FINANCIAL STABILITY BOARD

Evaluation of the effects of too-big-to-fail reforms

Technical Appendix

28 June 2020

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Background

In the aftermath of the 2007-08 financial crisis, the G20 launched a comprehensive programme of financial reforms intended to increase the resilience of the global financial system while preserving its open and integrated structure. With the reforms agreed and implementation under way, it is becoming possible to analyse the effects of these reforms. In 2017, the FSB, in collaboration with the standard-setting bodies (SSBs), developed a framework for the evaluation of the effects of the reforms. It has subsequently carried out a series of evaluations using this framework:

(i) Incentives to centrally clear over-the-counter (OTC) derivatives (2018);

(ii) Evaluation of the effects of financial regulatory reforms on infrastructure finance (2018); and

(iii) Evaluation of the effects of financial regulatory reforms on small and medium-sized enterprise (SME) financing (2019).

In May 2019 the FSB launched an evaluation of too-big-to-fail (TBTF) reforms. This evaluation examines the extent to which TBTF reforms are achieving their objectives and aims to identify any material unintended consequences whether positive or negative.

A working group drawn from FSB member institutions, including SSBs and international organisations, has conducted the evaluation. It has been chaired by Claudia M. Buch, Vice-President of the Deutsche Bundesbank, supported by FSB Secretariat staff and research assistants from the Bank for International Settlements. The FSB engaged six academic experts to provide feedback on the methodological approaches, empirical analysis and interpretation of results. The working group analysed information from a variety of sources, including:

- Responses to a call for public feedback issued in May 2019;
- Responses to a questionnaire of FSB member jurisdictions;
- Feedback from a stakeholder workshop in September 2019;
- Interviews with market participants;
- A review of the relevant literature; and
- New evidence on the effects of reforms using analytical work and data procured from commercial data providers, FSB member authorities and other sources.

This Technical Appendix complements the evaluation consultation report by providing a detailed description of the analytical approaches, data sources and results of the empirical analysis.

The working group organised the work along different streams, each staffed by a subset of working group members. For some parts of the analysis the work has been carried out at the Bank for International Settlements (BIS), where the proprietary data needed to perform them was stored in order to fulfil confidentiality requirements. For other parts of the analysis, working group members and their colleagues carried out their work in their own organisations.

In all cases the work has been subject to extensive quality controls. The work performed at the BIS has been reviewed by other members of the working group while on site at the BIS, as well as staff from the FSB Secretariat. The work performed in members' organisations has been subject to the internal governance processes of each organisation.

Generally the quality controls included checking the dataset used in the analysis, the code written to produce results and the interpretation of such results. In most cases more than one person worked on each piece of analysis, and other people checked the code used to obtain results, and replicated the outputs generated. Data sources have been cross-checked with experts in each jurisdiction for consistency and accuracy.

The rest of the Appendix follows the same order as the consultation report. It initially describes the work performed on the feasibility of reforms, with a detailed description of the resolution reform index (RRI). It then reports the analysis on the market's perceptions of the credibility of reforms, before turning to the way in which banks responded to them and to the analysis of their broader effects. Before discussing the analysis in depth we begin with a short introduction to the general approach adopted and data used.

1. Introduction to the empirical approaches

This technical appendix contains more details on the work presented in the consultation report. It covers:

- the feasibility of resolution – which covers the RRI and loss-absorbing capacity;
- the market's perceptions of the credibility of reforms – which includes several studies on the funding cost advantage for SIBS on various financial instruments;
- banks' responses to reforms – which covers the evolution of banks' balance sheets, and credit allocation;
- evidence on the broader effects of reforms – which include studies on the evolution of the global banking network, structural changes and changes in systemic risk measures.

1.1. Data

A huge amount of empirical work has been carried out in the making of the consultation report. The empirical analysis in this technical appendix uses a number of different datasets. Some are used in a number of studies, and so here we give a brief overview.

Market price data such as credit default swaps (CDS) and bank equity typically come from Bloomberg or Thompson Reuters Datastream. Both are proprietary datasets, which contain high-frequency data (most of the studies use daily data but intra-day is available) on a wide range of financial market prices; volumes traded; bid-ask spreads; market capitalisation etc. The databases also contain data on industry classification (e.g. for distinguishing banks from non-banks); and meta data on the security so that, for example, it is possible to distinguish between holding companies and operating companies. Coverage varies by jurisdiction, with over 50 years of history for key developed markets. Index data also exists for over 68 countries. It is particularly useful for most of the studies on credibility of the reforms, which use market price data to draw inferences based on the difference between various financial instrument prices.

The main data set for the evaluation's analysis is obtained from SNL Financial, provided by S&P Market Intelligence (S&P MI). It contains detailed financial information on over 25,000 banks worldwide (although with a slight bias towards US banks). It contains data on balance sheets; income statements; merger and acquisitions and credit ratings at annual frequency. It covers over 20 years of banking data and is updated daily. It is generally at the consolidated bank level, with the exception of foreign subsidiaries.

Many of the banks in the S&P dataset are small. To arrive at a consistent data set that includes SIBs and non-SIBs for all countries under consideration, the evaluation has excluded banks with total assets of less than €10 billion, with the exception of Argentina and Singapore for which smaller banks were included in order to have both SIBs and non-SIBs in the sample.

1.2. Empirical methods

An issue common to all the methodologies is defining the set of banks against which to compare systemically important banks (SIBs). The application of the TBTF reforms was not a natural experiment, nor applied randomly or quickly. The reforms arose because some banks were more systemically important than others, and were phased in owing to the implementation cost. Another identification problem is that the reforms were not only applied to global systemically important banks (G-SIBs). For example, some G-SIB reforms, such as increased capital requirements, may also have applied to domestic systemically important banks (D-SIBs) or other large domestic banks. This means it is not always possible to find a clean identification of the effects of the reforms. There is often a trade-off between external - the extent to which results from a study can be applied to other situations or events - and internal validity – the degree of confidence that the relationship being tested is not influenced by other factors. In other words, lack of a clear identification limits the ability to draw general conclusions. In some cases, the evidence may not permit inferences to be drawn beyond observing correlations, without identifying causation. But this does not mean it should be considered as bad evidence: when it is not possible to easily identify or think of an alternative explanation - high correlations between two variables should be considered to be indicative evidence.

The first empirical method commonly used in the analysis is **difference in differences** (DiD). This methodology involves comparing some variable of interest across two groups. (For example, this might be total assets, or profits.) The first group has been affected (or “treated”) by the action whose effects we want to observe, such as a TBTF reform (marked in green on the diagram below). The other has not. For the example, in the diagram below, SIBs are considered “treated” and other banks are the “control” or “untreated” banks. If the two groups are reasonably similar and evolving in a similar way before the treatment, then the differences in outcomes can be considered to be attributable to the treatment.

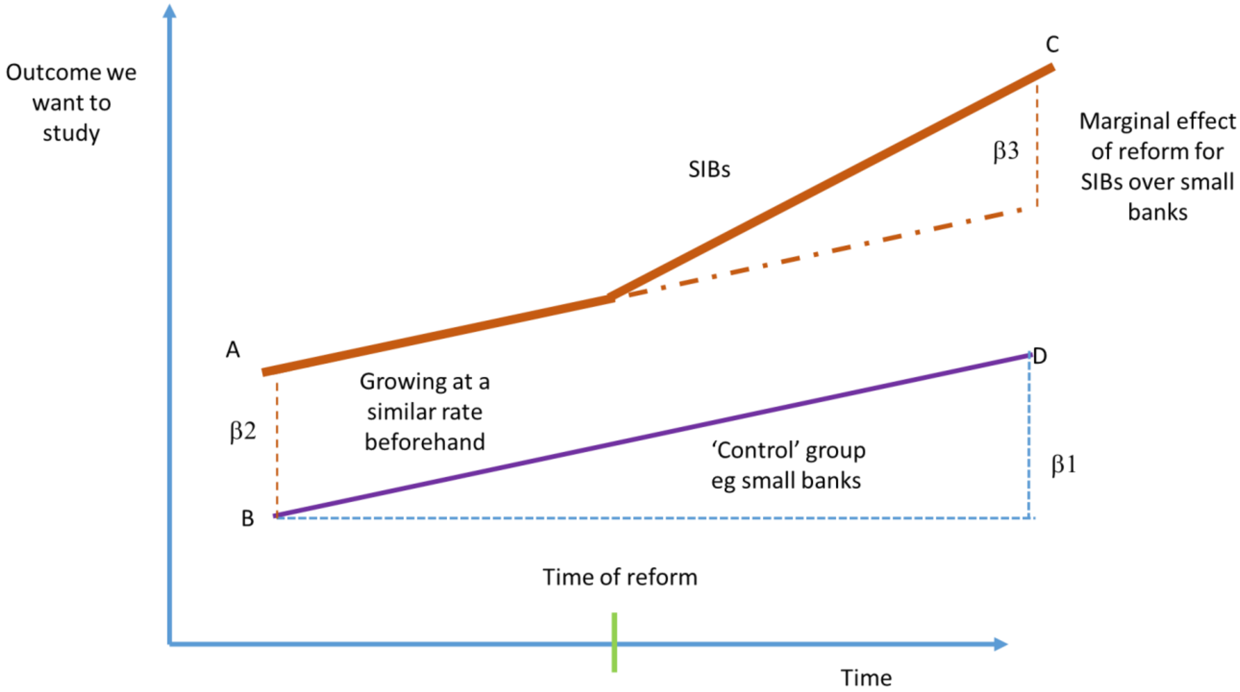
In some cases, it is simpler to identify effects because the sets we are trying to compare are identical in all ways apart from one. But this is clearly not the case with G-SIBs: indeed, they have been assigned this status precisely because they are different from other banks. For example, simply comparing the funding cost of G-SIBs and other banks does not account for other differences between them, such as the different business activities SIBs undertake, or the fact that G-SIBs may have higher leverage.

However, this problem is not insurmountable, and DiD is useful when randomisation is not possible. Using DiD removes biases in the period after treatment which could have been the result of permanent differences between the treated and untreated groups (i.e. G-SIBs and non-G-SIBs) as well as biases that arise from anything which is the result of an unrelated trend occurring in both groups. If the trend in the outcome variable between the treated and non treated banks is similar before the time of the event (see the parallel lines in the diagram below) then the methodology is still valid. In the example of the diagram below: if G-SIBs and small banks were growing at a similar rate before the reform then the study we want to do would still be valid.

The regression model is normally implemented as an interaction term between time and the treatment group variables in a regression such as:

$$Y = \beta_0 + \beta_1 time + \beta_2 intervention + \beta_3 time * intervention + \beta_4 other\ controls + \epsilon$$

These coefficients are represented in the diagram below. Point B(β_0) can be interpreted as the baseline average, D-B (β_1) is the time trend in the control group, A-B(β_2) is the difference in the two groups before intervention, and (C-A)-(D-B) β_3 is the difference in changes over time or the marginal effect of the treatment or intervention. This is the coefficient of interest.



A point to bear in mind is that a DiD methodology, captures the marginal effect of the reform (the difference between the dashed orange line and the solid orange line in the diagram), rather than the overall effect. For example we may be able to observe how a particular reform affected one set of banks more than another, but some aspects of the reform may affect both sets of banks. We cannot capture this just by using DiD and, if we just rely on it the total effect of the reform may be underestimated.

The second common approach is **event studies**. Event studies attempt to measure the effect of an event or "news", usually by using market prices. Usually studies estimate the relationship between two variables then see how that relationship changes around the time of the event. For example, Schäfer et al (2017) observe how the relationship between bank equity prices and the main equity index responds to news relating to bank reforms or failures. There are a number of crucial assumptions and considerations:

- The event: the event should be unexpected, otherwise the information content is likely to be zero. Insignificant results do not mean the reforms had no effect; an alternative inference is that they were expected and information had been priced in.

- Horizon and frequency: the event window needs to be long enough so that information can be priced in by investors, but short enough that there are no other major events. The more illiquid the market the harder this is to achieve.

2. Feasibility of resolution

2.1. The resolution reform index (RRI)

The evaluation developed an index to measure progress in resolution reforms. It has been used in a number of the technical studies described in the rest of this Appendix to look at the correlation between outcome variables of interest and the extent to which resolution reforms have been implemented in different jurisdictions. This section describes the purpose and construction of the index and presents its evolution across time.

2.1.1. Purpose of index

The RRI illustrates the progress of FSB jurisdictions in adopting comprehensive bank resolution reforms since the global financial crisis. It captures a mixture of legislative, regulatory, and policy guidance reforms. Given the dynamic nature of these reforms and the fact that international policy is still being developed, the index is not static and will be updated as new items are included and policies are issued.

The RRI is not intended to assess jurisdictions' compliance with international standards; indeed, some of its components go beyond the scope of those standards. The index is also not a benchmark of the resolvability of individual SIBs in each jurisdiction, nor does it reflect authorities' considerations in deciding whether and how to use different resolution tools.

Within the context of the evaluation, the index has been used in two ways:

1. As a descriptive statistic to show implementation progress of resolution reforms over time (2010-19) and across FSB jurisdictions.
2. As a variable in regression analyses carried out by the evaluation group, to help provide insights on the credibility and effects of the resolution reforms implemented.

2.1.2. Design principles

Four principles were used to determine the items to include in the index:

3. Items should capture **progress across the main areas of resolution reform** introduced since the global financial crisis. This includes, but is not limited to, steps by authorities to implement the FSB Key Attributes for Effective Resolution Regimes (Key Attributes), related implementation guidance, and additional requirements for G-SIBs (e.g. TLAC).
4. Items should provide unique information, in order to facilitate the analysis of relative progress between jurisdictions and identify the effects of resolution reform. This involves selecting items that tend to have **more variability** and **lower correlation** across jurisdictions and over time.

5. Items should be based on **consistent and accurate** data.
6. The relative weight of different items within the RRI should reflect **expert judgment**. All weighting systems involve implicit assumptions about relative importance, so this index reflects what resolution authorities consider to be important elements of an effective and credible resolution regime.

2.1.3. RRI design

The RRI comprises three sub-indices**:**

1. The first sub-index covers resolution powers and recovery and resolution planning.
2. The second sub-index covers the development of policies and guidance to operationalise resolution regimes (as opposed to the legal framework).
3. The third sub-index covers loss allocation, and includes bail-in powers and the existence of external loss absorbing capacity (LAC) requirements for SIBs.

To calculate the RRI, these three sub-indices are equally weighted. By splitting the RRI into three sub-indices, the evaluation has sought to give due weight to the reforms that are considered most important for the effectiveness and credibility of resolution. The weighting is consistent with attempts to capture the progress of resolution reforms found in the literature.[1]

The sub-indices are composed of the following items, with their weights in the overall RRI shown in parenthesis.

Sub-index 1: resolution powers

1. Powers to transfer or sell assets and liabilities, as described in the Key Attributes (5.6%).
2. Powers to establish a temporary bridge institution, as described in the Key Attributes (5.6%).
3. Power to impose temporary stay on early termination rights, as described in the Key Attributes (5.6%).
4. Recovery planning for systemically important banks, as described in the Key Attributes (5.6%).
5. Resolution planning for systemically important banks, as described in the Key Attributes (5.6%).
6. Powers to require changes to firms' structure and operations to improve resolvability, as described in the Key Attributes (5.6%).

[1] For example, the bank resolution index in the forthcoming working paper on *Bank Resolution Regimes and Systemic Risk* by Beck, Radev and Schnabel has four sub-indices that capture different dimensions of an effective bank resolution framework: general framework, powers, tools, and bail-in framework. The index constructed by Coleman, Georgosouli, and Rice in *Measuring the Implementation of the FSB Key Attributes of Effective Resolution Regimes for Financial Institutions in the European Union* (October 2018, Board of Governors of the Federal Reserve System, International Finance Discussion Paper No. 1238) is based on the twelve essential features found in the FSB Key Attributes standard.

Sub-index 2: policy and guidance

1. Public disclosure of bank resolution planning and resolvability assessments (3.7%). This covers disclosure by authorities of the resolution framework and tools (one third of the total), of their policies on resolution planning and resolution strategies (one third of the total), and of their resolvability assessment findings (one third of the total).
2. Cross-border enforceability of bail-in, as described in the 2015 FSB Principles for Cross-border Effectiveness of Resolution Actions (3.7%). This covers regulation by authorities on contractual provisions to ensure cross-border enforceability of bail-in for instruments issued by domestic banks governed by the law of a foreign jurisdiction.
3. Early termination of financial contracts, as described in the 2015 FSB Principles for Cross-border Effectiveness of Resolution Actions (3.7%). This covers regulation by authorities on contractual provisions to prevent exercise of early termination rights in resolution for contracts governed by the laws of a foreign jurisdiction.[2]
4. Operational continuity, as described in the 2016 FSB *Guidance on Arrangements to Support Operational Continuity in Resolution* (3.7%). This covers guidance by authorities on arrangements to support continuity of critical functions and/or critical shared services in resolution.
5. Funding in resolution, as described in the 2018 FSB *Funding Strategy Elements of an Implementable Resolution Plan* (3.7%). This covers guidance by authorities on assessing and preparing for banks' liquidity needs in resolution.
6. Continuity of access to FMIs, as described in the 2017 FSB *Guidance on Continuity of Access to Financial Market Infrastructures (FMIs) for a Firm in Resolution* (3.7%). This covers guidance by authorities on arrangements to support continuity of access to FMIs for a bank in resolution.
7. Valuation capabilities, as described in the 2018 FSBhttps://www.fsb.org/2018/06/funding-strategy-elements-of-an-implementable-resolution-plan-2/ *Principles on Bail-in Execution* (3.7%). This covers guidance by authorities to ensure that banks can support the valuation process during resolution.
8. TLAC holdings, as described in the 2016 BCBS *TLAC holdings standard* (3.7%). This covers implementation by authorities of the BCBS standard on the regulatory capital treatment of banks' investments in TLAC instruments.
9. LAC disclosures (3.7%). This covers implementation by authorities of the TLAC disclosure requirements in the 2017 BCBS *Pillar 3 disclosure requirements – consolidated and enhanced framework* standard, as well as any other (additional) disclosure requirements relating to LAC for SIBs.

Sub-index 3: loss allocation

1. Minimum external LAC requirements for SIBs (16.7%). This covers implementation of TLAC requirements for home jurisdictions of G-SIBs as described in the 2015 FSB TLAC Principles and Term Sheet, and any other LAC requirements imposed by FSB jurisdictions on D-SIBs. If a jurisdiction is home to both G-SIBs and D-SIBs but has only

[2] To be consistent with the rest of the sub-index, this variable only captures regulations or guidance by authorities requiring parties to include language in financial agreements that ensures stays on or overrides of termination rights are enforceable on a cross-border basis. It does not therefore capture voluntary adherence to the ISDA Universal Resolution Stay Protocol.

adopted LAC requirements for the former, then it will receive two thirds of the score. If a jurisdiction is home to only G-SIBs or D-SIBs (but not both) and has adopted LAC requirements for those institutions, it will receive the full score.

2. Powers to write down and convert liabilities (bail-in), as described in the Key Attributes (16.7%).

The items above do not cover all elements of bank resolution regimes. Other elements were excluded from the index because they:

- involve powers that may also be available in supervisory frameworks (e.g. power to remove or replace management of a failed bank);
- are highly correlated with items already included in the index (e.g. availability of several resolution powers presupposes the existence of a designated resolution authority); or
- cover areas where there is no consistent or accurate data to assess progress (e.g. availability and adequacy of public backstop funding arrangements).

2.1.4. Data sources

The index is based on information from the annual FSB resolution reports; FSB reports to the G20 on implementation and effects of reforms; the 2013, 2016 and 2019 FSB thematic peer reviews on resolution regimes; country peer reviews covering resolution regimes; and the BCBS progress reports on adoption of the Basel regulatory framework. This information has been supplemented by FSB jurisdictions' responses to a questionnaire carried out in mid-2019, and by cross-checking and follow-up with individual jurisdictions.

2.1.5. Index scoring scheme

Jurisdictions are scored on a 4-point scale for each of these items.

Score	Meaning
0	Not implemented (i.e. draft regulation or policy not published)
0.33	Under development (i.e. draft regulation or policy published or submitted to legislative body, or rule-making initiated under existing supervisory powers)
0.67	Partial implementation (i.e. final legislation, regulation or policy published but not yet effective, or only partly adopted in terms of scope or coverage, or introduced only as a pilot)
1	Fully implemented (i.e. final rule published and effective for all relevant banks)

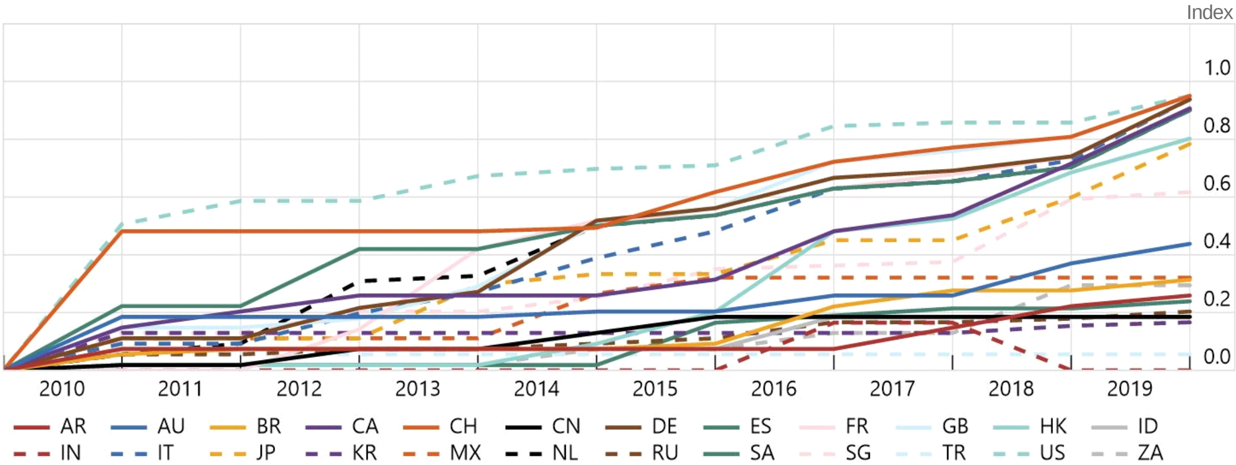
Each sub-index is constructed by calculating the jurisdiction's equally-weighted average of scores across each component item. The three sub-indices are then combined by calculating their simple average to produce the overall RRI. The RRI score for any particular jurisdiction will therefore vary between 0 and 1.

2.1.6. *RRI results*

A few conclusions can be drawn from the evolution of the RRI and its sub-indices over time and by jurisdiction (see figures below):

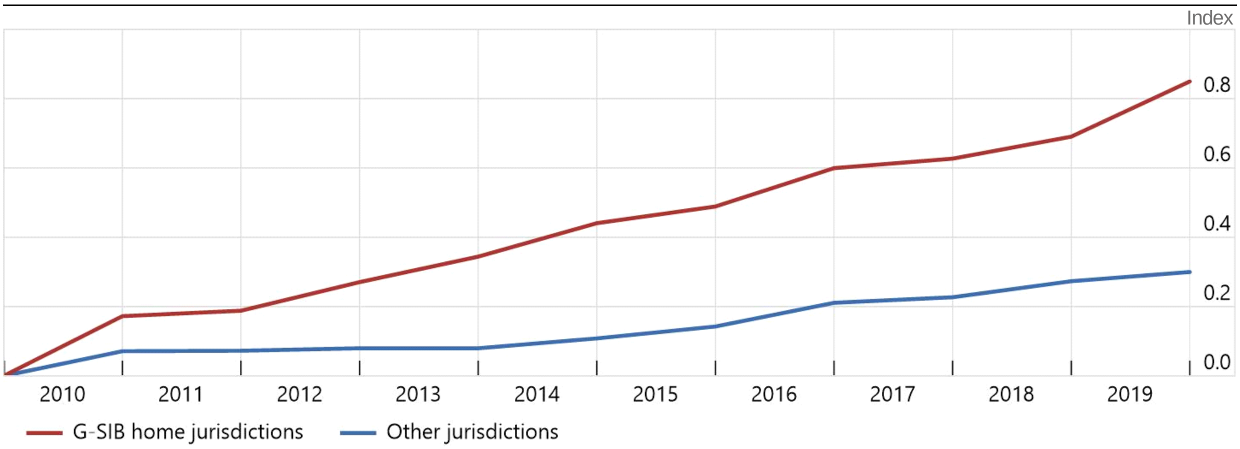
1. There has been strong overall progress in implementing resolution frameworks since 2010. This is shown by the increase in the RRI and each of its sub-indices over this period.
2. Most jurisdictions have created additional resolution powers and introduced recovery and resolution planning for systemically important banks. But progress in operationalising the resolution process – including with respect to loss allocation – is less advanced. This is shown by comparing the scores for sub-indices 1 with those of 2 and 3.
3. There are significant differences across FSB jurisdictions on resolution reforms, with progress most evident for G-SIB home and material host jurisdictions. This is shown by comparing the RRI and its sub-indices (especially 2 and 3) by jurisdiction.

