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Calibrating capital buffers for other systemically important institutions (O-SIIs) in Germany – Utilising the equal expected impact approach

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Non-technical summary

The Deutsche Bundesbank and BaFin in 2020 jointly refined the existing methodology for the calibration of buffers for other systemically important institutions (O-SIIs). The aim was to move to a more advanced model-based approach. The current implementation of the updated O-SII buffer calibration method is based on the equal expected impact (EEI) approach. This technical paper documents the considerations made as well as some steps taken during the process, and shows the policy decision that was ultimately implemented.

The basic idea of the EEI approach is to ensure sufficient loss-absorbing capacity for O-SIIs. The additional capital surcharge required for O-SIIs aims at internalising the risks these institutions pose to the financial system, and therefore at mitigating the too-big-to-fail problem. Following this objective, the capital surcharge is determined on the basis of a historical loss distribution. More precisely, the additional buffer is calibrated in such a way that the probability of default is reduced to a level that ensures that the expected damage from the default of a large institution is equal to that of a non-systemically important bank. Since the EEI approach provides a framework to calibrate O-SII buffers using economic principles, we regard it favourably compared to the previously applied clustering techniques, which lack a solid theoretical foundation for the size of the capital buffer.

We start by setting out the motivation for amending the existing approach. After that, we present the background to the EEI approach informing the refined calibration method, and explain the economic intuition of the approach. We then proceed to apply it to the German banking system and discuss the choices necessary for its operationalisation. After that, we discuss model-inherent limitations of the EEI approach. Based on these considerations, instead of a mechanistic implementation of the EEI approach, the functional form obtained from the estimated loss function is used as an allocation mechanism to distribute buffers of different sizes across banks with different degrees of systemic importance. Finally, we critically discuss some of the basic assumptions of the EEI approach and lay out issues to be addressed in future calibration approaches for O-SII buffers.

Nichttechnische Zusammenfassung

Deutsche Bundesbank und BaFin haben im Jahr 2020 gemeinsam die Methodik für die Kalibrierung der Puffer für Anderweitig Systemrelevante Institute (A-SRIs) überarbeitet. Das Ziel war dabei, einen ökonomisch besser fundierten Ansatz zu verwenden. Die aktuelle Implementierung der Kalibrierungsmethode für A-SRI-Puffer basiert auf dem „Equal Expected Impact“ (EEI)-Ansatz. Dieses Technische Papier dokumentiert die zugrundeliegenden Überlegungen sowie die praktischen Schritte im Kalibrierungsprozess, und zeigt die schlussendlich implementierte Politikentscheidung.

Die Grundidee des EEI besteht darin, eine ausreichende Verlustabsorptionsfähigkeit für A-SRIs sicherzustellen. Die für die A-SRIs erforderliche zusätzliche Eigenkapitalunterlegung zielt darauf ab, die Risiken dieser Institute für das Finanzsystem zu internalisieren und damit das Too-Big-To-Fail-Problem zu reduzieren. Dieser Zielsetzung folgend wird die Eigenkapitalunterlegung auf Basis einer historischen Verlustverteilung ermittelt. Genauer gesagt ist der zusätzliche Puffer so kalibriert, dass die Ausfallwahrscheinlichkeit auf ein Niveau reduziert wird, das sicherstellt, dass der erwartete Schaden aus dem Ausfall eines großen Instituts dem einer nicht systemrelevanten Bank entspricht. Da der EEI einen Rahmen bietet, um die A-SRI-Puffer auf ökonomisch sinnvolle Weise zu kalibrieren, halten wir ihn für vorteilhaft im Vergleich zu den zuvor angewandten Clustering-Techniken, denen eine solide theoretische Grundlage für die Größe des Kapitalpuffers fehlt.

Wir beginnen damit, die Motivation für die Überarbeitung des existierenden Ansatzes aufzuzeigen. Dann präsentieren wir den Hintergrund des EEI-Ansatzes, so wie er für den überarbeiteten Kalibrierungsansatz herangezogen wurde, und erklären die ökonomische Intuition des Ansatzes. Anschließend wenden wir den EEI-Ansatz für das deutsche Bankensystem an. Hierzu diskutieren wir modellimmanente Einschränkungen des EEI-Ansatzes. Entsprechend wird der dargelegte Ansatz nicht mechanisch implementiert. Vielmehr wird der funktionale Zusammenhang auf Basis einer geschätzten Verlustfunktion als Allokationsmechanismus zur Verteilung von Puffern unterschiedlicher Größe auf Banken mit unterschiedlicher Systemrelevanz herangezogen. Abschließend erfolgt die kritische Diskussion einiger Grundannahmen des EEI-Ansatzes und wir zeigen Ansatzpunkte auf, die bei einer Weiterentwicklung des Kalibrierungsansatzes von A-SRI-Puffern Berücksichtigung finden sollten.

Calibrating capital buffers

for other systemically important institutions (O-SIIs) in Germany

– Utilising the equal expected impact approach

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Abstract
A new approach, derived from the equal expected impact (EEI) approach, was used for the calibration of the buffers for other systemically important institutions (O-SIIs) in Germany in 2020. This technical paper presents a detailed background to the EEI approach as used for the updated calibration. First, we explain the economic intuition and the theoretical background of the EEI approach. We then proceed to implement it for the German banking system and present the result of its operationalisation. Finally, we discuss limitations of the EEI approach and specify issues to be addressed in future calibration approaches for O-SII buffers.

Keywords: O-SII buffer, too-big-to-fail, capital buffer calibration, equal expected impact.
JEL classification: E52, F33, G21

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Introduction

In the wake of the global financial crisis of 2007-09 several regulatory measures addressing the issue of "too big to fail" (TBTF) were put in place in order to lessen moral hazard incentives, to align risk-taking and bank resilience, and thereby to reduce the probability of government interventions and bail-outs.[1] There are negative externalities associated with the distress or failure of any financial intermediary, but these are disproportionately high in the case of large, complex and interconnected banks. These negative externalities include the impairment that a bank's failure would generate, e.g. the disruption to the stability of the financial system and its ability to provide credit and other essential financial services to households and businesses. In the event of the failure of a systemically important bank, not only would the financial sector experience disruptions, but its troubles would also cascade over into the real economy.

