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Fourth report on the consistency of risk weighted assets

Residential mortgages drill-down analysis

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Abbreviations

CRMO	Credit risk mitigation at origination
DTSO	Debt-to-service ratio at origination
EAD	Exposure at default
ILTV	Indexed loan-to-value
LGD	Loss given default
LTIO	Loan-to-income at origination
LTVO	Loan-to-value at origination
PD	Probability of default
RM	Residential mortgage
RW	Risk weights
RWA	Risk-weighted asset

Executive summary

1. As part of the analysis regarding the consistency of risk-weighted assets in residential mortgage portfolios, this report summarises the findings of the second phase: the drill-down analysis¹. The objective is to attempt to understand if, and how, different variables describing the portfolios (beyond the by-country² clusters) could explain the differences in risk weight across the EU banks³ found in phase one.
2. The investigated variables are the loan-to-value at origination (LTVO), the indexed loan-to-value (ILTV), the debt-to-service at origination (DTSO), the loan-to-income at origination (LTIO) and the credit risk mitigation at origination (CRMO). Data by year of origination for current⁴ exposures has also been collected. For this purpose, predefined buckets for each drill-down variable were used.
3. According to the answers provided by the banks about the use of such variables, the (indexed) loan-to-value and credit risk mitigations are more commonly used in the models; the debt-to-service coverage ratio and loan-to-income are used less frequently and only in PD models.
4. The documentation provided by the banks highlighted the use of different definitions for similar concepts. Sometimes they reflect country-specific features, but overall the definitions are usually bank-specific. This is an important caveat to consider when reading the outcome of the quantitative analysis.
5. The study confirmed the existence of a positive correlation between the value of the different drill-down variables (LTVO, ILTV, DTSO and LTIO) and the RWs at the sample level. However, RW sensitivity to drill-down variables was not always found to be a clear explanatory factor of the risk-weight variation within the EU sample.
6. The EAD distribution across the bucket values of drill-down variables has little impact on the disparity of RWs across the EU sample.
7. On examining the correlation and variability analyses, the indexed loan-to-value (ILTV) is the variable which most significantly influences RW variation.
8. The analysis by vintage confirms the existence of a close link between the level of LTVO and RW and the potential influence of the portfolio composition by vintage in explaining the variation in RWs.

¹ Drill-down results for SMEs have already been presented in the December interim report for SMEs and Residential mortgages:

<http://www.eba.europa.eu/documents/10180/15947/20131217+Third+interim+report+on+the+consistency+of+risk-weighted+assets+-+SME+and+residential+mortgages.pdf>

² In line with the first report, the country of exposure is the country where the collateral is located.

³ Across the 14 EU jurisdictions participating in this study, 43 banks submitted data for up to 10 countries.

⁴ By December 2012, as for phase one.

9. Some country specifics have been identified. Credit risk mitigants other than mortgages are important drivers which should be considered when assessing the variation in some countries, and seems to explain the lower RW sensitivity to the value of the financed real estate.
10. Further, when studying the level of the average drill-down variables at the banking-group level, the use of a specific combination does not appear to explain the differences in RWs.
11. Finally, the direct contribution of drill-down variables to the estimation of PD, LGD or both models does not seem to discriminate across banks in terms of RWs. This is probably because when it is not reported that these variables have been used in the estimations, it can be assumed that filtering credits based on those variables, when granting a loan to a customer, will play an indirect but significant role.

1. Introduction

12. This note reports on the second phase of the residential mortgage analysis, namely the investigation of the so-called drill-down variables and their impact on RWs:
 - loan-to-value at origination (LTVO);
 - indexed loan-to-value (ILTV);
 - debt-to-service at origination (DTSO);
 - loan-to-income at origination (LTIO);
 - credit risk mitigation at origination (CRMO).
13. For this analysis, the 43 banks in the EBA sample were asked to report their non-defaulted exposure-at-default (EAD) and their average RW by pre-set buckets for each of the drill-down variables. This information was collected for several European countries of exposures. This approach was necessary to investigate trends at the aggregate level. Banks were therefore allowed to make use of their own definitions for each variable, which they had to document.
14. The drill-down variables were selected from the variables that are commonly reported by the banks as being major risk drivers used in the banks' risk parameter estimations in the first phase of the Residential mortgages study. The final selection of the variables⁵ was done by EBA using expert judgement.
15. The first section of the report provides an overview of the definitions of drill-down variable used by banks. In the second section, the use of drill down variables in the modelling of the risk parameters is described. The third section covers the quantitative analysis and finally an overview of the findings is given.

⁵ The long list included: occupier owner/buy to let; type amortisation, type contractual interest rate, indexed debt-to-service and loan-to-income.

16. The analyses were carried out to determine whether:
- RW variability is driven by the drill-down variables;
 - the portfolio composition by drill-down variables can explain differences in RW within the EU sample;
 - any country-specific patterns exist;
 - the use of the variables in the PD/LGD estimations are significant.
17. The study does not aim to comment on the opportunity to use the different drill-down variables, or discuss the appropriateness of the RW sensitivity towards them.
18. The major limitations of the information used in the study are:
- the use of drill-down variables on a standalone basis (rather than in combination) does not help to establish whether different RW sensitivities are caused by different converging or distorting factors;
 - the absence of a complementary approach (e.g. hypothetical facilities for multi profiles⁶) to the real exposures data may severely limit the understanding of modelling choices and the impact of banks' credit policies;
 - the use of common and predefined buckets for all the countries involved may lack of granularity and limits the ability to understand RW sensitivity;
 - the absence of any information on PD/LGD parameters does not allow direct investigation of whether the drill-down variables mainly influence a particular parameter or detect possible compensation effects;
 - a separate but interlinked issue with d) is that the absence of information on when and how the minimum LGD 10%⁷ is applied limits and potentially distorts any assessments of the sensitivity;
 - the use by the banks of their own definitions for the drill-down variables facilitated the submissions (if available) of the data by the banks. However, the materiality of the use of different definitions across the bank sample has not been possible to be assessed in terms of additional source of variation..
19. The results of the study must be read alongside the results in the phase one report published in December 2013¹. A large part of the analysis was performed at EU sample level⁸.

⁶ The use of hypothetical facilities for residential mortgages has been positively tested in one country. Initially EBA evaluated this option but then decided that, considering the limited experience and complexity in providing all the relevant details to specify the transactions, a hypothetical facility would not be used in the study.

⁷ Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms (CRR), Art. 164(4).

⁸ An example of application of some investigations at country level is contained in Annex 5.

20. The report has not factored in supervisory action or model changes that have occurred since the observation date (31 December 2012).

2. Definitions

General

21. The reported documentation by banks indicates a wide range of definitions of the different variables, across banks and across countries. Within banking groups, definitions also appear to accommodate country-specific differences.
22. Not all banks report on all same aspects or in the same depth of detail for these definitions, i.e. some banks provided only general information. This does not allow a precise comparison of these definitions across banks nor an assessment of the full impact of any definition on the reported quantitative data
23. In addition, some banks made use of ‘proxies’ for reporting purposes, as some of the requested data were either not available (not recorded) in a straightforward way or not used internally. However, the former often only occurred for part of the stock of loans; in recent years, many of the banks mentioned have been improving data collection and storage for the types of variables we asked for.

By variable⁹

Loan-to-Value at Origination (LTVO)¹⁰

24. The most common definitions of LTVO used by banks include the following.
- Numerator: the sum of all (original) loan disbursements.
 - Denominator: the market value of the property at origination. If new loans (guaranteed by the same property) had been granted at later stages, these are generally taken into consideration in a new LTVO for this property, which takes into account capital already reimbursed.
25. In addition to this core definition, many variants were found, of which a summary is presented in the following table.

⁹ This section provides a summary of the internal definitions used by the banks for reporting the data for each drill-down variable. This excludes CRMO for which, according to the instructions, the banks were requested to provide data breakdown for pre-defined credit risk mitigants, and only in very few cases provided supplementary information.

¹⁰ For LTVO, the closest concept to the ratio was expected [loan amount at origination/market value at origination]; ‘loan amount’ refers to the sum of loans granted against one property.

Figure 1: Observed variant to the LTVO core definition across European bank sample

Numerator	Denominator
(+) Prior liens	(-) Prior liens
(-) Other CRM	(+) Other CRM
(+) Undrawn exposures	Different 'value' concepts : Estimated/expected Market value (with haircut or not) Purchase price Price based on internal models
(+) Further advances on property	
(+) Costs, fees	
(+) Non-housing loans but same collateral	
Split over multiple loans at 'origination' secured by the same collateral	

26. There is no consistency in how the banks include the factors mentioned in the table above (some banks include the factors in the numerator, some in the denominator, etc.). This makes any comparison at the sample level challenging.

Indexed Loan-to-Value at Origination (ILTV)¹¹

27. The ILTV definition builds logically on the one at origination for banks. Although, even more variation seems to be added to the definition due to the frequency of indexing the values (quarterly, semi-annually or yearly) or the different indexation methods used at national level. In the latter, next to the rather commonly used external indicators (which sometimes vary at country level), some banks also referred to the use of internal models for indexing the collateral valuation or the use of a stressed value based on lowest prices or downturn adjustment.

Debt-to-Service at Origination (DTSO)

28. The DTSO¹² was also investigated. In particular, along with the loan-to-income, the percentage of data not available was the highest for this variable, as quite often banks had only started to record and store those data very recently.

29. Again, many variations were found in the definitions used across banks. The following table lists a summary of the main ones in addition to the core definition. No significant country-specific patterns were observed in these definitions.

¹¹ By indexed loan-to-value was expected any concept close to the ratio (the current loan amount to the current market value).

¹² By DTSO was expected any concept close to the ratio (monthly instalment/net monthly revenues available).