RRI scores by jurisdiction **Figure 2.1.1**



Source: FSB.

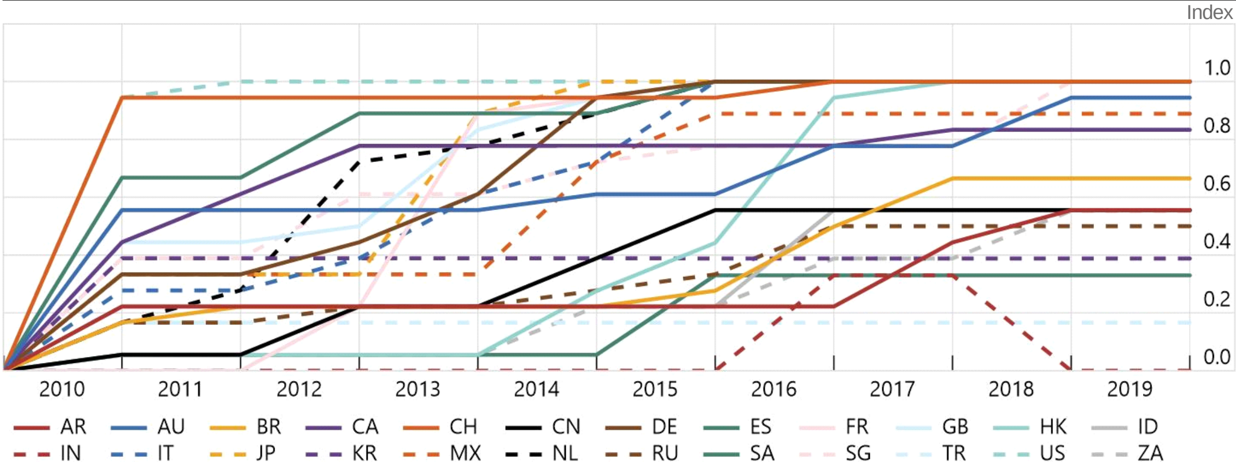
Average RRI scores for G-SIB home vs other jurisdictions **Figure 2.1.2**



Source: FSB.

RRI scores for Sub-Index 1

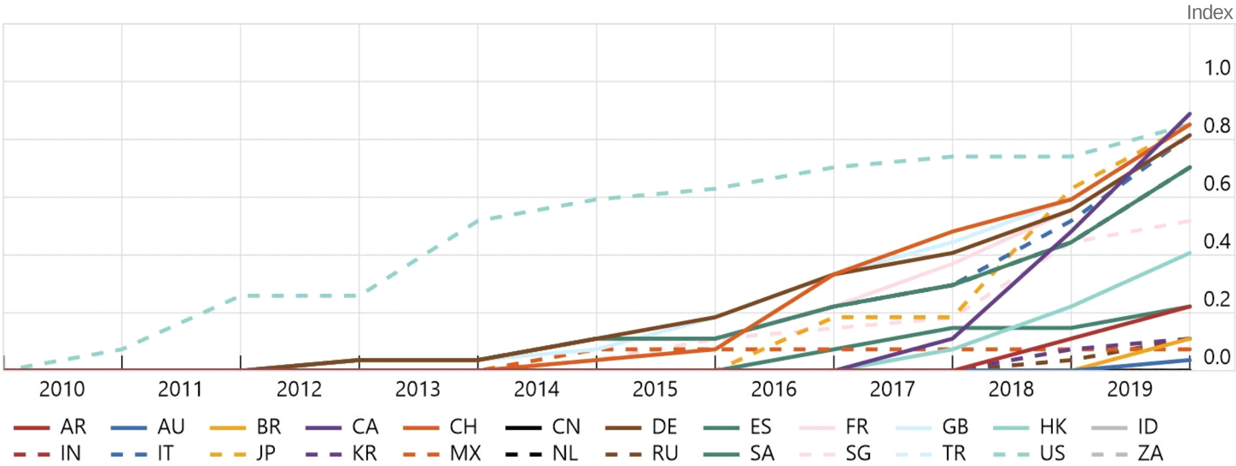
Figure 2.1.3



Source: FSB.

RRI scores for Sub Index 2

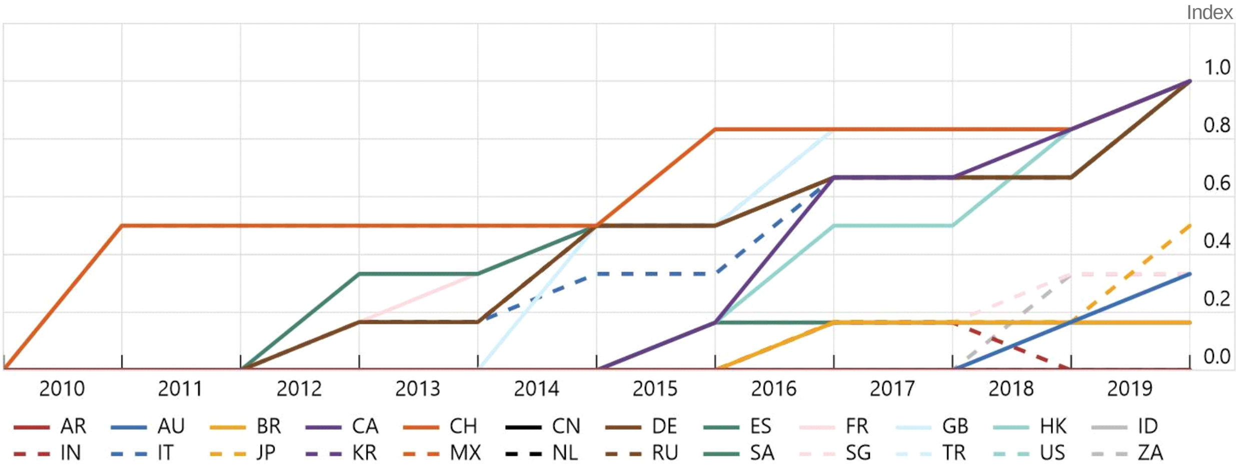
Figure 2.1.4



Source: FSB.

RRI scores for Sub-Index 3

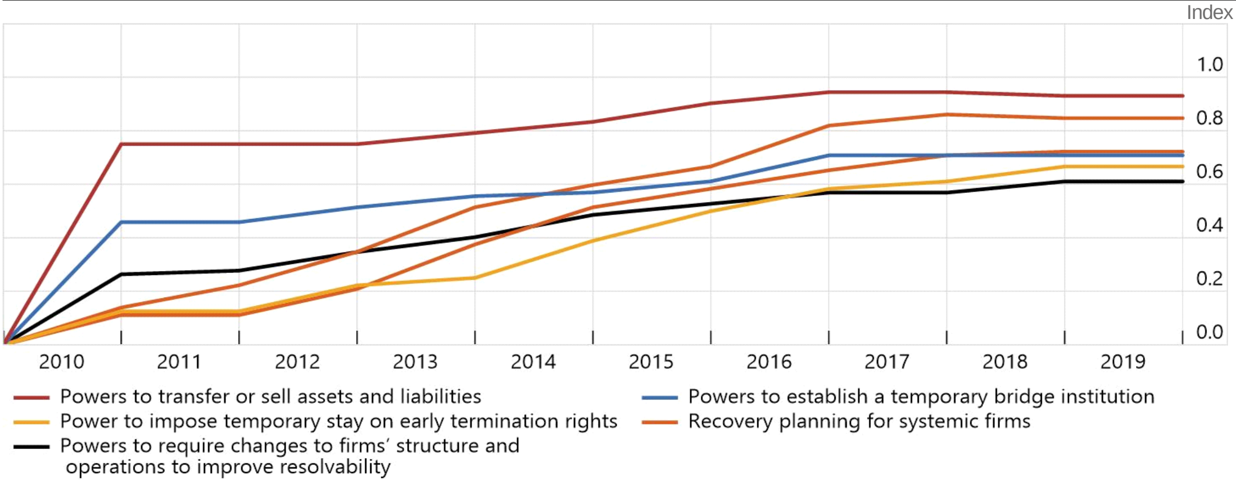
Figure 2.1.5



Source: FSB.

RRI scores for Sub Index 1 Indicators

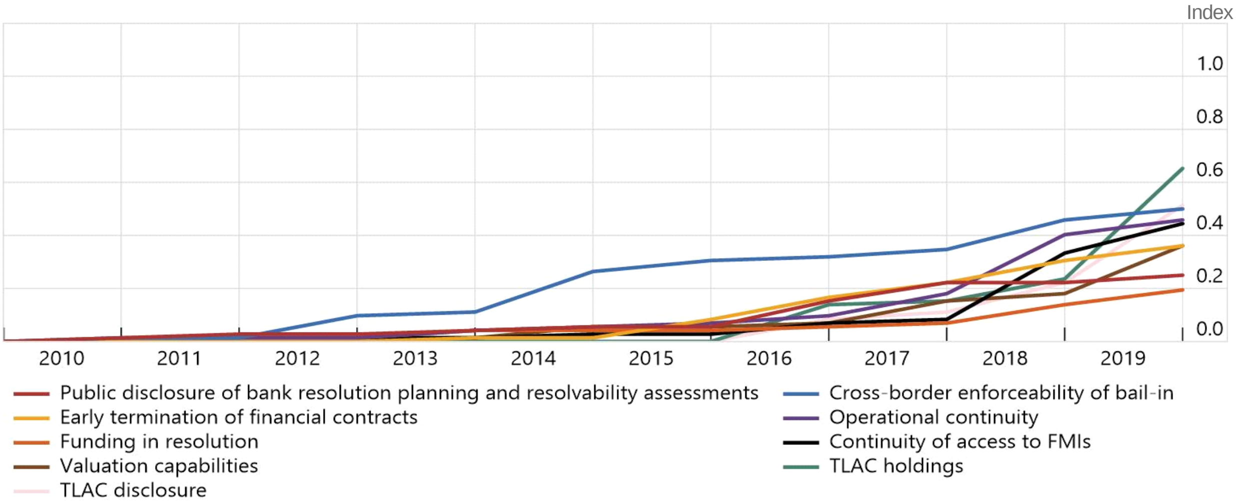
Figure 2.1.6



Source: FSB.

RRI scores for Sub Index 2 Indicators

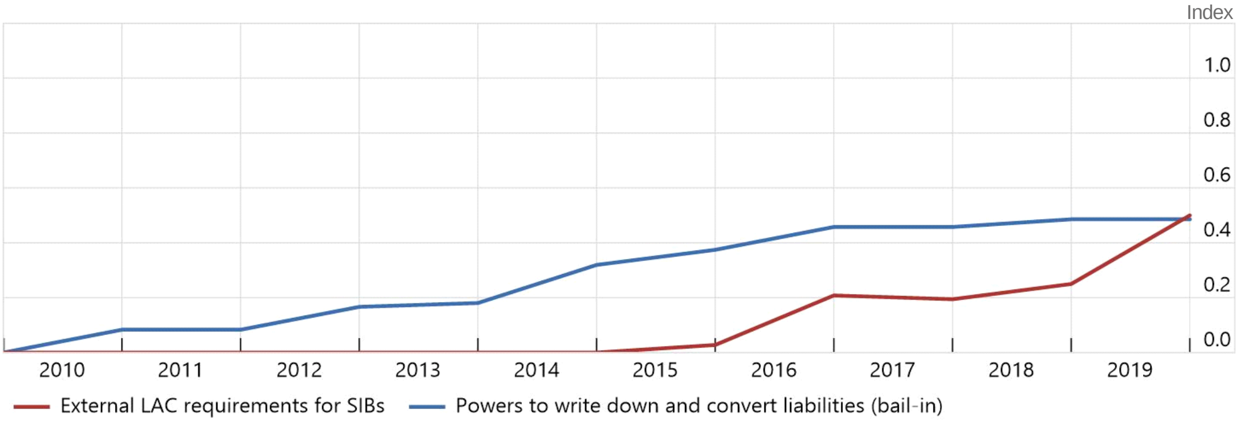
Figure 2.1.7



Source: FSB.

RRI scores for Sub Index 3 Indicators

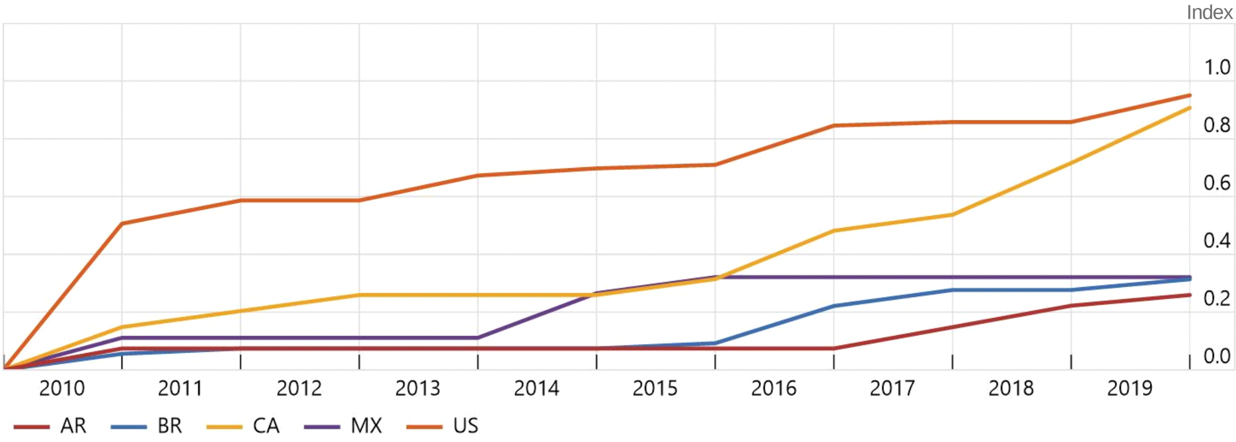
Figure 2.1.8



Source: FSB.

RRI scores – Americas region

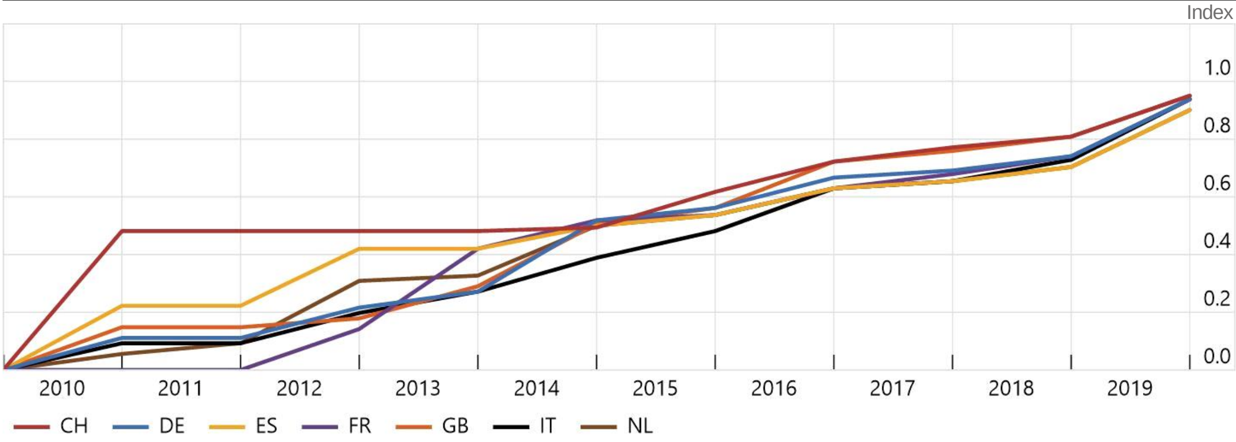
Figure 2.1.9



Source: FSB.

RRI scores - Europe

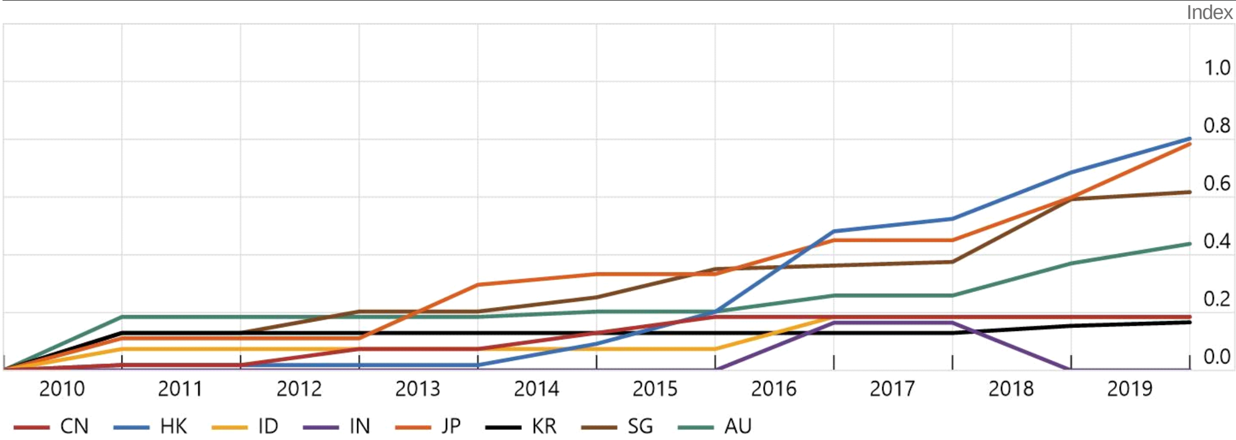
Figure 2.1.10



Source: FSB.

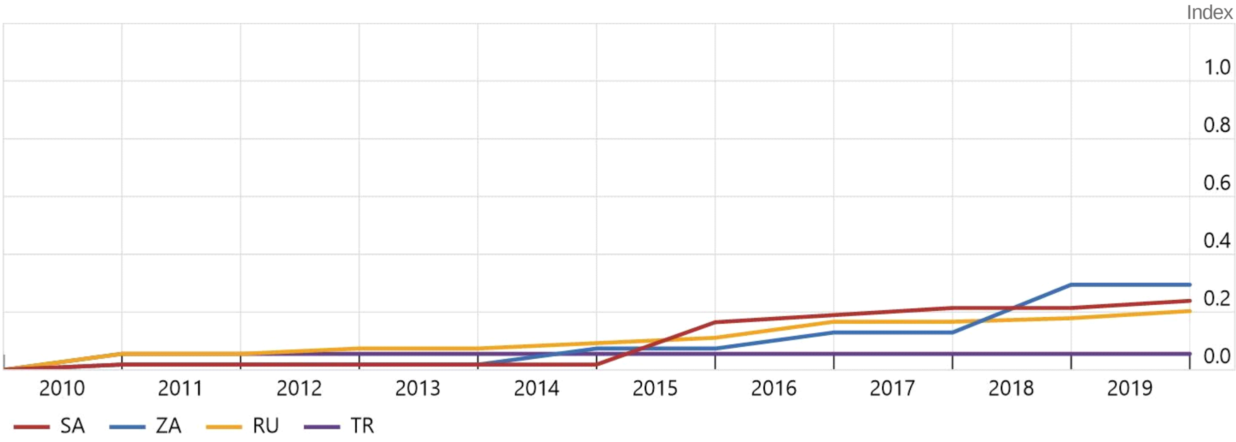
RRI scores – Asia-Pacific

Figure 2.1.11



Source: FSB.

RRI scores – Rest of world **Figure 2.1.12**



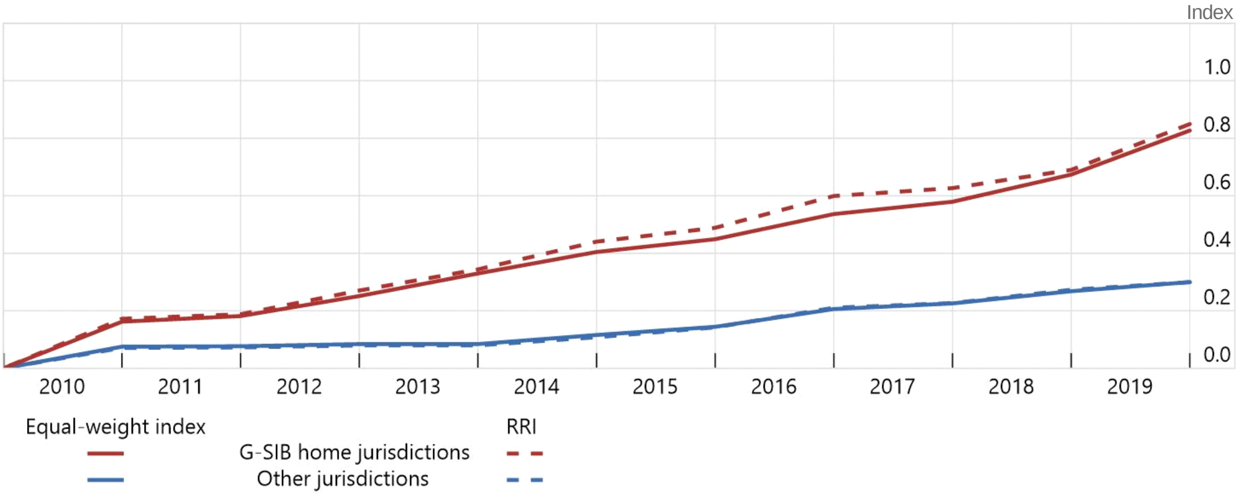
Source: FSB.

2.1.7. *Robustness tests*

To test the extent to which the chosen weighting system affects the RRI, an alternative equally-weighted index was created. The equally-weighted index was constructed by taking a simple average of the scores assigned to the 17 component items of the RRI for each jurisdiction. Each item therefore has a 5.8% weight in this index. As a robustness check the equally-weighted index was also used as a variable in the regression analyses.

The weighting system has a limited impact (see figures below). The effect of the weighting system is most significant for G-SIB home and material host jurisdictions, particularly during the middle years of the period. However, the conclusions drawn above remain valid in either specification.

Comparing the RRI with the equal-weight index **Figure 2.1.13**



Source: FSB.

2.2. Market dynamics of TLAC debt

The bank debt market has evolved significantly since the implementation of the TLAC requirements. Major banks[3] are required to have sufficient resources that can absorb losses in resolution. A number of eligibility conditions were also introduced in the standard. The supply of eligible debt instruments evolved significantly in terms of volume (minimal amount in excess of capital and leverage requirements), subordination requirements (senior preferred/non preferred, etc.), allocation (internal/external TLAC, HoldCo/OpCo, etc.) or contractual law.

It is therefore interesting to investigate how the TLAC market dynamics have changed over the last few years. We follow two approaches depending on the data used. Using secondary market data we assess investors' perception of risk and investigate how the market has been pricing the subordination feature of bank debt, in particular within the senior tranche. Using a sample of banks' debt issuances we then get insights from the primary TLAC debt market such as the main features of issued bonds, trends and pricing.

2.2.1. Modelling the risk perception of investors in the TLAC market

The risk perception of investors in the TLAC market can be assessed through the lens of the market price of senior preferred (SP) and senior non-preferred (SNP) debt tranches. The latter is TLAC-eligible. An interesting way is to compare the implied (risk-neutral) recovery rate of the SNP tranche with the SP one. We should logically find tranches' relative position in banks' liability structure. By order of bail-in hierarchy, SNP bonds are written down to absorb losses before SP bonds, so their recovery rates would differ.

For this purpose, we use as a benchmark the iBoxx benchmark indices spread[4] for EU and US banks.

Subtracted from the liquidity component, a bond's yield spread is the excess of the expected yield over the the risk-free rate (for which the swap rate is a good proxy). The usual assumption is that the excess yield is a required compensation for the possibility of default.

