EBA REPORT

RESULTS FROM THE 2019 MARKET RISK
BENCHMARKING EXERCISE

EBA REP/2020/04

EBA | EUROPEAN BANKING AUTHORITY

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Abbreviations

APR	all price risk
CA	competent authority
CDS	credit default swap
CO	commodities
CRD	Capital Requirements Directive
CRR	Capital Requirements Regulation
CS	credit spread
CS01	credit spread value of 1 basis point
CTP	correlation trading portfolio
CV	coefficient of variation
EBA	European Banking Authority
EQ	equity
ES	expected shortfall
EU	European Union
FRTB	fundamental review of the trading book
FX	foreign exchange
HPE	hypothetical portfolio exercise
HS	historical simulation
IMV	initial market valuation
IQD	interquartile dispersion
IR	interest rates
IRC	incremental risk charge
IT	information technology
ITS	implementing technical standards
LGD	loss given default
MC	Monte Carlo
MR	market risk
MRWA	market-risk-weighted asset
P&L	profit and loss
PD	probability of default
Q&A	question and answer
RTS	regulatory technical standards
RWA	risk-weighted asset
sVaR	stressed value at risk
VaR	value at risk

1. Executive summary

1. This report presents the results of the 2019 supervisory benchmarking exercise pursuant to Article 78 of the Capital Requirements Directive (CRD) and the related regulatory and implementing technical standards (RTS and ITS) that define the scope, procedures and portfolios for benchmarking internal models for market risk (MR).

2. The report summarises the conclusions drawn from a hypothetical portfolio exercise (HPE) that was conducted by the EBA during 2018/19. The primary objective of this exercise was to assess the level of variability observed in risk-weighted assets (RWA) for market risk produced by banks' internal models.

3. The exercise was performed on a sample of 50 European banks from 13 jurisdictions. The relevant institutions submitted data for 73 instruments recombined in 59 market portfolios in all major asset classes, i.e. equity (EQ), interest rates (IR), foreign exchange (FX), commodities (CO) and credit spread (CS), as well as 2 correlation trading instruments recombined in 4 portfolios (CTPs), for a total of 63 benchmark portfolios. Thus, the exercise covers the entire population of EU banks with internal models for MR at the highest level of consolidation.

4. In addition to the analytical part of the exercise, the EBA, in cooperation with the competent authorities (CAs), has as part of the exercise conducted interviews with a subsample of the participating banks to discuss the assumptions behind banks' models, the banks' results compared with the benchmarks, and how the banks approached and carried out the benchmarking exercise. In 2019, a limited set of interviews was carried out, which was helpful in bringing to light any missing risk factors, provided information on how additional risk factors were modelled and taken into account and provided feedback on how the EBA might improve forthcoming benchmarking exercises.

5. Finally, taking into consideration the results of the benchmarking exercise, CAs were asked to provide the EBA with responses to a questionnaire on the actions they plan to take with regard to each participating bank's internal model.

1.1   Main findings of the benchmarking analysis

6. The report measures variability in terms of the interquartile dispersion (IQD)[1] and the coefficient of variation (CV)[2] observed within each benchmark portfolio. The IQD is more robust than the CV when the sample is drawn from an unknown, fat-tailed distribution. As in the previous exercises on market-risk-weighted asset (MRWA) variability, the IQD metric suggests a level of dispersion for all the risk measures provided by banks that needs to be monitored.

7. The primary considerations are that the 2019 analysis shows a reduction in the dispersion in the initial market valuation (IMV) with respect to the 2018-2019 exercises; see, for instance, Table 1. This improvement was expected because of the simplification applied with the new exercise: instruments in this exercise consist of more plain vanilla instruments than in the previous exercises. Some variability in the results persists despite the simplification; this mainly stems from the fact that a new instrument appear to been differently understood by different banks. Some of these issues were addressed, when possible, and the quality of the data has improved during the exercise thanks to successive resubmissions.

8. Like for previous exercises, data quality issues continue to be a significant challenge for this exercise. Poor data quality stems from a wide variety of reasons. Some types of errors are trivial, such as the wrong unit reported, especially in the case of equity instruments. In order to improve data quality, the EBA notes that several rounds of iteration with submitters will be required, which can be difficult within the short time frame of the exercise. Other errors were linked to the misunderstanding of some instruments, such as instruments 40 and 49. The redraft of the legal text of the exercise for the next exercise should further improve the data quality in these aspects.

9. The majority of the significant dispersions has been examined and justified by the banks and the CAs. A minority of the outlier observations remains unexplained and is expected to be part of the ongoing supervision activities of supervisors, who are expected to monitor and investigate the situation (see Section 1.2 and Chapter 6 of this report).

10. From a risk factor perspective, equity and interest rate portfolios exhibit a lower level of dispersion than the other asset classes. This lower level of variability is likely to be due to the use of more consistent practices and assumptions that are more homogeneous across the banks

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[1] IQD is defined by the mid-interquartile range [(Q3 – Q1) ÷ 2] divided by the average of the quartiles [(Q3 + Q1) ÷ 2], called the mid-hinge. The higher the IQD is, the higher the dispersion in the data.

[2] CV is computed as the ratio of the standard deviation to the mean.

when modelling equity and interest rate risk (see Table 4: Interquartile dispersion for IMV and risk metrics by risk factor).

11. Regarding the single risk measures, across all asset classes, as expected, the overall variability for value at risk (VaR) is lower than the observed variability for stressed VaR (sVaR) (21% and 30% respectively, compared with 20% and 30% in 2018).[3] More complex measures such as incremental risk charge (IRC) and all price risk (APR) show a higher level of dispersion (54% and 37% respectively, compared with 37% and 57% in 2018). It has to be stressed in the direct comparison between 2018 and 2019 IQDs that the structures of the two exercises and the instruments of which they were composed are very different.

12. As for the past exercise, to deepen the analysis of VaR and further investigate the variability drivers, different VaR metrics were computed and compared with the banks' reported VaR. In particular:

- an alternative estimation of VaR, called profit and loss (P&L) VaR, computed by the EBA using the 1-year daily P&L series submitted by banks using a historical simulation (HS) approach; and

- a comparable VaR, called HS VaR, which corresponds to the regulatory VaR reported by those banks that use an HS approach (only).

13. When comparing variability between the regulatory VaR and these 'alternative' risk measures, one finds a slight decrease in the IQD when considering a more homogeneous sample (i.e. HS banks only). In fact, for all the risk types, the dispersion observed for the P&L VaR tends to be lower. This finding suggests that the modelling approach is not the only driver of the observed VaR variability. Other drivers, such as risks not captured in the model or the choice of absolute versus relative returns, are further explanations for the results' variability (see Table 4: Interquartile dispersion for IMV and risk metrics by risk factor).

14. Even so, within the subset of banks using an HS approach, modelling choices (see Table 6: Coefficient of variation for regulatory VaR by modelling choice) seem to make a noticeable difference. Scaled 1-day VaR, use of a lookback period of 1 year and use of weighted returns tend to produce lower dispersion than other modelling configurations, for EQ and FX. On the other hand, 10-day VaR, use of a lookback period greater than 1 year and use of weighted returns tend to produce lower dispersion than other modelling configurations, for IR and CS. At the same time, the same modelling choices tend to produce different VaR results in terms of conservativeness (see Table 7: Average regulatory VaR by modelling choice). This observation differs from the finding of the 2018 exercise, which was run over different portfolios and banks. Overall, it is clear that this analysis is extremely sensitive to the different portfolios used to

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[3] These values are derived as a simple average of the IQD across all non-correlation trading portfolios.

produce the statistic, which is driven by the low number of subjects available, so it cannot be generalised.

15. The dispersion in sVaR figures is generally higher than the dispersion observed for regulatory VaR (see Table 20 and Table 21). The stressed period used was the one applied by the bank for the capital purpose and it was not harmonised in the sample. Different choices for the stressed period are permitted by the Capital Requirements Regulation (CRR) and these choices are considered and challenged in the regulatory approval process. While allowing banks to use their individual stress periods reduces the comparability of the sVaR results across the sample, doing so facilitates the estimation of implied capital needs from the HPE. For this exercise, banks were asked to report the stressed period applied. Thanks to that, EBA made a subset of homogeneous time windows applied, and ran the benchmark for this subsample. It appears clear that, applying a homogeneous stress window, the sVaR figures tend to be less dispersed (see Table 34: Stress VaR statistics (2008-2009 stress period only)).

16. In addition to carrying out these analyses, the EBA compared between banks the ratio between sVaR and VaR for each of the hypothetical portfolios included in the benchmarking exercise (see Table 5: sVaR–VaR ratio by range (number of banks as a percentage of the total)). The ratio generally varies significantly between the portfolios, especially for instruments subject to credit spread risk (from 0.65 to 6.66). However, on average, the ratio lies at around 2.8 (see Table 24: sVaR/VaR statistics).

17. As expected, for the larger banks with significant trading activities, the benchmarking portfolios are generally relevant to their actual trading book. For smaller banks, this is less the case, and this is why EBA included simpler and more plain vanilla instruments in the 2019 exercise. The challenge remains to design a benchmarking exercise that can fit banks that have a very specialised business model. Overall, the portfolios are, however, reflective of the risk factors experienced by most banks. In the 2019 exercise we notice a substantial reduction of the VaR dispersion, at least in the aggregate portfolios (see Table 20: VaR statistics). Some single portfolios exhibit a substantial high dispersion, but the clarification provided for the 2020 exercise should have a positive effect on this aspect.

18. Regarding IRC, average variability (as measured by the average IQD for this category of portfolios) is higher than that observed for all other metrics considered in the report (54%). This high variability, substantially higher than the previous exercise (IQD was 37% on average for the 2018 exercise), is very difficult to compare, because of the substantial change in the composition of the CS portfolios (see Table 13: IRC statistics and cluster analysis and compare it with the previous exercise).

19. Regarding APR, average variability (as measured by the average IQD for this category of portfolios) is substantially high in relation to the other metrics considered in the report (37%). However, the APR assessment suffers from a chronical lack of contributions – only a few banks are authorised to model this asset class internally and most banks are currently in the process

of reducing their exposure to correlation trading portfolios (CTPs), i.e. these portfolios are supposed to be in run-down mode (see Table 14: APR statistics and cluster analysis).

20. An additional metric considered as part of the analysis was the diversification benefits observed for VaR, sVaR and IRC in the aggregated portfolios (see Table 15: Diversification benefit statistics). As expected, there is evidence that larger aggregated portfolios exhibited greater diversification benefits than smaller ones. In general, the level of dispersion observed in diversification benefits tends to be lower than that in the corresponding metrics at the level of the individual portfolios.

21. As had been done for the previous exercise, an assessment of the variability of the empirical estimates of the expected shortfall (ES) at a 97.5% confidence level was also carried out. The results indicate that the dispersion in this metric across risk factors is similar to that found for VaR and P&L VaR (see Table 23: Empirical expected shortfall statistics).

Dispersion in capital outcome

22. Alongside the variability analysis, the EBA also conducted an assessment regarding possible underestimations of capital requirements (see Table 16: Interquartile dispersion for capital proxy). As the analysis is based on hypothetical portfolios and the capital requirements were defined using a proxy, the results should be interpreted as approximations of potential capital underestimations. The proxy for the implied capital requirements was defined as the sum of VaR and sVaR across all portfolios. For purposes of comparison, the proxy was computed twice. In one case, the VaR and sVaR figures were multiplied by the banks' total multiplication factor and, in the other, by the regulatory minimum of 3 only, i.e. ignoring the banks' individual addend(s) set by the CAs. This metric enables one to compare banks and assess their variability in this regard.

23. The average variability across the sample, measured by way of the IQD, is significant (around 23%), especially for the most complex portfolios in the credit spread asset class. The analysis of the capital proxy pattern across the HPE's trades, moreover, suggests that, with the exception of interest rate products, the ranges of capital value dispersion are broadly consistent, irrespective of whether the banks' actual multiplication factors are used or not.

Additional analysis carried out in the 2019 exercise

24. With respect to the previous exercises, the EBA extended the analysis to other drivers of variation (see Section 5.2.5), such as the size of the bank, the business model of the bank, the level of approval granted by the CAs and the already mentioned stressed period applied in the sVaR calibration.

25. In a nutshell, from this additional analysis we can conclude that the size of the bank has an impact on the figures, since smaller banks tend to provide more dispersed results (see Table 8: Asset class comparison for VaR in terms of size of the banks).

26. The discrimination based upon the business model delivered weak conclusions, but this has to be attributed to the low number of observations within the categories and the fact that the majority of banks are cross-border universal banks (see Table 9: Asset class comparison for VaR in terms same business model (Cross-border Universal bank)).

27. The subsamples analysis based upon the level of approval delivered interesting results. A priori it was expected that having banks with different levels of approval would have increased the dispersion of the results of the risk measures. Contrary to this, the IQD results seem to be very stable among the subsamples of different approval levels. This is because, obviously, more homogeneous subsamples tend to provide smaller dispersions, but this positive effect is counterbalanced by the smaller number of firms in the sample. Basically, the benchmark provided and the 25th and 75th quantiles of the distribution tend to be very stable for the whole set of banks. This implies that the different level of approval biased the benchmarking results significantly less than expected (see Table 10: Asset class comparison for VaR in terms of level of approval).

28. Finally, as already mentioned above, and this was quite expected, sVaR figures are far less dispersed when the benchmark is computed for a homogeneous subsample of firms that applied a similar time period for the stress window used for calibrating the sVaR (see Table 11: Asset class comparison for Stress VaR in terms time window applied).

1.2 CAs' assessments based on supervisory benchmarks

29. CAs shared the outcomes of their assessments at bank level with the EBA (see Figure 16: CAs' own assessments of the levels of MR own funds requirements). The CAs' assessments confirmed the existence of some areas that require follow-up actions on the part of specific institutions whose internal models were flagged as outliers in this benchmarking exercise.

30. Overall, CAs' assessment of the over- and underestimation of RWA was encouraging, in the sense that CAs were aware of and able to explain the causes of the majority of the deviations. Although the majority of the issues were identified and actions put in place in order to reduce the unwanted variability of the RWA, the effectiveness of these actions can be evaluated only in the future and via further analysis.

31. The CAs are expected to pay great attention to the minority of the cases in which the over- and underestimations were unexplained, to closely monitor these institutions and to put in place additional effort to reduce these cognicional gaps in the future exercises.

1.3 2020 exercise – expected changes

32. The 2019 exercise has represented a significant change from the 2016-2018 exercises, in terms of simplification of the portfolios. This simplification had a positive effect in obtaining less dispersed results than with the previous portfolios, and it improved the significant data quality issues related to some portfolios, while focusing on the model risk elements.

33. It is expected that in the 2020 exercise the data submitted will further improve in quality due to the clarification of the legal text description of some instruments, and also to the further practice that the banks have gained from the present exercise. Unfortunately, the banks participating in the 2020 exercise cannot benefit from this 2019 benchmarking report, because the 2020 exercise has already started (October 2019) before the publication of this report.

34. The analysis run by the EBA for the 2020 exercise is expected to be relatively stable, and the EBA will try to deepen further the assessment of the new elements introduced this year. On the other hand, one aspect of the exercise will be new, the Present Value submission. For the 2019 exercise the Present Value was not collected due to a misalignment with the reporting framework. The problem should be resolved for the 2020 exercise, so this new element of the analysis will be considered in the future.

35. The EBA will also try to consider new measures of dispersion to define the outliers in the exercise, and will try to enhance the transparency of the result provided to the banks, so that they can better respond to the requests of their CAs.

36. In a long-run vision, the EBA will consider reshaping the instruments and the portfolios in the exercise in a way that still keeps the instruments simple, to ensure clarity on the instruments, as the different interpretations of the instrument has been a significant source of variability, but also recombines these instruments in such a way that the different portfolios have meaningful designs when compared with each other. In addition, very importantly, the fundamental review of the trading book (FRTB) is understood to be of particular significance for the market risk benchmarking exercise. In the future the exercise will require a major redesign to take into consideration the specific features of the FRTB.

2. Introduction and legal background

37. European legislators have acknowledged the need to ensure consistency in the calculation of RWA for equivalent portfolios, and the CRR and CRD include a number of mandates for the EBA to deliver technical standards, guidelines and reports aimed at reducing uncertainty and differences in the calculation of capital requirements.

38. In this regard, Article 78 of the CRD requires the EBA to produce a benchmarking study on both credit and market risk to assist CAs in the assessment of internal models. The study should highlight potential divergences among banks or areas in which internal approaches might have the potential to underestimate their own funds requirements that are not attributable to differences in the underlying risk profiles. CAs are to share this evidence within colleges of supervisors as appropriate and take appropriate corrective actions to overcome these drawbacks when deemed necessary. Directive (EU) 2019/878[4] of the European Parliament and of the Council of 20 May 2019 amending Capital Requirements Directive IV (CRD V) has not changed this mandate.

39. The EBA has devoted significant efforts to the analysis of the consistency of outcomes in RWA, to understand the causes of possible inconsistencies and to inform the regulatory repair process. The EBA's ongoing work on benchmarking, supervisory consistency and transparency is fundamental to restore trust in internal models and the ways in which banks calculate asset risks.

40. The use of internal models provides banks with the opportunity to model their risks according to their business models and the risks faced by the bank itself. The introduction of a benchmarking exercise does not change this objective; rather, it helps to identify the non-risk-based variability drivers observed across institutions.

41. This MR benchmarking exercise is an MRWA variability assessment performed over a large sample of banks (50 banks at the highest level of consolidation in 13 jurisdictions within the EU). The banks participating in this exercise are those that have been granted permission to calculate their own funds requirements using internal models for one or more of the following risk categories:

    a) general risk of equity instruments;

    b) specific risk of equity instruments;

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[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0878&from=EN

c) general risk of debt instruments;

d) specific risk of debt instruments;

e) foreign exchange risk;

f) commodities risk; and

g) correlation trading.

42. According to Article 362 of the CRR, the general risk of debt instruments should refer to interest rate risk. Similarly, the general risk of equity instruments refers to the change in value of indexes.

43. Banks that have approval only for general risk of equity or debt instruments (in accordance with Article 363 of the CRR) may use a different definition of general risk (e.g. by including credit spread risk in the interest rate general risk) if they are able to demonstrate that it leads to higher RWA. Separate permission is required for each risk category. Many banks do not have permission for internal models for all risk categories, so the number of contributions for each hypothetical portfolio in this exercise varies across the sample.

44. Banks that have permission to use the internal model for calculating MR own funds requirements for one or more but not all of the risk categories, in accordance with Article 363(1) of the CRR ('partial use'), exclude certain risks or positions from the scope of the internal model approval. In this case, the own funds requirements for the risk categories outside the scope of the internal model are calculated according to the standardised approach.

45. In addition, as set out in Article 369(1)(c) of the CRR, banks should conduct validation exercises on hypothetical portfolios to test that the model is able to account for particular structural features. These portfolios should not be limited to the portfolios defined in this exercise; however, this exercise is a useful starting point for banks to meet this legislative requirement.

46. The assessed MR results, when provided and where applicable, are VaR, sVaR, IRC and APR figures for specific and aggregated trades. Moreover, a preliminary assessment of IMV was performed, primarily to ensure that the participating banks make uniform assumptions when entering the hypothetical trades.

47. In addition to these submissions, banks using an HS approach for VaR were requested to provide 1 year of P&L data for each of the individual and aggregated portfolios modelled. The objective of collecting this additional information was to employ the data vector to perform alternative calculations for VaR using, where possible, a consistent 1-year lookback period and controlling, as far as possible, for the different options that banks can apply within regulation.

48. Regulation (EU) 2019/876[5] of the European Parliament and of the Council of 20 May 2019 amending the Capital Requirements Regulation as regards the leverage ratio, the net stable funding ratio, requirements for own funds and eligible liabilities, counterparty credit risk, market risk, exposures to central counterparties, exposures to collective investment undertakings, large exposures, reporting and disclosure requirements (CRR II) will have a significant impact on the market risk benchmarking exercise once it is fully implemented, but, for the time being, the CRR framework will be applied for the purpose of the benchmark exercise in accordance with Article 78 of the CRD.

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[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0876&from=EN

3. Main features of the 2019 market risk benchmarking exercise

49. Based on the EBA Benchmarking ITS, the MR benchmarking exercise is carried out following three main steps. First, the EBA defines the hypothetical instruments and portfolios, which are the same for all banks in order to achieve a homogeneous and comparable outcome across the sample. Second, banks are asked to submit the data accordingly. Third, and finally, the EBA processes and analyses the data, providing feedback to CAs. During the process, the EBA supports CAs' work by providing benchmarking tools to assess banks' results and detect anomalies in their submissions.

3.1 Definition of the market risk hypothetical portfolios

50. The MR portfolios have been defined as hypothetical portfolios composed of both non-CTPs and CTPs, as set out in Annex V of the Benchmarking ITS. The exercise includes 73 instruments recombined in 59 general portfolios (53 individual and 6 aggregated), capitalised under the VaR, sVaR and IRC models, comprising mainly plain vanilla and some complex financial products in all major asset classes: EQ (18 instruments and 10 individual portfolios), IR (19 instruments and 16 individual portfolios), FX (11 instruments and 6 individual portfolios), CO (4 instruments and 3 individual portfolios) and CS (21 instruments and 18 individual portfolios). The EBA also designed aggregated portfolios, obtained by combining individual ones, to take into account diversification effects. Each aggregated portfolio has a particular composition: the first (portfolio 57) encompasses all products; the second (portfolio 58) is made up of all EQ portfolios; the third (portfolio 59) is made up of all IR portfolios; the fourth (portfolio 60) is made up of all FX portfolios; the fifth (portfolio 61) is made up of all CO portfolios; and the sixth (portfolio 62) is made up of all CS portfolios.

51. In addition, the set of portfolios includes 2 instruments and 4 portfolios (3 individual and 1 aggregated) used for correlation trading activities, capitalised under the VaR, sVaR and APR models. These portfolios contain positions in index tranches referencing the iTraxx Europe index on-the-run series. The portfolios are constructed by hedging each index tranche with iTraxx Europe index on-the-run 5-year series to achieve zero credit spread value of 1 basis point (CS01) as of the initial valuation date (spread hedged). No further re-hedging is required.

52. A more detailed explanation of the portfolios can be found in the Benchmarking ITS on the EBA website.[6]

3.2 Data collection process

53. The data for the supervisory benchmarking exercise were submitted by banks to their respective CAs using the supervisory reporting infrastructure. Banks submitted the specified templates provided in the ITS, where applicable.

3.2.1 IMV

54. The reference date for IMV was 26 September 2018, 4.30 p.m. London time (5.30 p.m. CET). Banks entered all positions on 19 September 2018 ('reset or booking date'), and, once positions had been entered, each instrument aged for the duration of the exercise. Furthermore, banks did not take any action to manage the instruments in any way during the entire exercise period.

55. The IMV figure to be reported by the banks for each hypothetical instrument was defined as the mark to market of the instrument at the booking date plus the profit and loss from the booking until the valuation date and time. Therefore, it was the mark to market of the instrument on 26 September 2018, 5:30 p.m. CET.

3.2.2 Risk measures

56. According to the common instructions provided, banks should calculate the risks of the positions without taking into account the funding costs associated with the portfolios (i.e. no assumptions are admitted with regard to the funding means of the portfolios). Banks should moreover exclude, as far as possible, counterparty credit risk when valuing the risks of the portfolios.

57. Banks should calculate the regulatory 10-day 99% VaR on a daily basis. sVaR and IRC may be calculated on a weekly basis. sVaR and IRC should be based on end-of-day prices for each Friday in the time window of the exercise. For the four CTPs (54-56 and 63), APR was also requested.

58. For each portfolio, banks were asked to provide results in the base currency, as indicated in Annex V of the Benchmarking ITS. The choice of base currency for each trade was made to avoid polluting results with cross-dependencies on risk factors.

59. All collected data underwent a preliminary analysis to spot possible misinterpretations of the common instructions set out in the ITS/RTS on benchmarking and outliers, as defined hereafter.

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[6] https://eba.europa.eu/regulation-and-policy/supervisory-benchmarking-exercises/its-package-for-2019-benchmarking-exercise. Please also refer to Commission Implementing Regulation EU 2016/2070 of 14 September 2016 and Commission Implementing Regulation 2019/439 of 15 February 2019, laying down ITS in accordance with Article 78(2) of Directive 2013/36/EU (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1562830373986&uri=CELEX:32019R0439).

3.3   Participating banks

60. A total of 50 banks representing 13 EU countries participated in the exercise (see Table 17 in the annex). All EU banks with MR internal models approved by CAs were asked to submit data at all levels where own funds requirements are calculated. The EBA collected the results only at the highest level of consolidation.

61. CAs are in charge of conducting similar benchmarking investigations for results at a 'solo' level within their own jurisdictions for eligible banks.

3.4   Data quality issues

62. The data collection process aims to ensure the reliability and validity of the data obtained. In this regard, it is obvious that an unwanted driver of variability (which would pollute the results) could be misunderstandings vis-à-vis the portfolios and the specific instruments included in them.

63. IMV results reached the EBA in November/December 2018, after which the EBA carried out a preliminary IMV analysis and provided CAs with a tool to help them spot likely anomalies or misunderstandings regarding the interpretation of each portfolio. This was done to enhance the quality of all risk measures so that they would be provided according to a correct interpretation of the portfolios. This step was done before the computation of the risk measures by the banks. Where the price of an instrument fell outside a certain range,[7] more investigation had to be undertaken by the CA, which could – if necessary – ask the banks in its jurisdiction for a repricing and subsequent resubmission. The same process was carried out for the risk measure submission.

64. The issue experienced in the previous exercise linked to the aggregated portfolio figures was fixed. It should be recalled that some banks reported the IMVs and risk measures for the aggregated portfolios without including all relevant components.[8] The reason was that the 2018 (and previous) ITS required banks to report the value of aggregated portfolios even if not all individual portfolios are modelled for the benchmarking exercise. As a result, the submissions were not comparable with those valued in full. This issue has been addressed in the 2019 exercise, since banks have reported the results for the aggregated portfolios only if the results of all components have been submitted.[9] Unfortunately, the new structure of the 2019 exercise, i.e. a plurality of instruments that are recombined in a plurality of individual portfolios, which

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[7] The range means the interval between the first and third quartiles. These quartiles were considered, and subsequently updated when resubmissions were received.

[8] Some banks reported values for aggregated portfolios, taking into account only those components for which they had permission to use an internal model. This is clearly not a data quality issue and it is correct that banks report results only where they have permission to do so for regulatory purposes.

[9] Annex 5, Market risk 2019 BM, Section 1 (Common instructions), letter (z).

are themselves the components of the aggregated portfolios, produced a similar error, i.e. the absence of some component within some of the portfolios. Because of the lack of time between drafting of the RTS and the actual exercise, only the instructions for the 2021 exercise can be amended in this regard. Nonetheless, banks should not provide any portfolios where any instrument is missing, in order not to bias the risk measures analysis.

65. In the data analysis, it was clear that errors in the interpretation of some instructions and instruments are present, even though the instruments were simplified from the previous exercises, and some of the general instructions remain fairly stable. A complete list of the errors in the submitted data is beyond the scope of this report, but the most common and easily avoided mistakes worth mentioning are:

- Equity asset class: the problems are mainly due to the decision to put in a footnote the fact that the future positions should be multiplied by 100 contracts. Luckily, the errors generated by this drafting decision were easy to detect and to fix by resubmission. The instruction in the 2020 ITS was amended such that this error should not be repeated in that exercise.

- Interest rates: there were good results especially where the International Securities Identification Number was available. Minor errors were identified, such as reporting P&L instead of mark to market, or wrong booking (i.e. long position instead of short, or vice versa).

- FX: the only problematic instruments were 39 and 40, but the errors are quite easy to fix. Instrument 39 has been wrongly booked in many cases (i.e. short position instead of long). Instrument 40 was by far the most misrepresented: 25 out of 40 submissions were wrong. Luckily the error is quite trivial, i.e. banks reported the P&L or zero instead of the mark to market of the position. The instructions of the 2020 ITS were amended such that this error should not be repeated in that exercise.

- Credit spread: good results in terms of CV and IQD, with very few mistakes such as evident wrong booking (i.e. IMVs 1 000 times the benchmark) or long position instead of short, or vice versa.

- P&L submission: it has been noted that several banks reported the P&L even if they were not required to do it, while others did not report it although they were. Only banks with historical simulation models have to report the P&L vectors, in order to produce a consistent analysis of the risk measures. Furthermore, even though it was very well specified, some banks reported a 10-day P&L vector instead of the 1-day P&L. Although easy to spot, this mistake involved resubmissions of the result, and two banks' submission were excluded because of this. Moreover, the P&L series sometimes did not respect the parameters requested in the ITS (e.g. too short time series, wrong dates), so again these vectors have to be dropped in the analysis.

66. Although a large number of these mistakes were detected thanks to the EBA data analysis and corrected by resubmission/cleansing of the data from the banks, unnoticed errors in data submission could still be present in the dataset analysed, and this can potentially drive and pollute the results.

67.Ensuring data quality is a fundamental step for this kind of exercise. However, reporting errors might still occur in the run of the future exercises, and the process will allow both regulators and participating banks to learn from it.

4. Market risk benchmarking framework

68. The benchmarking exercise aims to assess the variability in banks' MR models and to identify the drivers that account for it. Variability in banks' models can come from three types of drivers.

69. First, variability can stem from banks' modelling choices that are explicitly contemplated in the regulation. For example, when modelling VaR, institutions can choose to use a lookback period longer than the minimum (i.e. the previous year), use a weighting scheme for the data series, calculate the 10-day VaR directly or, alternatively, obtain a 1-day VaR and rescale it using the square root of time approximation. Likewise, when modelling IRC, banks can choose from several sources of the probability of default (PD) and have a certain degree of freedom when choosing the transition matrices applied, or when deciding on the liquidity horizon applied to a particular instrument. It should be highlighted that all of these possibilities are, in principle, acceptable under the current regulatory framework (the CRR), provided that they have been agreed on with the CA during the approval process. Therefore, given the wide range of approaches that each institution using internal models can choose to implement, some degree of variability is expected.

70. Second, there are other modelling choices that are not explicitly contemplated in regulation, which may cause variability. Examples include differences in simulation engines, differences in pricing model assumptions, the modelling of returns, volatility, correlations and other indirect parameter estimates, additional risk factors considered in the models, different approaches to P&L computation and attribution, and a stochastic framework for the simulated shocks.

71. Finally, another source of potential variability originates from supervisory practices. In particular, the use of regulatory add-ons in the form of both VaR and sVaR multipliers and additional capital charges (e.g. to encompass risk not in VaR issues, any information technology (IT) and organisational weaknesses, independent pricing valuations or detected flaws) and, quite significantly, the application of limits to the diversification benefits applied by banks (i.e. not allowing a single calculation at consolidated level and, instead, requesting an aggregation of the capital results at sub-consolidated and/or subsidiary levels) are likely to increase the observed variability in capital. In most cases, these supervisory actions have been established to address known flaws or model limitations, or to add an additional layer of prudence. Therefore, they typically result in higher capital requirements than would otherwise be the case. However, they can also increase the variation in market own funds requirements between banks, particularly across jurisdictions. Although the effects on capital levels of these supervisory actions can be substantial, a benchmarking portfolio exercise is not suitable for assessing some of these supervisory actions. In particular, any constraints on diversification benefits and direct capital add-ons cannot be properly assessed, since these effects are entirely portfolio dependent. To assess these effects, it would be necessary to use a much more realistic (hypothetical) portfolio,

comprising thousands of instruments and including partial model approval. Nevertheless, some supervisory actions can be assessed; namely, the effects of regulatory add-ons on the VaR and sVaR multipliers will be analysed as part of this assessment.

72. Possible additional drivers of variation include:

- misunderstandings regarding the positions or risk factors involved, which could not be resolved during the preliminary assessment (see Section 3.2);

- non-uniform market conventions and practices adopted in the hypothetical portfolio booking;

- incompletely implemented models (e.g. because a pricing module is under testing, or an additional risk factor is being taken into consideration);

- missing risk factors not incorporated in the model;

- differences in calibration or data series used in the modelling simulation;

- additional risk factors incorporated in the model;

- alternative model assumptions applied; and

- differences attributable to the methodology used (i.e. Monte Carlo (MC) versus HS or parametric).

4.1 Outlier analysis

73. After the data quality assurance process, the EBA performed an 'extreme value' analysis aimed at excluding from the computation of the benchmarks those values for which the IMV was found to lie outside a certain tolerance range, due to misinterpretation of the trade or mistyping of bookings by the banks.

74. The presence of clear outliers in the data used to assess variability is deemed inappropriate, since these data points are likely to weigh heavily on the results, distorting the actual level of variability observed.

75. Extreme IMVs are defined as values outside the range of two truncated standard deviations[10] from the median. Since some results exhibited empirical distributions that had fatter tails than expected, outliers were defined as values differing by twice the truncated standard deviation or more from the median.

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[10] The truncated standard deviation is computed by excluding the values below the 5th and above the 95th percentile of the data series.

76. If a bank's IMV was found to be an extreme value for a particular instrument, then all risk measures related to that particular portfolio were removed from the computation of the final benchmark statistics. This approach increased the quality of the benchmark data, providing more consistency for the benchmarks of these metrics.

77. The dispersion across the contributions is summarised by the IQD coefficient, which is more robust than the coefficient of variation (CV) for data derived from fat-tailed distributions. The higher the IQD, the more dispersed the data. IQD is defined as:

$$IQD = abs[(Q_{75th} - Q_{25th})/(Q_{75th} + Q_{25th})],$$

where Q_{75th} and Q_{25th} denote the 75th and 25th percentiles respectively.

78. Another metric used in the variability studies is the CV, which is defined as the ratio between the standard deviation[11] and the mean (in absolute value):

$$CV = abs[StD/Mean].$$

79. The analysis reports both metrics, because they jointly allow a detection of the highest peaks of variability.

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[11] The standard deviation was considered in order to get a feeling of the entire variability and a harmonised approach across the HPE. Obviously, a truncated standard deviation may appear more consistent for some highly dispersed trades.

Table 1: IMV statistics and extreme values

EU Statistics for IMV by instrument

	Instr. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.[2]	25th	50th	75th	IQD
					Main statistics					Percentiles			
Equity	1	3,242,000	3,431,987	3,321,671	31,156	22,573	2,888	1%	39	3,312,000	3,321,612	3,323,962	0%
	2	756,017	787,200	764,280	4,104	1,063	16	1%	39	762,700	764,600	764,600	0%
	3	-765,197	-715,000	-739,802	8,429	6,179	762	1%	37	-739,837	-739,384	-737,817	0%
	4	-251,400	-226,849	-232,696	4,594	3,304	778	2%	37	-232,153	-231,170	-231,000	0%
	5	-1,960,129	-1,803,000	-1,882,316	24,140	15,934	2,517	1%	37	-1,882,324	-1,879,372	-1,877,621	0%
	6	-18,000	-17,212	-17,356	146	96	30	1%	36	-17,345	-17,310	-17,285	0%
	7	-104,000	-99,800	-101,359	695	483	143	1%	37	-101,372	-101,280	-101,107	0%
	8	-129,561	-121,800	-123,915	1,818	1,555	307	2%	37	-123,706	-123,449	-123,142	0%
	9	57,207	87,217	69,624	5,670	4,514	1,493	8%	37	68,864	70,664	71,650	2%
	10	-96,742	-68,602	-82,585	5,147	4,050	1,580	6%	37	-83,713	-82,328	-80,747	2%
	11	7,314	25,129	10,768	2,841	1,357	523	26%	36	9,313	10,685	10,900	8%
	12	4,380	15,050	8,467	1,638	1,010	409	19%	36	7,945	8,272	8,925	6%
	13	27,402	46,856	35,635	3,709	2,977	1,293	10%	37	34,620	35,913	36,573	3%
	14	-46,856	-27,402	-35,572	3,744	3,021	1,293	11%	37	-36,573	-35,913	-34,620	3%
	15	1,569	3,553	2,439	421	357	203	17%	36	2,174	2,375	2,591	9%
	16	1,600	2,960	2,352	281	235	128	12%	36	2,201	2,317	2,514	7%
	17	-24,051,946	-177,842	-23,137,420	3,827,030	110,821	22,216	17%	38	-23,770,000	-23,751,843	-23,729,255	0%
	18	857,619	1,139,832	1,056,476	45,854	25,081	4,410	4%	32	1,057,836	1,066,633	1,070,336	1%
Interest Rate	19	-65,660	-23,809	-27,079	5,822	1,027	842	22%	48	-26,945	-26,222	-25,308	3%
	20	-316,249	-19,949	-31,801	42,957	1,674	880	135%	46	-26,139	-25,211	-24,408	3%
	21	-26,048	27,468	-10,083	7,398	3,947	1,886	73%	48	-12,898	-9,437	-8,458	21%
	22	-6,220	94,091	4,510	13,330	1,013	517	296%	48	2,307	2,955	3,437	20%
	23	992,059	1,203,312	1,055,044	46,459	33,354	25,711	4%	24	1,022,552	1,052,366	1,071,105	2%
	24	7,042,000	7,130,858	7,093,125	20,913	17,724	1,506	0%	46	7,099,660	7,101,147	7,102,671	0%
	25	-2,168,054	-2,150,661	-2,160,419	4,165	3,586	287	0%	46	-2,162,279	-2,161,985	-2,161,724	0%
	26	4,444,618	5,126,702	5,037,414	120,093	71,067	4,017	2%	39	5,034,978	5,093,810	5,095,730	1%
	27	961,230	965,606	964,476	845	586	303	0%	44	964,291	964,798	964,996	0%
	28	6,692,900	6,962,817	6,889,553	90,409	82,289	1,859	1%	44	6,925,868	6,929,985	6,931,087	0%
	29	-6,068,275	-5,907,125	-6,019,454	49,096	44,290	839	1%	44	-6,043,513	-6,042,845	-6,035,791	0%
	30	-10,264,548	-10,194,384	-10,224,419	13,768	9,053	1,750	0%	44	-10,228,080	-10,226,478	-10,224,713	0%
	31	6,365,192	7,195,115	7,136,829	159,873	38,208	3,503	2%	46	7,167,990	7,188,703	7,191,362	0%
	32	5,473,850	5,520,810	5,499,345	11,013	9,339	1,116	0%	44	5,501,369	5,503,253	5,504,203	0%
	33	-11,226,140	-9,613,750	-9,752,462	306,652	22,192	3,799	3%	46	-9,699,338	-9,695,594	-9,688,179	0%
	34	4,509,750	5,430,570	4,630,631	148,164	68,155	10,327	3%	39	4,592,170	4,606,938	4,612,323	0%
	35	4,167,615	5,950,627	5,111,516	207,447	42,274	4,314	4%	40	5,115,150	5,128,138	5,132,168	0%
	36	22,122	128,980	40,140	13,719	2,776	1,582	34%	48	37,192	38,897	40,390	4%
	37	24,159	47,542	27,932	4,501	2,570	671	16%	47	26,101	26,836	27,507	3%
FX	38	-193,340	47,153	-154,393	58,712	47,759	7,207	38%	42	-185,881	-178,979	-169,520	5%
	39	-120,284	-25,176	-96,791	27,829	24,052	7,613	29%	42	-115,613	-108,162	-94,040	10%
	40	-851,443	993,115	470,488	475,885	427,652	3,053	101%	40	-5,061	851,171	851,967	101%
	41	81,182	95,365	88,909	2,416	1,418	1,166	3%	41	87,990	89,344	89,912	1%
	42	1,331,648	1,390,271	1,368,984	13,191	10,370	6,237	1%	41	1,365,459	1,370,237	1,377,795	0%
	43	-543,992	-505,911	-530,613	9,513	7,571	3,778	2%	41	-535,962	-533,048	-528,094	1%
	44	-129,388	-78,414	-114,825	8,685	2,629	2,235	8%	41	-118,030	-116,680	-113,325	2%
	45	913,416	965,051	926,784	9,678	6,276	4,874	1%	41	920,454	925,327	929,791	1%
	46	-795,411	-738,909	-774,556	11,831	8,656	4,033	2%	41	-780,306	-776,806	-771,212	1%
	47	-156,662	-4,791	-71,191	34,180	30,125	13,435	48%	39	-78,230	-64,795	-48,028	24%
Commodities	48	-37,775	-10,606	-29,913	6,960	5,413	4,767	23%	21	-35,191	-29,516	-28,153	11%
	49	11,065	36,387	29,838	6,784	5,361	3,757	23%	21	27,377	31,757	34,251	11%
	50	158,743	225,630	189,499	15,595	15,595	2,323	8%	19	188,048	190,060	195,667	2%
	51	-130,149	157,847	-90,286	60,779	60,779	1,592	67%	19	-103,290	-101,415	-100,236	2%
Credit Spread	52	-22,929	-5,200	-8,437	4,173	3,129	660	50%	28	-8,023	-7,053	-6,657	9%
	53	46,309	54,938	48,181	1,677	1,018	493	4%	28	47,255	47,724	48,647	1%
	54	16,922	20,967	17,940	679	290	190	4%	28	17,667	17,911	18,052	1%
	55	3,037	8,214	5,501	1,296	1,122	429	24%	27	4,483	5,852	6,245	16%
	56	59,210	70,921	66,580	2,802	2,333	1,706	4%	27	65,060	66,931	68,446	3%
	57	-39,854	3,292	-32,923	7,206	618	193	22%	28	-34,137	-33,871	-33,752	1%
	58	27,981	30,553	29,049	466	314	205	2%	28	28,807	28,999	29,254	1%
	59	-23,278	-18,592	-22,541	810	267	106	4%	29	-22,824	-22,733	-22,612	0%
	60	17,999	23,361	20,358	1,482	1,337	1,242	7%	28	19,017	20,576	21,132	5%
	61	-22,211	-13,662	-18,468	1,563	1,073	737	9%	28	-19,294	-18,565	-17,277	6%
	62	11,232	16,025	13,386	984	762	325	7%	28	13,001	13,288	13,613	2%
	63	19,145	24,102	21,166	831	486	312	4%	28	20,829	21,234	21,444	1%
	64	27,849	38,498	32,851	1,664	846	230	5%	28	32,544	32,748	33,003	1%
	65	34,712	37,045	35,457	466	332	173	1%	28	35,223	35,456	35,604	1%
	66	-36,782	-35,107	-35,908	328	248	90	1%	29	-36,037	-35,947	-35,880	0%
	67	-4,317	2,459	-2,409	1,216	726	401	51%	29	-2,931	-2,792	-2,232	14%
	68	933,990	1,002,443	944,021	17,222	13,273	1,648	2%	28	937,750	939,139	940,827	0%
	69	111,695	136,758	115,395	4,455	1,182	529	4%	27	113,997	114,387	115,369	1%
	70	1,001,252	1,173,900	1,021,786	28,876	5,535	1,087	3%	31	1,016,433	1,018,877	1,019,840	0%
	71	996,650	1,011,127	1,006,598	4,167	3,782	926	0%	31	1,006,947	1,008,267	1,008,515	0%
	72	-1,015,454	-1,002,493	-1,006,772	2,037	1,038	285	0%	31	-1,007,263	-1,007,078	-1,005,852	0%
	73	1,011,469	1,090,762	1,082,230	19,396	14,727	689	2%	31	1,087,229	1,089,238	1,089,420	0%
Correlation Trading	74	134,019	194,494	172,645	24,632	24,632	11,551	14%	6	151,149	181,900	192,408	12%
	75	151,682	180,562	164,301	11,979	11,979	5,542	7%	4	156,938	162,480	171,664	4%

[1] STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile

[2] Refers to the number of banks included in the computation of the statistics

Table 2: Average IMVs' interquartile dispersion by asset class

Average Interquartile dispersion by asset class

	Interquartile range 2019 exercise	Interquartile range 2018 exercise	Interquartile range 2017 exercise
Equity	2%	2%	16%
IR	3%	8%	8%
FX	15%	6%	7%
Commodity	6%	8%	9%
Credit spreads	3%	6%	17%
CTP	8%	103%	24%

80. Table 1 and Table 2 depict the results at the level of both each individual instrument and each risk type. As shown, the highest dispersion at the level of the individual instruments is detected for FX instrument 40 (long cash position) (IQD 101%). This was due to a misunderstanding in the interpretation of the instrument by a large number of banks. This kind of mistake should be avoided in the next exercise thanks to a redraft of the ITS for the 2020 exercise[12]. Also among the FX instruments, instrument 47 (cross-currency swap) presents a significant IQD (16%). Excluding these two problematic instruments gives us an average IDQ for the FX asset class of 2%, which can be interpreted as low dispersion.

