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Quantitative analysis on selected deposits insurance issues for purposes of impact assessment

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Contents

Abstract

The EU bank crisis management and deposit insurance (CMDI) framework lays out the rules for handling bank failures, while preserving financial stability, protecting depositors, and aiming to avoid the risk of excessive use of public financial resources. Notwithstanding the progress achieved in promoting a stable and integrated financial system, the objective of shielding public money from the effect of bank failures is only partially achieved. The evaluation of the current rules to handle a banking failure has in fact identified potential issues with the framework's design, implementation, and application. The review of the CMDI framework should provide solutions to address these issues and enable the framework to fully achieve its objectives and be fit for its purpose.

The following report covers three aspects closely related to the Deposit Insurance design and efficiency: the potential coverage of temporary high deposit balances (THDBs), the effectiveness and pooling effect of the EDIS, and the assessment of alternative methodologies to compute risk-based contribution to a common European Deposit Insurance Fund. Results show that an increase in the level of protection of THDBs up to EUR 500 000 would protect the wealth of households involved in real estate transactions. The report focuses also on the changes entailed by the establishment of a European Deposit Insurance Scheme and results points to the benefit of such a system. Notably, a unified scheme would be able to protect a higher amount of deposits than under the status quo where national schemes are in place.

Authors

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Executive summary

The EU bank crisis management and deposit insurance (CMDI) framework lays out the rules for handling bank failures, while preserving financial stability, protecting depositors, and aiming to avoid the risk of excessive use of public financial resources. The framework consists of three EU legislative texts and provides for a set of instruments that can be applied in the different stages of the lifecycle of banks in distress: the Bank Recovery and Resolution Directive (BRRD – Directive 2014/59/EU), the Single Resolution Mechanism Regulation (SRMR – Regulation (EU) 806/2014) and the Deposit Guarantee Schemes Directive (DGSD – Directive 2014/49/EU. Notwithstanding the progress achieved in promoting a stable and integrated financial system, the objective of shielding public money from the effect of bank failures is only partially achieved. The evaluation of the current rules to handle a banking failure has in fact identified potential issues with the framework's design, implementation, and application.

The Commission is working on a review of the CMDI framework to address the issues and enable the framework to fully achieve its objective and be fit for its purpose. This document, prepared by the JRC for FISMA, is a quantitative assessment of several policy options for a possible further harmonization of the level of depositor protection.

First, it presents an analytical work to assess the financial impact of harmonizing the coverage of Temporary High Balances (THBs), which arise in situations where a large amount of money stays in the bank account for a certain period. According to Article 6(2) DGSD, Member States are required to ensure that THBs are protected above EUR 100 000 for at least 3 months and no longer than 12 months after the amount has been credited or from the moment when such deposits become legally transferable. Results show that a temporary increase of the level of protection up to EUR 500 000 would protect the wealth of households involved in real estate transactions, enhancing depositor confidence, while limiting the additional burden on national DGSs and banks.

The second contribution aims to assess how the DGS pay-out capacity would change if the national DGSs are replaced or complemented by a common fund (European Deposit Insurance Scheme, EDIS). Results show that a system with common financial means is able to protect a higher amount of deposits than under the status quo. The more resources are mutualised, the more effective the system is. Pooling of resources in fact increases the probability of full protection of the deposits without liquidity shortfall and delivers a higher efficiency for various EDIS designs creating room for lowering the target level and consequently the cost for the baking sector.

Finally, the last section presents results for the implementation of several methodologies to calculate DGS contributions, based on the Guidelines on Methods for Calculating Contributions to DGS published by the European Banking Authority (EBA) in 2015. The section includes a detailed explanation of the methodology, as well as the different data quality check carried out in a dedicated confidential dataset.

1 Introduction

The EU bank crisis management and deposit insurance (CMDI) framework lays out the rules for handling bank failures, while preserving financial stability, protecting depositors, and aiming to avoid the risk of excessive use of public financial resources. The framework consists of three EU legislative texts and provides for a set of instruments that can be applied in the different stages of the lifecycle of banks in distress: the Bank Recovery and Resolution Directive (BRRD – Directive 2014/59/EU), the Single Resolution Mechanism Regulation (SRMR – Regulation (EU) 806/2014) and the Deposit Guarantee Schemes Directive (DGSD – Directive 2014/49/EU.

Notwithstanding the progress achieved in promoting a stable and integrated financial system, the objective of shielding public money from the effect of bank failures is only partially achieved. The evaluation of the current rules to handle a banking failure has in fact identified potential issues with the framework's design, implementation, and application. The review of the CMDI framework should provide solutions to address these issues and enable the framework to fully achieve its objectives and be fit for its purpose. Notably, the revision calls for a further harmonization of insolvency law to increase its efficiency and overall coherence to manage bank crises in the EU, as well as to enhance the level of depositor protection, including through the creation of a common depositor protection mechanism (European Deposit Insurance Scheme, EDIS).

The report illustrates the results of three analyses supporting the work of the review: (i) estimating the size of temporary high deposit balances (THDBs) related to certain transactions and the impact on the Deposit Guarantee Scheme (DGS) when protecting them; (ii) measuring the effectiveness and the pooling effect of the European Deposit Guarantee Scheme (EDIS); (iii) modelling and assessment of alternative methodologies to compute the risk-based contributions that banks should pay to the European Deposit Insurance Fund under EDIS.

For what concern the review of the THDB, the aim of the analytical work is to assess the financial impact of harmonizing the coverage of THBs under Article 6(2) of the DGSD. The novelty of the work is to look also at the impact on households which are involved in real estate transactions, for the part that is not included in the DGS protection. The analyses show that a temporary increase of the level of protection up to EUR 500 000 would protect the wealth of households involved in real estate transactions, enhancing depositor confidence, while limiting the additional burden on national DGSs and banks.

The second contribution aims to assess how the DGS pay-out capacity would change if the national DGSs are replaced or complemented by the EDIS, and to what extent synergies arise from the pooling of the national contributions into a single, European scheme. The results of the simulation exercise show that EDIS is more effective than the actual system, since a common deposit insurance scheme is able to protect a higher amount of deposits. The more resources are mutualized, the more effective is the system. In addition, pooling the resources increase the probability of full protection for covered deposits without liquidity shortfall, and open the possibility to lower the target level of the DGS, thus the costs for the baking sector.

Finally, the last section presents results for the implementation of several methodologies to calculate DGS contributions, based on the Guidelines on Methods for Calculating Contributions to DGS published by the European Banking Authority (EBA) in 2015. The section includes a detailed explanation of the methodology, as well as the different data quality check carried out in a dedicated confidential dataset. The data has been collected directly from Member States' authorities, via a survey that covers all necessary items to create the indicators. The results show how contributions might change in response to different risk indicators included in the calculation, and to the choice of methodology.

The report is organized as follows. Section 2 presents the analysis on assessing THDBs and the impact on the DGS when protecting them. Section 3 presents the analyses carried out to model different EDIS designs and assess their effectiveness to cope with potential bank payouts. Section 4 provides an overview of the different methodologies to calculate the risk-based contributions and the empirical implementation using confidential data. Section 5 concludes.

2 Review of temporary high deposit balances relating to certain transactions

2.1 Background

Temporary high deposit balances (THBs) arise in situations where a large amount of money stays in the bank account for a certain period. According to Article 6(2) DGSD, Member States are required to ensure that THBs are protected above EUR 100 000 for at least 3 months and no longer than 12 months after the amount has been credited or from the moment when such deposits become legally transferable. The following three categories are classified as THBs:

a) deposits resulting from **real estate transactions** relating to private residential properties;

b) deposits that **serve social purposes** laid down in national law and are linked to life events of a depositor such as marriage, divorce, retirement, dismissal, redundancy, invalidity or death;

c) deposits that serve purposes laid down in national law and are based on the payment of **insurance benefits** or compensation for criminal injuries or wrongful conviction.

As Member States retain discretion in terms of duration, the amount and the scope of protection, the coverage of THBs is currently largely divergent.

The EBA[1] proposed to the Commission a number of recommendations regarding the protection of THBs. The EBA opinion summarised the results of a questionnaire sent to DGSs and highlighted the need for a more in-depth harmonization (considering both the level of protection and the time limit) to improve the level playing field. In the study prepared by CEPS[2] for the Commission on the national options and discretions in the DGSD, it was proposed that a THB amount could be harmonised at EUR 500 000 for a period of 6 months.[3]

2.2 Objective

In order to follow up on the recommendations by the EBA and in the CEPS study, the objective of the JRC's analytical review below is to **assess the financial impact of harmonizing the coverage of THBs under Article 6(2) of the DGSD**. Building on past exercises, **the report quantifies the size of deposits generated from real estate transactions and insurance payouts linked to life events and criminal injuries protected** under Article 6(2)(a) and (c) of the DGSD. It assesses the cost for the DGS and banks when providing extra protection to these deposits.

The analysis also introduces a novel angle to the problem. **It looks at the impact on the wealth of households involved in real estate transaction absent the DGS protection**. This double perspective on costs and benefits could enable a better understanding of the implication of different policy options.

2.3 Related documents

The JRC identified three pre-existing sources dealing with the THB-related issues. Generally, the diverse approaches across Member States, the absence of other existing research related to the THBs and the limited available data with respect to the size of THBs and associated payout events represented the main challenges for the analysis.

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[1] *EBA Opinion on DGS pay-outs, 30 October* 2019.

[2] See https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/191106-study-edis_en.pdf, November 2019 (CEPS, 2009). Study prepared by CEPS for the Commission on national options and discretions under the DGSD and their treatment under EDIS.

[3] The study showed that, on average, the amounts eligible for THB increase with the higher coverage level across Member States. For example, if the coverage level was increased from EUR 100 000 to EUR 500 000, the additional amounts of covered deposits generated by THB could increase from 1.9% to 5.6% of total covered deposits, i.e. an increase of 3.7 percentage points. However, if the coverage level was increased from EUR 500 000 to an unlimited amount, the further impact on the amount eligible for THB could only be marginal.

2.3.1 Study conducted by the JRC in 2009[4]

The document contains a complete analysis of the impact of harmonizing THB, testing several covered amounts (up to EUR 200 000, EUR 300 000 or EUR 500 000) and time horizons (1.5, 3, 6, 12 months). The analysis focuses on the THB-related to **house purchases only**, which are assumed to represent the majority of all THBs-related claims, i.e. around 80% of the total.[5] All types of real estate transactions are treated equally and the size of THBs is calculated from the estimated house price distribution.

The model aims to estimate the actual size of THBs, whose actual amount is unknown. The model considers the number of *transactions*, the income distributions, and the *estimated average property prices*. **Table 1 summarises the main findings to measure the impact of protecting THBs: the increase of the amount of covered deposits due to the protection of THBs ranges between 2% and 10%.**

Table 1: Additional covered deposits when protecting THBs depending on three different thresholds and at different time horizons (JRC analysis published in the IA of the 2014 DGSD)

	3 months	**6 months**	**12 months**
threshold of EUR 200 000	1.66%	3.31%	6.62%
threshold of EUR 300 000	2.22%	4.45%	8.90%
threshold of EUR 500 000	2.50%	5.00%	10.00%

2.3.2 Study conducted by CEPS in 2019[6]

The report analyses the THB protection per Member State. Notably, the report summarises the following information:

- countries which already have practical experience with THBs;
- coverage level per type of deposits in each Member State (Table 4.1 on pages 41-42 of the report);
- duration per type of deposits in each Member State (Table 4.3 on page 48 of the report).

The report analyses 4 policy options: (1) Retaining THBs in the current form; (2) Eliminating national options on THBs; (3) Increasing the level of harmonization of national options; (4) Full harmonization of THB national options. It concludes that increasing harmonization (3) might be a suitable policy option. The latter could be combined with an increase in the level of covered deposits because THBs would be taken into account in the calculation of contributions.

For the analysis, the study uses a model, which estimates the size of THBs in each Member State, covering only primary residential property transactions. The model considers the number of *transactions*, residential *property prices*, *share of deposits* used for the purchase or obtained from the sale, and *period* during which the deposits are held on the account. In addition, the model distinguishes between different types of properties (detached houses, semi-detached houses, and flats), actors (first-time buyers, second or multiple-time buyers, and sellers) and regions (cities, towns and suburbs, and rural areas). Outflows of the deposits are considered to be 20% a month.

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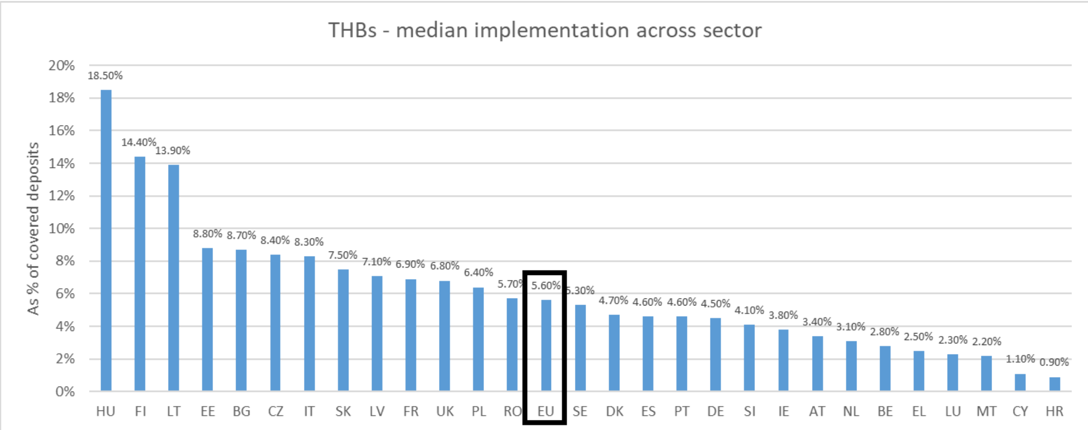
4 Report under Article 12 of Directive 94/19/EC as amended by Directive 2009/14/EC, 2009 (European Commission, 2009).

5 In a consultation paper, the UK FSA demonstrates that THB related to house purchase represent around 80 % of the total THB.

6 Options and national discretions under the Deposit Guarantee Scheme Directive and their treatment in the context of a European Deposit Insurance Scheme, November 2019 (CEPS, 2009). See pages 39-65 and Annex1.

Figure 1 shows the impact of protecting THBs up to EUR 500 000 for 6 months per Member State. **At the EU level, this corresponds to an increase of 5.6% of the actual covered deposits**.

Figure 1: Main results as published in the CEPS study at page 56 in Figure 4.2.



Source: CEPS calculations

2.3.3 Effects Analysis on the European Deposit Insurance Scheme

The Commission services' non-paper addressed the coverage of THBs in the context of the EDIS proposal of November 2015 and provided key statistics on the size of such deposits per category based on a survey conducted by the Dutch Presidency of the Council of the European Union. As regards the quantification of the options in place at the time in Member States, covered amounts for THBs differed widely among Member States. Table 14 of the report provided an overview of some key statistics. For real estate transactions and insurance benefits, the average and median for the EU were relatively close, both around EUR 500 000. However, this average/median still concealed a significant divergence in coverage ranging from as low as EUR 150 000 to as high as EUR 1 300 000 (or even 'unlimited' for insurance benefits in 2 Member States).

2.4 Impact on DGSs and banks when protecting THB related to real estate transactions[7]

For purposes of the current analysis, the JRC has updated the estimates of the size of THBs related to house purchases and followed the two-steps approach developed in the past in the study conducted in 2009.[4] This analysis has also used new data sources (e.g. ECB data on house price distribution) and additional assumptions to substitute the gaps revealed in the previous research (see point 3 above).

2.4.1 Step 1: Distribution of house prices

As one of the main updates, this analysis enhanced the estimates of house prices that are higher than the average house price. These higher priced transactions are the most affected by the lack of the DGS protection. Thus, the focus falls in the upper tail of the house price distribution.

Euro Area countries, HU, PL and HR

The ECB[8] has recently published data on house price distribution for countries in the euro area including Hungary, Poland, and Croatia as part of reporting on the *2017 wave of the Household Finance and Consumption Survey (HFCS).* The distribution by decile of household's main residence for 2017 is available in Table B4 of

[7] Contributions paid by banks will increase proportionally to the increase in covered deposits. Results of this section thus provide an estimate of the impact on DGS and of the increase in banks' contributions when protecting THB up to different coverage level.

[8] https://www.ecb.europa.eu/stats/ecb_surveys/hfcs/html/index.en.html, 2020 (ECB, 2020).

the survey. The data is an upper bound value, indicating the maximum price of houses in each decile. This statistical information, however, does not give an estimate of the average house price in the last decile, i.e. the most expensive 10% of houses. As this would be the group most likely affected by a threshold in the coverage of THBs, the average price of the last decile has been estimated by applying to the house price in the ninth decile an increase equal to 1.5 times the increase of house prices between the eighth and ninth decile.[9]

The prices for 2018 are based on the house price index available on Eurostat[10].

Remaining countries (BG, CZ, DK, RO, SE)

House prices are assumed to be distributed as household income. This means that households with an income 10% above the average would purchase a house whose costs is 10% higher than the average cost. In this respect, the JRC has verified that results for countries in the euro area do not change much when using a house price distribution estimated according to household income, which corroborates the first assumption.

The household income distribution by decile comes from Eurostat based on EU-SILC and ECHP survey data (Eurostat table: ilc_di01).[11] The average house purchase price for 2018 is indirectly obtained using information available from the European Mortgage Federation as: average size of mortgage divided by the corresponding Loan to Value Ratio (LTV). [12] Bulgaria and Sweden have been excluded from the analysis, as no data on mortgages is available to estimate the house price distribution.[13] Table 2 shows the final distribution of 2018 house prices at country level.

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9 The distribution of house prices conditional on income is available for the whole population (including the highest group) and the increase in the last deciles is around 1.5 times the previous increase. As there is a quasi-linear relationship between the conditional (on income) and unconditional house price distributions, the hypothesis of an increase of 1.5 times the previous increase in the last decile of the unconditional distribution seems to be reasonable. A sensitivity analysis exercise carried out for the purposes of this review confirmed that final results would not change under a price increase for the last decile up to 3 times the increase of house prices between the eighth and ninth decile.

10 Please refer to table *prc_hpi_a* in Eurostat.

11 The table does not provide a value for the last decile (10% largest incomes). The last 10 percent has been estimated, as per the house price distribution of countries in the euro system, assuming an increase of 1.5 times the increase between the previous two deciles, applied to the last observed price.

12 Information is available in Hypostat 2019, European Mortgage Federation.

13 An alternative approach would have been to use 2008 house prices available in the study conducted by the JRC in 2009 (European Commission, 2009) and apply the growth rates of the house price index. For reasons of data consistency, this was not included in this analysis.

Table 2: House price distribution for 2018 (EUR)

	House price distribution, € (2018)									
	1 decile	2 decile	3 decile	4 decile	5 decile	6 decile	7 decile	8 decile	9 decile	10 decile estimation
BE	144 014	185 161	216 021	257 168	277 742	308 602	349 235	395 011	462 903	582 245
BG *										
CZ *	54 146	65 613	73 172	81 284	89 681	99 253	110 671	127 249	153 291	200 348
DK *	139 964	172 231	198 057	222 887	249 583	275 434	309 616	351 103	416 525	532 943
DE	74 663	106 661	155 725	181 323	213 322	266 652	319 982	373 313	533 304	876 142
EE	10 170	21 187	31 781	45 023	58 795	71 825	84 749	105 936	160 069	282 763
IE	110 211	165 317	198 381	220 423	275 529	308 592	363 698	440 846	589 631	888 132
EL	23 960	32 387	41 016	50 763	60 915	71 068	81 931	101 525	137 161	209 376
ES	51 338	71 938	96 059	108 654	128 293	160 099	192 119	235 239	320 198	493 663
FR	87 513	121 901	147 126	169 982	198 089	223 726	259 863	309 489	411 725	615 738
HR	17 507	31 830	43 925	53 050	70 238	84 456	106 100	127 320	180 370	293 102
IT	69 577	99 395	119 274	139 153	155 056	188 851	218 669	248 488	347 883	556 613
CY	91 438	122 494	152 736	182 265	203 648	254 560	309 240	407 296	509 120	700 040
LV	5 478	10 957	16 106	21 913	27 940	35 719	43 498	52 702	76 697	129 077
LT	16 095	24 464	30 902	37 555	42 920	53 650	64 809	85 840	127 687	221 057
LU	338 297	443 212	535 280	642 337	698 006	802 921	896 059	1 070 561	1 306 084	1 737 092
HU	11 092	18 525	25 958	33 390	41 738	51 915	63 007	81 532	111 149	171 712
MT	92 559	132 228	158 673	185 119	211 564	238 010	296 190	317 347	449 574	730 558
NL	133 209	177 977	202 496	227 671	256 787	284 370	328 372	383 100	492 557	703 653
AT	104 709	149 943	177 481	209 417	261 771	293 184	329 413	412 133	523 543	735 833
PL	24 513	35 491	44 124	52 224	65 014	78 229	95 709	117 771	158 058	239 161
PT	44 105	60 755	77 184	88 211	109 932	121 290	143 563	175 098	242 579	382 811
RO *	28 342	42 334	54 658	67 244	78 280	92 916	111 104	132 128	165 142	227 036
SI	42 701	57 081	76 839	87 816	107 575	120 748	142 702	177 389	242 703	376 745
SK	26 843	40 479	53 257	60 451	75 161	85 898	98 997	118 110	161 059	248 909
FI	64 042	89 557	114 065	134 538	157 734	186 376	221 876	267 159	348 144	506 445
SE *										

***Note**:* Asterisk refers to countries whose house prices are assumed to be distributed as the household income. BG and SE have been excluded, as no data on mortgages are available to estimate the average house price.

2.4.2 Step 2: Calculation of non-covered THBs

Starting from the distribution of average house prices, the second step estimates the impact of providing a higher protection to the THBs as follows:

(1) For each decile of the distribution, the first EUR 100 000 of THBs are considered as protected under the standard harmonised level of protection. The reason is that the amount of covered deposits reported by DGSs at the end of the year include already the first EUR 100 000 of THBs, as it is not possible a priori to identify deposits with a THB and report them separately. Upon the assumption that the average number of deposits with a THB does not depend on the level of coverage above EUR 100 000, we conclude that, on average, an amount equal to the first EUR 100 000 of THBs is already included in the current statistics.[14] It is worth noticing that for a single bank account, the first EUR 100 000 of standard coverage might thus exceed the coverage level necessary to protect a real estate transaction and, as stated by CEPS (2019): "assuming that EUR 100 000 of the THBs are covered under the regular provisions, the average of THBs drops significantly." (page 56).

(2) Still for each decile, the lower value between the house price and the increased level of protection (minus the EUR 100 000 protected under the standard coverage level) is multiplied by 10% (each decile covers 10% of the total) and by the number of house transactions per year. It is assumed that transactions occur equally frequently across all houses prices (i.e. the number of transactions is the same in each decile).[15] Please refer to Annex A for details on the number of transactions.

[14] In the same way, the average amount of funds held in accounts to finance real estate transactions which is above the normal level of account balances but below the EUR 100 000 coverage can also be assumed to be constant over time.

[15] The ECB and the European Mortgage Federation report the number of transactions in their statistics. As the latter states that the number for some MSs might refer to general real estate transactions not related to housing and this might bias results, we prefer to use the information provided by the ECB in the Structural Housing Indicators Statistics (as done by CEPS).

Summing up the values in the deciles, we obtain the annual cost of protecting THBs up to certain thresholds (as increase in the actual amount of covered deposits). Under the assumption that the <u>number of transactions are uniform over the whole year</u>, the monthly impact is obtained by dividing by 12.

(3) Under the hypothesis that all funds related to the house purchases will be deposited on an account and will stay there for a variable time horizon, ranging from 1 to 12 months, one can derive the impact of protecting those deposits for different coverage periods. The model considers outflows of 20% on average each month, as proposed by CEPS in their study. This assumption seems to be more realistic than assuming deposits remain in the bank account for the same time horizon considered (i.e., 1 months up to 12 months). It should be noted that this is **a rather conservative hypothesis**, as in many cases, the buyer will only have the money on their account for the brief time between concession of a mortgage and payment (and even then, often in escrow), while often the seller might use part of the money to extinguish an existing mortgage (see analysis on wealth impacts for a discussion on these aspects).

2.4.3 Results

The JRC results **<u>likely overestimate the impact of protecting real estate THBs</u>**, regardless of the level of protection. In fact, in each decile, the transactions are likely to happen under the same house price value which is the upper bound given by the house price distribution. **<u>Real impacts on the DGSs might thus be lower than the value estimated in this exercise and numbers in this report can be considered as an upper limit of the impact</u>**. Moreover, all funding for transactions is supposed to be fully under the responsibility of the seller or owner.

Table 3 and Figure 2 summarise **<u>the cost for the DGSs of protecting THBs up to different levels of protection, as a share of additional covered deposits</u>**.[16] As contributions paid by banks are expected to increase proportionally to the increase in covered deposits, the results also estimate the additional contributions to be paid by institutions as a consequence of protecting this category of deposits. **<u>As an example, the increase in covered deposits when protecting THBs up to EUR 300 000 ranges from 0.44% to 2.05% depending on the time horizon. The impact increases under a coverage level of EUR 800 000 remaining under 3% of covered deposits for a 12-month protection</u>**. Please refer to the Annex A for an overview of results at Member State level.