The TBTF regulatory reforms aim to internalise these externalities. A core element of these reforms is higher capital buffers. Banks classified as systemically important are required to hold additional capital against their risky assets. Higher capital buffers increase banks' resilience in case of financial distress. Hence, better capitalisation of banks is associated with a lower probability of financial distress and failure.

While global systemically important banks (G-SIBs) are identified and regulated according to international standards set at the G20 level, national supervisory authorities in EU countries are in charge of setting capital surcharges for other systemically important institutions (O-SIIs). The Capital Requirements Directive IV (CRD IV)[2] requires all EU countries to (i) identify O-SIIs and (ii) charge them with additional capital requirements.[3]

Motivation

The *identification* of O-SIIs in Germany (BaFin/Bundesbank 2021) follows the EBA guidelines on criteria to assess other systemically important institutions (EBA 2014) which are based on the BCBS principles for dealing with domestic systemically important banks (BCBS 2012). The EBA Guidelines provide harmonised procedures for all EU countries: for each bank a score is calculated based on size, complexity, interconnectedness and substitutability – attributes that are proxies for the negative externalities generated by a potential failure.[4] Based on these scores a capital add-on, the O-SII buffer, is to be *calibrated*. However, there is no comparable guideline for mapping systemic importance scores to O-SII buffers. Thus, the calibration of O-

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[1] For a comprehensive overview of the different regulatory reforms addressing TBTF, see FSB (2021).

[2] From 2021 onwards, CRD V amends CRD IV which laid down these legal provisions for the first time.

[3] See Article 131 CRD IV.

[4] The scores assigned to the German banks rely on an extended version of the EBA's scoring model; see BaFin / Bundesbank (2020). While this extended version includes all mandatory indicators, a higher granularity applies to some of the sub-categories. Furthermore, some auxiliary indicators are introduced based on Annex 2 of the EBA Guidelines.

SII buffers is left to the discretion of national regulatory authorities. Legal provisions in the EU impose restrictions regarding the size of the buffer up to a certain percentage of a bank's risk-weighted assets (RWAs). Under the amendments of CRD V, the previous cap of 2% for O-SII buffers was lifted in 2020. Buffers can now be set at any rate, although buffers above 3% require approval by the European Commission. Beyond that, the ECB implemented a floor methodology, suggesting a minimum buffer ratio relative to given systemic importance scores within the scope of the ECB's assessment of macroprudential policies in the SSM area (ECB 2017).[5] The floor is meant to achieve higher consistency of O-SII buffers among European countries.

The recent adoption of CRD V and the concomitant lifting of the O-SII buffer limit prompted BaFin and the Bundesbank to refine and advance the method of mapping O-SII scores to O-SII buffers in Germany (see also the current report of the German Financial Stability Committee: AFS 2021). The main element of this methodological overhaul is the consideration of the equal expected impact (EEI) approach for the calibration of buffers. The aim of this paper is to provide the technical details on how the EEI approach has been utilised for setting O-SII buffers in Germany.

Calibration approaches – overview and application in other jurisdictions

Regulators across European jurisdictions rely on different approaches for the calibration of O-SII buffers. A recent survey (EBA 2020) among EU Member States provides an overview of national practices (see Table 1).

Table 1: Calibration approaches across European countries

Primary approaches	**Model-based approaches**		
	Complemented by EEI approach by:	**Complemented by other model-based approaches by:**	
Bucketing approaches Linear: 15 countries Nonlinear: 4 countries **Expert judgement** 3 countries **Other basic approaches** 3 countries	Belgium Croatia Estonia Finland Hungary Ireland Latvia	Austria Bulgaria Cyprus Czech Republic Greece France Lithuania Poland Sweden Slovakia	**Only model-based approach:** 2 countries

Source: authors' compilation based on EBA (2020).

[5] While the ECB floor methodology is not a legal prescription, falling below the floor will trigger discussions as to possible corrective policy actions based on Article 5 SSM-R.

Most countries, including Germany, rely on some kind of bucketing approach. Germany, prior to this methodological update, grouped banks by their systemic importance scores using a clustering algorithm, and assigned buffers per group. Other countries apply some transformation of scores into capital surcharges. Yet a substantial number of countries complement the more basic approaches with model-based approaches. Seven countries reported adopting some form of the equal expected impact approach when setting the O-SII buffer rates.

The equal expected impact (EEI) approach

The EEI approach is a model-based approach for calibrating capital buffer requirements for systemically important banks (ESRB 2017). Alongside other approaches, it has already been used for informing the BCBS when setting G-SIB buffers (BCBS 2011). Yet, so far only few European jurisdictions draw on this approach for the calibration of O-SII buffers (Table 1).

The basic idea of the EEI approach is as follows: the expected loss resulting from the failure of a systemically important bank is lowered to the level of the expected loss of a reference bank. Here, it is important to note that “loss” relates to the notion of “systemic loss given default” (sLGD), which reflects the damage to the financial system in the event of the failure of a systemically important bank. Systemically important banks’ probability of default is reduced by imposing additional loss-absorbing capacities through additional capital buffers corresponding to the banks’ degree of systemic importance. The additional capital buffer is to reduce the expected loss in case of a bank failure to the level of the expected loss that a failure of the reference bank would cause. The reference bank is therefore assessed as just below the threshold for systemic importance. Ultimately, the expected losses should be the same across banks. Thus, this approach is closely linked to the macroprudential goals associated with O-SII buffers, i.e. the internalisation of TBTF-related externalities. Moreover, the approach we present (FED 2015) permits us to derive a functional relationship between a bank’s systemic importance and an additional capital buffer.