A common way to model default probabilities is to use the hazard rate, i.e. the instantaneous default probability. In this regard, we have:

$$\frac{\partial V(t)}{\partial t} = -\lambda(t)V(t),$$

where $V(t) = 1 - P(t)$ is the cumulative probability of survival to time t and $\lambda(t)$ the hazard rate. $P(t)$ is the probability of default by time t, so that:

$$P(t) = 1 - e^{-\int_0^t \lambda(u)du} = 1 - e^{-\bar{\lambda}(t)t}$$

3 The requirement applies to EU banks according to the MREL regulation.

4 For more details, on how the indices are calculated, see https://www.markit.com/Company/Files/DownloadFiles?CMSID=910be37be7154e13bbb18aa81e801e90

Where $\bar{\lambda}(t)$is the average hazard rate between time 0 and time t. If we assume that the bond yield spread for a maturity of t years is $s(t)$ per annum, this is a good proxy of the average loss rate. Therefore, the average loss rate is $\bar{\lambda}(t)(1-R)$ where the estimated recovery rate is R:

$$\bar{\lambda}(t) = \frac{s(t)}{1-R}$$

If we assume that the SP and SNP tranches have the same $\bar{\lambda}(t)$, we can calculate the implied recovery rate of both tranches. For the SNP tranche, we have therefore the implied recovery rate of the SNP tranche:

$$R_{snp} = 1 - \frac{s_{snp}(t)}{s_{sp}(t)}(1 - R_{sp})$$

Where $s_{snp}(t)$ and $s_{sp}(t)$ are respectively the spread of SNP and SP tranches and R_{sp} is the recovery rate of the SP tranche. In the analysis, we set $R_{sp} = 40\%$, which is a consistent approximation for the recovery rate on senior unsecured bonds.[5]

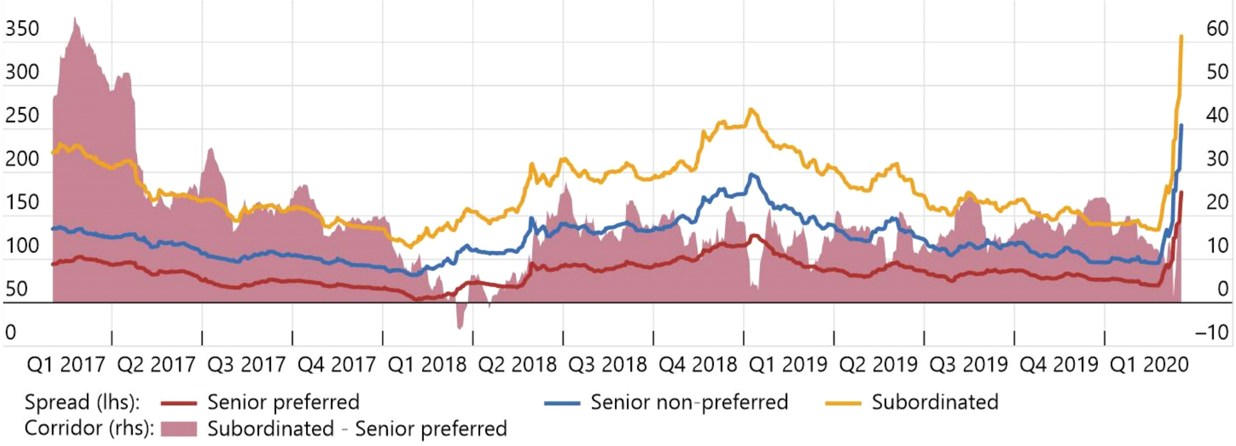
In the figures and tables below, the difference between recovery rates is clearly visible. The market prices in a lower recovery rate on SNP tranches than on SP ones to reflect the claim hierarchy.

For EU banks, we observe relatively high volatility of the SNP implied recovery rate. It plunged to levels close to zero in 2018 when the market was more risk-averse and climbed back early in 2019. With such a high level of sensitivity to risk aversion, SNP tranches behave more like subordinated (Tier 2) tranches. In other words, the SNP tranche goes closer and closer to the subordinated one, in particular under market stress (i.e. the SUB-SP corridor may become negative, Figure 2.2.1). But, further work needs to be done to confirm this result.

Spread indices by seniority ranking

In basis points

Figure 2.2.1



The corridor is calculated as (Subordinated - Senior Non Preferred) - (Senior Non Preferred - Senior Preferred)

Source: iBoxx.

5 Recovery rate on corporate bonds as a percentage of face value (1982-2012) estimated by Moody's.

2.2.2. TLAC issuance

The evaluation built two samples of banks' debt issuance, based on data extracted from Bloomberg and Eikon (Reuters), one with TLAC-eligible debt (G-SIBs and non G-SIBs) and the other with non-TLAC debt (G-SIBs only).

We remove outlier values and use either the *bond yield* or the *par yield* approach to estimate the yield to maturity (YTM) at issuance.

The *bond yield* is the single discount rate, when applied to all cash flows, that gives a bond price equal to its market price (in this case, the price at issuance). The bond yield *R* is thus defined as:

$$P = \sum_{i=1}^{(T-1)m} \frac{C/m}{(1+R/m)^{i/m}} + \frac{(100+C/m)}{(1+R/m)^{T}}$$

Where C is the coupon (assumed to be fixed), paid m times per annum, R the estimated YTM (through an iterative procedure) and P the price at issuance.

The *par yield* for a certain bond maturity is the coupon rate that causes the bond price to equal its par value. If d is the present value of one dollar received at maturity, A is the value of an annuity that pays one dollar on each coupon payment date, and m is the number of coupon payments per year, then the par yield C must satisfy:

$$100 = A\frac{C}{m} + 100d$$

The estimated spread at issuance is the difference between the YTM at issuance and the short rate of the jurisdiction.

The cost estimations are more relevant in EUR and USD because most bonds in the sample have been issued in these currencies. The yield and the spread at issuance are consistent with payment rank: subordinated debt (Tier 2, AT1) is clearly more costly in yield terms. In absolute level, banks, both G-SIBs and non G-SIBs, benefit from decreasing rates to reduce their funding cost at issuance. This is particularly visible for the EUR issuances between 2013 and 2019. However, in terms of credit risk, we do not see decreasing spreads across the years.

2.2.3. Conclusions

Market observations from the implied recovery of SNP and SP tranches suggest that bail-in risk is priced by the market. In term of risk sensitivity, the SNP tranche behaves like Tier 2 capital even though the SNP tranche is eventually called only on a gone-concern situation.

There is no clear evidence from this sample that G-SIBs benefit from funding cost advantages in the TLAC market. Funding costs are in fact lower for banks other than G-SIBs, in particular for senior debt. However, it is not conclusive at this stage. Indeed, the sample includes many European non G-SIBs, particularly small German banks, and European non-G-SIBs also have to issue TLAC/MREL debt to comply with EU law.

For both G-SIBs and non G-SIBs, the level of yield at issuance is consistent with the rating. The cost of issuances with no rating is similar to those with Investment Grade (IG) rating, as most issuances at that level of cost are logically senior debt.

Table 2.2.1: The main features of the banks' debt sample

TLAC and non-TLAC issuances

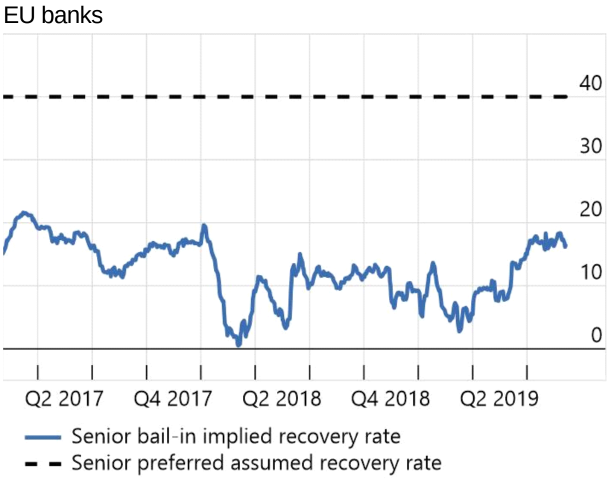
Type of issuance	Period	No. of issuances (obs.)	No. of banks*	Payment hierarchy	Jurisdiction	Currencies	Maturity type	Coupon type	Yield to maturity at issuance	Spread at issuance
TLAC	2013-2019	11,655	332 (55 G-SIBs, 277 non-G-SIBs)	Subordinated (AT1, T2), Senior Non preferred; senior preferred.	Mostly Advanced Economies (AE)	Mostly currencies from AE	At maturity, callable, perpetual	Fixed, variable, floating, stepped.	Estimated YTM if YTM not available in the sample	Estimated spread if not available in the sample
Non-TLAC	2013-2019	61,1261	385 (G-SIBs only)	Senior unsecured	Advanced Economies (AE) and China	Mostly USD and EUR	At maturity and convertible	Fixed, zero coupon, floating	Estimated YTM if YTM not available in the sample	Estimated spread if not available in the sample

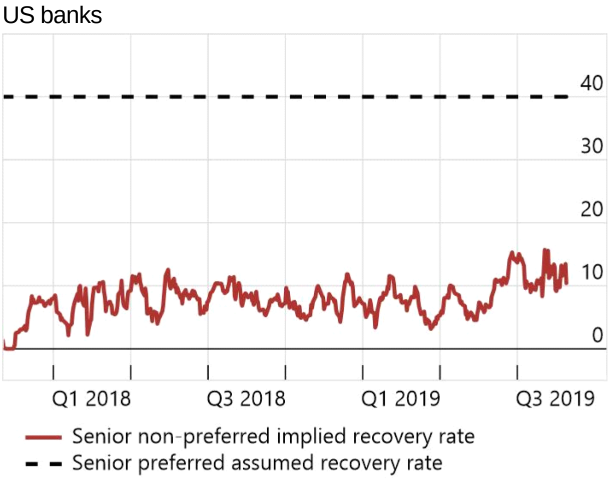
Sources: Bloomberg, Eikon (Reuters) and own calculations. *Entities (i.e. several entities in the same banking group)

2.2.4. Figures and Tables

Implied recovery rate: Senior Preferred vs Senior Bail-in

In per cent **Figure 2.2.2**

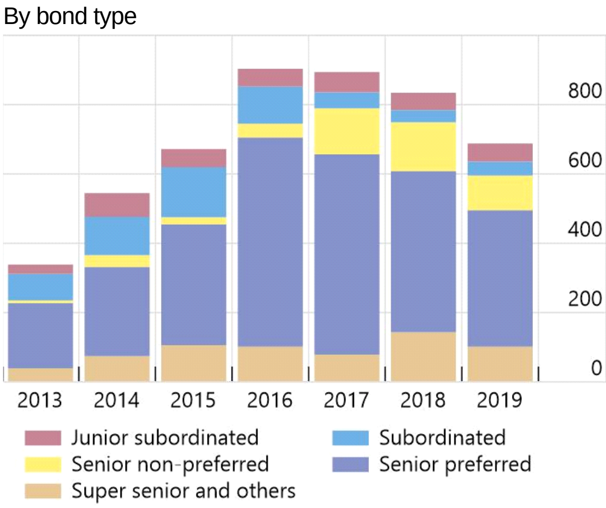


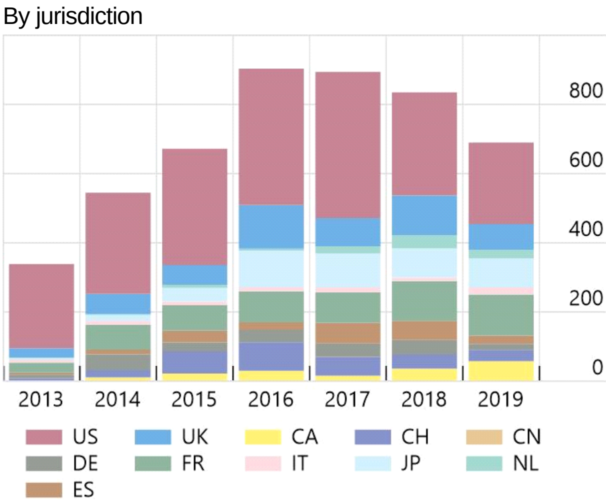


Sources: Markit; FSB calculations.

Volume of G-SIBs' TLAC and non-TLAC issuance

In billions of US dollars **Figure 2.2.3**



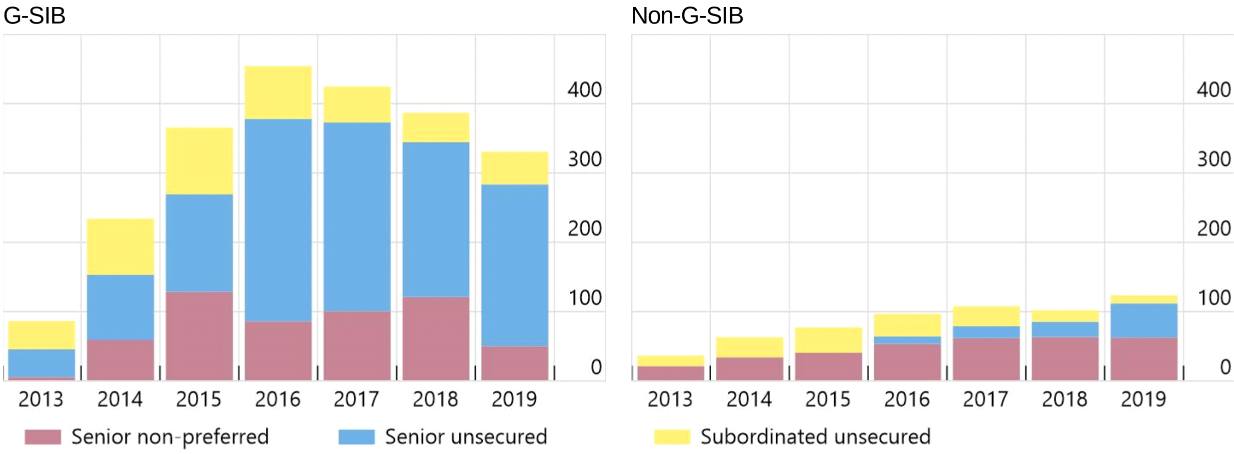


Sources: Bloomberg; Eikon.

Volume of TLAC debt issued by payment rank

In billions of US dollars

Figure 2.2.4

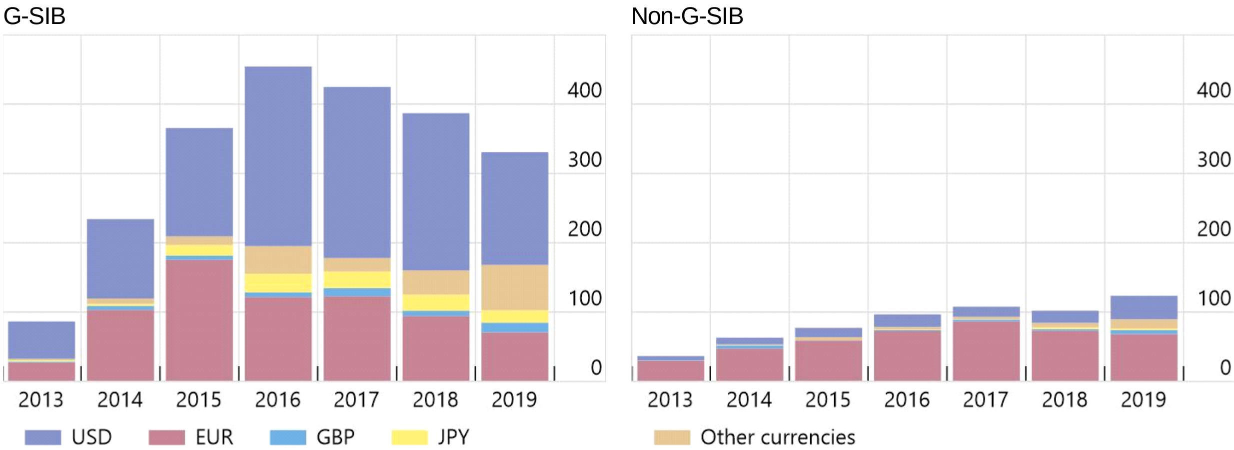


Sources: Bloomberg; Eikon.

Volume of TLAC debt issued, by currency

In billions of US dollars

Figure 2.2.5

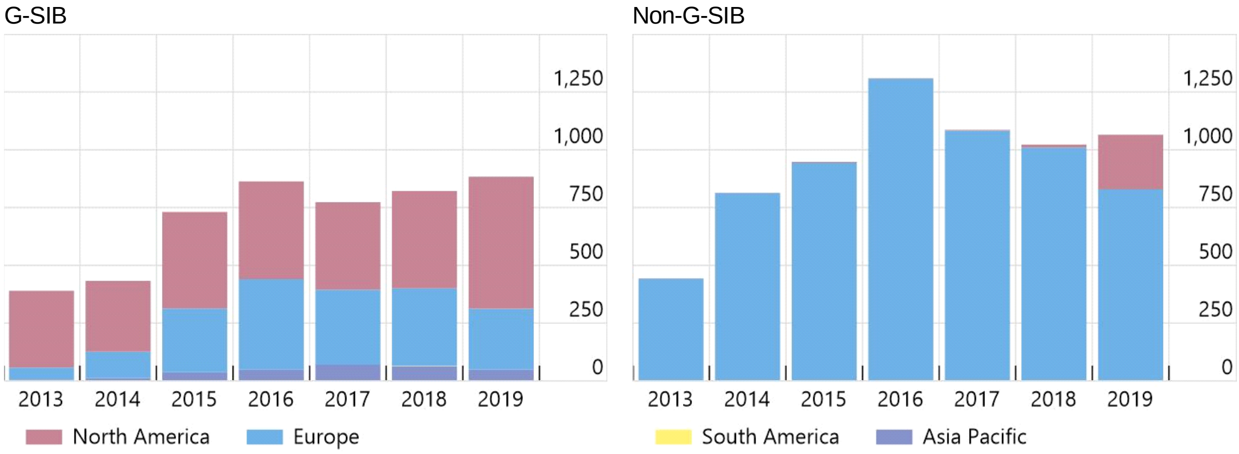


Sources: Bloomberg; Eikon.

Number of TLAC debt issuances by region

Number

Figure 2.2.6

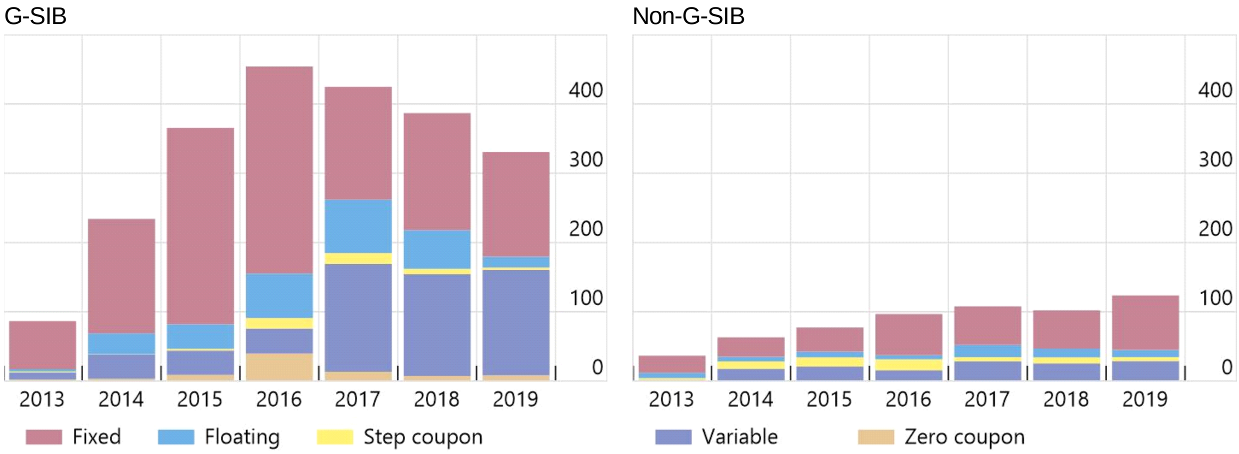


Sources: Bloomberg; Eikon.

Volume of TLAC debt issuances by coupon type

In billions of US dollars

Figure 2.2.7

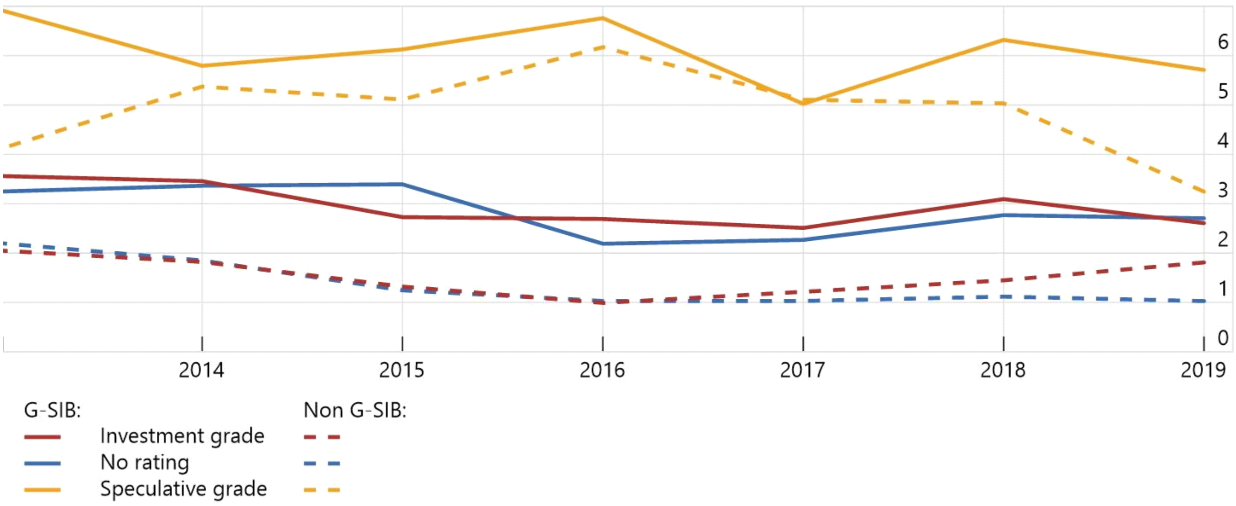


Sources: Bloomberg; Eikon.

TLAC yield at issuance by rating description

In per cent

Figure 2.2.8

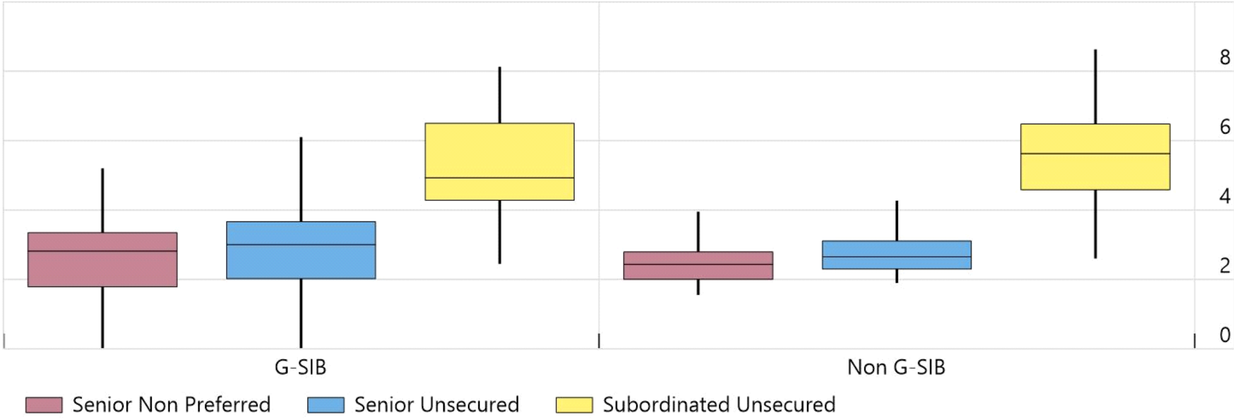


Sources: Bloomberg; Eikon.

Yield at issuance for TLAC (USD)

In per cent

Figure 2.2.9

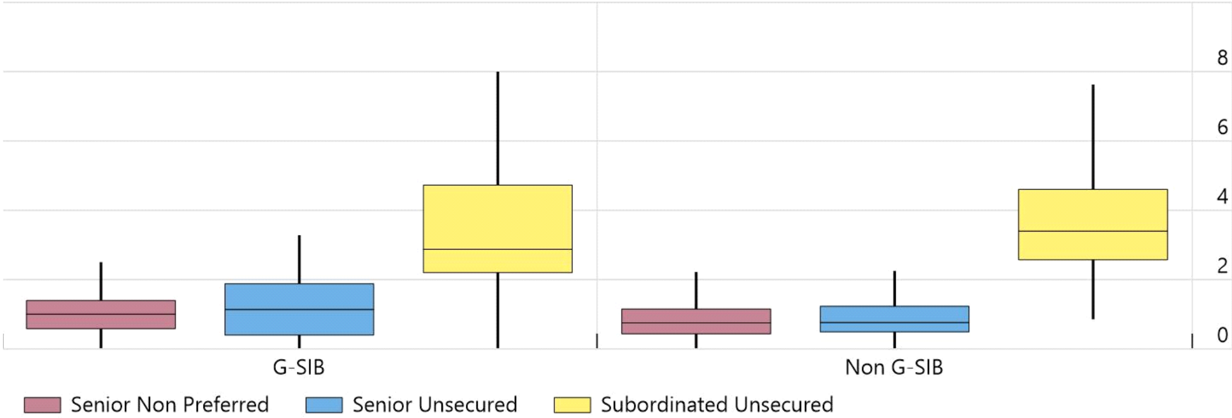


Sources: Bloomberg; Eikon.