Figure 2: Observed variant to the DTSO core definition across European bank sample

Numerator	Denominator
(+) Instalments of all non-housing loans (in this bank or in other banks)	(-) Instalments of all non-housing loans (in this bank or in other banks)
(+) Charges (residential costs, etc., childcare, etc.)	(-) Charges (residential costs, etc., childcare, etc.)
(+) Updated for latest advances	(+) X % rental income
By contract or not	Gross vs. net revenues
- X% income guarantor	(+) Non-regular professional revenue
Based on 'hypothetical' scenarios (standard credit)	(+) Capital income
Based on stressed scenarios	Updated for latest advances
(+) Instalments of all non-housing loans (in this bank or in other banks)	(+) X% income guarantor
Use of joint accounts or not	

Loan-to-Income at origination (LTIO) ratio¹³

30. The LTIO often builds on the monthly debt-to-service definitions used by banks, as many banks simply scale the numerator and denominator to one year, while others directly use the yearly available inputs. When scaling, factors range from 12 to 14 on average.

3. PD and LGD estimations

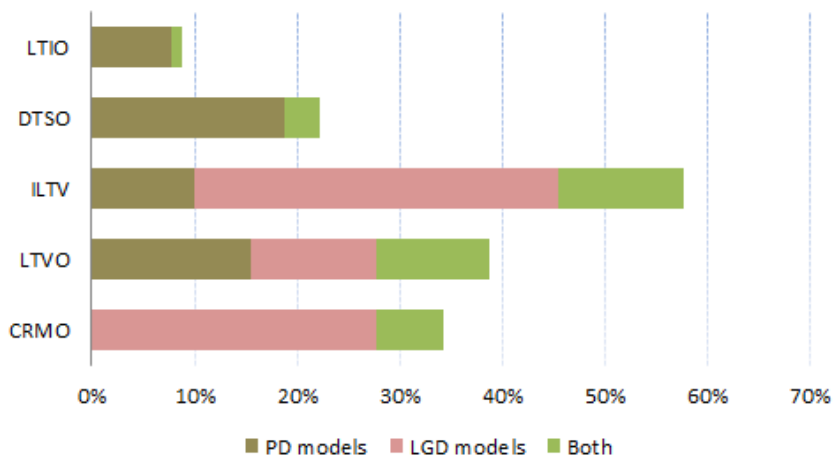
Use of drill-down variables in risk parameter estimations

31. Each bank was also asked if the variables were used as an input in the estimation of LGD, PD, both or none. In this regard, the indexed loan-to-value appears to be the main variable (58%¹⁴) of the five being used in any of the estimations. The second and third most commonly used variables are the LTVO and the credit risk mitigation. Loan-to-income is the least commonly used variable (see Figure 3).
32. For some banks, the variables at origination – especially debt-to-service, loan-to-income and loan-to-value ratios – are included in the credit assessment at origination and are therefore an indirect input in the PD and LGD modelling. However, as they are not a formal variable in the modelling and they will not appear in the percentages presented below.
33. Regarding the relatively low percentage use of CRMO, the most simple explanation is that if banks do not make use of multiple credit risk mitigation techniques (e.g. financial collateral, government guarantee, etc.), but simply use a mortgage, they may have mentioned not using the CRMO variable in their estimations.

¹³ By LTIO ratio, any concept close to the ratio was expected (borrowed amount/(net) annual income).

¹⁴ Either in PD, LGD or both models. In 42% of cases, the variable is therefore not used.

Figure 3: Percentage¹⁵ use of the variables in the PD/LGD/both estimations



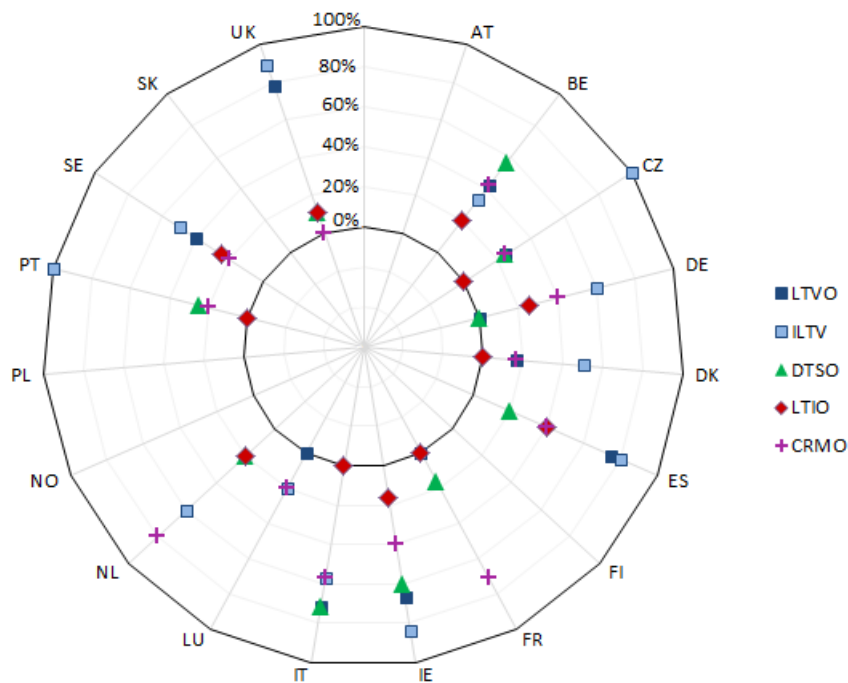
Source: EBA data collection (reference date: December 2012), EBA calculation

34. The debt-to-service ratio and loan-to-income ratios are never used as input in the LGD model only, whereas the credit risk mitigation variable is never used as input in the PD model only.
35. The indexed loan-to-value and credit risk mitigation are reported as being mainly used in LGD estimations. The use of the loan-to-value at origination for the PD modelling, as well as the significant use in both models (PD and LGD) for some variables (i.e. ILTV, LTVO and CRMO)¹⁶ was less expected.
36. Regarding the influence of the variables used in the RW sensitivity, see Section 5.

¹⁵ Out of a sample of 90 data points (banks exposures by country), across the 5 variables. No reporting for a variable is still considered to be a data point.

¹⁶ For LTIO and DTSO few exceptions of application are notable for both modelling, while no bank reported to apply such variables for LGD only.

Figure 4: Share of the drill-down variables used in the estimations, by country of localisation of exposures.



Reading note: as an example, the green triangle for BE means that 60% of the banks with exposures in Belgium reported to use DTSO within PD, LGD or both models. Countries with less than four observations are not reported.

Source: EBA data collection (reference date: December 2012), EBA calculation

37. Figure 4 provides an overview of the use of drill-down variables in the different countries.

38. In some cases, the prevalent use of one set of variables for the reporting banks in the sample is more evident. In particular:

- the indexed loan-to-value is largely used for exposures in the Czech Republic, Portugal, United Kingdom, Spain and Ireland;
- the existence of other credit-risk mitigants is more significant for exposures in the Netherlands and France;
- the DTSO is more significantly used for exposures in Italy and Belgium.

Combination of variables

39. Analysing the use of drill-down variables combined with others, the indexed loan-to-value again features as the most prevalent variable in any combination (more frequently used with LTVO and CRMO). When the banks reported using only one variable, the ILTV and the CRMO were again the most common ones.

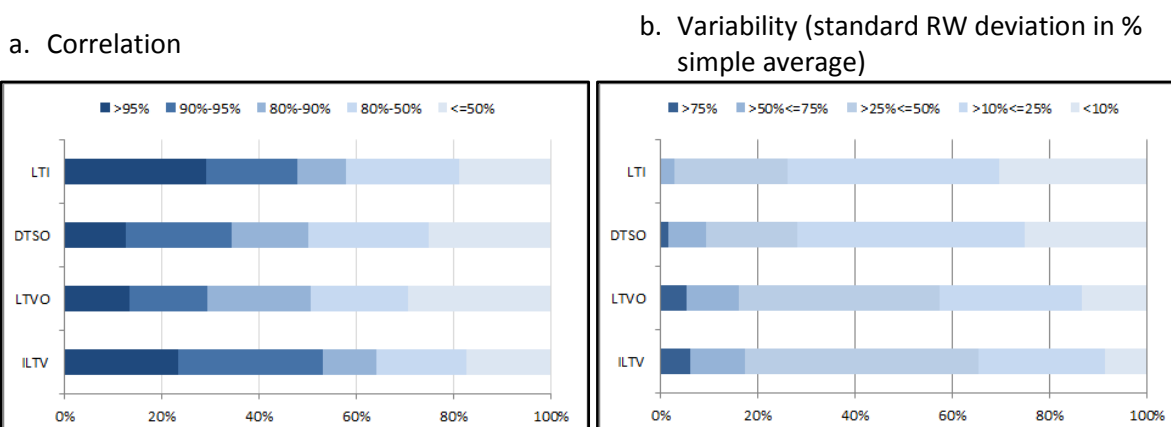
4. Quantitative analysis

40. Banks reported their EAD and RWA in the different countries where they have exposures for each variable (LTVO, ILTV, DTSO, LTI) and by bucket..
41. For the LTVO, the banks also provided a further breakdown of the RWs by vintage of origination.
42. Banks were also asked to provide quantitative information on the exposure amounts and risk-weighted assets, distinguishing between the level and type of different credit-risk-mitigation techniques, i.e. exposures fully and only secured at origination by mortgages and others (CRMO). In particular, more granular data has been collected for the exposures with 'mandate', (government guarantees, financial institutions guarantees, personal guarantees and financial collateral).
43. The quantitative data, combined with the more qualitative information where possible, have been used in top-down, correlation and variability analysis, or more simply to produce descriptive charts at EU sample level. Country-level investigation is likely to be very useful in making additional progress, facilitating the integration with first-phase findings and understanding the differences between banks.

RW correlation and variability by drill-down variables

44. For each drill-down variable, the correlation between RW and the drill-down variables was measured, and the variability (defined as the standard deviation RW in percentage of the simple average) of the RWs, making use of the values reported by the banks for each bucket.

Figure 5: Correlation and variability of RWs by drill-down variables



Reading note: each colour represents the share of the observations (bank risk weights for each drill-down variable for country x) having different range values for: a. correlation between risk weights and drill-down buckets values; b. standard deviation (in % simple average risk weights) in the reported risk weights for different drill-down buckets values.

Source: EBA data collection (reference date: December 2012), EBA calculation

45. For all the variables, a correlation above 80% was observed in the majority of cases. In particular, for the ILTV in around 65% of the observations, the correlation was above 80%.

46. Similarly, among the different variables observed, variability was significantly higher for ILTV where the standard deviation relative to the mean was higher than 25% in around 65% of the observations.