Table 3: EU statistics on the size of additional covered deposits, when protecting THBs up to different thresholds and different time horizons (excluding the first EUR 100 000) (in % of covered deposits).

	THDB 1 month			THDB 2 months			THDB 3 months			THDB 6 months			THDB 9 months			THDB 12 months		
	EU	Min	Max	EU	Min	Max	EU	Min	Max	EU	Min	Max	EU	Min	Max	EU	Min	Max
EUR 300 000	0.44%	0.02%	0.79%	0.79%	0.03%	1.42%	1.08%	0.05%	1.92%	1.63%	0.07%	2.90%	1.91%	0.08%	3.41%	2.05%	0.09%	3.67%
EUR 500 000	0.58%	0.02%	0.99%	1.05%	0.03%	1.78%	1.42%	0.05%	2.42%	2.15%	0.07%	3.66%	2.52%	0.08%	4.29%	2.71%	0.09%	4.61%
EUR 800 000	0.64%	0.02%	1.27%	1.16%	0.03%	2.29%	1.57%	0.05%	3.10%	2.38%	0.07%	4.69%	2.79%	0.08%	5.50%	3.00%	0.09%	5.92%

16 SE and BG have been excluded for the time being. Data on average house price not available.

Figure 2: Average EU impact per coverage level and time of coverage (excluding EUR 100 000)

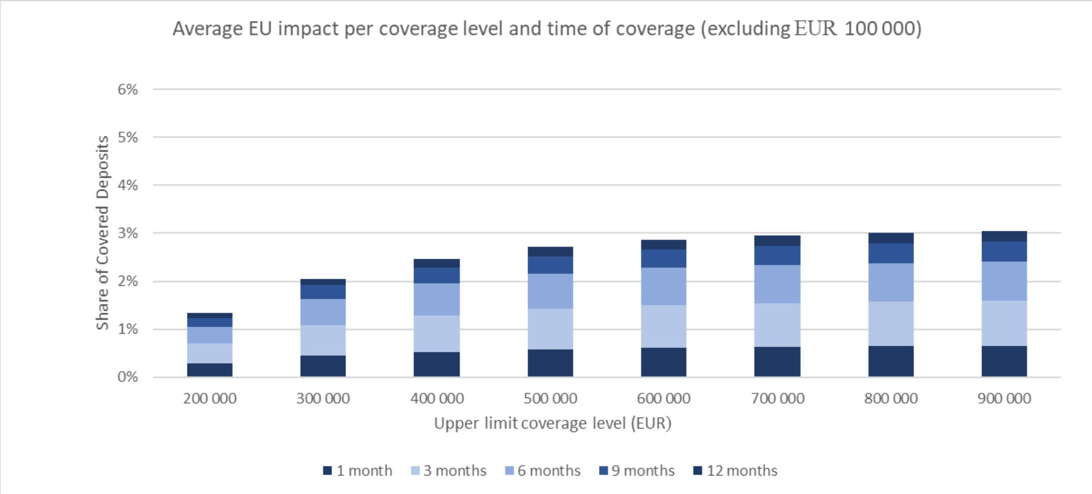

Table 4 compares the above results with those presented in the JRC study of 2009[4] estimating the size of THB according to different levels of protection and coverage duration. The two set of results diverge mainly as consequence of the outflow assumption currently implemented which was not taken into account in the previous analysis in 2009. The JRC has verified that results would be aligned, under the hypothesis of leaving deposits in the bank account for the whole period.

Table 4: Comparison with the study conducted by the JRC in 2009 (European Commission, 2009) - coverage level up to EUR 500 000.

	3 months	6 months	12 months
Current excluding €100,000	1.42%	2.15%	2.71%
European Commission (2009)	2.50%	5.00%	10.00%

The JRC also compared the results with those recently published by CEPS (2019). As stated in the CEPS study, the impact of protecting THBs would be of 3.9% of covered deposits under a level of protection of EUR 500 000, a time horizon of 6 months and the assumption of excluding the first EUR 100 000 (i.e. as in the JRC analysis). The difference with the JRC results would be around two percentage points.

The CEPS study presented more detailed results when including the first EUR 100 000 of THBs in their calculation. Moreover, besides the inclusion of the first amount of THBs, other methodological differences may drive the two sets of results apart. Unlike this analysis, CEPS considers different situations or sellers, first house buyers and second house buyers. These features are not specifically addressed in the current analysis.

The JRC has investigated how results would change including the first EUR 100 000 in the modelling. The table below proves that results would be aligned. Notably, the aggregate EU impact of protecting THBs is 5.6% according to CEPS and would be 3.8% according to the JRC analysis (with a difference of 2 pp), under a coverage level of EUR 500 000 and a time horizon of 6 months.

Table 5: Comparison of results between CEPS and the JRC using some of the CEPS' assumptions

	CEPS				**JRC**			
	Including EUR 100 000 ; Outflows are assumed to be around 20 % per month				Including EUR 100 000; Outflows are assumed to be around 20 % per month			
	months				**months**			
	3	***6***	***9***	***12***	***3***	***6***	***9***	***12***
EU average	3.9%	5.6%	6.5%	7.0%	2.5%	3.8%	4.4%	4.8%
min	0.6%	0.9%	1.1%	1.1%	0.2%	0.2%	0.3%	0.3%
max	12.6%	18.5%	21.6%	23.1%	7.6%	11.5%	13.5%	14.5%

On average, the two analyses **point in the same direction and are consistent**. Results can diverge at individual country level (please refer to the Annex A for an overview of results at Member State level), however, for the majority of countries the difference is lower than 5 percentage points. Hungary, Finland, Lithuania and Romania are exceptions. For those countries, the difference range from 6 to 13 percentage points:

> The CEPS study reported Hungary, Lithuania and Finland to be among the countries with the highest amount of THBs when protecting them up to EUR 500 000 for six months. However, according to the HFCS survey, the house prices median of Lithuania and Hungary are lower than EUR 40 000 and the JRC results for those countries are therefore lower. For Finland, the THB estimated by the JRC are lower than the median and this is coherent with the number of transactions and the house price distribution of this country.
>
> In the JRC analysis, Romania stands out as the country with a potentially very large impact. This is different from the findings in the CEPS study where Romania falls just above the EU average (see Figure 1). Three factors explain the high potential impact estimated in the current analysis: (1) the average house price estimated by the JRC based on 'loan-to-value' ratio is high; (2) the distribution of income is characterised by a wide and heavy tail due to a high income inequality in the country; (3) Romania has a low starting level of covered deposits with respect to other Member States resulting in a large final impact due to a large "denominator effect".

2.5 Impact on wealth of the part excluded from protection under THBs related to real estate transactions

This section looks at the protection of THBs from a novel angle. It analyses the impact on the wealth of households involved in a house transaction absent the DGS protection (under the assumption that every year, 2.5% of the households buy or sell a real estate asset). This approach focuses on the part of THBs not protected by the DGS because they are above the respective coverage level currently applicable in a Member State.

We develop the analysis under the assumption that all transactions would have a share of the house price covered by the mortgage, and the remaining part will be the one affecting household wealth in case of a bank failure (i.e. for the buyer, the amount of the mortgage is not transferable and thus protected. Similarly, we assume that the seller will directly transfer the proceeds of the sale to the bank to reimburse the mortgage).[17]In the absence of the DGS protection, each household potentially faces the risk of losing a share of deposits equal to the net value of the house, i.e. the value of the property without the mortgage.

In view of the above, the focus of this section is based on: (1) the average net value of household main residence whose distribution is available in Table F7 of the HFCS survey (ECB, 2020)[18] and (2) the net wealth per household published by ECB in Table J3. The two distributions are assumed to be correlated and the higher the net value, the higher the wealth.[19] For households with net house value below the coverage limit, the impact on wealth is equal to 0, whereas for deciles where the average house price exceeds coverage limit the impact is as follows:

(decile net house value – coverage limit)/decile household net wealth

The impact at country level is then obtained by averaging the deciles, and refers only to households involved in a house transaction.[20]

Table 6 shows that, under the standard level of protection of EUR 100 000, consumers involved in house transactions may be affected by a loss in their wealth in all the countries. In the absence of any DGS protection for THBs, LU would be the most affected with an average loss of 50% in the wealth of household THB.[21] However, as this threshold increases, the impact on wealth is reduced. By way of example, under the level of

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[17] This assumption is not included when analyzing the impact on the DGS as it is not possible to distinguish between sellers and buyers and therefore JRC choose to keep the prudent option of only using the outflows of 20% a month.

[18] Data is only available for euro area countries, HU, PL and HR.

[19] The last decile, missing for both of them, has been estimated using the same approach as for the household income and house prices (i.e. the increase from P90 to P100 is assumed to be 1.5 times the same increase from P80 to P90).

[20] Table B1 of the HFCS Survey gives information on the share of households owing a main residence.

[21] The analysis does not take into account the current level of protection.

protection of EUR 500 000, the impact on wealth would decrease to 13.1 % in LU (showing the highest number), while being negligible for the majority of countries.

It should be noted that in this case, these numbers are likely to be under-estimates, as not all of the differences between the “net value” and “market value” of houses is entirely due to mortgages to be extinguished.

Table 6: Impact on household net wealth[22]

	Threshold			
	EUR 100 000	EUR 300 000	EUR 500 000	EUR 800 000
BE	29.1%	4.1%	0.5%	0.0%
DE	21.1%	5.4%	1.8%	0.0%
EE	2.7%	0.0%	0.0%	0.0%
IE	25.5%	4.4%	1.1%	0.0%
EL	2.0%	0.0%	0.0%	0.0%
ES	10.9%	1.6%	0.0%	0.0%
FR	20.9%	3.0%	0.0%	0.0%
HR	7.7%	0.0%	0.0%	0.0%
IT	24.3%	3.6%	0.4%	0.0%
CY	19.0%	4.6%	1.7%	0.0%
LV	0.0%	0.0%	0.0%	0.0%
LT	2.1%	0.0%	0.0%	0.0%
LU	49.8%	27.2%	13.1%	3.8%
HU	1.3%	0.0%	0.0%	0.0%
MT	21.9%	2.1%	0.0%	0.0%
NL	17.0%	2.8%	0.0%	0.0%
AT	30.5%	5.8%	0.7%	0.0%
PL	5.6%	0.0%	0.0%	0.0%
PT	6.2%	0.0%	0.0%	0.0%
SI	13.0%	0.8%	0.0%	0.0%
SK	6.2%	0.0%	0.0%	0.0%
FI	13.7%	1.4%	0.0%	0.0%

2.6 Impact on the DGS when protecting THBs due to life insurances and criminal injuries

The JRC has also researched available information about the remaining types of THBs. There is a limited information about the size of deposits that: (i) serve social purposes linked to life events or (ii) are based on the payment of insurance compensation for criminal injuries. Therefore, data availability appears as a key challenge and the research has not revealed any available approach to quantify these types of THBs. Despite the data gaps, the JRC explored the analysis based on the amount of benefits paid by the insurance sector for events related to life or motor in relation to which the available data are the most promising and complete.

2.6.1 Life insurance

Life insurance can become a THB when the depositor receives a one-off amount or annuities of a life insurance on the bank account. If the bank fails, there is risk of losing the part of the amount depending on the coverage level applicable in a Member State.

For purposes of the analysis, the JRC used the data from Insurance Europe on the total amount of benefits payed by the insurance sector in each Member State[23] and sets out the following data limitations:

- The data do not specify if they refer to term life insurances or whole life insurances. This means that any annuity should be excluded when estimating the size of THBs because the whole life insurances

[22] The analysis uses information from the ECB HFCS. Therefore, BG, CZ, DK, RO, and SE, which are not participating in the survey, have been excluded.

[23] Insurance Europe provides data on the life benefits paid for 27 MS for the period 2013-2018 (see Table 40 in Annex A). The JRC has also identified additional data sources with life insurance information: (1) ECB provides ratios per country of households holding at least one life insurance among household members (ECB, 2020). However, this data covers only whole life insurances and term life insurances are excluded; (2) OECD reports tables by indicators, which reflect the most significant characteristics of the OECD insurance market. In most cases, the tables contain data of all OECD countries as well as aggregated "OECD" data from 1983 to 2017, for the following categories: life insurance, non-life insurance and total. Detailed information regarding the breakdown of these indicators is not available.

may also contain a saving component. However, no information is available on the size of the annuity or the share of lump sum payments that would qualify as THBs eligible for protection.

- Information on the number of beneficiaries is missing. Despite the above data limitations, it is possible to provide an overestimate of the impact on DGSs to protect THBs linked to life insurance, under the extreme assumption that the total amount, as published by Insurance Europe, would be fully covered. Table 7 shows the cost of protecting this category of THB, by calculating the amount of life benefits paid in 2018 as a percentage of covered deposits for each Member State. This is a worst-case scenario for the following reasons:
    - This assumption considers that an insurance payment only consists of a lump sum;[24]
    - It neglects that the total amount could be allocated to more than one bank account (multiple beneficiaries);
    - It excludes the possibility that the standard level of protection would cover at least a share of such deposit.

While these findings demand a cautious interpretation, they also point to the following conclusion: **the impact of protecting this category of deposits may be negligible for the majority of countries in particular as compared to the size of real estate transactions.**

Table 7: Percentage of life benefits paid with regard to the total amount of covered deposits[25]

	%Covered Deposits
BE	5.59%
BG	0.24%
CZ	1.48%
DK	18.87%
DE	4.34%
EE	0.49%
IE	8.88%
EL	1.32%
ES	3.41%
FR	10.12%
HR	1.21%
IT	10.33%
CY	0.82%
LV	0.51%
LT	N/A
LU	3.11%
HU	0.00%
MT	2.06%
NL	4.03%
AT	3.03%
PL	2.70%
PT	4.55%
RO	0.00%
SI	2.56%
SK	2.36%
FI	15.37%
SE	13.95%

It should be noted that these figures include life insurance pension products falling under second and third pillar mostly paying out annuities rather than lump sums. THB impacts for markets with high penetration rates of these products are therefore likely to be greatly inflated, possibly even by a factor of 3 or more. More data would be needed to be able to arrive at a more precise estimate.

24 In the reality, the total amount includes a savings component paid during the life of the contract. This component might constitute a significant share in some countries and would cause an over-estimation in the calculations.

25 For IE, for 2017 life benefits are used as for 2018 data are not available.

2.6.2 Criminal injuries

The JRC has also analysed criminal injuries damages. For purposes of this analysis, the data on car accidents and the related amounts of insurance payouts were used as a basis (source https://insuranceeurope.eu/insurancedata). Accordingly to Insurance Europe, data on total benefits paid in Europe show that the total amount for property and car claims is significantly lower than the amount for life benefits. One could thus expect that the impact on DGSs of protecting this category of deposits as THBs would be even lower, if not negligible, than that due to the THB life insurance category.

2.7 Conclusions

The current DGSD harmonises the standard level of deposit protection and allows some flexibility in other areas to reflect national specificities. As a result of this flexibility, the coverage of THBs varies among countries. More convergence is critical in order to enhance level playing field for depositors within the euro area and for all the Member States as well as for setting up a common deposit insurance fund.

This report analyses the appropriate financial cost of a higher protection for THBs in the EU. While modelling the size of these deposits is challenging mainly due to the limited data and information about transactions or events that generate them, there are, however, credible data and information that can substitute the missing information and outstanding data gaps (e.g. the data on the house prices distribution and so on).

The primary focus of the report is on the deposits arising from real estate transactions. The report covers different policy options in terms of level and duration of protection (up to a maximum of EUR 800 000 and 12 months). Depending on the selected threshold of the protection, the increase in covered deposits is estimated to range from 0% to 3% depending on the assumptions. For example, the impact of protecting THBs up to EUR 500 000 for 6 months implies an increase in covered deposits of 2.2% on average. This translates into an extra cost for the DGSs and an increase in bank contributions. Under the assumption of including the first EUR 100 000, the impact will increase up to 3.8%. Nonetheless, the size of THBs does not increase significantly above a coverage level of EUR 500 000. Subject to the explained methodological challenges, it is also clear that these – relatively low - figures are an overestimation of the impact on DGS and banks.

In order to determine the coverage of THBs, it is necessary to strike the right balance between the additional costs borne by banks or DGSs and the need to protect depositors. The report has put forward an innovative framework to measure the impact of the absence of THB protection on the wealth of consumers involved in the house transactions. The findings revealed that an increase of the level of protection up to EUR 500 000 might be successful in protecting the wealth of households in the majority of countries, with respect to the actual situation where people involved in house transactions might face the risk of losing a substantial share of their wealth. As a result, a policy option increasing the level of protection up to EUR 500 000 appears to better pursue the policy objective of enhancing depositor confidence while limiting the burden on DGSs and banks.

In addition, despite data gaps on sums arising from pensions, inheritances and criminal injuries, there is also some promising data on the amounts of insurance benefits from motor and life insurances. While any conclusion should be interpreted with caution, available data indicate that the size of THB arising as consequences of death or car accident events appear much less material than those from real estate transactions.

3 Measuring the effectiveness and the pooling effect of EDIS

3.1 Executive summary

Vice President Dombrovskis' 2019 mission letter emphasised the importance of agreeing on a European Deposit Insurance Scheme (EDIS), with the aim to increase the resilience of the Banking Union and thus enhance the overall financial stability. One of the priority of the Commission is to make progress on the Banking Union in fact "there is not greater way to stability and competitiveness than through a deeper economic and monetary Union."

The JRC has analysed in the past the effects of a common deposit insurance scheme for Member States within the Banking Union.[26] This report reflects on the possible parameters of a design of EDIS, and investigates on the role of EDIS when providing liquidity support in terms of effectiveness, defined as the ability to reimburse depositors, and of efficiency, defined as the ability to reimburse depositors at lower cost.[27]

With the overall aim to enhance the depositor confidence, we answer to the following (1) how DGS pay-out capacity would change if the current national DGS system is replaced or complemented by EDIS (2) whether synergies arise from pooling effects in the contributions.

The assessment focuses on the amount of covered deposits that are not protected in the event of a banking crisis given that funds are insufficient. Therefore, results will quantify the amount of covered deposits that cannot be reimbursed in the immediate aftermath of a banking crisis under each scheme.

The analysis is based on the SYMBOL model, which simulates bank failures and the corresponding multiple pay-outs hitting the Deposits Guarantee Schemes (DGSs) and the common fund. The analysis is developed at the individual bank level and results are then aggregated at the country/banking union level.

The main results can be summarised as follows:

1. **EDIS is more effective than status quo**: a system with common financial means is able to protect a higher amount of covered deposits than under the status quo. The more resources are mutualised, the more effective the system is. All variant of EDIS considered in the analysis significantly reduce the likelihood and the size of liquidity shortfall even under a systemic event. EDIS reduces the probability of a depositor pay-outs with liquidity shortfall by 80%-90% and covers 90%-95% of liquidity shortfalls that otherwise remain unprotected under the national DGSs. While all national DGSs protect €8 bn on average under the status quo, €14-15 bn of covered deposits are protected on average under EDIS. In case of a systemic crisis, the probability of a liquidity shortfall is 87% under the status quo, 46%-56% under EDIS (depending on the parameter settings). Under the status quo, all national DGS protect €22 bn on average. Under EDIS €31–36 bn of covered deposits are protected on average.
2. **Pooling of resources** (i) increases the probability of full protection of the covered deposits without liquidity shortfall and (ii) delivers a higher efficiency for various EDIS designs creating room for lowering the target level and consequently the cost for the baking sector.

[26] "The European Deposit Insurance Scheme: Assessing risk absorption via SYMBOL", JRC Science for policy report 2017.

[27] Loss sharing has not been analysed.

3.2 Proposals under investigation

The report compares different designs of EDIS with the status quo focusing on liquidity support, i.e. by quantifying the amount of liquidity shortfalls that cannot be covered. The objective is to measure effectiveness and efficiency of mutualising resources via a common fund (and mandatory lending). The treatment of losses ultimately borne by national DGSs in the medium-long term would add an additional layer of complexity to the analysis and for the time being the amounts recovered from insolvency procedures have not been considered. Therefore the loss coverage is not here analysed.[28] The use of DGS/EDIS funds in resolution is excluded as well.[29]

The following three design options have been modelled:

- **Status quo**

Currently, only national DGSs are in place. Each national DGS is responsible for covered deposits of the banks in its own Member State. The total initial amount of funds of the national DGS is fixed to 0.8% (target) of covered deposits in each country.

- **Full liquidity pooling EDIS**

This option considers that covered deposits in all participating Member States are guaranteed by a common scheme. Such EDIS is pre-funded by banks from all participating Member States, considering that all DGS funds (i.e. 0.8% of covered deposits in each country of the Banking Union) are transferred to EDIS. With this option, the risk of a pay-out is fully mutualized via a common fund. There are no more national funds. This option contemplates EDIS mutualizing all DGS funds in line with the Commission 2015 proposal for liquidity support only (first phase).

- **Hybrid EDIS**

The hybrid model is built around the idea of coexistence of a common fund and funds remaining within the national DGSs and allows for a mandatory lending between DGSs. The combined target level of the common fund and national DGSs is 0.8% of covered deposits. National DGSs retain a share α of collected funds. The remaining share (i.e. $1-\alpha$) is transferred to the common fund. This report considers the following different levels of α: 25%, 50%, or 75%. In terms of governance, the waterfall mechanism in place to activate the hybrid EDIS is made of three steps.

<u>Step one:</u> the DGSs are responsible for covered deposits of the banks in their own Member State. Each DGS can use only a share β of its national funds ($\alpha \times$ target) to reimburse covered deposits of its failing banks. When beta is equal to 100%, there is no earmarked mandatory lending and all the amount transferred to the national fund can be used for reimbursing depositors. [30] Otherwise, a beta lower than 100% is used to model an earmarked mandatory lending which requires to set aside a share of funds to be used for mandatory lending only.

<u>Step two</u>: the common fund provides liquidity support to a DGS in need when the latter has exhausted its funds available to pay-out covered deposits from their own country ($\beta \times \alpha \times$ target).

<u>Step three</u>: if the common fund has insufficient means, the beneficiary DGS is entitled to borrow through a mandatory lending mechanism. Each DGS shall respond to the request of the beneficiary DGS by mobilizing a

[28] In the medium-long term, a DGS may incur a loss if its pay-outs exceed the sum of resources that can be collected. A loss different from zero implies that the DGS itself fails. To quantify losses ultimately borne by national DGSs, two following potential resources should be taken into account (i) recoveries from insolvency proceedings. They may be modelled introducing a recovery rate as additional parameter. The recovery rate has been set equal to 60% of the amount of covered deposits of the failing banks in previous exercises, however country specific recovery rate could also be assumed; Please note that interest rates associated to loans, should vary only based on riskiness/repayment capacity of the institution(s) who will bear the ultimate responsibility for repaying the loans. (ii) extraordinary ex-post contributions collected in the long run. In previous exercises, they have been fixed to 0.5% of the amount of covered deposits of the relevant Member State.

[29] According to the DGSD and BRRD, the DGS/EDIS should also assist in the financing of the resolution of credit institutions and it is liable for the amount of losses that covered depositors would have suffered under an insolvency procedure (when one or more resolution tools other than the bail in tool is applied). The liability of a DGS/EDIS shall not be greater than the amount equal to 50% of its target level.

[30] In case of no earmarked mandatory lending, the DGSs do not need to keep any fund available for lending thus the DGS can use β =100% of its fund.

share of their funds (if available and subject to appropriate caps) and provide the loans. Such amount is capped to a share (γ) of either the initial or available financial means. It is assumed that these loans are repaid in full in the medium-long term.

Against this background, this report explores several sets of parameters, as illustration of possible alternative hybrid models. Nine different sets of parameters have therefore been tested. These proposals are presented in Table 8:

Table 8: Parameters used for the analysis of the hybrid model

Proposal		**Alpha**	**Beta**	**Gamma**	**ML as share of**
1. Small central fund	a.	75%	100%	33%	Initial national funds
	b.	75%	67%	33%	Initial national funds
	c.	75%	100%	33%	Available financial means
2. Medium central fund	a.	50%	100%	50%	Initial national funds
	b.	50%	50%	50%	Initial national funds
	c.	50%	100%	50%	Available financial means
3. Large central fund	a.	25%	100%	50%	Initial national funds
	b.	25%	50%	50%	Initial national funds
	c.	25%	100%	50%	Available financial means

For instance, under proposal 1.a:

- 75% (α) of the target remains at national level and 25% (1-α) of target is transferred to the common fund.
- The DGSs have at their disposal 100% (β) of national funds (α × target) to pay out covered deposits of its failing banks. No caution buffer is necessary for DGS lending.
- The DGSs have to lend funds to the beneficiary DGS, up to a limit of 33% (γ) of their *Initial national funds*, i.e. the lending is capped to γ × α × target.