Yield at issuance for TLAC (EUR)

In per cent

Figure 2.2.10

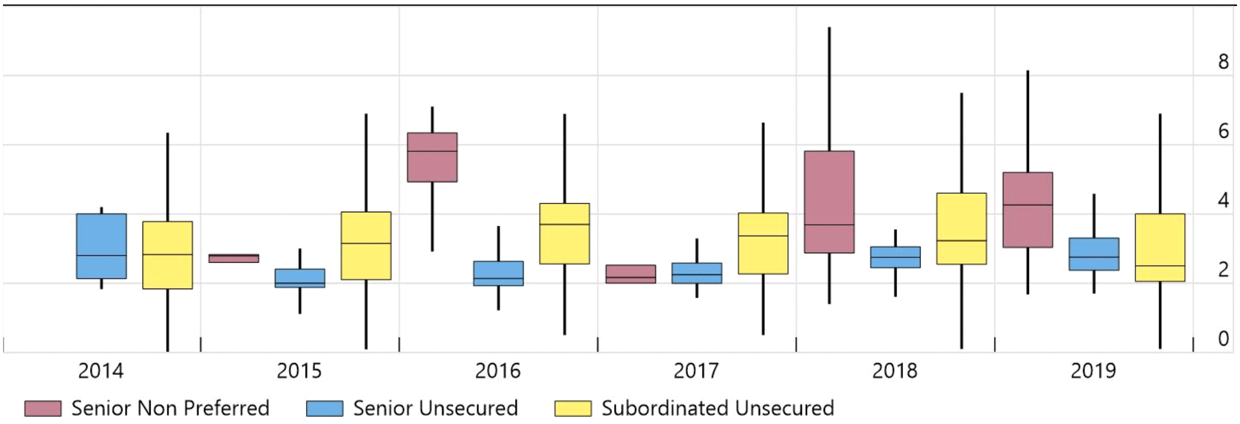


Sources: Bloomberg; Eikon.

Yield at issuance for Non-TLAC (USD)

In per cent

Figure 2.2.11

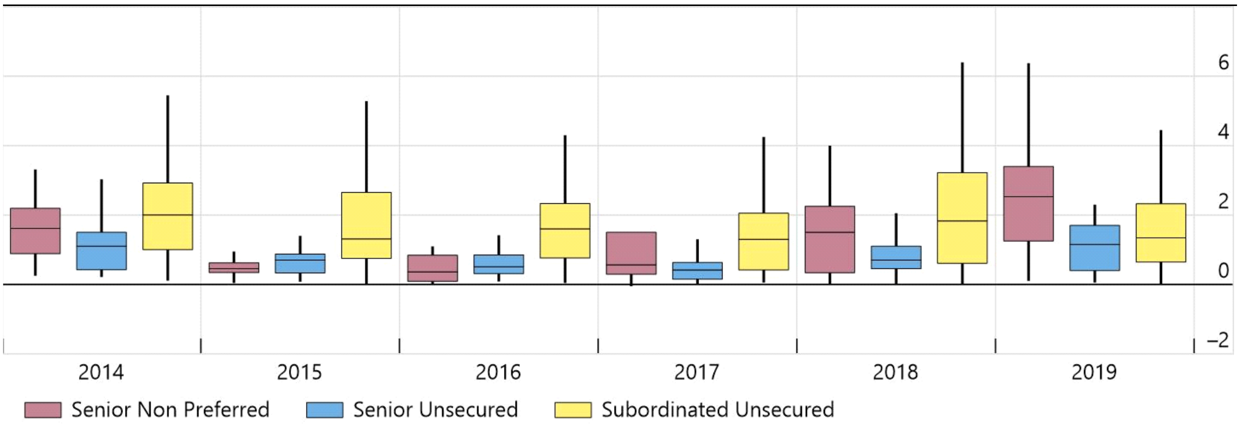


Sources: Bloomberg; Eikon.

Yield at issuance for Non-TLAC (EUR)

In per cent

Figure 2.2.12



Sources: Bloomberg; Eikon.

3. The market's perceptions of the credibility of reforms

A key component of the TBTF evaluation work is to measure the extent to which banks have benefited from an implicit funding subsidy (IFS) and to assess how it has changed following the implementation of the reforms. Where a SIB is perceived by the market as being TBTF, it likely enjoys an advantage in the funding markets due to the market's expectations that the SIB will be bailed out with some non-zero probability. This IFS from the perception of government guarantees could then lead to competitive distortions and misallocation of resources. Furthermore, creditors who expect to benefit from an implicit government guarantee are likely to be relatively insensitive to the risk of the borrowing bank, which impairs market discipline and creates moral hazard for SIBs.

Prior to the global financial crisis, systemically important banks were found to benefit from lower funding costs, as investors could expect to be bailed out in the case of a bank failure (Morgan and Stiroh 2005, Rime 2005). This benefit is typically called the funding cost advantage (FCA).

During the global financial crisis, ex ante expectations of state support were fulfilled following a series of public interventions (Acharya et al 2016, Santos 2014, Ueda and Weder di Mauro 2013, IMF 2014). Subsequently, TBTF reforms have led to the establishment of bank resolution frameworks. They have had the declared objective to reinstate market discipline by highlighting to investors that they would be required to bear losses in the future. For SIBs, the instrument of choice to achieve this adjustment of investors' perceptions is the bail-in tool, which can in principle be used on all unsecured liabilities. In order to assess whether the reforms have achieved their declared objective, the evaluation tracked the development of the FCA and its interaction with the reforms. If the reforms have been successful in reducing bail out expectations, investors in unsecured liabilities affected by a bail in should now demand an additional premium ("bail-in premium") in return for their higher default risk, which should lead to an increase in SIBs average funding costs. This would translate into a narrowing of the FCA.

It is important to note however that not all differences in funding costs are due to expectations of government support. Different funding costs may be associated with size, differences in risk, more liquid debt markets or easier access to external funding for the individual bank (see Kroszner, 2016 for an overview).

This section presents detailed results on the market's perceptions of the credibility of reforms. In particular, it discusses in detail the estimates of implicit funding subsidies carried out for the evaluation.

Section 3.1 describes the macroeconomic, monetary and financial indicators that are used in all of the studies, although not all of these indicators are used in every study. The remaining sections discuss the individual studies.

3.1. Macroeconomic, monetary and financial aggregates

Aggregate, country-specific factors that are likely to have an impact on the funding cost advantage fall into three categories: macroeconomic, monetary and financial.

As macroeconomic indicators, we include *GDP growth*, the *credit-to-GDP gap,* the *gross government debt-to-GDP ratio*[6] and the *ratio of bank assets to GDP.* These variables capture aggregate growth prospects and the level of the aggregate macro-financial risk, which – together with the government's fiscal capacity – determine market expectations about the interplay between the likelihood of a crisis and the likelihood of a government bail-out. Previous research has shown that these factors have an effect on equity and debt-funding costs of financial entities (Demirgüç-Kunt and Huizinga, 2013; Cubillas, Fernández and González, 2017; Poghosyan, Werger and de Haan, 2016). The variables are available at annual or quarterly frequency. Because they are not at a monthly frequency, we keep them constant at their respective frequency (e.g. debt/GDP ratio is constant for a given year for all months of that year).

[6] Adding the government budget deficit – as often done in the literature – does not change our conclusions as it is highly correlated with annual GDP growth.

As monetary policy indicators, we approximate the shape of the *interest rate term structure* by including the difference between the 2 and 10 year interest rate. The impact of monetary policy is further approximated by the short-term government bond yield (2 year). We also use the *shadow interest rate* as a measure of the trend growth rate, similar to Holston, Laubach, and Williams (2017).

Regarding financial indicators, we measure the market risk aversion by the well-known VIX index computed from the S&P 500 index options. The size of the bank sector is computed for each country on the basis of two input measures. The first measure is the asset value of the overall bank sector relative to GDP and the second is the value of systemically important banks' assets relative to the overall banking sector. Additional bank characteristics are the *total capital* and the *Tier I ratio*, i.e. the total bank capital and Tier I capital measured against the risk-weighted assets, where the total capital includes the Tier I capital and all forms of subordinated debt, loan losses provisions and preferred stock that are not included in Tier I. We include return on equity (ROE) and return on assets (ROA). The ROE and ROA are often considered to be the premier indicators of bank *profitability* that can be obtained from a bank's financial statement. Other things being equal, we would expect lower probability of bank default with a higher ROE (and ROA). We measure *leverage* as the ratio of asset book value to market equity. The source of the bank-specific data is SNL.

Finally, we include a country-specific *crisis probability* proposed by Engle and Ruan (2019) and the *US VIX*, both available at the monthly frequency.

3.2. Estimating funding advantages using a factor pricing approach

3.2.1. Introduction

We estimate IFS for SIBs for five geographical areas: Asia-ex-Japan, Canada, Europe, Japan, and the US. We also show results for Global, a category that pools data for all five regions. The IFS is estimated utilising a factor pricing approach implemented using equity market prices. Under this approach, we construct TBTF factor defined as the return on a portfolio that has a short position on financial firms perceived by market participants as systemically important and a long position on financial firms perceived as less systemically important. If more systemically important firms are perceived to benefit from implicit government guarantees, then they should have lower risk and returns as compared to less systemically important firms, resulting in a positive return for the TBTF factor on average.

The IFS is obtained from a regression of the excess equity returns of bank portfolios on the TBTF factor. Since the estimated loading (or beta) on the TBTF factor indicates a bank's exposure to the risk of systemic failures, it is expected that SIBs will have lower betas compared to other large firms. The difference in the betas of SIBs and other large firms, multiplied by the average return on the TBTF factor, is an estimate of the SIB's implied funding subsidy (in percent) relative to other large firms. The IFS can also be expressed in US dollars by multiplying the funding advantage by the average market capitalisation of SIBs.

Our study is closest in spirit to Gandhi and Lustig (2015) who find that, after controlling for standard risk factors, the largest commercial banks have lower returns than smaller banks. They develop a bank risk factor constructed from taking a long position in small commercial banks and a short position in large commercial banks. However, large financial firms may have a funding advantage over small financial firms for reasons other than implicit government guarantees, such as economies of scale and superior bargaining power when borrowing from banks. Moreover, government support for financial firms perceived as TBTF typically accrues only to the largest firms and not to moderately large firms. These facts motivate basing our TBTF factor on the returns of the largest financial firms relative to returns of other comparably large financial firms. Antill and Sarkar (2018) use a similar approach to decompose TBTF risk into components due to size, complexity, interconnectedness and leverage. Using US equity returns data, they find that the importance of different components of TBTF risk varies with time.

3.2.2. Data and methodology

We obtain the market value of equity and the book value of equity (BE) for the five geographical regions from EIKON for the period 2001 to 2019. Because of how we construct the TBTF factor (as explained below), the estimation period starts from July 2002. We consider July 2002 to June 2007 as the pre-crisis period, July 2007 to December 2008 as the crisis period, and 2009 to 2019 as the post-crisis period. The reform implementation period is 2012 to 2019.

From the asset pricing literature, it is well known that equity returns are determined by a number of risk factors that have to be accounted for in the analysis, in addition to TBTF risk. Accordingly, we use the five Fama-French factors (Market, Value, Size, Profitability and Investments) and the momentum factor, constructed separately for the five geographical areas as well as the Global portfolio.[7] Since the Fama-French factors are in US dollars, we convert the portfolio returns and the TBTF factor returns into US dollars using monthly exchange rates.[8]

Constructing the TBTF Factor

Recall that the TBTF factor is a portfolio with a short position on systemic firms and a long position on less systemic firms. We consider as systemically important all financial firms in the largest X% of the market value of equity (ME) in a particular year, where X varies by country depending on the size of the banking sector, as discussed below. Assuming that large financial firms are perceived as having a positive bailout probability, the TBTF factor is expected to have a positive return on average. An alternative method is to construct long-short positions based on large *banks*, instead of financial firms. A problem with this approach is that, since the dependent variables in the regressions are large bank portfolio excess returns (e.g. the average excess returns of the G-SIB portfolio), the results may be attributed to a mechanical correlation if large bank returns are also used to construct the TBTF factor. This concern is mitigated if we use financial firms to construct the TBTF factor.[9]

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7 The data is downloaded from Ken French's web site:
http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#International.
We thank Ken French for use of the data.

8 We obtain the monthly exchange rate data from FRED https://fred.stlouisfed.org/categories/95.

9 To further mitigate this concern, we have randomised the non-SIB banks in the TBTF factor. Specifically, each time we construct the TBTF factor, we replace a certain number of randomly selected large non-SIB banks the portfolios.in the long portfolio with other large non-SIB banks. We repeat this procedure multiple times, and then take the average of the estimates, We have checked that, for the US data, the results are robust to this alternative methodology.

A natural approach to selecting the size cut-off X is a threshold above which banks are subject to prudential regulation, which is $100 billion in the US. This corresponds to the 94th percentile of ME of US financial firms in 2009.[10] Thus, the TBTF factor for the US consists of a short position on the largest 6% of US financial firms and a long position in the next largest 6% of US financial firms.

For the remaining countries, we select the size cut-off X so that the average ME of financial firms at the cut-off is similar in the post-crisis period. This procedure results in the following size cut-offs: Asia ex Japan (5%), Canada (9%), Europe (7%), Japan (5%), US (6%) and Global (8%). Table 3.2.1 shows that the average ME of financial firms at the selected cut-offs was similar for most regions in the post-crisis period, as it was between $16 billion and $18 billion for the US, Japan and Global, and between $30 billion and $37 billion for Asia ex-Japan, Canada and Europe. In the pre-crisis period, the average ME was between $15 billion and $30 billion for all regions except for Europe where the average ME was $51 billion due to a more concentrated banking sector. The average number of firms with ME higher than the size cut-offs in a year during the post-crisis period was 16 for Europe, between 5 and 6 for Asia, Canada and Japan, 29 for the US, and 82 for the Global portfolio. The corresponding numbers in the pre-crisis period were 12 for Europe, between 3 and 5 for Asia ex-Japan, Canada and Japan, 21 for the US and 58 for the Global portfolio.

Having selected the size cut-off X, we next construct the TBTF portfolio based on the following procedure:

- In June of year "t", we select the largest 2X% of all financial firms in each jurisdiction with non-missing values ME and calculate the median of ME.
- Considering firms with positive values of price to book value of equity PB as of December of year "t-1" we calculate percentiles 30 and 70 of BM=1/PB.
- Using these percentile cut-offs for ME and BM, we construct 6 portfolios in June of year "t" based on the following sorts:

	Median ME	
	Small Value	Big Value
70th BE/ME percentile		
	Small Neutral	Big Neutral
30th BE/ME percentile		
	Small Growth	Big Growth

- We obtain returns and ME data for these firms from July of year "t" to June of year "t+1"

[10] The US Dodd Frank Act in 2010 used a lower cut-off of $50 billion but this was raised to $100 billion in US Senate bill 2155 that was passed in May 2018.

- For each month from July of year "t" to June of year "t+1," we calculate ME weights for each of the six MVE x BM portfolios and calculate size weighted returns. Then, the TBTF factor returns are calculated as the (unweighted) average returns on the long positions minus the (unweighted) average returns of the short positions:
- TBTF factor = 1/3[(Long, BM1) + (Long, BM2 + (Long, BM3)] - 1/3(Short*BM1 + Short*BM2 + Short*BM3) (1)
- Where Long=below-median size portfolio; Short=above median size portfolio; BM1= <=30 percentile of BM portfolio; BM2= (30, 70] percentile of BM portfolio and BM3=>70 percentile of BM portfolio. Thus (Long, BM1) = size-weighted returns on portfolio with firms of size <= Median Size and BM<=30 percentile.

Regression Specification

We examine the exposure of SIBs to TBTF risk using time-series regressions of excess returns of bank portfolios on the TBTF factor. These regressions are estimated separately for each jurisdiction. For test portfolio "i", region "j" and period "t," the baseline regression is:

$$ERet_{i,j,t} = \alpha_0 + \beta_1 TBTF_{j,t} + \sum_{k=1}^{6} \beta_k Factor_{k,j,t} + \varepsilon_{it} \quad (2)$$

Where $ERet_{i,j,t}$ is the average excess return of test portfolio "i" in jurisdiction "j" for month "t" and $Factor_{k,j,t}$ is one of the 5 Fama-French and Momentum factors. If β_1 is smaller for SIBs relative to the control group, then SIBs have an implicit funding subsidy. Then, conditional on the average TBTF returns being positive, the IFS for SIBs relative to the non-SIB control group CON is:

$$\mathrm{IFS_{SIB}}\% = (\beta_{1,CON} - \beta_{1,SIB}) * average\ TBTF\ return \quad (3)$$

We require the average TBTF returns to be positive, since otherwise the systemic risk premia are negative, implying that the market does not perceive the TBTF firms to enjoy a government guarantee. Given that the average TBTF returns are positive, then the $\mathrm{IFS_{SIB}}>0$ as long as $\beta_{1,CON} > \beta_{1,SIB}$. If the estimate of β_1 is statistically insignificant, then we consider β_1 to be zero. We annualise the TBTF returns and express IFS in percent per year. The subsidy may also be expressed in US dollars by multiplying by the market capitalisation.

$$\mathrm{IFS_{SIB}}\$ = (\beta_{1,CON} - \beta_{1,SIB}) * average\ TBTF\ return\ * Average\ ME\ of\ SIBs \quad (4)$$

For the CON portfolio, we use large non-SIB banks, large non-bank financial firms or large non-financial firms. "Large" firms are those in the largest 10% of the ME distribution in any year.

3.2.3. Results

Evolution of Systemic Risk Premia

The TBTF factor is expected to have positive returns on average if investors perceive that more systemic financial firms have a higher probability of bailout. This return represents the systemic risk premium – the additional compensation that investors require to hold less systemic firms. The last row of Table 3.2.1 shows that, prior to the crisis, the TBTF factor return varies between 2.9% and 8.4% on an annualised basis with the exception of Canada where the average TBTF return is negative.[11] In the post-crisis period, returns on the TBTF factor generally decrease to between 1% and 4.66% on an annualised basis. Once again, the Canadian results are different, in that the average TBTF returns are higher - indeed, they become positive - than in the pre-crisis period. Apart from the Canadian case, these results are generally consistent with investors requiring lower compensation for bearing systemic risk in the post- relative to the pre-crisis period.

Figure 3.2.1 plots the cumulated returns on the TBTF factor that, except for Canada, are generally positive other than during 2002-03. For the US, the cumulated TBTF return also turns negative in September 2008, the month that Lehman Brothers announced its bankruptcy – possibly reflecting the market's reaction to Lehman not being bailed out. We use the Hodrick Prescott filter to decompose cumulated returns into its cyclical and trend components. The result shows that, for most countries, the cumulated TBTF returns have flatter trend lines - indicating reductions in the systemic risk premia - in the recent period.

In order for the TBTF factor to be informative of returns after accounting for the Fama-French and momentum factors, it should have small to moderate correlation with these factors. Table 3.2.2 shows that this is generally true for all jurisdictions, especially in the post-crisis period when the correlation is generally lower than 0.42. In the pre-crisis period, the correlation of SMB with the TBTF factor is moderately high (but still less than 0.59) for some regions. The result provides evidence that the TSIZE factor (intended to capture *systemic* risk) is not reflecting *systematic* risk embodied in standard risk factors.

Exposure to TBTF Risk

Results from estimating specification (2) are shown in Table 3.2.3. For brevity, the table only reportsβ_1, the loading on the TBTF factor. In the pre-crisis period (Panel A of the table), G-SIBs have a consistently negative and statistically significant "beta" or loading on the TBTF factor for all regions. The D-SIB portfolio for Asia (which has no G-SIBs) also loads negatively and significantly on the TBTF factor, but D-SIBs in other regions do not load significantly on TBTF except for the Global portfolio, which has a positive and significant D-SIB beta. The SIB portfolio, which pools G-SIBs and D-SIBs, loads negatively and significantly in every region, except for Canada where the loading is negative but not significant. A negative loading implies that SIBs' equity funding costs were lower the greater their exposure to TBTF risk. In other words, SIBs benefitted from being perceived as TBTF in the pre-crisis period.

Turning to the large non-SIB bank portfolio, we find that their loadings on TBTF are also typically negative but not significant except for Asia. Thus, large Asian banks were also perceived by the market to be TBTF. Large Global and US non-bank financial firms load negatively and significantly on the TBTF factor, but in other regions, they load positively. In contrast to financial firms, large non-financial firms generally have a statistically insignificant exposure to TBTF risk. Overall, the results show that during the pre-crisis period SIBs have a

[11] The result for Canada may mean that investors did not perceive large financial firms to be systemically important; alternatively, it may indicate that our procedure failed to distinguish more and less systemically important financial firms.

lower exposure to TBTF risk as compared to non-SIBs, with the exception of Asia where large non-SIB banks have an even smaller exposure to TBTF risk than SIBs.

Panel B of the Table shows results for the post-crisis period (2009-2019) that are largely similar to those in the pre-crisis period. The TBTF loadings remain negative and significant for G-SIBs. Differently from the pre-crisis period, the TBTF loadings are also significantly negative for Asian, Canadian and Global D-SIBs. SIBs have negative and significant TBTF betas in every region. Large non-SIB banks continue to have negative but mostly (except for Asia and Canada) insignificant TBTF "betas." Similarly, large US and Global non-bank financials continue to load negatively on the TBTF factor but with a smaller magnitude than the SIBs do, while non-financials generally load positively on the TBTF factor.

Next, we turn to a comparison of the pre- and post-reform implementation periods following the crisis. Panels C and D report results for the post-crisis pre-reform period (2009-2011) and the post-reform period (2012-2019). These results are largely similar to those in the pre-crisis period. Therefore, the results do not indicate a marked change in the exposure of SIBs and non-SIBs to TBTF risk over time. However, the implicit subsidies depend on the product of the TBTF risk exposure and the systemic risk premia, and we turn to these estimates next.

Estimates of Implied Funding Subsidies

We calculate the funding subsidies implied by the TBTF loadings, expressed as annualised returns, using equation (3), for pre- and post- crisis and reform periods. We use a Wald test to compare the subsidies between different periods.[12]

Table 3.2.4 shows the funding subsidies to SIBs, as implied by their estimated exposures to the TBTF factor, relative to different control groups. Panel A of the table reports results using large non-SIB banks as the control group. The average subsidies to SIBs in the pre-crisis period are positive in every region except Asia and vary between 1.6% and 6% on annualised basis. Asian D-SIBs have a negative subsidy relative to big banks, indicating that large non-SIB Asian banks enjoyed an even larger IFS than Asian D-SIBs during the pre-crisis period. The subsidy is not defined for Canada, as the average TBTF return is negative in the pre-crisis period. In the post-crisis period, the average subsidies are similar to those in the pre-crisis period in magnitude, except for Japan where the subsidy declines from about 6% to about 2%. The Wald test cannot reject the hypothesis that pre- and post-crisis averages are equal in every region.

Comparing the post-crisis pre-reform period with the post-reform period, the subsidies are generally lower in magnitude than in the pre-reform period for all regions except Japan. The Wald test indicates that the subsidy is significantly lower in the post-reform implementation period for the Global and US SIB portfolios. For Asian D-SIBs, the subsidy is not defined in the pre-reform period, as the average TBTF returns are negative in this period.

[12] To compare the pre- and post-crisis estimates of SIBs and large non-SIB banks, we estimate a Seemingly Unrelated Regression (SUR) for the full sample with the excess returns of the SIB and large bank portfolios as the dependent variables, the same independent variables as in regression (2) and, in addition, dummy variables for the crisis and the post-crisis periods. We convert the loadings on the relevant TBTF variables into subsidy estimates for the pre- and post-crisis periods using equation (3) and then use the Wald test to compare them. A similar statistical procedure is carried out for the other cases.

Panel B of the table reports results using large non-bank financial firms as the control group. The evolution of these subsidies mostly follow a similar pattern as those with respect to large banks. Subsidies are statistically similar in the pre- and post-crisis periods in all regions, and they are significantly lower in the post-reform period relative to the pre-reform period for the Global portfolio. In addition, they are also significantly lower following reforms in Europe. One exception is Japan, where subsidies increase significantly following reforms. For Asian D-SIBs, the funding advantage is positive relative to large non-bank financials (whereas it was negative relative to large banks).

Panel C of the table reports results using large non-financial firms as the control group and obtain qualitatively similar results, but with one exception: for the Global portfolio, the funding advantage is significantly higher in the post-crisis period relative to the pre-crisis period.

Figure 3.2.2 illustrates the funding subsidies to SIBs in the Global portfolio, as implied by their estimated exposures to the TBTF factor, relative to different control groups.

Next, we calculate the funding subsidies implied by the TBTF loadings, expressed in USD, using equation (4). To admit cross-country comparisons, we express the USD subsidy as a share of total banking assets of the region. Table 3.2.5 shows the funding subsidies to SIBs for different control groups. The pattern of subsidies over time, and across regions, are similar to those obtained when the subsidy is expressed in return. In the pre-crisis period, the magnitudes range from 0.1% for Europe to 2% for Japan. The range shrinks to 0.12% to 1.2% in the post-crisis period. A similar shrinkage is apparent when comparing the pre-reform period (with subsidies ranging from 0.18% to 2.5%) to the post-reform period (with subsidies varying between 0.1% and 0.6%).

Dynamics of Subsidies

So far, we have compared the average subsidies to SIBs between periods. Now, we examine the dynamics of subsidies. To do so, we estimate 5-year rolling regressions and calculate the subsidies to SIBs using the average TBTF returns and the corresponding TBTF loadings in the 5-year period. Due to the short estimation period, the TBTF loadings are sometimes insignificant. In order to obtain an economically meaningful measure of subsidies, we do not assume the loadings are zero, as we did earlier.

Figure 3.2.3 shows the estimates for different control groups relative to SIBs in the Global portfolio. Although the levels are different (being smallest relative to large banks and largest relative to large nonfinancials), the dynamics are similar for the different control groups. The subsidy peaks between 3% and 8% in February 2009, falls thereafter before spiking again in November 2011 during the European crisis, and then mostly declines steadily before levelling off in 2018 at between 0.4% and 2%.