Credit risk mitigation

47. From the study of the LTVO definitions used by banks, and corroborated by the data analyses, it emerged that some banks make large use of the mortgage value as a credit mitigant when calculating the LTVO ratio. Some banks may even consider only the mortgage value in this calculation.
48. The existence of other credit risk mitigants is more relevant in some countries (see Figure 16 in Annex 1).
49. Overall, the data collected suggest that when residential mortgages exposures are secured by other credit risk mitigants, the RWs are higher, with the exception of some specific national instances such as:
- a. in France when exposure is supported by guarantees such as the 'Credit Logement', the average exposure-weighted RWs are lower (10%) than at portfolio level (13%);
 - b. in the Netherlands when exposures are accompanied by the NHG (Nationale Hypotheek Garantie) guarantee, the average exposure-weighted RWs are lower (8%) than at portfolio level (10%);
 - c. in Belgium when there is a 'mandate', the average exposure-weighted RWs are lower (7%) than at portfolio level (10%).
50. In France, the Netherlands and Belgium, among the residential mortgages exposures that are not only secured by mortgages, these national-specific instances are the most relevant. In some cases, those features, might explain (i.e. in France and the Netherlands) the lower sensitivities to LTV observed in the study.

Top-down analysis EU sample: benchmarks, portfolio composition (mix effect), RW levels and RW sensitivity (price effect)

51. The data submitted by the banks for each drill-down variable have been used to calculate EU benchmarks (exposure-weighted average¹⁷, see table below). Figure 16 in Annex 1 also contains statistics calculated for the drill-down variables in the different countries and at EU sample level.

¹⁷ As suggested by the charts in the Annex 4, the use of the median, in general, would produce benchmarks higher for the large majority of the buckets for the different drill-down variables.

Figure 6: EU benchmark RW by drill-down variables

ILTV		LTVO		DTSO		LTI	
Buckets	RW	Buckets	RW	Buckets	RW	Buckets	RW
[0-50%]	7%	[0-50%]	7%	[0-10%]	10%	[0-1]	12%
[50-60%]	8%	[50-60%]	8%	[10-20%]	11%	[1-2]	11%
[60-70%]	10%	[60-70%]	10%	[20-25%]	12%	[2-3]	11%
[70-75%]	11%	[70-75%]	10%	[25-30%]	13%	[3-4]	12%
[75-80%]	13%	[75-80%]	14%	[30-35%]	14%	[4-5]	13%
[80-85%]	15%	[80-85%]	15%	[35-40%]	15%	[5-6]	14%
[85-90%]	17%	[85-90%]	17%	[40-45%]	15%	[6-7]	16%
[90-95%]	20%	[90-95%]	20%	[45-50%]	16%	[7-8]	18%
[95-100%]	21%	[95-100%]	19%	[50-60%]	16%		
[100-105%]	24%	[100-105%]	17%	[60-70%]	17%		
[105-110%]	24%	[105-110%]	16%				
[110-120%]	25%	[110-120%]	20%				
[120-150%]	28%	[120-150%]	13%				

52. The EU benchmarks have been used to conduct top-down analysis¹⁸ separately for each of the drill-down variables to see how the average RW at portfolio level (bank by country) is driven by a price or a bucket mix effect (see paragraphs 53 to 55 for the definition and Annex 2 for the calculations).
53. The top-down results presented in this section are based on all the observations available at EU sample level, and aim to provide an overall picture (although available, the information by country is not used at all). Indeed, applying the same approach at country¹⁹ (cluster) level allows more specific conclusions to be drawn, benefiting from the opportunity to control for market specific instances. Annex 5 illustrates the results of top-down analysis for one country based on the calculation of a country benchmark.
54. The price effect is calculated by applying the benchmark share (average of the banks' samples) to the difference between a bank's RW and the benchmark RW. In this way, the only difference between banks stems from the difference in RW level, and not from different exposure to different levels of drill-down variable (e.g. a different distribution of EAD by bucket of ILTV).
55. The price effect has also been broken down in terms of the 'level effect' and 'sensitivity effect'²⁰. The latter aims to measure the variability, relative to the benchmark, produced by applying different incremental changes in the RW between two of the bank's contiguous drill-

¹⁸ The top-down analysis has been performed replicating the same methodology applied in the previous studies. The general concept is to decompose the banks' RW differences from the benchmark by the progressive neutralisation of the potential variability contribution caused by the drivers.

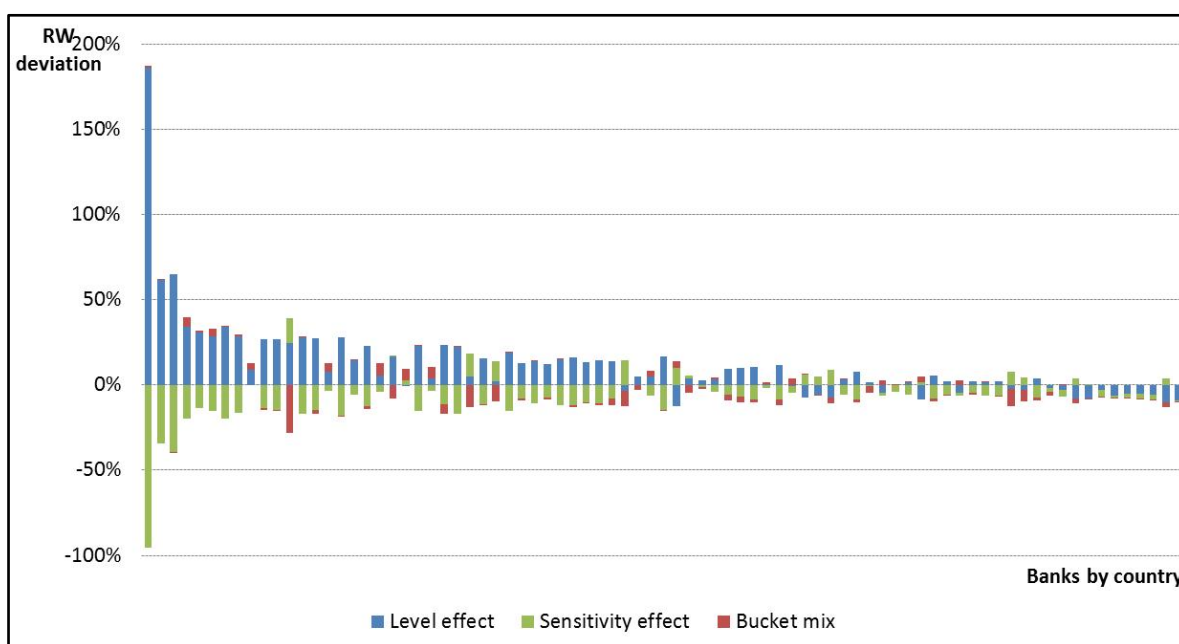
¹⁹ In the December SME and Residential mortgages report (Phase 1), the country dimension was identified as one of the key drivers in explaining RW variability.

²⁰ The sensitivity effect is measured by comparing the initial RW difference to the one resulting from the imposition for each observation of benchmark RW 'sensitivities' (average for the banks' sample for the incremental changes in the RW for increasing drill-down bucket values).

down buckets. For level effect is intended the residual RW gap after controlling for sensitivity, therefore tackling the level of the RW independent to the RW changes across drill-down buckets

56. The bucket mix effect is calculated by applying a bank's RW to the bank's deviation from the benchmark²¹ EAD distribution across the bucket. Therefore, here we are controlling for the difference in RWs applied to the benchmark distribution of EAD across bucket.
57. Notably, the price effect is much more significant than the bucket mix effect across all drill-down variables²². This means that the EAD distribution over the different buckets for each variable only has a minor effect on the average RW at the portfolio level across the sample of banks.
58. The bucket mix effect, even if small at sample level, only seems to play a significant role for some bank portfolios. Some country-specific patterns can also be seen, but without conclusive evidence, e.g. there is a possible LTVO bucket mix effect in Italy and the Netherlands, an ILTV-price effect in Italy and Ireland, and a DTSO price effect in Belgium.
59. In Figure 7²³ and Figure 8 below, the results for the top-down analysis for the ILTV sample are presented.

Figure 7: ILTV – break-down of the price (level and sensitivity) and bucket mix effects



Note: The banks are sorted by their RW deviation. A bank may be represented several times if it has submitted data for more than one country.

Source: EBA data collection (reference date: December 2012), EBA calculation

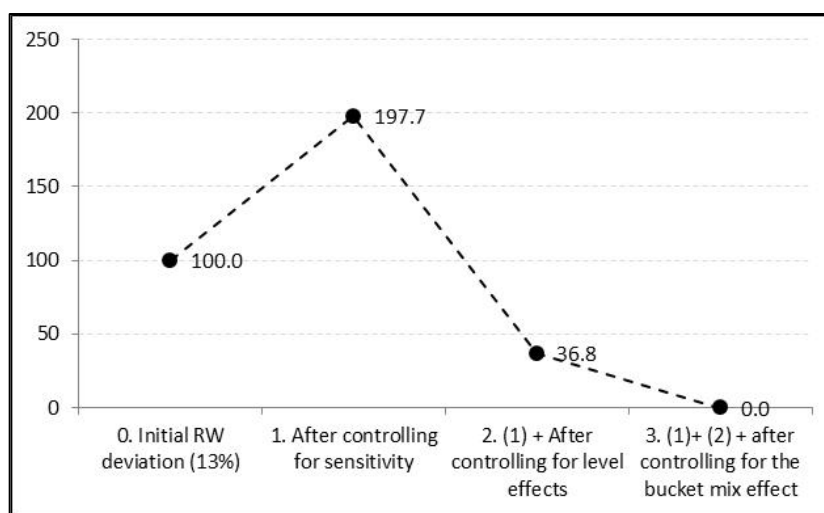
²¹ The benchmark EAD distribution is the average EAD distribution for the banks' sample.

²² Among the different drill-down variables, the ILTV has the 'highest' bucket mix effect (see Figure 7, Annex 3 and Annex 4).

²³ The results for other drill-down variables are presented in Annex 3. We focus here on the ILTV, as in the previous sections it has been shown to be the most used variable.