The contribution of this paper is twofold. First, it documents how the EEI approach has been utilised for O-SII buffer calibration in Germany and shows which capital buffers for O-SIIs in Germany were implemented by BaFin. Our operationalisation of the EEI approach allows for a better differentiation between smaller and larger O-SIIs than the formerly utilised bucketing approach that distinguishes between four buckets. Second, we discuss the reasons why certain adjustments to the mechanistic application of the EEI approach are justified.

The paper proceeds as follows: Section 2 presents the theoretical background to the EEI approach. In Section 3, we apply the approach to O-SIIs in Germany. In Section 4, we present some reasoning for deviating from the unmodified results of the EEI approach, and present the calibrated German O-SII buffers implemented by BaFin. Section 5 provides some impetus for further research on the EEI approach and its operationalisation for O-SII buffer calibration.

1. Formal set-up of the EEI approach

The equal expected impact (EEI) approach has received considerable attention for the calibration of TBTF-related capital requirements for various reasons (see, e.g., EBA 2020). First, it is based on economic reasoning. Second, it can offer a transparent and easy to implement way to calibrate capital add-ons. Finally, because of its transparency and clarity, it is easy to communicate to market participants and the public. The following description of the EEI approach is based on FED (2015).[6]

The expected impact EI_i of a failure of a bank *i* is equal to the probability of the bank's default PD_i times the harm that a failure of the bank would cause to the respective banking system (i.e. the systemic loss given default, $sLGD_i$):

$$EI_i = PD_i \cdot sLGD_i \, , \tag{1}$$

with $sLGD$ being an abstract notion reflecting the damage to the entire financial system caused by the failure of a systemically important bank. This damage captures a broad set of aspects. For instance, it includes the losses due to the failure of the bank to meet its obligations, and the losses imposed on the real economy through the loss of lending capacity in the event of its failure.

The core idea of the EEI approach is that the expected impact of a failure of any bank *i* that is deemed systemically important should be equal to the expected impact of the failure of a reference institution *R* that is not systemically important, and whose failure could be borne without major disruptions to the respective financial system and the real economy, i.e.

$$EI^R = EI_i \, . \tag{2}$$

Note that this approach as set out here implies risk-neutrality, i.e. indifference between shocks to smaller and larger banks if their expected damage is the same (see Section 5 for a brief discussion of this assumption).

Equation (1) can be combined with Equation (2), yielding

$$PD_i \cdot sLGD_i = PD^R \cdot sLGD^R \, . \tag{3}$$

By definition, the failure of any bank that is deemed systemically important causes more harm than the failure of the reference institution R, therefore $sLGD_i > sLGD^R$. Hence, the probability of default of any systemically important financial institution needs to be lower compared to the reference institution R to equalise the expected impact of a failure $PD_i < PD^R$. Higher

[6] More recently, Jiron et al. (2021) provide an alternative implementation for the EEI approach and apply it to G-SIBs.

capital buffers increase banks' resilience to adverse shocks and therefore reduce their probability of default. The goal of the EEI approach is, thus, to calibrate capital buffers for systemically important banks c_i^{osii} that reduce the *PD*s of these banks to such an extent that the resulting expected impact is equal to the expected impact of the reference bank's failure EI^R.

We follow the example of FED (2015) and estimate the *PD* from the historical distribution of the return on risk-weighted assets (RORWA) across the banking system.[7] We define RORWA of bank *i* in period *t* as

$$x_{i,t} := R_{i,t} / RWA_{i,t-1}, \tag{4}$$

with $R_{i,t}$ being the annual net return of bank *i* in period *t* and $RWA_{i,t-1}$ being the risk-weighted assets of bank *i* in the previous period. We use the RWAs of the previous period since RWAs are a stock variable whereas the annual return is a flow variable. The return is generated on the basis of the previous stock of RWAs and the current return also has an influence on the current RWAs. Using RWAs of period *t* instead of *t-1* could thus confound the RORWA distribution.

We assume that, for the observations with the largest losses (i.e. the bottom tail of the return distribution), the probability that the current RORWA $x_{i,t}$ is below a certain level y is distributed as follows:[8]

$$p(x_{i,t} < y) = \exp\left(a + b \cdot y\right). \tag{5}$$

The parameters *a* and *b* are to be estimated and they jointly determine the assumed distribution. The exponential of parameter *a* represents the overall share of negative observations. The higher the parameter *a,* the higher the share of losses in the distribution of RORWAs. The parameter *b*, in contrast, determines the slope of the density function of the distribution. The smaller the value for *b* (for a given *a*), the higher the losses at a given probability.

Currently, according to the regulatory requirements laid down in CRR and CRD IV, any bank in the EU is obliged to hold the regulatory minimum c^{min} of CET1 and the capital conservation buffer c^{ccb} (currently 4.5%and 2.5%, respectively, of a bank's risk-weighted assets).[9] Against

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[7] Alternatively, PDs could e.g. also be obtained from ratings or CDS. Unfortunately, though, this data is not available for a sufficient number of institutions in the German banking system. Furthermore, the advantage of using historical data is that the resulting PDs are independent of market sentiment and represent realised long-run values.

[8] Like Kuritzkes and Schuermann (2010), we find that the distribution of the risk-adjusted bank returns is far from the normal distribution.