81. Besides these FX instruments, IR instruments 21 and 22 (both IRS), and credit spread instruments 55 and 67 (both credit default swap (CDS)) also present IQDs above 15%.

82. For instrument 47 and the CDS in general, a substantial amount of additional details was provided in the 2020 ITS, so the expectation would be to see a decrease of the IQD for the future exercises.

83. Overall, the IQD by asset class for the instrument of the 2019 exercise is significantly lower than in the past exercises. This means that the simplification of the instrument instructed for the 2019 has achieved the desired outcome of obtaining a general low IQD of the instruments in the exercise.

84. Comparing the 2019 instruments with the 2018 instruments is not directly possible, but based purely on the decrease of the IQD it would appear that the quality of the data increased.

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[12] https://eba.europa.eu/regulation-and-policy/supervisory-benchmarking-exercises/its-package-for-2020-benchmarking-exercise

85. From a more aggregated risk-type perspective, EQ, IR and CS instruments show the lowest dispersion. CTP IMVs show a slightly higher dispersion, since there are proper differences in market practices and assumptions/conventions from banks (i.e. choice of on-the-run iTraxx Europe series, choice of coupons and tranching assumptions). Furthermore, the high IQD for the FX class is driven mainly by two instruments (40 and 47) that were misunderstood by the banks' submitters. The commodity class show an aggregated IQD of 6%, which is still lower than the previous exercises.

86. A cluster analysis (see Figure 1, Figure 2, Figure 17and Table 3) was performed to strengthen and deepen the aforementioned descriptive insights. It shows the dispersion of the IMVs by instruments and helps in identifying clusters in the instruments' pricing that could explain the scattering of IMVs for some trades. Despite all data quality assurance efforts, the results of this analysis suggest that the clusters observable for some instruments are brought about by different feasible interpretations of the instruments.

Table 3: IMV cluster analysis – number of banks by range

2019 IMV cluster analysis by instrument: number of banks by range

(X = ratio with the median)

| 100 | *Range containing more than 15% of the total obs for that particular portfolio* |

	Instr. ID	300% < X	300% ≥ X >200%	200% ≥ X >150%	150% ≥ X >100%	100% ≥ X >50%	50% ≥ X >0	0 ≥ X >-100%	-100% ≥ X >-200%	Num obs.
Equity	1				19	21				40
	2				8	32				40
	3				18	20				38
	4				20	18				38
	5				18	20				38
	6				20	17				37
	7				19	19				38
	8				17	21				38
	9				19	19				38
	10				19	19				38
	11			1	17	19				37
	12			1	18	18				37
	13				20	18				38
	14				20	18				38
	15			1	18	18				37
	16				17	20				37
	17				21	17	1			39
	18				17	16				33
Interest Rate	19			1	23	25				49
	20		1	1	21	24				47
	21		5	5	14	20	3	1		48
	22	1		2	23	18	2	2		48
	23				12	12				24
	24				24	23				47
	25				23	24				47
	26				19	21				40
	27				24	21				45
	28				23	22				45
	29				23	22				45
	30				23	22				45
	31				25	22				47
	32				24	21				45
	33				25	22				47
	34				19	21				40
	35				21	20				41
	36		1		23	25				49
	37			3	23	22				48
FX	38				21	14	7	1		43
	39				22	14	7			43
	40				22	3	2	13	1	41
	41				20	22				42
	42				21	21				42
	43				20	22				42
	44				21	21				42
	45				22	20				42
	46				20	22				42
	47		5	2	12	17	4			40
Commodities	48				9	9	2			20
	49				9	9	2			20
	50				8	10				18
	51				9	8			1	18
Credit Spread	52	1	2		12	14				29
	53				15	14				29
	54				15	14				29
	55				14	13				27
	56				13	14				27
	57				15	13		1		29
	58				15	14				29
	59				15	15				30
	60				15	14				29
	61				15	14				29
	62				14	15				29
	63				14	15				29
	64				15	14				29
	65				15	14				29
	66				15	15				30
	67			1	14	11	3	1		30
	68				15	14				29
	69				13	14				27
	70				16	16				32
	71				15	17				32
	72				16	16				32
	73				15	17				32
CTP	74				3	4				7
	75				2	2				4

87. In particular, as shown in Table 3 and Figure 2:

- Instrument 15 (EQ): there are few extreme outlier observations, compared with a very low IMV, which does not represent a substantial problem for the CAs.
- Instrument 21 (IR): only one observation is an extreme outlier, which can be explained by the instruments being wrongly booked (inverted sign) by the firm.
- Instrument 40 (FX): there are many significant outliers, explained by the misinterpretation of the instrument (see also data quality issues in Section 3.4 of the report).
- Instrument 49 (CO): there are only two significant outliers, which skewed the distribution significantly due to the small number of overall observations.
- Instrument 67 (CS): in this sovereign CDS short position, one submission is clearly wrongly booked. The other IMVs are very small and close to zero, which can exacerbate the IQD analysis.

88. Some of these extreme outlier banks were classified as a high priority for the CAs (see also Chapter 6), so they were followed with greater attention during the whole exercise, in order to specifically define the reason for the extreme result.

89. Other kinds of difficulties were found for CTPs, principally because of the scarcity of contributions and the complex nature of these trades, along with their spread hedging. However, from the observed IMV results, there is slightly more pricing consistency for the first CTP, portfolio 28, which refers to a long-hedged position on an equity tranche of the iTraxx EU index (attachment 0%; detachment 3%). This is due to the more standard market tranching points.

90. One source of variability for these instruments is related to the index hedge practice. Commonly, the index hedge seems to be made at the point of inception of the trade when a CS01 spread hedge tranche is traded. However, a couple of banks did not comply with this market practice. Moreover, variability in the IMV and risk measures results could also occur if the banks calculated different hedge ratios (i.e. the ratio of the change in the mark to market of the tranche to the change in the mark to market of the index for a shift in the credit curve for all underlying names) based on their proprietary pricing models.

91. In the past, some banks erroneously computed the IMV results as a P&L from the booking date to the valuation date. In order to achieve a uniform interpretation, the EBA issued a question and answer (Q&A) tool that defined the IMV as the mark to market at the valuation date and time for each trade.[13] This has helped in the 2019 exercise, and this error seems to be present only in a limited number of cases (few banks reported the P&L for instrument 40).

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[13] See Q&A 2016/2993 published on the EBA website on 2 December 2016.

92. Some minor misalignments in the IMV have been detected due to the reporting of the 'clean price' (i.e. the price of a trade excluding the accrued interest) instead of the 'dirty price' (i.e. the price of a trade including any interest), which is what was intended for the mark to market valuation. This has been detected especially in the bond price, such as instruments 24-35.

93. In addition, the EBA recommends that banks make better use of the Q&A tool, by submitting questions before the start of the exercise, to avoid misinterpretations in the future. Banks are kindly invited to provide, using the Q&A tool, their best practice and market standard conventions when further specifications of the hypothetical trades are needed.

94. Evidence from the large majority of the banks is that IMV comes from front office systems. This is acknowledged as the best practice for alignment with real market-trading activities.

95. Figure 1 and Figure 2 report the clusters found in the IMV results for a sample of low IQD instruments (0% IQD or close to zero) and high IQD (the highest in the asset class) instruments. All the instruments' IMV distributions are available in the annex in Figure 17.

Figure 1: IMV scatter plots – low-IQD instruments
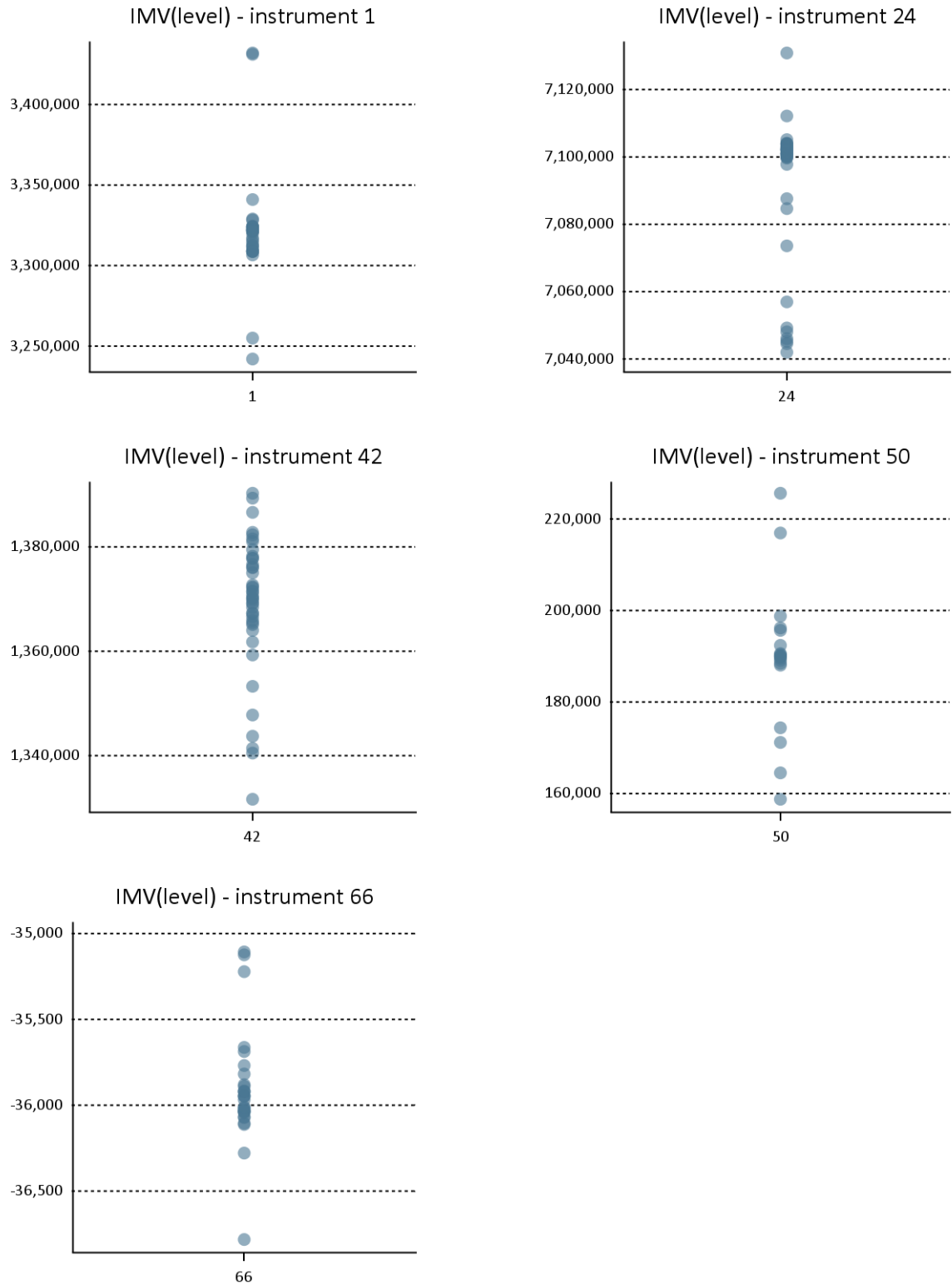
Figure 2: IMV scatter plots – high-IQD instruments

IMV(level) - instrument 15

IMV(level) - instrument 21

IMV(level) - instrument 40

IMV(level) - instrument 49

IMV(level) - instrument 67
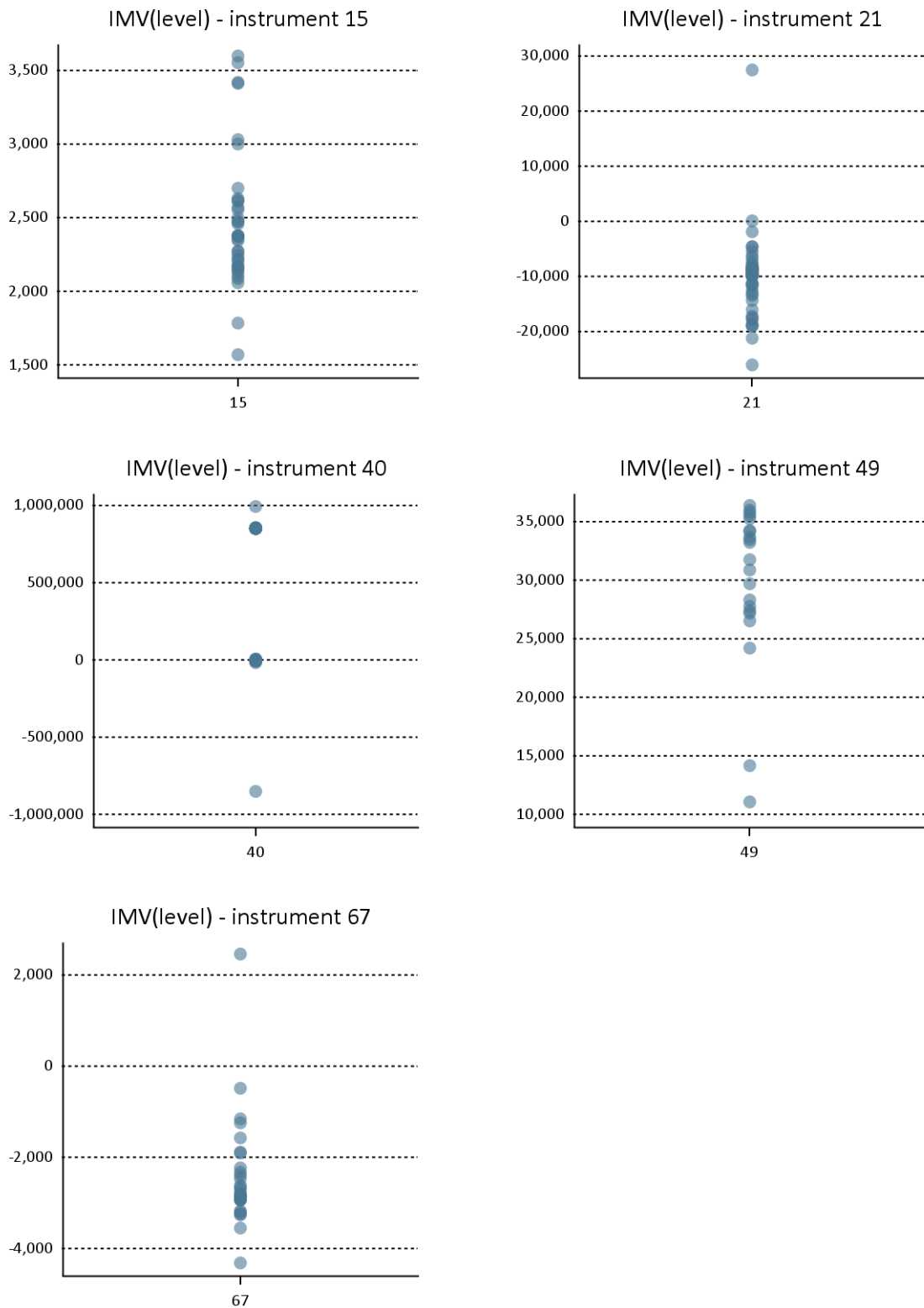
96. The 'concentration index', given by the percentage of values between 50% and 150% of the median value in Table 3, shows that, overall, 97% of the observations lie between those ranges.

97. This result is an improvement on that reported following last year's MR benchmarking exercise, showing again that the simplification of the instruments for the 2019 exercise produced the expected result.

98. Given the EBA's experience with past benchmarking exercises, values lying in this range might be considered acceptable, on the basis of fine-tuning as successive benchmarking exercises are run. Nevertheless, the aim will be to increase this IMV empirical range coverage in the next exercises.

99. For many hypothetical instruments, the IMV variability is explained by the divergence in terms of both fixings and market practice assumptions by the participating banks. Therefore, the interpretation of the deals and market practices substantially explain the observed variability.

4.2 Risk and stressed measures assessment

100. For VaR and sVaR, variability was assessed by using the banks' reported VaR and sVaR over a 2-week period (from 21 January 2019 to 1 February 2019). Banks submitted weekly or daily observations, depending on their models, and the final risk measures by portfolio were obtained by averaging the observations over the 2 weeks.

101. In the sample, 16 out of 50 banks calculated weekly sVaR measures. The remaining two thirds of the participating banks computed daily sVaR measures.

102. In addition, a P&L VaR measure produced by the EBA using the P&L data provided by banks using an HS approach was analysed. The relevant banks delivered a yearly 1-day P&L vector for each of the individual and aggregated portfolios modelled. These were used to compute the P&L VaR.

103. The additional P&L information for non-APR portfolios allowed the EBA to compute the alternative measure for VaR previously defined, and to check the variability of the results across banks by calculating VaR using a 1-year lookback period.

104. Additional checks were carried out for the available P&L vectors, such as the 1-day P&L versus the 10-day P&L (either overlapped or not), where applicable. Furthermore, the time series with the wrong time window were dropped. P&L vectors provided by banks with no HS model were also dropped. A final consistency check across the HS banks consisted of the computation of the ratio between P&L VaR and the provided regulatory VaR, which can be expected to be close to 1.[14]

105. Clearly, the P&L VaR assessment is possible only for banks applying an HS approach, and with at least 185 days of results submitted. Accordingly, banks applying an MC or parametric

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[14] It should be noted that this expectation depends on the lookback period for VaR.

approach, or another approach other than HS, cannot be subject to this assessment, and have been dropped from the sample (see also Section 3.4, 'Data quality issues').

106.   The P&L VaR was computed as the absolute value of the empirical first percentile of the P&L vector rescaled to 10 days by applying the square root of time approximation, without applying any data-weighting scheme:[15]

$$VaR_{99\%}^{10day} = \sqrt{10} * VaR_{99\%}^{1day}$$

107.   The P&L vector is used to assess the degree of P&L correlation across banks, as well as the level of volatility shown in each bank's vector. This analysis should provide useful insights into the degree of market consensus on the relevant risk factors, in terms of both market dynamics and volatility levels. Obviously, this analysis, like most of those discussed here, relies on sufficient data points and portfolios being modelled by banks to ensure robustness and consistency.

108.   The IRC analysis cannot be deepened like that for VaR because of the higher level of confidence (99.9%) and longer capital horizon (1 year) applied in these metrics. Nevertheless, a variability analysis was performed. In the paragraph concerning IRC, particular emphasis is reserved for missing, zero or unrealistically low results, which suggest that key underlying risk factors are not efficiently captured by the IRC internal model.

109.   In the sample, 14 out of 30 banks computed weekly IRC measures.

110.   It is apparent that more complex risk measures are computed on a weekly basis only.

111.   For APR, only a small number of contributions were submitted because of the scarcity of approved internal models on CTPs, and because, as a result of the recent financial crisis, most institutions deem the CTP business to be in considerable attenuation. Therefore, the sample is quite limited.

112.   In the sample, five out of seven banks computed weekly APR measures.

113.   The ES, as an alternative risk metric to VaR, has been estimated from the daily P&L series by averaging the P&L observations below the 2.5th percentile converted by the square root of time approximation and taking the absolute value:

$$ES_{97.5\%}^{10day} = \sqrt{10} * ES_{97.5\%}^{1day} = \sqrt{10} \ \frac{1}{n} \ \sum_{i=1}^{n} P\&L_{t_i}$$

where n = number of days describing the 2.5th quantile rounded to the highest decimal.

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[15] Some banks apply data weighting at a risk factor level and these will be present in the P&L vectors. This is an implicit source of variability that cannot be controlled.

114.   For the aggregated portfolios, diversification effects were checked with regard to the VaR, sVaR and IRC metrics, whether they were provided or estimated.

115.   For the most inclusive portfolios, the aggregate portfolios, the implied capital charges were also computed and their variability analysed. Where possible, the idiosyncratic factors that drive variability and the impact of regulatory add-ons (e.g. multipliers) were analysed.

116.   It is worth noting that, although the effects on capital levels of these supervisory actions can be substantial, an HPE is not suitable for assessing such differences. This is particularly the case for diversification benefits, since these effects are entirely portfolio dependent. More on this is included in the following subsection, 'Limitations'.

117.   Finally, to make the analysis more comprehensive, CAs were asked to complete a questionnaire about the takeaways from this benchmarking analysis and the actions they plan to take to overcome potential weaknesses in the banks' MR models (see Section 6 of this report). Through the interview process, the EBA had the opportunity to discuss directly some issues raised by CAs when challenging the models in the ongoing assessment process.

4.2.1   Limitations

118.   The design of the benchmarking portfolio exercise described in the ITS aims to ensure the quality of the data used in the report to be produced by the EBA and, more importantly, to identify the banks and portfolios that need specific attention from the responsible CAs. Nevertheless, any conclusions on the total levels of capital derived from the hypothetical data should be treated with due caution. The hypothetical portfolios are very different from real portfolios (in terms of size and structure). What is more, the data cannot reflect all actions taken by supervisors.

119.   From a methodological perspective, the sVaR metric variability observed could originate either from differences in modelling or from the different data periods used for sVaR computation. Further variability stems from different stress periods of banks because there is no common benchmarking stress period. To allow more specific analyses on this aspect, in the 2019 benchmarking exercise, more information about the stressed VaR window time was requested from banks, by expanding the relative template envisaged in Annex VI of the Benchmarking ITS (in this regards, see subsection 5.2.5.d, 'Common stress period considered', below).

120.   Another limitation that was tackled this exercise is to produce a segregated analysis for institutions with partial model approval (e.g. general risk only), in order to split the result for portfolios with specific risk to filter the additional unwarranted dispersion of VaR figures. The benchmark analysis was run by splitting banks with full approval for equity and IR from those with partial approval, in order to filter out the variability of the risk measure introduced by the partially approved banks.

121.   Banks with partial model approval provided insights into how they approached the benchmarking exercise. It has been found that the differences reported by the banks with respect to the EBA's benchmark measure are almost entirely explained by considering the internal measure of risk, which is not approved for capital purposes but is more complete in terms of risk factor coverage.

122.   In summary, the reporting of partial use approval results should be continued for the purpose of the exercise, but be treated within the specific sample, in order to assess any bias they could introduce in the results of the rest of the sample observed.

5. Overview of the results obtained

5.1 Analysis of VaR and sVaR metrics

123.   As for the previous exercise, the dataset used to perform the assessment of risk measures was determined based on the outcome of the IMV extreme value analysis. As explained in Section 4.1, banks' data were taken into account only for portfolios for which an IMV was submitted and the IMV was not classified as an outlier.

124.   To check if submissions (by portfolio) were at least approximately symmetrically distributed around the mean and/or the median, the EBA checked for any significant differences between the mean and median values for the truncated sample. Table 19 in the annex reports the banks' VaR results in relation to the median, aggregated into six buckets, to enable detection of unexpected clusters.

125.   As appears clearly from Table 19 and Table 20, a relatively high variability of the VaR has been found in portfolios 24 and 25 within the IR asset class, portfolio 32 for FX and portfolio 33 for CO. The analysis also identifies clusters for portfolios 42, 45, 46, 51 and 56 (credit spread). For FX portfolio 32 the high dispersion of the VaR was probably linked to the lack of detail of instrument 47 (cross-currency swap), while for CO portfolio 33 the high dispersion comes from a relatively close to zero VaR of the hedge portfolio. The high dispersion in IR and CS portfolios could be explained from a joint fact: missing permission of model specific IR and low absolute value of some of the VaR figures that tend to exacerbate the difference in the IQD figures.

126.   In contrast to the previous exercise, the VaR values for CTPs (portfolios 54 to 56) are not excessive, except for portfolio 54 (the one with iTraxx instrument 74). The small sample size and scattering of results did not allow a deeper analysis of the CTP portfolios. However, the variability analysis concerning CTPs and the results found are reported, since internal models for this risk category are formally authorised and envisaged by the CRR.

127.   The cluster analysis presented above is superior to a simple outlier analysis that flags submissions more than a designated number of standard deviations from the mean, as this method cannot easily be used for clustered or strongly asymmetric portfolios.

Interquartile dispersion

128.   Figure 3 and Table 4 summarise the variability of the results, measured via the IQD and coefficient of variation, for the IMV as well as all three VaR measures (i.e. VaR, VaR for HS banks only and VaR calculated from the 1-year P&L series submitted by HS banks). Table 4 also includes the VaR results for MC simulation banks.

129.   In terms of risk type, the IQDs for VaR for EQ and IR portfolios are slightly lower than for the other risk types. Overall, the IQD is generally slightly higher than in the 2018 exercise, but a

comparison of the two is difficult due to the substantial change in the structure of the portfolios in the 2019 exercise.

130. As expected, the IQD for sVaR is higher than for VaR (see the bottom panels of Figure 3). One of the reasons for this is likely to be the difference between banks in the 1-year stress period used, which is chosen based on each participating bank's actual portfolio. It might therefore be the case that the sVaR is not calculated with respect to the 1-year period that maximises VaR for the given hypothetical portfolio.

Figure 3: Interquartile dispersion and coefficient of variation for IMV and risk metrics by portfolio

Table 4: Interquartile dispersion for IMV and risk metrics by risk factor

Average Interquartile dispersion by risk factor

	IMV	VaR (all sample)	SVaR	P&L VaR	VaR HS banks	VaR MC banks	Exp shortfall
Equity	2%	14%	25%	13%	13%	12%	13%
IR	3%	16%	28%	14%	17%	15%	14%
FX	15%	22%	26%	21%	22%	20%	20%
Commodity	6%	24%	18%	21%	20%	13%	23%
Credit spr.	3%	28%	39%	23%	24%	20%	24%

131.   Table 4 suggests that there is evidence that when a homogeneous subset of banks is considered (i.e. HS or MC banks) the VaR results show less dispersion than the total sample. With regard to the P&L VaR, it is observed that the dispersion is slightly decreased with respect to both HS VaR and all-sample VaR for all the asset classes, except in the commodity asset class (HS VaR versus P&L VaR).

132.   When comparing variability for HS VaR and MC VaR, this year's analysis tells us that the MC VaR are less dispersed than the HS VaR. The previous exercise gave us mixed results, but we need to keep in mind that the portfolio composition was very different. Nonetheless, the analysis needs to keep in mind that the sample of MC banks is quite small compared with that of HS banks (i.e. 8 MC banks versus 31 HS banks). Regarding parametric banks, a similar analysis is not informative, as the total number of parametric banks is very small (i.e. four banks in the sample) and, furthermore, most of them could not provide results for many portfolios.

133.   The ratio between sVaR and VaR was also analysed across the sample (see Table 24 in the annex). Some banks have ratios below 1 for many portfolios, while other banks have extremely high ratios for some portfolios. While it is generally expected that the sVaR is greater than the VaR, the clear disproportion between these values is usually a natural indication that something is wrong with the data submitted, and the EBA and CAs paid great attention to this observation.

134.   As indicated in Table 5, which reports the distribution of the sVaR–VaR ratio classified in three buckets (i.e. below 1, between 1 and 3, above 3) for each portfolio, this ratio is more dispersed for the credit spread positions. It is worth noting that two IR trade portfolios (portfolios 18 and 26) and three CS trade portfolios (portfolios 36, 49 and 50) have a significant proportion of ratios below 1. This indicates that the (bank-level) stress period was not appropriate for these particular hypothetical trades.

Table 5: sVaR–VaR ratio by range (number of banks as a percentage of the total)

Distribution of sVaR / Var ratio over portfolios

(X = ratio with the median)

	Port. ID	X > 3	1 < X ≤ 3	X ≤ 1
Equity	1	34.2%	63.2%	2.6%
	2	81.1%	18.9%	0.0%
	3	2.7%	94.6%	2.7%
	4	27.8%	66.7%	5.6%
	5	40.5%	48.6%	10.8%
	6	8.1%	81.1%	10.8%
	7	63.3%	30.0%	6.7%
	8	2.8%	86.1%	11.1%
	9	0.0%	89.2%	10.8%
	10	75.0%	22.2%	2.8%
Interest Rate	11	66.7%	27.1%	6.3%
	12	37.8%	51.1%	11.1%
	13	64.6%	33.3%	2.1%
	14	60.4%	35.4%	4.2%
	15	40.9%	54.5%	4.5%
	16	8.7%	84.8%	6.5%
	17	5.1%	76.9%	17.9%
	18	5.1%	30.8%	64.1%
	19	50.0%	45.8%	4.2%
	20	48.9%	38.3%	12.8%
	21	55.3%	38.3%	6.4%
	22	65.2%	30.4%	4.3%
	23	6.5%	84.8%	8.7%
	24	60.0%	37.5%	2.5%
	25	71.7%	28.3%	0.0%
	26	12.8%	61.5%	25.6%
FX	27	19.0%	81.0%	0.0%
	28	5.0%	90.0%	5.0%
	29	9.8%	90.2%	0.0%
	30	39.0%	61.0%	0.0%
	31	80.5%	19.5%	0.0%
	32	68.4%	31.6%	0.0%
Commodity	33	60.0%	40.0%	0.0%
	34	0.0%	94.4%	5.6%
	35	50.0%	50.0%	0.0%
Credit Spread	36	10.7%	35.7%	53.6%
	37	69.2%	30.8%	0.0%
	38	60.7%	39.3%	0.0%
	39	38.5%	61.5%	0.0%
	40	53.6%	46.4%	0.0%
	41	53.6%	46.4%	0.0%
	42	46.2%	46.2%	7.7%
	43	38.7%	51.6%	9.7%
	44	41.9%	54.8%	3.2%
	45	50.0%	43.3%	6.7%
	46	36.7%	50.0%	13.3%
	47	46.4%	53.6%	0.0%
	48	53.3%	46.7%	0.0%
	49	10.7%	64.3%	25.0%
	50	3.6%	64.3%	32.1%
	51	51.9%	44.4%	3.7%
	52	57.7%	42.3%	0.0%
	53	57.7%	42.3%	0.0%
CTP	54	42.9%	42.9%	14.3%
	55	25.0%	75.0%	0.0%
	56	50.0%	50.0%	0.0%
ALL-IN no-CTP	57	91.3%	8.7%	0.0%
Equity Cumulative	58	80.0%	20.0%	0.0%
IR Cumulative	59	2.6%	60.5%	36.8%
FX Cumulative	60	78.4%	21.6%	0.0%
Commodity Cumulative	61	11.1%	88.9%	0.0%
CS Cumulative	62	44.4%	44.4%	11.1%
CTP Cumulative	63	60.0%	40.0%	0.0%

5.2   A closer look at the VaR and sVaR results

135.   Figure 4 and Figure 5 give an overview of the VaR and sVaR results for portfolios 1 to 56, i.e. they do not include the aggregated portfolios, where fewer observations were available for the reasons explained above (see Section 3.4).

136.   Distinguished by portfolio, the figures show the average VaR and sVaR over the 10-day submission period for each bank, normalised by the median[16] of the given portfolio.[17]

137.   Comparing Figure 4 and Figure 5, it looks as if the dispersion is higher for sVaR than for VaR (sVaR 30% IQD versus 21% VaR IQD on average). Differences in dispersion between VaR and sVaR seem steady, but more marked for the credit spread portfolios, in which sVaR shows a higher level of dispersion than the other asset classes (approximately 39%). This is due to the higher complexity of some of these products than other asset classes and to the different banks' choices regarding the stress period.

138.   EQ and IR are the asset classes with the lowest levels of dispersion for VaR (14% and 16%), while for sVaR it was the CO asset class (18%).

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[16] The portfolio median is the median of the average VaR and sVaR over the submission period.

[17] Note that the figures are restricted to VaR–median and sVaR–median ratios below 450%.

Figure 4: VaR submissions normalised by the median of each portfolio

VaR: all portfolios (exc. aggregated)
(ratio with the median)

VaR: all portfolios (exc. aggregated)
(ratio with the median below 50%)
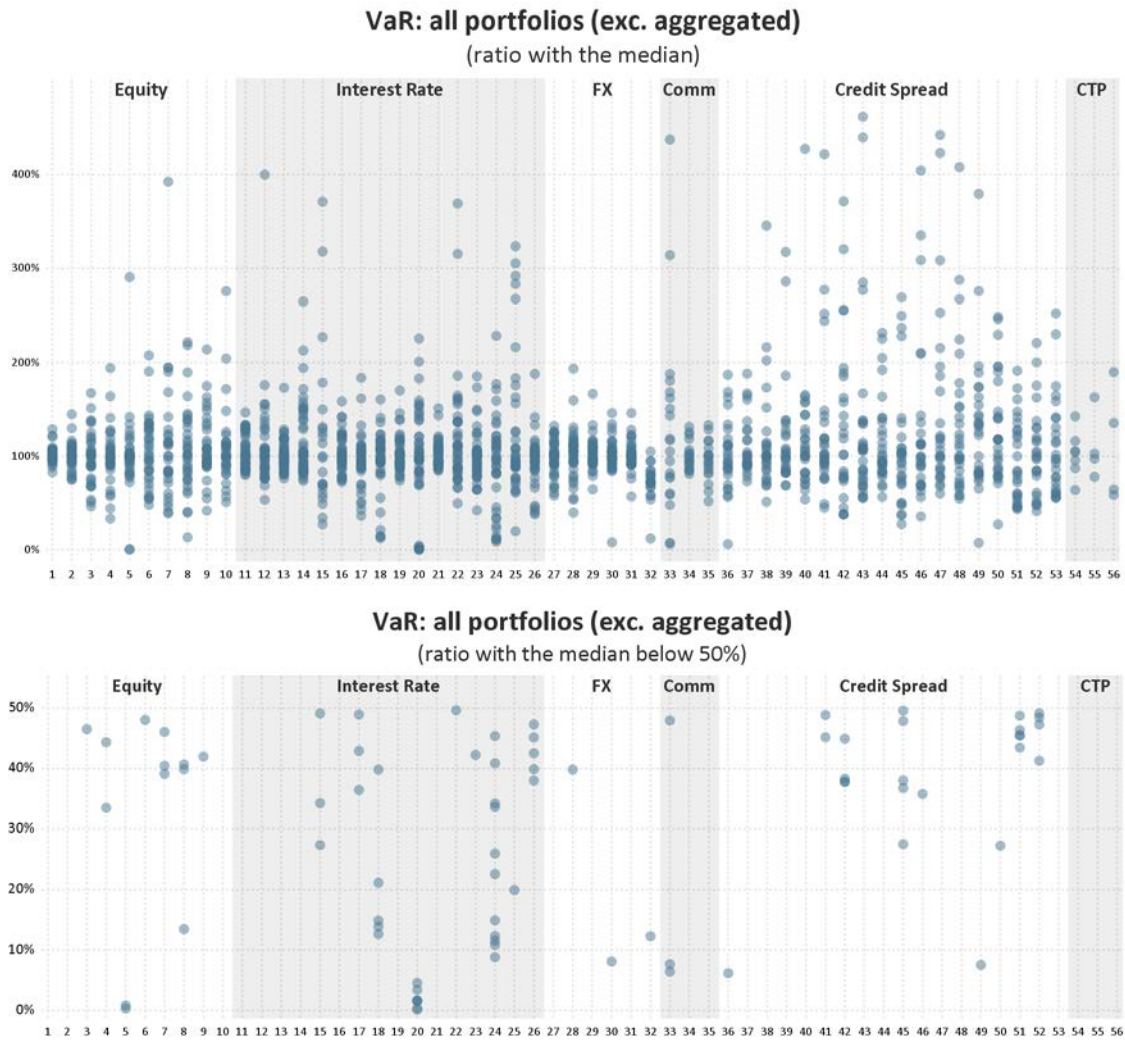
Figure 5: sVaR submissions normalised by the median of each portfolio
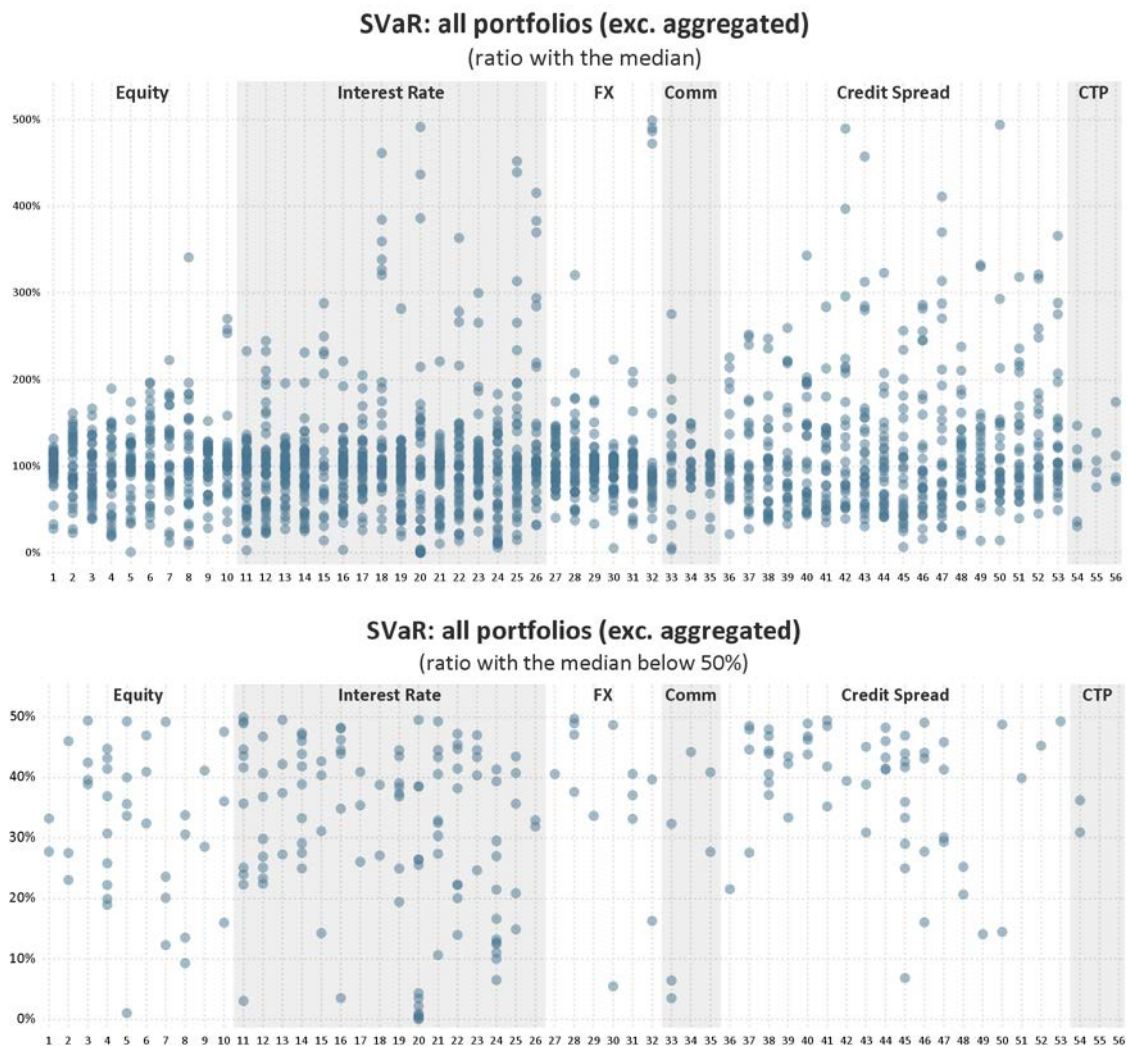
139. Table 20 and Table 21 in the annex report all VaR and sVaR statistics along with EU benchmarks for all HPE portfolios.

5.2.1 Comparison of sVaR–VaR ratios

140. Banks were assessed in relation to the full sample not only by their VaR and sVaR values but also by their sVaR–VaR ratios. In general, it should be expected that sVaR would be at least as high as VaR, as sVaR is calibrated to a 1-year period of significant stress. This is verified in 92% of cases. However, since the stress period is calibrated on a bank-by-bank basis using the banks' actual portfolios, for the hypothetical portfolios underlying the HPE the sVaR–VaR ratio could in some instances conceivably be smaller than 1.

141. Figure 6 shows the ratio of the average sVaR to the average VaR for each bank. The sVaR–VaR ratio varies significantly across the portfolios. Excluding outliers, the average sVaR–VaR

ratio per portfolio varies between 0.65 and 6.66.[18] The portfolios with the lowest levels of dispersion for the sVaR–VaR ratio (excluding outliers) are portfolios 1 (EQ) and 29 (FX).

Figure 6: sVaR–VaR ratio for the average VaR and sVaR by portfolio
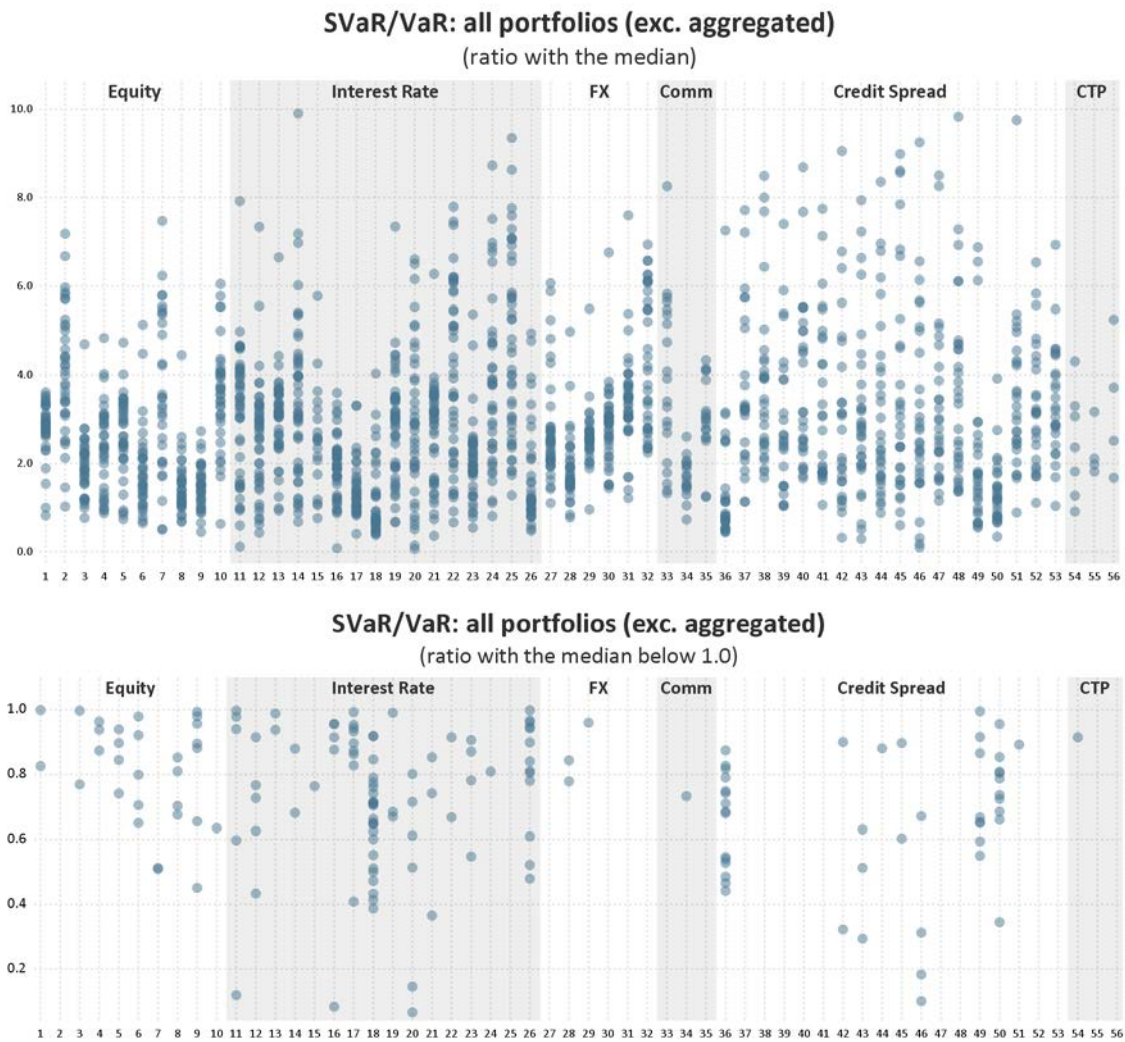
142.   A few banks have a high sVaR–VaR ratio for portfolios in certain asset classes only. This suggests that this asset class dominates the banks' real trading portfolios and, for that reason, drives the calibration of the sVaR window.

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[18] The minimum among the single asset class portfolios (1-21) between the 25th and 75th percentiles is 0.96; see Table 20.

143. In line with the higher dispersion observed for the sVaR for this asset class, for the ratio, the dispersion for credit spread portfolios (on average) also seems to be higher than the dispersion for the other asset classes.