60. The level effect is more important than sensitivity effect, but both are present at EU sample level (see Figure 8)²⁴. There are significant differences in their materiality and sign (+/-) between the banks and countries²⁵: in about 80% of the observations, the sensitivity effect is negative (lower than the benchmark); around 70% of the banks' (by country portfolio) have a positive level effect (RW after controlling sensitivity higher than benchmark).

Figure 8: ILTV results – Indexed (100) standard deviation dynamic after controlling the price (level and sensitivity) and bucket mix effects results



Source: EBA data collection (reference date: December 2012), EBA calculation

61. The bucket mix effect accounts for around one-third of the index standard deviation; and in 60% of the cases, the bucket mix effect is negative (EAD concentration towards lower (less risky) ILTV buckets than the benchmark).

RW sensitivity to ILTV buckets in the EU sample²⁶

62. Upon finding the price effect to be the main contributor to the top-down analysis, an investigation was undertaken to determine if there is a correlation between level and sensitivity effects, and to establish the nature of the relationship between price effects and average RWs for the ILTV sample²⁷. The correlation was calculated (R squared = 85%) and simple graphical analysis was used.
63. Figure 9 plots the results of the top-down analysis for the RW level and sensitivity effects.
64. As depicted in Figure 9, the level (x-axis) and sensitivity effects (y-axis) clearly correlate (positive level effects are associated with negative sensitivity effects and vice-versa).

²⁴ The 'sensitivity' effect accounts for about 40% $((197.7-100)/((197.7-100)+(197.7-36.8)))$ of the price effect and about one fourth of the overall variation $(100-36.8)/(100*40\%)$.

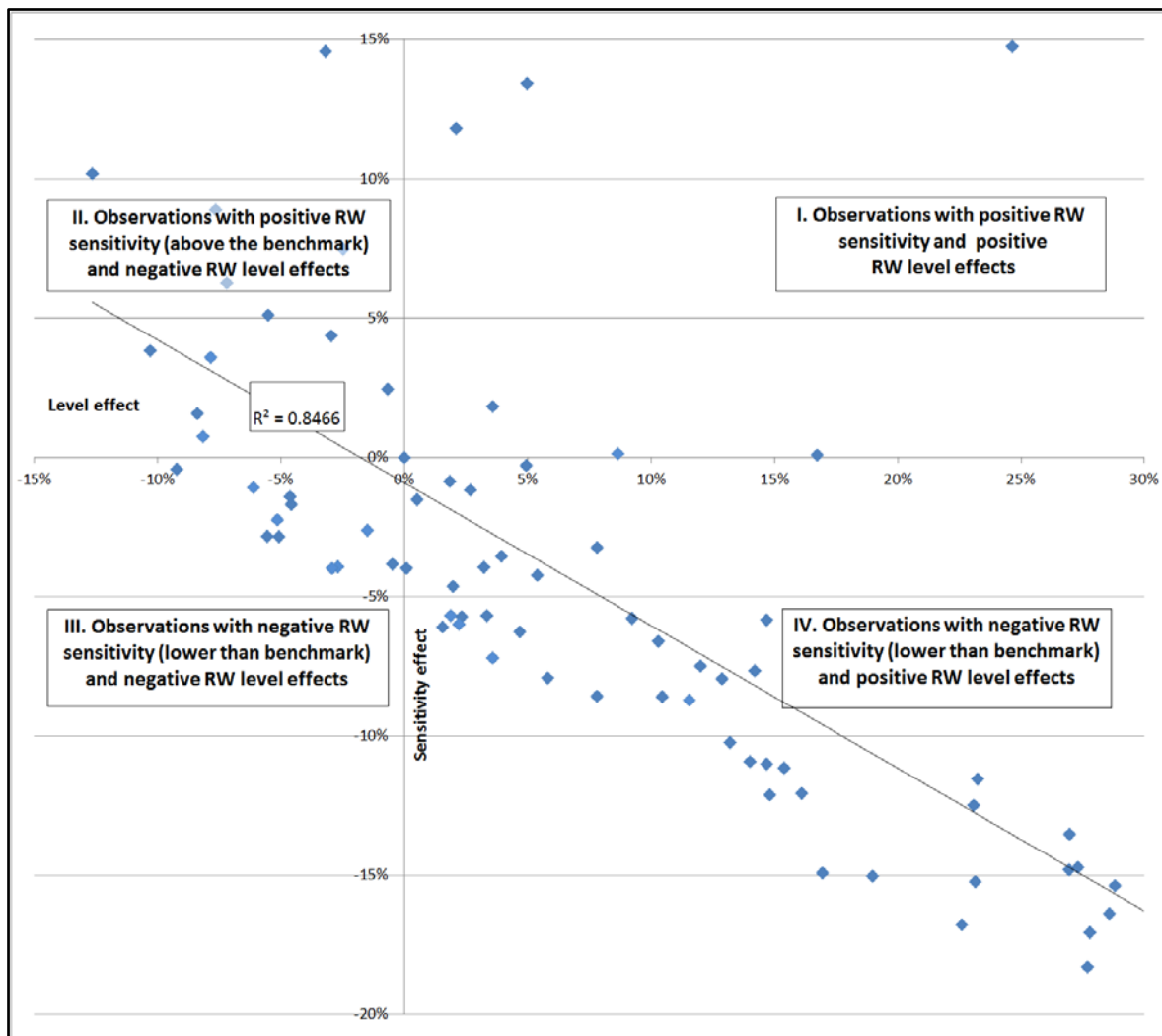
²⁵ The 'sensitivity' effect for ILTV appears more in PT, SE and the UK.

²⁶ In Annex 3 are contains charts with EAD and RW distribution by buckets (1st quartile, median, exposure-weighted average and 3rd quartile) for the different drill-down variables.

²⁷ The preliminary correlation and variability RW analysis identify the ILTV as a potentially more useful variable (among the variables observed) in explaining RW variation.

65. The chart in Figure 9 was then used to analyse the extent to which the distance of the observations, from the origin of the coordinate (benchmark), was influenced by the average RWs: the lowest RWs (lower than the benchmark) are concentrated below the black line in the third quadrant (south-west), and only a few appear in the lower area of the second quadrant (north-west). On the other hand, the majority of the banks with the highest RWs are concentrated in the lower area of the fourth quadrant.

Figure 9: ILTV – Correlation between RW level and RW sensitivity in the EU sample (top-down results)



Level effect (x axis) and sensitivity effect (y axis) are the decomposed top-down results for price effect. A bank may be represented several times if it has submitted data for more than one country. A small number of observations with extreme values in the south-east quadrant have not been reported.

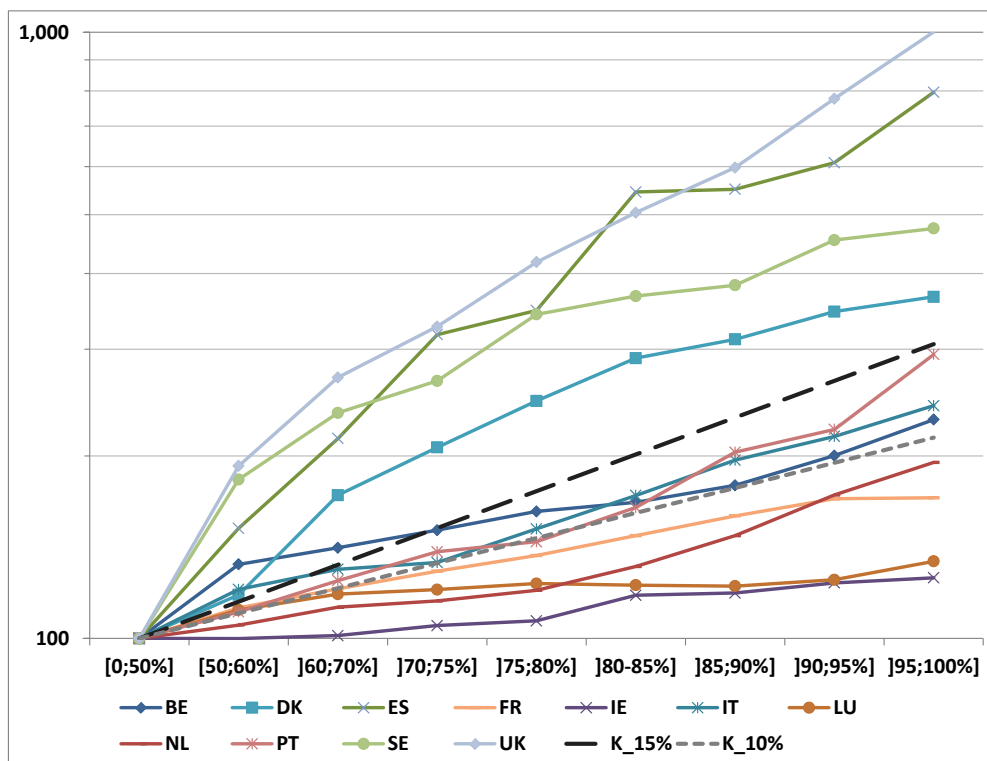
Source: EBA data collection (reference date: December 2012), EBA calculation

66. An in-depth investigation²⁸ of selected observations confirmed the findings of the top-down and correlation analysis. The RW differences are influenced by the RW sensitivity along the buckets for ILTV, but the relative importance may vary significantly among the other observations. Similar conclusions are reached for the RW-level effect. The presence of the RW sensitivity (or level) does not correlate with the RW gap from the benchmark.
67. In many cases, the RW differences appear to be explained by the RW level being driven by differences in the riskiness of the portfolio (default and loss rates) or, for example, by conservative margins in the estimates.

RW sensitivity to ILTV buckets: country specificities

68. To detect the presence of any country-specific patterns, the observations were grouped by country, and the average RW were plotted for each ILTV bucket (see Figure 10).
69. Exposures in the UK, Spain, Sweden and Denmark show, on average, the highest RW sensitivity with the level of the ILTV (the black line represents the hypothetical constant cumulative variation of 15% from the basis (100)). For exposures in the UK and Spain, and to a lesser extent for Sweden and Denmark, this is also in line with the answers provided by the banks regarding the widespread use of these variables in the models.
70. Exposures in the Netherlands, France, Luxembourg and Ireland show the lowest RW sensitivity (below the black dotted line, which represents the hypothetical cumulative variation of 10% from the basis (100)). The lower sensitivity observed in France and the Netherlands may be explained in part by the potential influence of other credit risk mitigants ('credit lodgement' and 'NHG').