Under option 2.b:

- 50% (α) of the target remains at national level and 50% (1-α) of target is transferred to the common fund.
- The DGSs have at their disposal 50% (β) of national funds (α × target) to pay out covered deposits of its failing banks. Caution buffer equal to 50% (1-β) is introduced for DGS lending. In this case, the beneficiary DGS will participate in the last step using their own fund set aside for mandatory lending.
- The DGSs have to lend funds to the beneficiary DGS, up to a limit of 50% (γ) of their *Initial national funds*, i.e. the lending is capped to γ × α × target.

and under option 3.c:

- 25% (α) of the target remains at national level and 75% (1-α) of target is transferred to the common fund.
- The DGSs have at their disposal 100% (β) of national funds (α × target) to pay out covered deposits of its failing banks. No caution buffer is necessary for DGS lending.
- The DGSs have to lend funds to the beneficiary DGS, up to a limit of 50% (γ) of their *Available financial means*, i.e. the lending is capped to γ × A*vailable financial means.*

The following definitions and working assumptions are required:

- The SYMBOL model is used to simulate bank losses. While this model considers the 27 EU MSs to run, results will then focus on the 19 MSs participating in the Banking Union, i.e. participating to EDIS.
- Available financial means are defined as the amount of funds at disposal of the national DGS or EDIS at a given time. At time zero, the amount corresponds to the target level, i.e. 0.8% of the covered deposits.
- Liquidity needs (or pay-out) are defined as the amount of covered deposits that a DGS/EDIS is required to cover as a consequence of a bank failure.

- Liquidity shortfalls are the share of pay-outs that cannot be covered.
- In case of a full liquidity pooling or hybrid models, liquidity shortfalls not covered by the protection scheme are reported back to individual MSs. The amount of liquidity shortfalls is divided between MSs proportionally to the liquidity needs of each national DGS (i.e. the amount of covered deposits to be reimburse in each country).
- Ex-post contributions to replenish the national funds are neglected.

3.3 Modelling

The losses used to assess the different proposals are generated via the Systemic Model of Banking Originated Losses (SYMBOL) for the 27 MS. Banks' failures depend on their initial level of capital and the severity of the shock. The focus of the present exercise is on the pay-outs to be covered by either national DGS or EDIS owing to banks failures. Results are then aggregated at national or at Banking Union level. It is worth emphasizing that results are based on the same set of underlying simulated banks' failures.

The analysis is structured in two steps. In the first one, 100 000 banking crisis realizations are produced, where at least one bank in the sample fails. Failure happens with the depletion of a bank total regulatory capital. These cases trigger the DGS intervention to reimburse the amount of covered deposits of banks under liquidation.[31] In the second step, it is checked whether for each simulation, the concerned deposit insurance schemes could withstand the simulated crisis. In particular, the schemes are compared on the grounds of *uncovered liquidity needs*, i.e. to what extent they would be able to provide coverage for the covered deposits of failed banks in very short term.

3.3.1 Dataset

The simulations are based on end-of-year unconsolidated balance sheet data for commercial, saving and cooperative banks. The main data source on banks' financial statements is Orbis Bank Focus, a proprietary database of banks' financial statements produced by Bureau van Dijk.

This commercial database lacks information on specific variables for some banks in the sample, in particular capital and risk weighted assets. In those cases, capital is imputed via a robust regression by common equity, while risk weighted assets are approximated using the total regulatory capital ratio (at bank or country level)[32]. Data on covered deposits held by each bank are also needed for the present analysis. The amount of covered deposits by bank is not publicly available. Hence, statistics at the country level and bank-level on customer deposits are used. In particular, the ratio of covered deposits over customer deposits at the country level is computed and then this ratio is applied to the customer deposits held by each bank to get an estimate of the amount of covered deposits for each bank.

For the reference year 2018, the dataset covers on average 78% of EU banking assets, with a sample of around 3 136 banks.[33] Information on the sample is presented in Table 9 with aggregated values for some selected variables. The table includes the data relative to all MS, and not only the 19 MS of interest, because all countries are used to generate losses via the SYMBOL model.

[31] Large banks are assumed to be resolved while only the smaller banks would go into insolvency.

[32] The procedure for the imputation of missing values of capital and RWA is described in "SYMBOL database and simulations for 2013, P. Benczur, J. Cariboni, F. E. Di Girolamo, A. Pagano, M. Petracco, JRC European Commission, Technical Report, JRC9298"

[33] When the sample includes either a small number of banks or the share of total assets covered is low, results should be interpreted with caution, since a minor change to any bank's data or the addition of a new bank could have large effects on results.

Table 9: Descriptive statistics of samples used for SYMBOL simulations, 2018 unconsolidated data

	Nbr.of banks	Total assets (TA) bn€	Capital bn€	Risk weighted assets (RWA) bn€	RWA/TA	Capital/RWA
AT	471	706.0	65.2	341.0	48.3%	19.1%
BE	27	914.2	63.2	325.5	35.6%	19.4%
BG	17	47.5	5.3	26.7	56.2%	19.9%
CY	6	52.0	4.0	22.4	43.1%	17.9%
CZ	17	1 96.9	15.3	77.7	39.5%	19.7%
DE	1,175	4 783.5	392.6	2 222.2	46.5%	17.7%
DK	62	625.7	51.8	227.9	36.4%	22.7%
EE	3	21.8	3.0	8.8	40.2%	33.8%
ES	78	2 084.7	181.5	1 077.7	51.7%	16.8%
FI	154	575.3	46.0	202.3	35.2%	22.8%
FR	162	7 131.7	393.3	2 181.3	30.6%	18.0%
GR	7	230.4	25.1	154.8	67.2%	16.2%
HR	20	52.8	6.9	30.2	57.1%	22.8%
HU	10	48.5	7.3	29.0	59.7%	25.1%
IE	23	275.8	32.9	1 53.1	55.5%	21.5%
IT	365	2 366.9	201.8	1 211.1	51.2%	16.7%
LT	6	27.0	2.3	12.7	47.2%	18.3%
LU	60	399.0	37.0	167.6	42.0%	22.1%
LV	14	20.5	2.6	11.6	56.5%	22.5%
MT	11	26.3	2.3	12.1	46.1%	19.3%
NL	14	1 699.6	119.9	5 30.3	31.2%	22.6%
PL	121	343.0	37.5	204.9	59.7%	18.3%
PT	105	290.7	26.9	168.8	58.1%	15.9%
RO	17	78.6	8.3	42.1	53.6%	19.8%
SE	79	627.1	47.2	197.7	31.5%	23.9%
SI	10	32.4	3.8	19.7	60.8%	19.1%
SK	10	66.1	6.0	39.3	59.4%	15.3%
UK	92	4 493.0	282.4	1 349.5	30.0%	20.9%

Source: Orbis Bank Focus and author computations.

3.3.2 Two banks' categories

In the present framework, banks are divided in two groups, the banks benefiting of the resolution mechanism and those going into liquidation**.**[34] The model also accounts for the possibility of liquidating a significant entity. This hypothesis mimics the limited empirical evidence available. The ECB supervised entities do not go automatically into resolution, as the SRB decides on a case-by-case assessment whether the conditions for resolution would be met. To model this uncertainty, banks are split into three groups: GSIBs, significant entities and less-significant institutions (LSIs) based on the assumption that it would be more likely for GSIBs and less likely for LSIs to meet the conditions for resolution. Hence, for the purpose of this analysis every group is associated with a probability of going into resolution when in trouble. For GSIBs and their subsidiaries this probability is set at 100%; for significant entities, the resolution probability is set at 80%, while the remaining institutions will always go into liquidation when in trouble thus triggering the DGS/EDIS intervention (i.e. with a resolution probability equal to 0%).

For the purposes of the exercise, the analysis is limited to banks which will trigger the DGS intervention in case of need. Results presented in the next sections should be interpreted with some caution when the number of banks in a country (or in sub-samples) is lower than 10.

3.3.3 Simulations

Results are based upon the simulation of multiple DGS pay-outs, obtained via the SYMBOL model (see Annex B for a description of the model), according to the following steps:

3.3.3.1 Simulation of economic losses deriving from banks' assets portfolios

SYMBOL approximates the probability distributions of individual bank's losses using publicly available information from banks' financial statements. The key input data necessary to run SYMBOL are the following:

- Total assets;
- Risk-weighted assets;
- Total capital and/or capital ratios.

In particular, the model estimates an average implied default probability of the individual banks' asset/loan portfolios by inverting the Basel FIRB formula for capital requirements. Starting from the estimated average probability of default of each individual bank's obligors, SYMBOL generates realisations for each individual bank's credit losses via Monte Carlo simulation using the Basel FIRB loss distribution function and assuming a correlation between simulated shocks hitting different banks in the system.

The output of SYMBOL is a matrix of simulated gross unexpected losses $L_{n,i}$ due to the risk of individual banks' assets portfolios and a correlation structure among banks : n represents the simulation run and i the institution.[35]

3.3.3.2 Identification of a failure for each bank in each simulation run

A default event triggering the DGS pay-out (or the resolution procedure in the case of a significant entity) occurs when the leftover total regulatory capital after absorbing the loss is lower than a certain threshold θ:

$$(K_i - L_{n,i}) < \vartheta,$$

where K refers to the total regulatory capital

[34] Significant banks in the Banking Union are entities belonging to groups falling under SSM supervision. They are thus selected on the basis of the list of significant banks published by the SSM. Significant banks headquartered outside of the Banking Union meet similar criteria as set by the ECB (Article 6(4) of SSM Regulation). As the Commission services do not have data on cross border activities and there is no available information on whether a bank has fulfilled the direct public finance assistance criterion, only the other criteria have been applied at the highest group level of consolidation, i.e. size criterion: total assets (TA) > 30 billion €; economic importance criterion: total assets > 20% GDP and total assets >5 billion €; top three: three largest banks in a Member State (MS) in terms of total assets.

[35] L: matrix N × 100 000, where N is the number of institutions in the sample and 100 000 is the number of simulations.

In this analysis the level ϑ is set equal to 0.[36] It corresponds to a situation where the capital is entirely depleted.

3.3.3.3 Estimation of liquidity needs (pay-out) for banks going into liquidation

The liquidity needs are calculated for the 19 MSs participating in the Banking Union. In case of default, it is assumed that the DGS will pay the total amount of covered deposits. The *Payout* matrix[37] consists in covered deposits of banks going into liquidation:

$$Payout_{n,i} = d_{n,i}CovDep_i$$

where $d_{i,n}$ is the default indicator, i.e

$$d_{n,i} = \begin{cases} 0 \ if \ (Capital_i - L_{n,i}) \geq 0 \\ 1 \ if \ (Capital_i - L_{n,i}) < 0 \end{cases}$$

3.3.3.4 Intervention of the DGS and (or) EDIS under different design settings

Two time conventions for modelling the intervention of the insolvency schemes are here discussed: i) when failures are simultaneous; ii) when failures occur at different times.

Simultaneous events

When failures are simultaneous, the model works at the aggregated level. Resources cover aggregated pay-outs and they are apportioned based on the amount of covered deposits, as a proxy for size (but other criteria might be applicable as well).

Status quo:

The initial amount of funds of the national depositor protection scheme is defined as a fixed amount and set at 0.8% of covered deposits in each country:

$$AFM\_DGS_{MS} = 0.8\% \times CD_{MS},$$

where *CD* stands for *covered deposits* and MS refers to a Member State in the Banking Union. Each national DGS is responsible for covered deposits of the banks in its country. In case the fund has been depleted, the liquidity shortfalls are calculated as follows:

$$LiquidityShortfall\_DGS_{MS} = max\{Payout_{MS} - AFM\_DGS_{MS}, 0\}.$$

Full liquidity pooling EDIS:

The initial amount of funds is set at 0.8% of the covered deposits in the countries participating in the Banking Union (BU):

$$AFM\_EDIS = 0.8\% \times \sum_{MS \in BU} CD_{MS}.$$

In case the pay-outs are larger than the fund available under EDIS, some covered deposits cannot be reimbursed and the liquidity shortfalls are calculated as follows:

$$LiquidityShortfall\_EDIS = max\{\sum_{MS \in BU} Payout_{MS} - AFM\_EDIS, 0\}.$$

Hybrid model

At each step of the intervention, deposits are covered up to the depletion of the instrument: i.e. the common fund will intervene only after the depletion of national DGS and mandatory lending will be called after the depletion of the common fund.

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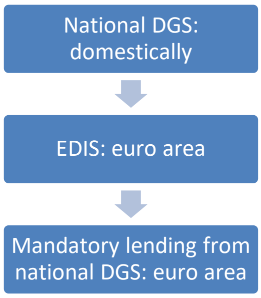
[36] This is coherent with the previous SYMBOL analyses contained in EC documents where the definition of default is the complete deployment of regulatory capital to cover simulated losses, i.e. $\vartheta = 0$.

[37] *Payout*: matrix N × 100 000.



For each MS of the Banking Union the target is set at 0.8% of covered deposits in the countries participating in the Banking Union (BU).

$$Target_{MS} = 0.8\% \times \sum_{i \in MS} CD_i,$$

This total amount is split into:

- a national fund that can be used domestically: $AFM\_DGS_{MS} = \boldsymbol{\beta} \times \boldsymbol{\alpha} \times Target_{MS}$,
- a national fund for the mandatory lending: : $AFM\_DGS_{MS} = (1 - \boldsymbol{\beta}) \times \boldsymbol{\alpha} \times Target_{MS}$,
- and a common fund: $AFM\_EDIS = \mathbf{(1\text{-}\alpha)} \times Target_{MS}$.

The national funds step in to cover the national aggregated pay-out at first. The left over funds and liquidity shortfalls after the DGS intervention are thus calculated:[38]

$$AFM\_DGS_{MS} = max\{AFM\_DGS_{MS} - Payout_{MS}, 0\},$$

$$LiquidityShortfall\_DGS_{MS} = max\{Payout_{MS} - AFM\_DGS_{MS}, 0\}.$$

In case of national funds lower than the amount necessary, the liquidity shortfalls are to be covered by the common funds, allocated pro rata to the amount of covered deposits:[39]

$$LiquidityShortfall\_EDIS_{MS} = max\{LiqiudityShortfall\_DGS_{MS} - AFM\_EDIS \times \frac{CD_{MS}}{\sum_{MS} CD_{MS}}, 0\}.$$

Once, the common fund has been exhausted, each national scheme would be able to borrow from other DGSs through a mandatory lending mechanism (ML). Given that all simulations are here simultaneous, it is not possible to model what is lent to whom thus the simulation works at aggregated level and apportions among DGSs based on some criteria.

If DGSs were asked to allocate ex-ante a share (1-β) > 0 of their funds for ML only, all of them would still have resources to use. If they were not (β=1), only some of them would be able to contribute to the ML. In both cases ML can be viewed either as an extra fund for the EDIS or as an amount that can be transferred from a still resourceful DGS to a depleted one.[40] The additional resources that each DGS can obtain and the amount of covered deposits that would not be protected in the event of a banking crisis are given by the following:[41]

$$ML = \begin{cases} \sum_{MS} min(\gamma \times \alpha \times 0.8\% \times CD_{MS}, AFM\_DGS_{MS}) & \text{under proposal a,} \\ \sum_{MS} \gamma \times \alpha \times 0.8\% \times CD_{MS} & \text{under proposal b,} \\ \sum_{MS} \gamma \times AFM_{DGS_{MS}} & \text{under proposal c.} \end{cases}$$

[38] *LiquidityShortfall_DGS: 19 × 100 000 matrix.*

[39] *LiquidityShortfall_EDIS: matrix 19 × 100 000.*

[40] *ML: matrix 19 × 100 000.*

[41] *LiquidityShortfall_ML: matrix 19 × 100 000.*

$$LiquidityShortfall\_ML_{MS} = max\{LiquidityShortfall\_EDIS_{MS} - ML \times \frac{CD_{MS}}{\sum_{MS} CD_{MS}}, 0\}.$$

Simulating a sequence of the bank failures

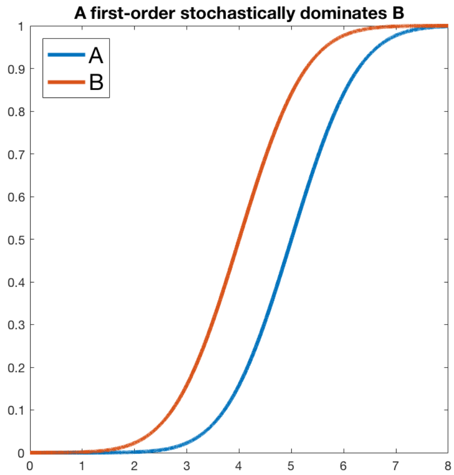
Modelling a sequence of bank failures could be important under the mandatory lending mechanism. Different sequences might have different impacts on a bank. Indeed, each bank receives a value of mutualized funds depending on its position in the sequence. While the fund(s) fully cover the pay-out of the first institutions, they may not be able to do so for the last banks failing. In this exercise sequences of bank failures are drawn randomly. [42]

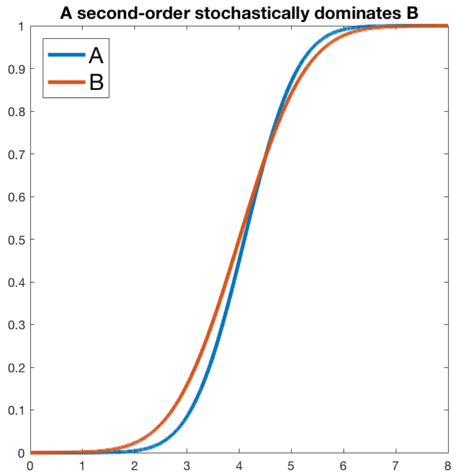
3.4 Effectiveness

In this section, we compare the different schemes[43] on their ability to cope with pay outs, i.e. on their absorption capacity. The outcome consists mainly of liquidity shortfall distributions, i.e. of distributions of covered deposits remaining unprotected in the immediate aftermath of a banking crisis. The reported charts and figures refer to rather extreme scenarios, with simulations where at least one of the schemes yields a liquidity shortfall. In less extreme scenarios, all the proposals are equivalent as they all allow reimbursing all covered deposits.

The JRC evaluates the effectiveness of the different schemes by comparing (i) the whole distribution of liquidity shortfalls under each scheme; (ii) the average size of liquidity shortfall during a systemic crisis.

The first one uses **stochastic dominance** to compare the distributions. A distribution first-order stochastically dominate another one, if it is always preferable. The second order stochastic dominance implies that a distribution has a higher mean and lower dispersion than another one, and thus is overall preferable. These two types of dominance can be checked by looking at the distributions' cumulative distribution functions (cdf). If a cdf is always below another one then this distribution first order stochastically dominates the second one. If the area below one cdf is always smaller than the area below another cdf, then the first distribution (second order stochastically) dominates the second distribution.



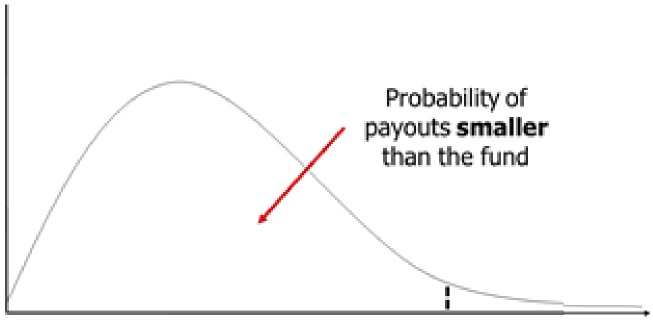


The second one is to look at the **amount of liquidity shortfalls conditional on systemic crisis** of different magnitude. As there is not enough historical data on DGS interventions to understand which part of the distribution represents a relevant event potentially affecting the DGS/EDIS funds, different levels of severity are analysed.

Figure 3: Example of a level of protection: the dashed segment highlights the percentile in the pay-out distribution at which covered deposits are fully protected.

[42] The simulation of sequential bank failures requires high computational power.

[43] As reminder: status quo, full liquidity pooling, and hybrid schemes made of national and common funds.



3.4.1 Stochastic dominance of the pay-out distributions

We recall that under the status quo each national DGS is assumed to reimburse the covered deposits in its own country. The liquidity shortfall is calculated at country and banking union level. These aggregated variables are then compared with the corresponding shortfalls in the case of the hybrid models and the fully-mutualised EDIS. The differences provide an insight into the loss-absorption capacity implied by choosing one of the scheme.

3.4.1.1 Aggregated results

Analysing aggregate results for the Banking Union, it is reasonable to conclude that under the current target level and in terms of liquidity needs, EDIS (full liquidity pooling or hybrid model) is always more effective than the status quo no matter its underlying parametrization. Owing to the large common fund without any cap on the amount to be used for reimbursing depositors, a full liquidity pooling turns out to be always the most effective.

EDIS (full liquidity pooling or hybrid) reduces the probability of a depositor pay-out with liquidity shortfall by 80%-90% and covers 90%-95% of liquidity shortfalls that would otherwise be unprotected under the national DGSs. Under the status quo, all national DGSs protect €8 bn of covered deposits on average while €14-15 bn of covered deposits are protected on average under EDIS. Results confirm that the more resources are mutualized, the more effective the system is. For the hybrid models, the degree of mutualisation given by mandatory lending or size of central fund is the main parameter leading to a significant impact on effectiveness. The large central fund is thus the closest to the full liquidity pooling.

Hereby, results refer to the simultaneous events. The general picture does not change when simulating different sequences of default and thus introducing the time component.

Figure 4 shows the liquidity shortfalls as a function of crisis severity and under the different schemes. On the y-axis, we have the leftover liquidity needs as a share of covered deposits. Fixing a specific level of liquidity shortfall (point on the y-axis), the x-axis is the probability of observing a liquidity shortfall lower or equal to this level. The figure zooms in the tails of the distributions (p>99.9%) to better highlight the differences between the alternative options. Original charts are available upon request to show the magnitude of the simulated retentions. Note that these curves are inversed cdf's and that stochastic dominance still holds.

In Figure 4 (top-panel), we present the liquidity shortfalls under the status quo (blue line) and full liquidity pooling (red line) schemes. We observe that for all simulated crisis, the second one presents lower liquidity shortfalls than the status quo. Similarly, Figure 4 (bottom-panel) shows that the status quo is always outperformed by the hybrid models since it presents higher liquidity shortfalls. As EDIS (hybrid and full liquidity pooling) outperforms the status quo in all simulations, all variant of EDIS first order stochastic dominate the national DGSs scheme.

Table 10 provides numerical evidence on the effectiveness of the different variant of EDIS. From a probabilistic point of view, first row confirms that EDIS (full liquidity pooling or hybrid) reduces the probability of a depositor pay-out with liquidity shortfall by 80%-90% (number of runs with liquidity shortfalls).[44] From a quantitative perspective, second row indicates that the areas below the EDIS curves are 40% to 50% smaller than under the national schemes. This superiority is due to the mutualisation (size of common fund and mandatory lending) which eases the flow of funds where they are needed. Funds unused at national level will be used by other

[44] Conditioning on a subsample of simulations where pay-outs have been observed in at least one of the scheme.

DGSs running short of money. Thereby, EDIS (full liquidity pooling or hybrid) cover 90-95% of liquidity shortfalls that would otherwise be unprotected under the national DGSs (third row). In addition to this consideration, we estimate the amount of covered deposits protected under each scheme (last row): all national DGSs protect €8 bn of covered deposits on average under the status quo. €14-15 bn of covered deposits are protected on average under EDIS (full liquidity pooling or hybrid).

Figure 4: Liquidity shortfalls under the common and national funds.

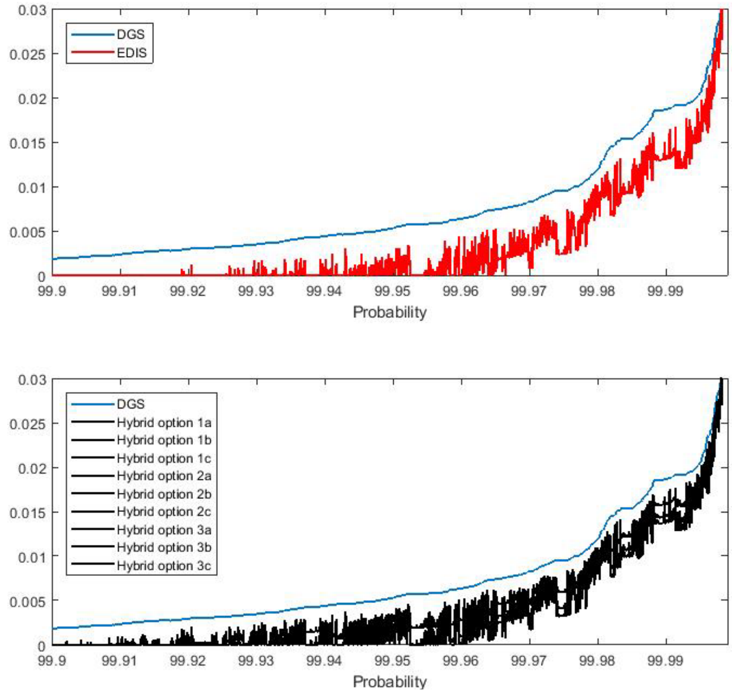


Table 10: Numerical evidence of effectiveness

	DGS	Full liquidity pooling	Small central fund hybrid *option a*	Small central fund hybrid *option b*	Small central fund hybrid *option c*	Medium central fund hybrid *option a*	Medium central fund hybrid *option b*	Medium central fund hybrid *option c*	Large central fund hybrid *option a*	Large central fund hybrid *option b*	Large central fund hybrid *option c*
Share of runs with liquidity shortfalls conditional on a pay-out in any scheme	100%	10%	17%	17%	17%	13%	13%	14%	11%	11%	11%
Ratio of the area below EDIS's curve over DGS's	1	0.44	0.58	0.58	0.59	0.49	0.49	0.50	0.46	0.46	0.46
Share of DGS liquidity shortfalls covered by EDIS	-	95%	91%	91%	90%	93%	93%	93%	94%	94%	94%
Average amount of covered deposits protected by each scheme	€8 bn	€15 bn	€13 bn	€13 bn	€13 bn	€14 bn	€14 bn	€14 bn	€15 bn	€15 bn	€15 bn

3.4.1.2 Results at MS level

Looking at individual countries, EDIS (full liquidity pooling or hybrid models) is more effective than the status quo, in terms of probability and size of liquidity shortfall, in the majority of crisis scenarios and for all countries except one. However, it is difficult to determine which mutualised schemes to prefer for effectiveness between hybrid and full liquidity pooling.