5.2.2 Drivers of variation

144. Based on the qualitative information provided by banks (Figure 7 to Figure 11), the most common methodological approach used by banks to model MR is HS (65%). Although the majority of banks use the same methodological approach, the dispersion of VaR remains significant, probably because other modelling choices play a key role in producing variability of the risk measures (e.g. differences in time scaling and/or weighting scheme choices, absolute versus relative returns for different asset classes).

Figure 7: Qualitative data: VaR methodological approaches
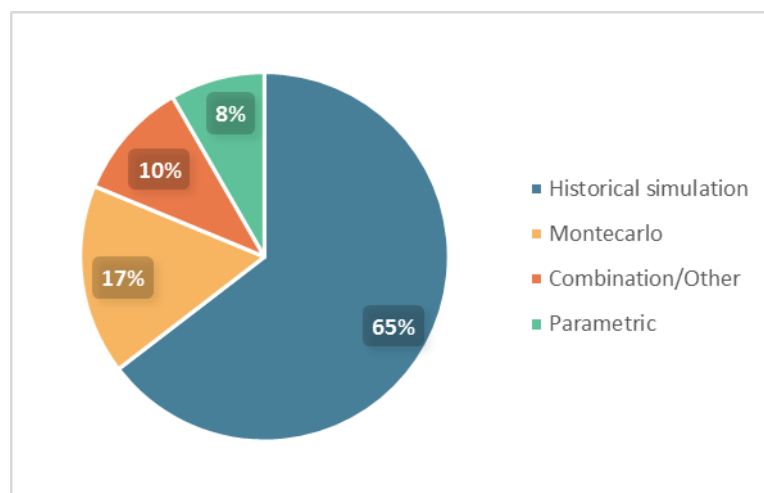
Figure 8: VaR submissions normalised by the median of each portfolio (by methodological approach)

VaR: all portfolios (exc. aggregated)
(ratio with the median - HS banks in orange)

VaR: all portfolios (exc. aggregated)
(ratio with the median below 50% - HS banks in orange)
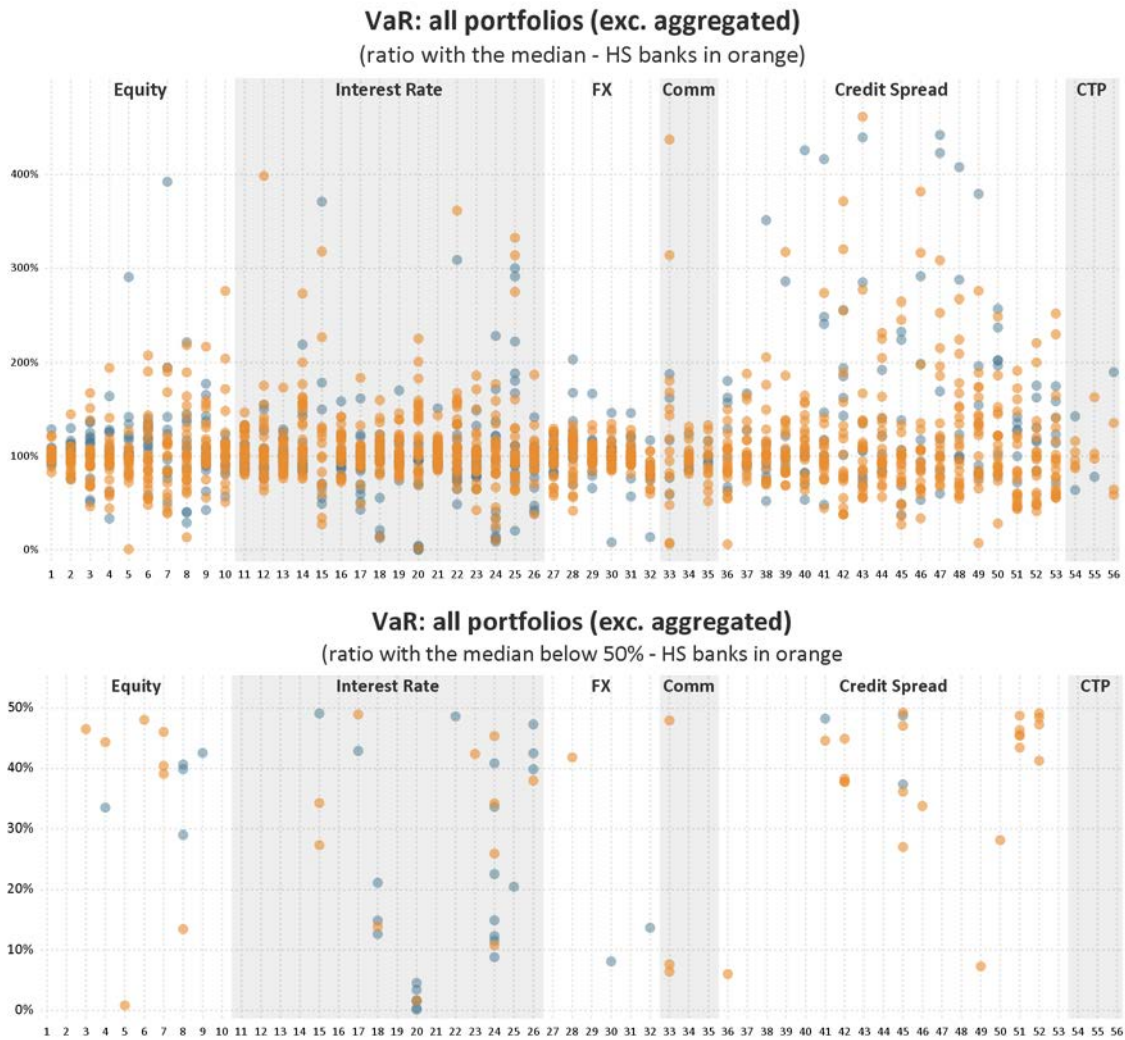
145.   With regard to the regulatory 10-day VaR computation, by far the preferred method is rescaling the 1-day VaR to the 10-day VaR using the square root of time approximation.

Figure 9: Qualitative data: VaR time-scaling techniques
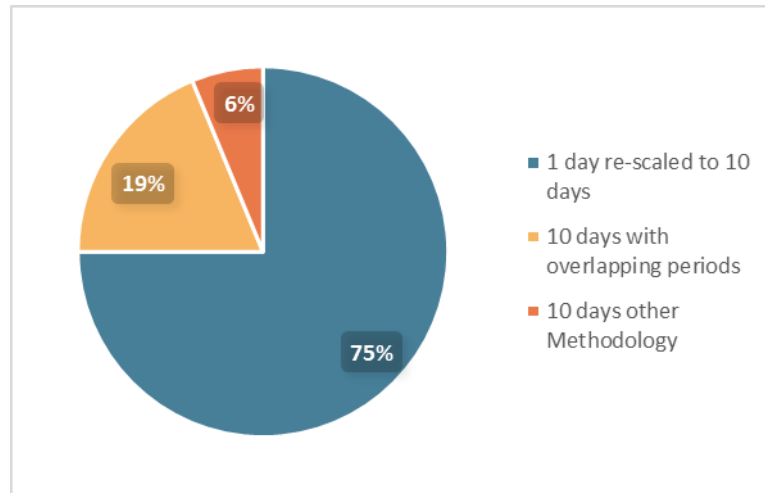
146.   Concerning the historical lookback period used to calibrate banks' VaR models, more than half of the banks use the minimum period of 1 year. Only a minority (5 out of 50) of the banks use a period greater than 2 years.

Figure 10: Qualitative data: VaR lookback period length
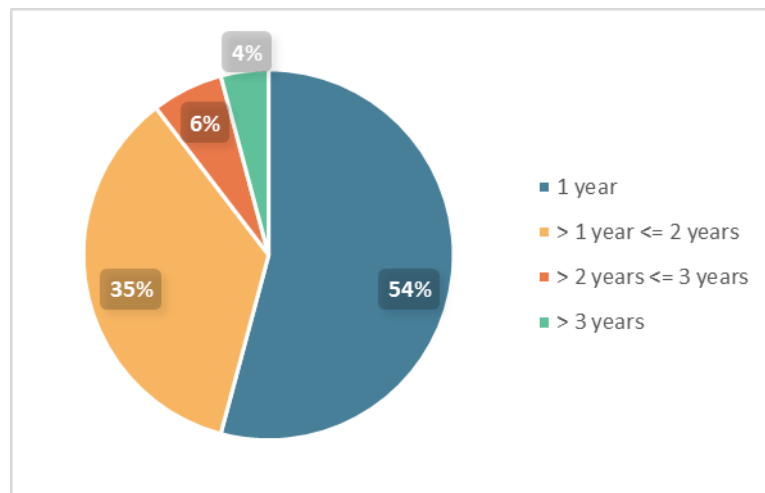
147.   As for the possible use of a data-weighting scheme, the great majority of banks' models use unweighted data in the regulatory VaR computation (36 out of 50 respondents, or 72%).

Figure 11: Qualitative data: VaR weighting choices
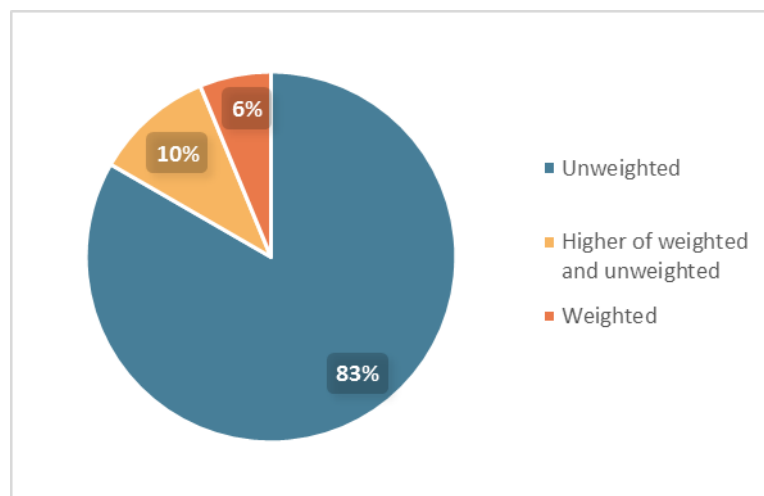
148. Finally, with regard to supervisory actions on regulatory add-ons, 64% of the banks in the sample have a total multiplication factor greater than the minimum of 3, which includes the addend resulting from the number of over-shootings (Table 1 in Article 366 of the CRR) and any supervisory extra charge(s). The average total multiplication factor in this sample is equal to 3.5, with a maximum of 5. Hence, quite a number of banks either have to correct for excessive over-shootings or are subject to supervisory measures. In addition, some banks have been assigned other kinds of added penalties that encompass risk 'not in VaR' and additional charges for IRC and APR. This was apparent from the additional and related information provided by some CAs about their supervised banks, and from discussions with some banks during the interviews.

149. These responses suggest that the observed variation may be due to a number of different drivers. The EBA chooses to present the analysis using the following broad headings:

- supervisory actions;
- modelling differences; and
- other drivers of variation.

5.2.3 Supervisory actions

150. Supervisory actions can take different forms and are therefore difficult to capture fully in the analysis. However, the effects of some types of supervisory charges can be approximated. The effect of a higher VaR or sVaR multiplier imposed by a CA because of model weaknesses, for example, can be studied using the following proxy:

$$\text{Capital proxy} = m_{vaR} * VaR + m_{sVaR} * sVaR$$

where m_{vaR} and m_{sVaR} are the total regulatory multipliers given by 3 plus any add-on resulting from excessive backtesting exceptions and other prudential extra charges imposed by the regulator (where appropriate).

151.   Including the multipliers in the analysis did not significantly change the results in terms of variability across the sample; that is, the positioning across the sample changed, but, on average, the extent of the dispersion did not.

152.   Other supervisory measures, such as capital add-ons, cannot be easily captured. They are normally calculated at an aggregate level on the basis of the banks' actual portfolios and, therefore, cannot readily be computed for the hypothetical portfolios used for benchmarking. Moreover, it tends to be the case that these add-ons are intended to capture difficulties in modelling risks associated with more exotic trades not represented well in the HPE.

5.2.4   Modelling differences

153.   As explained in Chapter 4, the CRR permits banks to tailor their VaR models to their specific requirements by making different modelling choices. To test the impact of different modelling choices in a controlled manner, four sample portfolios were selected. Obviously, the average sample size in this analysis is limited.

154.   The portfolios – portfolios 1, 21, 31 and 41 – cover the main asset classes (i.e. EQ, IR, FX and CS) and were chosen due to the low variability of the submissions received for them. Six subsets of banks were defined, within (and hence controlling for) the sample of banks using historical simulation, distinguishing the following modelling choices:

- 1-day (20 banks) scaled versus 10-day (10 banks) overlapping returns[19];
- the length of the historical lookback period (1 year versus > 1 year)[20]; and
- the use of weighting (yes or no)[21].

155.   As shown in Table 6, there seems to be evidence that the modelling choices matter. For instance, for the subsamples of banks using the HS methodological approach, the choice of regulatory VaR stemming from a scaled 1-day VaR, a lookback of 1 year and use of unweighted returns seems to produce lower dispersion VaR results for EQ and FX. For the IR asset class, the dispersion seems low in any modelling choice, with a small advantage for the 10-day, > 1 year and unweighted scheme. For the CS asset class, there is significant difference in dispersion, with a strong advantage for the 10-day, > 1 year and weighted scheme. In this specific asset class, it looks as if the model approval level (i.e. general approval only versus general plus specific

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[19] 20 banks adopted 1-day returns, while 10 banks adopted 10-day returns.

[20] 12 banks adopted 1 year, while 18 banks adopted > 1 year.

[21] 27 banks adopted unweighted, while 3 banks adopted weighted.

approval) significantly biases the results. For future reference, banks with only general approval will be removed from this analysis.

156. In Table 7, we see the average results of the same six subsamples of banks in terms of the magnitude of the VaR. We notice that the year choice is the one that delivers the most conservative VaR for all the asset classes. The 1-day option delivers the most conservative choice for IR, FX and CS, while the weighted choice delivers the most conservative results only for IR and FX.

157. These results cannot be directly matched to the previous year's results, because of the difference in the instruments. It is also clear that these results strongly depend on the portfolios' selection for this analysis. Therefore, from this analysis, it is difficult to support the idea that one specific model choice will lead to consistently low-risk measures.

Table 6: Coefficient of variation for regulatory VaR (controlling for HS) by modelling choice (%)

| Port. | Coefficient of Variation for regulatory VaR (controlling for HS) |
	1-day	10-day	1y	>1y	unweighted	weighted
EQ 1	7%	11%	7%	9%	8%	12%
IR 21	13%	11%	13%	11%	10%	21%
FX 31	9%	11%	6%	12%	9%	18%
CS 41	50%	17%	47%	28%	40%	55%
mean	20%	13%	18%	15%	17%	27%

Table 7: Average regulatory VaR by modelling choice

| | VaR |
	1-day	10-day	1y	>1y	unweighted	weighted
EQ 1	2,176,058	2,149,466	2,225,296	2,118,031	2,185,409	2,039,694
IR 21	212,472	207,742	223,002	203,672	207,581	240,673
FX 31	331,218	315,579	324,056	326,653	324,938	331,423
CS 41	11,638	11,071	12,955	10,080	11,820	7,926

5.2.5 Other drivers of variation

158. In addition to the drivers of variation discussed in the preceding two subsections, there may be other drivers of variation.

159. In subsection 5.2.4, 'Modelling differences', for instance, only results obtained with HS VaR were discussed, although the methodological aspects considered are expected to be important for other model types (e.g. MC simulation) as well.

160.   Another driver of variation is the risks not captured in a model. Due to the simplification of the exercise from the past exercise, the majority of the most exotic instruments were deleted, so most of the possible risk factors not in the models are no longer present in the exercise. Moreover, banks that are not able to model specific trades are allowed by the Benchmarking RTS not to submit the risk measure. This is shown for example in instrument 18 (IR – auto-callable equity option), where only 24 observations (over 50 banks) are available. Nonetheless, for this non-vanilla product, the IQD is only 10% for the VaR, which means that the banks submitter presented fairly consistent risk measures, so probably not many risks not in VaR were present.

161.   Probably, the use of proxies leads to spurious variability in some of the hypothetical portfolios characterised by less liquid risk factors, for example some credit spreads. This consideration also applies to the sVaR.

162.   In the previous exercise, the EBA committed to analysing aspects not considered in past exercises, because of the lack of some data necessary for filtering the sample results. Therefore, in the following, four additional drivers of variation will be tested: (a) size of the bank, (b) business model, (c) level of approval of model (e.g. general interest risk versus general and specific interest risk approval, or general equity risk versus general and specific equity risk approval) and (d) window time selected for the calibration of the stressed VaR.

a.   Size of the bank

163.   The size of the banks was selected based on common reporting results of banks concerning the RWA for market risk. It was preferred to use the market risk RWA to select the size because a bigger bank in terms of total RWA can have a relatively smaller market risk trading book. Therefore the dimension of the market risk RWA was preferred. It should be noted that market risk RWA also incorporates the standardised measure, but sorting the bank by the internal model market risk RWA did not change the composition of the sample substantially.

164.   The banks were divided into three subsamples: large (above the 75th quantile), medium (between the 75th and 25th quantiles) and small (lower than the 25th quantile). Detailed VaR tables are presented in the annex (see Table 26, Table 27 and Table 28).

165.   Table 8 summarises the effect of the size of the bank. It appears that medium-sized and large banks exhibit very similar dispersions among different asset classes, and the dispersions are fairly consistent with the whole sample, even if the whole sample tends to exhibit higher dispersion. The small bank results, on the other hand, run counter to the rest of the sample. This implies that the size of the banks does matter and that more variability in size increases the dispersion of the general results submitted. Further analysis of this aspect will be carried out in the next exercise.

Table 8: Asset class comparison for VaR in terms of size of the banks

Size of the bank

	VaR - Avg. Interquartile Range			
	All Banks	*Small Banks*	*Medium Banks*	*Large Banks*
Equity	14%	29%	12%	13%
Interest Rate	16%	28%	17%	13%
FX	22%	20%	22%	9%
Commodities	24%	4%	18%	20%
Credit Spread	28%	15%	27%	28%
CTP	27%		14%	14%
All-in	17%	14%	14%	12%

b.   Business model

166.   The business model of the banks in the sample was selected based on a preceding analysis run by the EBA (EBA – LCR Report[22]). In the sample of 50 banks, 15 were not classified. Of the remaining 35, 27 were classified as cross-border universal banks, which is by far the most numerous business model in the sample. The remaining 8 banks had different business models, but were too few to use as a subsample for this kind of analysis, so the cross-border universal bank business model was selected.

167.   Specific VaR results for banks classified as cross-border universal banks are in Table 29 of the annex. Table 9 summarises the impact of the business model on different asset classes. It is clear that the business model selected is so predominant in the sample that it does not allow for proper discrimination among the whole sample; therefore, the dispersion of the banks belonging to the same business model is very close to the dispersion of the whole sample of the banks. Judging from the results, there is some weak evidence that the business model has some effect in increasing the dispersion of the VaR submission. Further analysis of this aspect will be carried out in the next exercise.

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[22] https://eba.europa.eu/-/eba-reports-on-the-monitoring-of-the-lcr-implementation-in-the-eu

Table 9: Asset class comparison for VaR within the same business model (cross-border universal bank)

	VaR - Avg. Interquartile Range	
	All Banks	*Cross-border Universal bank*
Equity	14%	14%
Interest Rate	16%	17%
FX	22%	21%
Commodities	24%	18%
Credit Spread	28%	26%
CTP	27%	17%
All-in	17%	18%

c.   Level of approval

168.   Banks can have different levels of approval for equity and interest rate risks. To be more specific, banks can apply to obtain approval for the general equity or interest rate risk or they can apply for approval of the specific equity or interest rate risk as well. See also the discussion in Section 4.2 on this point. In general, having approval for both the general and the specific parts of the equity and interest rate risks allows the banks to fully model the instruments in the equity and credit spread sections of the exercise. Nonetheless, banks with only general approval are required to report these instruments as well, but this has been known to generate additional dispersion in the risk measures submitted. For this reason, for this exercise, the EBA filtered all the results submitted and produced the IDQ statistics for the banks belonging to the sample of banks with different levels of approval.

169.   Among the banks that submitted results for interest rate risk, in the report 33 banks have general and specific approval (see Table 30) and 15 banks have only general approval (see Table 31). Among the banks that submitted results for equity asset risk, in the report, 35 banks have general and specific approval (see Table 32) and 7 banks have only general approval (see Table 33).

170.   Table 10 summarises the result of the analysis when the filter for the level of approval is applied. It is clear that having banks with different levels of approval tends to slightly bias the benchmarking results. Nonetheless, because of the reduction in the size of the sample, the IQD tends to slightly increase when a more homogeneous subsample is represented. Looking at Table 10 we see that the EQ asset class IQD is virtually identical for the full sample and the subsample of firms with the full level of approval. The CS asset class is also virtually identical, since almost no banks without specific IR approval submitted any CS result. Finally, for the IR asset class, splitting the sample between banks with general and specific approval and banks with only general approval does not produce significant changes in the benchmark for this asset class; only the distribution of the result tends to be flat on the left side of the distribution for banks with general approval only (i.e. lower risk measure figures reported). Further analysis of this aspect will be carried out in the next exercise.

Table 10: Asset class comparison for VaR in terms of level of approval

	VaR - Avg. Interquartile Range			
	All Banks	*IR Gen + Specific*	*IR Gen only*	*Eq Gen + Specific*
Equity	14%			14%
Interest Rate	16%	17%	20%	
Credit Spread	28%	28%		

d.   Common stress period considered

171.   The stress window applied by the participating banks has always been understood as one of the main sources of the greater dispersion of the sVaR than the VaR, but this hypothesis was not tested before for lack of information regarding the time window applied by the banks to calibrate the sVaR. This information was collected for the 2019 exercise, and applied here to test the impact of the stress time window selected to calibrate the sVaR.

172.   Generally speaking, in their time window for the sVaR the banks select periods that include either 2008-2009 or 2011 in order to calibrate their sVaR, with a preference for 2008-2009. Because of the bigger number of banks selecting 2008-2009, EBA filtered the sample of the banks that applied a 2008-2009 time window for sVaR calibration, obtaining a subsample of 30 banks. The benchmark and the related statistics for this subsample of banks are available in Table 34, in the annex, and they are easily comparable with the full sample sVaR statistics in Table 21.

173.   Table 11 summarises this stress period filtering analysis. It looks clear that the different time window selected for the bank actually has a significant impact on sVaR statistics, so that the subsample with the same stress period exhibits significantly smaller dispersion results for sVaR than the whole sample. Further analysis of this aspect will be carried out in the next exercise.

Table 11: Asset class comparison for sVaR in terms of time window applied

	SVaR - Avg. Interquartile	
	All Banks	*Stressed Period*
Equity	25%	19%
Interest Rate	28%	24%
FX	26%	23%
Commodities	18%	18%
Credit Spread	39%	34%
CTP	31%	13%
All-in	19%	17%

5.2.6 Portfolio comparison

174. Selective comparison of VaR results across portfolios can be informative in instances where the riskiness of those portfolios may be ranked in a model-independent way. For example, all else being equal, it is expected that a more diversified and hedged portfolio would lead to a lower VaR than a more concentrated and unhedged portfolio.

175. This hypothesis can be tested with several portfolios in the 2019 exercises. It is suggested to use the following portfolios:

- portfolio 16, which is composed of instruments 24 (Long 5 million German Bond – 10 years) and 25 (Short 2 million German Bond – 5 years);

- portfolio 17, which is composed of instruments 24 (Long 5 million German Bond – 10 years), 25 (Short 2 million German Bond – 5 years) and 26 (Long 5 million German Bond – 10 years), so it is equal to portfolio 16 plus instrument 26.

176. Both of these portfolios involve sovereign bond instruments, yet portfolio 16 is concentrated on only one issuer, and it is partially hedged (long and short positions). To this portfolio, portfolio 17 adds a second issuer, without any hedge. Against this background and in view of the specific portfolio definitions, one would expect the following result:

$$200\% \times VaR_{Portfolio\ 16} < VaR_{Portfolio\ 17}.$$

177. Table 12 reports when this hypothesis holds true.

Table 12: Portfolio comparison for VaR, sVaR and IRC

	VaR(P17) > VaR(P16)	sVaR(P17) > sVaR(P16)	IRC(P17) > IRC(P16)
Num of banks	39 out of 39	39 out of 39	25 out of 27

	VaR(P17) > 1.5*VaR(P16)	sVaR(P17) > 1.5*sVaR(P16)	IRC(P17) > 1.5*IRC(P16)
Num of banks	38 out of 39	37 out of 39	25 out of 27

	VaR(P17) > 1.8*VaR(P16)	sVaR(P17) > 1.8*sVaR(P16)	IRC(P17) > 1.8*IRC(P16)
Num of banks	38 out of 39	26 out of 39	25 out of 27

	VaR(P17) > 2*VaR(P16)	sVaR(P17) > 2*sVaR(P16)	IRC(P17) > 2*IRC(P16)
Num of banks	35 out of 39	14 out of 39	24 out of 27

178. The comparison between the two portfolios with respect to regulatory VaR shows that only 4 out of 39 banks do not fulfil the initial expectation. The same comparison based on sVaR yields

25 banks not in line with this expectation. Concerning the IRC model, three banks do not fulfil the a priori expectation.

5.3   Analysis of IRC

179. Banks with an approved IRC model constitute a subsample of those with an approved VaR model; only banks using internal models for specific risk of debt instruments are permitted to use IRC models (Article 372 of the CRR).

180. The total number of submissions for IRC results for each trade, after the data-cleaning process run as previously described, is reported in Table 13.

181. In the context of the HP exercise, only a few banks made submissions for IRC, and, among those banks, a number submitted very low figures. This suggests that important risk factors (in the context of the HPE) have not been modelled. While the submission of low figures may be linked to risk factors not modelled, this should not be taken to mean that banks with higher IRC figures included all risk factors from a given portfolio in their model.

182. The number of submissions is particularly small for some of the all-in portfolios. Statistical inferences for these portfolios are thus not appropriate. A prerequisite for consideration of banks' submissions for the all-in portfolios is that a bank needs to be able to model all corresponding underlying portfolios.

183. Like it is for VaR, a selective comparison of IRC results across portfolios can be informative in instances where the riskiness of those portfolios may be ranked in a model-independent way. As shown in subsection 5.2.6, the expected diversification relationship holds for all but three of the banks that submitted such results.

184. It is recommended that CAs assess the extent to which these missing risk factors are important in the context of banks' overall risk, and whether or not they need to be added to the model.

185. CAs should devote particular attention to portfolios 36, 39, 46, 48 and 49. IRC shows a higher level of dispersion for portfolios 36, 39, 46, 48 and 49 than the dispersion observed in other credit spread portfolios, especially the simplest ones.

186. As is the case for VaR and sVaR, banks can choose from a range of permitted modelling approaches for IRC. For example, banks need to choose:

- a source of credit risk estimates such as PD and loss given default (LGD);
- the number of systemic factors used to model the co-movement among obligors in their portfolios;
- the size and granularity of credit spread shocks to apply to positions with an obligor following a rating transition; and
- the liquidity horizons to assign to positions with a particular obligor.

187. The responses to the qualitative questionnaire relating to the IRC methodological aspects suggest that the use of market LGD predominates among respondents (Figure 12), with 13 banks out of 30 using market convention as the source of LGD. A minority of banks, 6 out of 30, use their own IRB models as the source of LGD. The rest, 11 banks, use various other sources to obtain the LGD. The PDs are provided in 60% of cases by rating agencies, in 22% by the IRB, in 15% by other sources and in only 3% by market-implied PD. The transition matrices are mostly taken from rating agencies (23 respondents out of 28), while just one bank uses its IRB and the rest use various other sources.

Figure 12: Qualitative data: source of LGD for IRC modelling
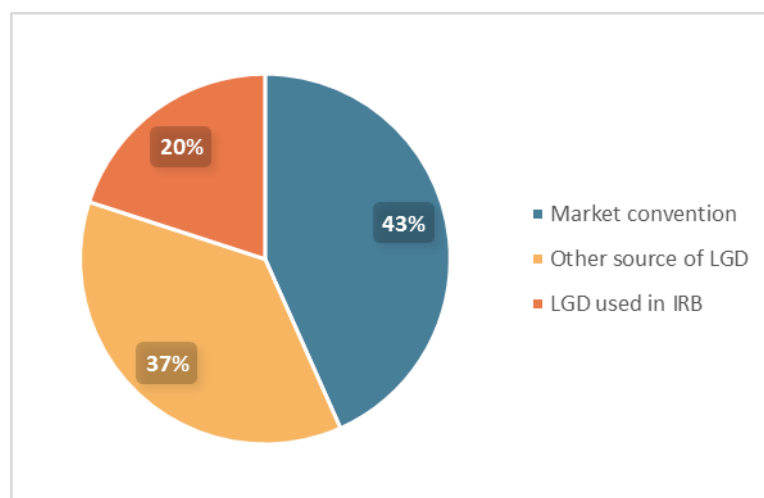
188. A majority of respondents stated, moreover, that they use more than two systemic modelling factors at the overall IRC model level (Figure 13). The liquidity horizon applied at the portfolio level for the IRC model is predominantly between 9 and 12 months (22 respondents out of 30).

Figure 13: Qualitative data: number of modelling factors for IRC
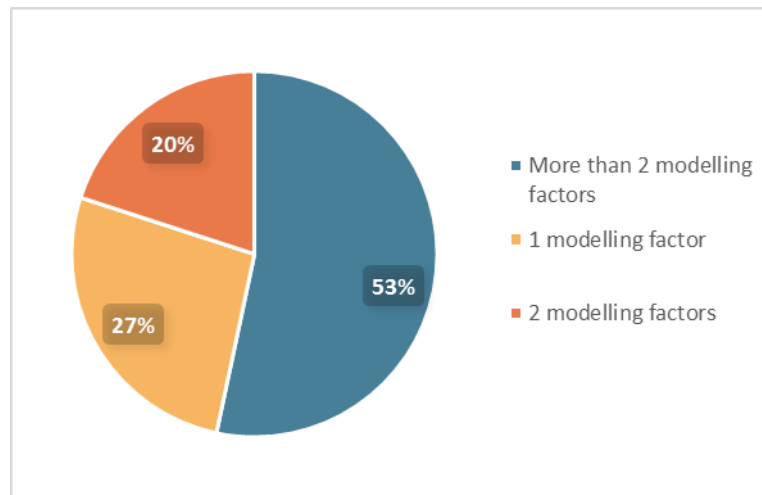
189. Hence, in the context of IRC, the modelling practices across the sample of banks participating in the benchmarking exercise seem to be consistent.

Table 13: IRC statistics and cluster analysis

EU Statistics for IRC

	Port. ID	Main statistics								Percentiles			
		Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.[2]	25th	50th	75th	IQD
Interest Rate	15	46,337	645,296	265,721	163,912	163,912	86,715	62%	15	156,209	223,417	354,287	39%
	16	0	2,812,228	478,420	626,173	389,512	166,824	131%	24	126,128	243,143	602,665	65%
	17	141,795	3,716,207	1,959,092	1,110,777	1,001,542	875,476	57%	20	1,035,987	2,148,056	2,870,780	47%
	18	445,670	5,718,936	3,063,052	1,651,123	1,651,123	1,133,364	54%	19	1,822,085	2,955,449	4,405,933	41%
	23	0	3,100,631	923,951	813,491	674,632	437,105	88%	24	292,905	665,256	1,293,762	63%
	24	99,649	4,983,097	3,169,598	1,280,618	1,054,177	480,224	40%	21	2,486,000	3,636,433	3,914,936	22%
	26	170,970	8,147,515	3,592,471	2,069,349	2,069,349	1,382,434	58%	19	2,151,252	3,533,686	5,162,076	41%
Credit Spread	36	15,514	611,208	182,265	193,747	193,747	38,498	106%	19	45,196	69,782	342,436	77%
	37	13,033	130,473	63,652	26,487	19,232	18,522	42%	20	44,188	66,223	73,295	25%
	38	163	144,802	57,235	33,493	25,737	21,521	59%	22	36,063	49,248	84,000	40%
	39	12,412	611,207	224,015	208,901	192,926	96,781	93%	20	49,345	126,071	375,294	77%
	40	11	199,456	64,422	42,762	29,672	19,314	66%	23	37,730	53,878	81,147	37%
	41	44,747	981,296	557,493	290,530	290,530	203,798	52%	18	237,388	624,820	794,648	54%
	42	17,676	570,000	142,386	142,107	142,107	30,194	100%	19	62,084	82,114	225,211	57%
	43	177,424	926,905	558,442	222,093	222,093	197,083	40%	19	396,926	607,211	743,914	30%
	44	21	275,853	116,942	81,176	72,319	41,864	69%	22	60,443	93,726	141,111	40%
	45	14	4,936,037	340,079	1,082,793	43,131	42,963	318%	20	58,197	103,346	135,346	40%
	46	353	254,414	72,303	83,251	74,399	39,155	115%	21	11,895	40,238	101,750	79%
	47	28,166	243,921	112,349	62,250	54,707	52,220	55%	22	49,000	112,435	158,491	53%
	48	0	275,134	63,835	84,636	84,636	22,682	133%	18	6,620	25,362	58,744	80%
	49	12,412	611,206	209,668	215,474	199,955	65,050	103%	20	45,702	83,389	375,132	78%
	50	0	262,116	62,571	61,046	61,046	31,054	98%	19	18,137	42,451	97,600	69%
	51	0	2,379,000	338,667	598,335	598,335	75,501	177%	17	41,772	111,395	210,422	67%
	52	0	2,323,500	327,053	604,731	418,574	64,221	185%	22	36,390	91,866	255,512	75%
	53	33,939	2,608,000	366,940	650,078	650,078	65,413	177%	16	76,856	133,748	239,093	51%
ALL-IN no-CTP **	57	395,371	8,117,548	3,462,325	2,319,103	2,319,103	1,709,765	67%	11	1,954,155	3,707,980	4,878,754	43%
CS Cumulative **	62	156,433	5,445,847	870,278	1,023,491	210,971	147,250	118%	23	545,594	692,844	844,154	21%

[1] *STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile*

[2] *Refers to the number of banks included in the computation of the statistics*

** *For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included in the computation of the benchmarks for that particular aggregate portfolio.*

190. Table 13 shows that the average variability of IRC is higher than that observed for VaR. This table presents a summary of the descriptive statistics concerning the IRC values submitted, along with the median, first and third quartiles used to select out-of-range values to be discussed with the banks during the interviews. On average, 30 banks provided results for IRC in relation to the IR and CS hypothetical trades, net of the aggregated portfolios where missing values were predominant.

5.4   Analysis of APR

191. In their responses to the qualitative questionnaire relating to the APR methodological aspects, 5 out of 6 respondents stated that they use more than 2 modelling factors at the overall CTP model level.

192. With regard to the source of LGD estimates at the overall CTP model level, most respondents use market LGD, while a minority of banks use the LGD underlying their internal ratings-based approach for credit risk or other sources. As in the case of IRC, the rating agencies are the principal source for PD estimates and transition matrices; only one bank uses its own IRB model to provide them. The liquidity horizon applied at the portfolio level for the CTP model is predominantly between 9 and 12 months.

193. It should be highlighted that all of these options are, in principle, acceptable under the current regulatory framework and that it is up to banks and CAs to agree on the most appropriate ones to be applied by each bank during the validation process, with particular reference to the banks' individual trading portfolios and trading activities. Thus, given the wide range of approaches that institutions using an internal model can choose to implement, some degree of variability among the resulting capital requirements is expected.

194. At the same time, these differences in implementation are clearly not the only factors behind variability. There are other modelling choices that are not explicitly contemplated in regulation, such as differences in simulation engines and data sources, differences in the methods used to compute risk factors when data are not directly observable (e.g. all indirect parameters such as volatilities and correlations), the absence of some of the risk factors considered and differences in approximations when repricing positions.

195. The majority of banks with an approved APR model used a one-factor Gaussian copula model, in which the potential loss is estimated by averaging a number of worst-case scenarios corresponding to a 1-year development in the market along with market parameter simulations (i.e. credit spreads, recovery rates, default correlations, CDS/index basis) and transition matrices for rating migrations.

196. The average variability of the APR charge is 34% when computed by averaging the IQD of each CTP. This variability is due to the assumptions and modelling choices made by banks, but it is difficult to arrive at any takeaway because of the very small number of contributions (Table 14). This is also the reason why no further meaningful analysis, for example with respect

to VaR, is possible. Table 14 should therefore be used for reference only, since the sample size cannot be considered statistically robust.

Table 14: APR statistics and cluster analysis

EU Statistics for APR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.[2]	25th	50th	75th	IQD
					Main statistics					*Percentiles*			
CTP	54	15,704	105,192	42,358	33,321	33,321	16,810	79%	6	16,243	33,572	49,863	51%
	55	100,600	116,855	108,890	6,642	6,642	4,031	6%	4	104,697	109,053	113,083	4%
	56	543,970	3,115,827	1,600,143	1,096,942	1,096,942	520,139	69%	4	850,249	1,370,388	2,350,037	47%
CTP Cumulative	63	488,790	2,991,403	1,443,441	1,093,249	1,093,249	441,928	76%	4	704,858	1,146,786	2,182,025	51%

[1] *STDev trunc* is the standard deviation computed excluding values below the *5th* and above the *95th* percentile
[2] Refers to the number of banks included in the computation of the statistics
** *For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included in the computation of the benchmarks for that particular aggregate portfolio.*

5.5   P&L analysis

197.   The P&L analysis is complementary to the outcome of the assessment of variability based on VaR modelling. For each individual portfolio, the P&L vectors provided by banks using HS were compared, and a benchmark analysis is provided in the annex (see Table 22).

198.   A graphic exemplification of low and high IQD portfolios is represented below in Figure 14 and Figure 15. Even though the P&L vectors available are much longer, only 3 months (1 November 2018 to 1 February 2019) are reported, to simplify the representation. Additional examples of low and high IQD portfolios can be found in the annex in Figure 24 and Figure 25. It is clear that P&L vectors series that perform better tend to be closer to the benchmark. On the other hand the low absolute value of the P&L, as for the risk measures, tends to provide misleading information if we consider the IQD figures alone.

Figure 14: P&L chart example of low IQD
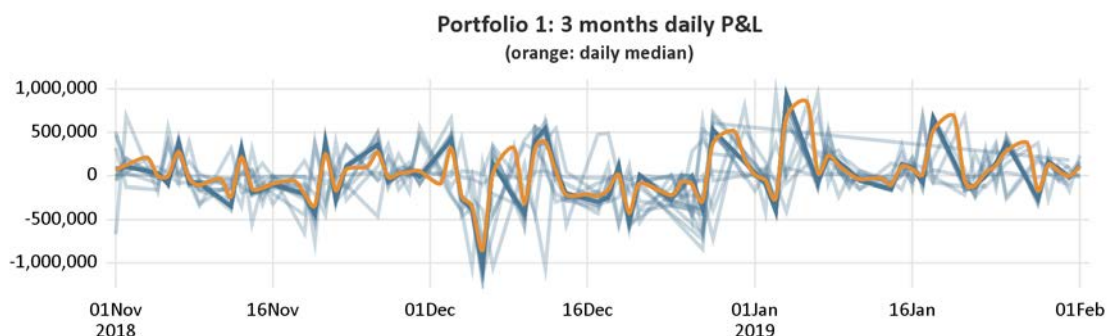
Figure 15: P&L chart example of high IQD

Portfolio 7: 3 months daily P&L
(orange: daily median)
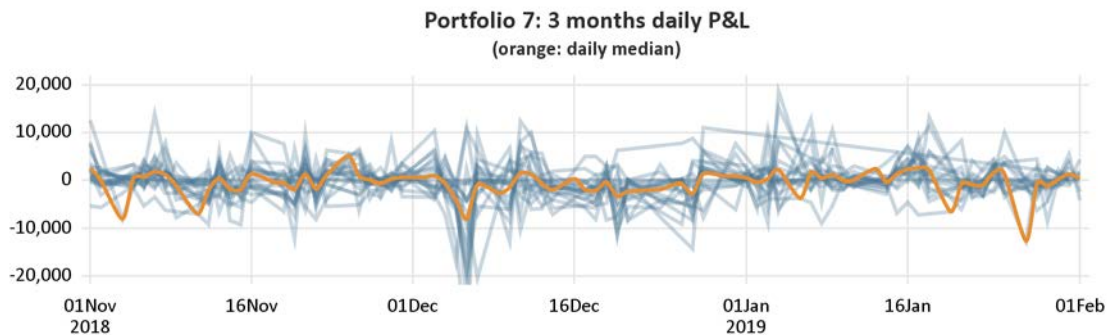
199.   Another useful check for the P&L results submitted was a comparison of the ratio between the P&L VaR computed by the EBA (see Section 4.2 and Table 25) and the regulatory VaR submitted by the participating banks. A significant deviation of this ratio from 1 indicates an incoherent submission from the bank (see Table 25 in the annex). Moreover, it allows the tightness or the width of the realised P&L distribution for each bank to be checked at each hypothetical trade position. This can be done by referring to the standard deviation of the P&L series.

200.   Another metric computed by the EBA from the P&L series provided by HS banks is the empirical ES (see Table 23 in the annex). The empirical ES results have approximately the same level of dispersion as the P&L VaR (see Table 4 in Section 5.1).

5.6   Diversification benefit

201.   An additional metric considered as part of the analysis was the diversification benefit observed for VaR, sVaR and IRC in the aggregated portfolios.

202.   The diversification benefit of a given metric (e.g. VaR) is computed as the absolute benefit, i.e. the difference between the sum of the single results for each individual position and the result for the aggregated portfolio, divided by the sum of the single results from each individual portfolio. Table 15 summarises the results of the analysis.

203.   As expected, there is evidence that larger aggregated portfolios exhibited greater diversification benefits than smaller ones. The diversification benefit for all-in portfolio 57 (all-in no-CTP portfolio), for instance, clearly exceeds the benefit for the other risk types, whose all-in portfolios are based on fewer individual instruments. With regard to the dispersion shown by the diversification benefits, it is possible to observe a significantly higher IQD for some portfolios than for others, and – in some cases – a quite comparable dispersion across VaR, sVaR and IRC (e.g. interest rate and commodity risk categories).

Table 15: Diversification benefit statistics

Diversification benefit statistics

Diversification benefit = (Sum of single portfolios VaR - Aggregated Port. VaR)/Sum of single portfolios VaR

VaR

	Port.	Other statistics			Percentiles			Interquartile dispersion
		Ave.	STDev	Num obs. [3]	25th	50th	75th	
ALL-IN no-CTP	57	81%	2%	11	80%	81%	82%	2%
Equity Cumulative	58	74%	5%	30	72%	73%	76%	3%
IR Cumulative	59	30%	11%	37	25%	29%	33%	13%
FX Cumulative	60	40%	7%	35	36%	39%	43%	9%
Commodity Cumulative	61	7%	21%	16	1%	2%	3%	56%
Credit spread Cumulative	62	28%	12%	26	20%	24%	34%	27%

sVaR

	Port.	Other statistics			Percentiles			Interquartile dispersion
		Ave.	STDev	Num obs. [3]	25th	50th	75th	
ALL-IN no-CTP	57	75%	3%	10	74%	75%	76%	1%
Equity Cumulative	58	74%	6%	29	71%	73%	75%	3%
IR Cumulative	59	49%	14%	37	40%	50%	55%	16%
FX Cumulative	60	31%	10%	34	28%	32%	35%	11%
Commodity Cumulative	61	6%	15%	7	1%	2%	2%	25%
Credit spread Cumulative	62	12%	9%	17	6%	10%	16%	45%

IRC

	Port.	Other statistics			Percentiles			Interquartile dispersion
		Ave.	STDev	Num obs. [3]	25th	50th	75th	
Credit spread (36 to 53)**	27	17%	106%	22	36%	44%	49%	16%

5.7   Dispersion in capital outcome

204.   As a final means of comparison, for each individual position, a variable given by the sum of the regulatory VaR and sVaR was computed. This variable was used in two ways: using the banks' total multiplication factor; and using the regulatory multiplication factor only, i.e. ignoring the banks' individual addend(s) set by the CAs. The results were averaged across a given risk type, thus arriving at a proxy for the implied capital outcome.

