inputs from other risk factors are used in interpolation or extrapolation techniques for the replacement of missing data points in the data inputs for a given risk factor (treated in paragraphs 42 and 43 of the GL). Paragraph 31 of the CP was addressed for all replacement methodologies, including interpolation or extrapolation techniques, which involve data inputs of other risk factors.	Removal of paragraph 31 of the CP from the GL and inclusion of new paragraphs 27 and 42 in the GL.

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		The EBA, after analysing the concerns flagged by the respondents on the application of paragraph 31 of the CP (in particular, in terms of stability of the historical time series of data inputs), acknowledges the following:	

1. the Basel text clearly sets out that a risk factor obtained as a combination of modellable risk factors is modellable (see paragraph 31.26, Principle 1) and that a risk factor obtained as a combination of modellable and non-modellable risk factors is non-modellable (see paragraph 31.13, footnote 3);

2. as a consequence of 1., the Basel text sets out requirements for interpolation and extrapolation techniques, which are always based on modellable risk factors (see paragraph 31.26, Principle 1);

3. the two cases (a) and (b) mentioned above should be treated separately, for the sake of clarity;

4. the requirements set out for the two cases (a) and (b) should be consistently aligned, in order to fully reflect the Basel text and to avoid any potential regulatory arbitrage;

5. as a consequence of 4., where data inputs from other risk factors are used in interpolation or extrapolation techniques for the replacement of missing data points in

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		the data inputs for a given risk factor, those other risk factors should be modellable;	
		6. the modellability assessment should be performed in accordance with the criteria set out in the relevant RTS, which specify the frequency of that assessment (i.e. a quarterly frequency is envisaged, as according to the final draft RTS on modellability assessment, the relevant criteria shall be met over a 12-month observation period which is updated at each reporting reference date).	
		Considering the points mentioned above, the EBA is of the opinion that the provision included in paragraph 31 of the CP should be broadly maintained in the GL. However, considering that a notion of data inputs broader than the one proposed in the CP should be used, and with a view to treating the cases (a) and (b) mentioned above separately, the structure of the GL and the wording used have been revised.	
Question 4. Do you agree with the inclusion of paragraph 34 of the CP in the GL? Do you envisage any issues that could be associated with paragraph 34 of the CP?	One respondent suggests removing paragraph 34 of the CP from the GL and allow banks flexibility to choose the most appropriate extrapolation methodologies (if they are able to demonstrate the appropriateness of their choice). One respondent, considering interpolation and extrapolation as a distinctive aspect of the internal model, deems the GL as being too prescriptive on the use of extrapolation and also as too restrictive regarding the use of extrapolation only for not	The EBA acknowledges that no strong arguments were brought from respondents to justify a deletion of paragraph 34 of the CP. In particular, the EBA considers Backtesting and PLAT as insufficient tools to identify inappropriate interpolation or extrapolation decisions. Additionally, the EBA considers that an introduction of more flexibility in paragraph 34 of the CP, or a complete removal of paragraph 34 of the CP from the	Removal of paragraph 34 of the CP from the GL and inclusion of new paragraphs 28 and 43 in the GL.

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	available market data inputs. This could cause application of proxies of an inferior quality compared to extrapolation or the case that no proxy may be available. The respondent specifies that limitations in the use of sound proxy methodologies may impact the results of Backtesting and Profit and Loss Attribution Test. If no proxy is available, as a consequence, shocks beyond the last modelled pillar would be zero with a significant impact on risk factor eligibility tests to IMA, in particular on PLAT.

Portfolio Backtesting is recognised as a valid tool to identify whether risk factors simulated adequately reflect market volatility and correlations. The PLAT, where a failure would force a desk to SA, is deemed to be a mechanism strict enough to penalise insufficient quality of interpolation/extrapolation.

The respondent provides an example on FX volatilities, which should show that proxying via extrapolation across adjacent data points performs better compared to currency pair substitution (the extrapolation leads to higher correlation and comparable volatilities between underlying and proxy compared to the currency substitution approach). This statement is supported by an analysis of 73 currency pairs, in which a comparison is made in the SVaR period between 1) a flat extrapolation from 1Y implied volatility of a currency pair to 3Y tenor of the same pair and 2) a currency substitution based on regression analysis for 3Y implied volatility. While tenor substitution shows an average correlation of 0.96 (and showing | GL, would be non-compliant with Principle 1, point (b) in paragraph MAR31.26 of the Basel text.

For those reasons, the EBA is of the opinion that the provision included in paragraph 34 of the CP should be maintained in the GL.

However, considering that a notion of data inputs broader than the one proposed in the CP should be used, and with a view to treating the cases (a) and (b) mentioned in the analysis to Question 3 separately, the structure of the GL and the wording used have been revised. | |

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	less variance) for correlation, currency substitution shows between 0.83 and 0.86 (depending on moneyness); tenor substitution and currency substation show average values for volatility of the risk factor comparable to the value for the proxied risk factor (ratio between 0.97 and 0.98) One respondent suggests revising paragraph 34 of the CP to take into account concerns that the provisions in that paragraph may be too prescriptive when proxy methodologies are used, and that the flexibility of making a choice of approach used should be left to institutions. The respondent states that the correlation between different risk factors could change over time and that, due to market dynamics, closest risk factors possibly are not so correlated. Therefore, the respondent suggests that statistical analysis should be provided before applying those replacement techniques.		