Hereby, results refer to the simultaneous events. The general picture does not change when simulating different sequences of default and thus introducing the time component. Despite the fact that the preferred mutualized scheme of each country might differ, the national scheme is confirmed to be the least performing and generating the highest amount of liquidity shortfalls. The impact of modelling the time component of bank failures has been analysed comparing different sequences: (1) ranking banks in descending order of assets, i.e. the largest insolvent bank is sent to liquidation as first; (2) ranking banks in ascending order of assets, i.e. the smallest insolvent bank is sent to liquidation as first; (3) averaging 50 random sequences.

For sake of simplicity, numerical evidence has been summarized in Table 11. More detailed results are available upon request. From a probabilistic point of view, EDIS (full liquidity pooling or hybrid model) reduces the probability of pay-out with liquidity shortfalls, being characterized by low number of runs with liquidity shortfalls (first group of columns). However, the more effective design between the hybrid model and a full liquidity pooling is not straightforward. Small countries seem to benefit from the first option, while the others may be better protected with hybrid schemes.

The second group of columns reveals that in all country except one, EDIS (full liquidity pooling or hybrid) reduces the amount of liquidity shortfalls that would otherwise remain unprotected under the national DGSs in more than 50% of cases. Also in that case, the more effective scheme between the hybrid model and a full liquidity pooling is not straightforward.

Nonetheless, it is possible to infer the second order stochastic dominance of EDIS from the last group of columns though. In fact, the essential feature of having an area below the curve smaller than the one under the fully national system is respected.

Table 11: Statistics on liquidity shortfalls conditional on having a pay-out in at least one of the scheme

	Share of runs with liquidity shortfalls conditional on a pay-out in any scheme			Share of runs with lower liquidity shortfalls than with DGS		Ratio of the area below EDIS's curve over DGS's	
	DGS	EDIS	Hybrid models	EDIS	Hybrid models	EDIS	Hybrid models
MS 1	100.00%	22.22%	22.22%-27.78%	100%	100%-100%	0.04	0.05-0.11
MS 2	94.85%	19.69%	20.69%-25.73%	95%	93%-94%	0.09	0.09-0.14
MS 3	76.60%	42.00%	29.6%-36.4%	70%	74%-84%	0.5	0.54-0.68
MS 4	99.97%	8.92%	9.4%-11.84%	95%	94%-95%	0.15	0.15-0.19
MS 5	82.15%	31.48%	24.61%-30.85%	78%	79%-86%	0.22	0.22-0.26
MS 6	100.00%	21.77%	22.51%-28.04%	97%	96%-97%	0.13	0.14-0.22
MS 7	85.10%	48.85%	47.71%-63.01%	84%	85%-91%	0.54	0.57-0.71
MS 8	70.42%	55.63%	29.93%-54.58%	60%	60%-82%	0.68	0.7-0.82
MS 9	58.66%	57.24%	23.67%-41.87%	55%	65%-89%	0.34	0.37-0.5
MS 10	100.00%	17.95%	18.56%-22.83%	99%	99%-100%	0.12	0.12-0.17
MS 11	36.00%	79.87%	24.8%-56.67%	30%	39%-72%	0.73	0.72-0.81
MS 12	73.09%	42.41%	31.88%-39.86%	70%	74%-87%	0.24	0.26-0.42
MS 13	53.13%	69.34%	29.87%-54.01%	51%	61%-92%	0.49	0.52-0.66
MS 14	99.39%	17.06%	18.18%-21.55%	95%	95%-96%	0.08	0.08-0.13
MS 17	58.80%	58.33%	20.83%-28.24%	59%	89%-99%	0.2	0.21-0.35
MS 18	83.12%	34.24%	30.26%-36.11%	81%	82%-90%	0.36	0.38-0.51
MS 19	99.26%	25.74%	27.21%-30.15%	99%	99%-100%	0.1	0.11-0.19
MS 20	60.58%	48.64%	26.72%-48.46%	60%	61%-86%	0.15	0.16-0.28
MS 21	100.00%	17.32%	19.1%-27.05%	91%	90%-91%	0.21	0.23-0.48

3.4.2 Liquidity shortfalls conditional under a systemic crisis

Liquidity shortfalls are sorted according to the distribution of simulated economic losses for the whole sample.45 This allows to draws conclusion on the size and probability of liquidity needs corresponding to a systemic crisis of different severities. When focusing on the liquidity support, EDIS increase the effectiveness of the status quo at Banking Union and country level.

Focusing on events whose severity is higher than the 2008 crisis, EDIS first and then hybrid models outperform the status quo at aggregated level. EDIS (full liquidity pooling or hybrid models) reduces the probability of liquidity shortfall from 87% to 46%-56%, depending on the combination of parameters, and cover 55%-68% of liquidity shortfalls that would otherwise be unprotected under the national DGSs. Under the status quo, all national DGSs protect €22 bn of covered deposits while the number increases up to €31-36 bn under EDIS (full liquidity pooling or hybrid models).

At country level, results are in most cases in line with the aggregated findings for the Banking Union. EDIS manages to lower the amount of liquidity needs with respect to the status quo. Concerning the probability of liquidity shortfalls, the tendency indicates that EDIS is increasing the probability of facing pay-outs with the increase of the crisis severity, much more than a national scheme. The explanation here is that the higher the crisis, the higher the number of institutions in need. In case the funds available for insolvency would not be large enough, the financial means would be split across banks proportionally to the amount of covered deposits. A common fund such as EDIS would yields a larger number of liquidity pay-outs even protecting much more deposits in terms of amount.

Hereby, results refer to the simultaneous events. Table 12 provides the numerical evidence at Banking Union level. First group of columns reports the estimated probability of liquidity shortfall at aggregated level. Second group of columns reports the ratio of the area below EDIS liquidity shortfalls over the area below DGS' liquidity shortfalls. Third group of columns indicates the share of liquidity shortfalls that would otherwise be unprotected under the national DGSs. Finally, last columns quantify the amount of covered deposits protected under each scheme.

The statistics per MS can be found in Table 13 to Table 15 for different level of severity: probability of pay-outs with liquidity shortfalls (first group of columns), liquidity shortfalls that would otherwise remain unprotected un the status quo (second group of columns), and area below the curves (last group of columns). More detailed results are available upon request.

Table 12: Statistics on liquidity shortfalls conditional a systemic crisis scenario at Banking Union level

	Probability of liquidity shortfall			Ratio of the area below EDIS's curve over DGS's			Share of DGS liquidity shortfalls covered by EDIS		Average amount of covered deposits protected by each scheme		
	DGS	EDIS	Hybrid models	DGS	EDIS	Hybrid models	EDIS	Hybrid models	DGS	EDIS	Hybrid models
Less severe crisis[46]	75%	30%	31%-38%	1	0.64	0.66-0.76	77%	66%-76%	€18 bn	€28 bn	€25-28 bn
2008 event[47]	87%	46%	47%-56%	1	0.69	0.71-0.80	68%	55%-67%	€22bn	€36 bn	€31-36 bn
More severe crisis[48]	98%	84%	85%-91%	1	0.85	0.86-0.91	37%	25%-36%	€31bn	€48 bn	€42-48 bn

45 Sorting economic losses in increasing order does not guarantee increasing DGS pay-outs. Indeed, extreme economic losses may not always correspond to extreme DGS pay-outs.

46 Percentile 99.9 on the distribution of losses.

47 Event with severity comparable to the 2008 financial crisis corresponds to 99.95% on the distribution of losses.

48 Percentile 99.99 on the distribution of losses.

Table 13: Statistics on liquidity shortfalls conditional on systemic crisis scenario less severe than the 2008 financial crisis

	Probability of liquidity shortfall			Share of runs with lower liquidity shortfalls than with DGS			Ratio of the area below EDIS's curve over DGS's	
	DGS	EDIS	Hybrid models	DGS	EDIS	Hybrid models	EDIS	Hybrid models
MS 1	0%	0%	0%	0.03%	0.00%	0%-0.01%	0.08	0.1-0.22
MS 2	10%	6%	7%-8%	0.51%	0.16%	0.17%-0.22%	0.31	0.33-0.44
MS 3	6%	8%	5%-7%	0.32%	0.23%	0.23%-0.26%	0.72	0.74-0.84
MS 4	19%	10%	10%-12%	0.54%	0.24%	0.25%-0.3%	0.44	0.46-0.56
MS 5	17%	18%	14%-18%	0.33%	0.18%	0.18%-0.2%	0.54	0.55-0.62
MS 6	8%	4%	5%-6%	0.94%	0.27%	0.29%-0.45%	0.28	0.3-0.48
MS 7	46%	30%	30%-36%	0.74%	0.48%	0.5%-0.59%	0.65	0.68-0.79
MS 8	4%	6%	3%-5%	0.24%	0.19%	0.19%-0.21%	0.78	0.8-0.89
MS 9	5%	11%	4%-8%	0.19%	0.12%	0.13%-0.15%	0.64	0.65-0.76
MS 10	10%	6%	6%	0.53%	0.19%	0.2%-0.26%	0.35	0.37-0.49
MS 11	5%	20%	5%-13%	0.07%	0.08%	0.07%	1.08	0.92-1.03
MS 12	25%	28%	22%-28%	0.69%	0.39%	0.4%-0.49%	0.56	0.58-0.72
MS 13	9%	24%	8%-18%	0.46%	0.31%	0.32%-0.37%	0.68	0.69-0.8
MS 14	11%	6%	7%-8%	0.76%	0.23%	0.25%-0.36%	0.31	0.33-0.48
MS 17	2%	5%	2%	0.31%	0.14%	0.14%-0.2%	0.43	0.46-0.63
MS 18	41%	29%	29%-33%	0.66%	0.38%	0.4%-0.47%	0.58	0.61-0.72
MS 19	2%	1%	1%	0.55%	0.15%	0.17%-0.29%	0.28	0.31-0.53
MS 20	15%	27%	15%-26%	0.82%	0.38%	0.39%-0.52%	0.46	0.48-0.63
MS 21	8%	5%	5%-6%	0.43%	0.22%	0.23%-0.31%	0.51	0.55-0.73

Table 14: Statistics on liquidity shortfalls conditional on a systemic crisis scenario whose severity is comparable or higher than the 2008 financial crisis

	Probability of liquidity shortfall			Share of runs with lower liquidity shortfalls than with DGS			Ratio of the area below EDIS's curve over DGS's	
	DGS	EDIS	Hybrid models	DGS	EDIS	Hybrid models	EDIS	Hybrid models
MS 1	0%	0%	0%	0.03%	0.01%	0.01%-0.02%	0.22	0.26-0.57
MS 2	14%	12%	12%-14%	0.68%	0.30%	0.31%-0.4%	0.43	0.45-0.59
MS 3	9%	14%	9%-12%	0.49%	0.39%	0.4%-0.44%	0.79	0.81-0.89
MS 4	27%	17%	17%-20%	0.83%	0.45%	0.47%-0.55%	0.54	0.56-0.66
MS 5	25%	32%	26%-31%	0.53%	0.34%	0.35%-0.39%	0.65	0.66-0.75
MS 6	12%	8%	8%-10%	1.46%	0.52%	0.55%-0.83%	0.35	0.38-0.57
MS 7	64%	46%	47%-55%	1.23%	0.84%	0.87%-1.01%	0.69	0.71-0.82
MS 8	6%	10%	5%-9%	0.37%	0.30%	0.31%-0.34%	0.83	0.84-0.91
MS 9	7%	20%	7%-14%	0.29%	0.21%	0.21%-0.24%	0.72	0.73-0.82
MS 10	14%	10%	10%-11%	0.77%	0.36%	0.37%-0.48%	0.46	0.48-0.62
MS 11	7%	33%	8%-23%	0.09%	0.12%	0.09%-0.11%	1.29	0.98-1.2
MS 12	38%	45%	36%-45%	1.05%	0.67%	0.7%-0.82%	0.64	0.67-0.78
MS 13	11%	39%	12%-30%	0.57%	0.44%	0.44%-0.49%	0.77	0.78-0.86
MS 14	16%	12%	12%-13%	1.10%	0.44%	0.47%-0.66%	0.4	0.43-0.6
MS 17	3%	9%	3%-4%	0.46%	0.24%	0.25%-0.33%	0.53	0.55-0.71
MS 18	56%	46%	46%-51%	1.04%	0.68%	0.71%-0.82%	0.66	0.68-0.78
MS 19	3%	2%	2%-2%	0.85%	0.28%	0.31%-0.49%	0.33	0.36-0.58
MS 20	22%	43%	25%-42%	1.23%	0.67%	0.7%-0.87%	0.55	0.57-0.71
MS 21	13%	9%	9%-10%	0.75%	0.42%	0.44%-0.57%	0.56	0.59-0.76

Note: * A crisis with economic losses comparable to the ones observed in 2009 is at percentile 99.95%.

Table 15: Statistics on liquidity shortfalls conditional on a systemic crisis scenario more severe than the 2008 financial crisis

	Probability of liquidity shortfall			**Share of runs with lower liquidity shortfalls than with DGS**			**Ratio of the area below EDIS's curve over DGS's**	
	DGS	**EDIS**	**Hybrid models**	**DGS**	**EDIS**	**Hybrid models**	**EDIS**	**Hybrid models**
MS 1	0%	0%	0%	0%	0%	0%	0	0
MS 2	25%	28%	28%-29%	1.27%	0.93%	0.95%-1.07%	0.73	0.74-0.84
MS 3	17%	35%	20%-30%	1.92%	1.63%	1.66%-1.79%	0.85	0.87-0.94
MS 4	47%	43%	44%-46%	2.11%	1.73%	1.76%-1.93%	0.82	0.83-0.91
MS 5	49%	67%	57%-67%	1.36%	1.19%	1.2%-1.26%	0.88	0.88-0.93
MS 6	22%	21%	21%-22%	2.88%	1.89%	1.97%-2.42%	0.66	0.68-0.84
MS 7	93%	84%	85%-91%	3.23%	2.61%	2.67%-2.92%	0.81	0.82-0.9
MS 8	13%	28%	13%-26%	0.80%	0.76%	0.75%-0.78%	0.95	0.95-0.97
MS 9	15%	44%	16%-30%	0.52%	0.50%	0.48%-0.49%	0.96	0.93-0.95
MS 10	28%	26%	26%-26%	1.72%	1.24%	1.27%-1.45%	0.72	0.74-0.85
MS 11	17%	71%	22%-52%	0.22%	0.36%	0.24%-0.33%	1.59	1.09-1.47
MS 12	76%	84%	78%-84%	2.63%	2.21%	2.25%-2.42%	0.84	0.86-0.92
MS 13	23%	77%	30%-67%	1.10%	1.05%	1.02%-1.05%	0.95	0.92-0.95
MS 14	32%	30%	31%-31%	2.42%	1.63%	1.69%-2.03%	0.67	0.7-0.84
MS 17	8%	26%	7%-10%	1.36%	0.96%	0.98%-1.17%	0.7	0.72-0.86
MS 18	88%	84%	83%-88%	2.50%	2.06%	2.1%-2.26%	0.82	0.84-0.9
MS 19	6%	6%	6%	1.67%	0.94%	1%-1.33%	0.56	0.6-0.8
MS 20	48%	83%	57%-84%	2.52%	1.94%	1.98%-2.18%	0.77	0.79-0.87
MS 21	19%	18%	18%-19%	1.50%	1.23%	1.26%-1.39%	0.82	0.84-0.92

3.5 Pooling effect

Mutualizing resources creates synergies that could be exploited in order to lower the target level. The section evaluates the efficiency to reimburse depositors at lower cost, without jeopardising the effectiveness achieved under EDIS. A sensitivity analysis investigates the possibility to collect lower amount of funds and its impact on the protection of depositors. Main results point to the possibility to maintain or even increase the current level of depositors' protection with a lower target level. Depending on the design of the hybrid model, the target level could be set between 0.5% and 0.8%, without lowering the depositors' protection. The more resources are mutualised the lower the target level could be.

Table 16 summarizes results at Banking Union level of applying different target levels to EDIS (full liquidity pooling and hybrid models). **The actual 0.8% target level** guarantees EDIS and the hybrid models, no matters the combination of parameters, to be always preferable to the status quo in terms of both probability of pay-outs with liquidity shortfalls and size of covered protected which remain unprotected. **By lowering the target level down to 0.7%,** the first order stochastic dominance would not hold anymore (column B) because there are simulations (0.2% of cases) where liquidity shortfalls under EDIS are higher than under the status quo. The second order will hold up as the area below the curves of the alternative schemes is still lower or equal to the one generated from national DGSs (column D). **Down to 0.5%,** any alternative to the status quo would succeed in reducing the number of runs with liquidity shortfalls in the majority of cases, nonetheless there would be a low probability (0.01%) of simulation runs with pay-outs associated to the alternative schemes only (column C). Finally, **a target level as low as 0.2%** would make the probability of liquidity shortfalls conditional on a crisis similar than under the status quo and the stochastic dominance would not be satisfied anymore.

Under a 0.5% target, a more in depth analysis clarifies that: (i) there is a 95% probability that a EDIS (full liquidity pooling/all hybrid models) provides a better protection than under the status quo by covering 88% of liquidity shortfalls that would otherwise be unprotected under the national DGSs. In this case, EDIS (full liquidity pooling/hybrid) protect €12 bn of covered deposits on average and national schemes €8 bn of covered deposits on average. (ii) There is a 5% of probability that national schemes provide better protection than under EDIS. National schemes would cover 8% of liquidity shortfalls that would otherwise be unprotected (under EDIS). In this case, EDIS protects €32 bn on average (0.05% of covered deposits) and national schemes €36 bn on average.

More detailed results are available upon request.

Table 16: Sensitivity analysis on the EDIS target level.

		Target	Stochastic dominance			Probability of having liquidity shortfall conditional on a systemic crisis			
			First order		Second order				
			Number of runs the scheme is outperforming (conditional on all schemes)	Runs with liquidity shortfalls (conditional on having a pay-outs at least in one of the scheme).	Ratio of the area below a scheme's curve over the DGS'	99.5%	99.9%	99.95 %	99.99 %
		A	B	C	D	E	F	G	H
1	DGS	0.8%	0%	100%	1	43%	75%	87%	98%
	HC1a/1b		100%	17%	0.58	13%	38%	56%	91%
	HC3a/3b		100%	11%	0.46	10%	31%	47%	85%
	EDIS		100%	10%	0.44	9%	30%	46%	84%
2	DGS	0.8%	**0.2% under HC1 0.1% under HC3/EDIS**	100%	1	43%	75%	87%	98%
	HC1a/1b	0.7%	**99.8%**	19%	0.64%	14%	43%	62%	93%
	HC3a/3b		**99.9%**	14%	0.52	12%	36%	54%	88%
	EDIS		**99.9%**	12%	0.49	11%	34%	52%	87%
3	DGS	0.8%	0.5% under HC1 0.2% under HC3/EDIS	**99.99%**	1	43%	75%	87%	**98%**
	HC1a/1b	0.5	95%	**25%**	0.79	19%	54%	72%	**96%**
	HC3a/3b		98%	**19.5%**	0.68	16%	47%	66%	**95%**
	EDIS		98%	**18.6%**	0.65	15%	45%	64%	**94%**
4	DGS	0.8%	30% under HC1 40% under HC3/EDIS	89%	**1**	**43%**	**75%**	**87%**	**98%**
	HC1a/1b	0.2%	59%	56%	**1.21**	**41%**	**77%**	**88%**	**99%**
	HC3a/3b		68%	42%	**1.09**	**34%**	**72%**	**85%**	**99%**
	EDIS		70%	39%	**1.06**	**33%**	**71%**	**85%**	**98%**

3.6 Conclusions

The above assessment shows that a system with joint financial means and joint liability, such as EDIS or the hybrid model, would be more effective and efficient in providing liquidity support, i.e. provide a higher level of protection than a scheme based solely on national Deposit Guarantee Schemes and such system is considerably less likely to fall short of pay-outs than a national DGS. The main results can be summarised as follows:

- **EDIS is more effective than status quo**: a system with common financial means is able to protect a higher amount of covered deposits than under the status quo. The more resources are mutualised, the more effective the system is. All variant of EDIS considered in the analysis significantly reduce the likelihood and the size of liquidity shortfall even under a systemic event.
  - EDIS reduces the probability of a depositor pay-outs with liquidity shortfall by 80%-90%.
  - The hybrid models are more efficient than the status quo and less efficient than the full liquidity pooling EDIS: the more resources are mutualized, the more efficient the system is.
  - EDIS covers 90%-95% of liquidity shortfalls that otherwise remain unprotected under the national DGSs.
  - EDIS maximize the use of funds: when a national system has liquidity shortfall in at least one MS, the average amount of funds used is 16% of the total available amount in the BU. When the full liquidity pooling EDIS faces liquidity shortfall, the amount of funds used is always 100%.
  - Under the status quo, all national DGS protect €8 bn on average. Under EDIS, €14-15 bn of covered deposits are protected on average.
  - For the hybrid models, the allocation of funds between the central fund and the national DGS is the only parameter which has a significant impact on the effectiveness.
- **In case of a systemic crisis, EDIS outperforms the status quo.** The probability of liquidity shortfall and the amount of covered deposits that would not be protected is lower.
  - The probability of a liquidity shortfall is 87% under the status quo, 46%-56%EDIS (depending on the parameter settings).
  - EDIS covers 55% - 68% of liquidity shortfalls that otherwise remain unprotected under the national DGSs.
  - Under the status quo, all national DGS protect €22 bn on average. Under EDIS €31-36 bn of covered deposits are protected on average.
- **Pooling of resources creates synergies that could be exploited in order to lower the target level.** A sensitivity analysis investigated the possibility to collect lower amount of funds and its impact on the protection of depositors. Depending on the design of the hybrid model, the target level could be set between 0.5% and 0.8%, without lowering the depositors' protection. The more resources are mutualised the lower the target level could be.

The model assesses the effectiveness of EDIS in pooling funds for liquidity coverage but does not allow distinguish effects on economic loss absorption after insolvency proceedings. Loss coverage is therefore not analysed and neither the role of DGS/EDIS in resolution. There are additional elements that the model does not take into consideration: e.g. transactions costs, implementation times, monitoring issues, mechanism of operationalization of the schemes, behavioural aspects, risk of repayment of loans.

4 Analysis on banks' Risk-Based contributions to EDIS Database 2018

4.1 Background

The European Commission (EC) Joint Research Centre (JRC) is supporting the Directorate General for Financial Stability, Financial Services and Capital Markets Union (DG FISMA) in assessing the impact of different approaches for the calculation of risk-based contributions to the European Deposit Guarantee Scheme (EDIS).

The technical framework for determining these contributions is based upon EBA guidelines on methods for calculating contributions to deposits guarantee schemes. EBA developed such guidelines pursuant to Article 13(3) of the Directive 2014/49/EU of the European Parliament and of the Council and they set alternative methodologies and risk indicators to compute risk-based contributions.

Starting from this report, JRC developed and tested alternative scoring methods and the results of this analysis are summarized in the present report.

4.2 Introduction

The main objective of a Deposit Guarantee Scheme is to refund depositors whose bank has failed, up to a certain threshold and within a certain number of days. Depositors benefit from a timely protection for a substantially large share of their wealth from bank failures. This commitment is beneficial for the stability of the financial system, as it prevents depositors from making panic withdrawals from their bank, which would bring severe economic consequences.

In November 2015, the European Commission adopted a legislative proposal to set up a European Deposit Insurance Scheme (EDIS), a single deposit insurance system for all bank deposits in the Banking Union. EDIS can be regarded of as one of the pillars of the Banking Union, with the aim of increasing the resilience of the banking systems against potential future crises.

The adopted legislative document affirm that, among other things, banks should pay to EDIS fund ex-ante contributions based on their risk profile (risk-based contributions). The European Commission is in charge of defining the methodology to evaluate the risk profile of each bank and the corresponding risk-based contributions. To accomplish this task, Directorate General for Financial Stability, Financial Services and Capital Markets Union (DG FISMA) asked for the technical and quantitative support of the Joint Research Centre (JRC). The present report aims at summarizing the analyses developed by the JRC in this context.

Pursuant to Article 13(3) of the Directive 2014/49/EU of the European Parliament and of the Council, the European Banking Authority (EBA) published guidelines on methods for calculating contributions to DGS (EBA, 2015). These guidelines establish the technical basic framework for the analysis in this report, to develop alternative risk-based methodologies for banks contributions.