Effect of Resolution Reforms

To identify the effect of resolution reforms, we use the resolution reform index (RRI) discussed in Section 2.1.

We regress the time series of SIBs' funding advantage on RRI. If progress in resolution reforms is credible to market participants, then we expect the relation to be negative, which is what we find in Table 3.2.6. The result indicates that the funding advantage of SIBs diminishes when there is progress in the implementation of resolution reforms. The estimated constant of 2.35% implies that this is the average funding advantage of SIBs in the absence of resolution reforms (RRI=0). Thus, the estimated coefficient of RRI of 3 implies that 2/3 implementation of resolution reforms would reduce the SIB funding advantage to zero.

Credit rating agencies have assessed whether jurisdictions have “effective” or “operational” resolution regimes (“credible jurisdictions”, for short). We hypothesise that credible jurisdictions have on average lower funding advantages for SIBs relative to jurisdictions where rating agencies assess that resolution regimes are not credible (“not credible jurisdictions”). Credible jurisdictions with available data are Canada, Europe and Hong Kong. Not credible jurisdictions with available data are Australia, Japan and Singapore. We estimate the funding advantages of credible and not-credible jurisdictions for the pre- and post-reform period. For this analysis, we use 2009-13 as the pre-reform period and 2014-19 as the post-reform period because for some countries, implementation of resolution of reforms was minimal prior to 2014. Further, we were unable to construct the TBTF factor for Singapore and so we used the TBTF factor for Asia-ex-Japan as a proxy.

The results are in Table 3.2.7. After estimating the implicit subsidy to SIBs in each jurisdictions, we calculate a GDP-weighted average for the credible and not-credible jurisdictions. If estimates are missing for any jurisdictions, we use the estimates for the remaining jurisdictions. We find that funding advantage for SIBs decrease from the pre- to post-reform periods for credible jurisdictions but the opposite is true for not-credible jurisdictions, and these changes are statistically significant in most cases. This is true for all the groups that SIBs are compared to: large banks, large non-bank financials and large non-financials.

Effect of Size of Banking Sector

The first row of Panel A of Table 3.2.8 shows the effect of an increase in the size of the banking sector (as measured by the share of banking sector assets to GDP) on the funding advantage. The coefficient is positive, indicating that a bigger share of the banking sector is associated with a larger funding advantage, but the result is not statistically significant. However, when the variable is included with the other macroeconomic variables in column 5, the estimate is both positive and significant.

Effect of Sovereign Indebtedness

The second row of Panel A of Table 3.2.8 shows the effect of an increase in the ratio of sovereign debt to GDP on the funding advantage. The coefficient is negative, indicating that increased sovereign indebtedness is associated with a lower funding advantage, and the result is statistically significant. One interpretation of this result is that a more indebted country has a reduced capacity to bail out SIBs.

Effect of Investor Uncertainty

The fourth row of Panel A of Table 3.2.8 shows the effect of an increase in VIX, the volatility implied by equity index options, on the funding advantage. The coefficient is positive and significant indicating that in times of greater expected volatility, the funding advantage of SIBs is higher. The result is intuitive, in that during volatile periods, SIBs are more likely to default.

Effect of Monetary Policy Stance

The fourth row of Panel A of Table 3.2.8 shows the effect of an increase in the interest rate on the funding advantage. The coefficient is negative but not significant. When the variable is included with the other macroeconomic variables in column 5, the estimate is positive and significant, suggesting a positive association between interest rates and the funding advantage.

Effect of Probability of Crisis

Changes in the funding advantage may occur due to changes in the market's perceptions of the probability of a crisis, rather than regulations. To assess this hypothesis, we regress the probability of a systemic crisis, which is obtained from Engle and Ruan (2019). Panel B of Table 3.2.8 shows that a higher probability of crisis is associated with a greater funding advantage, consistent with the hypothesis. However, the constant in the regression is positive and statistically significant, indicating that the funding advantage remains non-zero after accounting for the effects of crisis probability.

3.2.4. Conclusions

In this study, implicit funding subsidies are estimated based on a factor pricing approach using equity returns of SIBs and other large banks, large non-bank financial firms or large non-financial firms. Under this approach, a TBTF risk factor is constructed and the exposure of SIBs and other large firms to this factor is estimated, after accounting for standard risk factors such as size and value. SIBs benefit from an implicit funding subsidy if they have a lower exposure to the TBTF risk factor than other large firms do, after accounting for other risk factors that may also explain equity returns.

Pooling all regions, we create a global portfolio of SIBs and find that following the crisis, the funding advantage of SIBs has declined, as compared to the pre-reform period. Moreover, the funding advantages decrease with greater progress in implementing resolution reforms, as measured by Resolution Reform Index. Consistent with the views of rating agencies, jurisdictions considered by the rating agencies to have credible resolution regimes are also the ones that typically have larger reductions in the funding advantage.

The evolution of SIB funding advantages varies across jurisdictions. While G-SIB funding advantages declined on average in the post-reform period in Europe and the US, this was not the case in other regions. Similarly, the negative effect of the progress of resolution reforms on the funding advantage is not uniform across jurisdictions.

The SIB funding advantage is influenced by macroeconomic conditions such as the ratio of sovereign debt to GDP and the interest rate, the size of the banking sector and investor uncertainty.

3.2.5. *Figures and Tables*

Table 3.2.1: Summary Statistics for TBTF factor

The table shows the size percentile above which financial firms are considered systemic. We show the average market value of equity (ME) of firms at the size cutoff and the average number of firms with ME higher than the cut-off. Finally, the table reports the annualised return on the TBTF factor.

Panel A: July 2002-June 2007

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Percentile Cutoff	8	5	9	7	5	6
Average ME at cutoff ($B)	20.83	15.44	28.70	51.21	23.25	20.14
Average # of firms above cutoff	58.37	4.08	3.00	12.06	4.51	20.98
TBTF average return (%)	2.91	4.20	-2.97	4.47	8.40	3.21

Panel B: 2009-2019

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Percentile Cutoff	8	5	9	7	5	6
Average ME at cutoff ($B)	17.90	29.60	31.58	36.88	16.91	16.30
Average # of firms above cutoff	82.36	6.34	4.73	16.42	6.31	29.39
TBTF average return (%)	2.75	1.00	4.47	4.66	3.79	2.76

Table 3.2.2: Correlations of TBTF factor with Risk Factors

The table shows the correlation between the TBTF factor and the momentum factor (MOM) and the five Fama-French factors: market (Mktrf), size (SMB), value (HML), investability (CMA) and profitability (RMW).

Panel A: July 2002-June 2007

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Mktrf	-0.32	0.22	-0.04	0.10	-0.21	-0.02
SMB	0.59	-0.09	0.25	-0.01	0.09	0.49
HML	0.42	0.22	0.00	-0.04	-0.17	0.23
RMW	0.22	-0.37	-0.19	-0.14	0.27	-0.20
CMA	0.00	0.19	0.20	0.11	-0.32	0.05
MOM	0.48	-0.39	-0.07	-0.10	0.30	0.14

Panel B: 2009-2019						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
Mktrf	-0.36	0.10	-0.37	0.00	0.05	-0.10
SMB	0.12	0.10	-0.08	-0.06	0.07	0.08
HML	-0.33	0.13	-0.20	0.01	-0.22	-0.31
RMW	0.39	-0.39	0.10	0.12	0.26	0.29
CMA	0.02	-0.17	0.06	0.01	-0.17	-0.04
MOM	0.42	-0.11	0.29	-0.07	0.00	0.29

Table 3.2.3: Regression Results: Exposure to TBTF Risk

The table shows results from regressing test portfolios excess returns on the TBTF factor, the five Fama-French factors and the momentum factor. We only show the loadings on the TBTF factor for brevity. The test portfolios are the value-weighted excess returns on G-SIBs, D-SIBs, large non-SIB banks, large non-bank financials, and large non-financial firms. ***/**/* indicate that the estimates are significant at the 1%/5%/10% level or less.

Panel A: July 2002-June 2007 (Pre-crisis)						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
G-SIB	-0.68***	--	-0.62***	-0.26**	-0.77***	-0.62***
D-SIB	0.22**	-0.29***	0.04	0.23	-0.35	
SIB	-0.54***	-0.29***	-0.15	-0.21*	-0.75***	-0.62***
Large Banks	-0.04	-0.36***	-0.18	0.28	-0.06	-0.16
Large Non-Bank Financials	-0.67***	0.12	0.37**	0.26	-0.18	-0.57***
Large Non Financials	-0.04	0.04	-0.16	0.04	0.01	-0.05

Panel B: 2009-2019 (Post-crisis)						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
G-SIB	-0.73***	--	-0.68***	-0.33***	-0.47***	-0.72***
D-SIB	-0.38*	-0.25***	-0.30***	0.10	0.11	
SIB	-0.66***	-0.25***	-0.42***	-0.27**	-0.43***	-0.72***
Large Banks	-0.25	-0.34***	-0.47***	-0.19	0.01	0.03
Large Non-Bank Financials	-0.52**	0.31***	0.88***	0.14	0.03	-0.46**
Large Non Financials	0.11*	0.08**	-0.05	-0.03	-0.04	0.05**

Panel C: 2009-2011 (Pre-reform, post-crisis)						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
G-SIB	-0.95***	--	-0.58	-0.39***	-0.46**	-0.54*
D-SIB	-0.25	-0.14**	-0.20	-0.03	-0.20	
SIB	-0.76***	-0.14**	-0.32	-0.35***	-0.44**	-0.54*
Large Banks	-0.22	-0.21*	-0.44	-0.12	0.12	0.08
Large Non-Bank Financials	-0.63	0.31***	1.01***	0.21*	-0.43*	-0.62***
Large Non Financials	0.10	0.05	-0.06	-0.07	0.08	0.05**

Panel D: 2012-2019 (Post-reform)						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
G-SIB	-0.53*	--	-0.75***	-0.47***	-0.52***	-0.99***
D-SIB	-0.51	-0.36***	-0.44***	0.27	0.23	
SIB	-0.53**	-0.36***	-0.53***	-0.36**	-0.46***	-0.99***
Large Banks	-0.32	-0.40***	-0.54***	-0.25	0.02	-0.06
Large Non-Bank Financials	-0.16	0.27***	0.51***	0.00	0.20	-0.17
Large Non Financials	0.03	0.13***	0.02	0.03	-0.09	0.05

Table 3.2.4: Funding Advantages for SIBs Implied by Exposure to TBTF factor (Returns per Year)

The table shows the funding advantage of SIBs, as implied by their estimated exposures to the TBTF factor, in return percent. Panel A shows the advantage of SIBs relative to large non-SIB banks. Panel B shows the advantage of SIBs relative to large non-bank financials. Panel C shows the advantage of SIBs relative to large non-financials. The subsidy is proxied by the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period, conditional on the return being positive. If the average TBTF return is negative, then the subsidy is undefined in this methodology. A statistically insignificant exposure is taken to be zero. ***/**/* indicate that difference in funding advantages between the pre- and post-crisis periods, or between the pre- and post-reform periods, or between the pre- crisis and post-reform periods, are significantly from zero at the 1%/5%/10% level or less.

Panel A: Funding Advantage Relative to Large non-SIB Banks

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Pre-Crisis versus Post-Crisis Periods						
July 2002-June 2007	1.57	-0.28	--	0.94	6.32	2.00
2009-2019	1.80	-0.09	-0.23	1.26	1.62	2.00
Pre-Reform versus Post-Reform Periods						
2009-2011	2.37	--	--	3.46	1.13	5.11
2012-2019	1.39**	-0.14	-0.10	1.00	1.95	0.33***
Pre-Crisis versus Post-Reform Period: Test of statistical significance						
2012-2019	NS	NS	NS	NS	NS	Significant

Panel B: Funding Advantage Relative to Large Non-Bank Financials

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Pre-Crisis versus Post-Crisis Periods						
July 2002-June 2007	-0.38	1.23	--	0.94	6.32	0.17
2009-2019	0.38	0.56	5.80	1.26	1.62	0.74
Pre-Reform versus Post-Reform Periods						
2009-2011	2.37	--	--	5.56	0.03	-0.79
2012-2019	1.39**	2.48	7.18	1.00**	1.95***	0.33
Pre-Crisis versus Post-Reform Period: Test of statistical significance						
2012-2019	NS	NS	NS	NS	NS	NS

Panel C: Funding Advantage Relative to Large Non-Financials

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Pre-Crisis versus Post-Crisis Periods						
July 2002-June 2007	1.57	1.23	--	0.94	6.32	2.00
2009-2019	2.10**	0.33	1.88	1.26	1.62	2.14
Pre-Reform versus Post-Reform Periods						
2009-2011	2.37	--	--	3.46	1.13	5.60
2012-2019	1.39**	1.93	3.65	1.00	1.95	0.33***
Pre-Crisis versus Post-Reform Period: Test of statistical significance						
2012-2019	NS	NS	NS	NS	NS	Significant

Table 3.2.5: Funding Subsidies for SIBs Implied by Exposure to TBTF factor (Dollars Relative to Banking Sector Assets)

The table shows the funding advantage of SIBs, as implied by their estimated exposures to the TBTF factor, in US dollars as a share of banking sector assets. Panel A shows the advantage of SIBs relative to large non-SIB banks. Panel B shows the advantage of SIBs relative to large non-bank financials. Panel C shows the advantage of SIBs relative to large non-financials. The subsidy is proxied by the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period, conditional on the return being positive. If the average TBTF return is negative, then the subsidy is undefined in this methodology. A statistically insignificant exposure is taken to be zero. ***/**/* indicate that difference in funding advantages between the pre- and post-crisis periods, or between the pre- and post-reform periods, or between the pre- crisis and post-reform periods, are significantly from zero at the 1%/5%/10% level or less.

Panel A: Large Banks

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Pre-Crisis versus Post-Crisis Periods						
July 2002-June 2007	0.16	-0.21	--	0.14	1.99	1.59
2009-2019	0.16	-0.07	-0.58	0.12	0.47	1.21
Pre-Reform versus Post-Reform Periods						
2009-2011	0.18	--	--	0.33	0.30	2.47
2012-2019	0.13**	-0.11	-0.26	0.10	0.57	0.21***
Pre-Crisis versus Post-Reform Period: Test of statistical significance						
2012-2019	NS	NS	NS	NS	NS	Significant

Panel B: Large Financials

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Pre-Crisis versus Post-Crisis Periods						
July 2002-June 2007	-0.04	0.90	--	0.14	1.99	0.14
2009-2019	0.03	0.45	14.75	0.12	0.47	0.45
Pre-Reform versus Post-Reform Periods						
2009-2011	0.17	--	--	0.53	0.01	-0.38
2012-2019	0.13**	1.97	18.20	0.10**	0.57***	0.21
Pre-Crisis versus Post-Reform Period: Test of statistical significance						
2012-2019	NS	NS	NS	NS	NS	NS

Panel C: Large Non-Financials

	Global	Asia ex Japan	Canada	Europe	Japan	United States
Pre-Crisis versus Post-Crisis Periods						
July 2002-June 2007	0.16	0.90	--	0.14	1.99	1.59
2009-2019	0.18**	0.27	4.77	0.12	0.47	1.29
Pre-Reform versus Post-Reform Periods						
2009-2011	0.18	--	--	0.33	0.30	2.71
2012-2019	0.13**	1.54	9.25	0.10	0.57	0.21***
Pre-Crisis versus Post-Reform Period: Test of statistical significance						
2012-2019	NS	NS	NS	NS	NS	Significant

Table 3.2.6: Effect of Progress in Resolution Reforms on Funding Advantage of SIBs

This table shows results from a regression of the funding advantage of SIBs in the global portfolio, on the Resolution Reform Index RRI. The funding advantage is estimated using 5 year rolling regressions. The standard errors are corrected using the Newey-West procedure. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Funding Advantage of SIBs	
Resolution Reform Index RRI	-3.14**
Constant	2.35***

Table 3.2.7: Funding Advantages of SIBs for Countries with Credible and Not-Credible Resolution Regimes (Returns per Year)

The table shows the funding advantage of SIBs, as implied by their estimated exposures to the TBTF factor, in return percent, relative to large non-SIB banks. The subsidy is proxied by the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period, conditional on the return being positive. If the average TBTF return is negative, then the subsidy is undefined in this methodology. Countries with credible resolution regimes (according to rating agencies) are Canada, EU and Hong Kong. Countries not considered credible by rating agencies are Australia, Japan and Singapore. Credible and not credible subsidies are the GDP-weighted averages of the individual country subsidies. . ***/**/* indicate that difference in funding advantages between the pre- and post-reform periods are significantly from zero at the 1%/5%/10% level or less.

Comparison Group	Countries with credible resolution regimes				Countries without credible resolution regimes			
Panel A: 2009-2013 (Pre-reform, post-crisis)								
	Canada	Europe	Hong Kong	GDP-wtd Avg: Credible	Australia	Japan	Singapore	GDP-wtd Avg: Not Credible
Large Banks	0.48	0.81	---	0.78	---	0.72	---	0.72
Large Financials	4.17	3.12	---	3.21	---	0.45	---	0.45
Large Non-Financials	1.41	1.91	---	1.87	---	0.56	---	0.56
Panel B: 2014-2019 (Post-reform)								
	Canada	Europe	Hong Kong	GDP-wtd Avg: Credible	Australia	Japan	Singapore	GDP-wtd Avg: Not Credible
Large Banks	1.13	0.59	---	0.64*	0.12	1.99	-0.74	1.58***
Large Financials	6.64	1.14	---	1.60***	3.75	3.46	2.37	3.47***
Large Non-Financials	4.87	1.35	---	1.65	2.87	2.59	0.56	2.57***

Table 3.2.8: Effect of Banking Sector Size, Monetary Conditions, Sovereign Debt and Investor Uncertainty on Funding Advantage of SIBs

This table shows results from a regression of the funding advantage of SIBs in the global portfolio, on banking sector assets relative to GDP, sovereign debt to GDP, the 2-year US interest rates, and VIX (Panel A) and the probability of crisis (Engle and Ruan, 2019) in Panel B. The funding advantage is estimated using 5 year rolling regressions. The standard errors are corrected using the Newey-West procedure. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Effects of Banking Sector Size, Interest Rates, Sovereign Debt and VIX

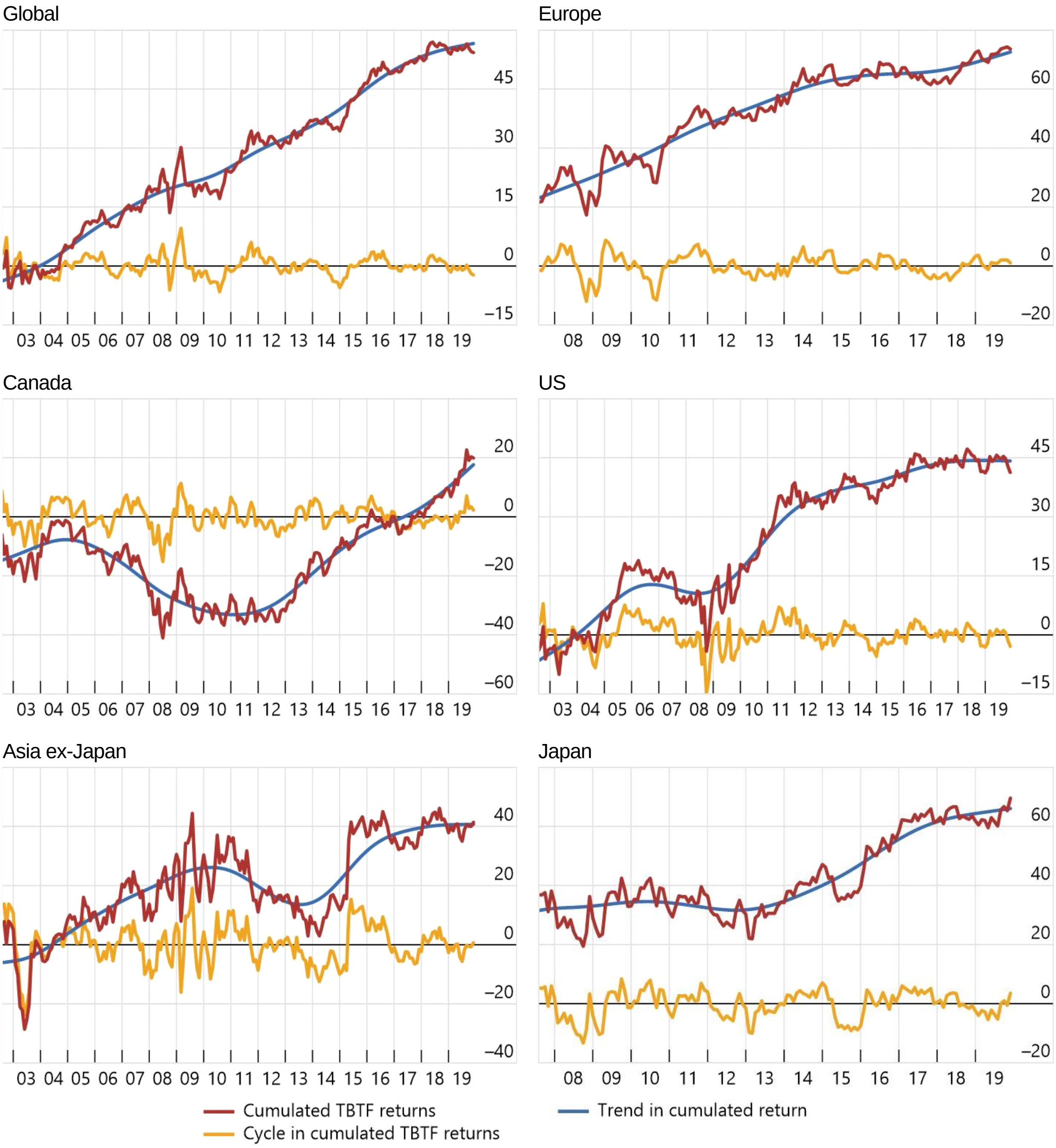
Dependent variable: Funding Advantage of SIBs					
Bank Assets/ GDP	0.01				0.11***
Sovereign Debt/ GDP		-0.04***			-0.03***
VIX_US			0.05***		0.03***
2-year US Interest Rate				-0.19	0.34**

Panel B: Effect of Probability of Systemic Crisis

Dependent variable: Funding Advantage of SIBs	
Probability of crisis	1.55**
Constant	0.93***

Cumulated returns on the TBTF factor

Portfolio returns (%) **Figure 3.2.1**



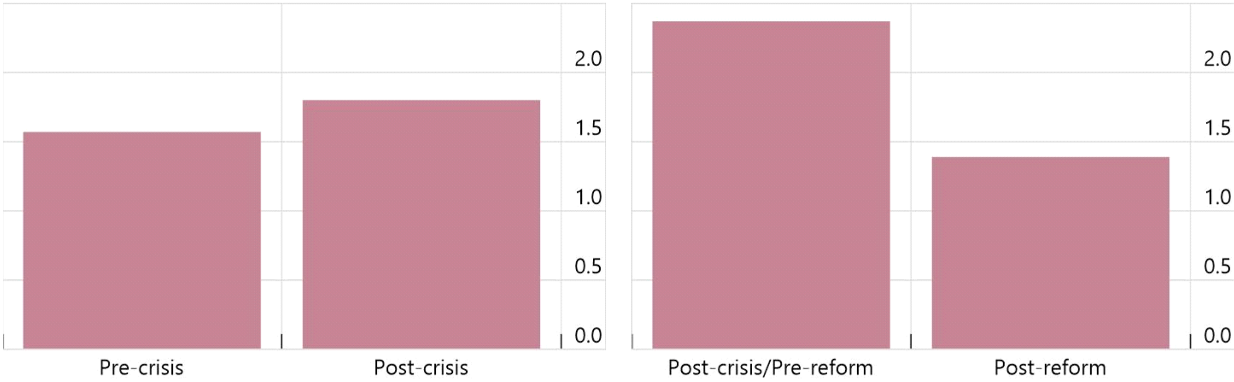
Notes: The figure shows the cumulated returns on the TBTF factor. Also shown is a decomposition of the returns into its cyclical and trend components using the Hodrick-Prescott filter. Europe includes Austria, Belgium, Switzerland, Germany, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Sweden and the United Kingdom. Asia ex-Japan includes Australia, Hong Kong, New Zealand, and Singapore.

Sources: Federal Reserve Bank of St Louis (FRED); Eikon: Kenneth R. French website.