²⁸ Not included in the report.

Figure 10: RW sensitivity by ILTV for selected²⁹ countries

Note: Logarithm values calculated using the first bucket as a basis (100). Within the same country, there are notable differences among the reporting banks.

Source: EBA data collection (reference date: December 2012), EBA calculation.

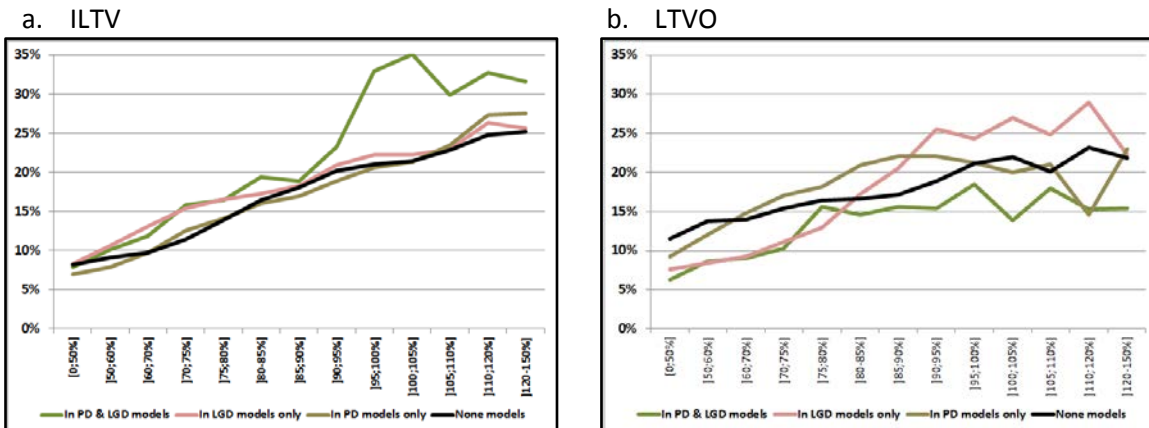
RW sensitivity and drill-down variables used in the PD/LGD estimations

71. For each drill-down variable, we grouped the banks based on their answers about the use of drill-down variables in the models (both, LGD, PD or none), and investigated the potential difference in relative RW sensitivity. The analysis did not provide strong evidence, but it was possible to observe that:

- for ILTV between 50% and 80%, the RWs are significantly higher when the banks use the variable in the LGD (pink line) or both models (green line) than in the other cases;
- for LTVO above 80%, the RWs are higher when the banks use the variable in the LGD models (pink line). When the variable is used in both PD and LGD models, the RWs are lower in most of the buckets (green line).

²⁹ Only EU countries with at least five observations

Figure 11: Average riskweight by bucket for ILTV and LTVO for groups of banks built on the use/non-use variables in the models (PD, LGD, both or none)

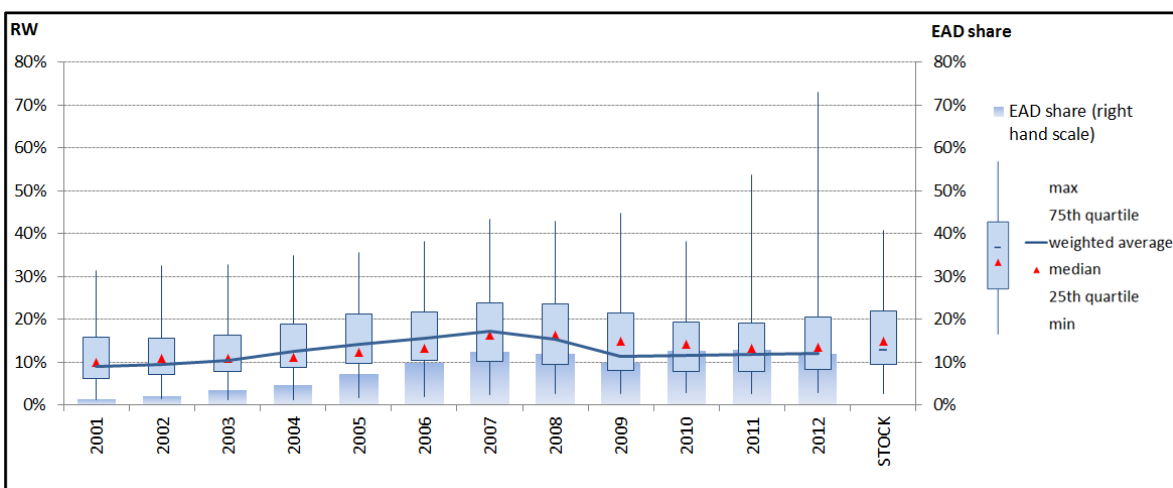


Source: EBA data collection (reference date: December 2012), EBA calculation

RW sensitivity by vintage of loans

72. Using the by vintage at origination information, it is possible to investigate if there is any notable relationship between vintage and RW levels, the stability over time of the LTVO, and the extent to which the different existing portfolio mix by vintage explain the variability in RWs.
73. As shown in Figure 12³⁰, the RWs appear to be sensitive to the year in which loans originated. Indeed, by looking at the median and the interquartile distribution, a clear increase in RWs from 2001 to 2007, and a decrease in the following years until 2011 can be seen.

Figure 12: RWs and EAD by vintage of loans at origination



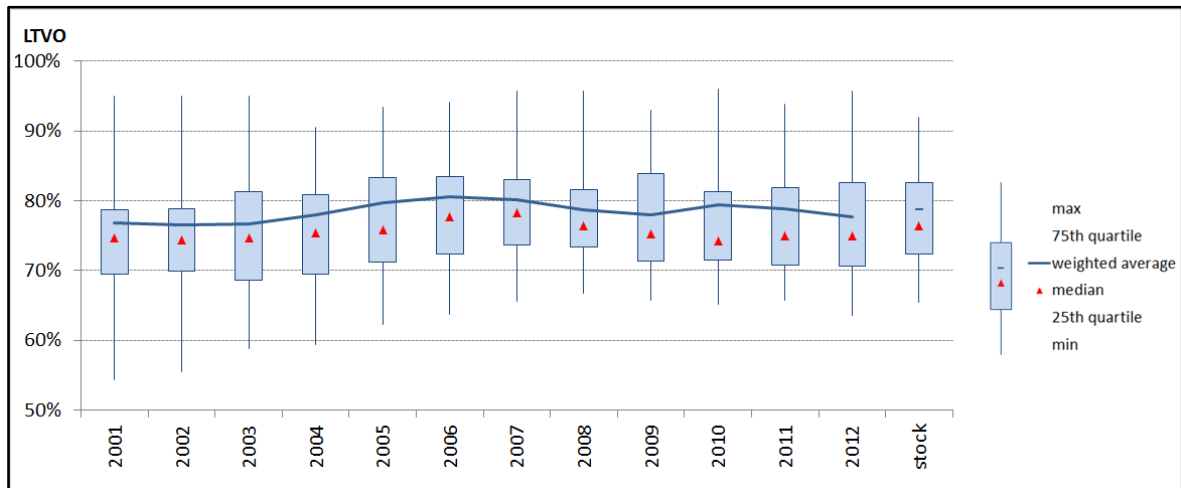
Note: Within the sample, notable banks display a more stable or much stronger dynamic (increase/decrease) in the RW over time.

Source: EBA data collection (reference date: December 2012), EBA calculation

³⁰ For data quality issues, the data from one outlier bank have been discarded.

74. Similarly, by examining the variation of the average LTVO³¹ by year of vintage, Figure 13 shows that the evolution is similar to that of RWs across the vintage years, with an increase from 2001 to 2007; in the following years, until 2012, the trend is less stable and not always consistent, but this could be due to outliers distorting the weighted average.

Figure 13: Average LTVO across the European bank sample by vintage of loans



Note: Within the sample, notable banks display a more stable or much stronger dynamic (increase/decrease) in the LTVO over time.

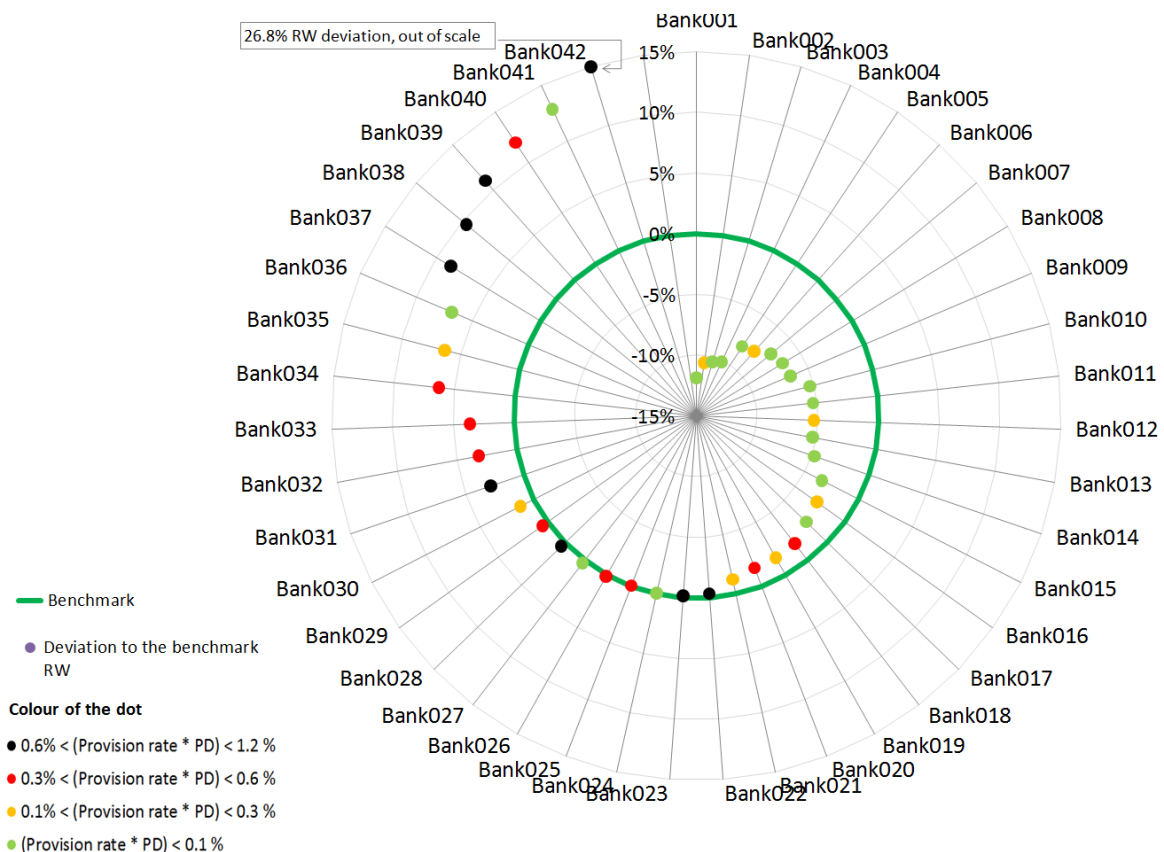
Source: EBA data collection (reference date: December 2012), EBA calculation

³¹ The statistics are calculated based on an EAD-weighted LTVO for each vintage year, for each banking group. Therefore the statistics do not represent the variation of LTVO for particular banking group across countries of exposures. For exposures belonging to the bucket above 150% LTVO, 160% have been applied. Otherwise for each bucket the upper bound of the bucket has been used.