In order to properly calibrate the risk-based contributions methodology, appropriate and complete bank-level data are of paramount importance. Since data coverage available in the public domain is often incomplete and may not have the desired quality, the Commission launched a first data survey in May 2017 to collect, from national authorities of the EU member States (MS), sound bank-level data to estimate banks' contributions to EDIS. Data mainly focused on those banks' balance sheet data mandatory to build the risk indicators. One additional data collection has been launched in early 2020, to retrieve data updated as of end 2018. All the results presented in this report are based on the dataset collected via the 2020 survey.

The set of bank-level risk indicators included in the present analysis are either those identified in the EBA guidelines or those suggested by MS representatives.

The report is organized as follows. Section 4.3 presents the general methodology set in the EBA guidelines and the alternative methods, developed by the JRC in cooperation with DG FISMA, to compute the contributions. Section 4.4 describes the collected dataset, the quality assurance process and methodology to impute missing data. Section 4.5 shows the results of the analysis and Section 4.6 concludes.

4.3 Methodologies to compute the risk-based contributions

EBA guidelines are meant to "set out principles for technically sound methods for calculating contributions to ensure that costs of deposits insurance are borne primarily by the banking sector and that the available financial means reach the target level within the time horizon envisaged in Directive 2014/49/EU". EBA identifies both the set of risk indicators and different methodologies to transform the risk indicators into a factor to compute risk contributions. The remainder of this section will describe the general principles and the alternative methodologies we have developed, stemming from the guidelines.

According to the EBA guidelines, annual contributions paid by individual member institutions should be calculated using the formula:

$$C_i = CR \cdot ARW_i \cdot CovDep_i \cdot \mu$$

where C_i is the annual contribution of institution *i*, CR is the contribution rate (identical for all institutions in a given year), ARW_i is the aggregate risk weight for institution *i*, i.e. the risk adjustment according to the bank's risk profile, $CovDep_i$ are covered deposits of institution i and μ is the adjustment coefficient that guarantees that the overall amount of contributions meet the annual target. Different options are foreseen to compute ARW_i starting from risk indicators based on balance sheet data.

4.3.1 Risk Indicators

The risk indicators to compute risk-based contributions should cover five risk categories:

- Capital
- Liquidity and funding
- Asset quality
- Business model management
- Potential losses for the DGS

EBA identified a subset of core risk indicators that should be included in the computations of risk-based contributions, but allows adding additional indicators in the overall computations, based on the discretion of the competent authorities. For the purpose of the present analysis, we consider both the indicators suggested by EBA and those suggested by MS representatives. The overall set of indicators is listed in Table 17 (definitions of all the indicators are summarized in Annex I). The table divides the indicators into the core indicators (according to EBA) and the additional indicators that might be included in the computations. The last column reports the sign assigned to each indicator.

Table 17: List of potential Risk indicators

	Indicator Name	Source	Sign
1	**Capital adequacy**		
	Leverage ratio (LR)	EBA core indicator	-
	Capital Coverage ratio (CCR) or CET1 ratio (CET1)	EBA core indicator	-
2	**Liquidity and funding**		
	Liquidity Coverage Ratio (LCR)	EBA core indicator	-
	NSFR. [49]	EBA core indicator	-
3	**Asset quality**		
	Non-performing loans ratio (NPL ratio)	EBA core indicator	+
	NPL coverage ratio (NPL cov ratio)	Additional indicator	-
	Net Non-performing loans ratio (net NPL ratio)	Additional indicator	+

[49] NSFR has been introduced in 2019 and at present it is not considered in the data collection.

	Indicator Name	Source	Sign
	Non-performing exposures ratio (NPE ratio)	Additional indicator	+
	Net Non-performing exposures ratio (net NPE ratio)	Additional indicator	+
	Dynamic transformation ratio	Additional indicator	+
	Level 3 assets ratio (L3 ratio)	Additional indicator	+
	Top 3 Sovereign Exposures	Additional indicator	+
	Top 5 Sovereign Exposures	Additional indicator	+
	Risk-Weighted Sovereign exposure (Grid 1)	Additional indicator	+
	Risk-Weighted Sovereign exposure (Grid 2)	Additional indicator	+
4	**Business model and management**		
	Risk weighted assets ratio (RWA ratio)	EBA core indicator	+
	Return on Assets (RoA)	EBA core indicator	+
	Return on Equity (RoE)	Additional indicator	+
	Large Exposures ratio (LE ratio)	Additional indicator	+
	IPS membership (IPS)	Additional indicator	-
	Interconnectedness	Additional indicator	+
5	**Potential losses for the DGS**		
	Unencumbered assets ratio	EBA core indicator	-
	MREL ratio	Additional indicator	-

Risk indicators are aggregated into a single measure of risk by means of an arithmetic weighted average. It implies that each indicator j used for the calculations must be coupled with a weight wj. The sum of all the weights must be equal to 100% and core risk indicators must account for at least 75% of the overall weights. In case only core risk indicators are used, EBA guidelines fix the set of weights as summarized in Table 18.

Table 18: EBA core indicators - risk categories and weights

Risk category	Capital	Liquidity and funding	Asset quality	Business model and management	Potential use of DGS funds
Weight	24%	24%	18%	17%	17%

4.3.2 Methodology to compute the risk adjustments

The risk adjustment that enters the formula for risk-based contributions is computed in three steps:

- From raw indicators to Individual Risk Score: risk indicators are rescaled over the range [0 100], thus getting the Individual Risk Scores (IRS). This step is necessary to make all the different indicators comparable each other.
- From Individual Risk Scores to Aggregate Risk Scores: IRS are aggregated into a single measure, the Aggregate Risk score (ARS), by means of an arithmetic weighted average. The formula to compute the ARS of the bank *i* is the following:

$$ARS_i = \sum_j w_j \cdot IRS_{i,j}$$

where w_j is the weight assigned to the risk indicator j and $IRS_{i,j}$ is the Individual Risk Score of bank i for the indicator j.

- From Aggregate Risk Score to Aggregate Risk Weight: ARS are rescaled into a predefined range to obtain the Aggregate Risk Weight (ARW) that enters in the formula for the risk-based contributions. The range is between 0.75 and 1.5, but EBA guidelines allow for wider ranges up to [0.5 2]. In this analysis we present results for both the basic range ([0.75 1.5]) and the extended one ([0.5 2]).

EBA guidelines foresee two different approaches to compute the IRS and the ARW, namely the “bucket” and the “sliding scale” methods. The bucket approach divides the sample into a pre-defined number of buckets and then it assigns each value to a bucket according to some pre-defined rule, where an identical value is assigned to all points that belong to the same bucket. The sliding scale method assigns each indicator a score by means of a continuous transformation. Extreme values are identified by pre-determined rules and are assigned the extreme admissible values of the transformation.

EBA guidelines advise some general rules only on how to set the numbers and thresholds for the buckets and the extreme values, thus in the present analysis we have developed four alternative options for the buckets method and four for the sliding scale method. They are summarized in Table 19 and they are discussed more in details in the next sections.

Table 19: List of scoring methods compatible with the EBA guidelines

Method	IRSs scoring	ARW scoring	Range
Bucketing	3 Buckets for each IRS	4 risk classes	75% - 150%
			50% - 200%
		10 risk classes	75% - 150%
			50% - 200%
	5 Buckets for each IRS	4 risk classes	75% - 150%
			50% - 200%
		10 risk classes	75% - 150%
			50% - 200%
Sliding Scale	90% winsorisation	Linear	75% - 150%
			50% - 200%
		Exponential	75% - 150%
			50% - 200%
	IQR winsorisation	Linear	75% - 150%
			50% - 200%
		Exponential	75% - 150%
			50% - 200%

4.3.2.1 Buckets method

In the present analysis, we apply two alternative buckets options, where banks are assigned to 3 or 5 different buckets. The boundaries of the buckets are based on the percentiles of the empirical distribution of each indicator: in this case, only relative riskiness matters. [50] The two settings are summarized in Table 20 and Table 21.

[50] A different way to build buckets would be to set absolute thresholds for buckets. This option would require an additional effort to calibrate the thresholds, taking into account the time series of the different indicators and the changing prudential requirements.

Table 20: Three relative buckets

Buckets	Boundaries	IRS for sign (+)	IRS for sign (-)
Bucket 1 (25% of banks)	< 25th percentile	0	100
Bucket 2 (50% of banks)	[25th – 75th) percentile	50	50
Bucket 3 (25% of banks)	>= 75th percentile	100	0

Table 21: Five relative buckets

Buckets for IRS (+)			Buckets for IRS (-)		
Buckets	**Boundaries**	**IRS**	**Buckets**	**Boundaries**	**IRS**
Bucket 1 (50% of banks)	< 50th percentile	0	Bucket 1 (5% of banks)	< 5th percentile	100
Bucket 2 (25% of banks)	[50th – 75th) percentile	25	Bucket 2 (10% of banks)	[5th – 15th) percentile	75
Bucket 3 (10% of banks)	[75th – 85th) percentile	50	Bucket 3 (10% of banks)	[15th – 25th) percentile	50
Bucket 4 (10% of banks)	[85th – 95th) percentile	75	Bucket 4 (25% of banks)	[25th – 50th) percentile	25
Bucket 5 (5% of banks)	>= 95th percentile	100	Bucket 5 (50% of banks)	>= 50th percentile	0

The 3-buckets approach is symmetric because it assigns the best (worst) score to the best (worst) 25% of the banks in the sample and the remaining 50% is assigned an intermediate value (IRS = 50). The 5-buckets approach tend to favour "good" banks because it assigns 0 to the best 50% of the banks, while only the worst 5% of the banks are assigned 100.

In the next step, each IRS is associated to its weight and the ARS is determined through an arithmetic weighted average. The ARS is then associated to a risk class in order to obtain the final ARW, which should be used to calculate the risk adjusted contribution of each institution. We tested two different settings for the bucketing of the ARS: 4 risk classes (the minimum number of risk classes according to EBA guidelines) and 10 risk classes. Values and boundaries are detailed in Table 22 and Table 23.

Table 22: Four Risk classes for the ARW

Risk Class	Boundaries set on ARS value	ARW (Basic range)	ARW (Extended range)
Risk Class 1	ARS in [0 – 25)	75%	50%
Risk Class 2	ARS in [25 – 50)	100%	100%
Risk Class 3	ARS in [50 – 75)	125%	150%
Risk Class 4	ARS in [75 100]	150%	200%

Table 23: Ten Risk classes for the ARW

Risk Class	Boundaries set on ARS value	ARW (Basic range)	ARW (Extended range)
Risk Class 1	ARS in [0 – 10)	75%	50%
Risk Class 2	ARS in [10 – 20)	83.3%	66.7%
Risk Class 3	ARS in [20 – 30)	91.6%	83.3%
Risk Class 4	ARS in [30 – 40)	100%	100%
Risk Class 5	ARS in [40 – 50)	108.3%	116.7%
Risk Class 6	ARS in [50 – 60)	116.6%	133.3%
Risk Class 7	ARS in [60 – 70)	125%	150%
Risk Class 8	ARS in [70 – 80)	133.3%	166.7%
Risk Class 9	ARS in [80 – 90)	141.6%	183.3%
Risk Class 10	ARS in [90 – 100]	150%	200%

One should note that boundaries defining the different risk classes here are absolute and do not depend on the relative distribution of the ARS. It might happen that, depending on the distribution of the ARS, some risk classes could be empty.

4.3.2.2 Sliding scale

The sliding scale method sets an upper and a lower boundary to limit extreme values for each risk indicator. For IRS with positive sign, values above the upper boundary are set equal to 100 and values below the lower boundary to 0. Analogously, for IRS with negative sign, values below the lower boundary are set equal to 100 and values above the upper boundary are fixed to 0. Values falling within the two extremes are rescaled proportionally.

Also in this approach, the boundaries have been set based on the percentiles of the empirical distribution of the raw indicators. We applied the following two different winsorization approaches:

- 90% winsorization. The best and worst 5% of the banks are assigned the extreme values (0 and 100, respectively), and the remaining 90% of the banks are assigned intermediate values on a proportional basis.
- Interquartile range [51] winsorization (IQR). Values falling below the 25th percentile minus 1.5 times the interquartile range or above the 75th percentile plus 1.5 times the interquartile range are assigned the extreme values. All the other values falling within these two extreme are rescaled between 0 and 100 on a proportional basis.

Table 24 shows the general formulas (valid for both the 90% and the IQR winsorizations) to compute the IRS from the raw indicators; Table 25 defines the extremes of the winsorization approaches.

[51] In statistics, the interquartile range is defined as the difference between the 75th and the 25th percentiles of the empirical distribution.

Table 24: Sliding scale method - IRS values

Boundaries	IRS for sign (+)	IRS for sign (-)
raw ind > a	IRS = 100	IRS = 0
raw ind in [b a]	$IRS = \frac{raw\ ind - b}{a - b}$	$IRS = \frac{a - raw\ ind}{a - b}$
raw ind < b	IRS = 0	IRS = 100

Table 25: Winsorization boundaries

90% winsorization	IQR winsorization
$a = 95^{th}\ percentile$ $b = 5^{th}\ percentile$	$a = Q3 + 1.5 * IQR$ $b = Q1 - 1.5 * IQR$

Note: Q1 is the 25th percentile, Q3 the 75th percentile of the distribution

As for the buckets approach, each IRS is then associated with its weight and the ARS is computed for each bank by the arithmetic average. Following the EBA guidelines, under the sliding scale approach the ARS can be rescaled into the ARW through a linear or exponential transformation.

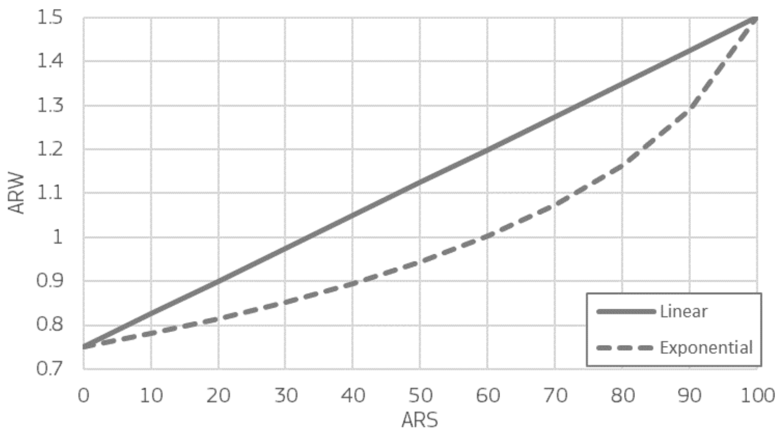
Linear formula:

$$ARW_i = \beta + (\alpha - \beta) \cdot ARS_i/100$$

Exponential formula:

$$ARW_i = \beta + (\alpha - \beta) \cdot (1 - \log_{10}(10 - 9 \cdot ARS_i/100))$$

Figure 5: Linear and Exponential transformations



***Note*:** Linear and exponential transformations from ARS to ARW for the sliding scale approach for the interval [0.75 ; 1.5], assuming the parameters α=1.5 and β=0.5.

4.3.3 Risk-based contributions

Once the ARW is calculated, we can compute the risk-based contributions that each bank should pay to the DGS. According to Article 10(2) of the EU Directive 2014/49/EU, the target level is set equal to 0.8% of the amount of covered deposits of the banks insured by the DGS and DGS must collect it by 2024. However, in our analysis we assume that the DGS would enter in force today, and will collect the contributions for the following ten years.

The elements of the formula presented at the beginning of Section 2 can be further extended as follows:

- The contribution rate CR is equal to $0.8\%/N$, where N corresponds to the number of years necessary to reach the target (ten years in our calculations).
- The adjustment coefficient μ must fulfill the condition that every year the sum of banks' contributions must be equal to 1/N of the target:

$$\sum_i c_i = \frac{0.8\%}{N} * \mu * \sum_i ARW_i * CovDep_i \equiv \frac{0.8\%}{N} * \sum_i CovDep_i$$

and thus

$$\mu = \frac{\sum_i CovDep_i}{\sum_i ARW_i * CovDep_i}.$$

It implies that the final risk correction is not given by ARW only, but it is ARWi*μ. The value of μ can be either greater or smaller than one; it depends only on the overall relative distribution of ARWi in the sample considered for the computations.

4.4 Data

Risk-based contributions are computed using data on banks' balance sheet items. DG FISMA launched a second survey in early 2020 to collect detailed bank level balance sheet data from national authorities and representatives of the EU. The data collected via the survey cover all the items necessary to construct the risk indicators listed in Table 1. Annex I details the references to the data fields. The survey also collected information on the consolidation level of each reported data point. Since harmonized reporting standards have not been fully implemented yet in all Member States, especially with regard to financial data (FINREP), MS were also given the opportunity, for selected variables, to report the national proxy of the variable. Data were requested as of end-2018.

All MS provided data on their banking systems and information, at least partial, is reported for more than 4,400 banks, corresponding to EUR 32,740 bn of total assets and EUR 6,446 bn of covered deposits.

MS were requested to identify the following special categories of institutions:

1) Entities excluded from applying Capital Requirements Regulation/Directive IV (CRR/CRDIV) according to Art. 2 (5) CRD IV;
2) Entities members of an 'Institutional Protection Scheme' (IPS) fulfilling the criteria as set out in Art. 113 (7) CRR and recognized as DGS;
3) Central body or entities affiliated to a central body according to 10(1) of Regulation (EU) 575/2013.

To understand to what extent MS datasets represent the country's banking population, data were also compared with statistics at country level provided by ECB and EBA on total assets and covered deposits. ECB data refer to total assets held by monetary and financial institutions in each country: they also account for the third-country branches, which are out of the scope of EDIS, and thus these statistics can result different than figures reported by MS. EBA published data on deposits covered by EU DGS for 2018. Data on covered deposits are in line with those provided by EBA and it allows concluding that the coverage of the dataset across countries is quite good.

4.4.1 Quality checks

Data provided by MS cannot be directly used to run all the analyses, but some preliminary checks are needed in order to guarantee the internal coherence of the data collected and the quality of the final results based on them. The following checks are performed:

- Total assets minus capital minus total/covered deposits greater than zero;
- Total deposits greater than covered deposits;
- Total capital greater than CET1 capital;
- Total assets minus loans and advances to credit institutions greater than zero;

- Total assets minus capital minus deposits minus financial liabilities to credit institutions greater than zero;
- Target CET1 ratio including Pillar II adjustments greater than or equal to 4.5%;
- Combined buffer requirements greater than or equal to 0.625% RWA.
- Unencumbered Asset less or equal to Total Asset
- Total Sovereign Exposures less or equal to Total Asset

We also compared banks' data and indicators with country-level statistics published in the EBA (2018). If banks failed any of the above checks, we went back to MS and asked them to double-check the figures or to provide us with further clarification. Whenever possible, risk indicators provided by the MS were also re-computed with the raw data to check for the accuracy of the formulas applied.

We also checked for the coherence of the consolidation level of the different items entering the formulas for the different risk indicators: in case of a consolidation mismatch (i.e. the consolidation level of the numerator is different from the one of the denominator), indicators were deleted from the dataset and treated as missing. For some indicators (unencumbered asset ratio and sovereing exposures indicators) we assume that the banks reported the value of unencumbered assets and sovereign exposures at the same consolidation level. If not indicated, we assume that the consolidation level corresponds to the one reported for all the other indicators.

4.4.2 Risk indicators availability

In principle, the data requested in the survey to compute the risk indicators should be available for all banks, [52] however, the dataset collected is not complete and there are missing data. Table 26 and Table 27 report for each indicator and for each MS the percentage of banks with available data; [53] the colours help detecting which countries and which indicators might face issues.

Table 26 shows that the coverage for the core indicators is quite good across all MS. Unfortunately, additional indicators like the MREL ratio cannot be used since the coverage is extremely low. The data on sovereign exposures are satisfactory to conduct the analysis.

Table 26: Availability of Risk Indicators across MS

	Capital Adequacy			Liquidity	Asset Quality						
MS	**LR**	**CCR**	**CET1**	**LCR**	**NPL ratio**	**NPL cov ratio**	**Net NPL ratio**	**NPE ratio**	**Net NPE ratio**	**Dyn. Ratio**	**L3 ratio**
MS 1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 4	100%	100%	100%	100%	100%	99%	100%	100%	100%	100%	95%
MS 5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 6	100%	73%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 7	100%	100%	100%	100%	97%	97%	97%	99%	97%	97%	39%

[52] Only non-CRR entities are exempted from reporting the data entries necessary to build the risk indicators: these banks were requested to report data on total assets, total and covered deposits only.

[53] Since non-CRR entities are not obliged to report these data, they are excluded from these figures.

	Capital Adequacy			Liquidity	Asset Quality						
MS	LR	CCR	CET1	LCR	NPL ratio	NPL cov ratio	Net NPL ratio	NPE ratio	Net NPE ratio	Dyn. Ratio	L3 ratio
MS 8	92%	91%	92%	91%	100%	100%	100%	100%	100%	90%	100%
MS 9	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 10	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	93%
MS 11	90%	0%	90%	92%	100%	100%	100%	100%	100%	85%	100%
MS 12	97%	97%	97%	97%	96%	96%	95%	97%	96%	96%	0%
MS 13	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 14	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 15	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 16	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 17	96%	96%	96%	100%	100%	100%	100%	100%	100%	96%	100%
MS 18	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 19	100%	67%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 20	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 21	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 22	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MS 23	100%	100%	100%	100%	100%	100%	100%	100%	100%	47%	100%
MS 24	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	38%
MS 25	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	88%
MS 26	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 27: Availability of Risk Indicators across MS (cont.)

	Business model and management					Potential Losses for the DGS		
MS	RWA ratio	RoA	RoE	LE ratio	Interconnectedness	Unenc. assets ratio	MREL I ratio	Sovereign Exposures
MS 1	100%	100%	100%	100%	100%	100%	13%	100%
MS 2	100%	100%	100%	100%	100%	100%	50%	100%
MS 3	100%	100%	100%	98%	100%	100%	0%	100%

	Business model and management					Potential Losses for the DGS		
MS	**RWA ratio**	**RoA**	**RoE**	**LE ratio**	**Interconnectedness**	**Unenc. assets ratio**	**MREL I ratio**	**Sovereign Exposures**
MS 4	100%	100%	100%	100%	99%	100%	0%	95%
MS 5	100%	100%	100%	100%	100%	100%	0%	81%
MS 6	100%	100%	100%	100%	100%	100%	0%	66%
MS 7	100%	100%	100%	100%	63%	100%	38%	95%
MS 8	100%	92%	92%	91%	100%	92%	0%	89%
MS 9	100%	100%	100%	100%	100%	100%	97%	97%
MS 10	100%	100%	100%	0%	100%	100%	25%	100%
MS 11	100%	90%	90%	90%	100%	90%	0%	86%
MS 12	97%	100%	100%	97%	99%	97%	0%	90%
MS 13	98%	100%	100%	92%	100%	89%	0%	99%
MS 14	100%	100%	100%	100%	100%	100%	0%	100%
MS 15	100%	100%	100%	100%	100%	100%	0%	100%
MS 16	100%	100%	100%	100%	100%	100%	0%	100%
MS 17	100%	96%	96%	96%	100%	96%	0%	81%
MS 18	100%	100%	100%	100%	100%	100%	38%	88%
MS 19	100%	100%	100%	100%	100%	100%	98%	100%
MS 20	100%	100%	100%	100%	100%	95%	79%	91%
MS 21	100%	100%	100%	100%	100%	100%	0%	100%
MS 22	100%	100%	100%	100%	100%	100%	0%	94%
MS 23	100%	100%	100%	100%	100%	100%	0%	99%
MS 24	100%	100%	100%	100%	100%	93%	12%	98%
MS 25	100%	100%	100%	100%	94%	100%	96%	98%
MS 26	100%	100%	100%	100%	100%	100%	93%	100%

To complete the picture on the dataset, a correlation analysis of risk indicators has been run and the corresponding matrix is shown in Table 28. Green cells correspond to high positive correlations, red cells to high negative correlations. The correlation is computed via a Spearman pairwise correlation (i.e. correlation between ranks). We can observe that indicators within the same risk category and with the same sign are in general positively correlated, while indicators from different categories are generally negatively low correlated. This guarantees that, when aggregating indicators into the ARS, there are no compensations that might lower the final value of the ARS. All sovereign indicators are highly correlated among each other, and the choice of one indicator with respect to another depends on other consideration, since the cross-section dynamic of these metrics are very similar across the banking sample.