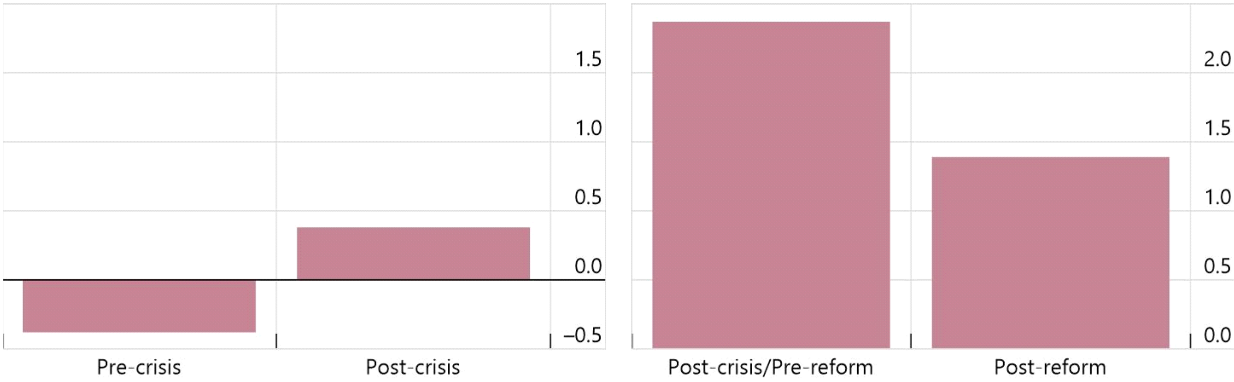
Funding Cost Advantage of SIBs in the Global Portfolio

Portfolio returns (%) **Figure 3.2.2**

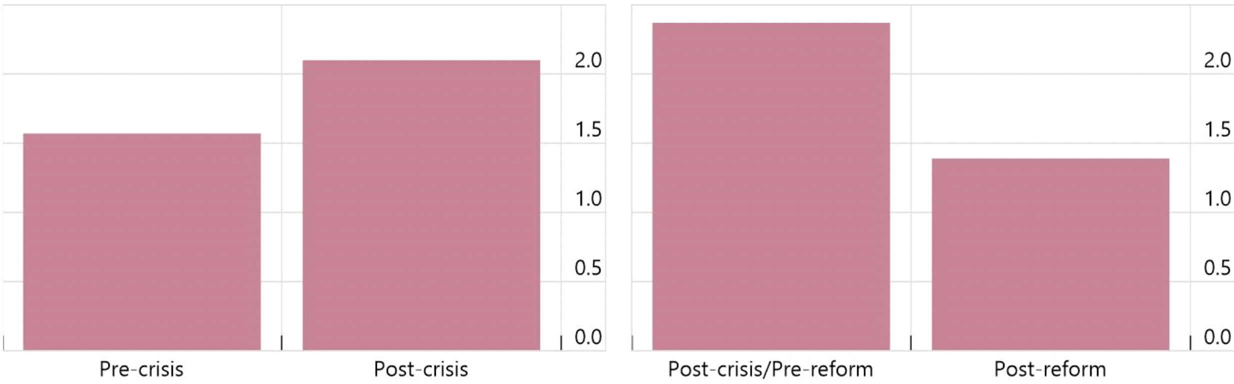
Panel A: Funding Advantage Relative to Non-SIB Large Banks



Panel B: Funding Advantage Relative to Non-Bank Financials



Panel C: Funding Advantage Relative to Non-Financials

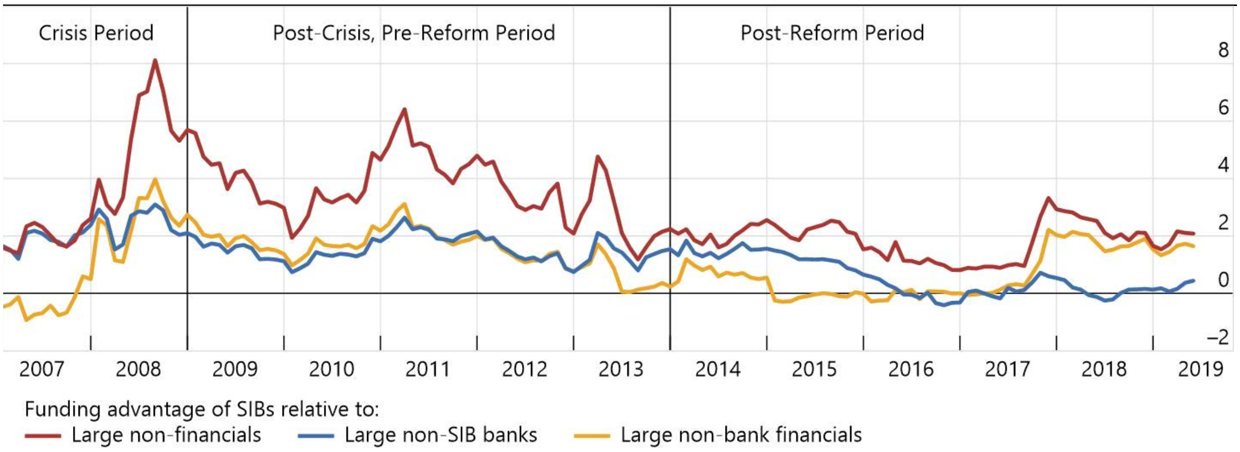


Notes: The figure shows the average funding cost advantage (FCA) of SIBs in the Global portfolio for the pre-crisis, post-crisis, post-crisis/pre-reform and post-reform periods. Panel A shows the advantage of SIBs relative to large non-SIB banks. Panel B shows the advantage of SIBs relative to large non-bank financials. Panel C shows the advantage of SIBs relative to large non-financials. The subsidy is proxied by the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period, conditional on the return being positive.

Sources: Federal Reserve Bank of St Louis (FRED); Eikon: Kenneth R. French website.

Dynamics of Funding Cost Advantage of SIBs in the Global Portfolio

Portfolio returns (%) **Figure 3.2.3**



Notes: The figure shows the time series of funding cost advantage of SIBs in the Global portfolio. The estimates start from July 2007 as we use 5-year rolling window regressions. The funding advantage of SIBs is shown relative to large non-SIB banks, large non-bank financials and large non-financials. The subsidy is proxied by the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period.

Sources: Federal Reserve Bank of St Louis (FRED); Eikon: Kenneth R. French website.

3.3. A funding cost comparison based on CDS data

3.3.1. Introduction

We explore how the TBTF reforms have affected the FCAs of SIBs. We define the group of SIBs to include both G-SIBs and D-SIBs. To explore the reform effect on FCAs, we compare the pricing of credit default swaps (CDS) of SIBs with that of a suitable control group deemed less systemically important (non-G-SIBs and non-SIBs). We study two dimensions of the pricing of CDS. First, we test whether the reforms have affected the level of the funding cost advantage. Second, we test whether reforms have altered the sensitivity of CDS spreads to changes in the risk of the reference entity (i.e. the bank to which they refer). If reforms were successful in convincing markets that SIBs' creditors can no longer expect to be bailed out to the same extent as before reforms, then we should observe that SIBs' funding cost advantages are lower post-reform, and that SIB's CDS have become more risk sensitive.

Briefly, our results are that reforms have significantly reduced the funding cost advantage of SIBs, with estimates in the range of 27 to 32 bp (see Table 3.3.8). By contrast, we do not find conclusive evidence that reforms have raised the risk-sensitivity of SIBs' CDS spreads (see Table 3.3.10 and Table 3.3.11). However, the sensitivity of SIB's CDS prices to their risk has increased since the 2007-08 crisis. Further, we find some weak evidence that progress in the implementation of resolution reforms, as measured by the resolution reform index, correlates with a decrease in the funding cost advantage of SIBs. Yet these results are statistically insignificant.

Can CDS spreads be used to measure funding costs? Clearly, CDS spreads are not a direct measure of a firm's funding costs. They are the cost of insurance against the default of a firm. In theory and absent market frictions, however, CDS spreads should move one-to-one with the credit spread of a matched bond. Indeed, before the crisis, this seems to have been the case (Hull, Predescu, and White, 2004; Blanco, Brennan, and Marsh, 2005; Longstaff, Mithal, and

Neis, 2005). By contrast, a more recent study (Bai and Collin-Dufresne, 2019) has documented that CDS spreads have been consistently lower than bond credit spreads during and after the crisis. However, the CDS-bond basis has shrunk in recent years, which suggests that CDS spreads have become a better proxy of funding costs.

3.3.2. Data

Table 3.3.1 lists the variables we consider in the following. Beyond CDS spreads, these include measures of firm risk, such as expected default frequencies from Moody's, balance sheet metrics of banks' capitalisation, leverage and funding structure, macroeconomic variables, and aggregate financial market data. The rest of this section explains our data and data cleansing procedure.

Table 3.3.1: Data sources

Data type	Source
CDS	Markit
Bank-level controls	SNL
EDFs	Moody's
VIX	CBO
Credit/GDP gap	BIS
GDP growth, government debt ratio	IMF
Resolution index, banking sector assets	FSB
Government bond yields	Bloomberg
Crisis probability	Engle and Ruan (2019)

CDS data

Our data source for CDS spreads is Markit, from which we use data for all banks[13] domiciled in FSB member jurisdictions, G20 jurisdictions and G-SIB home jurisdictions.[14] This leaves us with 26 jurisdictions.[15] Our monthly panel starts in January 2004 and ends in September 2019.[16] The specific CDS contracts we download are single-named 5-year (5Y) senior composite CDS – the most popular market segment (ISDA 2016). To build the final dataset, we take the following steps:

13 In fact we start with the entire universe of entities classified as financials, government and other and but use only banks.

14 Two exceptions: First, we include Finland and Sweden because Nordea (G-SIB) has moved its headquarters from Sweden to Finland. Second, we exclude Dexia (former G-SIB) and thereby Belgium (which was a G-SIB host).

15 Not all countries will be included in all analyses because of data quality issues or non-availability of the covariates required for the analysis at hand.

16 Earlier periods are affected by the dot-com bubble.

1. We identify for each jurisdiction the most widely used document clause[17] and currency, see Table 3.3.2. [18] For every firm, we only keep the CDSs with the dominant document clause and currency.[19]
2. We obtain a single CDS series per firm by averaging over the CDSs that survive the first step. There are cases when a CDS expires and a new one is issued and there is some data overlap between the two. If this is the case, we obtain a single series by averaging across the spreads of the two contracts.
3. We observe that due to re-naming, mergers and other events, the firm-level CDS series are often short. In order to obtain longer series, we use the meta-information provided by Markit on changes in identifiers.
4. We exclude some series (either sub-periods or full series) that appear illiquid, e.g. featuring long-lasting flat sections, sudden jumps, and excessive volatility.
5. We observe that there are cases where we have CDS data for both a holding company and the corresponding operating company. Similarly, there are cases where CDS data on non-financial firms and on their financing arms are available. As a rule, for these cases, we select the series such that, first, we avoid double counting and, second, the selected series reflects the risk associated with the core business of the firm. For banks, this means that we use the CDS series of the holding company unless its data appear less reliable visually.[20]
6. We exclude every CDS series with less than four years of observations and series with coverage of less than 75% between the first and the last observation.
7. We trim CDS spreads at the 99%-level, i.e. we replace every observation above the 99th percentile with a missing value.

Firm controls

The purpose of these control variables is to account for firm characteristics that may affect CDS pricing. We choose a narrow set of control variables that are closely related to firm risk. Our main measure of firm risk is the one-year expected default frequency (EDF) from Moody's (CreditEdge+). This measure is popular in the literature (see, for example, Lewrick, Serena, and Turner (2019)).[21] Note that as *EDFs* build on prices of traded assets, they are only available for a selected number of firms. As a robustness check, we also use Moody's *risk-neutral EDFs (*obtained in a similar way; see Saita, 2007, p.101 ff. for a derivation*)*. This alternative measure is sometimes employed in the asset pricing literature (Berndt et al., 2004; Giordano and Siciliano, 2015). Additional firm controls include the *common equity tier 1 ratio*

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[17] Previous research (Packer and Zhu, 2005) has shown that while pricing differences across clauses are small, they do exist.

[18] We define the dominant document clause and the dominant currency as the one with most non-missing data points in our sample (for each country separately). When selecting the dominant clause, we treat the newer ISDA 2014 definitions as the successor of the previous definition from 2003, i.e. we treat both as if they are the same. When both are available, we use a simple average of both contracts. While important pricing differences may exist across new and old clauses (see Neuberg et al., 2018), it is not clear a priori which clause is more relevant to capture the market view of firm risk.

[19] It turns out that (1) the coverage of firms referenced by CDS does not deteriorate by much if we exclude other currencies or clauses, and that (2) where several currencies or clauses are available for one referenced entity, the respective CDS spreads are highly correlated in both levels and 1st differences (weekly data).

[20] See Section 3.3.5 for cases where high quality data are available for both the holding and the operating company.

[21] Moody's computes EDFs by calibrating a Merton (1974) type structural model using balance sheet data (to obtain the default point), asset valuation, and past asset volatility as inputs. The structural model is used to back out the theoretical default risk. These numbers are then scaled such that the theoretical default risk matches the realised defaults.

(CET1 ratio), the *leverage ratio (LR),* and the ratio of *subordinated debt to total liabilities*. These balance sheet ratios – included at an annual frequency – are standard in the literature (Acharya et al., 2016; Ahmed, Anderson and Zarutskie, 2015). The source of this information is SNL Financial.

Macroeconomic and macro-financial controls

Aggregate country-specific factors are likely to have an impact on the pricing of CDS contracts (see Section 3.1). Note that because they are not at a monthly frequency as our CDS data, we keep them constant at their respective frequency (e.g. debt/GDP ratio is constant for a given year for all months of that year).

Bank classification and reforms data

Data on the classification of banks into G-SIBs, D-SIBs, and non-SIBs and the resolution reform index (as constructed by the FSB) are based on input from FSB members and provided by the FSB secretariat.

3.2.3.1 Descriptive statistics of sample

After the data processing steps, the final dataset consists of approximately 28,000 observations of CDS spreads, measured at the bank-month level (Table 3.3.3). The number of observations entering the regressions is, however, substantially lower when additional controls are added.

Table 3.3.4 shows how many non-missing observations are available if an additional data category is matched to the CDS data. A dataset with CDS, EDFs, bank controls and Engle's crisis probability has around 7,000 observations. This highlights the steep trade-off between adding appropriate controls from different sources and having a large and representative sample.

The geographic distribution of our CDS data by FSB regional consultative group (RCG)[22] is shown in Table 3.3.5. The majority of the observations are from Europe, Asia and the Americas. This clearly puts some restrictions on the feasibility and reliability of region-specific analyses.

Table 3.3.6 shows the summary statistics for the CDS spread and for selected indicators at bank-level. Most notably, the average CDS spread for G-SIBs is below the CDS spread of the two other groups, despite having similar expected default frequencies and lower CET1 ratios. This suggests that G-SIBs may benefit from bail-out expectations. In terms of size, G-SIBs are on average four times larger than D-SIBs and seven times larger than other banks.[23]

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[22] In addition to the regular FSC members, the FSB has set up regional consultative groups (RCGs) to reach out to authorities in 70 other countries and jurisdictions (see also https://www.fsb.org/work-of-the-fsb/).

[23] It is important to note that the reported statistics will typically not coincide with the ones obtained by other analyses exploiting the full dataset as provided by SNL. This is partly because our sample is different due to the non-availability of CDS for all banks. The latter restricts our sample considerably, especially concerning D-SIBs and non-SIBs for which CDS are often not available. Also, EDFs are not available for banks not listed on financial markets.

A time-series plot of CDS spreads for the three groups reveals that the result of a lower CDS spread for G-SIBs as compared to other banks also holds over the entire horizon. What stands out, however, is that during and immediately after the great financial crisis, the difference seems to have been high relative to all other periods. Further, we note that the average CDS spread for all bank types was much lower pre-crisis when compared to all other periods.

As a next step, we plot the average CDS spread (unweighted average over all banks) and the average 1-year EDF for all bank-month observations where both variables have non-missing values. The figure reveals that, in the pre-crisis period, CDS and EDFs were very low when compared to other periods. This chart suggests that comparing pre and post-crisis periods is essentially a comparison between two regimes. One explanation for this could be that the objective level of risk has risen post-crisis, another that the perception (and pricing) of risk has changed. Thus, CDS spreads may have changed due to changes in credit risk and not necessarily because of reforms. Figure 3.3.5 provides further evidence of this: the relationship between firm risk (EDF) and the pricing of that (default) risk by markets (CDS spread) has changed over time. To construct the graph, we form groups according to the EDF level: below median, between median and the 75th percentile and above the 75th percentile. Then we compute the average CDS spread for each group. From a visual inspection, we conclude that the relationship between EDF and CDS has changed over time. More specifically, it appears that the market price of insurance per "unit of default risk" (i.e. EDF group) has generally increased. Finally, in Figure 3.3.6, we plot the cross-sectional correlation of EDF and CDS spreads. The figure seems to suggest that the correlation between risk and its pricing increases in times of crisis. It was low before the crisis, increased during the crisis and then dropped somewhat. From this level, the correlation increased again in the run-up to the European debt crisis. More recently, the correlation has started to decrease again. One possible interpretation of this is that risk-sensitivity may be time varying and a clear attribution to reforms is challenging.

3.3.3. Analytical setup

We test two hypotheses: first, that TBTF reforms have reduced the funding cost advantage of systemically important banks (SIBs) and, second, that the reforms have increased the sensitivity of CDS spreads with respect to firm risk. For the former question, we test this hypothesis using the following difference-in-differences specification:

$$Y_{i,t} = \alpha_0 + \boldsymbol{\beta_1} \cdot \boldsymbol{SIB_i} \cdot \boldsymbol{Post_t} + \delta_1 \cdot SIB_i + \delta_2 \cdot Post_t + \beta_x \cdot x_{i,t-12} + \gamma_{c,t} + \gamma_i + \epsilon_{i,t} \qquad (1)$$

In equation (1), the dependent variable, $Y_{i,t}$, is the CDS spread of bank *i* in month *t*. SIB_i is a dummy variable that equals one if a bank is categorised as a systemically important bank (different definitions of the dummy variable SIB are used in the following, as described below) and zero otherwise. $Post_t$ is another dummy variable that obtains a value of one for all observations after 2011 and zero otherwise. We control for time-varying bank risk through bank-level controls $x_{i,t-12}$. These controls enter with a lag to account for endogeneity, as in Lewrick et al. (2019) and Acharya et al. (2016). Moreover, we control for time-invariant unobserved bank-level heterogeneity through bank fixed effects $\{\gamma_i\}_{i=1 \dots I}$. For unobserved heterogeneity at the country level that equally affects the treatment and control group observations in a given period, we control through period-times-country fixed effects $\{\gamma_{c,t}\}_{c=1...C,t=1...T}$.

In all our regressions, we compute standard errors clustered at the bank level.[24]

The coefficient of interest is β_1. A positive value of this coefficient indicates that CDS spreads in the treatment group have increased relative to those in the control group. This is equivalent to a reduction in the funding cost advantage of SIBs, which is the intended effect of reforms. The purpose of the fixed effects and bank-level controls is to obtain an estimate of β_1 that reflects only the part of the funding cost advantage that derives from the market perception that SIBs are more likely to be bailed out. Put differently, the rationale for the inclusion of the fixed effects and bank-level controls is to obtain an estimate of the implicit funding subsidy.

In robustness checks, we replace period-times-country fixed effects by a combination of country fixed effects and time varying macroeconomic control variables.

The second hypothesis is that the pricing of SIBs' CDS has become more risk sensitive. We would expect this to be the case if investors perceive that the risk of suffering losses on the debt of a SIB has risen. This is the intended effect of the TBTF reforms given that they aim to make government bail-outs less likely. The baseline regression model uses Moody's expected default frequencies (EDF) as a firm-risk metric. Ideally, this metric should measure the risk of a firm abstracting from potential bail-out. If, by contrast, the risk metric changes with bail-out expectations to the same extent as CDS spreads, then we may erroneously fail to diagnose a change in risk sensitivity. We find it reasonable, however, to assume that EDFs are only affected by bail-out expectations to a very limited extent. The reason is that EDFs depend on equity prices (valuation and volatility) and equity owners are unlikely to benefit much from bail-out.[25] The respective regression specification is

$$Y_{i,t} = \alpha_0 + \beta_1 \cdot SIB_{i,t} \cdot Post_t + \boldsymbol{\beta_2 \cdot SIB_{i,t} \cdot Post_t \cdot EDF_{i,t}} + \delta_1 \cdot SIB_i + \delta_2 \cdot Post_t + \delta_3 \cdot EDF_{i,t} + \delta_4 \cdot SIB_i \cdot EDF_{i,t} + \delta_5 \cdot Post_t \cdot EDF_{i,t} + \beta_x \cdot x_{i,t} + \gamma_{c,t} + \gamma_i + \epsilon_{i,t} \qquad (2)$$

The notation is the same as used previously. Here, the coefficient of interest is β_2. A positive value of β_2 would suggest that reforms have raised the risk sensitivity of CDS spreads, as intended by the TBTF reforms. Put differently, if β_2 is positive, the relationship between bank risk (as proxied by EDF) and funding costs (as proxied by the CDS spread) has become stronger in response to the TBTF reforms.

We run these regressions using different sample periods; see Figure 3.3.1.

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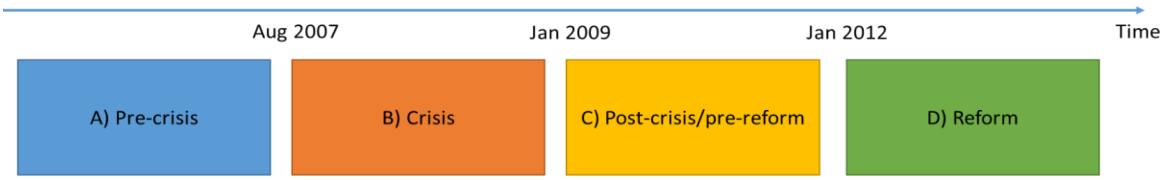
[24] However, the variable itself, e.g. CET1 ratio, is constant for the entire year.

[25] We include the risk-neutral EDFs in robustness checks; see data section and section on robustness checks.

Crisis and reform periods **Figure 3.3.1**



Notes: A) Pre-crisis period extends from January 2004 to July 2007, B) crisis period extends from August 2007 to December 2008, C) post-crisis/pre-reform period extends from January 2009 to December 2011, and D) reform period extends from January 2012 to the end of the estimation sample.

We consider the following specifications:

C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period.

A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period.

A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period.

A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

All the above-mentioned analyses were performed using two alternative definitions of treatment and control groups:

1. Our baseline specification assumes that the treatment group consists of both G-SIBs and D-SIBs (“SIBs”) and the remaining non-SIB banks are the control group.
2. Alternatively, we assume that the treatment group consists only of G-SIBs,[26] while keeping the non-SIB banks as the control group. Our expectation is a bigger treatment effect in the second specification because, here, the difference in the treatment and the control group in terms of their systemic relevance is more pronounced.

3.3.4. Results and discussion

We start by reporting our findings on the change in the level of funding cost advantages, based on equation (1). We then turn to the question of whether the risk sensitivity of SIBs’ CDS spread has changed in response to the TBTF reforms, based on equation (2).

3.3.4.1. Baseline specifications

Regarding the first question, our main finding is that the funding cost advantage has declined for SIBs during the period of TBTF reform implementation, both when compared to the post-crisis/pre-reform period (i.e. 2009-11) and when compared to the entire pre-reform period (2004-11). Estimates of the reform effect are a reduction in the funding cost advantage of

[26] For this purpose, all banks designated at least once as a G-SIB were considered as treated.

between 27 bp and 32 bp (see the coefficient estimates for “post X treat” in Table 3.3.8). By contrast, we do not find that SIBs’ funding cost advantages have changed relative to their pre-crisis levels (see column 3 of Table 3.3.8). This is because SIBs enjoyed a relatively high FCA during the crisis period, including the European debt crisis, as can also be inferred from the descriptive statistics in Figure 3.3.3. The CDS spread for non-SIBs tends to be higher in the crisis periods. This moves the average FCA of the control period (2004-11) up and would suggest that the FCA has declined since the implementation of reforms.

If we base our inference on the narrower definition of the treatment group as only G-SIBs, we obtain somewhat higher estimates of reform effects (see Table 3.3.9). This is in line with our expectations: We expect to find greater reform effects for G-SIBs because stricter reforms apply to these banks than to the rest of the group of SIBs.

Regarding the second question (risk sensitivity), we find some weak evidence that the risk sensitivity of CDS spreads has increased in response to the TBTF reforms (see the coefficient estimates for “post X treat X risk” in Table 3.3.10 and Table 3.3.11). This is mainly true if we consider G-SIBs as the control group. Based on the size of coefficients (and not their significance), we find the biggest increase in risk sensitivity if we compare the pre-crisis (A) and the post-crisis period (C+D, see 4th column of Table 3.3.10 and Table 3.3.11, respectively). This may suggest that increased risk sensitivity is due to a structural break induced by the crisis rather than caused by TBTF reforms. This is in line with the observation that EDFs, CDS spreads, and the correlation were at very low levels in the run-up to the crisis. This may reflect overly optimistic market valuations at that time.

3.3.4.2. Implicit funding subsidies by country group

In order to analyse regional heterogeneity in the effect of TBTF reforms, we study different country group samples. Namely, we separately consider banks from (1) the euro area (Germany, Spain, France, Italy, Netherlands, Finland, Sweden),[27] (2) the US, and (3) Asia-Pacific.[28] Further, we re-estimate the global sample without the euro area to exclude the potential bias from the European debt crisis (“world ex euro area”). We did not consider other groups of countries or other individual countries because either they seem too heterogeneous (e.g., with respect to the institutional setup or economic structure) or they have insufficient observations for reliable inference.