Table 16: Interquartile dispersion for capital proxy

Interquartile dispersion for capital proxy

	Capital proxy (banks own mult)	*Capital proxy (fixed mult, =3)*
Equity	22%	21%
IR	26%	25%
FX	27%	24%
Commodity	18%	16%
Credit spreads	32%	31%
CTP	18%	13%

205.   Table 16 suggests that variability is slightly exacerbated by regulatory add-ons. In any case, the ranges of capital value dispersion remain broadly aligned whether or not the banks' actual multiplication factors are used.

6. Competent authorities' assessment

206.   For each participating institution, the CAs provided individual assessments of any potential underestimation of the capital requirement as required by Article 78(4) of the CRD and Articles 9 and 10 of the draft RTS on supervisory benchmarking. This chapter highlights some key information derived from these assessments.

207.   The EBA designed a questionnaire regarding this assessment, which asked CAs to provide detailed information concerning the level of priority, based on both judgemental and qualitative/quantitative examination results, the overall assessment concerning the MR capital requirements of the internal models and, finally, the CAs' ongoing monitoring activities.

208.   A total of 48 questionnaires from 13 jurisdictions, provided by the CAs, have been considered in this assessment of the MR benchmarking exercise.

209.   Regarding the level of priority of the assessments, six banks (12.5%) are reported to be high priority for intervention by CAs. CAs gave high priority to those banks that were outliers in the analysis, are particularly significant for the jurisdiction, have a history of incorrect submission or were identified as potential candidates for the interview process. The criteria for selecting banks were substantially based on firms' results in terms of the capital requirement proxy (below the 25th percentile or above the 75th percentile) and other thresholds relating, for instance, to the ratio of sVaR to VaR across all portfolios or significantly low figures for IRC.

210.   Figure 16 reports the CAs' own overall assessments of the levels of own funds requirements. When it comes to benchmark deviations, justified or not, 31 banks were reported by CAs as under- or overestimating MR own funds requirements, of which 27 provided justifications for this. Obviously, 'not justified' implies that further and targeted CA investigation is required. Finally, 17 banks had consistent results (i.e. no benchmark deviations).

211.   CAs' assessments acknowledge 4 cases out of 48 of unjustified under- or overestimation of internal model market capital requirements that require further in-depth analysis. Obviously, CAs, and the joint supervisory teams where applicable, pay greater attention to the potential underestimation cases, both across the portfolio and across the risk categories.

Figure 16: CAs' own assessments of the levels of MR own funds requirements 2019
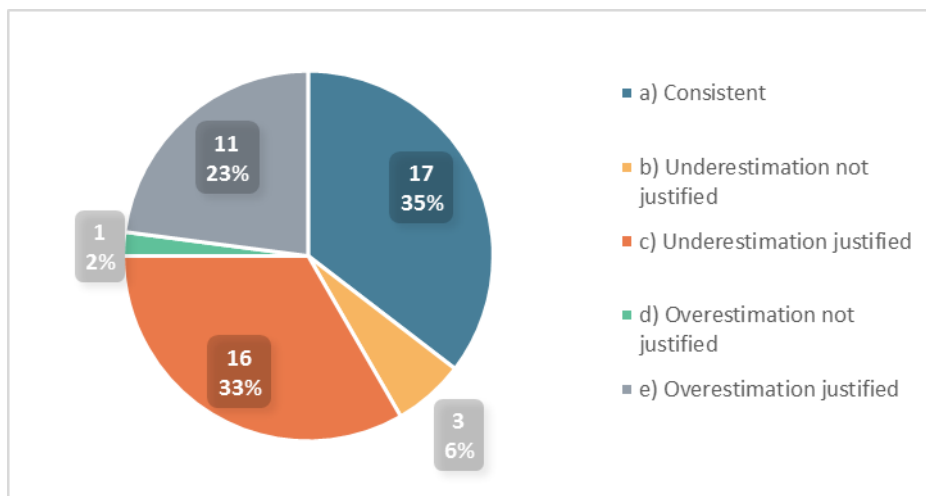
212. The main factors and reasons that may explain possible underestimations are benchmarking portfolios that do not represent the actual composition of the real trading portfolios of the institutions, missing risk factors not incorporated in the models, weaknesses in pricing model assumptions or modelling choices that are not particularly accurate, misunderstandings regarding the positions or risk factors involved, differences in calibration or data used in modelling estimation and/or simulation, and spot problems in specific asset classes that biased the submission. These explanations were offered by a large majority of the applicable respondents.

213. Three banks were identified as possibly underestimating, not justified, during the banks' internal assessment process run by the CAs. CAs are currently undertaking some monitoring activities (both ongoing and on-site) of the internal models, to check all the issues related to these banks.

214. To be more specific, for one bank, the CAs assessed that the underestimation, even though not fully justified, was focused on specific portfolios where the benchmarking was considered less reliable by the CAs, and also the CAs had additional examinations in place that provided further reassurance of the quality of the internal model result for the bank.

215. For the second subject, the inability to fully justify the underestimation was driven by the difficulties in disentangling the model-driven outliers from the error-driven implementation, which in the case of the bank in question were significant. In this specific case the CA is closely monitoring the bank, and there are in place past corrective actions, such as additional capital add-on, and current ones, such as due date, to solve the findings reported by the CAs.

216. The third subject of unjustified underestimation is the only one classified as low priority by the CA, because the benchmarking portfolio is unrepresentative of the actual trading activity. The CAs has already reported to the bank in question numerous findings, linked to an

inadequate IT system, that does not allow specific computation of some of the trades in the exercise. The CAs is following closely the implementation of the improvement in the IT system, and assigned to the bank a specific add-on capital requirement in order to allow for the model's deficiencies.

217.   The bank identified as possibly overestimating, not justified, submitted a very limited set of results in the exercise, and the CAs was therefore unable to fully explain and investigate the misalignment.

218.   Overall, CAs planned some actions for 10 banks, such as:

    a.   reviewing the banks' internal VaR and IRC models;

    b.   supervisory extra charge;

    c.   stringent conditions on any extension of the internal model approach;

    d.   further internal model investigation at peer level.

219.   Currently, 9 banks have a due date for making the improvements to their MR internal models already requested by CAs.

7. Conclusion

220.	This report has presented an analysis of the observed variability across results provided by EU banks that have been granted permission to adopt internal models for MR own funds requirements.

221.	It must be recalled and emphasised that, as the quantitative analysis is based on hypothetical portfolios, this report focuses solely on potential variations and not on actual variations. The analysis shows the extent of the variability in these hypothetical portfolios, but that cannot automatically lead to conclusions regarding real under- or overestimations for the MR capital charge.

222.	However, the analysis might help in determining possible supervisory activities to address uniformity and harmonisation across the Member States, and in promoting in-depth future cross investigations of this matter.

223.	The objective of the benchmarking exercise was not to reach a final judgement on the key drivers of variation and the calculation of the implied capital charges, but to provide supervisors with insights into how to increase comparability and reduce the variability between the banks attributable to non-risk-driven behaviours.

224.	In particular, the report provides inputs for CAs on areas that may require their further investigation, such as IMV variability for some credit spread products. Supervisors should pay attention to the materiality of risk factors not in VaR and, in particular, not encompassed in the IRC models.

225.	Moreover, the conclusions reached in regular supervisory model monitoring activities will take into account the outcome of the supervisory benchmarking exercises to achieve greater alignment between CAs' targeted internal model reviews and the EU's benchmarking analysis.

226.	Overall, this exercise exhibits a significantly reduced IMV variability, despite some errors in data submission, mainly because this was the first submission with the new portfolios. There is probably room for improvement in Risk Measures variability, even if significantly reduced variability between VaR aggregated portfolios is observed. Further improvement in variability should be achieved in the future exercise through the clarification provided in the 2020 ITS. The new analysis carried out in the exercise was helpful, and the considerations of level of approval, size of the banks, business model adopted and stress period are interesting, and will probably be further deepened in the future exercise. Only a limited set of interviews was run in this exercise because, at this point in the benchmark exercise, the number of banks that have not been interviewed is limited. Regardless of this, the interview has been very useful for EBA to understand some weaknesses of the exercise.

227.   Finally, this report provides a framework that can be considered useful for the purpose of future benchmarking exercises under Article 78 of the CRD. Therefore, the type of analysis conducted (i.e. the statistical tools provided to CAs, the graphs and tables created, the methodology defined, the discussions held during the interviews with the selected subgroup of participating banks, etc.) offers a clear direction for future investigations of and activities on these issues.

8. Annex

Table 17: Banks participating in the 2019 EBA MR benchmarking exercise

Country	Bank name
AT	Erste Group Bank AG
AT	Raiffeisen Bank International AG
BE	Belfius Banque
BE	Dexia
BE	KBC Groupe
DE	COMMERZBANK Aktiengesellschaft
DE	DekaBank Deutsche Girozentrale
DE	Deutsche Bank AG
DE	DZ BANK AG Deutsche Zentral-Genossenschaftsbank, Frankfurt am Main
DE	Landesbank Baden-Württemberg
DE	Landesbank Hessen-Thüringen Girozentrale
DE	Norddeutsche Landesbank -Girozentrale-
DK	Danske Bank A/S
DK	Nykredit Realkredit A/S
ES	Banco Bilbao Vizcaya Argentaria, S.A.
ES	BFA Tenedora de Acciones, S.A.
ES	Banco Santander, S.A.
ES	CaixaBank, S.A.
FI	Nordea Bank Abp
FR	BNP Paribas
FR	Groupe Crédit Agricole
FR	Groupe BPCE
FR	Société générale S.A.
GB	J P Morgan Capital Holdings Limited
GB	Barclays Plc
GB	Citigroup Global Markets Europe Limited
GB	Credit Suisse Investments (UK)
GB	Goldman Sachs Group UK Limited
GB	HSBC Holdings Plc
GB	Lloyds Banking Group Plc
GB	Merrill Lynch UK Holdings Ltd
GB	Mitsubishi UFJ Securities International PLC
GB	Morgan Stanley International Ltd
GB	Nomura Europe Holdings PLC
GB	Standard Chartered Plc
GB	The Royal Bank of Scotland Group Public Limited Company
GB	ICBC Standard Bank Plc (was Standard Bank Plc)
GR	Alpha Bank, S.A.
GR	Eurobank Ergasias, S.A.
GR	National Bank of Greece, S.A.
IT	Banco BPM SpA
IT	Intesa Sanpaolo S.p.A.
IT	UniCredit S.p.A.
NL	ABN AMRO Group N.V.
NL	Coöperatieve Rabobank U.A.
NL	ING Groep N.V.
NL	NIBC Holding N.V.
PT	Banco Comercial Português, SA
SE	Skandinaviska Enskilda Banken - group
SE	Swedbank - group

Country	AT	BE	DE	DK	ES	FI	FR	GB	GR	IT	NL	PT	SE
N.banks	2	3	7	2	4	1	4	14	3	3	4	1	2

Table 18: Instruments/portfolios underlying the HPE

Instruments

	EQUITY
	EQUITY
1	Long EURO STOXX 50 index
2	Long 10000 BAYER (Ticker: BAYN GR) shares.
3	Short Future BAYER (Ticker: BAYN GR) (1 contract = 100 shares).
4	Short Future, PEUGEOT PSA
5	Short Future, ALLIANZ
6	Short Future BARCLAYS
7	Short Future DEUTSCHE BANK
8	Short Future CRÉDIT AGRICOLE
9	Long Call Option. Underlying BAYER
10	Short Call Option. Underlying BAYER
11	Long Call Option. Underlying PFIZER
12	Long Put Option. Underlying PFIZER
13	Long Call Option. Underlying BAYER
14	Short Call Option. Underlying BAYER
15	Long Call Option. Underlying AVIVA
16	Long Put Option. Underlying AVIVA
17	Short Future NIKKEI 225
18	Auto-callable Equity product
	IR
19	5-year IRS EUR – Receive fixed rate and pay floating rate.
20	Two-year EUR swaption on 5-year interest rate swap.
21	5-year IRS USD. Receive fixed rate and pay floating rate.
22	2-year IRS GBP. Receive fixed rate and pay floating rate.
23	Long position on 'Cap and Floor' 10-year UBS AG (Ticker: UBSG VX) Notes.
24	Long GERMANY GOVT EUR 5 MLN (ISIN DE0001135085)
25	Short GERMANY GOVT EUR 2 MLN (ISIN DE0001102358))
26	Long ITALY GOVT EUR 5 MLN (ISIN IT0005246134)
27	Long ITALY GOVT EUR 1 MLN (ISIN IT0004953417)
28	Long SPAIN GOVT EUR 5 MLN (ISIN ES00000124C5)
29	Short FRANCE GOVT EUR 5 MLN (ISIN FR0011317783)
30	Short GERMANY GOVT EUR 10 MLN (ISIN DE0001102390)
31	Long UNITED KINGDOM GOVT GBP 5 MLN (ISIN GB0002404191)
32	Long PORTUGAL GOVT EUR 5 MLN (ISIN PTOTETOE0012)
33	Short UNITED STATES GOVT USD 10 MLN (ISIN US9128283P31)
34	Long BRAZIL GOVT 5 MLN USD (ISIN US105756BT66)
35	Long MEXICO GOVT 5 MLN USD (ISIN US91086QBC15)
36	10-year IRS EURO – Receive floating rate and pay fixed rate.
37	5-year IRS EURO – Receive floating rate and pay fixed rate.
	FX
38	6-month USD/EUR forward contract
39	6-month EUR/GBP forward contract.
40	Long 1 MLN USD Cash.
41	Long Call option. EUR 10 MLN.

42	Long Call option. EUR 10 MLN.
43	Short Call option. EUR 10 MLN
44	Short Call option. EUR 10 MLN.
45	Long Put option. EUR 10 MLN.
46	Short Put option. EUR 10 MLN
47	5-year Mark to Market (MtM) Cross Currency EUR/USD SWAP
	COMMODITIES
48	Long 3,500,000 6-month ATM London Gold Forwards
49	Short 3,500,000 12-month ATM London Gold Forwards contracts
50	Long 30 contracts of 6-month WTI Crude Oil Call option
51	Short 30 contracts of 6-month WTI Crude Oil Put option
	CREDIT SPREAD
52	Long (i.e. Buy protection) USD 1 MLN CDS on PORTUGAL.
53	Long (i.e. Buy protection) USD 1 MLN CDS on ITALY.
54	Short (i.e. Sell protection) USD 1 MLN CDS on SPAIN.
55	Long (i.e. Buy protection) USD 1 MLN CDS on MEXICO.
56	Long (i.e. Buy protection) USD 1 MLN CDS on BRAZIL.
57	Long (i.e. Buy protection) USD 1 MLN CDS on UK.
58	Short (i.e. Sell protection) EUR 1 MLN CDS on AXA (Ticker CS FP).
59	Long (i.e. Buy protection) EUR 1 MLN CDS on AXA (Ticker CS FP).
60	Short (i.e. Sell protection) EUR 1 MLN CDS on Aviva (Ticker AV LN).
61	Long (i.e. Buy protection) EUR 1 MLN CDS on Aviva (Ticker AV LN).
62	Short (i.e. Sell protection) EUR 1 MLN CDS on Vodafone (Ticker VOD LN).
63	Short (i.e. Sell protection) EUR 1 MLN CDS on ENI SpA (Ticker ENI IM).
64	Short (i.e. Sell protection) USD 1 MLN CDS on Eli Lilly (Ticker LLY US).
65	Short (i.e. Sell protection) EUR 1 MLN CDS on Unilever (Ticker UNA NA).
66	Long (i.e. Buy protection) EUR 1 MLN CDS on Total SA (Ticker FP FP).
67	Long (i.e. Buy protection) EUR 1 MLN CDS on Volkswagen Group (Ticker VOW GR).
68	Long position on TURKEY Govt. notes USD 1 MLN (ISIN US900123CF53)
69	Long (i.e. Buy protection) USD 1 MLN CDS on TURKEY. Effective date as booking date.
70	Long position on AXA notes EUR 1 MLN (ISIN FR0011524248)
71	Long position on Volkswagen Group notes EUR 1 MLN (ISIN XS1586555861)
72	Short position Volkswagen Group notes EUR 1 MLN (ISIN XS1586555606)
73	Long position on Total SA notes EUR 1 MLN (ISIN XS0830194501)
	CTP
74	Short position in spread hedged Super Senior tranche of iTraxx Europe index on-the-run series.
75	Long (i.e. Buy protection) USD 1 MLN First to Default Basket Swap on {Brazil, Mexico and Turkey}.

Individual Portfolio	**Combination of instruments:**
1	1 – 1000 instruments
2	3 – 1000 instruments; 4 – 1000 instruments; 5 – 1000 instruments

3	13 – 100 instruments; 10 – 100 instruments
4	15 – 100 instruments; 16 – 100 instruments
5	17 – 1000 instruments
6	9 – 500 instruments; 10 – 500 instruments
7	18 – 1 instrument
8	11 – 1000 instruments; 12 – 1000 instruments
9	2 – 1 instruments; 14 – 100 instruments
10	6 – 1000 instruments; 7 – 1000 instruments; 8 – 1000 instruments
11	19 – 1 instrument
12	20 – 1 instrument
13	21 – 1 instrument
14	22 – 1 instrument
15	23 – 1 instrument
16	24 – 1 instrument; 25 – 1 instrument
17	24 – 1 instrument; 25 – 1 instrument; 26 – 1 instrument
18	24 – 1 instrument ; 25 – 1 instrument ; 26 – 1 instrument ; 27 – 1 instrument ; 28 – 1 instrument; 29 – 1 instrument ; 30 – 1 instrument
19	19 – 1 instrument; 36 – 1 instrument
20	19 – 1 instrument; 37 – 1 instrument
21	36 – 1 instrument; 37 – 1 instrument
22	19 – 1 instrument; 20 – 1 instrument
23	31 – 1 instrument
24	33 – 1 instrument; 34 – 1 instrument; 35 – 1 instrument
25	21 – 1 instrument; 33 – 1 instrument
26	26 – 1 instrument; 27 – 1 instrument; 28 – 1 instrument;32 – 1 instrument
27	38 – 1 instrument; 39 – 1 instrument
28	40 – 1 instrument; 41 – 1 instrument
29	41 – 1 instrument; 42 – 1 instrument; 43 – 1 instrument
30	44 – 1 instrument; 45 – 1 instrument
31	46 – 1 instrument
32	47 – 1 instrument
33	48 – 1 instrument; 49 – 1 instrument
34	50 – 1 instrument; 51 – 1 instrument
35	48 – 1 instrument; 51 – 1 instrument
36	52 – 1 instrument; 53 – 1 instrument; 54 – 1 instrument
37	55 – 1 instrument; 56 – 1 instrument
38	58 – 1 instrument; 59 – 1 instrument
39	54 – 1 instrument; 55 – 1 instrument
40	60 – 1 instrument; 61 – 1 instrument
41	62 – 1 instrument ; 63 – 1 instrument ; 65 – 1 instrument ; 66 – 1 instrument ; 67 – 1 instrument
42	68 – 1 instrument; 69 – 1 instrument
43	70 – 1 instrument; 71 – 1 instrument; 73 – 1 instrument
44	71 – 1 instrument; 72 – 1 instrument
45	70 – 1 instrument; 59 – 1 instrument
46	66 – 1 instrument; 73 – 1 instrument
47	64 – 1 instrument
48	71 – 1 instrument; 72 – 1 instrument; 67 – 1 instrument
49	57 – 1 instrument; 54 – 1 instrument
50	53 – 1 instrument; 27 – 1 instrument

51	55 – 5 instruments; 35 – 1 instrument
52	56 – 5 instruments; 34 – 1 instrument
53	55 – 5 instruments; 35 – 1 instrument; 56 – 5 instruments; 34 – 1 instrument
54	74 – 1 instrument
55	75 – 1 instrument
56	75 – 5 instruments; 68 – 5 instruments; 34 – 1 instrument; 35 – 1 instrument
Aggregated Portfolio	**Combination of individual portfolios:**
57 ALL-IN no-CTP	1, 2, 6, 7, 9, 11, 12, 18, 21, 27, 28, 30, 31, 32, 33, 34, 38, 41, 43
58 EQUITY Cumulative	1, 2, 6, 7, 9
59 IR Cumulative	11, 12, 18, 21
60 FX Cumulative	27, 28, 30, 31, 32
61 Commodity Cumulative	33, 34
62 Credit Spread cumulative	38, 41, 43
63 CTP cumulative EUR	54, 56

For a detailed description of the portfolios, please refer to the EBA website: https://eba.europa.eu/eba-publishes-updated-its-package-for-2019-benchmarking-exercise

Refer also to Commission Implementing Regulation (EU) 2016/2070 of 14 September 2016, laying down ITS in accordance with Article 78(2) of Directive 2013/36/EU, http://data.europa.eu/eli/reg_impl/2016/2070/2018-06-07

Table 19: VaR cluster analysis – number of banks by range

2019 VaR cluster analysis: number of banks by range

(X = ratio with the median)

100

	Port. ID	300% < X	300% ≥ X >200%	200% ≥ X >150%	150% ≥ X >100%	100% ≥ X >50%	50% ≥ X >0	Num obs.
Equity	1				19	19		38
	2				19	18		37
	3			2	18	16	1	37
	4	1		2	15	16	2	36
	5		1		17	18	1	37
	6		1	1	19	15	1	37
	7	2		4	10	12	3	31
	8		2	3	14	13	4	36
	9		1	5	14	16	1	37
	10	3	2	1	14	16		36
Interest Rate	11				26	22		48
	12	1		4	17	23		45
	13			1	22	25		48
	14		3	8	17	20		48
	15	2	1	1	7	8	3	22
	16			1	23	22		46
	17			2	16	19	2	39
	18			1	19	15	4	39
	19			1	23	24		48
	20		2	5	15	18	7	47
	21			1	22	24		47
	22	3		6	16	20	1	46
	23			3	19	23	1	46
	24		1	3	13	12	11	40
	25	9	3	4	9	20	1	46
	26			1	18	16	4	39
FX	27				21	21		42
	28		1	1	24	13	1	40
	29			1	22	18		41
	30				21	19	1	41
	31				21	20		41
	32	15			3	19	1	38
Commodity	33	2		5	4	6	3	20
	34				8	10		18
	35				8	10		18
	36			3	10	14	1	28
	37			4	8	14		26
	38	1	1	1	12	13		28
	39	1	1	1	10	13		26
	40	1		3	12	12		28
	41	1	3		10	12	2	28
	42	2	2	5	6	7	4	26
	43	2	2	1	12	14		31
	44	1	3	2	9	16		31
	45	1	4		9	10	6	30
	46	5	1	2	7	14	1	30
	47	4	2	3	8	11		28
	48	1	4	4	8	13		30
	49	1	1	6	8	11	1	28
	50		5	3	9	10	1	28
	51			3	8	11	5	27
	52		2	2	8	10	4	26
	53		2	3	7	14		26
CTP	54				3	4		7
	55			1	1	2		4
	56			1	1	2		4
ALL-IN no-CTP	57				8	14	1	23
Equity Cumulative	58			1	14	14	1	30
IR Cumulative	59				19	15	4	38
FX Cumulative	60			2	16	19		37
Commodity Cumulative	61				8	8	2	18
CS Cumulative	62	2	1		11	11	2	27
CTP Cumulative	63			1	1	2	1	5

Table 20: VaR statistics

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc [1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs. [2]	25th	50th	75th	IQD
Equity	1	1,782,174	2,769,033	2,176,219	186,605	142,163	103,010	9%	33	2,071,063	2,150,191	2,275,650	5%
	2	1,631,826	3,155,255	2,193,046	327,145	264,869	167,411	15%	31	2,038,732	2,178,651	2,369,775	8%
	3	9,055	32,576	19,501	5,224	4,313	2,891	27%	29	17,251	19,453	22,344	13%
	4	656	428,100	16,615	79,142	573	206	476%	29	1,752	1,956	2,162	10%
	5	12,289,873	49,343,411	18,167,082	6,425,789	2,739,574	1,603,887	35%	31	15,379,730	16,983,618	18,621,159	10%
	6	13,980	60,353	30,157	10,979	9,187	7,195	36%	29	22,659	29,080	36,508	23%
	7	14,018	348,100	51,607	64,469	25,868	10,178	125%	27	25,660	35,839	46,040	28%
	8	11,191	157,324	84,037	30,214	23,639	16,619	36%	28	66,398	83,016	99,904	20%
	9	38,824	197,800	95,852	30,872	21,918	9,126	32%	28	82,807	91,154	102,793	11%
	10	133,603	1,390,911	313,463	235,989	84,817	37,675	75%	26	231,818	261,162	299,650	13%
Interest Rate	11	47,764	79,768	61,087	9,489	8,490	6,258	16%	42	52,856	59,765	65,463	11%
	12	30,624	70,893	42,723	9,989	8,856	4,771	23%	38	35,560	40,423	44,025	11%
	13	82,445	187,116	111,122	19,123	14,179	8,881	17%	39	99,855	107,965	120,309	9%
	14	17,163	49,452	25,050	7,407	5,415	2,457	30%	41	20,110	22,559	25,823	12%
	15	4,950	67,030	22,188	16,000	12,410	6,133	72%	21	11,930	18,063	23,700	33%
	16	77,636	169,785	110,564	21,577	18,985	9,369	20%	38	99,196	107,067	125,585	12%
	17	130,400	491,429	287,520	77,198	61,500	29,965	27%	28	260,552	303,756	325,391	11%
	18	59,376	578,562	431,231	151,072	131,412	45,813	35%	24	422,720	468,763	514,576	10%
	19	70,522	162,248	98,408	17,466	13,646	8,146	18%	39	87,420	95,293	110,559	12%
	20	5	9,143	4,110	2,123	1,893	952	52%	39	3,370	4,054	5,644	25%
	21	172,308	307,500	208,411	29,048	23,897	17,261	14%	38	188,614	203,418	220,798	8%
	22	16,148	120,007	36,445	16,946	9,123	6,431	47%	37	27,882	33,191	40,761	19%
	23	68,947	302,253	161,616	43,376	32,947	19,447	27%	34	137,756	162,505	172,327	11%
	24	17,800	264,248	148,273	64,199	56,523	28,252	43%	27	125,786	154,038	187,070	20%
	25	6,181	478,850	77,784	117,788	92,793	6,929	151%	30	24,883	30,130	67,028	46%
	26	212,787	793,069	519,385	148,392	127,837	50,598	29%	25	486,228	559,800	590,766	10%
FX	27	312,451	683,249	526,909	96,151	86,659	53,520	18%	33	486,304	539,824	574,184	8%
	28	5,316	16,919	12,361	3,032	2,537	2,127	25%	22	10,307	12,700	14,778	18%
	29	100,204	253,653	156,056	26,403	17,895	9,583	17%	33	142,856	152,045	166,390	8%
	30	32,391	584,192	400,315	83,433	43,803	28,515	21%	34	368,032	398,995	425,062	7%
	31	184,127	471,772	324,714	47,680	32,937	15,499	15%	34	305,964	322,811	337,571	5%
	32	3,918	343,100	148,795	146,534	144,653	10,794	99%	32	22,877	28,602	315,874	86%
Commodity	33	295	14,448	5,226	3,434	3,434	2,168	66%	18	2,771	4,601	7,464	46%
	34	235,121	367,043	286,012	41,849	41,849	25,590	15%	16	253,623	279,212	314,275	11%
	35	236,088	449,668	338,048	60,429	60,429	45,025	18%	15	292,511	337,536	392,055	15%
Credit Spread	36	16,448	54,259	30,976	9,837	7,974	5,118	32%	20	24,954	30,071	35,966	18%
	37	16,736	43,000	25,687	7,397	6,284	3,899	29%	21	20,940	22,867	29,136	16%
	38	2,253	15,147	4,813	2,682	1,449	637	56%	23	3,261	4,311	4,790	19%
	39	9,929	41,277	16,135	6,512	2,969	2,509	40%	21	12,596	14,430	17,859	17%
	40	2,724	21,653	5,804	3,675	1,424	943	63%	24	3,971	5,084	6,001	20%
	41	5,247	45,262	14,366	9,552	9,552	1,254	67%	19	9,987	10,869	12,787	12%
	42	10,671	104,900	37,649	27,659	23,256	14,079	74%	20	18,199	28,244	48,469	45%
	43	16,059	133,826	38,289	32,614	24,602	6,535	85%	20	22,449	28,984	35,951	23%
	44	5,522	88,299	14,442	16,663	4,319	2,162	115%	23	8,146	9,761	13,714	25%
	45	3,916	25,227	11,296	5,311	4,172	2,381	47%	21	8,449	10,830	11,567	16%
	46	3,162	125,703	17,328	25,693	8,805	3,304	148%	22	6,114	9,355	18,486	50%
	47	1,715	15,651	4,446	3,578	2,695	676	81%	23	2,240	2,851	5,297	41%
	48	5,354	39,966	12,720	8,655	8,655	3,473	68%	19	7,436	9,797	14,905	33%
	49	5,904	24,880	10,874	4,657	3,404	2,902	43%	21	7,284	9,019	12,808	27%
	50	6,048	50,854	24,253	10,682	8,135	4,396	44%	20	17,563	21,420	26,156	20%
	51	46,171	194,297	103,114	49,694	49,694	42,819	48%	17	58,769	101,588	137,784	40%
	52	36,072	192,914	91,303	41,553	35,007	26,099	46%	23	53,292	87,335	113,434	36%
	53	82,064	373,375	173,176	91,258	91,258	60,236	53%	16	94,140	147,936	221,986	40%
Correlation Trading	54	3,482	7,756	5,530	1,450	1,450	786	26%	6	4,743	5,440	6,316	14%
	55	22,803	47,616	32,214	10,724	10,724	3,613	33%	4	25,606	29,218	38,822	21%
	56	171,920	556,081	328,496	182,982	182,982	112,515	56%	4	180,476	292,991	476,516	45%
ALL-IN no-CTP **	57	1,061,712	1,686,312	1,412,880	168,637	168,637	81,674	12%	11	1,321,525	1,395,320	1,525,912	7%
Equity Cumulative **	58	403,567	1,953,400	1,214,923	248,968	148,291	121,631	21%	30	1,122,602	1,189,009	1,351,238	9%
IR Cumulative **	59	107,562	837,520	545,993	150,954	125,493	60,663	28%	36	509,981	575,893	625,371	10%
FX Cumulative **	60	517,829	1,241,860	857,267	155,809	129,904	71,025	18%	32	771,837	821,725	980,462	12%
Commodity Cumulative **	61	45,093	366,326	264,665	70,124	70,124	25,709	27%	17	240,304	266,014	283,858	8%
CS Cumulative **	62	15,969	133,693	41,315	28,049	20,791	9,646	68%	25	24,425	34,071	42,246	27%
CTP Cumulative **	63	148,655	487,852	287,399	161,438	161,438	99,840	56%	4	156,705	256,545	418,094	45%

[1] STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile

[2] Refers to the number of banks included in the computation of the statistics

** For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included
in the computation of the benchmarks for that particular aggregate portfolio.

Table 21: sVaR statistics

EU Statistics for SVaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc [1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs. [2]	25th	50th	75th	IQD
Equity	1	1,727,730	8,197,875	6,006,871	1,385,057	1,127,475	600,532	23%	33	5,769,768	6,210,380	6,848,979	9%
	2	2,062,468	13,609,342	8,849,232	3,269,237	2,998,672	2,696,184	37%	31	6,805,689	8,923,414	11,897,499	27%
	3	15,237	65,386	37,572	13,638	12,301	10,757	36%	29	27,469	39,165	45,076	24%
	4	1,001	412,300	19,008	75,679	2,375	1,716	398%	29	2,359	5,269	6,918	49%
	5	15,018,967	59,565,474	42,591,205	13,210,003	12,222,489	9,883,697	31%	31	33,039,538	44,636,306	54,520,003	25%
	6	15,418	93,369	51,038	20,112	17,827	14,715	39%	29	42,515	47,605	62,665	19%
	7	15,398	278,692	137,274	67,792	58,987	41,709	49%	26	97,649	125,052	178,003	29%
	8	11,217	410,318	134,202	75,750	50,064	29,935	56%	28	94,156	120,341	157,006	25%
	9	40,567	215,962	137,689	41,209	34,801	26,216	30%	28	109,756	141,659	167,875	21%
	10	147,081	2,481,693	991,736	567,185	470,509	133,794	57%	26	702,542	916,961	1,017,900	18%
Interest Rate	11	6,500	497,033	197,546	88,643	66,718	42,788	45%	42	149,517	213,012	245,714	24%
	12	26,320	262,302	115,674	59,764	54,138	43,890	52%	38	67,130	112,506	134,235	33%
	13	93,637	671,105	340,218	100,821	77,420	59,946	30%	39	282,381	342,327	411,217	19%
	14	22,637	209,522	87,292	38,152	27,369	18,926	44%	41	70,016	90,437	105,400	20%
	15	7,317	268,981	70,527	60,585	40,186	22,704	86%	21	35,199	51,200	106,135	50%
	16	7,727	484,870	209,564	84,746	65,258	41,015	40%	38	165,057	218,981	255,184	21%
	17	104,619	679,932	388,548	127,349	104,376	67,910	33%	28	314,799	400,325	460,055	19%
	18	86,332	1,075,154	380,200	238,624	186,831	67,550	63%	24	285,795	317,698	386,636	15%
	19	59,629	863,784	289,113	135,241	92,631	55,282	47%	39	217,348	306,349	353,197	24%
	20	4	207,928	22,744	36,891	21,207	6,531	162%	39	6,417	12,948	19,901	51%
	21	68,936	1,432,129	601,646	246,788	191,051	97,697	41%	38	507,390	646,826	720,867	17%
	22	21,159	421,203	151,465	86,325	72,351	49,204	57%	37	92,583	151,068	197,276	36%
	23	76,464	594,934	307,882	112,470	95,273	53,527	37%	34	256,003	309,196	363,057	17%
	24	61,289	1,119,698	559,505	321,678	297,784	238,981	58%	27	240,317	610,188	838,908	55%
	25	35,808	1,026,080	257,264	235,909	188,868	66,135	92%	30	129,699	171,213	269,965	35%
	26	200,532	2,326,864	693,089	408,541	217,139	67,116	59%	25	562,114	629,229	686,192	10%
FX	27	536,913	1,941,759	1,358,977	349,701	310,700	260,440	26%	33	1,094,983	1,322,669	1,631,340	20%
	28	8,699	74,117	25,699	14,466	9,491	6,736	56%	22	16,346	23,125	28,845	28%
	29	253,289	699,615	409,623	96,592	79,467	38,093	24%	33	365,994	396,361	434,453	9%
	30	66,005	2,690,677	1,152,864	389,637	216,831	139,859	34%	34	1,041,153	1,204,734	1,298,154	11%
	31	374,295	2,363,916	1,067,193	352,239	248,959	155,892	33%	34	902,426	1,129,065	1,253,841	16%
	32	25,774	1,038,738	443,159	375,384	363,807	96,056	85%	32	122,705	157,834	803,590	74%
Commodity	33	631	49,617	18,808	11,959	11,959	4,068	64%	18	14,322	17,965	22,458	22%
	34	203,844	691,436	479,561	133,917	133,917	86,261	28%	16	404,660	460,722	580,887	18%
	35	292,996	1,212,995	970,149	273,037	273,037	132,676	28%	15	917,223	1,054,729	1,182,455	13%
Credit Spread	36	13,807	121,445	33,528	31,126	24,291	5,392	93%	20	17,030	22,422	34,116	33%
	37	23,821	217,500	104,588	57,958	51,563	40,179	55%	21	71,117	86,142	129,714	29%
	38	6,512	43,472	17,305	8,965	6,913	7,028	52%	23	10,220	17,550	21,685	36%
	39	19,586	102,852	51,647	26,365	23,843	16,491	51%	21	34,271	46,312	67,199	32%
	40	8,060	37,311	20,165	10,332	9,792	8,436	51%	24	11,231	18,387	27,390	42%
	41	12,939	78,364	38,078	18,493	18,493	15,654	49%	19	20,321	36,757	51,273	43%
	42	25,636	318,271	93,215	71,807	49,332	31,411	77%	20	37,038	64,994	136,689	57%
	43	30,532	245,593	98,448	55,487	43,308	32,274	56%	20	63,342	78,574	122,923	32%
	44	12,740	167,478	38,073	34,371	20,109	12,278	90%	23	17,069	30,854	41,614	42%
	45	11,182	98,745	42,353	25,969	22,734	18,642	61%	21	20,933	38,445	59,937	48%
	46	4,068	72,321	32,879	21,617	19,764	12,340	66%	22	15,811	25,279	46,163	49%
	47	3,255	45,463	15,099	11,898	10,089	5,305	79%	23	6,624	11,059	21,412	53%
	48	7,358	84,738	38,062	19,793	19,793	9,939	52%	19	25,614	35,553	46,177	29%
	49	7,110	45,583	17,164	10,281	8,123	3,276	60%	21	11,197	13,721	19,177	26%
	50	4,453	65,618	32,696	13,430	9,531	8,864	41%	20	24,118	30,703	42,908	28%
	51	98,144	782,400	317,748	192,012	192,012	82,500	60%	17	170,700	245,913	417,781	42%
	52	96,817	686,300	286,095	174,310	153,352	70,230	61%	23	160,647	213,812	378,554	40%
	53	194,961	1,445,200	580,340	369,684	369,684	115,376	64%	16	330,632	395,152	800,178	42%
Correlation Trading	54	4,430	17,159	11,728	5,465	5,465	1,713	47%	6	5,191	14,330	14,926	48%
	55	51,557	94,154	70,333	18,003	18,003	10,352	26%	4	57,458	67,810	83,207	18%
	56	666,294	1,398,753	917,291	337,370	337,370	118,000	37%	4	684,059	802,058	1,150,523	25%
ALL-IN no-CTP **	57	3,802,056	7,078,821	5,827,667	973,087	973,087	636,419	17%	11	5,129,372	5,980,235	6,601,923	13%
Equity Cumulative **	58	1,221,258	6,042,005	4,182,107	1,329,883	1,202,157	507,680	32%	30	3,975,124	4,674,177	5,017,463	12%
IR Cumulative **	59	105,072	1,830,157	687,022	355,919	290,195	153,818	52%	36	465,548	601,909	820,153	28%
FX Cumulative **	60	1,226,223	4,944,446	2,850,778	711,881	547,094	332,875	25%	32	2,570,673	2,855,486	3,213,532	11%
Commodity Cumulative **	61	346,857	690,772	479,445	113,853	113,853	39,411	24%	17	397,837	432,109	567,199	18%
CS Cumulative **	62	28,494	264,431	96,564	54,340	41,353	26,509	56%	25	63,886	78,840	116,688	29%
CTP Cumulative **	63	549,370	1,227,884	791,431	306,686	306,686	114,548	39%	4	579,687	694,235	1,003,175	27%

[1] STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile

[2] Refers to the number of banks included in the computation of the statistics

** For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included
   in the computation of the benchmarks for that particular aggregate portfolio.

EU Statistics for PnL VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.[2]	25th	50th	75th	IQD
				Main statistics						Percentiles			
Equity	1	1,951,782	2,487,059	2,173,400	121,132	121,132	68,963	6%	18	2,104,128	2,172,638	2,242,055	3%
	2	1,811,571	2,334,631	2,102,269	139,781	139,781	37,465	7%	17	2,074,628	2,098,734	2,192,040	3%
	3	9,028	30,617	20,423	4,717	4,717	2,025	23%	19	17,625	20,349	22,017	11%
	4	1,009	4,057	2,042	744	744	390	36%	17	1,534	1,907	2,297	20%
	5	1,532,365	20,012,726	15,689,810	3,715,400	3,715,400	447,085	24%	18	15,994,656	16,430,158	16,888,783	3%
	6	16,583	64,746	34,271	13,210	13,210	6,337	39%	19	24,315	31,246	35,810	19%
	7	13,212	64,155	30,329	15,380	15,380	10,221	51%	15	17,807	28,822	37,947	36%
	8	2,760	167,070	69,283	38,353	38,353	13,494	55%	18	50,725	60,795	85,283	25%
	9	51,583	182,916	98,312	27,519	27,519	10,327	28%	17	87,537	98,657	101,674	7%
	10	130,789	438,409	284,235	85,819	85,819	13,834	30%	14	252,511	268,903	280,161	5%
Interest Rate	11	44,983	76,570	60,211	9,490	8,559	5,883	16%	22	53,759	59,193	71,505	14%
	12	21,844	55,030	41,049	6,697	4,104	3,158	16%	20	38,496	40,903	44,754	8%
	13	83,579	132,186	104,853	12,938	11,036	5,009	12%	22	99,354	102,381	108,931	5%
	14	16,191	37,948	24,934	6,871	6,225	2,500	28%	21	20,960	22,115	31,396	20%
	15	4,879	45,666	21,934	11,190	11,190	4,731	51%	13	15,837	20,202	24,933	22%
	16	78,068	142,310	108,545	15,260	11,770	7,703	14%	20	99,552	106,926	117,139	8%
	17	143,538	409,957	316,068	62,012	62,012	40,335	20%	17	273,954	322,552	354,257	13%
	18	61,334	578,200	469,406	125,995	125,995	52,864	27%	15	441,155	500,864	544,746	11%
	19	85,574	117,051	99,681	10,508	9,691	8,813	11%	20	90,662	97,151	111,644	10%
	20	2,816	7,514	4,764	1,278	1,099	1,070	27%	22	3,510	4,792	5,660	23%
	21	163,589	225,956	204,249	17,972	15,488	10,634	9%	21	194,364	208,622	216,281	5%
	22	20,346	108,852	34,979	18,596	6,435	3,786	53%	20	28,042	30,323	34,841	11%
	23	133,546	298,400	167,961	36,920	21,830	9,467	22%	21	148,950	163,271	166,535	6%
	24	73,637	219,442	148,068	35,544	35,544	12,471	24%	21	129,119	145,204	156,173	9%
	25	21,273	475,964	98,239	139,388	139,388	7,596	142%	19	25,566	30,090	95,644	58%
	26	205,153	681,650	541,774	111,470	111,470	42,469	21%	15	500,718	565,021	597,674	9%
FX	27	1,954	665,604	517,517	137,265	60,757	43,286	27%	20	496,102	539,388	581,527	8%
	28	10,369	48,511	15,557	9,648	9,648	1,723	62%	14	11,473	13,128	15,105	14%
	29	117,975	182,044	141,257	16,677	13,420	13,101	12%	20	131,148	135,687	153,422	8%
	30	340,394	447,665	382,401	31,260	27,377	23,874	8%	21	351,013	386,697	394,388	6%
	31	290,060	377,593	327,195	22,617	18,712	14,165	7%	21	313,065	323,185	337,350	4%
	32	20,346	328,466	152,891	141,889	141,889	4,952	93%	19	22,557	25,298	309,018	86%
Commodity	33	400	13,791	5,628	3,665	3,665	1,890	65%	12	3,327	4,741	7,781	40%
	34	256,211	378,212	320,157	44,373	44,373	33,422	14%	10	284,605	318,685	351,448	11%
	35	312,063	445,767	379,559	51,662	51,662	43,651	14%	9	335,102	393,962	429,143	12%
Credit Spread	36	23,111	59,155	35,956	11,231	11,231	5,352	31%	13	28,381	30,880	37,410	14%
	37	15,470	42,454	26,959	7,586	7,586	4,732	28%	14	21,739	26,520	30,345	17%
	38	1,929	6,280	3,707	1,047	1,047	437	28%	16	3,183	3,649	4,069	12%
	39	12,151	20,741	15,668	2,843	2,843	1,689	18%	14	13,626	14,953	17,962	14%
	40	1,685	7,098	4,362	1,327	1,327	901	30%	17	3,943	4,060	5,202	14%
	41	3,880	27,189	10,987	5,617	5,617	1,487	51%	12	8,952	9,278	11,792	14%
	42	9,303	144,276	34,725	37,191	37,191	8,547	107%	15	13,852	21,543	32,606	40%
	43	15,728	100,434	28,821	22,412	22,412	3,223	78%	13	19,891	23,115	25,298	12%
	44	4,914	18,955	9,307	3,869	3,869	1,658	42%	14	6,783	8,315	10,099	20%
	45	3,844	14,252	8,064	3,062	3,062	2,286	38%	15	5,313	7,533	10,635	33%
	46	3,162	92,152	14,293	23,587	23,587	2,112	165%	13	5,961	7,912	10,432	27%
	47	1,723	15,249	3,959	3,380	3,380	711	85%	16	2,139	2,850	3,881	29%
	48	3,317	16,959	9,312	4,012	4,012	2,844	43%	12	6,242	8,950	12,569	34%
	49	5,774	20,925	10,227	4,323	4,323	1,749	42%	14	7,246	8,730	11,454	23%
	50	5,721	32,435	21,869	6,918	6,918	3,543	32%	13	18,913	22,455	24,862	14%
	51	41,287	194,876	92,693	49,856	49,856	21,512	54%	12	58,066	71,953	128,654	38%
	52	36,232	197,547	92,585	50,428	50,428	20,858	55%	16	60,627	80,031	103,024	26%
	53	10,556	372,295	153,286	106,452	106,452	40,990	69%	11	84,474	127,895	168,885	33%
Correlation Trading	54	3,162	10,186	6,486	3,527	3,527	2,947	54%	3	3,162	6,110	10,186	53%
	55	20,048	43,478	31,763	16,568	16,568	11,715	52%	2	20,048	31,763	43,478	37%
	56	188,405	210,033	199,219	15,293	15,293	10,814	8%	2	188,405	199,219	210,033	5%
ALL-IN no-CTP **	57	1,275,350	1,402,444	1,353,251	52,849	52,849	26,222	4%	6	1,299,696	1,373,003	1,396,006	4%
Equity Cumulative **	58	1,136,823	1,952,536	1,252,178	187,300	187,300	32,466	15%	18	1,164,899	1,192,594	1,236,043	3%
IR Cumulative **	59	492,929	669,407	594,126	59,877	55,890	36,275	10%	22	528,793	610,251	641,746	10%
FX Cumulative **	60	505,639	1,206,395	826,036	159,314	120,208	59,623	19%	21	740,523	795,575	903,279	10%
Commodity Cumulative **	61	267,289	382,565	332,808	43,820	43,820	32,899	13%	10	291,315	348,840	365,600	11%
CS Cumulative **	62	17,026	100,990	31,160	19,336	19,336	6,125	62%	17	20,724	25,453	33,223	23%
CTP Cumulative **	63	164,438	178,699	171,569	10,084	10,084	7,130	6%	2	164,438	171,569	178,699	4%

[1] STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile

[2] Refers to the number of banks included in the computation of the statistics

** For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included
   in the computation of the benchmarks for that particular aggregate portfolio.