Table 28: Correlation matrix

	LR	CET1 ratio	LCR	NPL ratio	Top3 Sov. Exp. ratio	Top5 Sov. Exp. ratio	Risk-Weighted Sov. Exp. (Grid 1)	Risk-Weighted Sov. Exp. (Grid 2)	RWA ratio	RoA	Unenc. assets ratio
LR	1.00	0.59	0.07	-0.02	-0.13	-0.13	-0.08	-0.04	0.38	0.25	0.07
CET1 ratio	0.59	1.00	0.19	-0.14	0.14	0.13	0.09	0.09	-0.35	0.18	-0.04
LCR	0.07	0.19	1.00	0.25	0.20	0.20	0.24	0.22	0.08	0.00	-0.14
NPL ratio	-0.02	-0.14	0.25	1.00	0.24	0.23	0.32	0.39	0.39	0.02	0.00
Top3 Sov. Exp. ratio	-0.13	0.14	0.20	0.24	1.00	1.00	0.86	0.68	-0.35	-0.03	0.04
Top5 Sov. Exp. ratio	-0.13	0.13	0.20	0.23	1.00	1.00	0.88	0.70	-0.34	-0.03	0.05
Risk-Weighted Sov. Exp. (Grid 1)	-0.08	0.09	0.24	0.32	0.86	0.88	1.00	0.89	-0.25	0.00	0.08
Risk-Weighted Sov. Exp. (Grid 2)	-0.04	0.09	0.22	0.39	0.68	0.70	0.89	1.00	-0.21	0.12	0.02
RWA ratio	0.38	-0.35	0.08	0.39	-0.35	-0.34	-0.25	-0.21	1.00	0.05	0.20
RoA	0.25	0.18	0.00	0.02	-0.03	-0.03	0.00	0.12	0.05	1.00	-0.01
Unenc. assets ratio	0.07	-0.04	-0.14	0.00	0.04	0.05	0.08	0.02	0.20	-0.01	1.00

4.4.3 Data management

As already discussed, the dataset built with MS data is not complete, but there are missing data. Risk-based contributions cannot be computed if (some) risk indicators are missing; hence the following alternative approaches are possible:

- Delete banks with missing data. If a bank does not report a value necessary to compute contributions, it is removed from the dataset. The main drawback of this approach is that the final dataset might be much smaller than the original one.
- Assign the highest value of a given risk indicator (the riskiest score) to the missing data.
- Develop a methodology to impute missing data. The main drawback is that the quality of imputed data depends on the data availability: if many data points are missing, the overall quality of imputed data might not be satisfactory (one would have to impute many missing data with few information at his disposal).

The second and the third avenues are applied in this context. For the third hypothesis, treated separately in the results section, we replace the missing value with the median value of the indicator at the MS level. Data imputation applies to CRR entities only.

Covered deposits

Covered deposits are the basis to compute contributions and, in principle, they should be available for all banks. In some cases, banks did not report the amount of covered deposits, thus covered deposits were estimated from customer deposits, if available, as follows:

- Compute for each country C the coverage ratio, i.e. the ratio between the amount of covered and customer deposits over all the banks j providing both data:

$$CovRatio_C = \frac{\sum_{j \in C} CovDep_{j,C}}{\sum_{j \in C} CustDep_{j,C}}$$

- Apply the country-specific coverage ratio to the amount of customer deposits of each bank i in country C not providing covered deposits:

$$CovDep_{i,C} = CustDep_{i,C} * CovRatio_C.$$

If banks do not report data neither on covered or on customer deposits, they are excluded from the dataset. In the dataset, 68 banks do not report data on covered deposits, of which 8 have data on total deposits: for these banks it is thus possible to estimate covered deposits, while the remaining 60 banks are removed from the dataset.

4.5 Results

This section is devoted to present the results of the risk-based contributions under all the methodologies discussed in Section 2. We examine different underlying hypotheses and different risk indicators in the computations. We will present statistics on results aggregated at MS level and for different groups of banks.

The groups are defined on covered deposits as follows:

- Large banks: banks with covered deposits greater than €10 bn,
- Medium banks: banks with covered deposits between €1 bn and €10 bn,
- Small banks: banks with covered deposits between €100 mn€ and €1 bn,
- Tiny banks: banks with covered deposits lower than €100 mn.

As initial assumption, the target level will be reached within 10 years. Moreover, unless otherwise specified, risk-based contributions are computed for CRR banks only.

4.5.1 Baseline Scenario

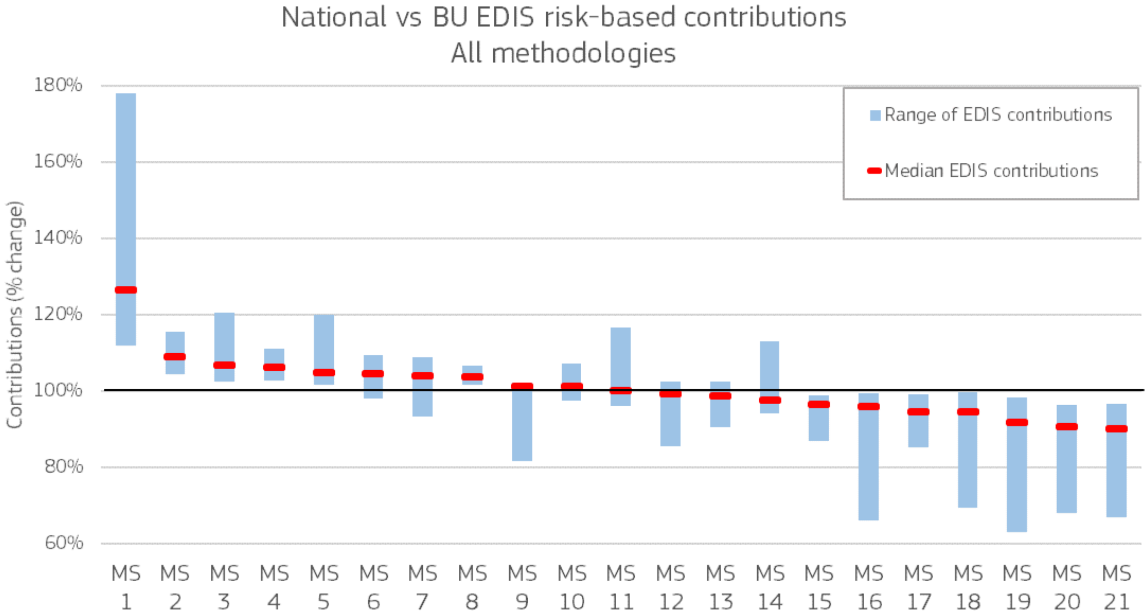
The baseline scenario aims to depict a basic situation in which all institutions pay a contribution based upon the set of EBA core risk indicators. The sets of indicators and weights applied in this analysis are shown in Table 29 (see also par. 58 of the EBA guidelines).

Table 29: EBA guidelines approach: indicators, weights and signs applied in the baseline scenario (only core risk indicators)

Risk Indicators		**Weight**	**Sign**
1.	**Capital**		
	Leverage ratio	12%	-1
	CET1 ratio	12%	-1
2	**Liquidity and funding**		
	LCR	24%	-1
3	**Asset quality**		
	NPL ratio	18%	1
4	**Business model and management**		
	RWA ratio	8.5%	1
	ROA	8.5%	1
5	**Potential losses for the DGS**		
	Unencumbered assets ratio	17%	-1

Figure 6 shows contributions aggregated at country level under a pure national system and under EDIS framework assuming that BU countries will join EDIS. The black line represents the contributions collected under pure national systems (equal to the yearly target). The blue vertical bars show the extent of variation of EDIS risk-based contributions; the horizontal red bar corresponds to the median level of EDIS risk based contributions.

Figure 6. National vs Banking Union EDIS risk based contributions aggregated at MS level. Contributions computed applying core risk indicators and weights



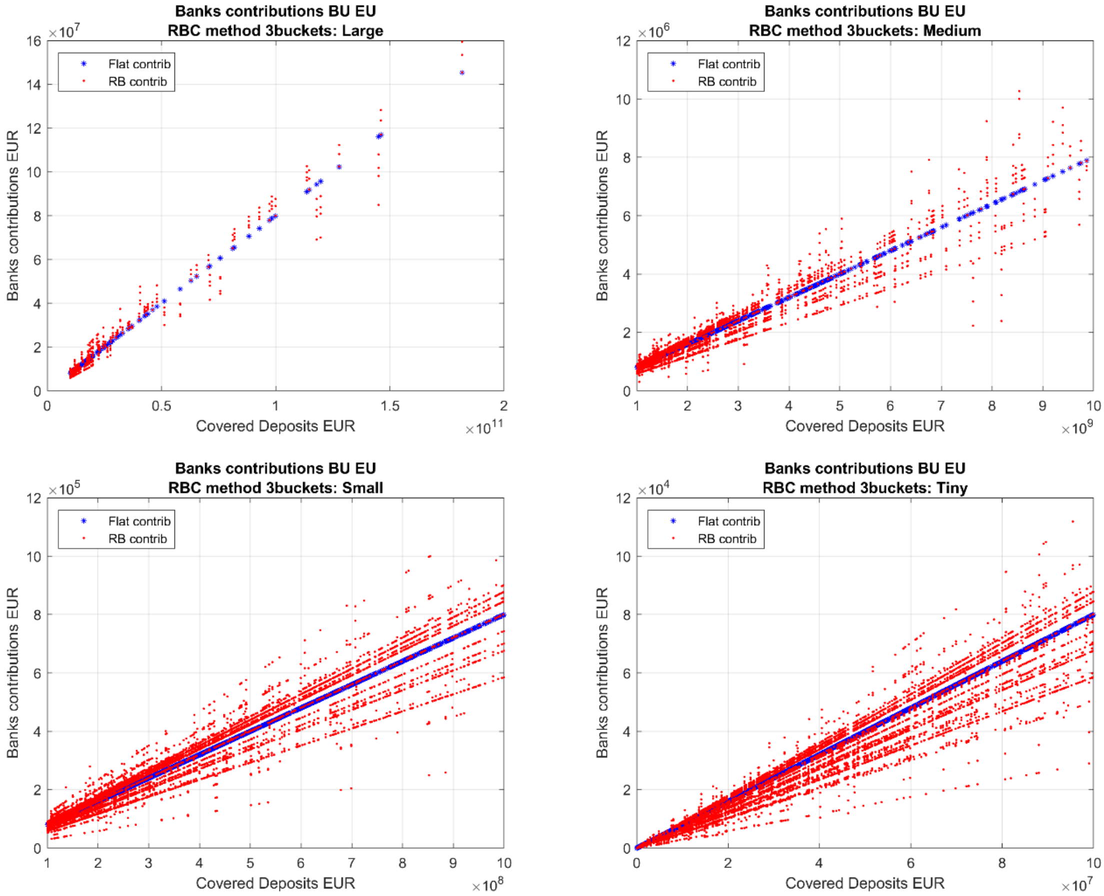
The four charts in Figure 7 show, for the four groups of banks, the amount of contributions computed under all the EBA models when BU banks join EDIS (red dots) and the non-risk based contributions, computed as a share of banks' covered deposits[54] (blue dots). Banks are sorted based on their covered deposits and the figure refers to the method with 3 buckets for IRS. One can notice that, across the different groups, under a risk-based framework some banks get a discount while others increase their contributions.

[54] Non risk-based contributions of bank *i* are simply computed as:

$$C_i = CovDep_i * \frac{0.8\%}{10},$$

being 10 the number of years to reach the target.

Figure 7: Non-risk-based versus risk-based contributions



To better understand the differences between non-risk-based and risk-based contributions at banks' level for the different methodologies, Figure 8 shows the percentage differences in contributions for all banks in the sample. Banks are sorted based on their covered deposits and the height of each bar represents the percentage difference in contributions with respect to non-risk based contributions. The buckets approaches (top charts) lead to larger deviations in contributions than the sliding scale ones (bottom charts). The reason is that under sliding scale approach, risk indicators are rescaled in a smoother way than for the buckets approach. Moreover, as expected, contributions computed by rescaling the aggregate risk scores over the expanded range [0.5 - 2] show larger variations than the ones computed with the basic range [0.75 - 1.5]. This general feature occurs across all the methods.

Figure 8: Percentage differences between non-risk-based and risk-based contributions

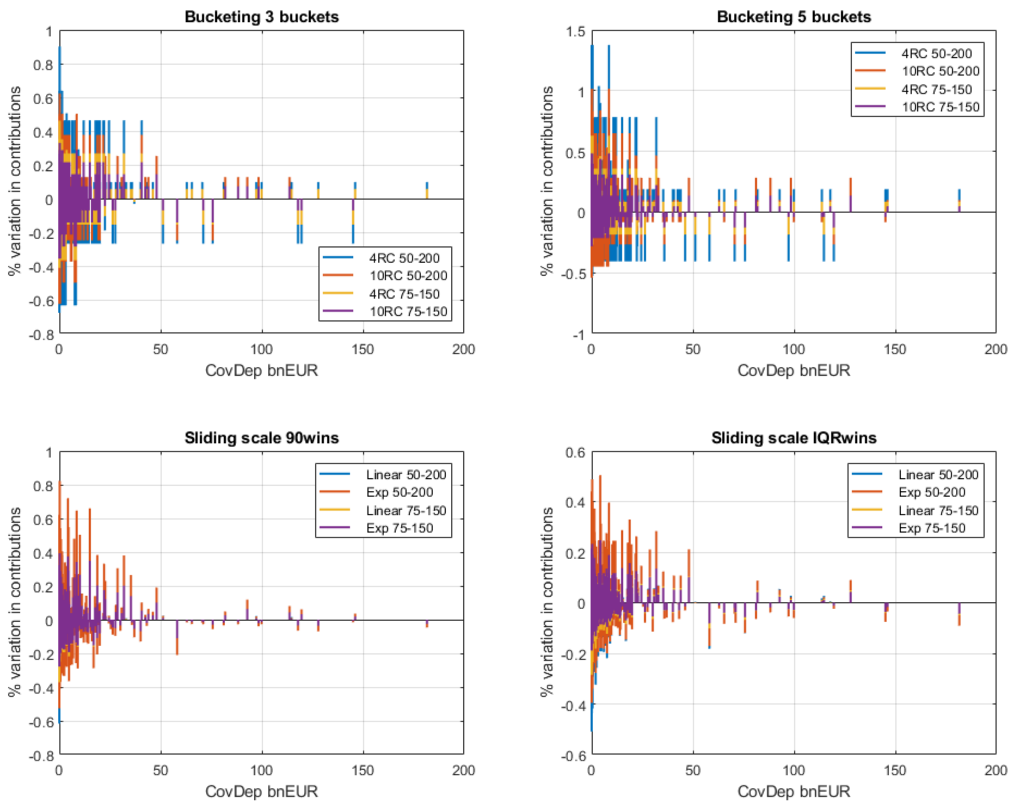


Table 30 reports some statistics on the differences in contributions (both in absolute and relative terms) for the four groups of banks. One can observe that large banks tend to pay more when a risk-based framework is in place, and especially when the bucketing approach is in place (the average or the median difference are positive in all cases). Tiny banks pay less under all approaches, being the median differences always lower than zero.

Table 30: Selected statistics on the differences between non-risk based and risk-based contributions

	Bucketing – 3 buckets				Bucketing – 5 buckets			
Type of banks	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**
Large	375 187	147 273	-31 118 030	15 090 049	897 639	886 273	-38 867 241	28 868 295
	1.7%	0.2%	-26.8%	46.4%	3.8%	8.6%	-40.6%	78.2%
Medium	-54 744	2 738	-4 151 404	3 434 700	-107 525	-134 502	-3 157 565	9 398 550
	-2.1%	0.2%	-63.4%	63.9%	-6.7%	-8.4%	-45.0%	137.6%
Small	-1 838	4 586	-448 856	316 950	-16 559	-12 327	-346 775	589 088
	-0.6%	4.8%	-63.4%	90.2%	-4.1%	-8.1%	-52.6%	137.6%

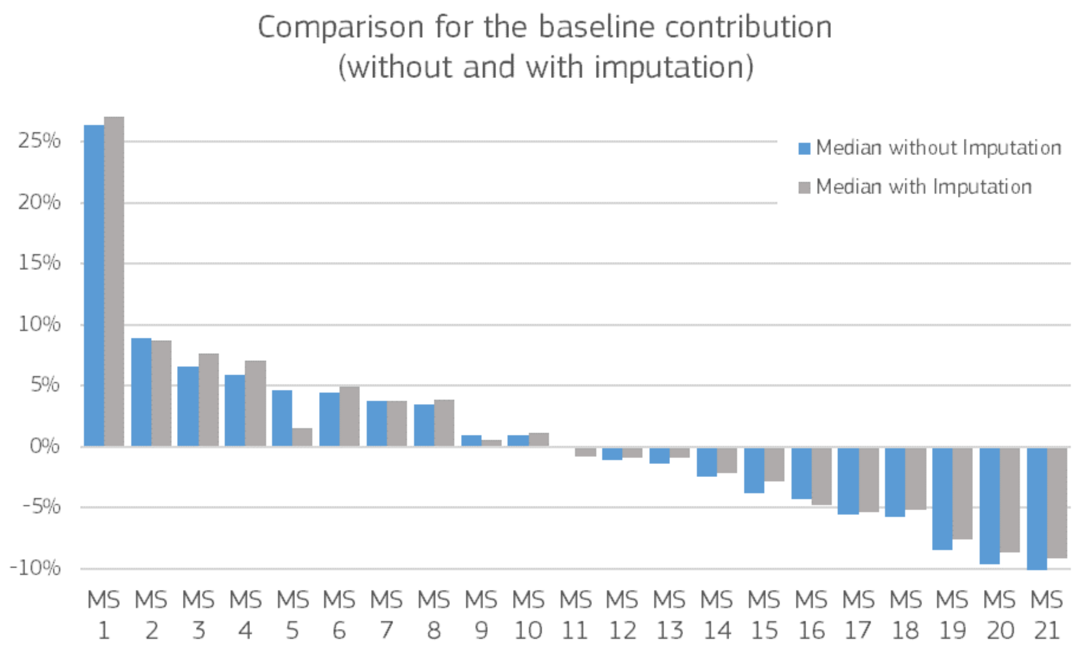
Tiny	-2 210	-784	-50 233	35 436	-1 869	-2 001	-41 948	61 642
	-9.1%	-7.1%	-67.7%	63.9%	-5.6%	-12.2%	-54.1%	137.6%
	Sliding Scale – 90 winsorization				**Sliding Scale– IQR winsorization**			
Type of banks	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**
Large	136 527	-204 874	-9 745 886	9 720 564	-376	-61 933	-13 214 051	9 191 353
	0.6%	-1.1%	-28.8%	65.9%	1.1%	-0.6%	-18.2%	32.9%
Medium	-22 680	-13 623	-2 095 617	4 417 441	-7 853	-4 165	-1 335 379	2 702 446
	-0.8%	-0.9%	-36.4%	72.0%	-0.1%	-0.3%	-32.4%	50.4%
Small	727	-396	-225 628	308 803	3,200	2 358	-196 460	184 783
	-0.1%	-0.2%	-41.1%	82.3%	1.3%	1.1%	-41.8%	48.8%
Tiny	-1 170	-705	-28 750	30 574	-192	-290	-24 907	20 059
	-5.6%	-3.7%	-61.6%	62.2%	-1.5%	-2.2%	-50.9%	43.9%

4.5.2 Baseline Scenario with imputation

In this section, we evaluate the baseline scenario (i.e. with core indicators only) replacing the missing values with the median value at MS level. In other words, if a particular indicator is not reported for one or more banks, we calculate the median value of this indicator for all banks that belong to the same MS and we substitute the missing value. As pointed out before, if many data points are missing, the quality of imputed data might be not satisfactory. In addition, it might be that the imputed data might be quite different with respect to the original (missing) value, reducing or increasing the score of the bank and changing the risk profile in a biased direction.

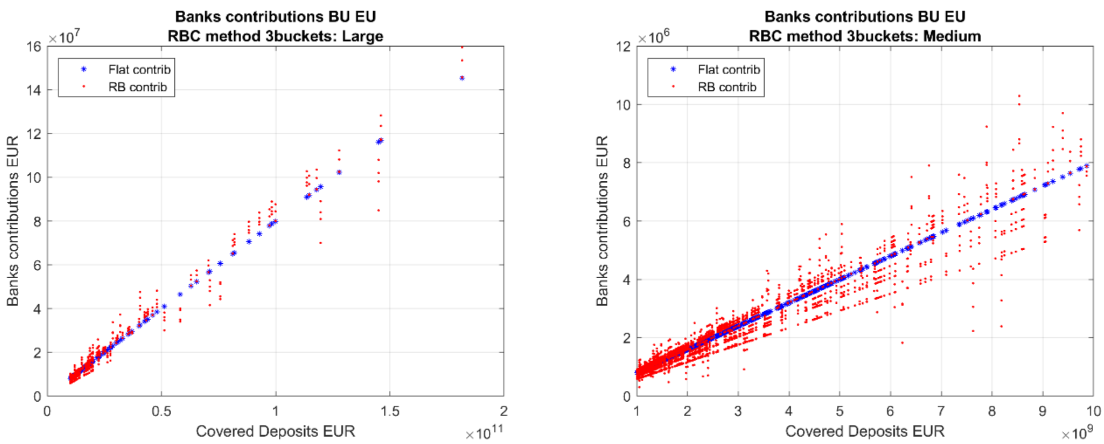
Also in this case, all institutions pay a contribution based upon the set of EBA core risk indicators, introduced in Table 29 (see also par. 58 of the EBA guidelines). Figure 9 shows the contributions aggregated at country level under a pure national system and under EDIS framework assuming that BU countries will join EDIS. The blue bars represent the size of the contributions collected under EDIS risk based contributions without imputation of missing values. The grey vertical bars show the impacts of estimating the missing values.

Figure 9: Banking Union EDIS risk based contributions aggregated at MS level. Contributions computed applying core risk indicators and weights with imputation of missing values



The four charts in Figure 10 show, as before, for the four groups of banks the amount of contributions computed under all the EBA models when BU banks join EDIS (red dots) and the non-risk based contributions, computed as a share of banks' covered deposits[55] (blue dots). Banks are sorted based on their covered deposits and the figure refers to the method with 3 buckets for IRS.

Figure 10: Non-risk-based versus risk-based contributions (with imputation)



55 Non risk-based contributions of bank *i* are simply computed as:

$$C_i = CovDep_i * \frac{0.8\%}{10},$$

being 10 the number of years to reach the target.

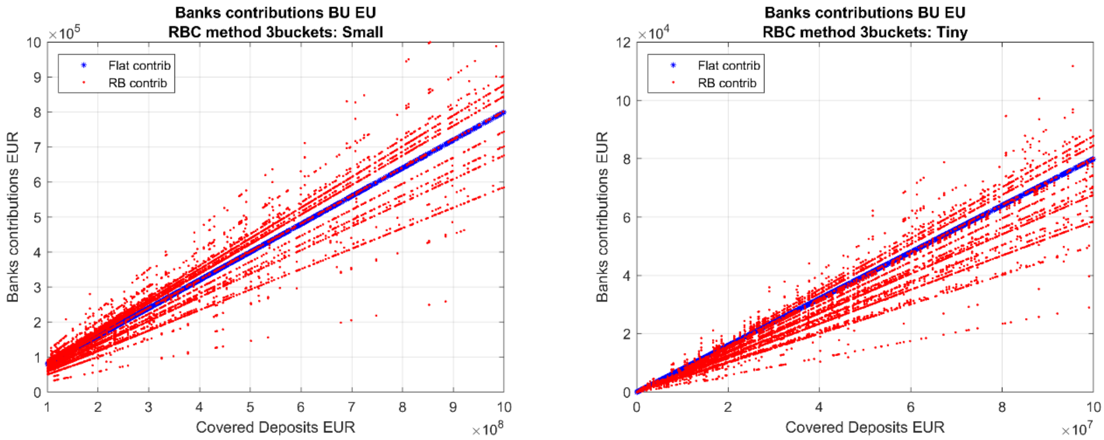


Figure 11 shows the percentage differences in contributions for all banks in the sample. Banks are sorted based on their covered deposits and the height of each bar represents the percentage difference in contributions with respect to non-risk based contributions. The conclusions are the same with respect to the baseline without imputation of missing values.

Figure 11: Percentage differences between non-risk-based and risk-based contributions (with imputation)

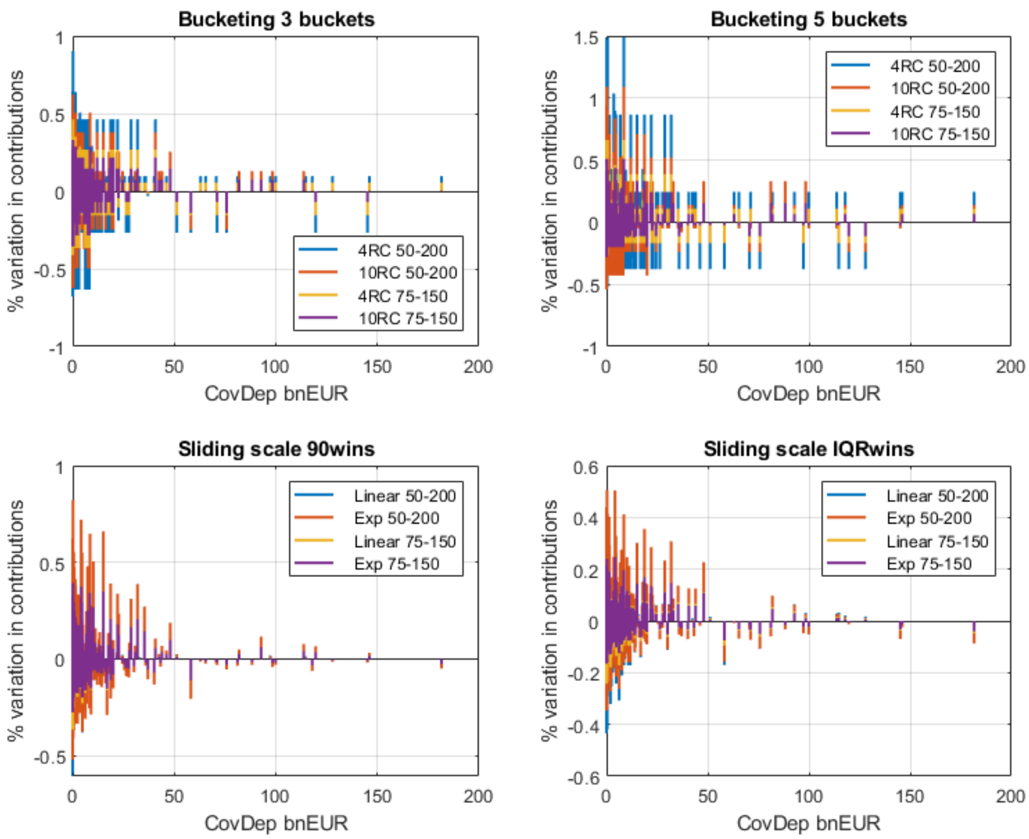


Table 31 reports some statistics on the differences in contributions (both in absolute and relative terms) for the four groups of banks.