Analyses at banking-group level: drill-down variables and RW

75. The previous analyses have taken into account the country dimension. Here, the purpose is to understand to what extent the combination of the drill-down variables may influence the RWs at the banking-group level.
76. For this purpose, it is necessary to study whether the average level of drill-down variables is related at the level of RWs by banking group.
77. Firstly, Figure 14³² represents the relationship between the RW deviation and the estimated 'experienced loss rates' for the European bank sample.
78. Figure 14 shows that the 'experienced loss rate' is a relevant explanatory factor for the variability in RWs within the EU sample.

Figure 14: RW deviation from the benchmark RW (non-defaulted exposures) and comparison with the estimated 'experienced loss rate' (EAD-weighted PD for non-defaulted exposure times the provision rate (provisions/EAD) for defaulted exposures), IRB RM portfolio, by bank



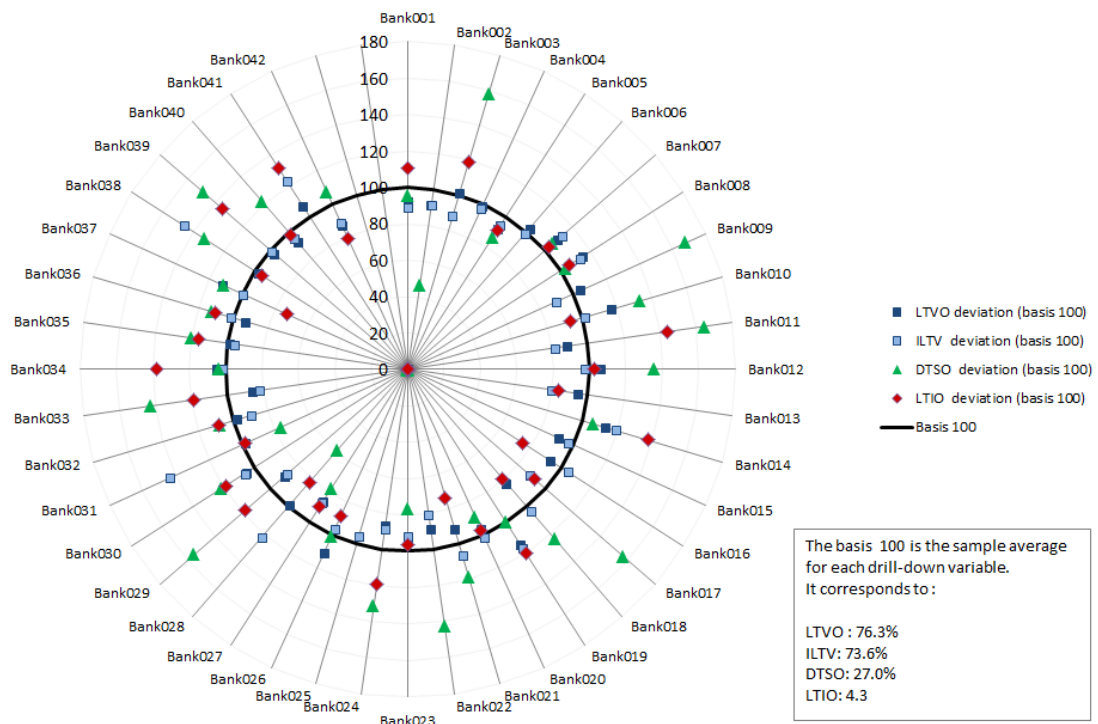
Note: Banks are sorted by their RW deviation.

Source: EBA data collection (reference date: December 2012), EBA calculation

³² This figure was first presented in the report published in December 2013, p. 28, Fig. 12 <https://www.eba.europa.eu/documents/10180/15947/20131217+Third+interim+report+on+the+consistency+of+risk-weighted+assets+-+SME+and+residential+mortgages.pdf>

79. Secondly, it is useful to determine whether the level of the estimated ‘experienced loss rate’ was driven by the different levels of drill-down variables.
80. For this purpose, the average level of drill-down variable for the same banking groups can be seen below.
81. Figure 15 represents the deviation from the EAD-weighted average drill-down variable for each bank. The banks are ordered by RW deviation (as in Figure 14).

Figure 15: Deviation of the LTVO, ILTV, DTSO and LTIO variables by banking group compared to the European average, basis 100



Note: The banks are sorted by their RW deviation.

Example case to assist with reading the table: The banks are ordered around the spiral chart by increasing RW, so the first bank at the right of the vertical axis (Bank 13) is the one with the lowest RW. For this bank, the average LTIO index is around 110 (red diamond). The basis 100 for the LTIO is 4.3, therefore this bank has an average LTIO that is around 10% higher than the sample average (so, close to 4.8). For the LTVO and ILTV, this bank has its indexes close to 90, meaning that this bank has an average LTVO and ILTV 10% below the sample LTVO and ILTV (which means an average LTVO around 70% and an average ILTV around 66%, as the basis 100 for LTVO and ILTV are 76.3% and 73.6%). For DTSO, the bank is close to the benchmark with an index of around 95 (a DTSO value around 26%).

Source: EBA data collection (reference date: December 2012), EBA calculation

82. From those figures (Figure 14 and Figure 15), it seems clear that the deviation for the level of drill-down variables does not explain the deviation in RWs (or the experienced loss rate), as no common pattern is found among banks with low RW deviation, or among the ones with high RW variation.

83. This finding has the same limitations as the former analyses, as the definitions of the drill-down variables are different across and within the European banking group, and only data at the bucket level has been collected³³.
84. Nevertheless, this analysis has still an advantage in that it shows the variability among the EU bank sample in terms of the average level of the drill-down variable. As shown previously, this may be due to exposures in different countries but also to bank specificities (including their different definitions).

5. Conclusions

85. This study aims to shed some light upon the different roles of selected risk variables (LTVO, ILTV, DTSO, LTIO and CRMO) within modelling practices across European banks. The conclusions reflect the analytical objective of this study and should feed the current debate about assessing and enhancing comparability for residential mortgages in Europe. Therefore the findings will be part of the considerations for any future policy initiatives.

Summary of findings from qualitative information analysis

86. The answers provided by the banks regarding the use of the variables in the models confirmed the importance of (indexed) loan-to-value and credit risk mitigations. Debt to service ratio and loan-to-income are used less frequently, except in PD models.
87. Overall, the documentation provided by banks, although succinct, highlighted the banks' use of different definitions for similar concepts. Sometimes they reflect country-specific features, but overall the definitions are bank specific.
88. Although it is not possible to assess the materiality of such differences in influencing the variation observed in the RWs in the EU sample, the difference in definitions is an important caveat to consider when reading the findings of the study.
89. The use of internal definitions and the diversity of such definitions are necessary to reflect the banks' own experience, modelling choices and credit policies, as well as the country specificities. Nevertheless, this requires each competent authority to make an effort to assess the materiality of such various definitions and their impact. The European study provides only an initial overview.

Summary of findings from quantitative investigation

90. From the quantitative analysis, the existence of a positive correlation between the value of the different drill-down variables (LTVO, ILTV, DTSO and LTIO) and the RWs at EU sample level was confirmed.

³³ The average drill-down variables by banking group are calculated using the median of the bucket, but for the first bucket the upper bound is used, and 160% for the EAD above 150% for LTVO and ILTV, 80% for the EAD above the 70% for DTSO and 9 for the EAD above the 8 bucket for the LTIO. Non-available data are not taken into account.

91. Despite general positive evidence, the RW sensitivity assigned by banks to the different drill-down buckets across the variables was not always found to be a clear explanatory factor of the RW in the EU sample. This is the case even if risk-weight sensitivity across the buckets is generally observed. Country differences and non-trivial bank specificities complicate the study.
92. The EAD distribution across the bucket values of drill-down variables has little impact on the RW disparity across the European sample.
93. The ILTV is the variable that more significantly influences RW variation. Overall, the RW sensitivity for ILTV accounts for about one-fourth of the total variability at EU sample level; its contribution varies significantly among the different country bank observations.
94. Some country specificities have been identified. Credit risk mitigants (other than mortgages) are very important drivers to be considered when assessing the variation in some countries, and seems to explain the lower RW sensitivity to the value of the financed real estate.
95. The use/non-use of the variables in the models does not influence the RW sensitivity as much as was initially expected. One possible explanation is that even if not used as direct input in models, one can assume that the filtering of credits based on those variables when granting loans to customers indirectly play a significant role.
96. The analysis by vintage confirms the existence of a close link between the level of LTVO and RWs, and the potential influence of the portfolio composition by vintage in explaining the variation in RW.
97. Further, when studying the level of the average drill-down variables at the banking-group level, the use of a specific combination did not account for the differences in RW.
98. Investigating the drill-down variables did contribute much to the study of experienced losses when explaining the difference in RW. However, it did complement the study, shedding additional light on the sources of variation, and creating the basis for both better knowledge and comparison of the banks at country level.
99. The findings show the relevance of using a country-by-country approach when making sample analyses, but also when analysing individual results; each bank/observation should also be benchmarked by country level when deeper understanding is required.
100. Following this, final conclusions at bank level can only be drawn by the national competent authorities, taking the European benchmarks but also the specific market structure for residential mortgages into account.
101. This is consistent with the approach suggested in the Consultation Paper regarding supervisory benchmarking exercises, which empower the competent authority to perform the assessment of the internal approaches and assess the different risk profiles within the bank's portfolios.