Table 23: Empirical expected shortfall statistics

EU Statistics for empirical expected shortfall

	Port. ID	Main statistics								Percentiles			
		Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.[2]	25th	50th	75th	IQD
Equity	1	1,964,205	2,536,086	2,200,053	145,675	145,675	140,939	7%	18	2,092,139	2,238,146	2,288,190	4%
	2	1,852,401	2,356,943	2,139,842	108,275	108,275	24,459	5%	17	2,109,601	2,171,462	2,188,252	2%
	3	8,923	25,124	19,646	3,711	3,711	1,407	19%	19	18,117	19,523	21,787	9%
	4	68	3,282	1,801	753	753	342	42%	17	1,472	1,782	2,167	19%
	5	1,502,853	17,579,728	15,159,298	3,538,024	3,538,024	493,813	23%	18	15,359,026	15,850,611	16,346,653	3%
	6	17,041	75,879	35,071	15,902	15,902	6,223	45%	19	24,053	30,436	35,346	19%
	7	0	70,810	29,555	16,610	16,610	11,424	56%	16	17,876	29,567	38,627	37%
	8	2,755	168,220	70,252	33,546	33,546	9,322	48%	18	56,532	61,666	86,423	21%
	9	53,594	147,155	110,441	23,015	23,015	9,165	21%	17	96,798	117,626	121,858	11%
	10	120,657	448,270	267,368	81,908	81,908	18,726	31%	14	238,351	246,215	267,313	6%
Interest Rate	11	47,203	73,562	60,840	7,817	7,017	3,899	13%	22	56,020	59,475	64,886	7%
	12	23,591	57,644	40,832	6,537	3,694	2,233	16%	20	37,897	42,036	43,268	7%
	13	82,626	122,848	102,032	11,084	9,652	7,648	11%	22	95,983	99,511	108,868	6%
	14	17,215	33,124	22,791	4,405	3,720	1,486	19%	21	20,070	20,978	26,870	14%
	15	4,944	44,135	22,973	11,647	11,647	5,107	51%	13	17,092	19,893	28,590	25%
	16	74,408	132,133	104,816	14,241	11,328	8,525	14%	20	97,229	101,052	116,844	9%
	17	139,008	453,925	317,644	68,647	68,647	22,747	22%	17	292,511	315,258	331,226	6%
	18	57,424	702,662	512,845	148,979	148,979	73,569	29%	15	457,473	521,324	620,414	15%
	19	85,440	106,941	96,738	6,570	5,882	5,462	7%	20	91,229	95,381	103,380	6%
	20	2,824	8,734	4,609	1,365	991	761	30%	22	3,426	4,733	5,319	22%
	21	173,369	218,672	197,581	12,213	10,412	6,378	6%	21	191,691	196,816	207,819	4%
	22	24,880	116,670	37,364	19,802	6,672	5,278	53%	20	27,780	32,142	37,915	15%
	23	131,000	315,652	171,322	50,194	38,989	11,641	29%	21	145,808	159,094	165,721	6%
	24	69,239	229,912	150,241	36,235	36,235	24,148	24%	16	128,287	151,379	176,071	16%
	25	23,219	459,207	97,417	137,936	137,936	6,409	142%	19	25,692	29,921	90,289	56%
	26	205,215	770,709	596,530	140,642	140,642	92,676	24%	15	522,353	600,892	698,841	14%
FX	27	1,883	694,438	500,770	134,210	54,592	32,443	27%	20	481,871	517,586	537,815	5%
	28	10,324	46,505	15,490	9,204	9,204	1,614	59%	14	11,450	13,120	14,455	12%
	29	121,932	181,566	144,028	15,204	12,082	6,608	11%	20	134,783	140,382	149,167	5%
	30	323,204	466,951	378,562	41,289	35,872	20,260	11%	21	351,903	368,563	396,895	6%
	31	300,665	380,890	326,663	19,022	14,099	14,983	6%	21	312,195	327,179	334,575	3%
	32	21,283	346,090	152,519	141,686	141,686	4,050	93%	19	21,883	25,334	286,334	86%
Commodity	33	408	12,320	5,856	3,682	3,682	2,066	63%	12	3,300	4,970	8,802	45%
	34	240,059	342,786	291,709	39,295	39,295	29,102	14%	10	257,521	286,404	337,991	14%
	35	309,066	422,716	367,016	41,053	41,053	39,305	11%	9	336,891	362,648	407,614	9%
Credit Spread	36	23,257	47,702	32,409	7,336	7,336	3,803	23%	13	27,778	29,762	35,182	12%
	37	14,577	44,886	26,001	7,230	7,230	3,961	28%	14	21,466	25,790	28,508	14%
	38	1,657	6,236	3,978	1,151	1,151	653	29%	16	3,307	3,982	4,614	17%
	39	11,549	21,869	15,248	2,675	2,675	1,755	18%	14	13,251	14,954	16,747	12%
	40	1,447	7,922	4,774	1,543	1,543	640	32%	17	4,274	4,914	5,253	10%
	41	3,754	25,399	11,373	5,090	5,090	905	45%	12	9,597	9,952	12,572	13%
	42	7,926	141,155	36,001	38,431	38,431	9,902	107%	15	13,849	23,750	34,583	43%
	43	15,299	106,461	30,064	24,537	24,537	3,493	82%	13	20,151	22,608	26,101	13%
	44	4,775	25,169	10,146	5,279	5,279	1,946	52%	14	7,027	9,071	10,919	22%
	45	3,867	15,135	8,069	3,321	3,321	1,899	41%	15	5,373	7,524	9,423	27%
	46	3,261	87,571	15,136	22,573	22,573	2,402	149%	13	5,939	8,341	9,705	24%
	47	1,811	14,201	3,986	3,273	3,273	794	82%	16	2,040	2,764	4,650	39%
	48	3,465	25,628	9,884	5,759	5,759	2,497	58%	12	6,408	8,718	12,051	31%
	49	6,848	23,003	11,230	4,293	4,293	1,820	38%	14	8,605	9,957	11,948	16%
	50	8,581	33,798	23,111	7,147	7,147	4,677	31%	13	18,196	21,894	29,494	24%
	51	40,761	201,851	93,225	53,599	53,599	19,721	58%	12	56,909	68,367	140,359	42%
	52	33,414	219,081	94,503	54,470	54,470	21,449	58%	16	60,040	81,489	113,418	31%
	53	10,980	394,212	156,434	111,327	111,327	44,359	71%	11	83,384	127,744	226,005	46%
Correlation Trading	54	3,426	10,431	6,622	3,543	3,543	2,582	54%	3	3,426	6,007	10,431	51%
	55	23,838	37,267	30,553	9,496	9,496	6,714	31%	2	23,838	30,553	37,267	22%
	56	180,124	202,301	191,213	15,682	15,682	11,089	8%	2	180,124	191,213	202,301	6%
ALL-IN no-CTP **	57	1,250,889	1,420,168	1,320,032	64,201	64,201	31,446	5%	6	1,279,816	1,296,799	1,375,720	4%
Equity Cumulative **	58	1,165,237	1,723,216	1,296,928	139,823	139,823	59,656	11%	18	1,222,872	1,251,608	1,315,118	4%
IR Cumulative **	59	493,863	803,483	619,546	80,472	67,354	36,155	13%	22	572,034	607,327	649,727	6%
FX Cumulative **	60	483,250	1,140,969	807,369	154,351	120,216	97,122	19%	21	728,482	807,754	910,249	11%
Commodity Cumulative **	61	243,967	344,706	298,045	37,779	37,779	33,068	13%	10	257,992	308,108	336,956	13%
CS Cumulative **	62	16,449	106,647	32,719	20,566	20,566	4,908	63%	17	23,686	27,649	32,677	16%
CTP Cumulative **	63	156,759	175,611	166,185	13,331	13,331	9,426	8%	2	156,759	166,185	175,611	6%

[1] STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile

[2] Refers to the number of banks included in the computation of the statistics

** For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included
in the computation of the benchmarks for that particular aggregate portfolio.

Table 24: sVaR/VaR statistics

EU Statistics for sVaR/VaR

	Port. ID	Main statistics								Percentiles			
		Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.[2]	25th	50th	75th	IQD
Equity	1	0.83	3.61	2.79	0.61			22%	38	2.68	2.90	3.12	8%
	2	1.03	7.18	4.10	1.39			34%	37	3.14	4.09	5.10	24%
	3	0.77	4.69	1.95	0.69			36%	37	1.56	1.91	2.27	19%
	4	0.87	4.84	2.36	0.97			41%	36	1.42	2.37	3.03	36%
	5	0.74	4.73	2.63	0.91			34%	37	2.13	2.62	3.31	22%
	6	0.65	5.14	1.85	0.93			50%	37	1.26	1.69	2.14	26%
	7	0.51	7.47	3.62	1.77			49%	30	2.14	3.40	5.32	43%
	8	0.68	4.45	1.51	0.68			45%	36	1.12	1.34	1.68	20%
	9	0.45	2.73	1.49	0.48			32%	37	1.18	1.49	1.72	19%
	10	0.63	6.05	3.56	1.16			33%	36	3.00	3.62	4.08	15%
Interest Rate	11	0.12	7.92	3.15	1.46			46%	48	1.74	3.44	4.09	40%
	12	0.43	7.34	2.60	1.28			49%	45	1.67	2.80	3.27	32%
	13	0.94	6.65	3.04	0.93			31%	48	2.49	3.15	3.56	18%
	14	0.68	9.90	3.41	1.83			54%	48	1.88	3.16	4.32	39%
	15	0.76	13.63	3.83	3.43			89%	22	2.10	2.58	3.58	26%
	16	0.08	3.60	1.91	0.71			37%	46	1.35	1.91	2.26	25%
	17	0.41	3.31	1.43	0.61			43%	39	1.03	1.27	1.62	22%
	18	0.39	4.03	1.17	0.85			72%	39	0.65	0.76	1.35	35%
	19	0.67	7.34	2.87	1.22			42%	48	1.93	3.00	3.48	29%
	20	0.07	35.91	5.41	6.90			128%	47	1.93	2.94	5.12	45%
	21	0.37	6.27	2.75	1.10			40%	47	1.65	3.10	3.52	36%
	22	0.67	11.28	4.17	2.21			53%	46	2.25	3.98	5.89	45%
	23	0.55	5.37	2.05	0.87			42%	46	1.73	1.97	2.43	17%
	24	0.81	10.14	3.92	2.12			54%	40	2.34	3.78	4.77	34%
	25	1.28	13.63	4.92	2.55			52%	46	2.89	4.57	6.66	40%
	26	0.48	4.94	1.67	1.13			68%	39	0.95	1.19	2.11	38%
FX	27	1.10	6.07	2.70	1.12			42%	42	2.07	2.45	2.76	14%
	28	0.78	4.98	1.87	0.74			40%	40	1.52	1.64	2.06	15%
	29	0.96	5.49	2.61	0.61			23%	41	2.40	2.56	2.72	6%
	30	1.44	6.76	2.84	0.88			31%	41	2.41	2.92	3.09	12%
	31	1.22	7.60	3.43	1.05			31%	41	3.04	3.47	3.76	11%
	32	2.24	10.25	4.46	1.80			40%	38	2.80	4.15	6.03	37%
Commodity	33	1.32	8.26	3.87	1.83			47%	20	2.52	3.66	5.39	36%
	34	0.73	2.61	1.68	0.43			25%	18	1.47	1.67	1.97	15%
	35	1.24	4.34	3.03	0.86			28%	18	2.64	3.00	3.71	17%
Credit Spread	36	0.44	7.26	1.46	1.39			95%	28	0.68	0.85	1.70	43%
	37	1.13	10.44	3.90	2.16			56%	26	2.28	3.25	5.19	39%
	38	1.68	8.49	3.80	1.83			48%	28	2.45	3.40	4.33	28%
	39	1.04	10.18	3.26	2.13			65%	26	1.61	2.58	4.09	44%
	40	1.67	12.02	4.07	2.34			58%	28	2.38	3.16	5.05	36%
	41	1.06	12.83	3.76	2.51			67%	28	1.80	3.08	4.90	46%
	42	0.32	9.05	3.05	2.08			68%	26	1.59	2.44	3.98	43%
	43	0.29	7.94	3.11	1.85			60%	31	1.97	2.79	3.62	29%
	44	0.88	8.36	3.15	1.95			62%	31	1.69	2.31	4.13	42%
	45	0.60	10.90	3.88	2.76			71%	30	1.70	2.95	5.12	50%
	46	0.10	9.25	3.05	2.08			68%	30	1.71	2.46	4.30	43%
	47	1.16	10.18	3.54	2.21			62%	28	2.16	2.88	4.31	33%
	48	1.36	9.83	3.64	2.04			56%	30	2.02	3.42	4.67	40%
	49	0.55	6.88	2.07	1.69			82%	28	0.97	1.63	2.38	42%
	50	0.34	3.92	1.36	0.72			53%	28	0.81	1.21	1.57	32%
	51	0.89	9.75	3.47	1.71			49%	27	2.44	3.09	4.30	28%
	52	1.11	6.54	3.30	1.37			42%	26	2.17	3.15	4.25	32%
	53	1.04	6.93	3.43	1.25			36%	26	2.71	3.24	4.35	23%
Correlation Trading	54	0.91	4.31	2.43	1.11			46%	7	1.55	2.36	3.18	35%
	55	1.81	3.17	2.27	0.53			23%	4	1.94	2.04	2.37	10%
	56	1.68	5.25	3.29	1.34			41%	4	2.31	3.11	4.10	28%
ALL-IN no-CTP **	57	0.98	5.97	4.26	1.09			26%	23	3.73	4.20	5.05	15%
Equity Cumulative **	58	1.00	5.58	3.56	1.19			33%	30	3.26	3.72	4.32	14%
IR Cumulative **	59	0.22	3.99	1.34	0.74			56%	38	0.84	1.15	1.53	29%
FX Cumulative **	60	1.56	6.54	3.32	0.77			23%	37	3.02	3.27	3.69	10%
Commodity Cumulative **	61	0.98	14.88	2.56	3.05			119%	18	1.46	1.68	2.00	16%
CS Cumulative **	62	0.59	6.74	2.87	1.50			52%	27	1.86	2.67	3.52	31%
CTP Cumulative **	63	1.58	8.34	4.27	2.37			55%	5	2.52	3.70	5.24	35%

[1] STDev trunc is the standard deviation computed excluding values below the 5th and above the 95th percentile

[2] Refers to the number of banks included in the computation of the statistics

** For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included
in the computation of the benchmarks for that particular aggregate portfolio.

Table 25: P&L VaR/VaR statistics

EU Statistics for P&L VaR/VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc [1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs. [2]	25th	50th	75th
										Percentiles		
Equity	1	0.80	1.16	1.00	0.09			9%	15	0.95	0.99	1.08
	2	0.85	1.30	1.09	0.12			11%	15	1.01	1.11	1.17
	3	0.56	2.29	1.03	0.38			37%	15	0.84	0.93	1.11
	4	0.43	2.05	1.19	0.43			36%	14	0.89	1.15	1.45
	5	0.01	3.49	1.15	0.71			62%	14	0.97	1.03	1.15
	6	0.59	1.59	1.04	0.29			28%	15	0.74	1.04	1.21
	7	0.55	3.35	1.54	0.78			51%	12	0.82	1.44	1.99
	8	0.08	49.34	5.13	12.30			240%	14	1.05	1.46	2.80
	9	0.48	2.52	1.10	0.47			43%	15	0.80	0.97	1.20
	10	0.45	10.06	1.87	2.34			125%	14	0.95	1.05	1.61
Interest Rate	11	0.70	1.40	1.00	0.19			19%	25	0.83	1.00	1.10
	12	0.39	2.24	1.06	0.40			38%	23	0.81	0.96	1.24
	13	0.86	1.46	1.08	0.17			16%	25	0.95	1.01	1.23
	14	0.56	2.52	1.12	0.44			39%	25	0.85	1.05	1.25
	15	0.48	3.32	1.76	1.08			61%	5	0.75	1.63	2.62
	16	0.67	1.52	1.01	0.21			21%	23	0.87	0.96	1.14
	17	0.38	1.48	0.95	0.28			29%	17	0.82	0.96	1.15
	18	0.12	4.25	1.16	0.82			71%	17	0.83	0.98	1.24
	19	0.78	1.39	1.00	0.15			15%	26	0.89	0.98	1.08
	20	0.00	114.02	5.27	21.76			413%	26	0.70	0.86	1.37
	21	0.81	1.39	1.06	0.16			16%	26	0.93	1.03	1.15
	22	0.23	2.89	1.10	0.53			48%	25	0.79	1.11	1.32
	23	0.57	1.69	0.93	0.26			28%	24	0.74	0.90	1.04
	24	0.11	3.54	1.26	0.85			68%	16	0.72	1.07	1.57
	25	0.06	10.30	1.97	2.70			137%	24	0.56	1.01	1.51
	26	0.38	1.81	1.06	0.34			32%	17	0.89	1.03	1.17
FX	27	0.61	168.86	9.05	35.74			395%	21	1.01	1.06	1.20
	28	0.49	2.14	1.09	0.35			32%	18	0.91	1.07	1.21
	29	0.91	2.10	1.20	0.26			22%	20	1.06	1.14	1.23
	30	0.89	1.57	1.09	0.18			16%	20	0.96	1.04	1.21
	31	0.80	1.61	1.06	0.18			17%	19	0.91	1.03	1.16
	32	0.06	15.04	2.86	4.88			171%	19	0.40	1.02	1.30
Commodity	33	0.39	6.80	2.18	2.67			122%	4	0.52	0.77	2.44
	34	0.74	1.11	0.93	0.18			20%	2	0.84	0.93	1.02
	35	0.94	1.58	1.26	0.26			21%	3	1.11	1.27	1.43
Credit Spread	36	0.04	2.67	1.07	0.64			60%	11	0.74	0.97	1.29
	37	0.71	1.30	1.00	0.19			19%	9	0.85	1.04	1.08
	38	0.70	3.46	1.34	0.76			57%	10	0.92	1.00	1.46
	39	0.60	2.65	1.12	0.59			52%	9	0.79	1.04	1.12
	40	0.71	4.25	1.47	0.96			65%	10	1.05	1.15	1.37
	41	0.46	4.95	2.03	1.25			62%	10	1.26	1.59	2.40
	42	0.66	3.22	1.61	0.80			49%	9	0.91	1.68	2.06
	43	0.23	5.98	1.91	1.42			74%	12	1.16	1.69	2.11
	44	0.53	9.39	2.12	2.30			108%	12	1.00	1.34	2.00
	45	0.36	975.88	83.29	269.13			323%	12	1.10	2.08	3.63
	46	0.12	657.48	56.48	181.22			321%	12	0.76	1.31	2.82
	47	0.37	6.63	1.98	1.86			94%	10	0.94	1.21	1.76
	48	0.46	3.74	1.52	0.97			64%	12	0.70	1.38	1.99
	49	0.03	4.65	1.32	1.19			91%	11	0.67	1.11	1.45
	50	0.69	3.33	1.58	0.80			51%	11	0.88	1.38	2.09
	51	0.25	3.12	1.75	0.88			50%	10	1.38	1.69	2.46
	52	0.24	2.36	1.45	0.68			47%	9	1.16	1.62	1.88
	53	0.25	17.29	3.15	5.06			161%	9	1.16	1.42	2.24
Correlation Trading	54	0.34	0.80	0.57	0.23			40%	2	0.46	0.57	0.69
	55	1.14	1.14	1.14	0.00			0%	1	1.14	1.14	1.14
	56	2.65	2.65	2.65	0.00			0%	1	2.65	2.65	2.65
ALL-IN no-CTP **	57	0.74	2.62	1.12	0.52			46%	10	0.86	0.98	1.08
Equity Cumulative **	58	0.54	1.14	0.94	0.16			17%	12	0.87	0.98	1.01
IR Cumulative **	59	0.65	6.66	1.39	1.37			99%	16	0.89	1.10	1.22
FX Cumulative **	60	0.61	1.61	1.10	0.24			22%	17	0.97	1.11	1.24
Commodity Cumulative **	61	0.74	852.49	284.75	401.45			141%	3	0.88	1.02	426.75
CS Cumulative **	62	0.23	4.74	1.76	1.13			64%	11	1.17	1.90	2.00
CTP Cumulative **	63	2.73	2.73	2.73	0.00			0%	1	2.73	2.73	2.73

[1] *STDev trunc* is the standard deviation computed excluding values below the *5th* and above the *95th* percentile
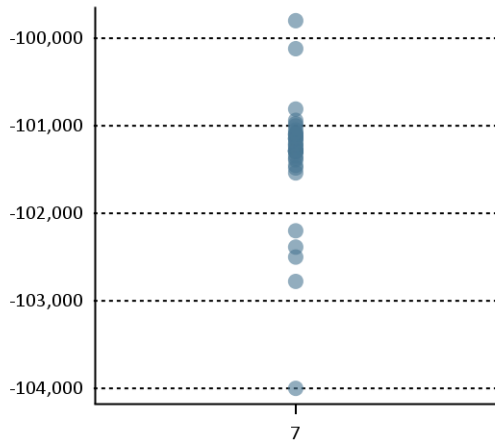
[2] Refers to the number of banks included in the computation of the statistics

** For the aggregated portfolios (57 to 63), banks that reported at least a missing portfolio IMV among the ones composing the aggregate are not included in the computation of the benchmarks for that particular aggregate portfolio.
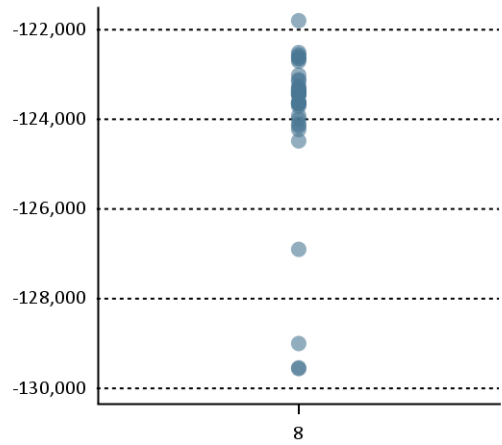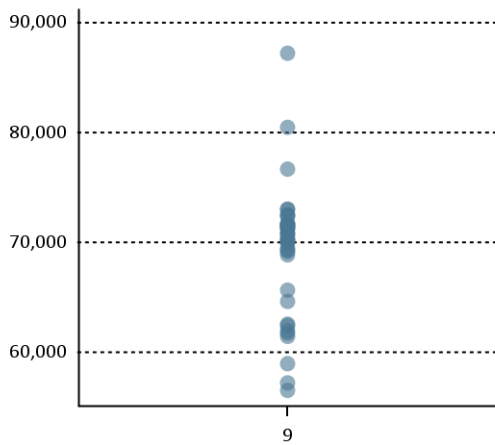
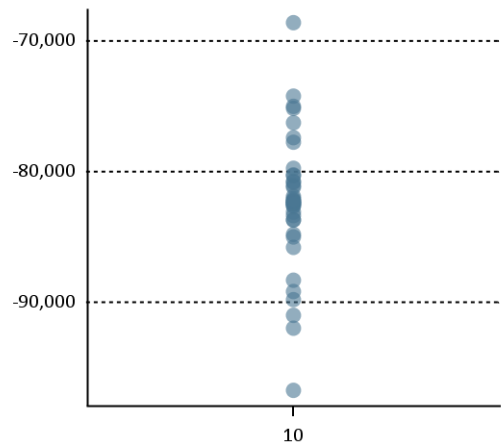**Figure 17: IMV scatter plots (all)**
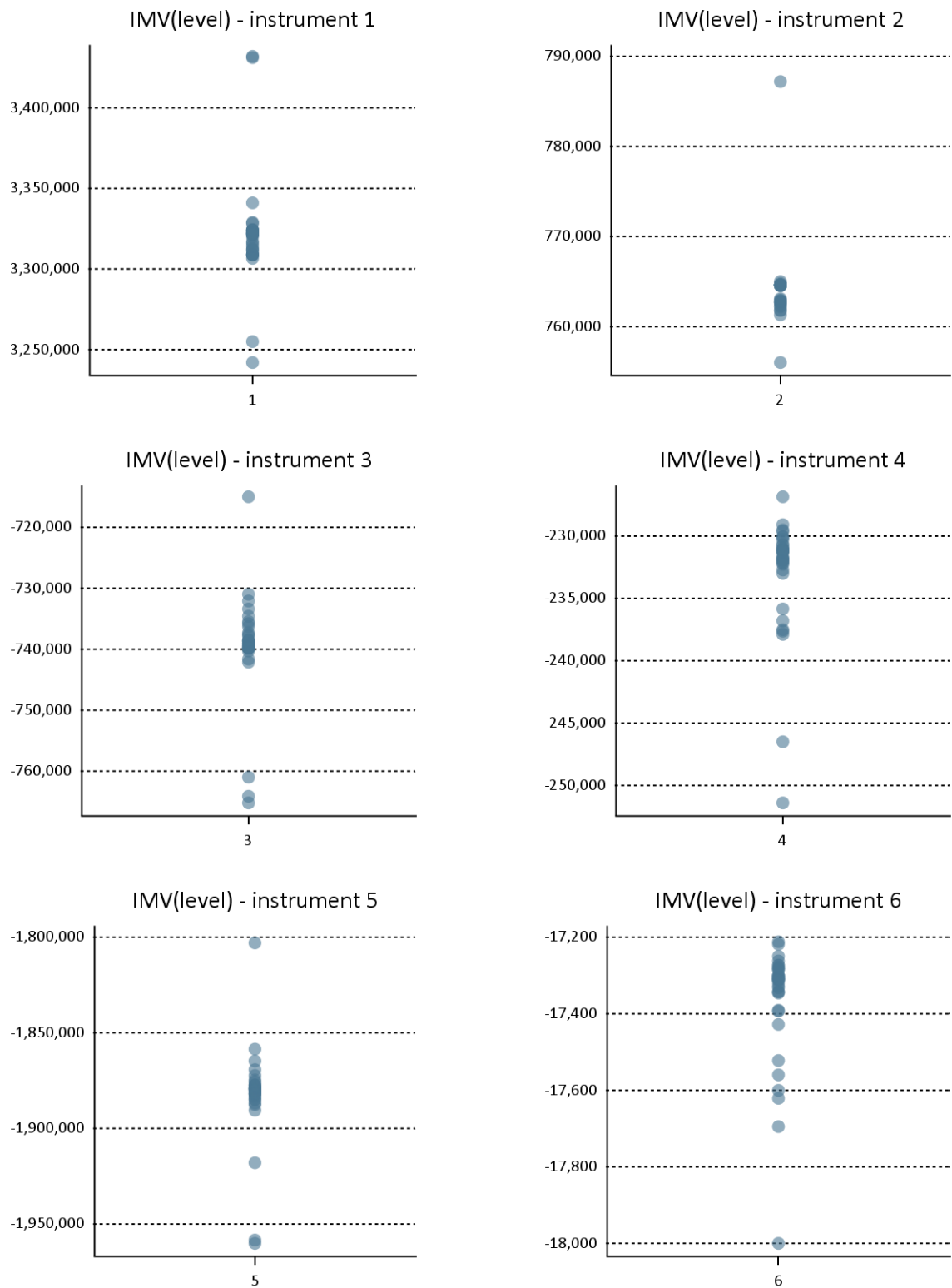
IMV(level) - instrument 7

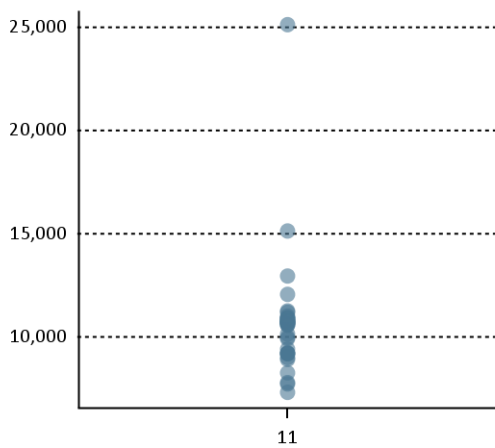## IMV(level) - instrument 8

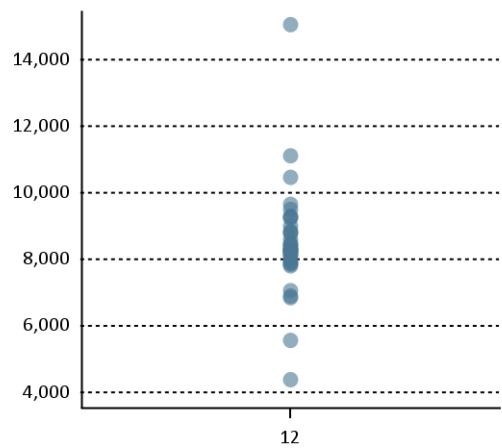## IMV(level) - instrument 9

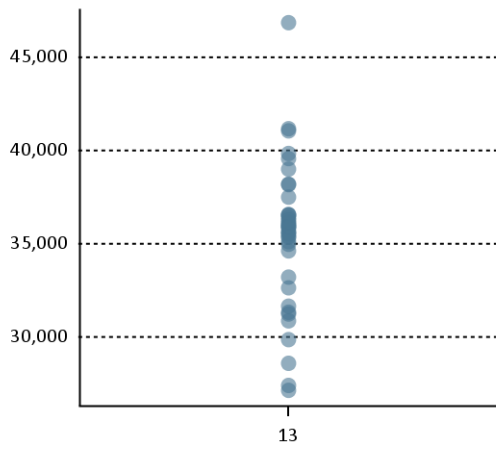## IMV(level) - instrument 10
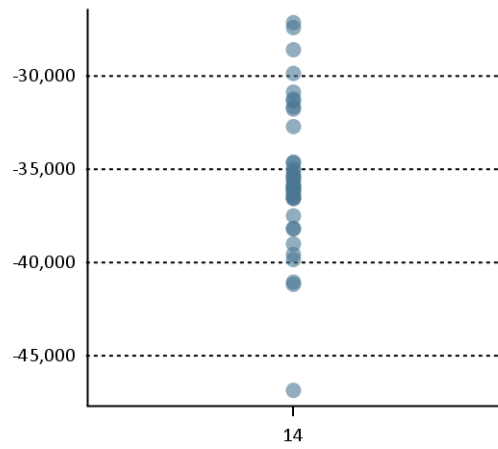

IMV(level) - instrument 11

IMV(level) - instrument 12

IMV(level) - instrument 13

IMV(level) - instrument 14

IMV(level) - instrument 15

IMV(level) - instrument 16

IMV(level) - instrument 17

IMV(level) - instrument 18

IMV(level) - instrument 19

IMV(level) - instrument 20

IMV(level) - instrument 21

IMV(level) - instrument 22

IMV(level) - instrument 23

IMV(level) - instrument 24

IMV(level) - instrument 25

IMV(level) - instrument 26

IMV(level) - instrument 27
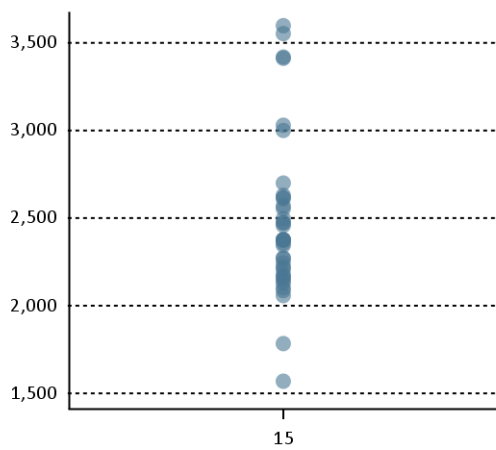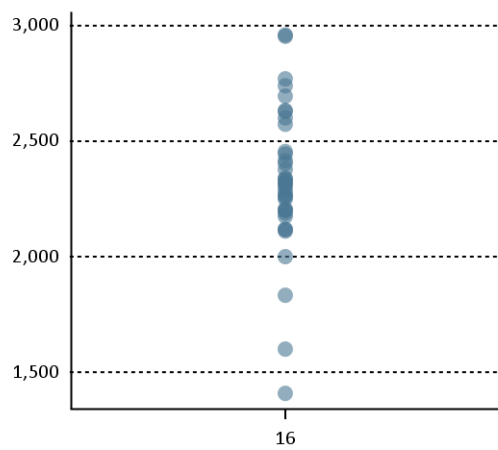