[9] Within the scope of this analysis, we cannot consider bank-specific requirements such as P2R and P2G and the CCyB (not activated at the time of the analysis), as well as bank-specific variation stemming from underlaps of lower tier capital.

this background, in our approach, the *PD* of an individual bank *i* is the probability that a negative return in the current period reduces the capital of a bank $c_{i,t}$ below the minimum regulatory requirements of $c^{min} = 4.5\%$. Consequently, we obtain

$$PD_{i,t} = p\left(c_{i,t-1} + x_{i,t} < c^{min}\right). \tag{6}$$

From Equations (5) and (6), it follows that the PD_i of any bank in a given period can be expressed as

$$\ln(PD_{i,t}) = a + b \cdot \left(c^{min} - c_{i,t-1}\right). \tag{7}$$

For the reference bank *R,* it is assumed that its capitalisation c^R with CET1 exactly equals the minimum regulatory requirements, including the capital conservation buffer: $c^R = c^{min} + c^{ccb}$. Under this assumption, PD^R can be expressed as

$$\ln(PD^R) = a + b \cdot \left(-c^{ccb}\right). \tag{8}$$

In order to calibrate a capital buffer for a systemically important bank c_i^{osii}, we combine Equations (3), (7) and (8), and obtain

$$c_{i,t-1} - c^{min} - c^{ccb} = \frac{1}{b} \cdot \ln\left(\frac{sLGD_i}{sLGD^R}\right). \tag{9}$$

Assuming that any systemically important bank exactly fulfils the regulatory requirements including the O-SII buffer ($c_{i,t-1} = c^{min} + c^{ccb} + c_i^{osii}$), the capital surcharge resulting from the EEI approach can be written as

$$c_i^{osii} = \frac{1}{b} \ln\left(\frac{sLGD_i}{sLGD^R}\right). \tag{10}$$

The term c_i^{osii} in Equation (10) provides us with a bank-specific capital buffer that is calibrated taking into account the harm that the respective bank would cause to its banking system relative to the reference institution $\left(\frac{sLGD_i}{sLGD^R}\right)$, as well as the distribution of historical losses in the banking system measured by the parameter *b*. Note that the capital buffer, in this case, is independent of the level of $c^{\min}$ and c^{ccb}, and also independent of parameter *a*, i.e. the overall share of losses. Since the EEI approach relates the PDs of systemically and non-systemically important banks, parameters like $c^{\min}$, c^{ccb} and *a* are identical for both types of banks and, hence, are irrelevant for the calibration of O-SII buffers.[10] The parameter *b*, by contrast, determines the relative distribution of the losses and is therefore crucial for the calibration of O-SII buffers based on the EEI approach.

The calibrated capital buffer hinges critically on the assumption of the distribution of RORWA; any other assumption of the RORWA distribution (normal distribution, t-distribution, etc.) would produce different results.[11] However, the choice of this distribution is backed by the finding that it captures the empirical features of the actual RORWA distribution well (see Figure 2). However, it has to be pointed out that Jiron et al. (2021) achieved even better approximations to the observed time series in their recent approach, in which they relied on a heavy tail distribution and extreme value theory.

2. Empirical implementation of the EEI approach

To determine O-SII buffers for banks in Germany according to Equation (10), we proceed in three steps: 1) We explain how we approximate the systemic loss given default of banks and choose an appropriate reference institution. 2) We then estimate a loss function based on historical RORWA data. 3) Finally, with O-SII scores, a reference bank and the estimated parameters provided, we derive an equation for the calculation of O-SII surcharges. In doing so, we broadly follow Ludwig et al. (2018).

2.1 Approximation of the sLGD and choice of reference institution

Approximation of the sLGD

The systemic loss given default $sLGD$ of a bank represents the harm that a possible failure would cause to the respective banking system. The O-SII score, obtained from the annual O-SII assessment, can be considered an adequate measure for the impact of a bank's failure, as the outcome of the assessment should reflect the potential impact of, or externality imposed by, a bank's failure (Principle 2, BCBS 2012). It should be noted that the O-SII score is a relative measure of systemic importance, i.e. it reflects the relative share of a certain bank in the entire German banking system (in basis points, bps) and not the absolute costs that arise if this bank fails. However, this is sufficient for the implementation of the EEI approach, since only the ratio of $sLGD$ values is required.

[10] The same would be true for other macro buffers, such as the CCyB, that are not included in our model.

[11] Passmore and von Hafften (2017), for instance, calibrate capital buffers to address TBTF-related risks relying on a Gumbel distribution.

Hence, the ratio of the $sLGD$ values in Equation (10) corresponds to the ratio of an individual bank's O-SII score and the O-SII score of the reference bank:

$$\frac{sLGD_i}{sLGD^R} = \frac{score_i}{score^R}. \tag{11}$$

Equation (11) implicitly assumes a proportional relationship between $sLGD$ values and O-SII scores. However, the ratio of the $sLGD$ values (and scores) in Equation (11) could also correspond to any monotonically increasing function, for instance:

$$\frac{sLGD_i}{sLGD^R} = \left(\frac{score_i}{score^R}\right)^n \tag{12}$$

Note that this function is linear for $n = 1$, and monotonically increasing for any $n > 0$. It is concave for $0 < n < 1$, and convex for $n > 1$.

Inserting this function into Equation (10) results in the following Equation for the O-SII buffer:

$$c_i^{osii} = \frac{n}{b} \ln\left(\frac{score_i}{score^R}\right). \tag{13}$$

Equation (13) shows that optimal O-SII buffers are strongly dependent on the choice of parameter *n* in this method. For $n > 1$ the resulting buffers are larger compared to a scenario that implicitly assumes $n = 1$. For $n < 1$ they are smaller.

As it is unclear how to choose an appropriate value for *n*, practical work has so far used the specification with $n = 1$, and we do so when applying the approach to the German banking system. However, it is not clear whether this is an appropriate assumption (see the discussion in FED 2015). Setting $n > 1$ means that the $sLGD$ of a systemically important bank rises more than proportionally with the score for systemic relevance. This assumption could be justified if, for example, the harm caused by fire sale liquidation of assets grows at an increasing rate with the size and complexity of banks, i.e. with the O-SII score.[12]

Choice of the reference bank

To compute O-SII buffers according to Equation (10), we need to choose a reference bank *R* that marks the threshold to systemic relevance in the banking system. However, we do not need to name a specific bank, we only need to know the systemic loss given default, i.e. the O-SII score, of a hypothetical reference bank at this threshold. The EBA Guidelines recommend a threshold of 350 for the annual O-SII identification exercise. However, national authorities can adjust this threshold to account for characteristics of their national banking system.