We have re-estimated equation (1) separately for the different country group samples. Note that we have considered only specifications with period-times-country fixed effects. Moreover, we only consider the baseline treatment-control specification, i.e. SIBs vs. non-SIBs. Results are in Table 3.3.12 to Table 3.3.15 and we discuss them below:

- For the euro area, we find a significant reform effect in that the FCA is 51.7 bp lower following reforms as compared to the post-crisis/pre-reform baseline period (January 2009 to December 2011). Comparing the pre-crisis period with the post-crisis reform

[27] We include Sweden, which is not a euro country because Nordea (a G-SIB) moved its headquarters from Sweden to Finland, which is 12a euro area country, during our sample period.

[28] We follow the FSB’s concept of regional consultative groups (RCG) and include Australia in the Asian group.

implementation period (A vs. D), there is no statistically significant difference in the FCA.

- For the USA, we find no significant reform effect if compared to the post-crisis/pre-reform baseline period (C vs. D). We find, however, that the pre-reform FCAs were significantly higher when compared to the implementation period (A+B+C vs D). This is consistent with a high FCA during the crisis period and a subsequent reduction of the FCA.
- For the Asia-Pacific region, we find no significant change between any of the periods.
- For the global sample excluding the euro area, we find weak evidence that the FCA has declined due to the implementation of reforms (C vs. D) and when comparing the post-implementation period with the pre-reform period (A+B+C vs. D). However, the effects are statistically not significant.

This leads to the conclusion that the reform effect is mainly on account of Europe while the average drop of the FCA in the post-crisis period is explained by a crisis-induced increase in bail-out expectations in the US and Europe.

3.3.4.3. Analysis based on resolution reform index

Below, we present the results of an analysis based on the RRI. This index measures for each country the progress in the implementation of the resolution reforms. It obtains values between 0 and 1, where 0 stands for no implementation and 1 stands for full implementation of all reform elements. The country-specific time series start in January 2010. The specification we estimate is a variant of equation (1), in which we replace the post-reform dummy $Post_t$ with the RRI:

$$Y_{i,t} = \alpha_0 + \boldsymbol{\beta_1 SIB_i} * \boldsymbol{RRI_{c,t}} + \xi_{it}^{1*} + \gamma_{c,t} + \gamma_i + \epsilon_{i,t}, \qquad (1^*)$$

where $RRI_{c,t}$ is the country-specific RRI, $\xi_{it}^{1**} = \delta_1 SIB_i + \delta_2 RRI_{c,t}$, and the remaining variables have the same definitions as in Section 3.3. Note that ξ_{it}^{1**} is unidentifiable because it is absorbed through the fixed effects included in the regression. Further, because data on the RRI are available only after 2010, we can only provide meaningful results for the comparison post-crisis/pre-reform vs. reform implementation (C vs. D). Table 3.3.16 shows the estimates for the overall RRI and for three sub-indices that consider progress in the implementation of specific reform elements. The estimates in this table use the baseline treatment-control specification, i.e. SIBs vs. non-SIBs.[29] We find weak evidence that a higher value for the RRI is correlated with a larger decline of the FCA across all specifications. However, none of the estimates is statistically significant.

3.3.4.4. Further robustness checks

In order to test the robustness of our results, we conduct a number of other checks. Each of these robustness checks uses SIBs as the treatment and non-SIBs as the control group.

First, we replace in specification (1), the period-times-country fixed effects with a set of macroeconomic variables, namely real GDP growth, the credit-to-GDP gap, the 10-year

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[29] However, the result also holds for our alternative specification of treatment and control groups.

government bond yield, a measure of the probability of financial crisis (Engle and Ruan, 2019), and the ratio of bank assets to GDP. Table 3.3.17 shows the estimation results. We find that the conclusions are qualitatively unchanged: The FCA drops significantly if we compare the reform implementation period with the post-crisis/pre-reform period (C vs. D) but we cannot identify a significant change between the pre-crisis and reform implementation period (A vs. D).

Second, we use the country-specific crisis probabilities of Engle and Ruan (2019) as an alternative risk metric to replace EDF(1Y) in the risk sensitivity regression of equation (2). Note that this changes the spirit of the risk sensitivity analysis: in the baseline with EDF(1Y), the risk sensitivity refers to a measure of bank-level default risk. In this robustness exercise, by contrast, we study the sensitivity to an aggregate systemic risk. The estimates collected in

Table 3.3.18 confirms the conclusion obtained from our preferred model: we do not find a significant reform effect on the risk sensitivity of SIBs' CDS spreads (C vs. D). However, we find that the risk sensitivity has increased significantly when we compare the reform implementation period with the full pre-reform period (A+B+C vs. D). This suggests that the result reflects a structural change since the crisis than a reform effect.

Third, we replace the EDF concept with the QDF(1Y) concept (see section on data for explanations) in the risk sensitivity regression in equation (2). As in the baseline specification with the EDF concept, this robustness check does not show a significant change in the risk sensitivity of SIBs' CDS spreads in response to the TBTF reforms (Table 3.3.19)..

Funding cost advantage as a function of macro-financial factors

In this section, we present results from an analysis of the extent to which macroeconomic or macro-financial factors have affected SIBs' funding cost advantages. One should not interpret our results causally.

We estimate the following specification:

$$Y_{i,t} = \alpha_0 + \boldsymbol{\beta_1 SIB_i * Post_t} + \boldsymbol{\beta_2 SIB_i * Macro_{c,t}} + \xi^3_{it} + \gamma_{c,t} + \gamma_i + \epsilon_{i,t}, \qquad (3)$$

where $Macro_{c,t}$ is one of the above variables, and $\xi^3_{it} = \delta_1 SIB_i + \delta_2 Post_t + \delta_3 Macro_{c,t}$. Note that the latter term cannot be identified because it is absorbed through the fixed effects. Also, note that we only run the regression for the variant where we compare the post-crisis/pre-reform period with the reform implementation period (C vs. D). By including the interaction of the SIB-Dummy and the Post-Dummy we can check, as a by-product, whether this alternative specification affects β_1, the coefficient of interest in the baseline specification of equation (1).[30]

For the VIX, our expectation is that $\beta_2 < 0$ because we hypothesise that the value of implicit subsidies is particularly high, i.e. funding costs for SIBs are relatively low (as implied by a negative β_2), when markets see a high risk of negative outcomes.

[30] Note that this setup assumes a constant relationship between the SIB status and the macro variable in terms of CDS spreads.

For the 10-year government bond yield, denoted by $Macro_{c,t} = i_{c,t}$, our expectation is that $\beta_2 < 0$ because we hypothesise that when interest rates are low, so are funding cost advantages.[31] By the same argument, we expect that a higher crisis probability should increase the FCA as, in times of heightened aggregate risk, SIBs should benefit more than non-SIBs. Below we point out how this is implied by a negative β_2. First, we define the funding cost advantage as $FCA_{i,t} = Y_{i,t}|_{SIB_i=0} - Y_{i,t}|_{SIB_i=1}$, i.e. the extent, to which funding costs would be higher if a bank did not have SIB status. The partial derivative of the funding cost advantage with respect to the government bond yield is

$$\frac{\partial FCA_{i,t}}{\partial i_{c,t}} = \frac{\partial Y_{i,t}|_{SIB_i=0}}{\partial i_{c,t}} - \frac{\partial Y_{i,t}|_{SIB_i=1}}{\partial i_{c,t}} = \delta_3 - (\beta_2 + \delta_3) = -\beta_2,$$

i.e. the funding cost advantage goes up when $i_{c,t}$ goes up, and it goes down when the government bond yield goes down, i.e. as we pointed out above. An intuitive explanation is that if β_2 is negative (positive), the funding cost of SIBs decreases (increases) with higher values of the macro-variable, which in turn leads to an increasing (decreasing) FCA.

For the two other variables, theory does not provide a clear-cut answer. A larger banking sector makes banks more important and thus should raise governments' incentives to bail out SIBs (to dampen potential knock-on effects). However, it also forces governments to put up more money to bail out banks in a systemic crisis. If fiscal room for manoeuvre is constrained, banks may become "too big to save". Cubillas, Fernández, and González (2017) confirm the existence of the latter effect. The same non-monotonic effect may be at work when examining the effect of the government's indebtedness. On the one hand, a lower debt-to-GDP ratio may enhance the government's fiscal capacity to bail out banks. Then, the funding cost advantage should be higher. On the other hand, lower indebtedness may put the government in a position to prop up the economy after a banking crisis and hence reduce the need to bail out a SIB. Then, the FCA should be lower as the government can easily (from a fiscal perspective) bail out banks and may be thus less likely to let the economy slide into a crisis. Estrella and Schich (2015) provide evidence for the former.

For the VIX, the 10-year government bond yield and the crisis probability, we find the expected signs (Table 3.3.20). A higher increase in investor uncertainty (VIX and crisis probability) and a lower interest rate level (yield of the 10-year bond) reduces SIBs' funding cost advantage, though only the coefficient on the interest rate is significant. The coefficient on the debt-to-GDP ratio is positive and significant. Thus, the CDS spreads of SIBs are higher and their FCA lower if government debt is higher, which confirms the finding of Estrella and Schich (2015). This would also be consistent with a positive feedback loop between bank risk and sovereign risk.

Finally, it is worth noting that β_1, the coefficient of interest in the baseline specification of equation (1), is positive in four out of five specifications (two are significant). This confirms our

31 This could be the case because of the zero lower bound (yields of SIBs cannot go down by as much as for non-SIBs). An alternative explanation is that in times of low interest rates, investors hunt for yield and buy higher yielding bonds from non-SIBs, which depresses the yield difference between the two.

previous result, namely that the FCA of SIBs decreased after the reforms were implemented (C vs. D).

3.3.5. A comparison of CDS spreads of holding and operating companies

3.3.5.1. Background

Some reform elements, such as TLAC and internal TLAC at the global level or MREL in the EU or ring-fencing in the UK, could differentially affect the probability of a bail-in of bonds of holding (HoldCo) and operating companies (OpCo). This could then drive a wedge between the pricing of HoldCo and OpCo debt. For instance, banks in the UK or Switzerland have issued TLAC liabilities at HoldCo level to achieve structural subordination (via their organisational structure). The HoldCo then holds/buys the internal TLAC issued by the OpCo. In a crisis scenario, an OpCo would pass on its losses to, and be recapitalised by, the HoldCo via the triggering of the OpCo's internal TLAC in accordance with its terms and conditions. This means that the statutory resolution powers including bail-in could be applied at the HoldCo level to address the loss-absorption and recapitalisation needs of the resolution group, without subjecting the OpCo to statutory resolution proceedings.[32] Second, a HoldCo is typically dependent on dividend payments or interest payments from the downstream OpCos to service its debt, which is the case even before the reforms. Thus, it seems reasonable to assume that HoldCo debt is riskier when compared to the debt of their operating companies, other things being equal. Against this background, we can formulate two hypotheses. First, we should observe a tendency towards diverging pricing following the inception of resolution reforms; see above. Second, more generally, we should also observe a differential pricing for risk (between HoldCo and OpCo) whenever the HoldCo is liable for debt of the OpCo (or companies) and markets believe that – for whatever reason – the HoldCo's probability of default is therefore higher. The issue of differential pricing – also due to the new regulatory environment – has also received some attention from the financial industry (e.g. UniCredit, 2017; International Financial Law Review, 2017; Financial Times, 2015).

The above hypothesis can be tested by comparing the CDS of the operating and holding company of the same banking group. This approach has the advantage that the comparison is within firm and (unobserved) firm characteristics are absent. At the same time, the comparison suffers from the small number of observations: High quality data for operating and holding companies are available only for a limited number of banking groups). In addition, the change in the definition of the credit event in 2014 may contaminate the comparison. In 2014, government intervention was added to the list of credit events in the ISDA master clause of the CDS contract. The difference in CDS spreads between the 2014 and 2003 definitions can therefore be interpreted as the price of protection (insurance) against government intervention (bail-in). The new 2014 definitions are in fact a more generous (insurance) contract and are therefore associated with a higher CDS spread. A paper by Neuberg et al. (2018) that uses CDS on European banks shows that this is indeed the case. They also show that the spread has declined over time, which they interpret as a sign of higher credibility of the bail-in regimes. Against this background, we conduct the analyses for both types of contracts separately.

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[32] Lewrick, Serena and Turner (2019) show that different ways to implement the bail-in-reforms do not seem to affect their estimate for the risk on such bail-inable bonds (p. 21).

All banks included in this analysis – except Capital One – are G-SIBs or D-SIBs. Capital One is, however, subject to the Federal Reserve's stress tests and the academic literature, which we follow here, often also includes such banks in the set of "treated" or "partially treated" banks (e.g. Berndt, Duffie and Zhu, 2019).[33]

3.3.5.2. Results

We find that the CDS spreads of HoldCos over OpCos have increased by between 20-35 bp since 2014 with the higher estimate coming from the new CDS contract (2014 definition). This may be an indication of increased credibility of resolution reforms (see transmission mechanisms above) and thus reflect an intended outcome of reforms.

A more in-depth inspection of our results for the full sample with all banks from Figure 3.3.8 shows, as expected, that the price of insurance against default for the holding company is always higher than that of the operating company, irrespective of the ISDA credit event clause used. A direct comparison of the difference between the two series in Figure 3.3.9 shows that the perceived default risk of the HoldCo relative to the OpCo increased during the great financial crisis.[34] More recently, the two series began to diverge again, starting around 2014. This holds for both ISDA definitions. For the 2003 definition, however, the within-firm spread decreased to zero again more recently. The divergence of the two series post-2014 may be partially driven by the higher riskiness of HoldCo debt due to lower bail-out expectations following resolution reforms. A regional breakdown for the US and all other countries reveals that the HoldCo-OpCo spread has always been positive for the US. It declined from its crisis peak to low levels, reaching its minimum around 2014, and has been increasing since then. By contrast, for banks in the other countries, the HoldCo-OpCo spread was historically not much above zero. This spread showed first signs of divergence from this low level around 2014 and moved up more substantially (and more permanently) in mid-2016 (Figure 3.3.10). These two dates correspond roughly to the European Parliament backing the European Commission's proposal to complete the Single Resolution Mechanism and – for the latter date – the European Commission proposing the banking reform package. Both events could be associated with the recognition of more credible resolution regimes by the markets.[35]

3.3.6. Conclusions

Our results show that reforms have significantly reduced the funding cost advantage of SIBs, with estimates in the range of 27 to 32 bp. By contrast, we do not find conclusive evidence that reforms have raised the risk sensitivity of SIBs' CDS spreads. Further, we find some weak evidence that progress in the implementation of resolution reforms (at national level), as measured by the resolution reform index, correlates with a decrease in the funding cost advantage of SIBs. Yet these results are statistically insignificant.

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33 See Federal Reserve Board (2019) for the most recent list of banks subject to the Dodd-Frank Act stress test (DFAST)

34 This holds also in 2003 in the aftermath of the economic downturn following the dot-com bubble

35 Of course, we note that a reliable identification of the market impact of such events is left to the study by the European Commission.

3.3.7. Tables and figures

Table 3.3.2: Dominant currency and document clause

Jurisdiction(s)	*Dominant currency*	*Dominant document clause*
France, Germany, Italy, Netherlands, Spain, Sweden/Finland, UK, Switzerland	EUR	MM, MM14
Argentina, Brazil, China, Hong Kong, India, Indonesia, South Korea, Mexico, Russia, Saudi Arabia, Singapore, South Africa, Turkey	USD	CR, CR14
Australia	USD	MR, MR14
USA, Canada	USD	XR, XR14
Japan	JPY	CR, CR14

Table 3.3.3: Number of observations by bank type

Firm type	Frequency
G-SIB	4,877
D-SIB	9,325
Non-SIB	13,447
Total	27,649

Table 3.3.4: Number of observations by firm type and data source in a matched dataset

	CDS		+Edf1		+ CET1 Ratio		+ Crisis Probability	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
G-SIB	4,877	18	3,837	28	3,169	29	2,299	32
D-SIB	9,325	34	4,721	35	3,855	36	2,462	34
Non-SIB	13,447	39	5,051	37	3,819	35	2,515	35
Total	27,649		13,609		10,843		7,276	

Notes: G-SIBs and D-SIBs as designated in 2018. May not add up due to rounding errors.

Table 3.3.5: Distribution of banks with at least one observation for CDS spreads by regional consultative group (RCG)

RCG	G-SIB	D-SIB	Non-SIB	Total
Americas	8	5	15	28
Asia	6	19	34	59
Europe	13	25	27	65
MENA	0	0	9	9
RU & ZA	0	4	7	11
Total	27	53	92	172

Notes: South Africa (ZA) and Russia (RU) are formally in separate RCGs but grouped for ease of exposition.

Table 3.3.6: Summary of risk factors and selected bank-level controls

		CDS Spread	EDF1	CET1 Ratio	Leverage Ratio	Total Assets	Risk Density
G-SIB	Mean	88.00	0.63	10.51	6.62	1238.34	0.45
	StdDev	72.89	0.67	2.60	2.49	642.46	0.17
D-SIB	Mean	115.99	0.67	11.78	6.43	320.93	0.48
	StdDev	112.41	0.73	4.23	2.45	265.52	0.20
Non-SIB	Mean	158.98	0.93	11.76	8.81	178.27	0.65
	StdDev	158.63	0.96	4.31	5.27	289.51	0.25

Notes: Total Assets and Sales in billion EUR, Leverage Ratio (book value of equity/total assets), CET1 Ratio (CET1 capital/RWA), and Risk Density (RWA/total assets) in percentage points. G-SIBs and D-SIBs as designated in 2018. The differences between groups are statistically significant.

Table 3.3.7: Banking groups used for the comparison of holding vs. operating company

Name of banking group	Number of observations
Bank of America	179
Barclays	114
Capital One	203
Credit Agricole	194
HBOS	198
HSBC	203
ING	202
JPM	196
Lloyds	85
RBS	202
Standard Chartered	203
Wells Fargo	172

Note: Observation for banking groups with a spread for HoldCo and OpCo.

Table 3.3.8: Diff-in-diff specifications (SIBs vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	A+B+C vs D	A vs D	A vs C+D
post=1 X treat=1	32.2*	27.0**	-3.0	-8.6
CET1 RATIO	-4.1**	-1.9	0.7	-0.9
SUBDEBT	7.2	3.9	6.2**	5.9
EDF	7.1***	8.7***	3.1*	8.8***
Constant	166.7***	136.6***	108.5***	138.2***
N	7531	8891	6463	8242
Adj. R-squared	0.9	0.9	1.0	0.9
Adj. R-squared within	0.07	0.04	0.03	0.03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.9: Diff-in-diff specifications (G-SIB vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1	35.6*	30.4**	-12.1	-17.6
CET1 RATIO	-4.5*	-1.4	2.3	-0.2
SUBDEBT	10.7	5.8	6.9*	9.8
EDF	7.2***	8.8***	4.0**	9.5***
Constant	168.3***	130.3***	94.8***	126.5***
N	5107	6145	4408	5647
Adj. R-squared	0.9	0.9	1.0	0.9
Adj. R-squared within	0.1	0.06	0.04	0.06

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.10: Risk sensitivity specifications (SIBs vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1 X EDF	8.8	15.3*	18.3	38.4
post=1 X treat=1	25.3	16.3	-8.2	-19.4
post=1 X EDF	-22.7**	-24.8***	-25.2	-23.1
treat=1 X EDF	-10.6	-16.8	-11.2	-41.9
CET1 RATIO	-3.5**	-1.9	0.5	-0.3
SUBDEBT	8.4	4.4	6.2**	6.6
Constant	157.7***	137.5***	112.5***	132.6***
N	7436	8820	6382	8171
Adj. R-squared	0.9	0.9	1.0	0.9
Adj. R-squared within	0.1	0.08	0.04	0.05

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.11: Risk sensitivity specifications (G-SIB vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1 X EDF	18.3*	26.8***	45.6	76.0
post=1 X treat=1	25.5	16.8	-22.1***	-34.8***
post=1 X EDF	-25.8***	-29.2***	-20.2	-23.7
treat=1 X EDF	-16.5**	-25.2**	-37.6	-82.5
CET1 RATIO	-3.9**	-1.8	1.8	0.4
SUBDEBT	11.0	5.6	6.8*	10.2
Constant	163.4***	136.9***	103.8***	125.9***
N	5038	6100	4353	5602
Adj. R-squared	0.9	0.9	1.0	0.9
Adj. R-squared within	0.1	0.1	0.06	0.07

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.12: Diff-in-diff specifications (SIBs vs. non-SIBs; region: euro area)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1	51.7**	41.6**	18.8	6.4
CET1 RATIO	-5.7	-4.0	-2.9	-4.2
SUBDEBT	13.4*	9.6*	6.2	5.4
EDF	2.0	4.4	2.4	5.8*
Constant	153.2***	127.0***	123.5***	157.2***
N	2278	2830	1939	2551
Adj. R-squared	0.9	0.9	0.9	0.9
Adj. R-squared within	0.1	0.09	0.03	0.04

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects.

Table 3.3.13: Diff-in-diff specifications (SIBs vs. non-SIBs; region: United States)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1	21.1	34.8**	-12.5	-17.4
CET1 RATIO	-4.5	-1.5	3.3**	1.3
SUBDEBT	17.7	1.0	5.7**	10.2
EDF	29.0**	33.4**	39.9***	33.3**
Constant	74.3	72.0*	3.7	31.9
N	1297	1733	1253	1578
Adj. R-squared	0.7	0.6	0.8	0.7
Adj. R-squared within	0.2	0.08	0.2	0.1

* p < 0.10, ** p < 0.05, *** p < 0.01. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.14: Diff-in-diff specifications (SIBs vs. non-SIBs; region: Asia-Pacific)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1	-4.1	-11.9	NA	NA
CET1 RATIO	0.5	0.6	0.4	0.2
SUBDEBT	-2.2	-5.6	8.8*	-1.7
EDF	6.3	5.5	4.1	6.5*
Constant	131.1***	137.2***	93.6***	126.0***
N	2098	2282	1729	2182
Adj. R-squared	0.9	0.9	0.9	0.9
Adj. R-squared within	0.03	0.04	0.04	0.03

* p < 0.10, ** p < 0.05, *** p < 0.01. "treat" refers to the treatment group as defined in the heading of the table. "post" refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.15: Diff-in-diff specifications (SIBs vs. non-SIBs; region: world ex euro area)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1	25.2	23.3	-10.8	-11.9
CET1 RATIO	-3.3	-0.9	2.3	0.2
SUBDEBT	6.3	2.8	6.9*	6.3
EDF	9.0**	10.1***	3.1	10.0***
Constant	166.0***	136.5***	99.0***	130.2***
N	5253	6061	4524	5691
Adj. R-squared	0.9	0.9	1.0	0.9
Adj. R-squared within	0.05	0.03	0.04	0.03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “treat” refers to the treatment group as defined in the heading of the table. “post” refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.16: Specifications with resolution reform index (RRI, SIBs vs. non-SIBs)

	(1)	(2)	(3)	(4)
	RRI all	**RRI_1**	**RRI_2**	**RRI_3**
treat=1 X RRI	20.3	25.0	7.4	12.4
CET1 RATIO	-2.8	-2.7	-2.7	-2.7
SUBDEBT	7.8	8.2	7.6	7.8
EDF	5.5**	5.6**	5.3**	5.4**
Constant	162.6***	155.2***	166.9***	164.3***
N	6634	6634	6634	6634
Adj. R-squared	0.9	0.9	0.9	0.9
Adj. R-squared within	0.03	0.03	0.03	0.03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “treat” refers to the treatment group as defined in the heading of the table. “post” refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects.