Table 31: Selected statistics on the differences between non-risk based and risk-based contributions

	Bucketing – 3 buckets				Bucketing – 5 buckets			
Type of banks	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**
Large	480 392	254 036	-31 148 193	15 073 141	934 272	617 474	-38 635 965	35 539 882
	1.4%	0.4%	-26.8%	46.3%	3.4%	6.6%	-43.0%	86.7%
Medium	-62 580	4 080	-4 152 255	3 451 594	-105 821	-121 009	-2 936 968	10 173 665
	-2.4%	0.4%	-63.4%	63.9%	-6.5%	-5.0%	-43.0%	148.9%
Small	-4 484	1 039	-448 948	316 595	-17 210	-13 636	-330 918	585 895
	-2.1%	0.4%	-63.4%	90.2%	-5.7%	-5.0%	-52.6%	148.9%
Tiny	-3 610	-2 342	-50 244	35 396	-4 437	-2 980	-41 956	61 574
	-14.1%	-15.5%	-67.7%	63.9%	-15.6%	-16.8%	-54.1%	148.9%
	Sliding Scale – 90 winsorization				**Sliding Scale– IQR winsorization**			
Type of banks	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**	**Avg Diff**	**Median Diff**	**Min Diff**	**Max Diff**
Large	162 494	-194 471	-9 620 242	9 908 331	32 211	-51 701	-12 614 936	8 733 970
	0.6%	-1.1%	-29.0%	66.0%	0.9%	-0.4%	-17.1%	35.5%
Medium	-23 667	-11 951	-2 077 939	4 423 874	-9 563	5 230	-1 530 908	2 811 994
	-0.8%	-0.8%	-38.0%	72.0%	0.0%	0.3%	-32.1%	50.4%
Small	42	-284	-226 851	309 296	2 733	2 510	-193 233	176 411
	-0.6%	-0.1%	-41.1%	82.3%	0.6%	1.2%	-42.0%	50.5%
Tiny	-1 864	-1 077	-28 750	30 574	-1 290	-759	-24 907	17 036
	-8.2%	-6.1%	-60.6%	62.2%	-5.8%	-5.1%	-43.5%	43.9%

4.5.3 Sovereign exposures risk indicators

In this section, we introduce four different sovereign risk indicators, in order to evaluate the impact of their impact in the computation of banks' riskiness. The indicators are based on the holdings of sovereign bonds (both belonging to the home country and to foreign country) and the riskiness of the exposures. The first two indicators are the Top 3 Sovereign Exposures and the Top 5 Sovereign Exposures. Both are calculated in the same fashion, i.e. taking the sum of the home plus the top 2 (top 4) exposures, divided by the total asset of the bank. These indicators measure the concentration of the banks' sovereign exposures.

The other two indicators (Risk-Weighted Sovereign exposure , grid 1 and 2) measure the riskiness of the bank, and are calculated as follows. We retrieve the ratings for the entire list of countries where the entire sample of banks have exposures greater than zero. The full list includes 106 countries. We retrieve the sovereign ratings for S&P, Moody's and Fitch (S&P Long-term Issuer Rating [SPI] Domestic, Moody's Long-term Issuer Rating [MIS] Domestic, Fitch Long-term Issuer Default Rating [FDL] Domestic), when available. The ratings are then translated into a numerical scale, reported in Table 32 that ranks the rating from the least risky to the riskiest. In case more than one rating is available, the score is calculated rounding down the value. For example, if the rating for S&P is equal to 9 (BBB) and the rating for Fitch is equal to 8 (BBB+), the final score will be equal to 8.

Table 32: Ratings and numerical scale

Moody's	S&P	Fitch	Scale
Aaa	AAA	AAA	1
Aa1	AA+	AA+	2
Aa2	AA	AA	3
Aa3	AA-	AA-	4
A1	A+	A+	5
A2	A	A	6
A3	A-	A-	7
Baa1	BBB+	BBB+	8
Baa2	BBB	BBB	9
Baa3	BBB-	BBB-	10
Ba1	BB+	BB+	11
Ba2	BB	BB	12
Ba3	BB-	BB-	13
B1	B+	B+	14
B2	B	B	15
B3	B-	B-	16
Caa1	CCC+	CCC+	17
Caa2	CCC	CCC	18
Caa3	CCC-	CCC-	19
Ca	CC	CC	20
C	C	C	21
D	D	D	22

The next step involves the calculation of the risk weight to attach to each exposure. To do so, we rely on the guidelines presented by the EBA (see Joint Final Draft ITS On The Mapping Of ECAIs' Credit Assessments" EBA ,2015) that allows mapping each rating to the corresponding default rates. The following table provides the default rates for six classes and the respective ratings per credit quality step for each provider. The mapping of the ratings for each provider and the credit quality step is reported in Annex 2.

Table 33: Long-run benchmarks

Credit quality step	Long run Benchmark		
	Mid Value	Lower bound	Upper bound
1	0.10%	0.00%	0.16%
2	0.25%	0.17%	0.54%
3	1.00%	0.55%	2.29%
4	7.50%	2.40%	10.99%
5	20.00%	11.00%	26.49%
6	34.00%	26.50%	100.00%

Source: Annex I of the "Joint Final Draft ITS On The Mapping Of ECAIs' Credit Assessments" EBA (2015)

Finally, we exploit two options to set up the final weight based on Table 33; the first basically use the mid value for each credit quality step, while the second uses also the lower and upper bound to have a more granular set of risk weights. Table 34 shows both options (grid 1 and grid 2) in combination with the rating scale. The final risk indicator is calculated, for each bank, as follows:

- multiply each exposure for the weight (including the home country exposure)
- sum all the weighted exposures at bank level
- divide the resulting amount by the total asset of the bank for comparability

Table 34: Ratings and risk weights

Moody's	S&P	Fitch	Scale	Grid 1	Grid 2
Aaa	AAA	AAA	1	0.10%	0.00%
Aa1	AA+	AA+	2	0.10%	0.10%
Aa2	AA	AA	3	0.10%	0.10%
Aa3	AA-	AA-	4	0.10%	0.16%
A1	A+	A+	5	0.25%	0.17%
A2	A	A	6	0.25%	0.25%
A3	A-	A-	7	0.25%	0.54%
Baa1	BBB+	BBB+	8	1%	0.55%
Baa2	BBB	BBB	9	1%	1.00%
Baa3	BBB-	BBB-	10	1%	2.39%
Ba1	BB+	BB+	11	7.50%	2.40%
Ba2	BB	BB	12	7.50%	7.50%

Moody's	S&P	Fitch	Scale	Grid 1	Grid 2
Ba3	BB-	BB-	13	7.50%	10.99%
B1	B+	B+	14	20%	11.00%
B2	B	B	15	20%	20.00%
B3	B-	B-	16	20%	26.49%
Caa1	CCC+	CCC+	17	34%	26.50%
Caa2	CCC	CCC	18	34%	34.00%
Caa3	CCC-	CCC-	19	34%	56.00%
Ca	CC	CC	20	34%	90.00%
C	C	C	21	34%	100.00%
D	D	D	22		100.00%

Table 35 reports the adopted weights assigned to all indicators to compute the risk-based contributions: the sovereign indicator is assigned 15% weight, the maximum admissible weight for additional risk indicators according to EBA guidelines. Each indicator is introduced singularly in the calculation, in order to see the different effects on the final contributions.

Table 35: EBA guidelines approach: indicators, weights and signs applied when including the sovereign risk indicators.

Risk Indicators		Weight	Sign
1.	**Capital**		
	Leverage ratio	10.2%	-1
	CET1 ratio	10.2%	-1
2	**Liquidity and funding**		
	LCR	20.4%	-1
3	**Asset quality**		
	NPL ratio	14.8%	1
4	**Business model and management**		
	RWA ratio	7.35%	1
	ROA	7.35%	1
	Sovereign Exposures Indicator	15%	-1
5	**Potential losses for the DGS**		
	Unencumbered assets ratio	14.7%	-1

The results for the four different indicators are reported in Table 36, taking as a reference the RBC national contribution. For instance, a value equal to 89.1% means that the contribution is 10.9% (100%-89.1%) lower with respect to the national contribution for that MS if we introduce this indicator in addition to the core indicators.[56] The color scale helps detecting the scenario where the contribution is higher (red cells) and lower (green cells). The overall picture is in general consistent also when using the database with imputation, albeit the values differs due to the imputation itself.

Table 36: Comparison between the RBC national contribution and the median risk-based contribution introducing the sovereign indicators

MS	Core indicators only	Top 3 Sovereign Exposures	Top 5 Sovereign Exposures	Risk-Weighted Sovereign exposure (Grid 1)	Risk-Weighted Sovereign exposure (Grid 2)
MS 1	89.9%	89.1%	89.0%	88.9%	90.0%
MS 2	90.3%	92.0%	92.0%	91.4%	91.3%
MS 3	91.5%	95.9%	95.9%	92.7%	92.0%
MS 4	94.3%	93.5%	93.5%	95.3%	95.8%
MS 5	94.5%	93.8%	94.6%	93.5%	93.2%
MS 6	95.7%	92.8%	92.8%	92.7%	92.9%
MS 7	96.2%	95.1%	95.2%	94.6%	94.1%
MS 8	97.6%	95.9%	96.0%	95.9%	96.5%
MS 9	98.7%	99.5%	99.6%	98.2%	98.2%
MS 10	99.0%	103.2%	103.3%	102.1%	99.6%
MS 11	99.8%	99.9%	99.8%	98.9%	98.9%
MS 12	101.0%	99.3%	99.3%	99.0%	99.6%
MS 13	101.0%	103.2%	103.0%	102.4%	103.0%
MS 14	103.4%	105.6%	105.7%	104.5%	103.1%
MS 15	103.8%	103.7%	103.7%	106.1%	105.7%
MS 16	104.4%	107.6%	107.6%	112.3%	113.6%
MS 17	104.6%	103.2%	103.5%	103.1%	103.3%
MS 18	105.9%	107.7%	107.7%	109.6%	110.0%
MS 19	106.6%	106.7%	106.6%	108.3%	109.7%
MS 20	108.9%	110.2%	110.2%	112.7%	113.1%
MS 21	126.4%	118.0%	118.0%	130.2%	130.9%

4.6 Conclusions

The JRC supported DG FISMA in the development and assessment of different approaches for the calculation of risk-based contributions to EDIS. EBA guidelines on methods for calculating contributions to deposit guarantee schemes set the technical background to develop alternative risk-based methodologies.

Following the EBA guidelines, JRC tested alternative methods for the buckets and the sliding scale approaches and results demonstrated that bucket approaches tended to have a higher impact on contributions whereas sliding scale approaches were closer to non-risk-based contributions.Bucket approaches also generated more extreme values. These results held true for different choices of risk indicators and weights.

The JRC computed banks' risk-based contributions when only core risk indicators (indicators that cannot be exluded from computations) were included and compared these results with additional sets of results obtained including additional risk factors related to sovereign exposures.

JRC will continue working on the risk-based contributions and support DG FISMA activities in this field by testing the effects of additional risk factors on banks' risk-based contributions.

[56] The baseline, set equal to 100%, correspond to the non-risk based contribution, where each bank pays a fixed contribution equal to 0.8% of their covered deposits.

5 Conclusions

This report presents and discusses several quantitative analysis on selected deposits insurance issues for purposes of impact assessments by the European Commission. In particular, the topics cover some of the issues addressed by the review of the EU bank crisis management and deposit insurance (CMDI) framework, which lays out the rules for handling bank failures, preserving financial stability, protecting depositors, and aiming to avoid the risk of excessive use of public financial resources.

The potential revisions flagged would require further harmonization of insolvency law and an overall coherence to manage bank crises in the EU, as well as to enhance the level of depositor protection, including through the creation of a common depositor protection mechanism (European Deposit Insurance Scheme, EDIS). This report in particular covers three topics: the temporary high deposit balances (THBs) and their impact on DGSs, the effectiveness and pooling effect of the European Deposit Guarantee Scheme (EDIS), and the modelling and the assessment of alternative methodologies for the calculation of risk-based contributions to a Deposit Guarantee Fund.

Overall, results show that there could be room for improvement in the actual framework. In particular, for what concerns the THBs, the findings show that an increase of the level of protection of temporary high deposit balances up to EUR 500 000 might be successful in protecting the wealth of households in the majority of countries, in situations where households involved in housing transactions might face the risk of losing a substantial share of their wealth. As a result, a policy option increasing the level of protection up to EUR 500 000 appears to better pursue the policy objective of enhancing depositor confidence while limiting the burden on DGSs and banks.

Regarding the effectiveness and pooling effect of EDIS, the assessment shows that a system with joint financial means and joint liability, such as EDIS or the hybrid model, would be more effective and efficient in providing liquidity support, i.e. provide a higher level of protection than a scheme based solely on national Deposit Guarantee Schemes, and that such system is considerably less likely to fall short on pay-outs than a national DGS.

Finally, we show how both the choice of methodology and individual risk indicators to calculate risk-based contributions, might affect the contribution of each Member State to EDIS.

6 Annex A

Number of transactions

The ECB and the European Mortgage Federation report the number of transactions in their statistics. As the latter states that the number for some Member States might refer to general real estate transactions not related to housing and this might bias results, the JRC prefers to use the information provided by the ECB in the Structural Housing Indicators Statistics (as done by CEPS). Missing values are imputed by using the EU average for Member States where data on transactions is available, based on the following steps:

- Derive the number of transactions per household dividing the total number of transaction by the total number of households, as available in Eurostat.[57] (column (4) of Table 37 estimated as column (1) / (3)).
- Estimate the EU average number of transaction per household, weighted by the number of households.
- Use the weighted average multiplied by the number of households for estimating the total number of transactions (Table 37).

Table 37: Number of transactions

	Number of transactions	Year of reference (from ECB)	Number of households 2018 (Eurostat lfst_hhnhtych)	Average number of transactions per household
	(1)	(2)	(3)	(4)
BE	125 700	2017	4 770 400	2.6%
BG	*68 485*		2 708 000	
CZ	*120 376*		4 759 800	
DK	73 600	2016	2 402 200	3.1%
DE	*1 032 001*		40 806 600	
EE	25 920	2018	610 900	4.2%
IE	32 240	2015	1 842 000	1.8%
EL	60 500	2016	4 383 600	1.4%
ES	532 260	2017	18 580 600	2.9%
FR	968 000	2017	29 778 200	3.3%
HR	2 430	2017	1 473 600	0.2%
IT	534 000	2016	25 925 800	2.1%
CY	*8 265*		326 800	
LV	*21 605*		854 300	
LT	*33 426*		1 321 700	
LU	10 700	2017	251 500	4.3%
HU	119 390	2015	4 124 800	2.9%
MT	6 530	2017	192 400	3.4%
NL	214 790	2016	7 834 200	2.7%
AT	78 130	2018	3 915 500	2.0%
PL	188 600	2017	14 608 900	1.3%
PT	153 290	2017	4 144 600	3.7%
RO	*189 531*		7 494 300	
SI	*22 435*		887 100	
SK	*47 758*		1 888 400	
FI	74 450	2016	2 677 100	2.8%
SE	156 870	2018	5 239 500	3.0%
Weighted Average				**2.5%**

Note*:* Italics indicate imputed number of transactions

[57] See table *fst_hhnhtych* of Eurostat , data is of 2018.

Increase in covered deposits when protecting THB arising from real estate transactions

Figures below show the impact of protecting THBs related to real estate transactions at Member State level, as a share of covered deposits. Numbers refer to the scenario whereby the level of protection increase up to EUR 500 000 and the deposits are protected for six month. Figure 12 refers to the methodology proposed by the JRC whereby the first EUR 100 000 are excluded from the calculation and the outflow assumption is implemented. Figure 13 shows how results change when including EUR 100 000 as proposed in the CEPS study. Figure 14 shows how results would change without the outflows and excluding EUR 100 000.

Figure 12: Increase in covered deposits per Member State when protecting THBs related to real estate (excluding EUR 100 000 and implementing the outflow assumption – JRC main scenario)

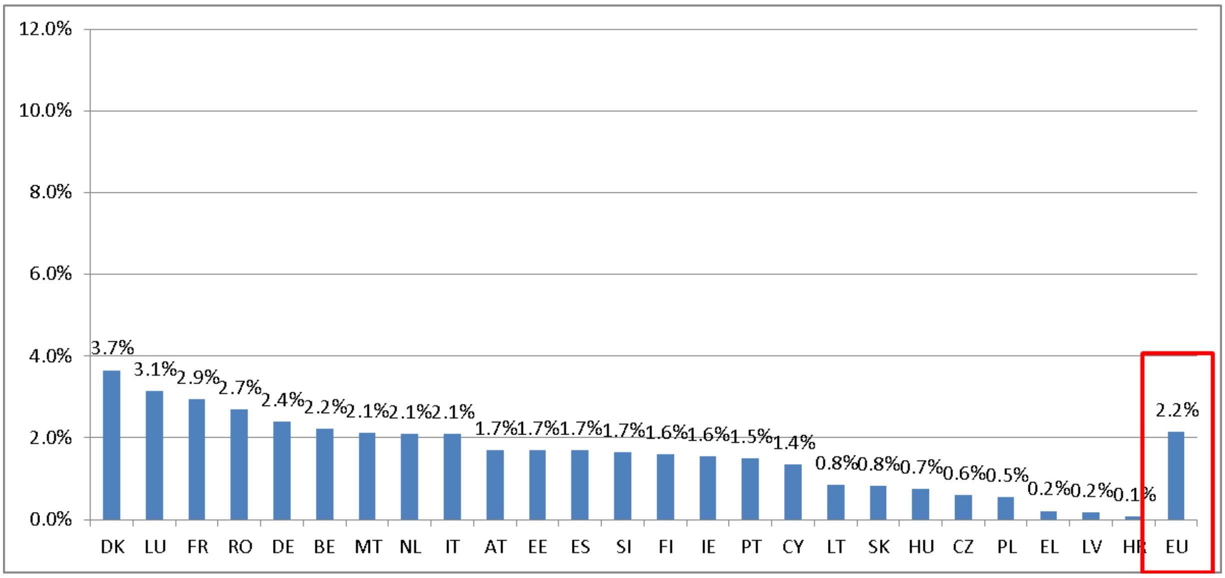


Figure 13: Increase in covered deposits per Member State when protecting THBs related to real estate (including EUR 100 000 and implementing the outflow assumption – CEPS main scenario)

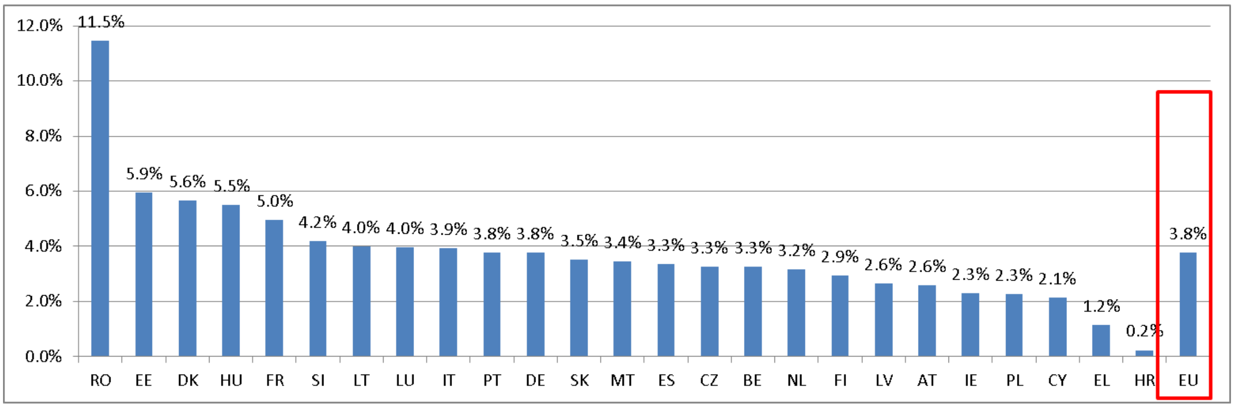
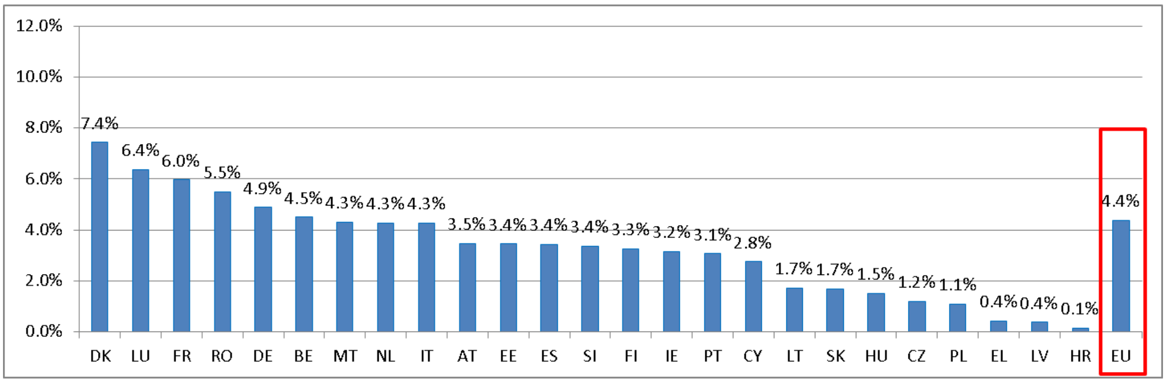


Figure 14: Increase in covered deposits per Member State when protecting THBs related to real estate (excluding EUR 100 000 and without the outflow assumption)



JRC vs CEPS results

The tables below compares CEPS findings with the JRC results when: (1) excluding the first EUR 100 000 from the estimation, (2) including the first EUR 100 000; (3) including the outflow assumptions as proposed by CEPS. Table 38 provides a comparison for different time horizons under a EUR 500 000 threshold. Table 39 compares results at 6 months when changing the level of THB protection.