[12] See Jiron et al. (2021) for an approach where $sLGD$ increases exponentially as a bank's score rises.

As the German banking system is large and highly fragmented, the Bundesbank and BaFin consider a lower threshold of 100 appropriate for the identification of O-SIIs in Germany. To be consistent with that, the same threshold is chosen for the implementation of the EEI approach, meaning $sLGD^R = score^R = 100$. The definition of a reference bank is an important part of the O-SII identification and influences the level of O-SII buffers significantly. Choosing a reference bank at a higher threshold, e.g. 350 bps as in the EBA Guidelines, would yield different buffers, and would result in buffers of 0% for banks below this threshold.

2.2 Estimating the loss function

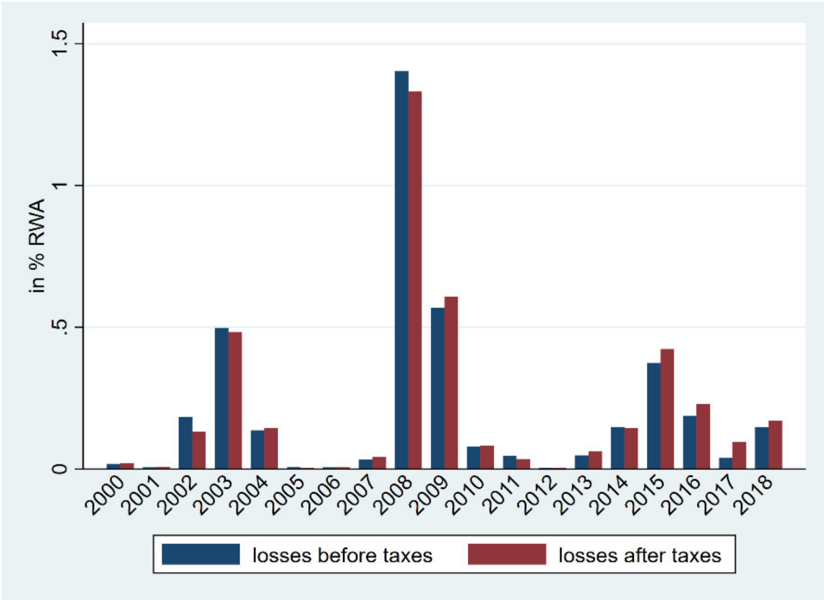
We continue by estimating the loss function from the distribution of historical RORWA data. The implicit assumption underlying this estimation is that bank returns in the (near) future will follow the same distribution as in the past. We compiled annual returns and RWA data for a sample of German banks for the years 2000 to 2018. This period covers different stages of the last credit cycle. In addition, a longer time series minimises the effect of outliers in the data. The sample is constructed from supervisory data on solvency and financial reporting (COREP/FINREP, national reports on bank-individual and consolidated data).

We limit our analysis to 40 larger banks in Germany, including all O-SIIs.[13] Smaller banks were not considered as their business models differ too much from those of the O-SIIs and their loss data might not be comparable. For the earnings data, time series for earnings after taxes are created at an individual and consolidated level.[14] After-tax income is used because the aim is to show the losses that the institution's equity must absorb. This also includes tax obligations that have a very high seniority. In addition, tax refunds in case of losses can mitigate the reduction of capital ratios. Therefore, income after tax is preferable from a conceptual point of view. Furthermore, the differences between losses before tax and after tax in the dataset are negligible (Figure 1).

[13] The banks in the sample were selected based on their O-SII score in the yearly O-SII assessments from 2016-19. All banks with a score of 20 basis points or higher were included. If one of these banks acquired another bank or merged with it, this bank is also included in the sample.

[14] Changes in the stock of the fund for general banking risks were regarded as appropriation of profits and therefore not included in income.

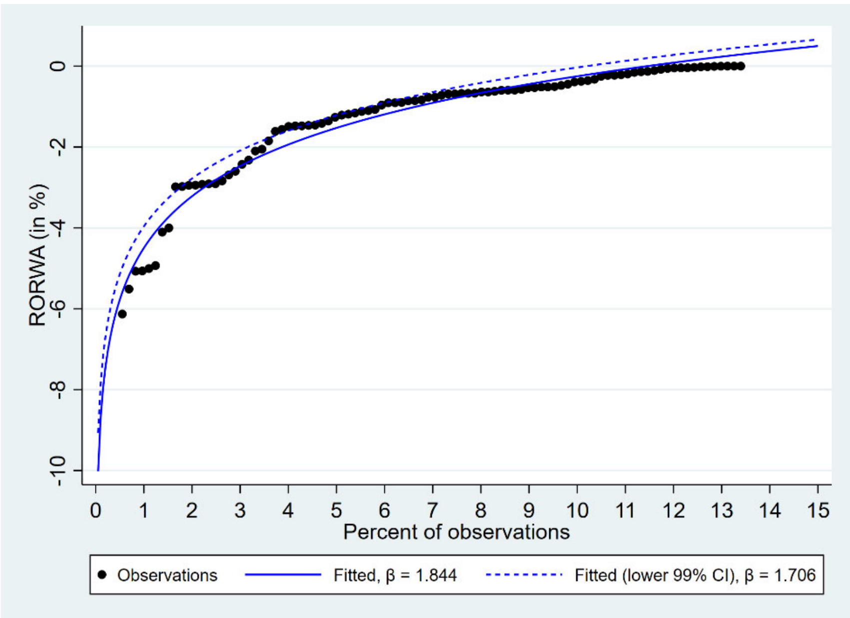
Figure 1: Aggregate losses as a percentage of total RWAs of banks in the dataset



Source: Bundesbank.

Using these RORWA time series, the loss distribution for the sample is estimated in the next step (Figure 2). Only the percentiles with a negative RORWA are included in the analysis.

Figure 2: Loss distribution



Source: Bundesbank.