Annexes

Annex 1: Country-weighted averages by country

Figure 16: Minimum, maximum and EAD-weighted average for the drill-down variables, by country

	RW	LTVO Min Mean Max	ILTV Min Mean Max	DTSO Min Mean Max	LTIO Min Mean Max	CRMO Min Mean Max
AT						
BE	10%	73% 80% 86%	62% 68% 73%	31% 37% 45%	3.9 4.1 5.4	24% 40% 58%
CZ	26%	71% 76% 86%	70% 73% 76%	29% 35% 38%	4.3 4.5 5.6	0% 2% 7%
DE	16%		73% 79% 85%			0% 22% 38%
DK	12%	70% 71% 82%	72% 75% 90%		3.2 3.2 5.7	0% 0% 14%
ES	17%	66% 73% 75%	59% 65% 70%	27% 32% 45%	4.7 5 7	0% 1% 16%
FI	10%					
FR	16%	77% 85% 91%	71% 72% 84%	21% 30% 36%	3 3.3 4.8	4% 62% 75%
IE	45%	73% 75% 78%	103% 109% 117%	16% 25% 36%	3.5 4 5.9	0% 0% 0%
IT	15%	63% 67% 68%	59% 61% 65%	29% 37% 45%	4.4 5 6.2	0% 0% 7%
LU	16%	54% 75% 87%	51% 68% 76%			5% 87% 100%
NL	10%	86.6% 87.1% 89%	83% 87% 94%	23% 26% 29%	4.6 4.8 6	17% 41% 67%
NO	9%					
PL	18%					
PT	22%	76% 77% 80%	66% 70% 77%	17% 31% 62%	4.3 4.9 6	0% 4% 55%
SE	5%	69% 72% 75%	59% 68% 72%			0% 1% 4%
SK	30%					
UK	11%	65% 71% 79%	64% 70% 89%	16% 23% 30%	3.1 3.6 4.8	0% 0% 0%
Total	15%	54% 76% 95%	51% 74% 117%	13% 27% 62%	2.4 3.9 7.2	0% 18% 100%

Note: Country-weighted averages are based on bucket medians, but the upper bound is used for the lowest bucket. For exposures above the latest bucket, 160% is taken for LTVO and ILTV, 80% for DTSO and 9 for LTIO. Exposures reported as non-available are excluded. Only countries with at least four observations are represented. CRMO statistics are calculated on the percentages of exposures with credit risk mitigant (other than mortgages) over the total amount of residential mortgages.

Source: EBA data collection (reference date: December 2012), EBA calculation

Annex 2: Top-down details on the methodology

For the top-down approach, the same methodology was followed as in the first interim report (Annex I), http://www.eba.europa.eu/documents/10180/15947/Interim-results-EBA-review-consistency-RWAs_1.pdf.

Applied to the current dataset, it means that the following calculations were used to analyse the deviation in terms of RW:

$$\Delta RW = (RW_{bank} - RW_{benchmark}) = \text{price effect} + \text{bucket} - \text{mix effect} =$$

$$\sum_{i=1}^k \{Share_EAD_{benchmark}^i \times (RW_{bank}^i - RW_{benchmark}^i)\} +$$

$$\sum_{i=1}^k \{RW_{bank}^i \times (Share_EAD_{bank}^i - Share_EAD_{benchmark}^i)\} \quad , \text{ with } i \text{ being the different buckets for the drill-down variable.}$$

The price effect is $\sum_{i=1}^k \{Share_EAD_{benchmark}^i \times (RW_{bank}^i - RW_{benchmark}^i)\}$.

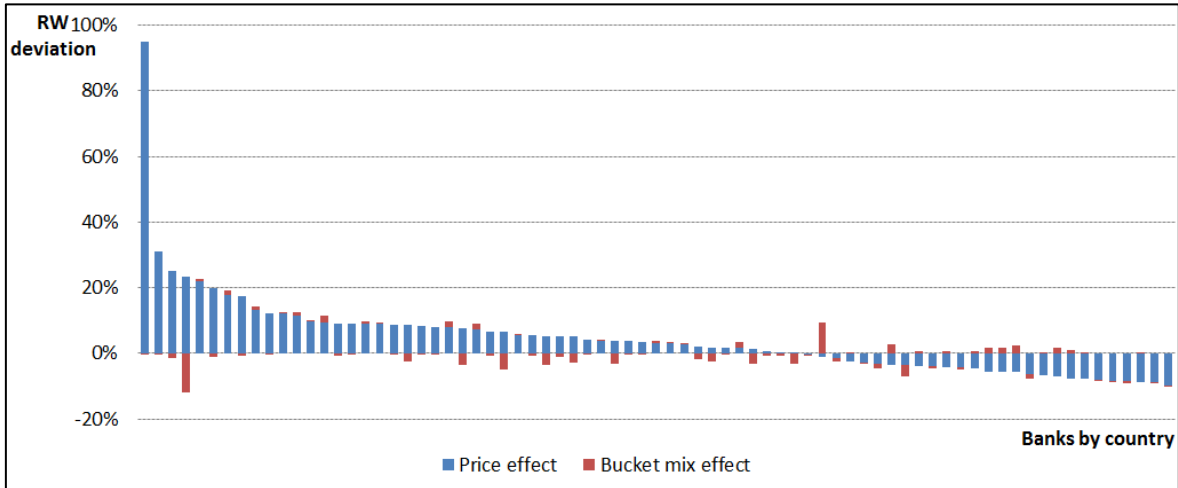
The price effect is then broken down between the sensitivity effect and the level effect:

- The sensitivity effect being $\sum_{i=1}^k \{Share_EAD_{benchmark}^i \times (RW_{bank}^i - RW_{sens_adj}^i)\}$,
with $RW_{sens_adj}^i = RW_{bank}^1 \times \left(\frac{RW_{benchmark}^i}{RW_{benchmark}^1} + 1 \right)$
- The level effect being $\sum_{i=1}^k \{Share_EAD_{benchmark}^i \times (RW_{sens_adj}^i - RW_{benchmark}^i)\}$

The bucket mix effect is $\sum_{i=1}^k [RW_{bank}^i \times (Share_EAD_{bank}^i - Share_EAD_{benchmark}^i)]$

Annex 3: Top-down analysis for the LTVO, DTSO and LTIO variables

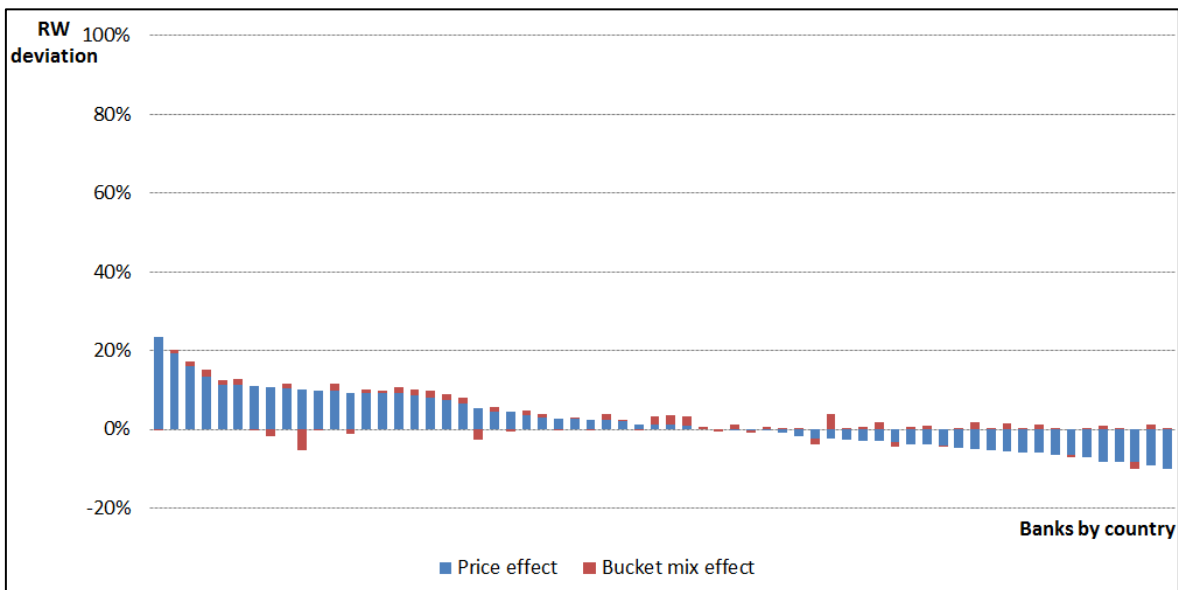
Figure 17: LTVO – Break-down of the price and bucket mix effects



Note: The banks are sorted by their RW deviation. A bank may be represented several times if it has submitted data for more than one country.