Table 38: Comparison with CEPS for a fixed upper limit coverage of EUR 500 000 for a different time of coverage:

	CEPS				JRC				JRC				JRC				JRC			
	Including EUR 100 000; Outflows are assumed to be around 20 % per month				Excluding EUR 100 000; Outflows are assumed to be around 20 % per month				Including EUR 100 000; Outflows are assumed to be around 20 % per month				Excluding EUR 100 000				Including EUR 100 000			
	months				months				months				months				months			
	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
EU average	3.9%	5.6%	6.5%	7.0%	1.4%	2.2%	2.5%	2.7%	2.5%	3.8%	4.4%	4.8%	2.2%	4.4%	6.6%	8.7%	3.8%	7.7%	11.5%	15.3%
min	0.6%	0.9%	1.1%	1.1%	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%	0.1%	0.1%	0.2%	0.3%	0.2%	0.5%	0.7%	0.9%
max	12.6%	18.5%	21.6%	23.1%	2.4%	3.7%	4.3%	4.6%	7.6%	11.5%	13.5%	14.5%	3.7%	7.4%	11.1%	14.9%	11.7%	23.3%	35.0%	46.6%

Table 39: Comparison with CEPS for different coverage levels with a fixed time of coverage at 6 months**:**

	CEPS				JRC				JRC				JRC				JRC			
	Including EUR 100 000; Outflows are assumed to be around 20 % per month				Excluding EUR 100 000; Outflows are assumed to be around 20 % per month				Including EUR 100 000; Outflows are assumed to be around 20 % per month				Excluding EUR 100 000				Including EUR 100 000			
	thresholds (EUR)				thresholds (EUR)				thresholds (EUR)				thresholds (EUR)				thresholds (EUR)			
	100 000	200 000	300 000	500 000	100 000	200 000	300 000	500 000	100 000	200 000	300 000	500 000	100 000	200 000	300 000	500 000	100 000	200 000	300 000	500 000
EU average	3.9%	3.4%	4.5%	5.6%	1.6%	1.1%	1.6%	2.2%	1.6%	2.7%	3.3%	3.8%	3.3%	2.1%	3.3%	4.4%	3.3%	5.4%	6.6%	7.7%
min	0.6%	0.9%	0.9%	0.9%	0.2%	0.0%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.3%	0.1%	0.1%	0.1%	0.3%	0.4%	0.5%	0.5%
max	12.6%	18.1%	18.5%	18.5%	8.8%	2.4%	2.9%	3.7%	8.8%	11.2%	11.5%	11.5%	17.8%	4.9%	5.9%	7.4%	17.8%	22.7%	23.3%	23.3%

Life benefits paid

Table 40: Life benefits paid in m€

	2013	2014	2015	2016	2017	**2018**
BE	17 888	17 478	19 585	18 599	17 653	16 381
BG	57	72	73	79	83	70
CZ	1 599	1 871	1 644	1 393	1 399	1 417
DK	14 897	17 094	15 377	15 425	16 006	17 148
DE	79 417	84 418	82 002	87 667	76 910	78 834
EE	40	41	42	51	54	46
IE	8 923	8 292	8 969	8 745	9 428	
EL	1 750	1 517	1 600	1 688	1 451	1 382
ES	23 815	26 936	28 066	24 110	26 639	24 788
FR	108 007	106 347	112 220	116 909	126 295	118 214
HR	205	200	216	242	276	312
IT	66 582	64 327	69 649	64 273	71 356	72 207
CY	399	247	0	217	196	213
LV	31	26	29	33	43	43
LT						
LU	719	469	677	697	987	987
HU	1 243	1 119	1 090	0	0	0
MT	140	157	175	208	221	247
NL	22 663	24 373	21 494	21 546	25 420	20 121
AT	6 343	7 155	8 442	7 767	7 141	6 622
PL	5 460	4 763	4 539	4 144	4 871	4 995
PT	2 838	8 693	9 084	9 346	6 375	6 553
RO	73	178	158	156	214	0
SI	388	379	406	405	470	484
SK	738	741	661	659	679	763
FI	16 730	17 273	17 800	18 595	18 932	19 884
SE	13 871	13 036	21 453	20 926	22 320	22 148

Source: Insurance Europe

7 Annex B

Brief description of SYMBOL

The Systemic Model of Banking Originated Losses model (SYMBOL, see De Lisa et al, 2011[58]) has been developed by JRC in cooperation with members of academia and representatives of DG FISMA. The core of the model is the Fundamental Internal Risk Based formula from the Basel III regulatory framework. The Basel III Fundamental Internal Risk Based formula works on the idea that credit assets outcomes fundamentally depend on a single factor.[59] This allows modelling and simulations to be carried out very easily. The formula has two additional useful characteristics in terms of modelling: (a) it uses a very limited number of parameters expressing the riskiness of credit assets and their correlation; (b) it gives comparable results when used on a set of sub-portfolios of assets, each with its own parameters, and then summing up results, or when directly considering the whole portfolio using average parameters values.

The model thus assumes that: (a) the Basel 3 regulatory model for credit risk is correct; (b) banks report risks accurately and in line with this model;[60] (c) all risks in the bank can be represented as a single portfolio of credit risks.[61] It is then possible to use publicly available data on total regulatory capital, risk weighted assets and total assets to obtain parameters representing the average riskiness of each bank's portfolio of assets.[62]

Once parameters are obtained for all banks, a set of loss scenarios are simulated. In each scenario, a number representing a realization of the single risk factor is randomly generated for each bank. To represent the fact that banks all operate in the same economy, the risk factors are correlated between themselves.

Given the realisation of the risk factors and the parameters above, it is possible to obtain from the model a simulated loss for each bank in each loss scenario.[63] These losses can then be applied to bank capital to see which banks "default" (i.e. exhaust or severely deplete regulatory capital) in the simulated scenario. If the policy set-up allows for any other loss-absorbing or re-capitalization tool (e.g. bail-in) these can also be applied at individual bank level. Losses, interventions of other tools and counts of defaults can then be aggregated across the whole banking sector. Moreover, given that the simulations work at individual bank level, other characteristics of banks subject to "default" can be tracked, such as covered deposits or total assets held.[64]

Given a sufficient number of loss scenario simulations (hundreds of thousands to millions), it is possible to obtain statistical distributions of outcomes for the banking sector as a whole.

It is finally possible to use such distribution to estimate the probability of events such as the probability that losses in excess of capital will be above a certain threshold (i.e. the statistical distribution of losses for resolution tools and/or public interventions), or the probability that banks holding more than a certain amount of covered deposits will be in default (i.e. the statistical distribution of intervention needs for the DGS).[65]

SYMBOL simulates the distribution of losses in excess of banks' capital within a banking system (usually a country) by aggregating individual banks' losses. Individual banks' losses are generated via Monte Carlo

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58 Please note that at the time of submission the acronym SYMBOL was not employed yet.

59 In a very simplified way: given the general situation of the economy, each asset will have a certain probability of defaulting. By considering such probabilities of default as the expected loss conditional on the economic situation and summing across assets it is possible to obtain an expected loss of the portfolio conditional on any economic scenario. The capital requirement is then the loss on a particularly adverse scenario.

60 When this is not the case, we need to rely on self-reported or supervisory assessments of the correction that would be needed when moving from the current system to a Basel III compatible system. It should be noted that the original framework of the model employed Basel II (and not III) compatible data, as this was the regulatory framework of reference at the time.

61 This does not mean that other risks are not considered, simply that they can be "mapped" in credit risk terms and modelled using the same framework.

62 Other parameters are fixed at the default levels set in the regulation.

63 It should be noted that SYMBOL is a "purely static" model. Losses are all realized (or known) at the same point in time for all systems' participants and banks do not dynamically react to events.

64 It is important to stress that, though the model simulates losses at individual bank level, individual bank results are not deemed to be usable per se.

65 Technically, what is obtained is the Value at Risk (VaR), or the loss which should not be exceeded under a certain confidence level. The confidence is given by the probability of observing a realization of the risk factor which is more extreme than the one corresponding to the reference scenario.

simulation using the Basel FIRB loss distribution function. This function is based on the Vasicek model (see Vasicek, 2002), which in broad terms extends the Merton model (see Merton, 1974) to a portfolio of borrowers.[66] Simulated losses are based on an estimate of the average default probability of the portfolio of assets of any individual bank, which is derived from data on banks' Minimum Capital Requirements (MCR) and Total Assets (TA).

The model includes also a module for simulating direct contagion between banks, via the interbank lending market. In this case, additional losses due to a contagion mechanism are added on top of the losses generated via Monte Carlo simulation, potentially leading to further bank defaults (see also Step 4 below). The contagion module can be turned off or on depending on the scope of the analysis and details of the simulated scenario.

In addition to bank capital, the model can take into account the existence of a safety net for bank recovery and resolution, where bail-in, DGS, and Resolution fund intervene to cover losses exceeding bank capital before they can hit Public Finances.

Estimations are based on the following assumptions:

- SYMBOL approximates all risks as if they were credit risk; no other risk categories (e.g. market, liquidity or counterparty risks) are explicitly considered;
- SYMBOL implicitly assumes that the FIRB formula adequately represents (credit) risks that banks are exposed to;
- Banks in the system are correlated with the same factor (see Step 2 below);
- All events happen at the same time, i.e. there is no sequencing in the simulated events, except when contagion between banks is considered.

STEP 1: Estimation of the Implied Obligor Probability of Default of the portfolio of each individual bank.

The main ingredient of the model is the average implied obligor probability of default of a bank. It is a single parameter describing its entire loss distribution. It is obtained by numerical inversion of the Basel IRB formula for credit risk, based on total minimum capital requirements declared in the balance sheet. Individual bank data needed to estimate the implied obligor probability of default are banks' risk-weighted assets and total assets, which can be derived from the balance sheet data. We present a brief overview of the main ingredients below. Benczur et al (2015) offers some additional details and discussion.

For each exposure *l* in the portfolio of bank *i*, the IRB formula derives the corresponding capital requirement $\mathrm{CR_{i,l}}$ needed to cover unexpected losses[67] over a time horizon of one year, with a specific confidence level equal to 99.9% (see Figure 15):

$$\mathrm{CR_{i,l}}(\mathrm{PD_{i,l}}) = \left[\mathrm{LGD}\cdot \mathrm{N}\left(\sqrt{\frac{1}{1-\mathrm{R}(\mathrm{PD_{i,l}})}}\mathrm{N}^{-1}\left(\mathrm{PD_{i,l}}\right) + \sqrt{\frac{\mathrm{R}(\mathrm{PD_{i,l}})}{1-\mathrm{R}(\mathrm{PD_{i,l}})}}\mathrm{N}^{-1}(0.999)\right) - \mathrm{PD_{i,l}}\cdot \mathrm{LGD}\right]\cdot \mathrm{M}\left(\mathrm{PD_{i,l}}\right),$$

where $\mathrm{PD_{i,l}}$ is the default probability of exposure *l*, *R* is the correlation among the exposures in the portfolio, defined as

$$\mathrm{R}(\mathrm{PD}) = 0.12\cdot\frac{1-\mathrm{e}^{-50\mathrm{PD}}}{1-\mathrm{e}^{-50}} + 0.24\cdot\left(1-\frac{1-\mathrm{e}^{-50\mathrm{PD}}}{1-\mathrm{e}^{-50}}\right) - 0.04\cdot\left(1-\frac{\mathrm{S}-5}{45}\right)$$

[66] The Basel Committee permits banks a choice between two broad methodologies for calculating their capital requirements for credit risk. One alternative, the Standardised Approach, measures credit risk in a standardised manner, supported by external credit assessments. The alternative is the Internal Rating-Based (IRB) approach which allows institutions to use their own internal rating-based measures for key drivers of credit risk as primary inputs to the capital calculation. Institutions using the Foundation IRB (FIRB) approach are allowed to determine the borrowers' probabilities of default while those using the Advanced IRB (AIRB) approach are permitted to rely on own estimates of all risk components related to their borrowers (e.g. loss given default and exposure at default). The Basel FIRB capital requirement formula specified by the Basel Committee for credit risk is the Vasicek model for credit portfolio losses, default values for all parameters except obligors' probabilities of default are provided in the regulatory framework. On the Basel FIRB approach, see Basel Committee on Banking Supervision, 2011.

[67] Banks are expected to cover their expected losses on an ongoing basis, e.g. by provisions and write-offs. The unexpected loss, on the contrary, relates to potentially large losses that occur rather seldom. According to this concept, capital would only be needed for absorbing unexpected losses.

with obligor size *S* =50.

Here LGD is the loss given default[68] and $\mathrm{M}(\mathrm{PD}_{i,l})$ is an adjustment term, defined as

$$\mathrm{M}(\mathrm{PD}_{i,l}) = \frac{(1 + (\mathrm{M} - 2.5) \cdot \mathrm{b}_{i,l}) \cdot 1.06}{1 - 1.5 \cdot \mathrm{b}_{i.l}}$$

with $\mathrm{b}_{i,l} = (0.11852 - 0.05478 \cdot \ln(\mathrm{PD}_{i,l}))^2$ and maturity M=2.5. Note that here all parameters are set to their regulatory default values.

The minimum capital requirement of each bank *i* is obtained summing up the capital requirements for all exposures:

$\mathrm{MCR}_i = \sum_l \mathrm{CR}_{i,l} \cdot \mathrm{A}_{i,l}$,

where $\mathrm{A}_{i,l}$ is the amount of the exposure *l*.

As there are no available data on banks' exposures towards each obligor, the model estimates the default probability of a single obligor (implied obligor probability of default, IOPD) equivalent to the portfolio of exposures held by each bank by inverting the above formulas. Mathematically speaking, the model computes the IOPD by numerically solving the following equation:

$\mathrm{CR}(\mathrm{IOPD}_i) \cdot \sum_l \mathrm{A}_{i,l} = \mathrm{MCR}_i$,

where MCR_i and $\sum_l \mathrm{A}_{i,l}$ are respectively the minimum capital requirement, set equal to 8% of the risk-weighted assets, and the total assets of the bank.

STEP 2: Simulation of correlated losses for the banks in the system.

Given the estimated IOPD, SYMBOL simulates correlated losses hitting banks via Monte Carlo, using the same IRB formula and imposing a correlation structure among banks.[69] The correlation exists either as a consequence of the banks' exposure to common borrowers or, more generally, to a particular common factor (for example, the business cycle). In each simulation run n=1,…,N_0, losses for bank *i* are simulated as:

$\mathrm{L}_{n,i} = \mathrm{LGD} \cdot \mathrm{N}\left[\sqrt{\frac{1}{1-\mathrm{R}(\mathrm{IOPD}_i)}}\mathrm{N}^{-1}(\mathrm{IOPD}_i) + \sqrt{\frac{\mathrm{R}(\mathrm{IOPD}_i)}{1-\mathrm{R}(\mathrm{IOPD}_i)}}\mathrm{N}^{-1}(\alpha_{n,i})\right]$,

where N is the normal distribution function, and $\mathrm{N}^{-1}(\alpha_{n,i})$ are correlated normal random shocks with correlation matrix $\sum$.

STEP 3: Determination of bank failure.

Given the matrix of correlated losses, SYMBOL determines which banks fail. As illustrated in Figure 15, a bank failure happens when simulated obligor portfolio losses (L) exceed the sum of the expected losses (EL) and the total actual capital (K) given by the sum of its minimum capital requirements plus the bank's excess capital, if any :

$\mathrm{Failure} \coloneqq \mathrm{L}_{n,i} - \mathrm{EL}_i - \mathrm{K}_i > 0$.

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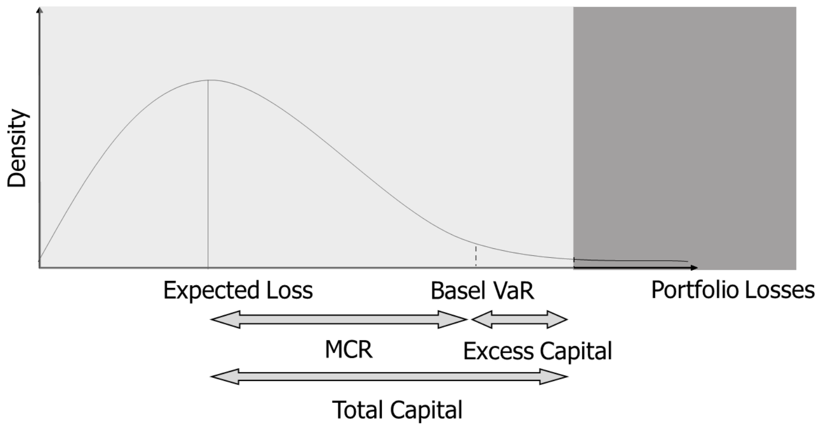
68 Set in Basel regulation equal to 45%.

69 The asset value of each bank's debtors evolves according to $X_{A,k} = \sqrt{R_A}(\sqrt{\rho}\beta + \sqrt{1-\rho}\beta_A) + \sqrt{1-R_A}Z_{A,k}$. Here $Z_{A,k}$ is the idiosyncratic shock to the debtor, β_A is the bank specific shock, while β is a common component. The parameter *ρ* controls the degree of commonality in the shocks of two different banks.

Figure 15: Individual bank loss probability density function



Note: MCR: minimum capital requirements. VaR: value-at-risk.

The light grey area in Figure 15 represents the region where losses are covered by provisions and total capital, while the dark grey one shows when banks fail under the above definition. It should be noted that the probability density function of losses for an individual bank is skewed to the right, i.e. there is a very small probability of extremely large losses and a high probability of losses that are closer to the average/expected loss. The Basel Value at Risk (VaR) corresponds to a confidence level of 0.1%, i.e. the minimum capital requirement covers losses from the obligors' portfolio with probability 99.9%. This percentile falls in the light grey area, as banks generally hold an excess capital buffer on top of the minimum capital requirements. The actual level of capital hold by each bank *i* determines the failure event.

STEP 4: Aggregate distribution of losses for the whole system.

Aggregate losses are obtained by summing losses in excess of capital of all distressed banks in the system in each simulation run.

Comparison among different setting of the hybrid model

In Figure 16, we compare the liquidity shortfalls of the hybrid models with the same size of common funds, i.e. large central fund (α = 25%), medium central fund (α = 50%) and small central fund (α = 75%).[70] From Table 41, the medium and large central fund have curves around 20% lower than the small central fund. Based on results shown in the same table, the large central fund reduces the number of runs with liquidity shortfall the most: about 40% decrease with respect to the small central fund. The former is thus always superior and preferable to all the alternative hybrid options proposed, because this setting of parameters benefits from a larger common fund.

Figure 16: Liquidity shortfalls under the hybrid schemes.

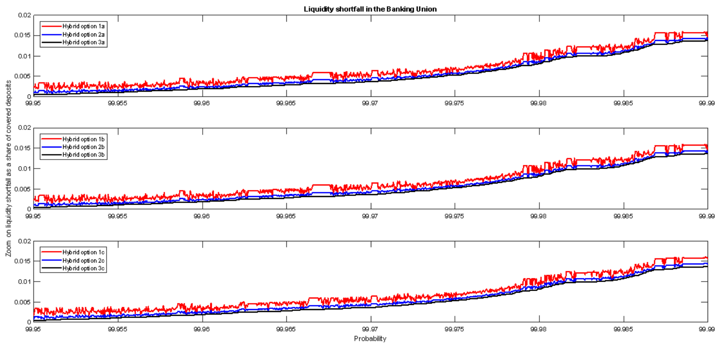


Table 41: Ratio of the area below a scheme's curve over the corresponding low ambition hybrid model. Number of runs with liquidity shortfall conditional on facing a pay-out in at least one of the hybrid models analysed.

	Small central fund hybrid *option a*	**Medium central fund hybrid *option a***	**Large central fund hybrid *option a***	**Small central fund hybrid *option b***	**Medium central fund hybrid *option b***	**Large central fund hybrid *option b***	**Small central fund hybrid *option c***	**Medium central fund hybrid *option c***	**Large central fund hybrid *option c***
Ratio of the area below a scheme's curve over small central fund *option a*'s	1	0.84	0.79	-	-	-	-		-
Ratio of the area below a scheme's curve over small central fund *option b*'s	-	-	-	1	0.84	0.79	-	-	-
Ratio of the area below a scheme's curve over small central fund *option c*'s	-	-	-	-	-	-	1	0.84-	0.78
Share of runs with liquidity shortfalls conditional on pay-outs in at least one hybrid scheme	98%	78%	66%	98%	78%	66%	100%	79%	66%

The key difference between the three large central fund (<u>*option a*, *option b*, and *option c*</u>) stands in the calculation of the mandatory lending available. *Option a* and *option b* set the amount of mandatory lending as a share of the initial national funds, whereas the amount of mandatory lending under *option c* is a share of the remaining available financial means. Therefore, in the latter case a share of funds sits with national DGSs and cannot be used by a borrowing DGSs. When comparing these schemes, the plot of the liquidity shortfalls reported in Figure 17 does not provide a clear cut to guarantee the stochastic dominance. To facilitate the

[70] Again, the figure zooms in the tail of the curves (p>99.9%) to better highlight the differences between the alternative options. Original charts are available upon request to show the magnitude of the simulated retentions.

comparison, it is convenient to look at Table 42, which gives an insight into (i) what is the scheme with the lowest number of simulations leading to the liquidity shortfalls (ii) what is the scheme with the lowest amount of liquidity needs. While, the worst combination of parameters turns out to be the last one, *option a* and *option b* seem to behave the same with an equally good performance.

Figure 17: Liquidity shortfalls under the preferred hybrid proposals.

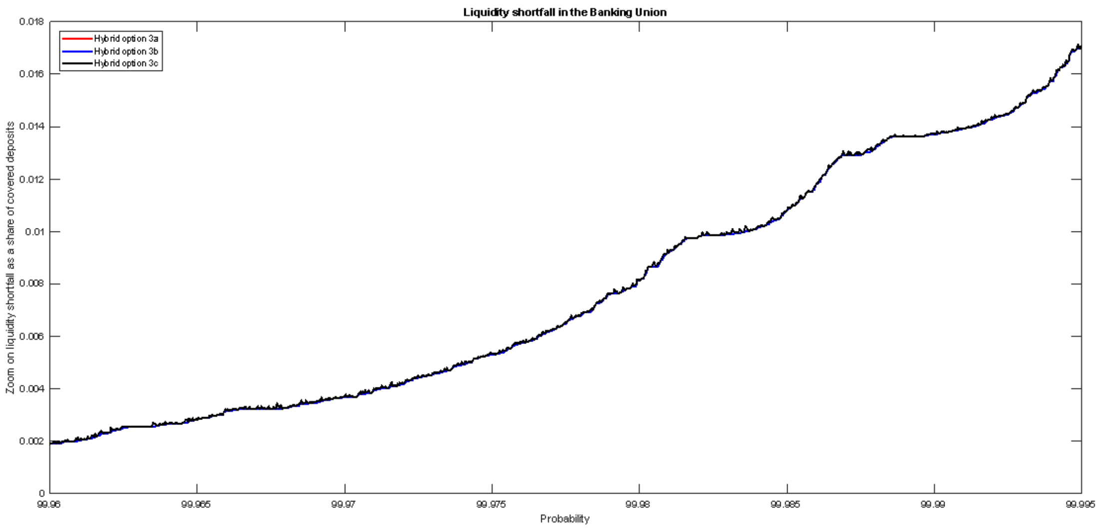


Table 42: Ratio of the area below each scheme's curve over the area of option a's curve. Number of runs with liquidity shortfall conditional on facing a pay-out in at least one of the high ambition hybrid models.

Alternative scheme	**Ratio of the area below the scheme's curve over *option a's***	**Share of runs with liquidity shortfalls conditional on payout in at least one of the large central fund**	**Share of runs with lower liquidity shortfalls wrt to:**		
			Large central fund proposal *option a*	Large central fund proposal *option b*	Large central fund proposal *option c*
Large central fund hybrid proposal *option a*	1	99.4%	-	50%	100%
Large central fund hybrid proposal *option b*	1	99.4%	50%	-	91%
Large central fund hybrid proposal *option c*	1	1	0%	8%	-

Comparison of the large central fund (option a or b) and full liquidity pooling

Figure 18 shows the liquidity shortfalls under a full liquidity pooling and under the large central fund hybrid model *option a*.[71] We observe that the hybrid's curve is always above in all the simulations and that the area below the hybrid curve is slightly larger than the full liquidity pooling (1.05 times larger). It shows the superiority of the fully liquidity pooling. In addition, from Table 43, a fully liquidity pooling also guarantees a reduction in the number of runs with liquidity shortfall after its intervention and the protection of an additional 0.04% of covered deposits.

[71] For a better readability of the figure, we only present the high ambition hybrid model *option a. Option b is very similar to option a and mostly overlaps it.*

Figure 18: Liquidity shortfalls under the fully liquidity pooling and the large central fund hybrid model option a (3a).

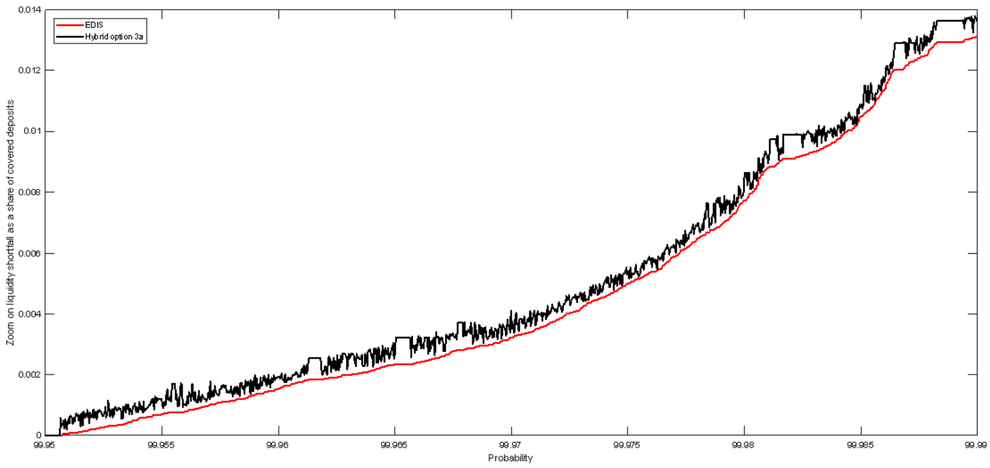


Table 43: Ratio of the area below the large central fund hybrid model *option a* (or *option b*) over EDIS'.

Alternative scheme	**Ratio of the area below the scheme's curve over the full liquidity pooling**	**Share of runs with liquidity shortfalls, conditional on payouts either in full liquidity pooling or large central fund hybrid model *option a* or *option b***	**Additional covered deposits wrt high large central fund hybrid proposal**
Full liquidity pooling	0.95	91.63%	0.042%
Large central fund hybrid proposal *option a*	1	100%	-
Large central fund hybrid *option b*	1	100%	-

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List of abbreviations and definitions

CMDI EU bank crisis management and deposit insurance framework

EDIS European Deposit Insurance Scheme

DGS Deposit Insurance Scheme

SYMBOL Systemic Model of Banking Originated Losses

THB Temporarily High Balance

THDB Temporarily High Deposit Balance

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