Equation (5) assumes a logarithmic relationship between the probability of losses and the severity of the losses. This assumption matches the German RORWA data well (see Figure 2), and further mimics the approach of FED (2015). For the estimation of parameters, we can rewrite Equation (5) as:

$$y = -\frac{a}{b} + \frac{1}{b}\ln\left(p(x_{i,t} < y)\right) = \alpha + \beta \cdot \ln\left(p(x_{i,t} < y)\right) \qquad \text{(14)}$$

where $\alpha = -\frac{a}{b}$ and $\beta = \frac{1}{b}$. Equation (14) can be estimated with the German RORWA data and yields $\alpha = -4.50$ (t = -70.45) and $\beta = 1.84$ (t =54.39).

Parameter α shifts the distribution function up and down and in this way determines how many percentiles of the distribution represent losses. Parameter β, on the other hand, determines the slope of the distribution function, i.e. the distribution of the losses across all percentiles considered.

As to estimating the coefficients of the loss distribution, some statistical uncertainty remains. This uncertainty in regression analysis is due to the limited number of observations (especially in the case of extreme losses) and idiosyncratic errors (e.g. measurement errors). Figure 2 shows the lower limit of the 99% confidence interval.

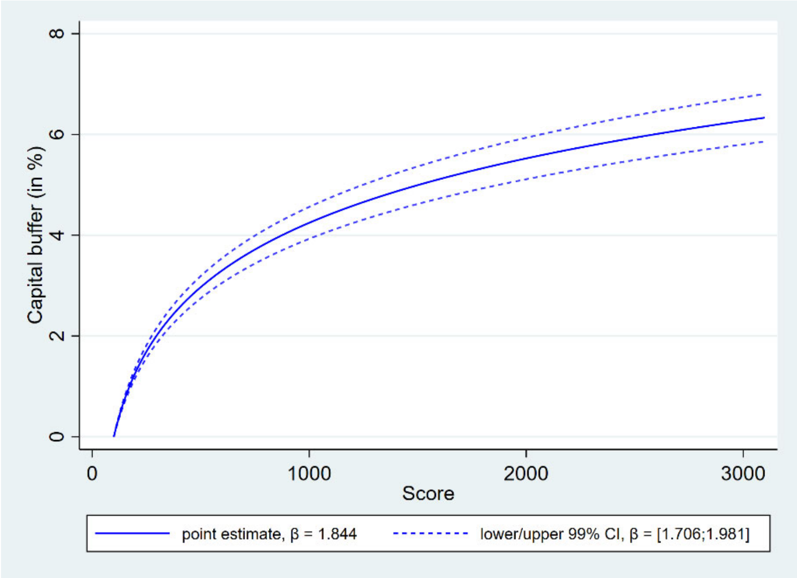
2.3 Calibration of capital surcharges

Based on the RORWA data, the value of 1.84 is obtained for β. The additional capital buffers for O-SIIs in Germany resulting from the EEI approach can therefore be calculated with the following equation:

$$c_i^{osii} = \frac{1}{b}\ln\left(\frac{score_i}{score^R}\right) = \beta \cdot \ln\left(\frac{score_i}{score^R}\right) = 1.84 \cdot \ln\left(\frac{score_i}{100}\right) \qquad (15)$$

Figure 3 shows the buffer function, i.e. the relationship between the systemic importance score and the related O-SII buffer, as well as the 99% confidence interval. The higher the estimated β, the more the additional capital requirement increases with the systemic importance of an O-SII.

Figure 3: Buffer function (%)



Source: Bundesbank.

3. Considerations related to policy implementation

When O-SII buffers were first introduced in Germany in 2016, their calibration was based on a clustering technique applied to O-SII scores in combination with a bucketing approach to relate score clusters to capital buffers. Against the background of the regulatory changes regarding O-SII buffers under CRD V, as well as the fact that more and more countries are also relying on more sophisticated model-based approaches (EBA 2020), BaFin and the Bundesbank decided to refine the calibration methodology for German O-SII buffers. The aim was to switch to a method with a sounder economic rationale. The path chosen was to further develop the calibration approach by switching to the EEI approach in combination with some form of bucketing.

3.1 Advantages and limitations of the EEI approach

The application of the EEI approach aims at overcoming some limitations of the previous approach. First, the EEI approach goes beyond a purely statistical approach (such as clustering) as it considers our understanding of systemic risk arising from a potential failure of a large institution in the banking system. Therefore, the EEI approach is seen as not only better founded by economic theory but also as more intuitive. Furthermore, it allows for better differentiation between larger and smaller systemically important banks as the buffer rates are continuously defined along the EEI function. In combination with a bucketing approach, it also allows for empty buckets, which was not possible with the previous clustering approach. This sets better incentives for banks to reduce their systemic importance, as it is clear to them when they will move into a lower (or higher) bucket. Beyond that, the EEI approach allows for consideration of possibly increasing marginal damage from systemic importance (by varying parameter n in Equation (13)).

For the calibration of the national O-SII buffers, it is worth considering some additional issues and side-constraints. Some simplifying model features inherent to the EEI approach provide grounds for deviating from a mechanistic application of the approach.

First, banks have improved their capitalisation substantially over the past decade. Changes in the regulatory requirements contributed to a significant increase in both the quality and the quantity of bank capital. The introduction of a wider set of microprudential and macroprudential capital requirements certainly also played a part in this development.[15] By definition, higher capitalisation improves the resilience of banks and the banking system to adverse developments and shocks. Therefore, the improved regulatory standards already help mitigate the adverse consequences that a potential failure of a large bank would have for the financial system and the real economy. Consequently, O-SII buffers calibrated based on loss data including from periods prior to the introduction of the new regulatory standards may be overestimated. Beyond that, the recently implemented recovery and resolution regimes may well reduce incentives for growing in size and for excessive risk-taking.