IMV(level) - instrument 28

IMV(level) - instrument 29

IMV(level) - instrument 30
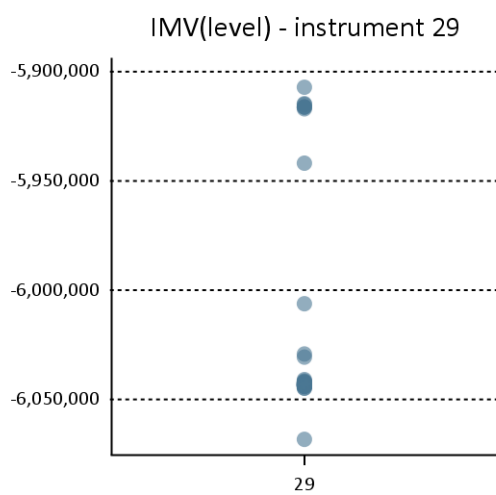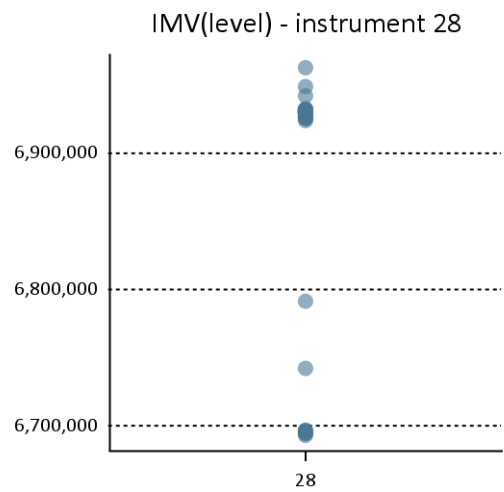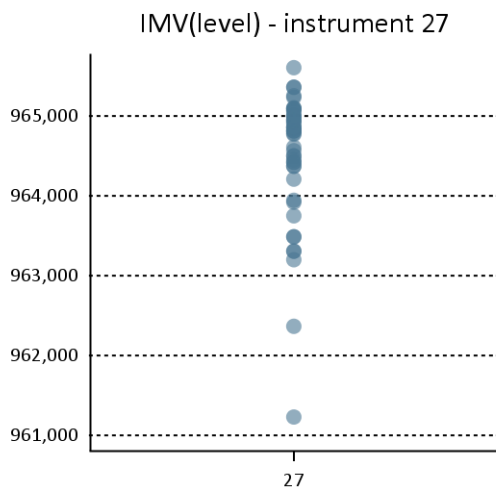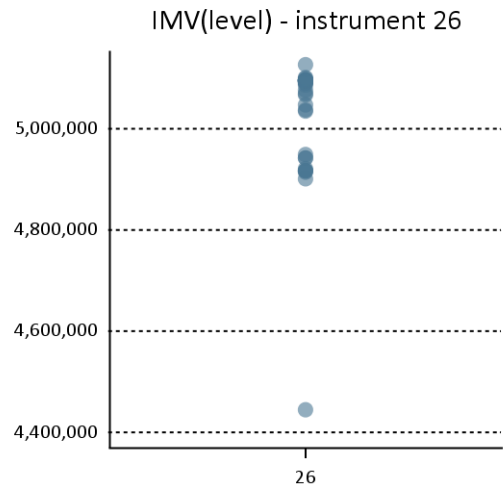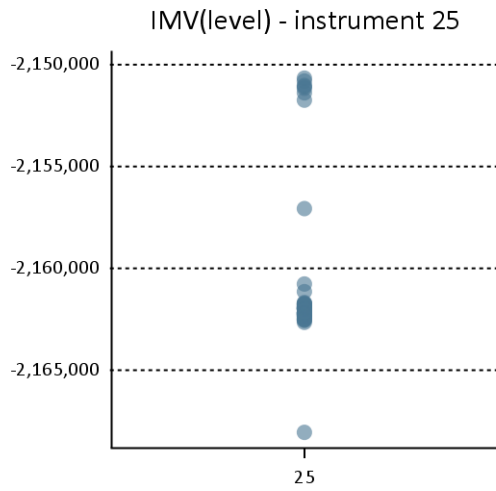
IMV(level) - instrument 31
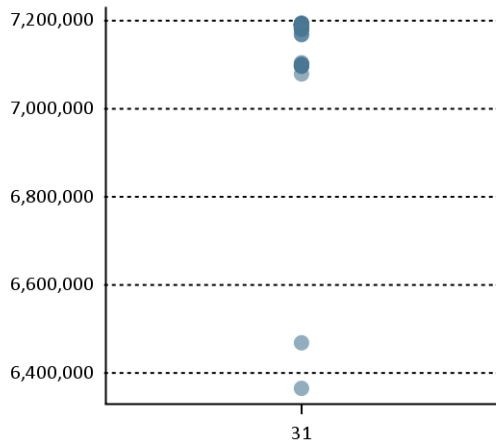
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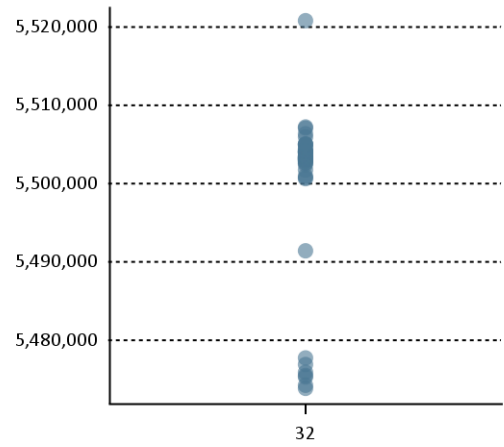
IMV(level) - instrument 33
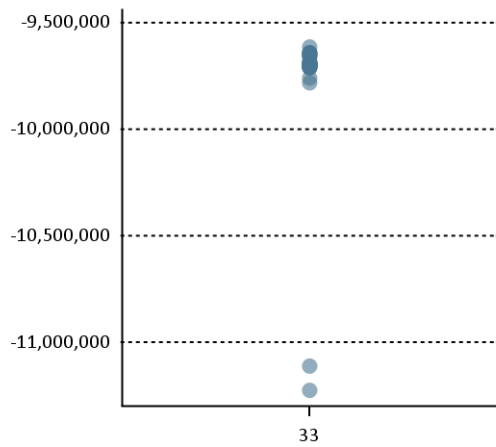
IMV(level) - instrument 34
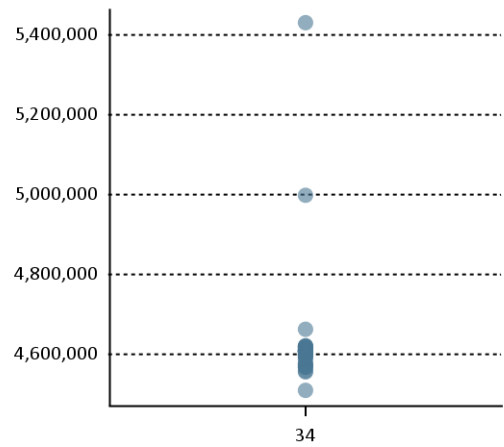
IMV(level) - instrument 35
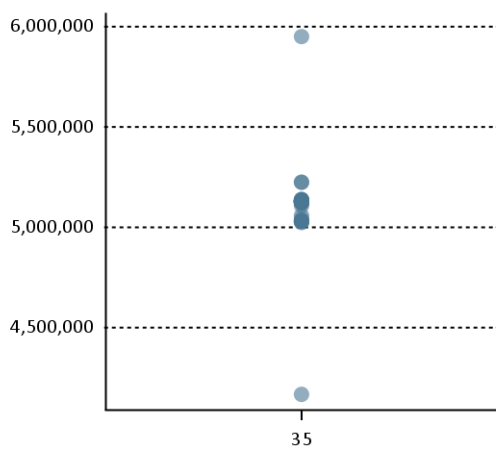
IMV(level) - instrument 36
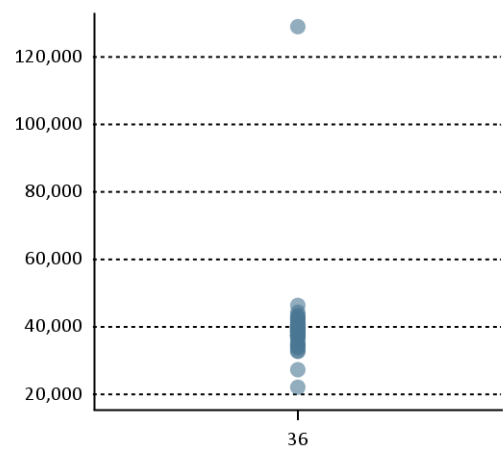
IMV(level) - instrument 37
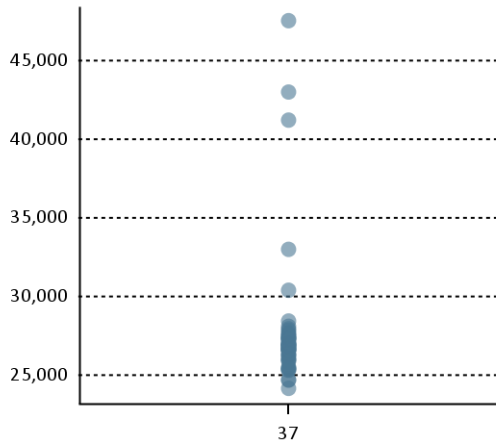
IMV(level) - instrument 38
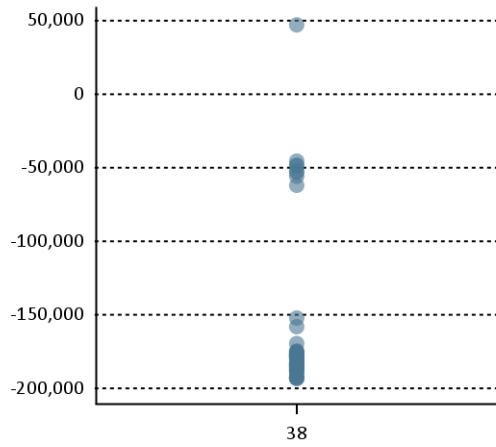
IMV(level) - instrument 39
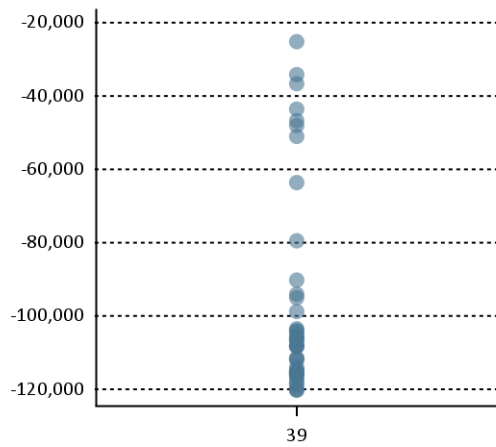
IMV(level) - instrument 40
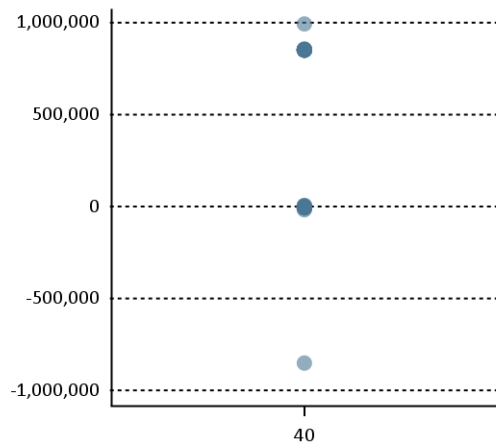
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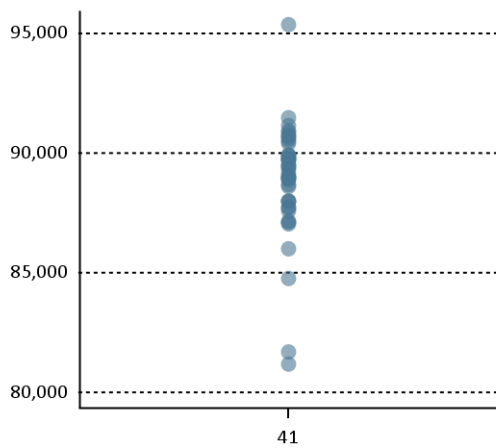
IMV(level) - instrument 42
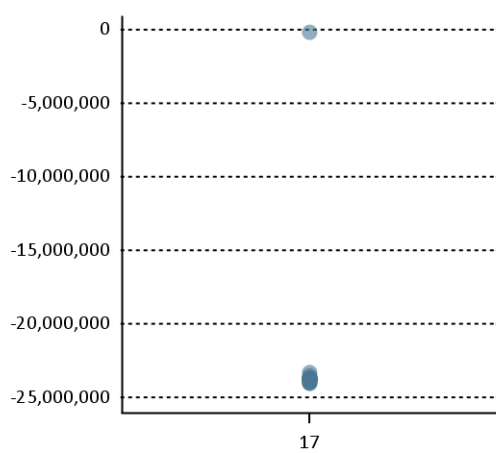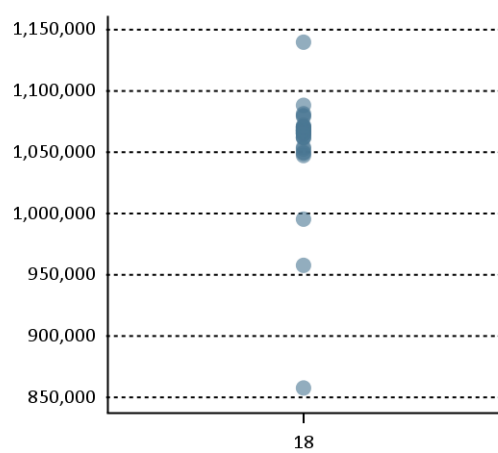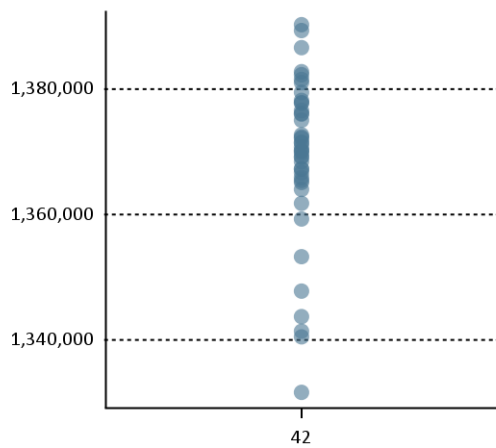
IMV(level) - instrument 43
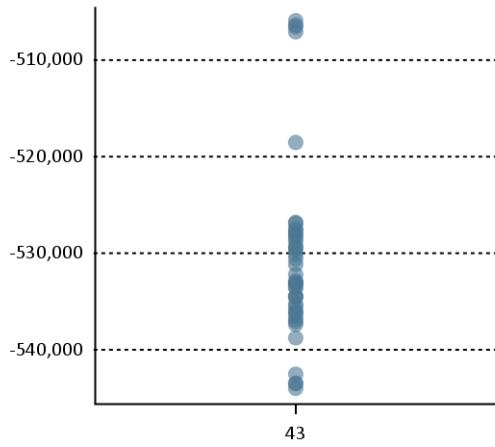
IMV(level) - instrument 44
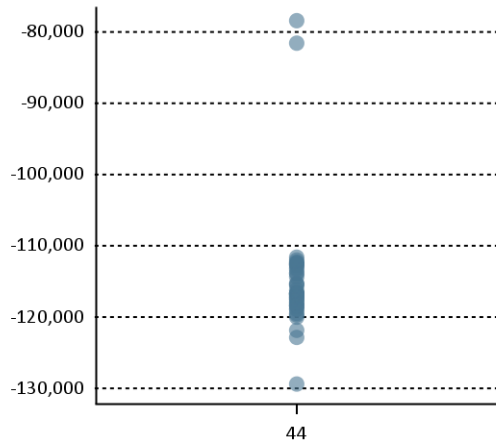
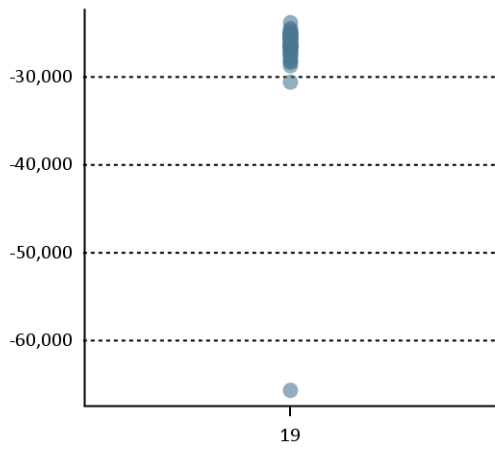IMV(level) - instrument 45
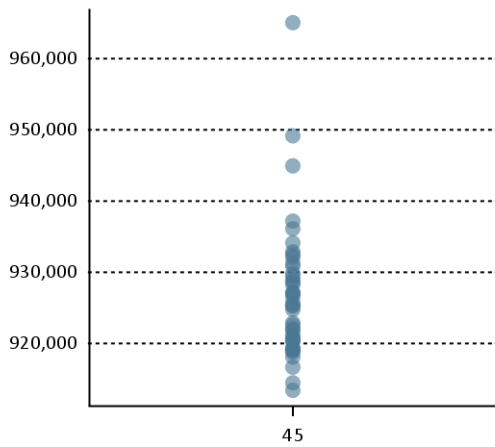
IMV(level) - instrument 46
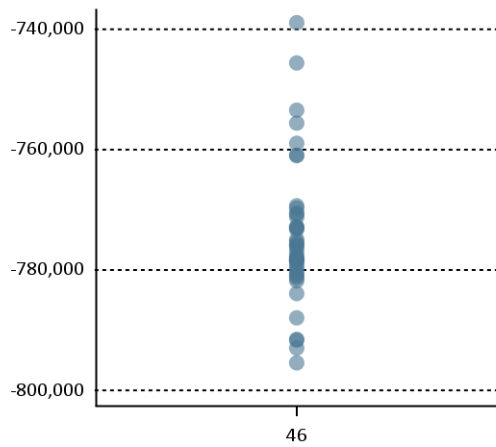
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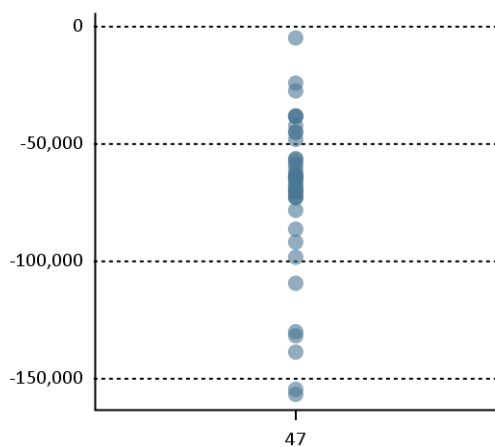
IMV(level) - instrument 48
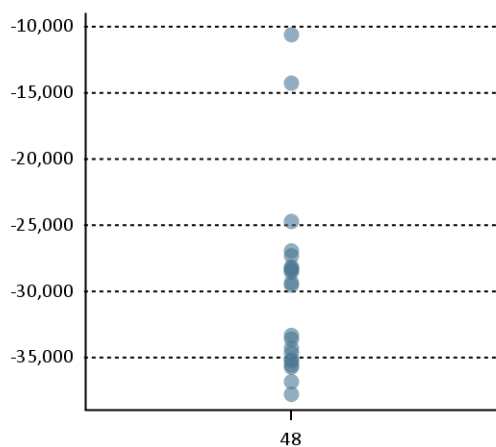
IMV(level) - instrument 49
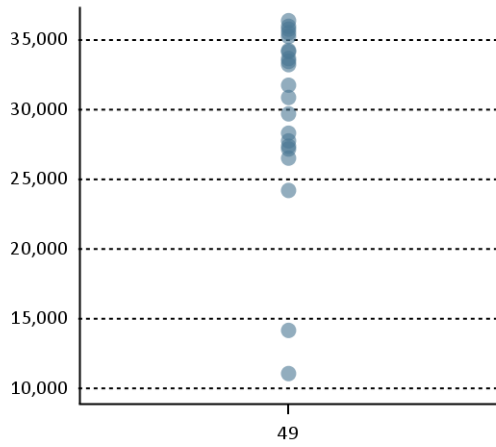
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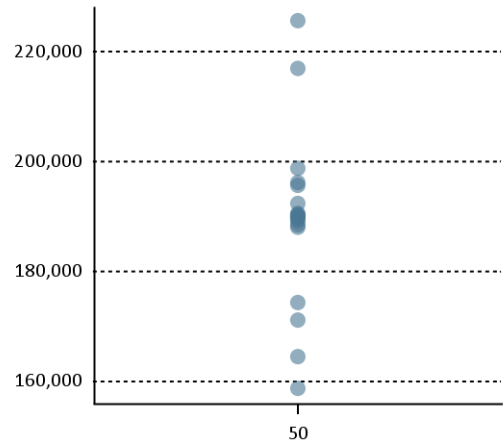
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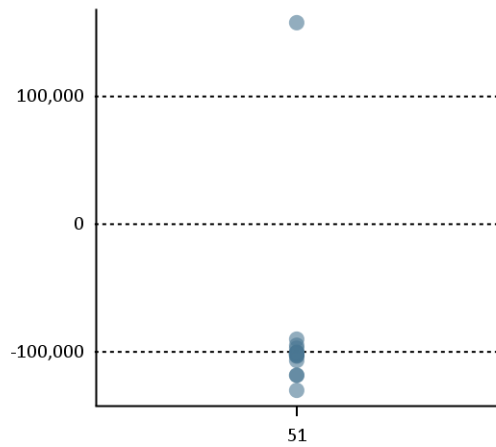
IMV(level) - instrument 52
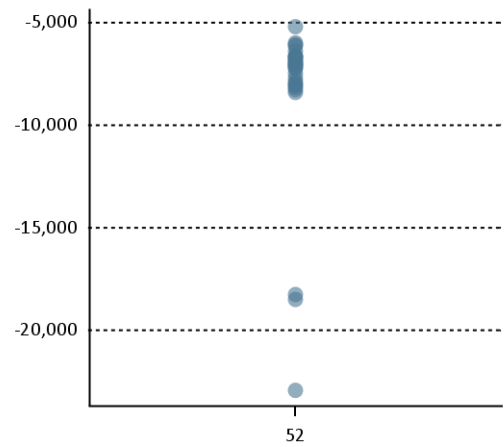
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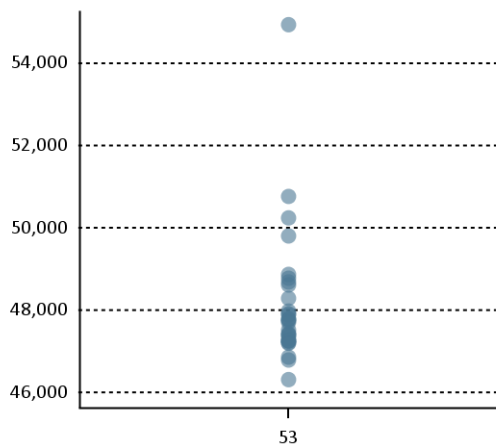
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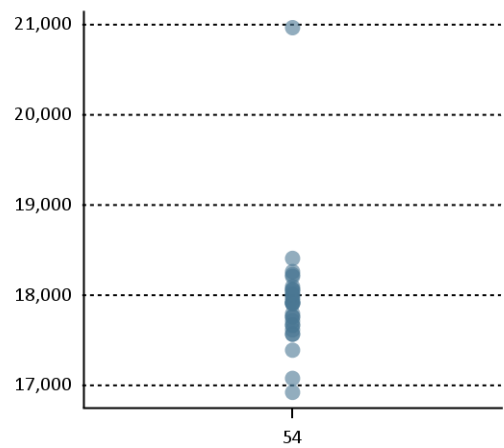
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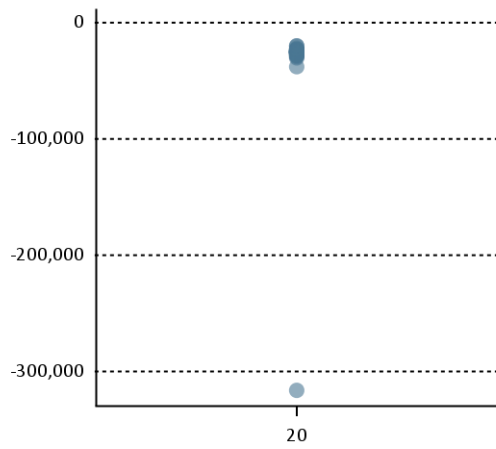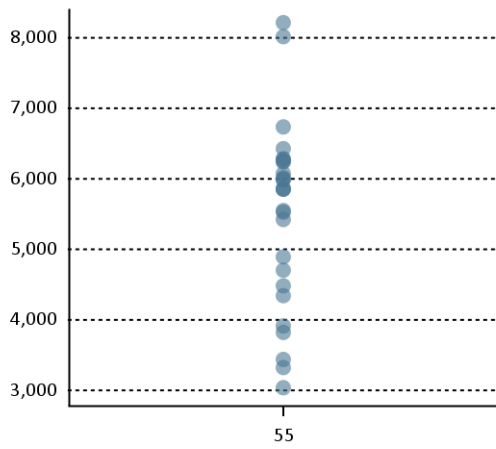
IMV(level) - instrument 56
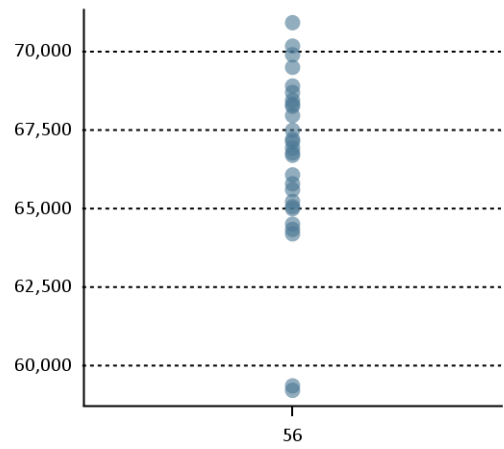
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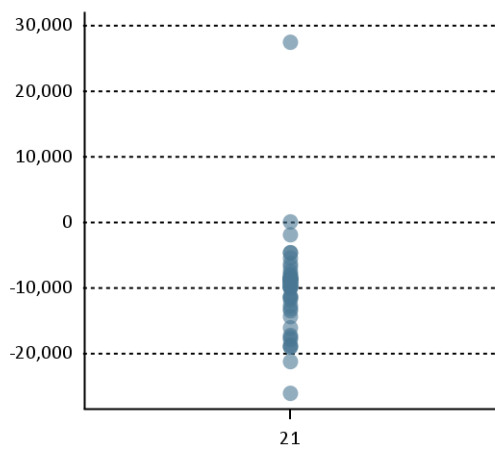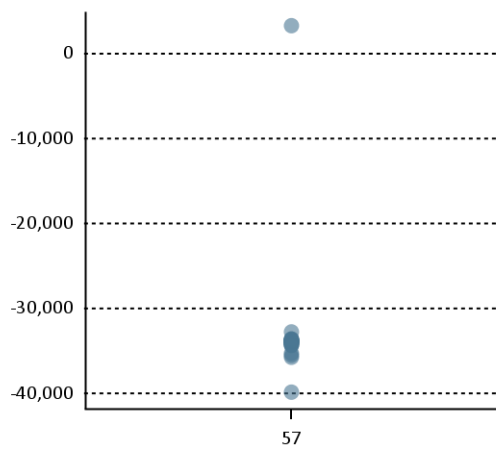
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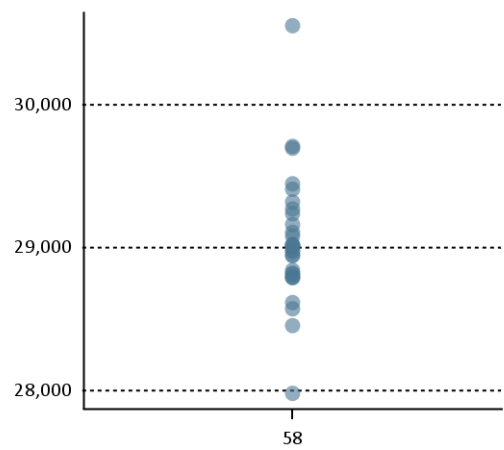
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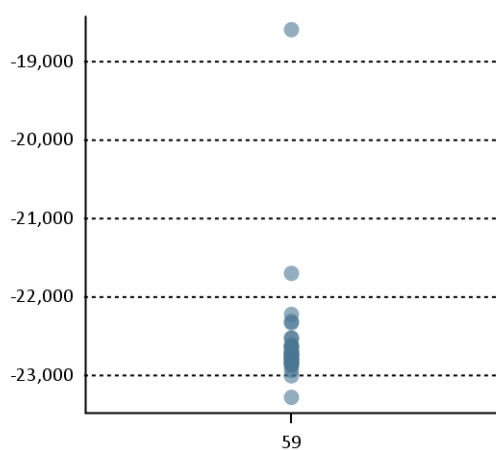
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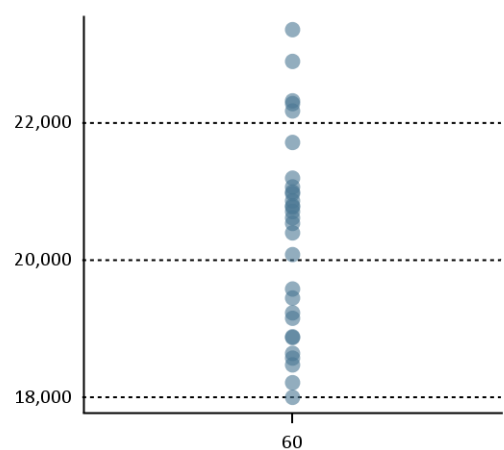
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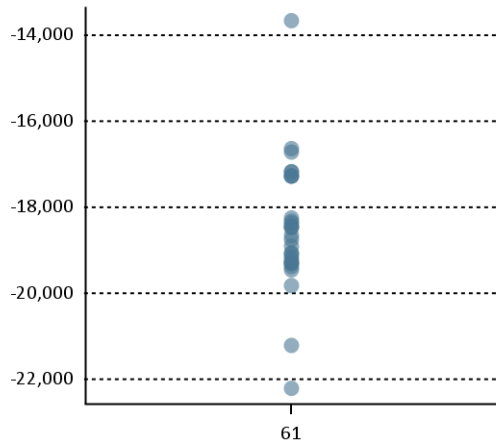
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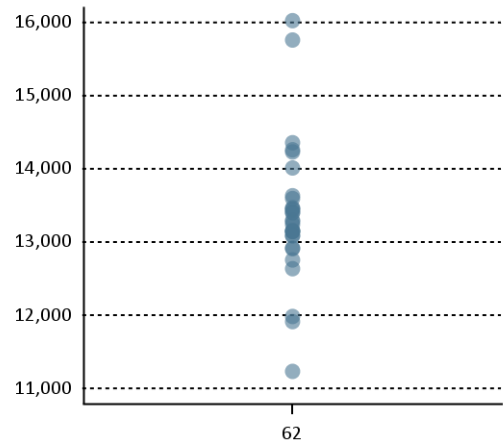
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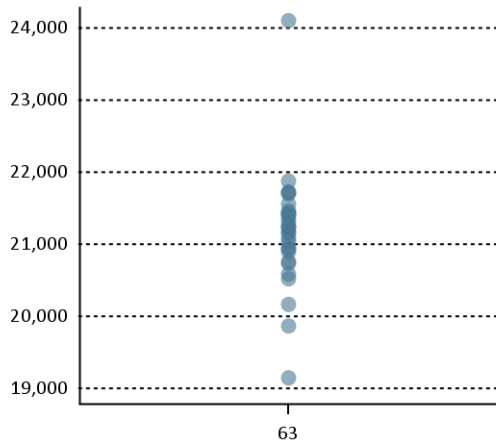
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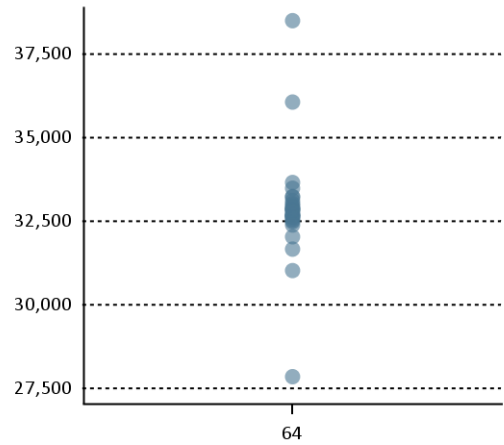
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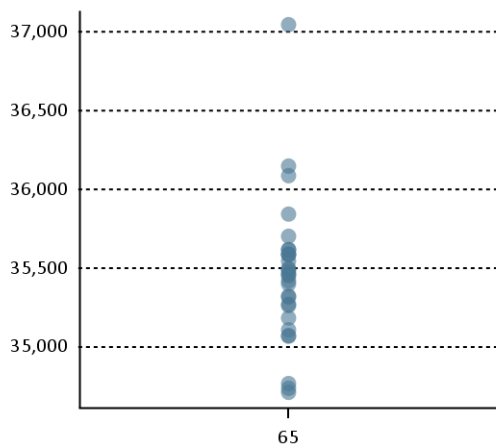
IMV(level) - instrument 66

IMV(level) - instrument 67

IMV(level) - instrument 68

IMV(level) - instrument 69

IMV(level) - instrument 70

IMV(level) - instrument 71

IMV(level) - instrument 72
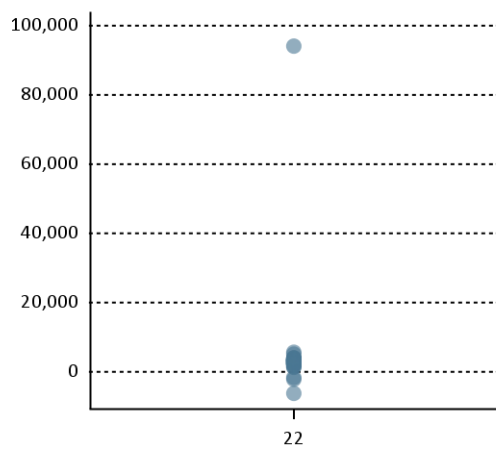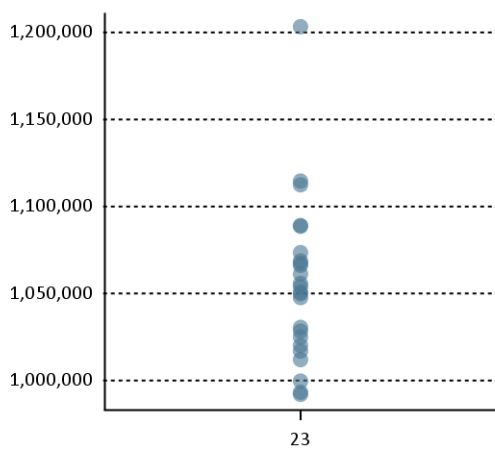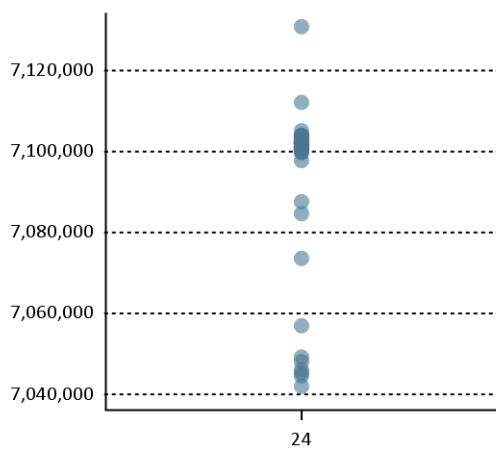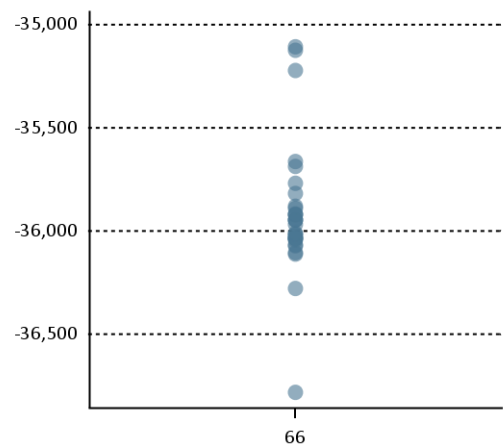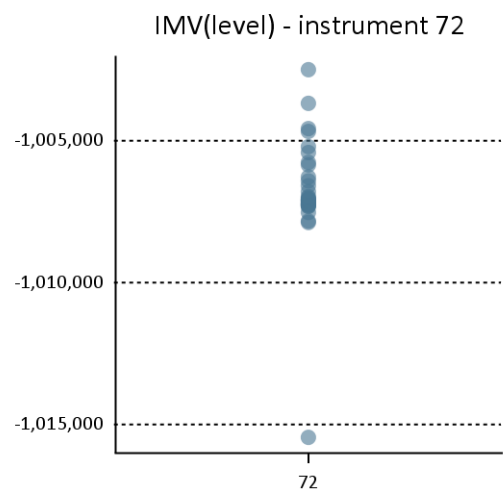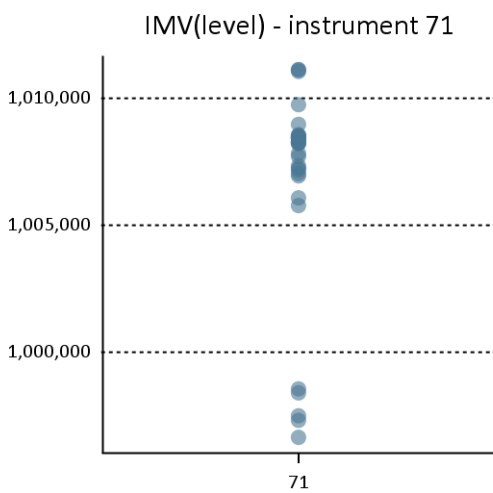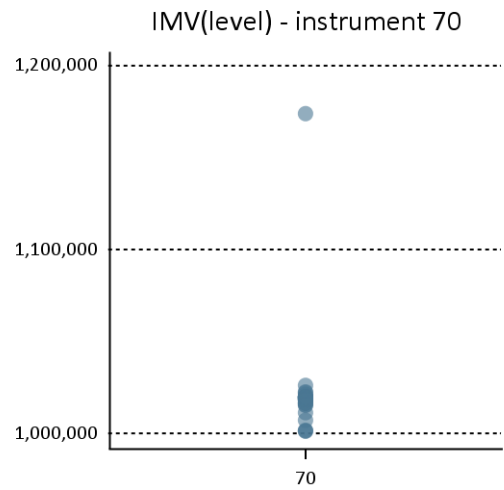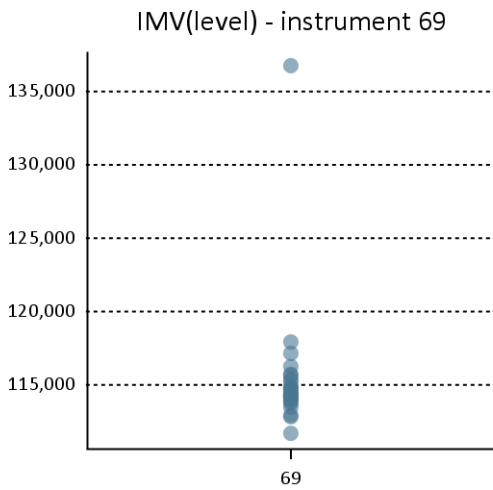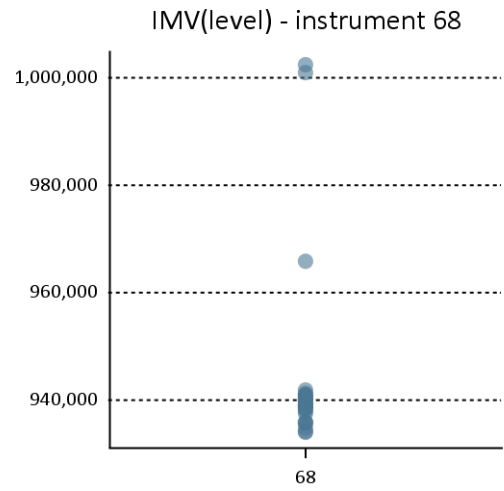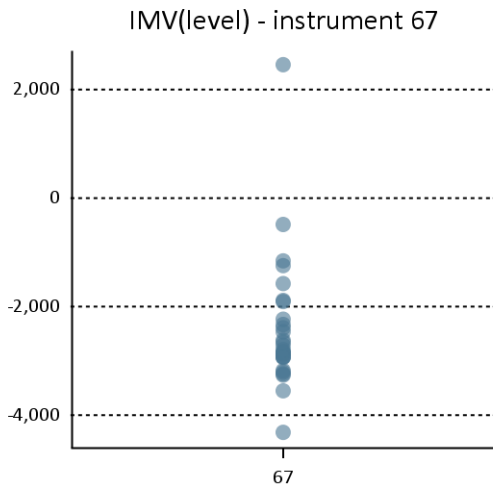
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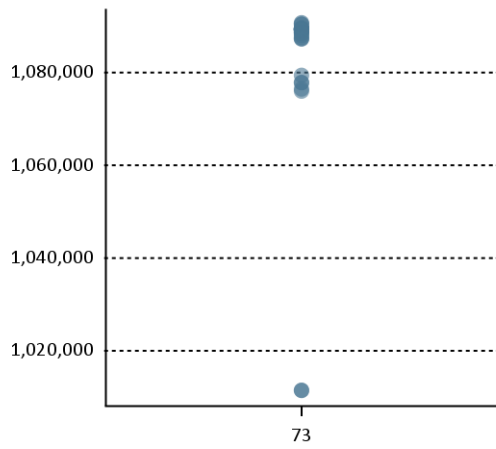
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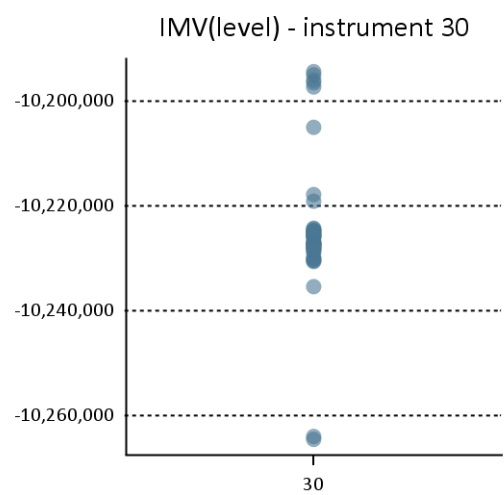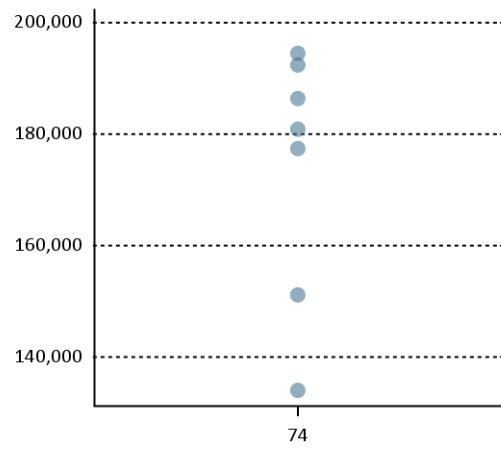

IMV(level) - instrument 75
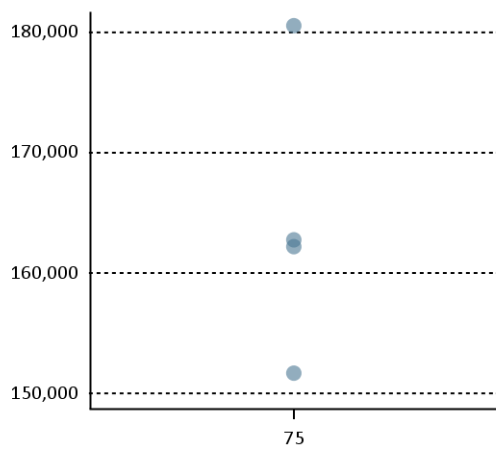
Figure 18: VaR submissions normalised by the median of each portfolio (by asset class)
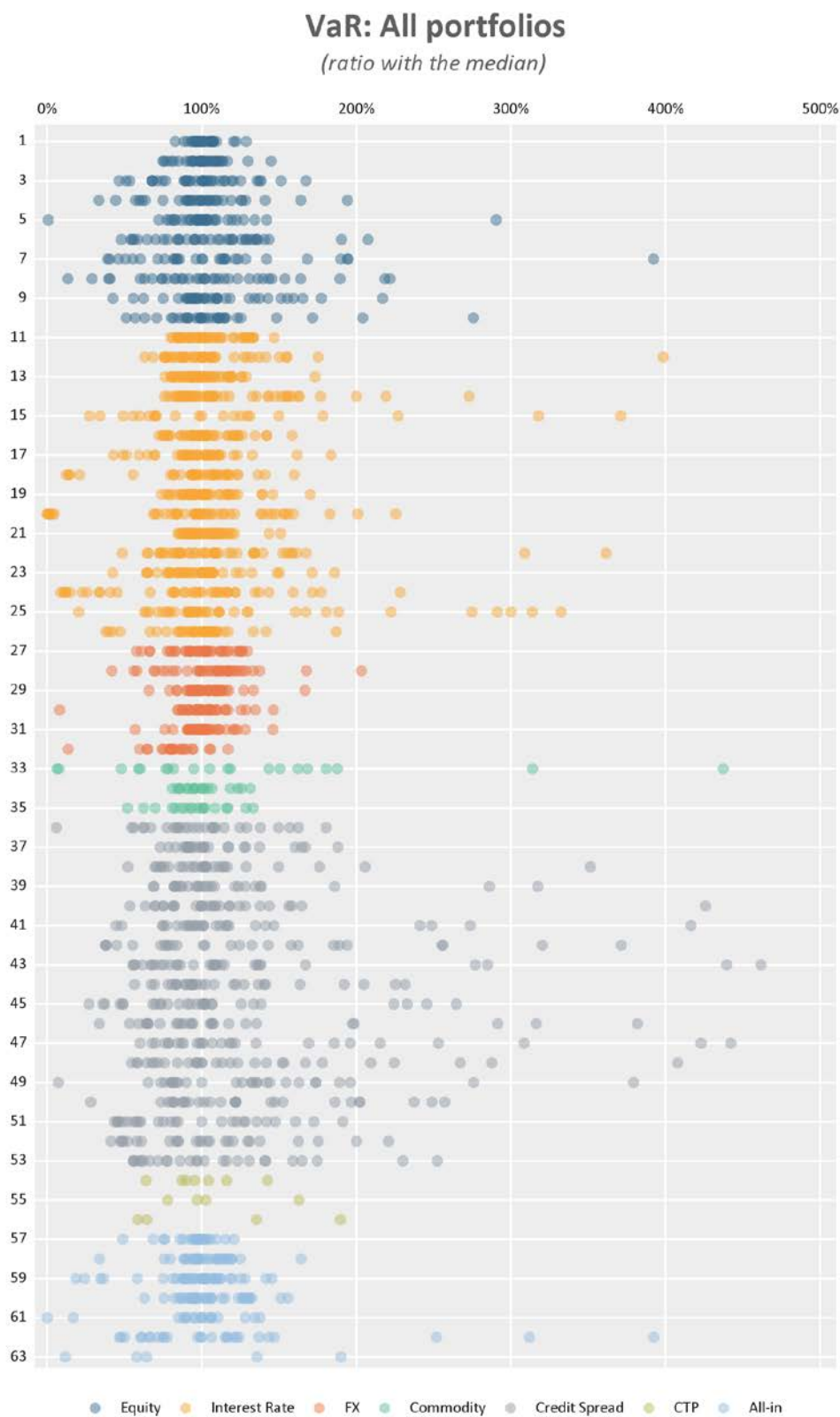
VaR: All portfolios
(ratio with the median)
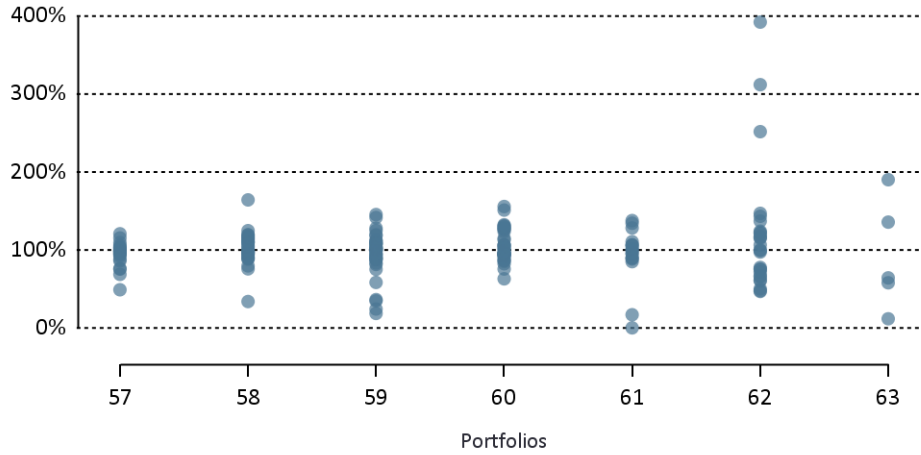
Legend: Equity, Interest Rate, FX, Commodity, Credit Spread, CTP, All-in

VaR: Aggregated portfolios
(ratio with the median)

Portfolios

VaR: Commodity portfolios
(ratio with the median)

Portfolios
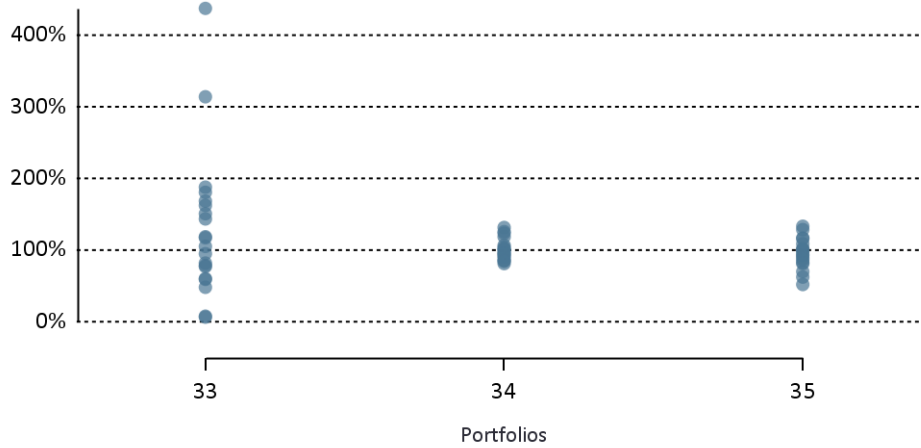
VaR: Credit Spread portfolios
(ratio with the median)
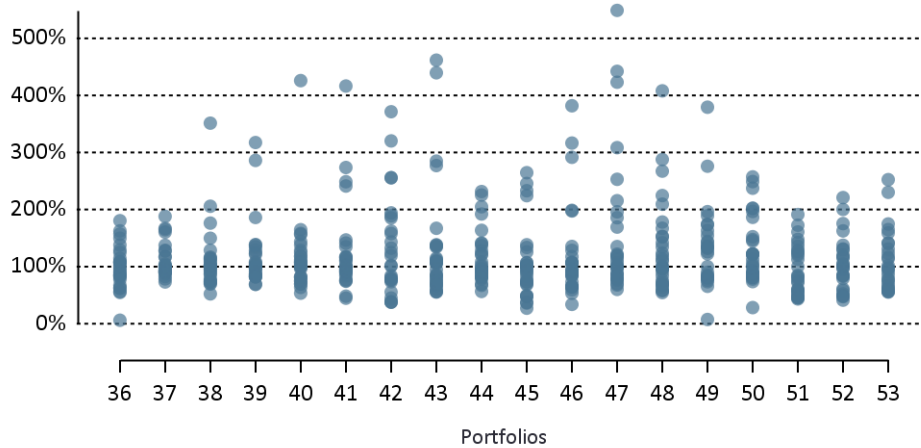
Portfolios

VaR: CTP portfolios

(ratio with the median)
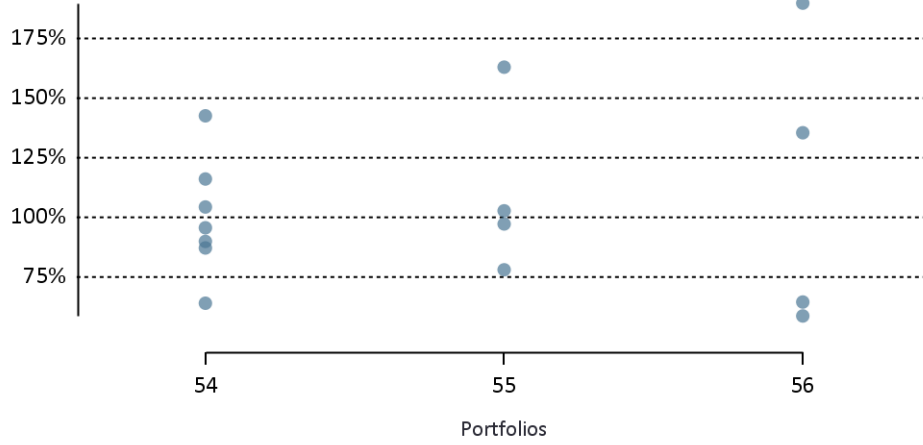
VaR: Equity portfolios

(ratio with the median)
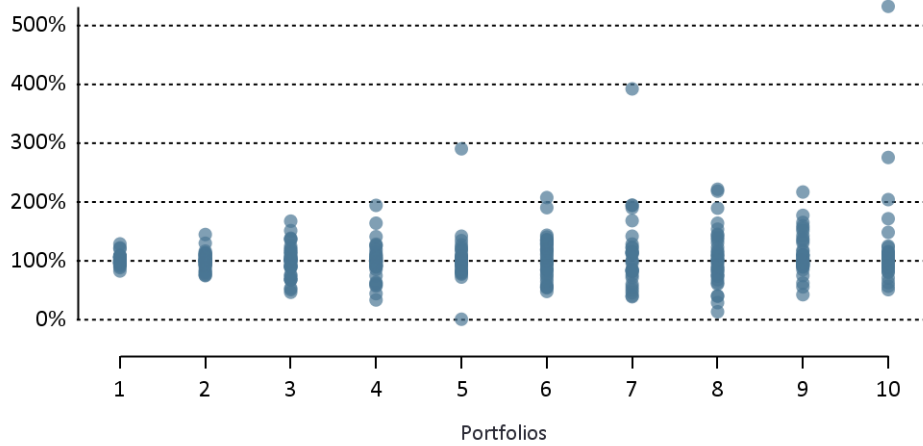
VaR: FX portfolios