Source: EBA data collection (reference date: December 2012), EBA calculation

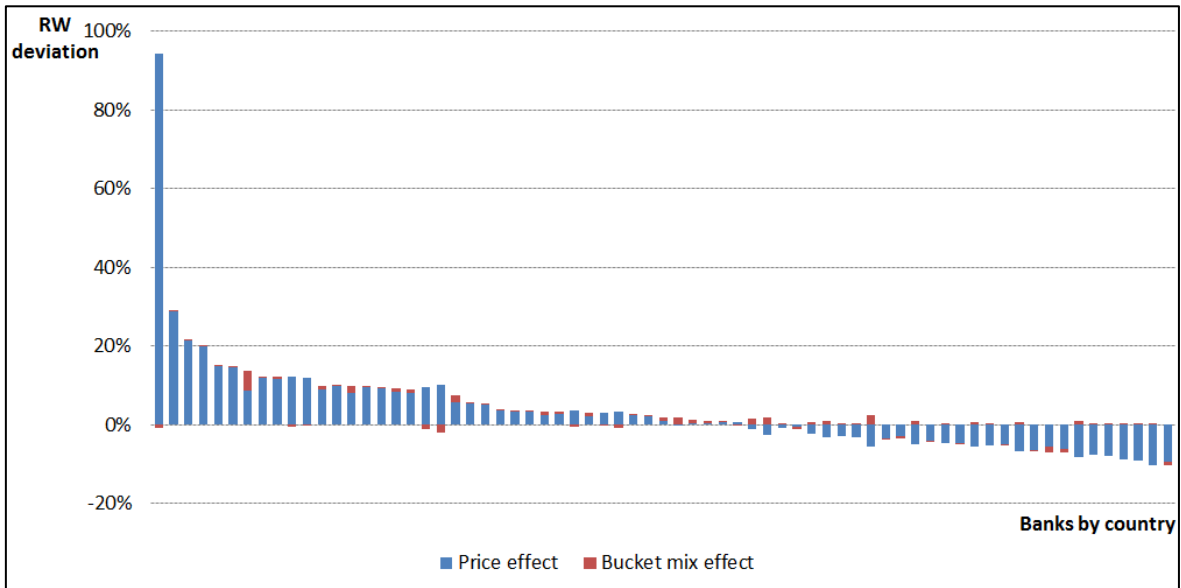
Figure 18: DTSO – Break-down of the price and bucket mix effects



Note: The banks are sorted by their RW deviation. A bank may be represented several times if it has submitted data for more than one country.

Source: EBA data collection (reference date: December 2012), EBA calculation

Figure 19: LTIO – Break-down of the price and bucket mix effects



Note: The banks are sorted by their RW deviation. A bank may be represented several times if it has submitted data for more than one country.

Source: EBA data collection (reference date: December 2012), EBA calculation

Annex 4: Average RW by bucket

Figure 20: Average riskweight by LTVO ratio

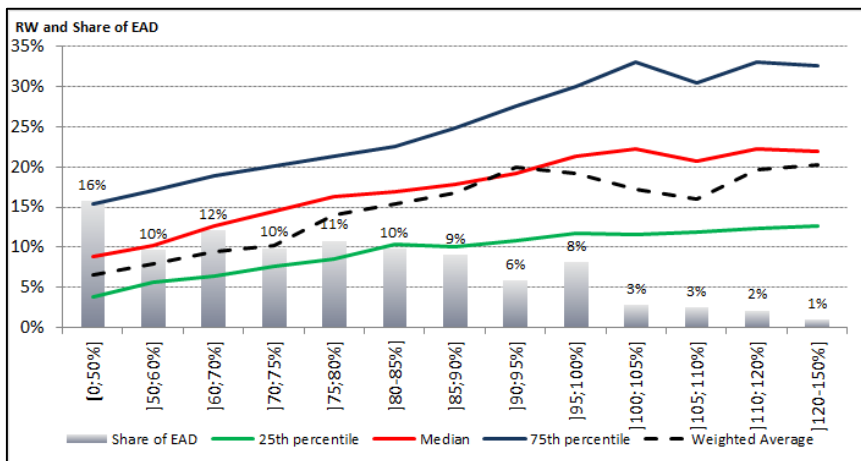


Figure 21: Average RW by ILTV ratio

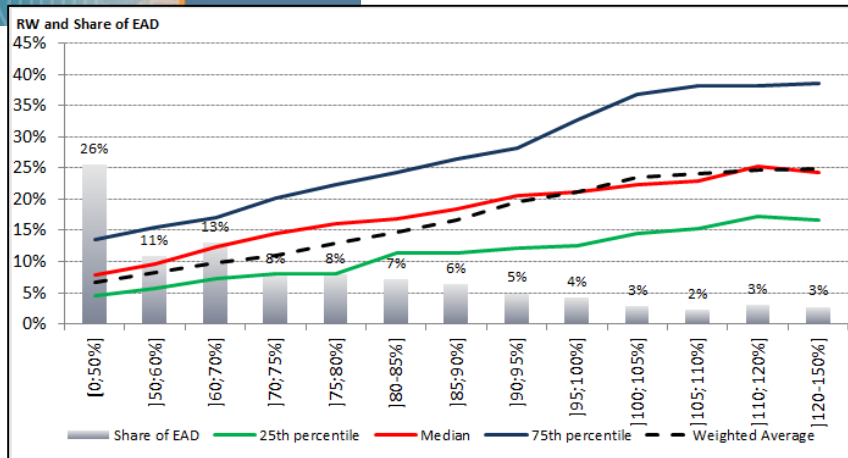


Figure 22: Average RW by DTSO

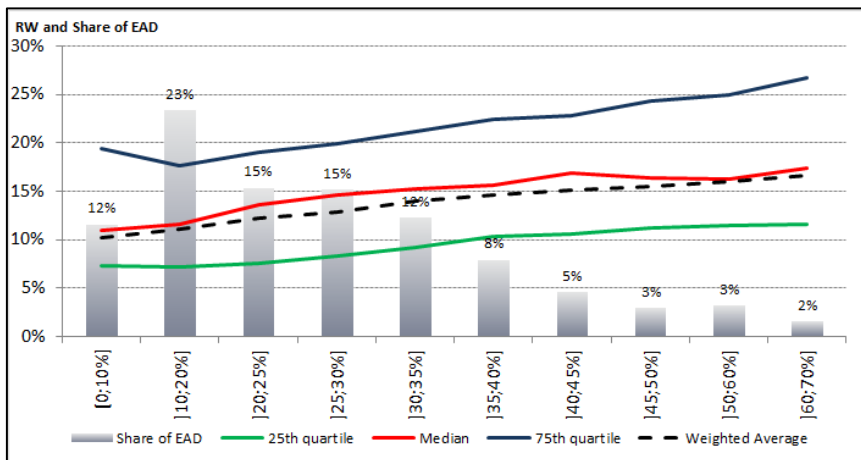
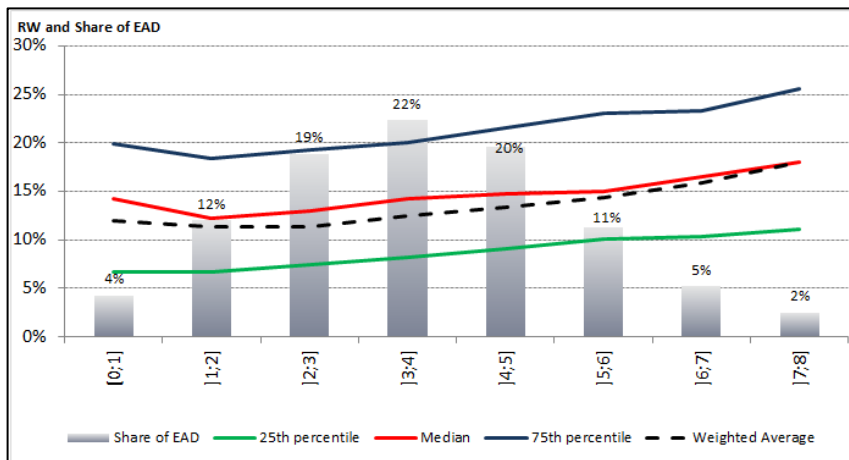
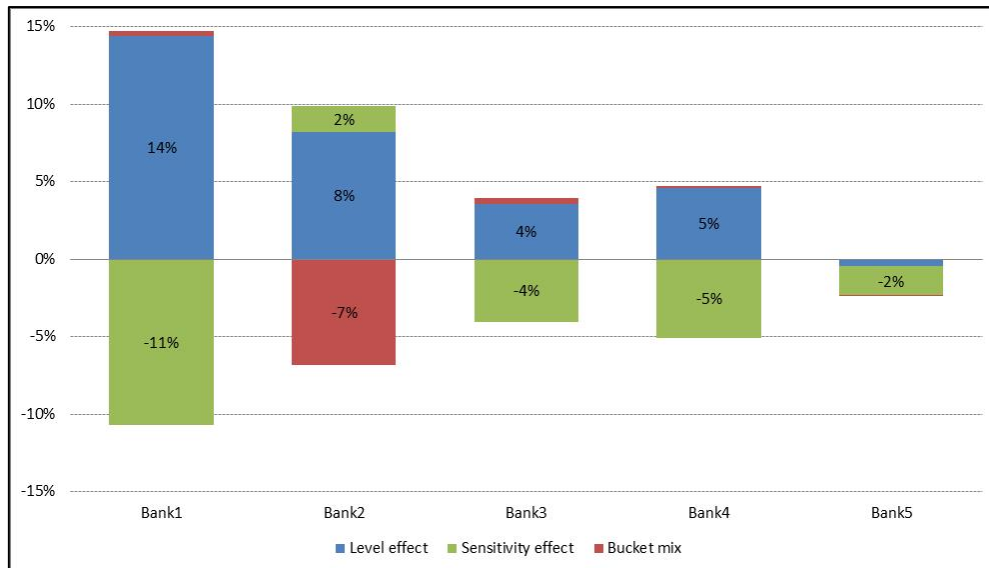


Figure 23: Average RW by LTIO



Annex 5: Application of the top-down approach at country level

Figure 24: ILTV – Break-down of the price (level and sensitivity) and bucket mix effects



Note: The banks are sorted by their RW deviation.

Bank 1 has the highest price effect (both level and sensitivity are material). The banks apply high RW for the different ILTV, but the RW sensitivity to ILTV is the lowest one among the banks in the cluster when compared to the country benchmark.

Bank 2 has the most significant bucket mix effect. This is due to the concentration of their exposures in the lowest ILTV buckets when compared to the benchmark. The RW applied in the different ILTV buckets are, in general, above and more sensitive to the benchmark.

Bank 3 and Bank 4 appear very similar. Those banks are closer to the benchmarks for RW at portfolio level. Nevertheless, they also show some differences in both the RW levels and the sensitivity applied to each ILTV bucket relative to the benchmark.

Bank 5 has, on average, RWs slightly lower than the benchmark, but it is also the bank most similar to the country benchmark for both portfolio composition and RW applied to the different ILTV buckets.