As a further issue, uncertainty related to the loss distribution, especially as to its lower tail, bears a significant risk of estimating incorrect coefficients for the EEI approach. Many of the observed losses feeding into the distribution are related to the global financial crisis of 2008-09, certainly an exceptional shock. In addition, only few observations inform the shape of the distribution at the lower end as extreme losses occur less frequently. Therefore, the *true* distribution could be different from the one obtained. However, a more precise capturing of the losses is not feasible.

Beyond that, and as in every model, the EEI approach suffers from model uncertainty. There is no certainty that the simplifying assumptions made are adequate. Accordingly, further uncertainty due to possible imperfections in model formulation exists. The last two points imply that the EEI approach may well work for a certain banking system, but it does not necessarily have to for every banking system. This is because the EEI approach does not necessarily provide the ideal fit of systemic importance and resilience. The calibration of buffers is based on the distribution of historical losses, and this distribution of losses is substantially determined by extreme values in any direction, which could lead to excessively high or low capital buffers. Finally, by construction, the EEI approach is not well-suited to capturing more complicated

[15] Related to this, it may also need to be considered that the O-SII-buffer does not operate as a stand-alone buffer. Rather, it is part of a complex hierarchy of macroprudential and microprudential buffers.

structural features of a banking system, such as heterogeneity, concentration, or the overall capitalisation of the banking system.

In addition to these limitations inherent to the EEI approach, time consistency should be considered in the calibration decision. Given that there is no major change in the risks or externalities addressed, some continuity in buffer sizes in the aggregate of O-SIIs seems to be a desirable objective in order to ensure a credible supervisory policy. This is to avoid sudden, unexpected and large shifts in the level of banks' capital requirements. Consequently, the outcome of the new calibration was expected to move within a certain range around the former buffer levels assigned to the German O-SIIs.

Altogether, the model-inherent limitations of the EEI approach in conjunction with the policy consideration provide a rationale for a modification of the estimated β based on expert judgement, as outlined in the next section.

3.2 Parameter beta

The EEI approach provides a functional relationship between the score capturing a bank's systemic importance and the size of an additional capital buffer, with parameter β determining the slope of the relationship (see Equation 15). In the following, we show a conceptual formalisation of how varying the parameter β affects the resulting O-SII buffers and thereby the loss-absorbing capacity. Varying β can be justified, for instance, based on expert judgement and in order to consider the above-described limitations.

Recall that the quantile function related to the loss distribution is defined as $y=\beta\cdot\ln(x)+\alpha$ (see Equation (14)), and that the estimated β informs the calibration of O-SII buffers. Hence, the size of O-SII buffers is formally linked to the probability of absorbing certain losses, in our case measured by negative RORWA (see Equation (15)).

In Equation (16) below, we replace the estimated β with β'. Remember that the loss distribution function is also determined by the constant α, which we replace with α' in Equation (16):

$$y'=\beta'\cdot\ln(x)+\alpha'. \tag{16}$$

While there is some degree of freedom in determining α', it is reasonable to assume the intercept of the x-axis (determined by the variable a in Equation (5)) to be the same as before. This assumption implies that the share of observations where banks experience losses (i.e. negative RORWA) is the same in Equations (15) and (16), respectively.

A simple calculation shows that α’ needs to satisfy

$$\alpha' = \frac{\beta'}{\beta} \cdot \alpha. \tag{17}$$

Consequently, Equation (16) can be rewritten as

$$y' = \beta' \cdot \ln(x) + \frac{\beta'}{\beta}\alpha. \tag{18}$$

Equation (18) is evidently a simple multiple of Equation (16), with the factor $\frac{\beta'}{\beta}$. As a result, the size of an O-SII buffer changes proportionally with the factor β. Beyond that, it can be concluded from (18) that the O-SII buffer corresponding to β’ captures the fraction $\frac{\beta'}{\beta}$ of the losses of the original capital buffer.

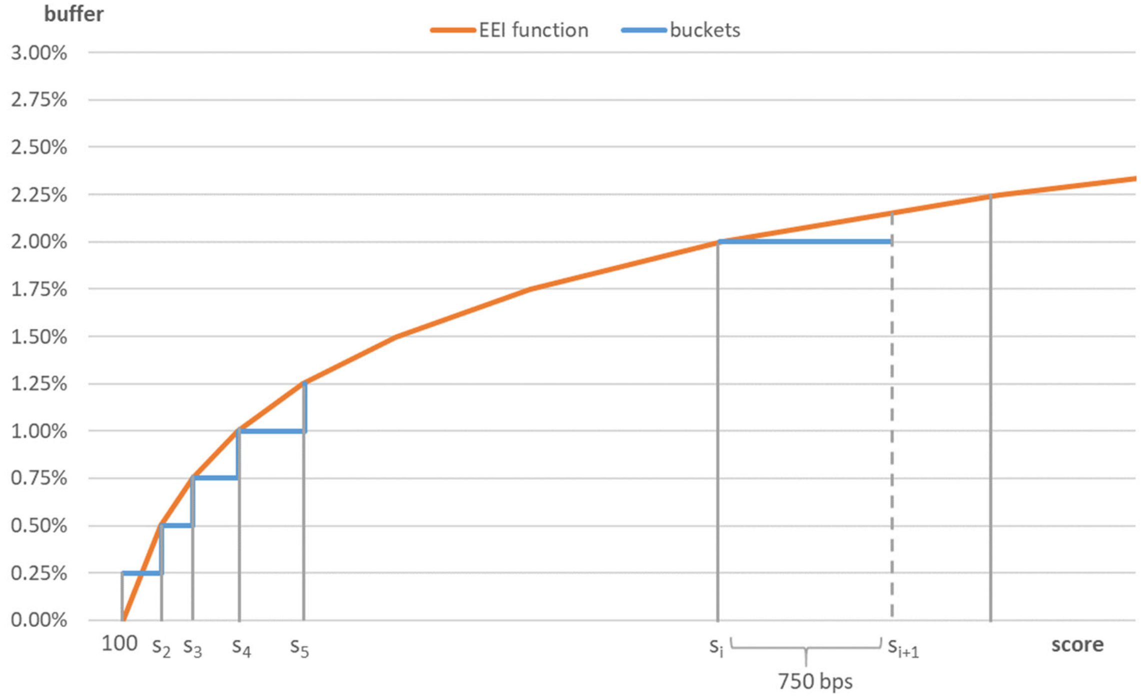
Overall, this section shows that the size of O-SII buffers and thereby the loss-absorbing capacity changes to the same degree as the change in the parameter β. These considerations need to be taken into account when expert judgement, reflecting considerations laid out in the previous section, is exerted.