(ratio with the median)
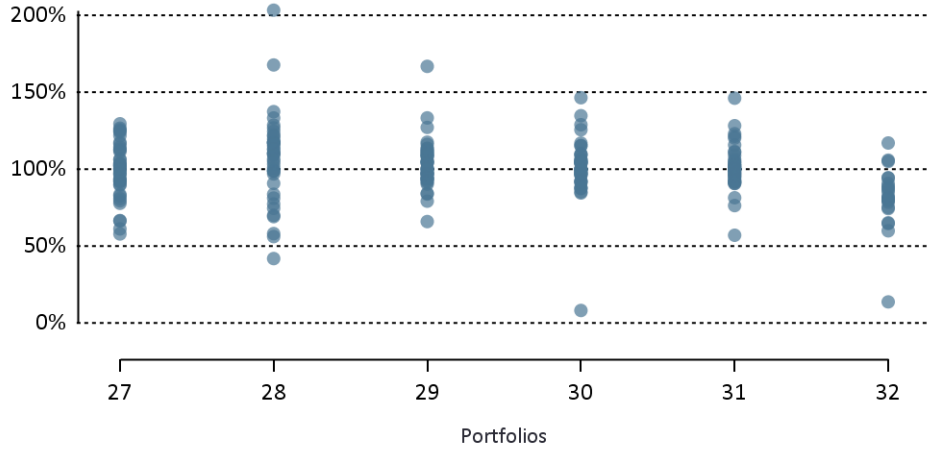
VaR: Interest Rate portfolios

(ratio with the median)
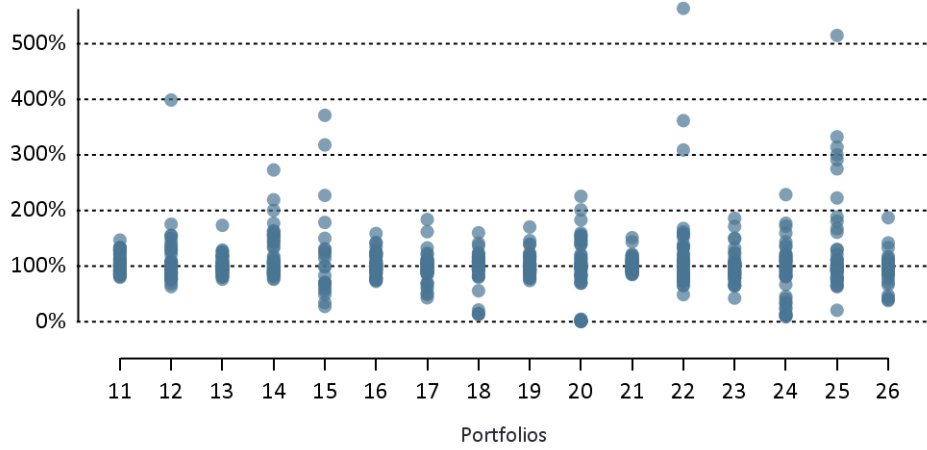
Figure 19: sVaR submissions normalised by the median of each portfolio (by asset class)

SVaR: All portfolios
(ratio with the median)
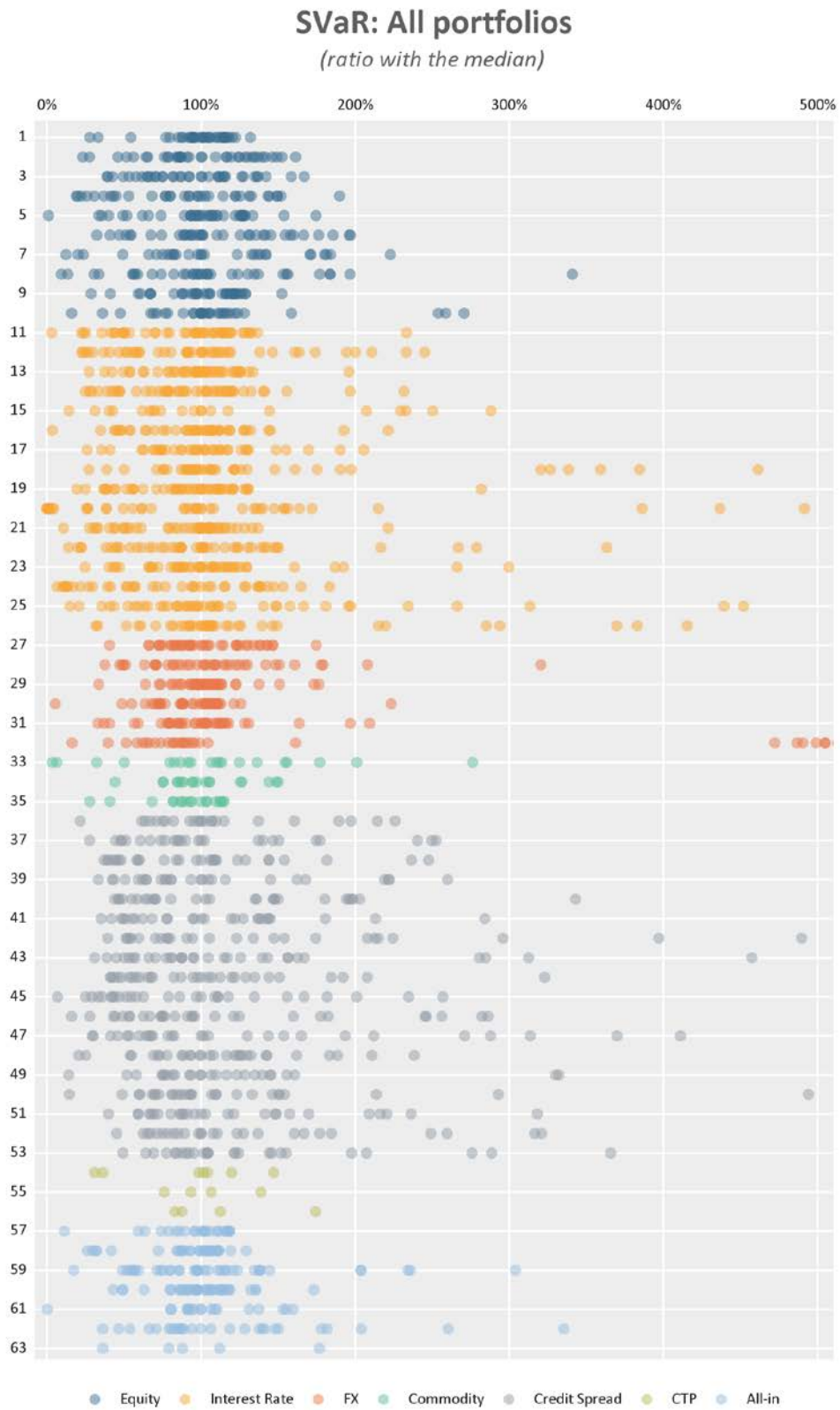
SVaR: Aggregated portfolios

(ratio with the median)
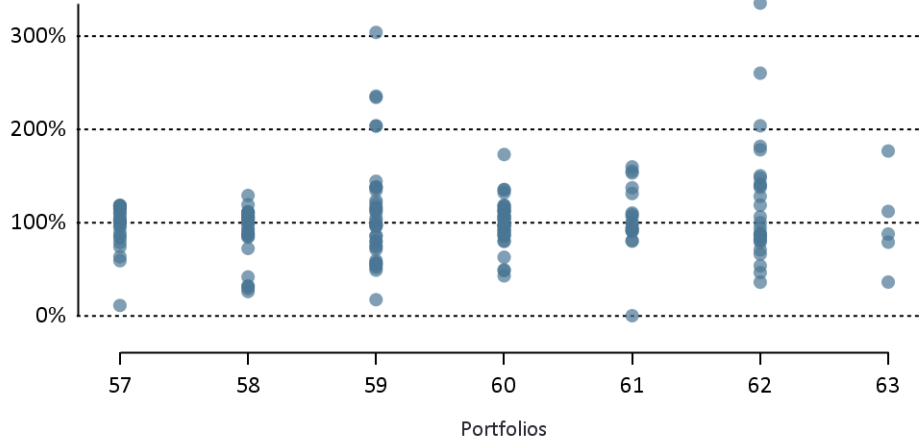
SVaR: Commodity portfolios

(ratio with the median)
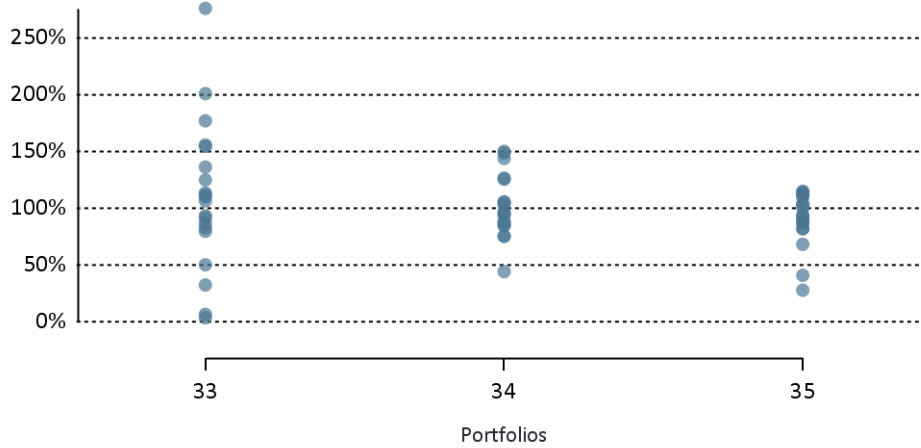
SVaR: Credit Spread portfolios
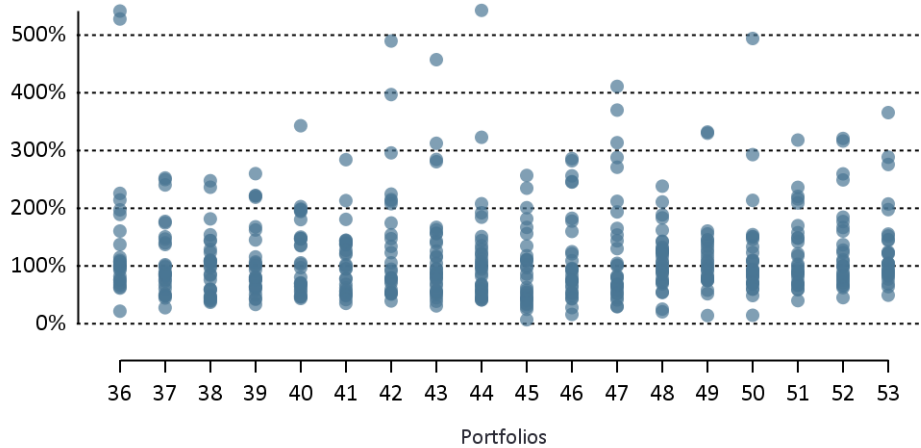
(ratio with the median)

SVaR: CTP portfolios

(ratio with the median)

Portfolios
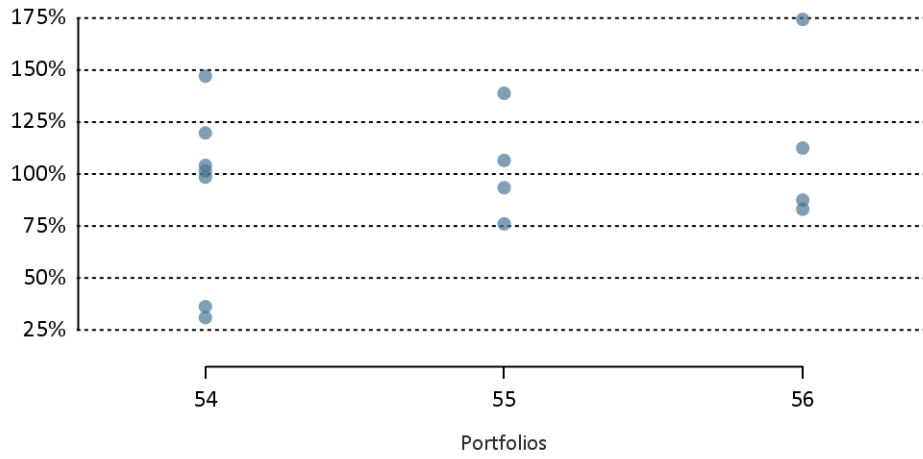
SVaR: Equity portfolios

(ratio with the median)
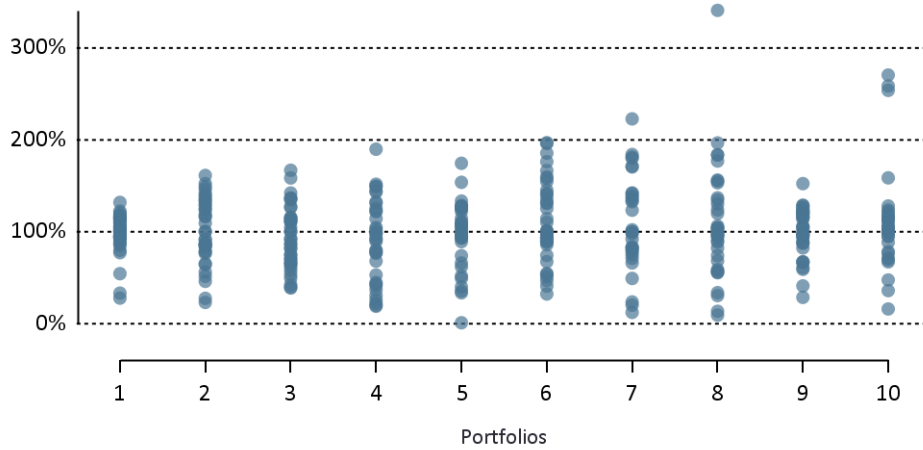
Portfolios

SVaR: FX portfolios

(ratio with the median)
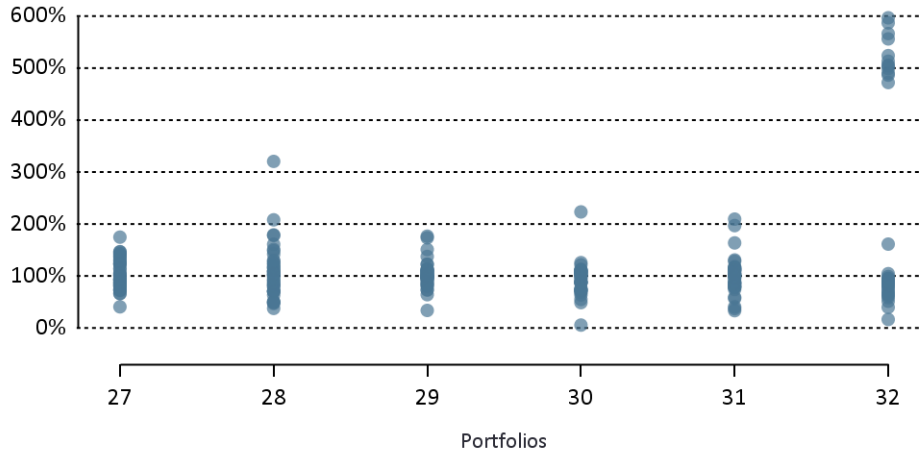
Portfolios

SVaR: Interest Rate portfolios

(ratio with the median)
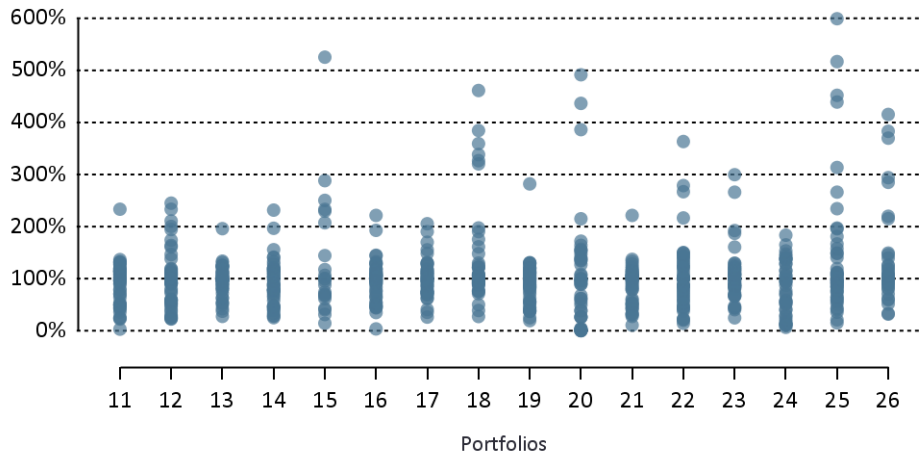
Portfolios

Figure 20: sVaR submissions normalised by the median of each portfolio (by methodological approach)

SVaR: all portfolios (exc. aggregated)
(ratio with the median - HS banks in orange)

SVaR: all portfolios (exc. aggregated)
(ratio with the median below 50% - HS banks in orange
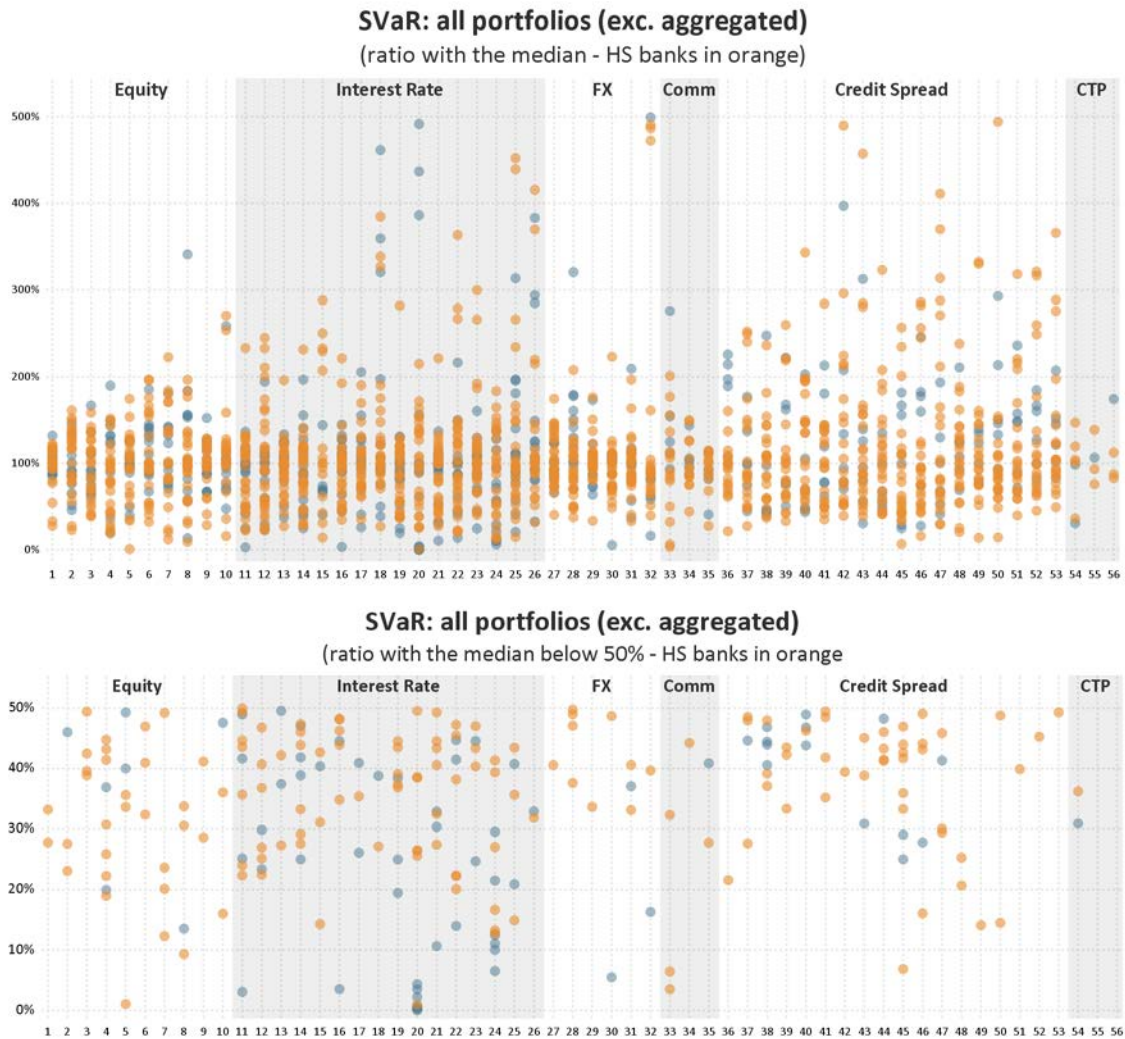
Table 26: VaR statistics (small banks only)

EU Statistics for VaR

	Port. ID	Other stats								Percentiles							Interquantile range
		Min	Max	Ave.	STDev	STDev_trunc¹	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	
Equity	1	1,954,802	2,356,137	2,133,756	148,722			7%	8	1,975,074	1,995,346	2,017,580	2,086,567	2,276,337	2,301,721	2,328,929	6%
	2	1,631,826	2,538,924	2,055,813	350,119			17%	8	1,637,015	1,642,205	1,679,134	2,188,669	2,253,550	2,396,597	2,467,760	15%
	3	10,414	24,330	17,679	5,044			29%	7	11,246	12,078	13,860	19,500	20,894	22,805	23,567	20%
	4	656	428,100	62,758	161,104			257%	7	808	960	1,184	1,871	3,155	173,520	300,810	45%
	5	12,289,873	24,106,529	17,659,102	3,835,538			22%	8	12,818,179	13,346,485	15,655,120	17,499,382	19,063,712	22,337,609	23,222,069	10%
	6	16,345	39,325	30,471	9,596			31%	7	16,558	16,770	25,477	34,400	36,136	38,161	38,743	17%
	7	14,500	348,100	144,134	178,791			124%	3	20,030	25,560	42,151	69,802	208,951	292,440	320,270	66%
	8	24,134	120,610	73,214	39,161			53%	7	27,025	29,916	41,979	68,394	107,700	116,104	118,357	44%
	9	38,824	197,800	105,392	52,578			50%	7	50,431	62,038	80,057	89,974	125,516	169,560	183,680	22%
	10	148,942	2,111,200	601,480	736,734			122%	8	154,628	160,314	199,162	241,559	574,222	1,606,997	1,859,099	48%
Interest Rate	11	48,620	74,915	60,022	8,955			15%	12	49,757	50,746	51,897	59,071	67,439	71,652	73,352	13%
	12	30,624	161,122	58,196	38,228			66%	12	30,973	31,322	40,990	45,877	58,628	79,916	120,519	18%
	13	86,385	129,000	106,104	12,391			12%	12	87,950	90,327	100,730	104,257	112,212	121,984	125,445	5%
	14	18,829	36,644	23,954	6,064			25%	12	19,143	19,470	20,108	20,944	25,791	33,048	34,818	12%
	15	23,700	27,091	25,395	2,398			9%	2	23,870	24,039	24,548	25,395	26,243	26,752	26,921	3%
	16	79,836	128,490	99,769	16,335			16%	10	80,834	81,832	85,997	97,698	111,889	118,473	123,481	13%
	17	130,400	558,011	251,016	139,908			56%	8	136,823	143,245	154,218	218,513	278,324	384,543	471,277	29%
	18	59,376	661,166	284,921	239,189			84%	8	61,385	63,393	68,627	242,277	460,968	539,320	600,243	74%
	19	74,878	139,106	101,191	20,135			20%	12	81,506	86,978	88,236	90,101	112,320	131,101	135,528	12%
	20	15	7,417	3,163	2,734			86%	11	39	63	101	3,848	5,210	6,000	6,708	96%
	21	183,492	292,100	212,845	33,901			16%	11	184,550	185,608	187,297	199,017	230,434	242,688	267,394	10%
	22	16,148	187,015	45,099	50,411			112%	10	18,567	20,985	23,012	34,905	35,902	51,192	119,104	22%
	23	68,947	198,452	146,320	33,406			23%	10	95,566	122,185	138,231	150,644	162,703	167,438	182,945	8%
	24	13,589	187,625	84,863	73,815			87%	9	15,273	16,958	18,964	52,726	144,252	181,525	184,575	77%
	25	6,181	82,810	31,363	20,244			65%	10	11,922	17,662	21,181	28,653	32,940	43,381	63,095	22%
	26	212,787	640,584	384,620	170,812			44%	8	216,483	220,180	234,487	348,679	518,612	584,035	612,309	38%
FX	27	359,277	540,100	475,926	54,548			11%	10	394,050	428,822	447,357	484,902	518,668	529,258	534,679	7%
	28	7,381	21,300	13,164	3,938			30%	10	7,984	8,587	12,307	12,811	14,300	16,161	18,730	7%
	29	100,204	169,470	143,291	22,189			15%	10	109,262	118,319	130,291	146,649	161,655	166,348	167,909	11%
	30	32,391	500,963	371,162	127,385			34%	10	169,450	306,508	384,630	395,337	409,485	470,013	485,488	3%
	31	184,127	358,000	297,709	49,124			17%	10	212,119	240,111	292,649	310,210	321,818	333,249	345,625	5%
	32	17,136	343,100	168,976	161,090			95%	6	19,063	20,990	25,383	154,981	309,853	330,958	337,029	85%
Commodity	33	3,541	4,365	3,953	583			15%	2	3,582	3,623	3,747	3,953	4,159	4,283	4,324	5%
	34	240,717	267,123	253,920	18,672			7%	2	242,037	243,357	247,318	253,920	260,521	264,482	265,803	3%
	35	279,598	315,987	297,792	25,731			9%	2	281,417	283,237	288,695	297,792	306,890	312,348	314,167	3%
Credit Spread	36	24,600	32,000	28,300	5,233			18%	2	24,970	25,340	26,450	28,300	30,150	31,260	31,630	7%
	37	22,558	43,000	32,779	14,454			44%	2	23,580	24,602	27,669	32,779	37,890	40,956	41,978	16%
	38	4,311	7,600	5,456	1,858			34%	3	4,326	4,340	4,384	4,457	6,029	6,971	7,286	16%
	39	11,921	45,800	28,860	23,956			83%	2	13,615	15,309	20,391	28,860	37,330	42,412	44,106	29%
	40	6,000	6,320	6,107	184			3%	3	6,000	6,000	6,001	6,002	6,161	6,256	6,288	1%
	41	10,598	11,887	11,162	659			6%	3	10,638	10,679	10,799	11,000	11,443	11,709	11,798	3%
	42	22,873	104,900	63,887	58,002			91%	2	26,975	31,076	43,380	63,887	84,393	96,697	100,799	32%
	43	20,244	40,100	31,220	8,233			26%	4	21,905	23,566	28,549	32,268	34,940	38,036	39,068	10%
	44	8,725	22,000	12,162	6,562			54%	4	8,726	8,727	8,729	8,961	12,394	18,158	20,079	17%
	45	11,000	14,464	12,343	1,858			15%	3	11,057	11,113	11,283	11,567	13,015	13,884	14,174	7%
	46	8,749	12,670	10,473	2,003			19%	3	8,874	8,999	9,374	10,000	11,335	12,136	12,403	9%
	47	2,000	3,405	2,548	752			30%	3	2,024	2,048	2,120	2,239	2,822	3,172	3,289	14%
	48	6,631	22,000	15,360	7,895			51%	3	7,713	8,795	12,040	17,449	19,725	21,090	21,545	24%
	49	12,250	13,000	12,625	531			4%	2	12,287	12,325	12,437	12,625	12,812	12,925	12,962	1%
	50	21,068	39,900	30,484	13,317			44%	2	22,009	22,951	25,776	30,484	35,192	38,017	38,958	15%
	51	52,742	150,000	86,505	55,025			64%	3	53,145	53,548	54,758	56,774	103,387	131,355	140,677	31%
	52	50,808	105,000	77,904	38,320			49%	2	53,517	56,227	64,356	77,904	91,452	99,581	102,290	17%
	53	83,400	208,500	145,950	88,459			61%	2	89,655	95,910	114,675	145,950	177,225	195,990	202,245	21%
CTP	54																
	55																
	56																
ALL-IN no-CTP	57	684,027	1,392,000	1,092,388	366,301			34%	3	735,738	787,449	942,582	1,201,137	1,296,569	1,353,827	1,372,914	16%
Equity Cumulative	58	1,050,400	1,953,400	1,436,844	465,348			32%	3	1,076,033	1,101,667	1,178,566	1,306,733	1,630,066	1,824,067	1,888,733	16%
IR Cumulative	59	107,562	647,600	342,435	231,890			68%	7	117,184	126,807	169,552	209,700	546,539	633,138	640,369	53%
FX Cumulative	60	755,938	1,060,300	863,426	133,793			15%	5	759,308	762,679	772,790	783,200	944,901	1,014,141	1,037,220	10%
Commodity Cumulative	61	240,304	269,640	254,972	20,744			8%	2	241,771	243,238	247,638	254,972	262,306	266,707	268,173	3%
CS Cumulative	62	46,700	46,700	46,700	#DIV/0!			#DIV/0!	1	46,700	46,700	46,700	46,700	46,700	46,700	46,700	0%
CTP Cumulative	63	30,226	30,226	30,226	#DIV/0!			#DIV/0!	1	30,226	30,226	30,226	30,226	30,226	30,226	30,226	0%

Figure 21: VaR ratio with median (focus on small banks)

VaR: all portfolios (exc. aggregated)
(ratio with the median - Small banks in orange)

Table 27: VaR statistics (medium-sized banks only)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquartile range
Equity	1	1,782,174	2,313,980	2,148,866	137,787			6%	19	1,893,539	2,018,927	2,097,411	2,150,191	2,263,784	2,309,826	2,310,759	4%
	2	1,749,011	2,473,497	2,179,638	217,845			10%	18	1,779,027	1,832,149	2,086,816	2,177,949	2,346,681	2,427,564	2,467,000	6%
	3	9,939	26,940	18,708	4,196			22%	19	12,901	13,721	17,310	18,743	20,250	23,896	26,739	8%
	4	868	3,210	1,914	487			25%	18	1,185	1,398	1,773	1,957	2,044	2,294	2,565	7%
	5	13,154,564	49,343,411	18,053,403	8,030,135			44%	18	13,419,837	13,842,477	14,926,911	16,726,092	17,532,833	19,127,154	24,663,151	8%
	6	15,751	55,387	29,951	9,938			33%	19	16,010	18,282	23,683	29,080	36,922	39,869	42,330	22%
	7	18,184	140,605	46,196	28,267			61%	17	20,933	26,250	30,041	40,967	44,272	68,718	83,820	19%
	8	11,191	184,076	93,534	44,752			48%	19	29,830	53,103	70,231	84,350	118,213	149,740	181,807	25%
	9	50,854	161,715	99,617	28,771			29%	19	56,278	66,113	84,768	98,897	113,495	139,414	146,974	14%
	10	185,096	2,341,681	419,628	510,245			122%	17	207,942	219,387	239,744	266,489	298,023	557,123	1,044,448	11%
Interest Rate	11	47,764	87,735	61,833	10,394			17%	26	50,329	50,868	54,742	59,726	66,304	76,499	77,845	10%
	12	25,500	62,779	40,830	9,396			23%	26	28,276	30,746	35,261	40,486	43,845	54,648	56,838	11%
	13	82,445	138,969	106,732	14,674			14%	26	87,457	89,223	95,202	105,908	113,202	126,924	133,744	9%
	14	17,163	61,563	26,757	9,437			35%	26	17,861	18,795	20,433	24,239	32,315	35,457	36,556	23%
	15	4,950	67,030	25,488	19,443			76%	12	7,750	10,229	12,406	19,326	27,233	55,780	61,744	37%
	16	77,636	152,156	112,143	20,379			18%	26	81,550	84,722	100,795	109,312	128,753	138,215	149,927	12%
	17	198,038	373,964	299,379	47,235			16%	21	210,621	212,554	280,725	309,732	327,566	341,985	366,437	8%
	18	260,483	749,690	490,847	101,450			21%	21	373,727	383,851	443,114	495,845	541,369	578,562	639,291	10%
	19	70,522	111,972	91,189	10,121			11%	26	74,397	77,795	84,600	92,371	97,434	99,392	108,705	7%
	20	67	9,143	4,113	1,876			46%	26	864	3,003	3,379	3,984	4,450	6,052	7,661	14%
	21	172,308	230,454	200,717	17,549			9%	26	174,472	177,959	189,332	198,867	216,733	223,230	225,713	7%
	22	24,089	120,007	41,217	22,744			55%	26	24,712	26,551	28,471	31,686	44,443	54,612	90,804	22%
	23	104,644	302,253	165,080	51,426			31%	26	105,519	110,928	131,331	157,085	173,209	243,111	270,033	14%
	24	16,588	351,913	148,951	80,510			54%	26	34,838	51,850	102,825	152,220	187,070	221,071	272,773	29%
	25	19,372	478,850	105,057	133,777			127%	26	21,873	22,952	27,176	36,323	98,771	330,725	404,257	57%
	26	372,236	1,047,148	567,599	135,724			24%	21	396,621	479,007	509,202	534,118	594,331	617,077	746,563	8%
FX	27	312,451	699,001	536,020	108,920			20%	23	332,836	370,615	498,796	550,842	605,205	676,333	682,710	10%
	28	5,316	17,448	13,102	3,288			25%	22	7,216	8,845	10,851	14,491	15,367	16,307	16,889	17%
	29	128,182	193,259	156,161	15,741			10%	22	137,411	140,563	143,846	155,037	166,158	176,091	178,621	7%
	30	339,891	537,645	406,883	50,823			12%	22	348,299	349,944	367,868	407,177	422,134	457,602	511,374	7%
	31	262,798	414,028	324,773	32,824			10%	22	295,549	296,243	302,783	322,249	335,954	358,171	390,407	5%
	32	3,918	339,846	146,624	146,174			100%	23	18,891	21,308	22,879	26,935	310,132	329,024	332,189	86%
Commodity	33	295	20,123	7,244	5,681			78%	11	1,252	2,208	3,779	6,602	8,029	14,448	17,286	36%
	34	226,477	344,302	283,593	37,178			13%	9	236,995	247,512	263,571	280,201	297,933	333,354	338,828	6%
	35	175,369	394,205	303,677	68,747			23%	10	191,190	207,012	278,373	319,205	343,092	369,507	381,856	10%
Credit Spread	36	1,809	54,259	27,426	12,231			45%	15	12,374	17,594	21,766	26,669	31,482	41,312	49,349	18%
	37	16,736	37,650	24,790	6,027			24%	14	17,465	18,375	20,604	23,102	29,136	31,008	33,907	17%
	38	2,253	6,456	4,265	1,092			26%	14	2,740	3,055	3,465	4,367	4,863	5,367	5,865	17%
	39	9,929	20,011	14,276	3,665			26%	14	9,950	10,341	11,864	12,596	17,527	19,783	19,930	19%
	40	2,724	8,042	5,097	1,670			33%	14	3,055	3,325	3,627	5,153	6,307	7,223	7,569	27%
	41	5,247	26,218	11,933	5,070			42%	14	7,099	8,121	9,364	10,373	14,121	15,771	19,542	20%
	42	10,671	90,468	33,014	21,601			65%	13	10,673	11,666	20,764	28,566	40,414	51,642	68,231	32%
	43	16,059	133,826	37,479	30,284			81%	16	16,207	16,397	21,337	27,976	39,051	64,364	93,665	29%
	44	5,522	20,003	10,501	3,433			33%	16	6,471	7,213	8,776	9,489	12,052	13,528	15,286	16%
	45	3,916	11,189,460	710,562	2,794,383			393%	16	4,941	5,311	7,863	9,931	14,375	27,631	2,818,862	29%
	46	4,990	6,042,044	396,768	1,505,696			379%	16	5,417	5,829	6,646	9,913	21,334	80,711	1,604,788	52%
	47	2,175	12,062	4,535	2,875			63%	14	2,218	2,289	2,564	3,292	5,516	8,001	9,939	37%
	48	5,734	20,514	10,758	3,849			36%	16	6,529	6,915	8,064	9,659	12,534	14,954	16,380	22%
	49	658	17,696	10,210	4,676			46%	15	4,330	6,194	7,068	11,383	13,085	16,117	17,253	30%
	50	15,780	55,093	29,413	12,969			44%	15	16,843	17,422	19,322	26,094	36,577	49,309	53,857	31%
	51	44,169	194,297	101,643	48,096			47%	13	45,444	46,458	61,479	101,588	124,548	166,064	182,885	34%
	52	41,320	192,914	96,335	47,708			50%	13	41,928	42,454	69,176	91,728	114,374	163,878	182,052	25%
	53	83,535	373,375	169,604	91,367			54%	13	86,231	88,454	98,124	150,322	182,491	311,081	353,630	30%
CTP	54	3,482	5,203	4,525	917			20%	3	3,623	3,764	4,187	4,892	5,047	5,141	5,172	9%
	55	22,803	30,028	26,415	5,109			19%	2	23,164	23,525	24,609	26,415	28,221	29,305	29,666	7%
	56	171,920	556,081	364,001	271,642			75%	2	191,128	210,336	267,961	364,001	460,041	517,665	536,873	26%
ALL-IN no-CTP	57	958,129	1,476,995	1,286,687	173,992			14%	12	1,010,405	1,054,030	1,187,711	1,349,445	1,425,570	1,445,801	1,460,771	9%
Equity Cumulative	58	403,567	1,419,010	1,117,601	237,257			21%	16	776,517	923,833	1,065,845	1,147,094	1,241,081	1,357,812	1,392,656	8%
IR Cumulative	59	336,062	837,520	586,599	121,479			21%	21	433,265	481,004	511,737	576,186	627,245	737,274	815,745	10%
FX Cumulative	60	517,829	1,280,354	861,673	188,944			22%	22	629,508	705,348	760,668	810,965	956,886	1,085,496	1,226,406	11%
Commodity Cumulative	61	295	357,500	256,575	98,168			38%	10	101,913	203,531	256,213	272,602	291,543	342,667	350,083	6%
CS Cumulative	62	16,256	133,693	39,147	28,398			73%	15	16,836	18,586	25,016	33,845	41,992	49,575	75,173	25%
CTP Cumulative	63	148,655	487,852	318,254	239,849			75%	2	165,615	182,575	233,454	318,254	403,053	453,933	470,893	27%

Figure 22: VaR ratio with median (focus on medium-sized banks)

VaR: all portfolios (exc. aggregated)
(ratio with the median - Medium banks in orange)

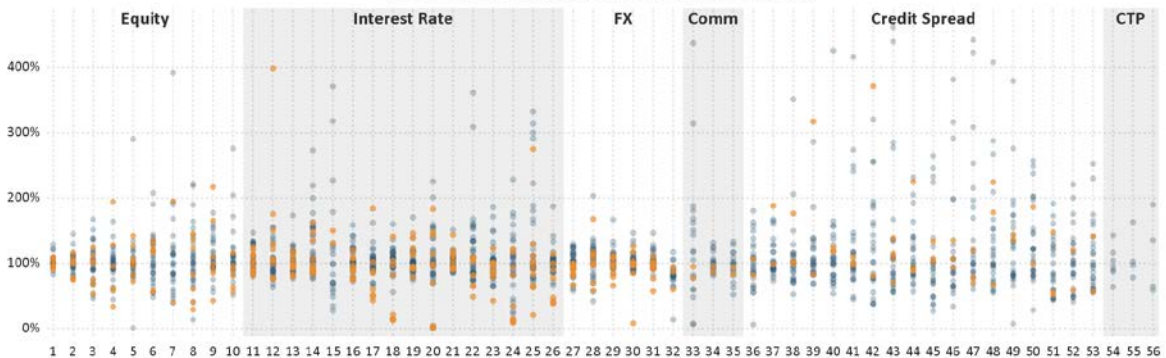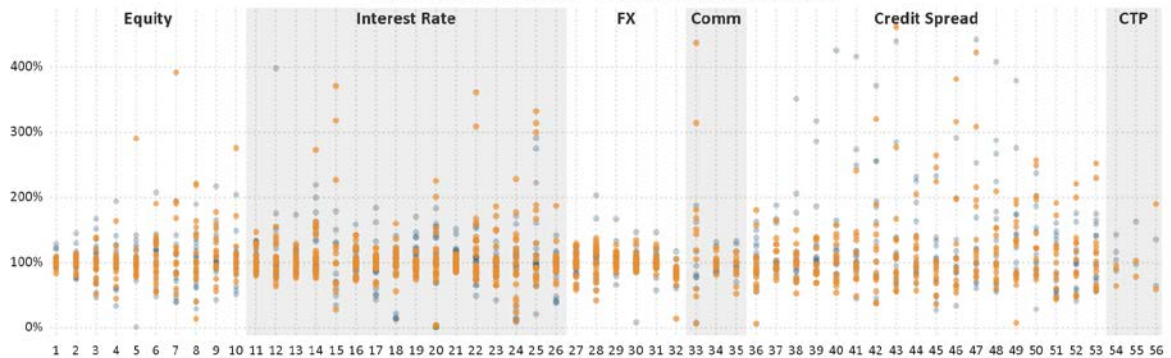## Table 28: VaR statistics (large banks only)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc¹	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Equity	1	2,058,510	2,769,033	2,299,711	252,901			11%	11	2,061,802	2,065,094	2,075,440	2,246,249	2,449,802	2,624,001	2,696,517	8%
	2	1,958,071	3,155,255	2,312,712	374,732			16%	11	1,984,656	2,011,240	2,048,134	2,178,651	2,399,315	2,831,958	2,993,607	8%
	3	9,055	32,576	21,591	6,737			31%	11	11,154	13,253	19,025	22,344	24,935	29,448	31,012	13%
	4	1,120	2,760	2,036	427			21%	11	1,436	1,752	1,848	2,069	2,245	2,465	2,612	10%
	5	137,875	22,810,979	16,575,385	5,844,698			35%	11	8,292,264	16,446,653	16,572,207	16,932,161	19,139,101	20,815,304	21,813,142	7%
	6	13,980	60,353	32,789	12,294			37%	11	17,932	21,885	26,056	30,703	38,631	41,742	51,048	19%
	7	14,018	50,886	31,052	12,063			39%	11	15,265	16,513	22,777	30,200	40,185	46,040	48,463	28%
	8	52,345	157,324	87,118	29,317			34%	11	54,443	56,541	66,985	89,174	94,863	108,579	132,952	17%
	9	81,626	141,670	101,110	20,411			20%	11	83,329	85,031	87,961	92,561	109,559	130,237	135,953	11%
	10	133,603	533,312	298,947	99,072			33%	11	185,339	237,074	259,358	287,917	310,369	387,619	460,465	9%
Interest Rate	11	50,600	79,768	67,148	10,845			16%	10	54,298	57,996	60,088	62,402	79,031	79,526	79,647	14%
	12	32,697	62,522	39,953	8,475			21%	10	32,919	33,141	35,291	38,718	40,325	42,824	52,673	7%
	13	96,673	187,116	122,902	26,479			22%	10	98,105	99,537	103,007	121,432	128,929	140,935	164,026	11%
	14	19,599	49,452	30,937	10,831			35%	10	20,485	21,371	22,156	26,727	38,704	45,572	47,512	27%
	15	6,193	32,236	15,240	8,536			56%	8	7,133	8,073	10,336	12,708	17,082	26,045	29,141	25%
	16	92,461	169,785	118,067	22,617			19%	10	95,887	99,312	105,323	108,953	127,807	138,641	154,213	10%
	17	264,176	491,429	324,377	72,282			22%	10	264,468	264,761	275,262	305,200	332,992	412,051	451,740	9%
	18	436,358	576,755	496,238	49,559			10%	10	438,463	440,567	447,176	502,965	533,281	550,647	563,701	9%
	19	82,751	162,248	110,986	23,041			21%	10	84,872	86,994	98,050	108,675	115,089	135,391	148,820	8%
	20	5	6,463	4,581	2,006			44%	10	1,261	2,517	3,984	5,113	6,087	6,338	6,401	21%
	21	184,043	307,500	225,145	36,174			16%	10	186,842	189,642	197,436	221,296	238,885	252,531	280,015	9%
	22	24,562	52,652	39,670	10,574			27%	10	24,748	24,934	33,339	40,460	49,072	51,592	52,673	19%
	23	148,767	215,125	171,707	18,170			11%	10	152,200	155,634	163,102	168,486	174,154	187,760	201,443	3%
	24	40,060	264,248	166,831	60,899			37%	10	84,044	128,028	148,204	167,710	175,992	247,148	255,698	9%
	25	28,653	87,753	41,975	20,193			48%	10	28,746	28,839	29,273	31,973	45,425	69,101	78,427	22%
	26	472,151	793,069	595,896	83,194			14%	10	506,433	540,714	564,202	580,359	600,998	668,873	730,971	3%
FX	27	496,097	673,912	594,721	58,361			10%	9	513,456	530,814	554,347	608,450	633,325	660,599	667,255	7%
	28	9,821	25,822	14,970	4,390			29%	9	11,138	12,456	13,345	13,996	14,951	17,814	21,818	6%
	29	142,856	253,653	174,143	34,580			20%	9	144,734	146,612	152,971	166,390	172,280	212,896	233,275	6%
	30	366,350	584,192	429,469	64,730			15%	9	374,899	383,448	388,434	416,558	438,998	484,607	534,399	6%
	31	309,596	471,772	364,246	50,291			14%	9	315,917	322,238	326,750	351,789	388,009	411,971	441,872	9%
	32	18,481	319,493	90,052	128,816			143%	9	20,276	22,070	23,220	24,350	33,470	315,700	317,597	18%
Commodity	33	352	8,640	4,570	2,834			62%	7	1,078	1,803	3,189	3,768	6,425	7,935	8,287	34%
	34	235,121	367,043	287,087	52,671			18%	7	236,263	237,406	246,703	278,224	317,909	357,420	362,231	13%
	35	236,088	449,668	358,867	81,337			23%	7	255,220	274,353	316,695	360,491	423,399	441,757	445,713	14%
Credit Spread	36	16,448	48,910	33,571	10,321			31%	11	17,678	18,908	27,462	34,445	40,160	45,033	46,971	19%
	37	18,954	38,200	24,449	6,582			27%	11	19,773	20,592	20,803	21,856	23,555	36,694	37,447	6%
	38	3,044	15,147	5,376	3,618			67%	11	3,103	3,162	3,548	3,955	4,837	8,869	12,008	15%
	39	13,173	41,277	18,814	8,343			44%	11	13,660	14,146	14,600	15,350	18,172	26,845	34,061	11%
	40	3,818	21,653	6,923	5,099			74%	11	3,996	4,173	4,545	5,103	6,739	8,376	15,015	19%
	41	4,852	45,262	16,669	12,184			73%	11	6,624	8,396	9,742	12,168	19,916	29,751	37,506	34%
	42	10,822	72,304	39,202	22,034			56%	11	11,759	12,696	21,983	37,404	53,593	72,148	72,226	42%
	43	17,884	127,426	41,177	33,722			82%	11	18,713	19,542	22,141	30,527	35,805	82,573	104,999	24%
	44	6,572	88,299	19,058	23,531			123%	11	7,239	7,906	8,166	10,000	17,365	22,608	55,454	36%
	45	2,935	25,227	10,445	6,256			60%	11	3,492	4,050	6,343	10,830	12,576	14,987	20,107	33%
	46	3,162	69,871	15,116	19,203			127%	11	4,577	5,991	6,939	8,267	10,531	27,268	48,570	21%
	47	1,715	15,651	5,312	4,669			88%	11	1,825	1,934	2,640	2,879	6,021	12,609	14,130	39%
	48	5,354	39,966	15,570	11,200			72%	11	5,525	5,695	7,906	10,734	21,277	28,186	34,076	46%
	49	7,247	34,213	13,966	8,562			61%	11	7,318	7,390	7,834	11,046	15,678	24,880	29,546	33%
	50	6,048	50,854	25,661	12,936			50%	11	11,399	16,750	18,111	21,772	32,119	43,367	47,110	28%
	51	46,171	163,278	93,725	42,247			45%	11	47,862	49,552	59,529	81,425	134,007	144,260	153,769	38%
	52	36,072	153,240	86,686	36,389			42%	11	40,828	45,583	63,630	86,206	95,728	142,025	147,633	20%
	53	82,064	258,542	158,472	65,521			41%	11	87,136	92,208	110,269	143,082	221,986	243,806	251,174	34%
CTP	54	4,743	7,756	6,123	1,266			21%	4	4,883	5,024	5,444	5,997	6,676	7,324	7,540	10%
	55	28,409	47,616	38,012	13,581			36%	2	29,369	30,330	33,211	38,012	42,814	45,695	46,655	13%
	56	189,031	396,951	292,991	147,021			50%	2	199,427	209,823	241,011	292,991	344,971	376,159	386,555	18%
ALL-IN no-CTP	57	1,321,525	1,686,312	1,450,862	139,110			10%	8	1,323,211	1,324,897	1,352,132	1,387,268	1,547,319	1,633,970	1,660,141	7%
Equity Cumulative	58	1,128,992	1,484,538	1,295,958	121,898			9%	11	1,141,524	1,154,075	1,171,407	1,310,139	1,380,788	1,421,900	1,453,219	8%
IR Cumulative	59	513,976	688,112	595,536	50,979			9%	10	527,981	541,586	571,444	584,049	630,274	648,337	668,225	5%
FX Cumulative	60	676,830	1,048,300	879,965	136,026			15%	9	713,219	749,607	779,678	872,419	1,016,023	1,043,649	1,045,975	13%
Commodity Cumulative	61	45,093	366,326	237,319	105,903			45%	6	92,673	140,254	236,110	246,612	276,650	325,092	345,709	8%
CS Cumulative	62	15,969	106,319	41,542	28,495			69%	11	18,335	20,700	22,593	34,071	39,734	85,779	96,049	28%
CTP Cumulative	63	164,755	348,335	256,545	129,811			51%	2	173,934	183,113	210,650	256,545	302,440	329,977	339,156	18%