3.3 O-SII buffers in the German banking system in 2021

To facilitate banks’ capital planning, capital buffer buckets are defined along the continuous EEI function. Capital buffer buckets are ranges across scores where the capital buffer is constant (*discretisation*), and provide for a more predictable allocation of capital buffers. These buckets increase in steps of 0.25 pp, starting from 0.25% and going up to 3.00%. Steps of 0.25% allow for a differentiated allocation of capital buffers to systemic importance of banks, and thereby provide incentives for reducing systemic importance.

The threshold value s_1 as the lower limit of the first capital buffer bucket of 0.25% is set to a score value of 100 basis points. The threshold values s_i of the other buckets result from rearranging the EEI function, inserting capital buffers and β, and solving for the score value. For all scores in the range between two threshold values s_i and s_{i+1} the same additional capital buffer applies (see Figure 5). All ranges are limited to a maximum width of 750 bps. Particularly for banks with higher scores, this limitation provides an incentive to reduce their systemic importance.

Figure 5: EEI function and capital buffer buckets



Source: Bundesbank.

It should be noted that the curve in Figure 5 is not equal to the curve depicted in Figure 3. This is because the practical implementation of the EEI approach for O-SIIs in Germany is to be understood as an allocation mechanism. The buffer requirements assigned to the different O-SIIs do not reflect the estimated EEI function in absolute terms. Rather, they represent a pro rata assignment.

Based on the EEI approach and the above considerations (see Section 4.1) BaFin, as the competent authority, chose the following calibration of O-SII buffers for 2021:

Table 1: O-SII buffers in Germany in 2021

O-SIIs	Score (bps)	O-SII buffer (%)
Deutsche Bank AG	2,418	2.00
Commerzbank AG	763	1.25
DZ Bank AG	499	1.00
UniCredit Bank AG	475	1.00
Landesbank Baden-Württemberg	360	0.75
Landesbank Hessen-Thüringen Girozentrale	309	0.75
Bayerische Landesbank	281	0.50
ING-DiBa AG	175	0.25
J.P. Morgan AG	168	0.25
Norddeutsche Landesbank - Girozentrale -	158	0.25
NRW.Bank	147	0.25
DekaBank Deutsche Girozentrale	133	0.25
Landwirtschaftliche Rentenbank	103	0.25

Source: BaFin.

The chosen calibration of the approach induced a reduction in O-SII buffer requirements at the aggregate level. Aggregate O-SII buffer requirements declined from the previous level of €14.7 billion by about €1.7 billion, which corresponds to roughly 1.5% of total core capital requirements for O-SIIs in Germany. Due to this reduction, capital requirements in Germany are now more aligned with the, on average, lower levels of requirements in other SSM countries, but still remain higher than them (AFS 2021).

4. Summary and outlook

The Deutsche Bundesbank and BaFin jointly decided in 2020 to complement the existing methodological practice for O-SII buffer calibration with the EEI approach. While the implementation for German O-SIIs for the years 2020 and 2021 generally followed the framework of the EEI approach, an exception was made with respect to the absolute size of the buffers. Instead of using the estimated parameter values of the EEI function as determined in Section 3.3, the obtained functional form is used as an allocation mechanism to distribute buffers of different size across banks with different degrees of systemic importance.

Future improvements to the EEI approach should address more fundamental issues such as the following:

(1) The product of PD and systemic LGD is the essential reference quantity for the EEI approach. By definition, equal importance is assigned to both parameters. However, it is the high loss of a highly systemic O-SII, even when materialising with low probability, which is likely to

lead to a financial crisis and high societal costs. This contrasts with the case of an O-SII with a much smaller systemic footprint which is less likely to cause a financial crisis even if the expected loss is the same. It is the likelihood of adverse developments resulting, e.g., from systemically important institutions that gave rise to the creation of macroprudential policy as a separate policy area after the global financial crisis of 2008-09. The creation of this policy area is probably a reflection of a certain degree of risk-adverse preferences of societies. Therefore, the EEI-implied functional relationship between PD and sLGD, which is derived by assuming risk-neutrality, should be considered against this background.

(2) The O-SII scores only represent an imperfect proxy for the sLGD. Since the score measures systemic importance on a stylised basis, it cannot quantify the monetary damage a default of an O-SII incurs for the financial system. In order to determine a more realistic proxy for the systemic impact of a default of an O-SII, supplementary simulations could be run imposing a range of shocks on the banks in the system, thereby assessing the subsequent system-wide losses.

(3) The consequences of a breach of regulatory capital requirements by an O-SII depend on the institution's overall level of capitalisation and not only the buffer in excess of the regulatory minimum. Even if the buffer of a systemically important institution is exhausted, and serious supervisory responses are triggered by the breach of the minimum required level of capital, the consequences to the financial system clearly depend on the overall level of the remaining capitalisation. This is because higher capitalisation at the system level ensures that claims of creditors can be better served, second-round effects will be reduced and thus government support becomes less likely.

If an implementation of the EEI approach were to comply with the requirements of (1), (2) and (3), it would fundamentally alter the shape of the EEI curve and is likely to contribute to a reallocation of regulatory capital requirements from smaller towards bigger systemically important institutions. Furthermore, the complexity of the calibration approach would increase as additional features of the banking system, such as the overall level of capitalisation, would have to be taken into consideration.

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