Figure 23: VaR ratio with median (focus on large banks)

VaR: all portfolios (exc. aggregated)
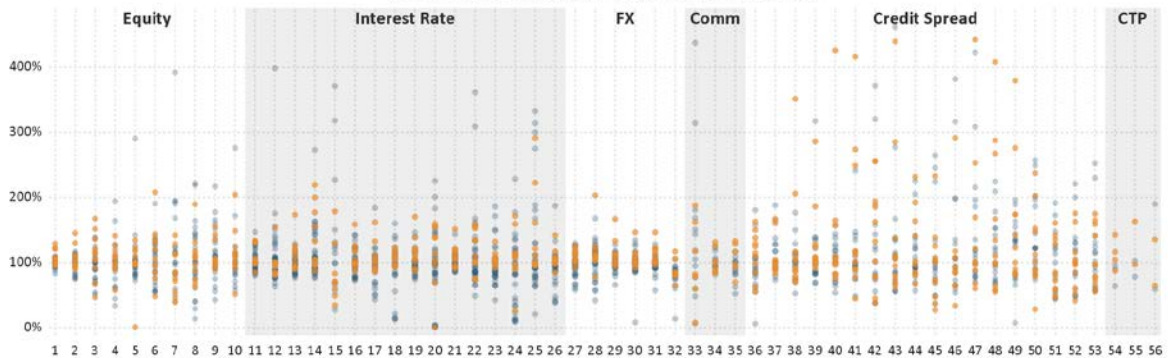(ratio with the median - Large banks in orange)

Table 29: VaR statistics (same business model – cross-border universal bank)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc¹	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Equity	1	1,782,174	2,313,980	2,138,178	135,467			6%	22	1,911,577	2,021,998	2,066,586	2,143,108	2,267,229	2,303,180	2,309,495	5%
	2	1,784,324	3,155,255	2,241,031	260,991			12%	21	2,011,240	2,038,732	2,140,873	2,180,477	2,335,600	2,408,294	2,473,497	4%
	3	9,939	32,576	19,691	4,823			24%	21	13,230	14,897	17,574	19,572	20,555	23,191	29,448	8%
	4	868	428,100	23,339	95,273			408%	20	1,107	1,229	1,790	1,957	2,359	3,269	25,015	14%
	5	137,875	49,343,411	17,985,027	8,463,984			47%	21	13,466,650	14,003,545	15,754,763	16,932,161	17,680,277	21,579,500	24,106,529	6%
	6	15,751	60,353	31,507	10,180			32%	21	16,039	20,434	24,882	30,703	37,335	40,880	41,742	20%
	7	14,018	348,100	53,732	74,344			138%	20	14,476	19,354	26,883	32,360	41,631	75,363	150,980	22%
	8	11,191	184,076	95,074	45,123			47%	20	32,023	50,423	67,412	86,915	114,569	159,732	181,540	26%
	9	50,854	197,800	100,398	33,981			34%	21	56,881	81,626	85,031	87,815	105,287	141,670	161,715	11%
	10	133,603	2,341,681	528,426	638,807			121%	20	182,522	210,797	236,955	262,941	402,825	1,462,940	2,122,724	26%
Interest Rate	11	47,764	87,735	63,045	10,076			16%	29	50,776	51,946	55,558	60,962	67,300	78,532	79,660	10%
	12	27,671	62,779	41,093	8,604			21%	28	30,944	31,669	35,227	40,355	43,890	53,224	56,565	11%
	13	82,445	135,850	105,804	12,566			12%	29	88,953	92,743	99,453	105,116	111,377	126,298	128,369	6%
	14	17,163	61,563	25,575	9,201			36%	29	18,254	19,339	20,110	22,559	25,823	35,190	38,240	12%
	15	4,950	67,030	23,369	18,050			77%	15	8,513	10,353	12,247	17,769	23,546	50,862	60,303	32%
	16	77,636	151,884	110,053	18,269			17%	28	80,210	83,268	101,473	110,376	124,784	132,119	134,058	10%
	17	130,400	558,011	290,414	80,211			28%	26	161,073	204,330	269,202	292,488	319,795	351,768	372,082	9%
	18	65,114	661,166	458,081	135,347			30%	26	139,521	317,105	444,191	491,473	523,168	552,202	618,665	8%
	19	70,522	132,600	97,096	13,684			14%	29	75,915	82,039	89,386	96,924	106,156	112,685	116,778	9%
	20	67	9,143	4,228	1,826			43%	29	1,201	2,821	3,372	4,033	5,644	6,228	6,407	25%
	21	173,711	292,100	208,884	24,232			12%	29	177,718	182,900	190,427	207,300	220,798	230,881	236,731	7%
	22	24,339	120,007	38,141	18,195			48%	28	25,006	26,649	28,506	33,488	41,698	51,196	53,252	19%
	23	104,644	302,253	163,979	43,468			27%	29	105,623	121,943	136,071	162,900	173,504	211,095	243,361	12%
	24	13,589	351,913	133,731	80,544			60%	29	21,208	36,927	62,953	137,802	172,715	209,671	233,643	47%
	25	21,631	478,850	75,793	100,309			132%	29	22,881	23,704	28,653	33,493	82,810	161,625	266,119	49%
	26	212,787	746,563	531,676	115,738			22%	26	271,709	384,428	510,950	561,331	589,374	615,582	634,707	7%
FX	27	312,451	683,249	538,931	92,587			17%	25	370,615	426,564	496,097	549,237	601,507	657,678	677,075	10%
	28	5,316	21,300	13,729	3,261			24%	24	7,609	10,403	12,506	14,150	15,451	16,261	17,280	11%
	29	127,391	193,259	154,000	15,107			10%	25	129,996	138,503	142,725	152,521	164,700	168,142	176,792	7%
	30	336,965	537,645	401,257	45,564			11%	25	341,557	349,479	367,814	394,200	422,266	450,430	465,258	7%
	31	246,332	392,017	322,016	31,224			10%	25	268,760	294,044	309,596	324,889	334,406	359,094	370,741	4%
	32	18,481	343,100	142,542	144,749			102%	24	21,296	21,878	23,158	26,423	314,091	318,283	336,691	86%
Commodity	33	2,208	20,123	7,548	5,177			69%	12	2,490	2,809	3,728	6,769	8,392	13,867	17,002	38%
	34	226,477	351,004	285,041	40,000			14%	12	233,326	240,314	260,871	279,212	306,104	342,934	347,318	8%
	35	210,528	449,668	329,426	63,382			19%	11	242,094	273,660	296,692	337,536	355,144	394,205	421,936	9%
Credit Spread	36	20,212	47,245	31,166	7,070			23%	17	22,698	24,513	25,719	30,607	34,445	39,895	42,637	15%
	37	16,736	43,000	26,116	7,574			29%	16	19,235	20,330	20,650	22,561	29,897	37,172	38,988	18%
	38	3,002	8,869	4,523	1,545			34%	17	3,035	3,115	3,792	4,311	4,790	6,009	7,854	12%
	39	9,929	45,800	15,917	8,469			53%	17	9,955	10,907	12,074	13,518	16,176	19,181	26,358	15%
	40	3,233	8,376	5,223	1,411			27%	17	3,479	3,552	4,115	5,246	6,000	6,836	7,527	19%
	41	4,852	26,218	11,898	4,604			39%	17	7,447	8,276	9,615	10,970	12,649	15,594	18,002	14%
	42	10,671	104,900	37,807	27,078			72%	16	10,785	11,759	20,493	31,219	46,526	71,937	94,076	39%
	43	16,059	133,826	33,913	25,563			75%	19	16,237	16,481	20,769	30,931	36,088	39,883	49,473	27%
	44	5,522	22,608	11,373	5,202			46%	19	6,467	6,744	8,041	9,216	13,076	20,402	22,061	24%
	45	3,916	11,189,460	632,209	2,634,749			417%	18	4,922	5,228	8,047	10,649	13,090	24,982	1,701,028	24%
	46	3,162	6,042,044	350,948	1,420,580			405%	18	4,716	5,691	6,291	9,355	12,508	50,716	1,013,154	33%
	47	1,715	12,062	4,218	2,844			67%	17	1,890	1,974	2,479	3,045	5,297	7,847	9,449	36%
	48	5,695	26,183	12,511	5,660			45%	18	6,230	7,102	9,097	10,915	14,471	20,960	22,627	23%
	49	5,904	17,696	10,426	3,835			37%	17	6,484	6,777	7,261	9,019	13,000	15,677	16,084	28%
	50	6,048	55,093	25,796	11,695			45%	17	13,834	16,824	18,974	22,540	31,568	40,796	44,730	25%
	51	44,169	194,297	94,460	49,127			52%	17	45,771	46,739	52,742	76,430	129,213	160,111	179,081	42%
	52	36,072	192,914	92,419	45,623			49%	16	40,008	42,127	51,365	89,531	113,669	147,479	179,337	38%
	53	82,064	373,375	164,871	88,633			54%	16	83,167	85,782	96,645	140,364	197,275	287,752	348,694	34%
CTP	54	3,482	4,743	4,113	892			22%	2	3,545	3,608	3,797	4,113	4,428	4,617	4,680	8%
	55	22,803	47,616	35,209	17,545			50%	2	24,043	25,284	29,006	35,209	41,412	45,134	46,375	18%
	56	189,031	556,081	372,556	259,543			70%	2	207,384	225,736	280,794	372,556	464,318	519,376	537,728	25%
ALL-IN no-CTP	57	684,027	1,611,538	1,289,866	231,169			18%	15	875,898	999,562	1,260,189	1,360,728	1,411,266	1,465,196	1,517,358	6%
Equity Cumulative	58	403,567	1,953,400	1,191,836	292,096			25%	19	892,505	1,029,686	1,078,655	1,154,138	1,320,946	1,413,192	1,531,424	10%
IR Cumulative	59	209,700	837,520	571,469	125,257			22%	24	350,642	454,482	526,768	584,049	624,434	686,446	729,900	8%
FX Cumulative	60	517,829	1,241,860	869,683	162,750			19%	23	717,720	747,558	776,783	810,965	1,027,307	1,069,529	1,085,776	14%
Commodity Cumulative	61	45,093	357,500	258,976	81,273			31%	11	135,603	226,113	245,767	266,014	288,720	341,019	349,259	8%
CS Cumulative	62	16,256	133,693	39,109	26,423			68%	17	16,918	19,337	25,607	36,278	41,273	48,057	66,813	23%
CTP Cumulative	63	30,226	487,852	227,611	235,199			103%	3	43,679	57,131	97,490	164,755	326,304	423,233	455,543	54%

Table 30: VaR statistics (IR and CS asset classes – only banks with general and specific IR risk approval)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Interest Rate	11	47,764	87,735	63,300	11,231			18%	31	49,513	50,600	53,688	61,012	74,296	79,462	79,633	16%
	12	25,500	70,893	43,052	11,071			26%	31	29,535	32,697	35,652	40,360	48,073	60,737	62,650	15%
	13	82,445	187,116	111,374	20,654			19%	31	86,852	87,872	99,654	107,965	123,163	129,163	137,387	11%
	14	17,664	61,563	27,826	10,333			37%	31	18,795	19,400	20,944	23,613	34,596	39,919	47,297	25%
	15	4,950	67,030	22,084	16,732			76%	19	6,068	8,341	12,247	17,769	23,546	44,304	58,381	32%
	16	77,636	169,785	113,472	22,386			20%	31	81,412	85,552	100,240	108,510	129,312	144,054	152,020	13%
	17	130,400	558,011	314,743	76,854			24%	29	228,884	262,596	274,745	310,200	333,642	379,817	456,150	10%
	18	99,200	749,690	494,159	111,997			23%	29	378,378	400,595	443,114	502,696	547,616	590,708	652,416	11%
	19	73,730	162,248	99,490	18,668			19%	31	77,795	82,582	88,190	95,783	108,675	117,605	132,504	10%
	20	5	6,463	4,333	1,565			36%	30	1,293	3,313	3,682	4,243	5,633	6,266	6,284	21%
	21	176,756	307,500	214,402	29,811			14%	30	186,093	188,612	192,213	209,267	225,713	240,185	271,545	8%
	22	16,148	120,007	38,518	18,673			48%	30	22,886	24,339	27,577	33,785	45,459	52,652	54,612	24%
	23	68,947	302,253	168,395	49,775			30%	31	104,994	115,814	137,864	166,420	179,846	241,866	261,474	13%
	24	16,588	264,248	151,968	60,299			40%	29	26,704	50,192	136,586	163,075	180,000	213,192	235,577	14%
	25	18,938	478,850	88,734	124,280			140%	31	20,985	23,306	27,278	31,631	85,282	318,385	383,860	52%
	26	238,200	1,047,148	571,271	136,096			24%	29	410,923	464,197	524,007	561,478	594,331	673,371	774,467	6%
Credit Spread	36	1,809	54,259	29,902	11,275			38%	28	16,607	18,113	24,280	29,016	35,205	45,696	48,327	18%
	37	16,736	43,000	25,261	6,932			27%	28	18,203	19,511	20,734	22,713	28,561	37,172	38,063	16%
	38	2,253	15,147	4,829	2,451			51%	28	3,017	3,127	3,626	4,367	4,903	6,799	8,425	15%
	39	9,929	45,800	17,318	8,585			50%	26	10,436	11,858	12,492	14,600	18,329	23,428	37,669	19%
	40	2,724	21,653	5,922	3,426			58%	28	3,340	3,555	4,159	5,319	6,369	7,982	8,259	21%
	41	4,852	45,262	13,711	8,562			62%	26	6,244	8,155	9,806	10,919	13,251	26,466	28,804	15%
	42	10,671	104,900	38,007	24,898			66%	26	10,711	11,759	21,607	31,219	50,736	72,226	85,927	40%
	43	16,059	133,826	38,575	29,540			77%	30	16,383	17,750	22,180	31,098	39,241	80,507	107,242	28%
	44	5,522	88,299	13,919	14,746			106%	30	6,669	7,553	8,315	9,588	13,621	20,203	22,335	24%
	45	2,935	11,189,460	384,031	2,040,831			531%	30	3,976	4,995	7,669	10,649	13,090	25,365	27,734	26%
	46	3,162	6,042,044	218,199	1,100,216			504%	30	5,246	5,948	7,071	9,355	17,032	39,134	100,579	41%
	47	1,715	15,651	4,627	3,574			77%	28	1,957	2,123	2,460	3,132	5,370	9,776	12,417	37%
	48	5,354	39,966	12,983	7,815			60%	30	5,712	6,265	7,645	10,268	14,978	22,418	27,284	32%
	49	658	34,213	11,858	6,470			55%	28	6,158	6,802	7,363	11,651	14,130	17,253	22,366	31%
	50	6,048	55,093	28,016	12,631			45%	28	16,119	17,134	18,906	25,055	34,477	45,613	52,461	29%
	51	44,169	194,297	96,735	44,888			46%	27	46,208	46,788	57,771	84,366	129,721	155,311	171,678	38%
	52	36,072	192,914	90,835	41,444			46%	26	41,573	42,634	57,263	86,770	111,325	147,633	169,418	32%
	53	82,064	373,375	163,074	78,052			48%	26	83,434	85,782	100,179	143,363	204,758	251,174	319,986	34%
IR Cumulative	59	209,700	837,520	591,629	119,038			20%	29	447,791	497,107	541,863	591,474	643,918	723,474	784,357	9%
CS Cumulative	62	15,969	133,693	40,402	27,377			68%	27	16,505	19,254	23,604	34,071	41,992	64,368	100,157	28%

Table 31: VaR statistics (IR and CS asset classes – only banks with general IR risk approval)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Interest Rate	11	50,304	76,492	62,341	7,898			13%	15	53,334	54,927	56,312	60,655	67,221	73,778	75,388	9%
	12	30,699	161,122	49,002	34,325			70%	13	30,770	31,011	35,261	40,486	44,025	50,953	95,324	11%
	13	89,230	135,850	107,701	13,386			12%	15	90,171	91,658	99,205	105,335	113,104	125,468	129,951	7%
	14	17,163	36,644	26,063	6,561			25%	15	18,721	19,678	20,518	24,295	32,290	34,200	35,342	22%
	15	10,040	27,091	19,659	8,733			44%	3	11,221	12,401	15,943	21,845	24,468	26,042	26,566	21%
	16	79,836	132,055	105,519	16,171			15%	14	82,412	83,827	97,283	106,267	110,681	127,378	129,738	6%
	17	148,751	366,437	247,839	73,668			30%	9	151,667	154,583	198,038	267,699	285,486	325,144	345,791	18%
	18	59,376	527,025	349,905	180,405			52%	9	61,671	63,967	260,483	435,602	457,853	511,469	519,247	27%
	19	70,522	139,106	95,530	16,967			18%	15	73,571	78,320	85,751	91,174	103,417	111,304	119,992	9%
	20	64	9,143	3,580	2,897			81%	14	66	95	1,506	3,253	4,341	7,855	8,446	48%
	21	172,308	242,688	200,656	21,795			11%	15	173,290	175,891	182,260	199,017	215,302	227,032	235,620	8%
	22	25,830	187,015	50,268	43,645			87%	14	27,429	28,412	30,765	35,834	40,476	85,041	132,095	14%
	23	106,042	173,504	149,902	19,731			13%	14	118,962	127,101	139,124	154,666	163,833	169,128	170,837	8%
	24	13,589	351,913	113,401	113,118			100%	10	17,835	22,080	39,091	66,439	126,967	280,687	316,300	53%
	25	6,181	187,720	48,795	45,942			94%	14	15,129	20,452	27,589	31,701	53,426	87,162	130,817	32%
	26	212,787	617,077	458,184	155,112			34%	9	217,011	221,236	372,236	504,883	568,181	614,685	615,881	21%
Credit Spread	36																
	37																
	38																
	39																
	40																
	41																
	42																
	43	20,244	20,244	20,244					1	20,244	20,244	20,244	20,244	20,244	20,244	20,244	0%
	44	8,725	8,725	8,725					1	8,725	8,725	8,725	8,725	8,725	8,725	8,725	0%
	45																
	46																
	47																
	48																
	49																
	50																
	51																
	52																
	53																
IR Cumulative	59	139,638	622,078	425,773	179,441			42%	8	160,578	181,518	301,913	502,545	539,793	589,953	606,015	28%
CS Cumulative	62																

Table 32: VaR statistics (EQ asset class – only banks with general and specific EQ risk approval)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Equity	1	1,782,174	2,769,033	2,209,180	199,484			9%	31	1,962,556	2,047,181	2,086,360	2,195,524	2,296,931	2,356,137	2,608,836	5%
	2	1,631,826	3,155,255	2,221,402	305,002			14%	30	1,764,902	1,845,813	2,060,352	2,179,564	2,367,451	2,473,161	2,700,093	7%
	3	9,055	32,576	19,850	5,285			27%	31	11,585	13,253	17,432	19,639	22,348	26,717	28,194	12%
	4	868	428,100	15,770	76,527			485%	31	1,180	1,465	1,798	1,969	2,195	2,760	3,505	10%
	5	137,875	49,343,411	17,502,475	7,032,273			40%	31	13,310,607	13,799,318	15,567,247	16,932,161	18,050,736	20,815,304	22,195,240	7%
	6	13,980	60,353	30,721	10,659			35%	31	15,895	16,345	24,585	29,456	36,922	39,616	48,565	20%
	7	14,500	348,100	52,375	63,018			120%	28	17,098	19,381	28,825	38,007	47,251	69,677	115,824	24%
	8	11,191	184,076	92,125	35,184			38%	31	54,443	61,653	70,822	84,785	110,840	127,738	158,788	22%
	9	50,854	197,800	106,666	30,504			29%	31	75,024	82,600	86,828	98,897	123,907	145,336	156,224	18%
	10	133,603	2,341,681	425,175	502,836			118%	30	174,147	210,797	253,323	284,319	316,314	551,994	1,485,223	11%
Equity Cumulative	58	900,834	1,953,400	1,252,863	203,200			16%	27	977,902	1,060,286	1,134,521	1,236,076	1,358,730	1,420,166	1,465,747	9%

Table 33: VaR statistics (EQ asset class – only banks with general EQ risk approval)

EU Statistics for VaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Equity	1	2,012,721	2,275,650	2,125,993	90,429			4%	6	2,027,307	2,041,892	2,076,398	2,117,827	2,156,463	2,218,259	2,246,954	2%
	2	1,689,961	2,473,497	2,138,515	261,622			12%	6	1,777,154	1,864,347	2,070,486	2,188,669	2,241,569	2,362,530	2,418,013	4%
	3	13,187	23,191	18,187	4,299			24%	5	13,529	13,871	14,897	17,873	21,788	22,630	22,911	19%
	4	1,164	2,451	1,653	605			37%	4	1,170	1,176	1,194	1,499	1,958	2,254	2,352	24%
	5	12,289,873	24,106,529	17,719,082	4,244,929			24%	5	13,131,944	13,974,016	16,500,230	17,473,661	18,225,115	21,753,964	22,930,246	5%
	6	21,885	40,880	34,726	7,497			22%	5	24,485	27,085	34,885	37,386	38,592	39,965	40,422	5%
	7	14,018	44,272	30,937	15,442			50%	3	16,068	18,118	24,269	34,521	39,396	42,322	43,297	24%
	8	24,134	157,324	66,191	61,708			93%	4	25,482	26,830	30,873	41,653	76,971	125,183	141,253	43%
	9	56,881	89,974	79,443	13,463			17%	5	61,007	65,134	77,514	85,031	87,815	89,111	89,542	6%
	10	210,487	1,390,911	465,947	517,338			111%	5	214,754	219,020	231,818	239,744	256,776	937,257	1,164,084	5%
Equity Cumulative	58	403,567	1,154,075	873,463	409,496			47%	3	469,485	535,403	733,157	1,062,748	1,108,411	1,135,809	1,144,942	20%

Table 34: Stress VaR statistics (2008-2009 stress period only)

EU Statistics for SVaR

	Port. ID	Min	Max	Ave.	STDev	STDev_trunc[1]	MAD (median absolute deviation)	Coefficient of variation (STDev/Mean)	Num obs.	5th	10th	25th	50th (Median)	75th	90th	95th	Interquantile range
Equity	1	5,682,339	8,197,875	6,536,584	638,742			10%	24	5,783,855	5,865,854	5,930,492	6,469,482	7,039,813	7,182,034	7,315,835	9%
	2	4,108,289	14,397,699	9,930,364	2,401,971			24%	23	7,486,582	7,622,123	7,935,850	10,396,842	11,758,549	12,418,261	13,222,676	19%
	3	19,367	65,386	38,623	11,831			31%	24	21,588	25,485	29,001	37,640	45,148	53,374	55,387	22%
	4	1,001	412,300	22,615	84,972			376%	23	1,422	2,027	3,821	5,165	6,762	7,593	7,960	28%
	5	462,641	77,940,358	48,451,310	13,944,501			29%	23	40,050,855	41,673,855	43,026,981	48,085,424	55,959,943	57,332,886	67,544,630	13%
	6	15,418	93,762	56,449	21,879			39%	24	22,854	25,746	42,453	58,387	74,022	82,546	87,705	27%
	7	15,398	278,692	137,021	67,541			49%	20	24,710	57,939	99,595	125,052	177,401	215,331	227,869	28%
	8	11,217	236,700	129,049	52,434			41%	23	66,923	67,788	102,981	124,343	159,400	187,882	210,572	22%
	9	94,665	215,962	152,694	29,431			19%	24	98,201	118,928	134,560	157,007	172,699	181,381	182,487	12%
	10	436,499	14,171,692	2,214,451	3,592,933			162%	22	710,928	874,632	919,868	1,031,001	1,130,195	2,466,393	11,711,235	10%
Interest Rate	11	47,642	290,975	199,126	71,105			36%	29	66,195	92,041	165,868	220,311	245,714	274,465	281,284	19%
	12	28,331	275,723	124,002	66,254			53%	29	36,732	44,934	81,522	113,852	155,355	220,003	247,510	31%
	13	212,991	447,735	345,626	57,267			17%	29	237,483	279,619	326,509	341,636	384,712	421,465	427,776	8%
	14	41,675	177,960	89,598	30,462			34%	29	42,665	55,233	70,098	90,437	105,000	127,132	135,555	20%
	15	21,864	268,981	83,472	66,661			80%	14	28,208	32,696	38,149	52,840	114,667	141,731	190,047	50%
	16	76,278	484,870	221,999	83,092			37%	28	99,511	105,592	178,790	232,597	256,413	297,149	316,727	18%
	17	141,711	594,496	391,101	107,169			27%	23	246,708	257,156	303,276	408,408	457,989	516,829	523,430	20%
	18	86,332	1,221,666	356,767	214,934			60%	23	135,703	253,419	288,693	308,487	345,359	455,855	611,316	9%
	19	76,657	398,131	280,994	94,982			34%	29	116,541	130,601	246,607	306,600	344,267	374,616	395,353	17%
	20	20	88,598	20,143	23,396			116%	28	1,209	3,396	7,020	12,722	19,627	54,095	77,930	47%
	21	177,586	886,194	592,574	209,301			35%	28	201,284	246,802	542,247	661,039	702,087	807,015	850,009	13%
	22	33,668	354,856	166,722	105,157			63%	29	43,351	61,692	122,666	151,068	197,276	225,797	343,464	23%
	23	124,819	822,679	355,553	136,654			38%	28	211,005	242,751	271,490	344,377	380,750	520,960	588,980	17%
	24	61,289	1,006,327	543,513	315,645			58%	28	68,832	100,711	282,759	638,118	840,134	892,910	931,018	50%
	25	90,026	1,051,791	321,422	270,503			84%	28	127,461	139,546	163,391	197,929	335,646	791,969	976,676	35%
	26	200,532	2,614,030	716,813	444,759			62%	23	374,688	407,657	582,790	659,197	709,080	893,965	937,011	10%
FX	27	954,508	1,941,759	1,415,765	310,702			22%	26	991,904	1,094,062	1,176,193	1,340,201	1,687,648	1,888,646	1,925,082	18%
	28	8,699	74,117	25,973	12,961			50%	25	11,372	12,768	19,648	25,140	29,659	36,276	40,360	20%
	29	292,878	687,088	417,798	75,816			18%	26	325,061	354,169	384,920	399,477	441,483	485,836	530,733	7%
	30	874,790	1,516,000	1,189,223	177,041			15%	26	882,406	902,325	1,063,678	1,231,405	1,323,735	1,351,965	1,435,527	11%
	31	836,933	2,363,916	1,199,162	323,762			27%	26	896,237	905,960	980,821	1,152,245	1,268,955	1,463,611	1,755,621	13%
	32	92,080	1,118,231	439,461	373,317			85%	26	99,555	107,691	134,434	153,571	797,117	902,278	970,741	71%
Commodity	33	9,016	49,617	23,049	10,548			46%	14	12,465	14,484	15,889	20,243	27,110	34,829	40,847	26%
	34	347,272	691,436	504,680	115,818			23%	14	375,490	390,811	414,203	479,790	581,970	678,768	687,522	17%
	35	431,142	1,212,995	1,014,483	208,716			21%	14	713,114	864,992	926,102	1,071,049	1,199,179	1,207,295		12%
Credit Spread	36	4,842	146,989	32,497	30,931			95%	18	13,509	16,307	19,174	23,228	33,444	48,842	65,092	27%
	37	38,458	217,500	109,514	53,290			49%	16	42,783	53,967	72,436	103,119	134,909	179,832	209,677	30%
	38	7,123	41,500	19,230	9,077			47%	17	7,599	7,771	13,346	18,853	25,238	28,978	33,806	31%
	39	23,477	120,400	54,594	27,500			50%	17	27,428	29,272	35,218	47,388	69,195	90,198	107,065	33%
	40	8,060	63,068	24,123	14,401			60%	17	8,499	8,846	11,694	24,847	33,157	36,405	41,816	48%
	41	18,192	336,416	63,251	73,019			115%	19	23,699	27,152	34,785	46,800	52,973	81,620	150,831	21%
	42	33,366	318,271	110,762	83,458			75%	16	33,692	34,444	49,403	87,865	141,309	225,200	273,112	48%
	43	24,277	359,370	103,669	75,340			73%	19	43,016	53,278	66,044	82,233	116,201	149,756	237,223	28%
	44	12,740	99,647	36,076	21,207			59%	19	13,303	15,884	18,206	34,657	43,028	58,361	67,690	41%
	45	9,629	13,457,185	755,663	3,076,290			407%	19	11,026	15,067	20,368	33,105	67,037	128,342	1,567,778	53%
	46	4,068	55,879,405	2,966,649	12,813,422			432%	19	6,737	10,139	17,301	23,014	37,778	66,280	5,653,029	37%
	47	4,572	45,463	16,769	12,884			77%	19	5,640	6,617	7,479	11,236	23,448	35,471	41,826	52%
	48	8,993	84,738	41,648	16,156			39%	19	23,952	27,295	33,108	38,377	46,622	59,129	67,127	17%
	49	1,937	115,917	19,835	24,551			124%	19	6,334	7,710	11,575	14,170	19,510	21,554	36,119	26%
	50	4,453	151,711	34,257	31,078			91%	18	13,407	17,364	22,280	27,542	33,539	45,327	62,107	20%
	51	163,413	782,400	347,911	180,619			52%	16	165,302	171,585	210,779	293,255	446,250	561,672	631,426	36%
	52	139,646	686,300	334,841	183,603			55%	16	155,397	164,078	201,853	268,022	429,167	615,923	679,068	36%
	53	306,061	1,445,200	629,639	340,319			54%	16	323,067	330,632	373,695	530,612	790,534	1,115,136	1,216,447	36%
CTP	54	4,430	21,078	13,745	6,894			50%	4	5,948	7,465	12,017	14,736	16,464	19,232	20,155	16%
	55	72,261	94,154	83,207	15,481			19%	2	73,356	74,450	77,734	83,207	88,680	91,964	93,059	7%
	56	701,824	1,398,753	1,050,288	492,803			47%	2	736,670	771,517	876,056	1,050,288	1,224,520	1,329,060	1,363,906	17%
ALL-IN no-CTP	57	4,437,423	7,078,821	6,041,386	854,052			14%	14	4,802,598	5,038,274	5,440,073	6,071,819	6,852,640	7,054,671	7,071,003	11%
Equity Cumulative	58	1,498,399	5,573,622	4,467,532	1,038,199			23%	20	1,931,359	3,757,297	4,140,008	4,864,842	5,051,305	5,213,958	5,233,434	10%
IR Cumulative	59	295,485	1,419,017	575,107	249,028			43%	23	313,673	336,046	393,612	517,593	697,614	812,802	830,061	28%
FX Cumulative	60	1,389,643	3,863,541	2,926,276	503,734			17%	26	2,445,355	2,496,070	2,642,755	2,913,787	3,231,050	3,382,490	3,716,807	10%
Commodity Cumulative	61	348,990	690,772	498,234	116,299			23%	14	377,400	392,896	405,995	465,074	587,425	668,477	677,911	18%
CS Cumulative	62	52,331	264,431	102,084	51,785			51%	17	55,235	60,716	66,806	93,603	111,400	148,615	181,540	25%
CTP Cumulative	63	610,003	1,227,884	918,944	436,908			48%	2	640,897	671,791	764,474	918,944	1,073,414	1,166,096	1,196,990	17%

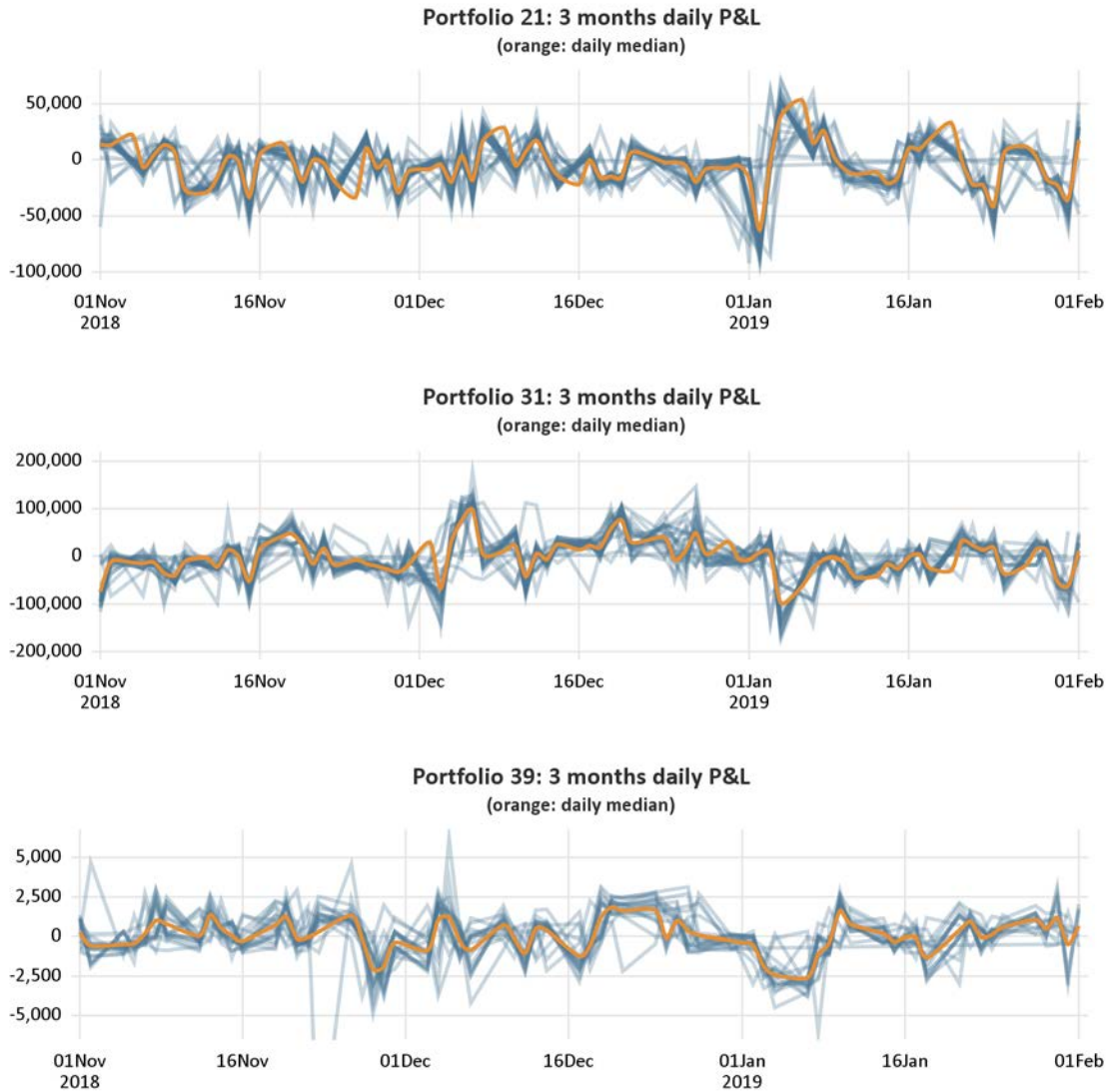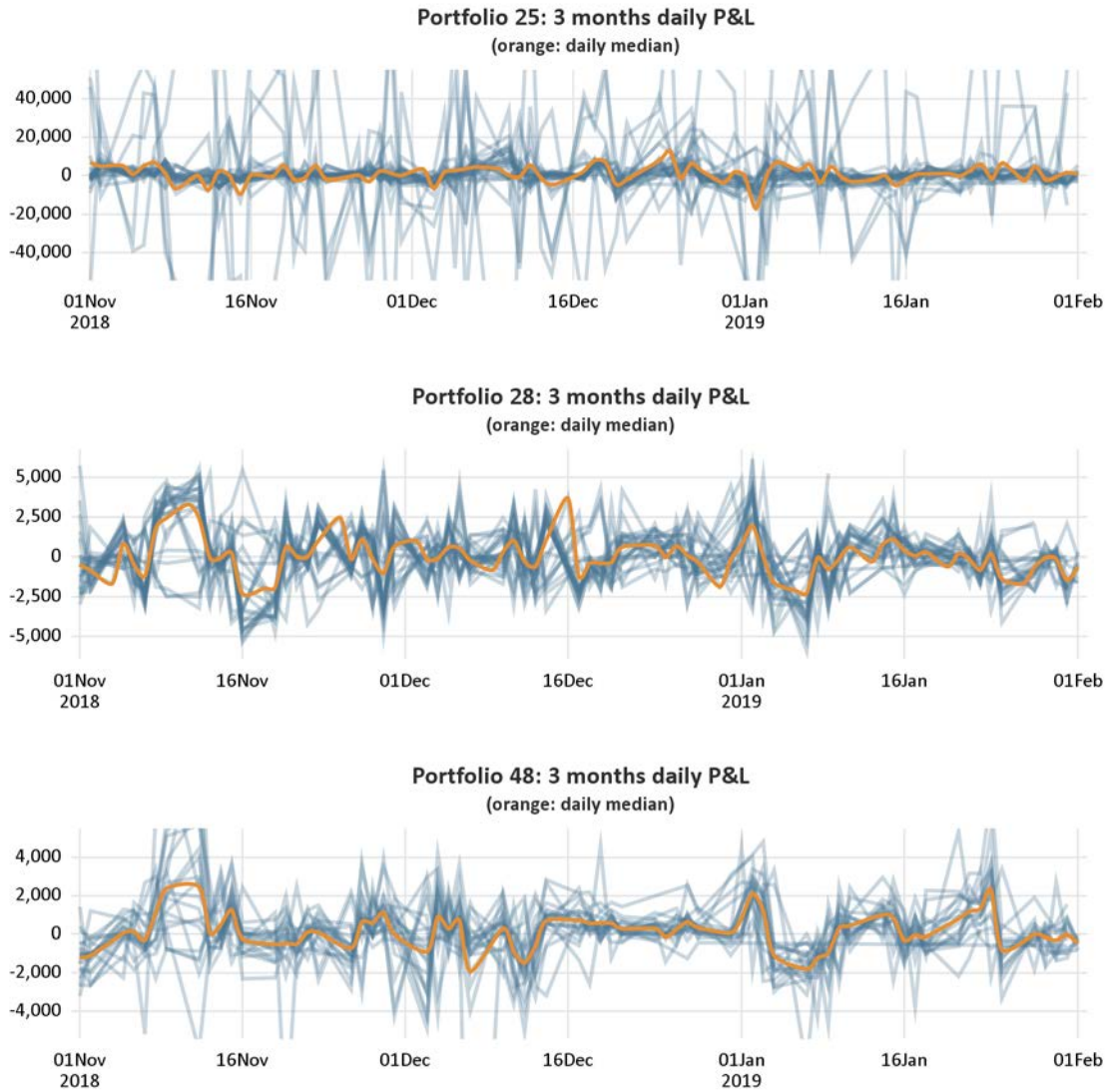**Figure 24: Additional P&L charts with examples of low IQD**

Portfolio 21: 3 months daily P&L
(orange: daily median)

Portfolio 31: 3 months daily P&L
(orange: daily median)

Portfolio 39: 3 months daily P&L
(orange: daily median)

Figure 25: Additional P&L charts with examples of high IQD

Portfolio 25: 3 months daily P&L
(orange: daily median)

Portfolio 28: 3 months daily P&L
(orange: daily median)

Portfolio 48: 3 months daily P&L
(orange: daily median)