Table 3.3.17: Diff-in-diff specifications with bank-level and macro controls (SIBs vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1	33.9*	30.7**	-3.2	-12.7
CET1 RATIO	-3.4	-0.9	2.2	0.7
SUBDEBT	11.7	2.4	3.3	6.4
EDF	13.9***	14.4***	6.5*	15.3***
RGDP Growth	-3.1*	-6.7**	-8.7***	-5.8**
Credit/GDP Gap	0.5	-0.3	0.06	-0.2
govt10y	24.3***	19.5***	23.1***	23.6***
Debt/GDP	-1.4	-1.7**	-1.0	-1.5*
Pr(Financial Cris.)	0.8***	1.4***	0.6**	0.9***
Bank Assets/GDP in %	-0.2	0.1	-0.07	0.04
Constant	197.9**	140.8**	130.0**	138.2**
N	4310	5260	3808	4838
Adj. R-squared	0.9	0.8	0.9	0.9
Adj. R-squared within	0.5	0.4	0.6	0.5

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “treat” refers to the treatment group as defined in the heading of the table. “post” refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.18: Risk sensitivity specifications with Engle-Ruan prob. of crisis as risk metric (SIBs vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1 X Pr(Financial Cris.)	0.3	0.7*	4.8	8.1
post=1 X treat=1	29.5**	18.9	-11.1	-12.5
post=1 X Pr(Financial Cris.)	0	0	0	0
treat=1 X Pr(Financial Cris.)	-0.8	-1.1**	-5.0	-8.8
CET1 RATIO	0.2	0.7	0.6	0.5
SUBDEBT	-0.9	-1.0	-0.7	-1.2
Constant	133.1***	125.4***	112.8***	141.5***
N	8442	10028	7255	9231
Adj. R-squared	0.9	0.9	0.9	0.9
Adj. R-squared within	0.07	0.08	0.005	0.04

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “treat” refers to the treatment group as defined in the heading of the table. “post” refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.19: Risk sensitivity specifications with QDF(1Y) as risk metric

(SIBs vs. non-SIBs)

	(1)	(2)	(3)	(4)
	C vs D	**A+B+C vs D**	**A vs D**	**A vs C+D**
post=1 X treat=1 X QDF	1.1	4.2	11.0	38.9
post=1 X treat=1	30.9	20.9**	-7.4	-18.4
post=1 X QDF	-9.5***	-10.9***	-13.8	-12.1
treat=1 X QDF	-1.3	-4.9	-8.0	-41.2
CET1 RATIO	-3.6**	-2.5**	-0.6	-1.6
SUBDEBT	8.5	4.7	7.2**	7.2
Constant	152.3***	142.5***	128.1***	148.0***
N	7359	8412	5985	7766
Adj. R-squared	0.9	0.9	1.0	0.9
Adj. R-squared within	0.1	0.1	0.04	0.06

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “treat” refers to the treatment group as defined in the heading of the table. “post” refers to the choice of the periods as indicated in columns 1-4. All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Table 3.3.20: Macroeconomic interactions (C vs. D, SIBs vs. non-SIBs)

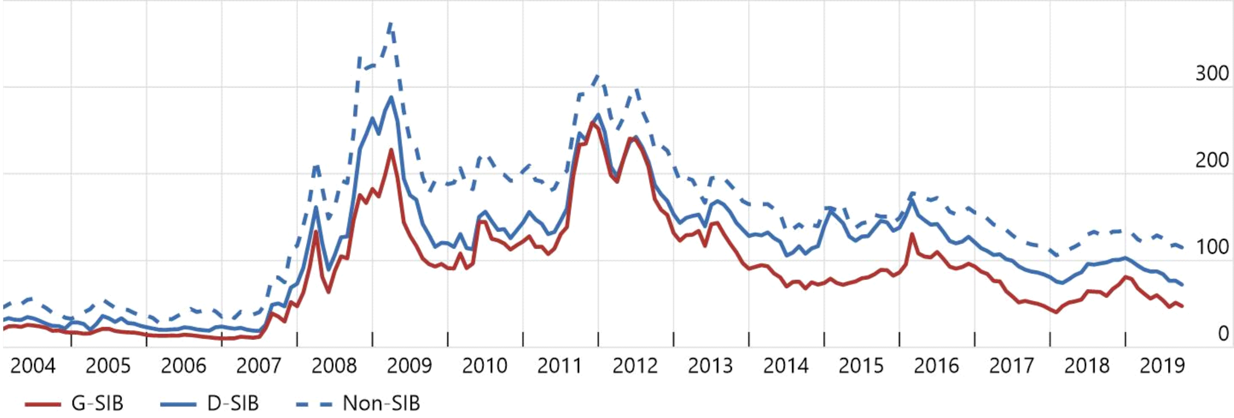
	(1)	(2)	(3)	(4)	(5)
	VIX	**govt10y**	**bankAss2gdp_FSB**	**gross_gdp_debt**	**probability_of_crisis**
treat=1 X macrovar	-0.5	-10.6*	0.3	2.9***	-0.08
post=1 X treat=1	27.3*	18.2	26.8	-3.4	44.1***
CET1 RATIO	-4.2**	-4.1*	-5.1**	-4.2**	-3.7*
SUBDEBT	7.2	10.8	5.8	8.3	12.3
EDF	7.2***	7.5***	7.9***	7.3***	9.3**
Constant	175.0***	186.4***	139.4**	34.3	142.4***
N	7531	6778	6577	7531	4944
Adj. R-squared	0.9	0.9	0.9	0.9	0.9
Adj. R-squared within	0.07	0.09	0.07	0.1	0.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “treat” refers to the treatment group as defined in the heading of the table. “macrovar” refers to the variable as indicated in columsn 1-5 All specifications include bank and country-times-month fixed effects. C vs. D: This specification defines the post-crisis/pre-reform period (C) as the pre-treatment period. A+B+C vs. D: This specification defines the full pre-reform period (A+B+C) as the pre-treatment period. A vs. D: This specification defines the pre-crisis period (A) as the pre-treatment period. A vs. C+D: This specification does not consider reform effects but how the FCA has changed post-crisis vs. pre-crisis. The dummy $Post_t$ is re-defined to obtain a value of one for all observations after 2008 and zero in the pre-crisis period.

Average CDS spread (G-SIBs, D-SIBs, non-SIBs)

In basis points

Figure 3.3.2

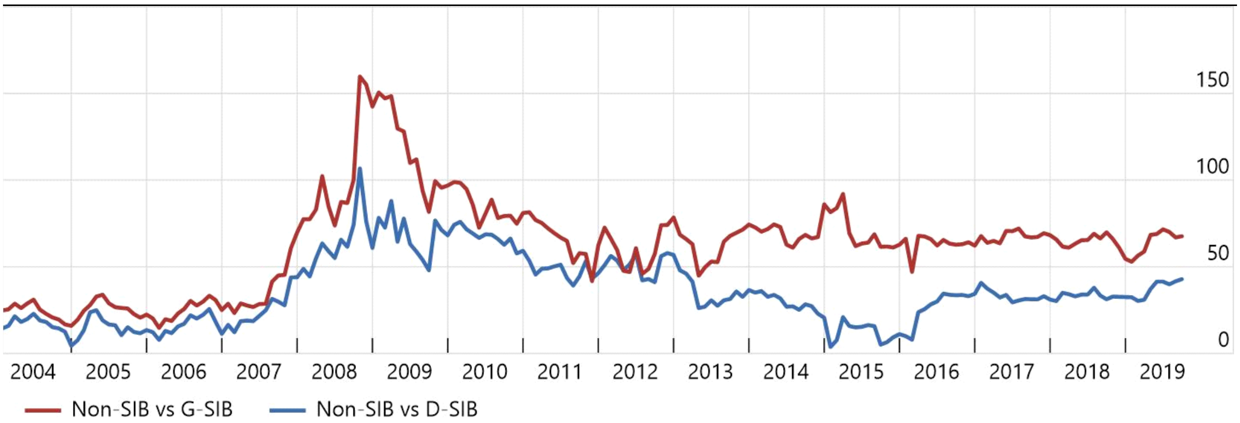


Source: Markit.

Difference in CDS spread between the three bank types (non-SIBs are baseline)

In basis points

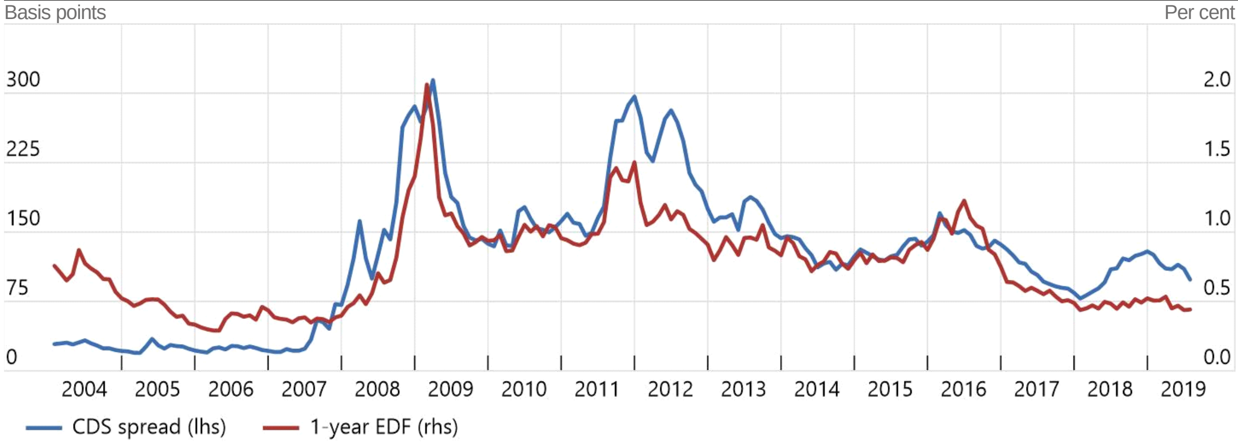
Figure 3.3.3



Source: Mrkit.

Time series of EDF and CDS

Figure 3.3.4

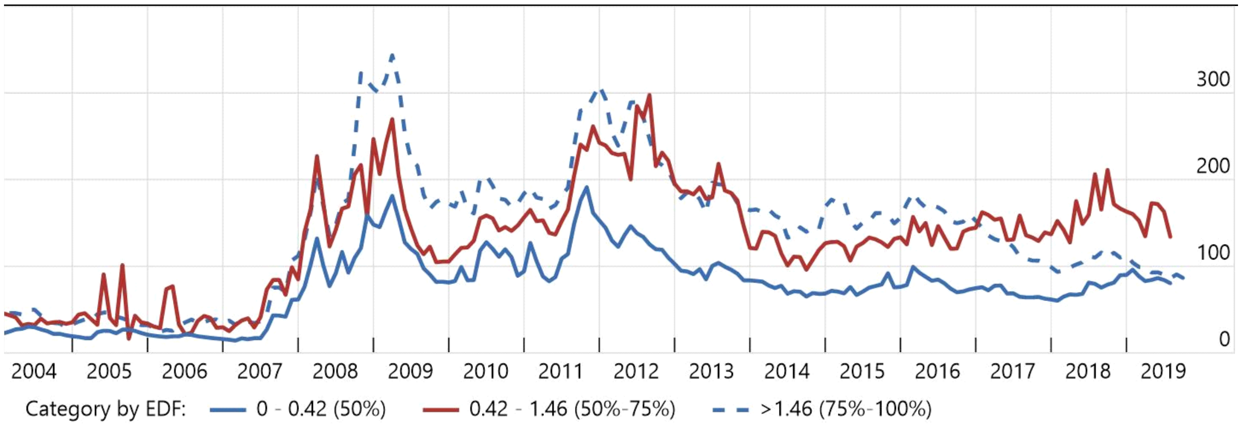


Sources: Markit; Moody's.

CDS spread by EDF category

In basis points

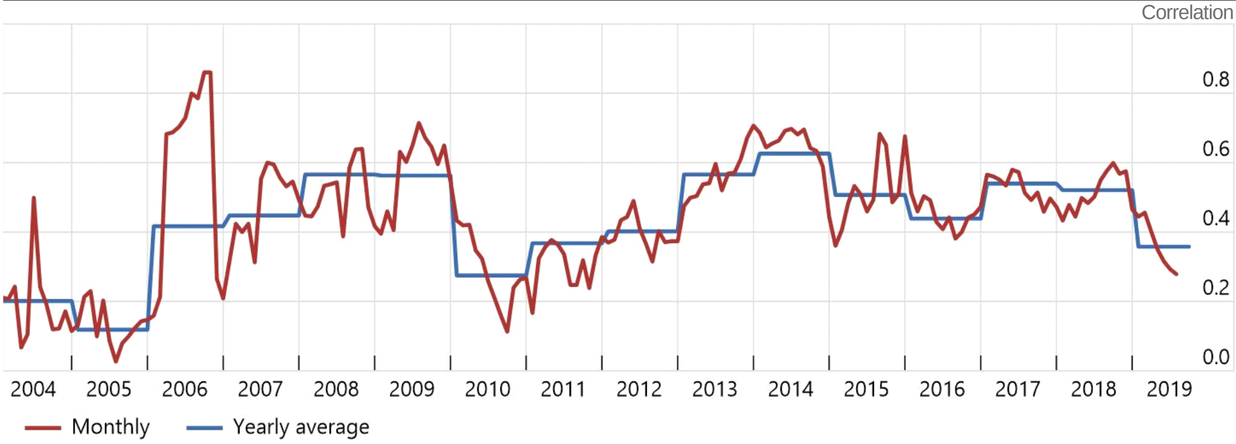
Figure 3.3.5



Sources: Markit; Moody's.

Cross-sectional correlation of EDF and CDS

Figure 3.3.6



Sources: Markit; Moody's.

Time series CDS spread and varying credit clauses

In basis points

Figure 3.3.7 & 3.3.8

Figure 3.3.7. ISDA 2003 & 2014 definitions

Figure 3.3.8. ISDA 2003 definition

Source: Markit.

Difference of spread between holding and operating company

In basis points

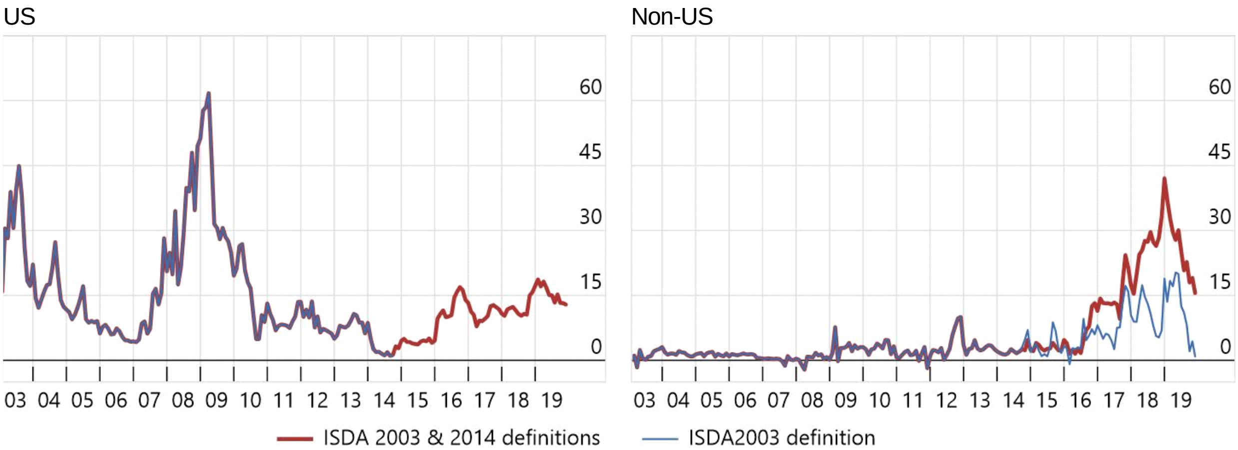
Figure 3.3.9

Source: Markit.

Difference of spread between holding and operating company, regional samples

In basis points

Figure 3.3.10



Note: Non-US includes UK, FR, NL.

Source: Markit.

3.4. An analysis of bond yield spreads in Canada

3.4.1. Introduction

This section estimates the FCA for SIBs using yields of corporate bonds at the time of their issuance. Previous studies suggest that SIBs' FCA peaked during the global financial crisis period of 2007-2008, remained high for a few years, and then fell. At the same time, the existing literature also finds that SIBs' FCA both following the crisis and following the reforms remained at least as high as the average experienced before the crisis. Our contribution to the literature is twofold: first, we extend the time frame covered by previous work, to include a more recent post-regulatory reform implementation period, ending in the second quarter of 2018. Further, we estimate the FCA using a rich sample of Canadian corporate bond issuances across multiple currencies (USD, EUR, CAD, GBP).

3.4.2. Data and Methodology

Data on primary market bond pricing comes from DataScope. We search all bonds issuances by the largest 60 corporations since 2000 following a common selection criterion used in the literature (see Acharya et al. 2016, Santos 2014). We only retain unsecured fixed-coupon bonds that have no equity or derivative-like feature (e.g., they are non-callable, non-puttable, non-convertible, and have no warrants). We consider bonds that are either senior unsecured or junior/subordinated unsecured. We further limit the sample to bonds with at least 1-year to maturity that include an offering price (i.e. ytm) and with an issuance amount. For bonds with missing ytm, we assume that they were issued at par such that their ytm equals their coupon rate.

For each bond that reports a ytm or a coupon rate, we calculate a corresponding spread relative to a term-matched government bond. We use the entire government yield curve to obtain the spread for every bond-maturity and impute the corresponding government yield for bonds with terms for which a government term does not exist. To avoid extreme spread observations, we exclude bonds with small issuance amounts (i.e. less than $10 million). While Canadian corporations issue debt in various currencies, we retain the four major ones: USD, CAD, Euro, and GBP. The sample ends in the second quarter of 2018 to avoid including bail-in eligible debt. Since September of 2018, any senior unsecured debt issued by Canadian SIBs is considered having total loss absorbing capacity (TLAC) and includes equity-like features as it could face conversion via bail-in.

The final sample includes all bonds with data for a full set of control variables from 2000 to the second quarter of 2018. It covers 1711 issuances, of which 66% are by the six largest banks (that are SIBs) and the rest are by other corporations (banks, financials, and non-financials). About 70% of the issuances are in USD, 23% in CAD, and the rest is split evenly between EUR and GBP denominated bonds.

Regression Specification

We run the following two baseline specifications:

$$Y_{i,b,t} = \beta_0 + \beta_1 * SIB_i + \beta_2 * \left(bond\ controls_{i,b,t}\right) + \beta_3 * \left(issuer\ controls_{i,t}\right) + \alpha_t + \epsilon_{i,b,t} \quad (1)$$

$$Y_{i,b,t} = \beta_0 + \beta_1 * (SIB_i * policy_t) + \beta_2 * \left(bond\ controls_{i,b,t}\right) + \beta_3 * \left(issuer\ controls_{i,t}\right) + \beta_4 * policy_t + \alpha_t + \rho_i + \epsilon_{i,b,t} \quad (2)$$

The dependent variable is the bond spread for issuer *i*, of bond *b*, in time period *t,* relative to a maturity-matched government instrument of the same currency; α_t *and* ρ_i are quarter-time and issuer fixed effects. SIB is a dummy variable that equals 1 if the issuer is a SIB. The SIB designation applies to the whole sample period, hence if an institution is designated as such after 2010, it is treated as a SIB throughout the entire sample period. *policy* captures a varying set of dummy variables such that:

crisis dummy equals 1 if year = 2008 or 2009;

pre reform dummy equals 1 if year = 2010 or 2011, and

post reform dummy equals 1 if year >= 2012.

Bond controls include the natural logarithm of its term to maturity in months (Lnterm) and its size (lnsize), its ranking (dummy=1 if *senior unsecured*), and a dummy =1 for USD denominated bonds. We include three issuer control variables: *Issuer_rating*, which captures the issuer's highest rating at the time of issuance. We follow Badertscher et al. (2019) and use Moody's letter grade to convert the rating designation from Aaa (the highest) to B3 (the lowest reported in the sample) into a numerical scale from 1 (Aaa) to 16 (B3). The second control is issuer size (lnTA, in natural log), and the third is the issuer's *Equity_ratio*, defined as the book value of equity over assets. Both measures are obtained monthly from Eikon as of the time of the bond issuance. Finally, we winsorize all variables at the 1st and 99th percentiles.

For both specifications the coefficient of interest is β_1. In equation (1) it captures the spread differential between SIBs and non-SIBs. In equation (2), a positive value of this coefficient indicates that the spread of the treatment group is higher relative to the control group following the reforms, as intended, since this implies a smaller implicit funding cost advantage of SIBs.

3.4.3. Results

Descriptive Statistics

Figure 3.4.1 plots the aggregate number of bond issuances and their total value (in billions of USD) over time. In general, the number of observations is not uniformly distributed with relatively fewer observations for SIBs in the 2000-2006 period, issuances then peak in 2007-2008 (with 123 and 149 issuances, respectively), fall sharply in 2010-2011, and pick up again around 2016-2017 (137 and 86 issuances, respectively). Annual dollar values of SIB issuances rise gradually until 2007, after which they fluctuate between \$20bn and \$40bn per year. There is a noticeable spike in 2016, with more than \$60bn, corresponding to the large number of issuances in that year. The non-SIBs issuance pattern is less volatile, with issuances peaking in the 2008-2011 period, ranging between 40 to 50 per year. For the non-SIBs, the years with the largest issuance amounts are 2010 and 2011, with average issuances per year of about $32bn, with typical issuance amounts in other years ranging between $10bn-$20bn.

Next, we report the summary statistics in Table 3.4.1, where we compare the two groups along their bond and issuer characteristics. SIBs issuances command a lower average spread of about 20bp, compared with the non-SIBs (127 bp, vs. 147 bp). However, the average non-SIB bond has a longer term (170 months vs. 37 months) and is larger in size (at $522 million vs. $330 million for the SIBs). We note as well that while 70% of the non-SIBs issuances are ranked as senior unsecured, only a third of the SIBs bonds are considered as such. The groups differ along their level of risk, as the SIBs median ratings of Aa2 is two notches higher than that of the non-SIBs, which is at A3. As expected, SIBs are also larger with an average asset size of $580bn vs. $37bn by the non-SIBs.

Preliminary evidence on the spreads' evolution over time is presented in Figure 3.4.2, which shows a comparison of the distribution of spreads across the two groups by plotting the interquartile range and the median. The figure suggests that for the SIBs, the median spread varies within the 50-100bp band, aside from a sharp spike in 2008, when it reaches above 150bp. The non-SIB spread follows a similar pattern albeit at a higher range of 100-200bp, while spiking above its upper range in 2008. We test for the annual spread differential between the two groups in Table 3.4.2. The results provide evidence on the existence of a funding advantage for the SIBs (consistent with Figure 3.4.2), which is statistically significant for the 2002-2011 period. The spread differential ranges from a low of 40bp in 2006 to a high of 100bp in 2009. The results also indicate that the funding advantage in the post-reform implementation period (2012 onward) has diminished, given lack of statistical significance between the groups' spreads (which turns negative in all but one of the years). Similar evidence is reported in Figure 3.4.3, which plots the coefficient estimates from a regression of the spread on a set of interacted SIB and yearly dummies.

These preliminary results are broadly in line with the empirical evidence from the literature suggesting that SIBs' funding cost advantages peaked during the global financial crisis, remained high for a few years, and then fell. However, since in our sample the two groups differ along their bond and issuer characteristics, we need to control for them in the next step when conducting the regression analysis, as these features could also contribute to the funding cost differential between the groups.

Regression Analysis

Table 3.4.3 reports our main specification results. From Column 1 we observe that the coefficient on the SIB dummy is negative at 38bp, but it is not statistically significant. However, when we consider the sub-periods and run the regression with firm fixed effects, results from the second column confirm that the SIBs were benefiting from a lower funding cost during the crisis. Specifically, the loading on the interaction term between the SIB and the crisis_2008_2009 dummies is negative and significant (at the 5% level), indicating that during this period SIBs' bond spreads were cheaper by 47bp compared with bonds issued by the non-SIBs. The results also show that in the post reform period (2012 onwards) there is no evidence of a funding advantage to SIBs, as the interaction term for that period is insignificant. We also highlight some key control variable estimates: senior unsecured bonds attract a higher spread than junior subordinated bonds, but larger bonds or those by better-rated issuers command a lower spread (i.e. *Issuer_rating* and lnsize are negative and significant, respectively).

Table 3.4.4 offers additional evidence on SIBs by decomposing this dummy into a G-SIB dummy (to capture 2 of the banks, Royal Bank of Canada and the Toronto Dominion Bank) and a D-SIB dummy (for the other 4: Bank of Montreal, the Bank of Nova Scotia, Canadian Imperial Bank of Commerce, and National Bank of Canada). From the first set of results we find there is no evidence of a funding advantage for either group, as the G-SIB and D-SIB dummies are insignificant. In the second column of Table 3.4.4, the coefficient on the interaction term for G-SIB and the post-reform dummies is positive and significant (at the 5% level), indicating that during the 2012-2018 period, G-SIBs paid on average 137bp more on their issued bonds compared to the rest. Compared to the pre-reform period of 2010-2011, the G-SIBs funding cost increase by about 160bp in the post reform period. As for the D-SIBs, there is only weak evidence of a funding advantage during the crisis period, where they pay on average 56bp less than the rest. This result is only significant at the 10% level. In contrast to G-SIBs, D-SIBs do not face higher funding costs in the post reform period.

Our next set of specifications assesses the relation between funding costs and the rate of progress on the implementation of resolution reforms. To the extent that markets perceive the reforms as credible, a faster implementation should be correlated with a reduction in the funding cost advantage. To that end, we substitute the period dummy-controls with RRI described in Section 2.1.

Table 3.4.5 reports the rate of policy implementation across the different RRI measures for Canada since 2010. For RRI 1, the progress on resolution reforms occurs in two waves: it was quick until 2012, but it slowed-down afterwards, before picking up momentum again between 2015-2016. The implementation of the policies under RRI 2 and RRI 3 takes place later in the sample period, as they pick up momentum in 2018 (RRI 2) and 2016 (RRI). In Table 3.4.6, we show that the overall effect from the index on the spreads is insignificant, but the sub-component attributed to recovery and resolution powers (i.e. RRI 1) is negative, indicating that the SIBs' funding costs increase by 192bp when these reforms are implemented. We note, however, that the estimated coefficient is only weakly significant and we find no evidence for a differential effect on the G-SIBs or on the D-SIBs.

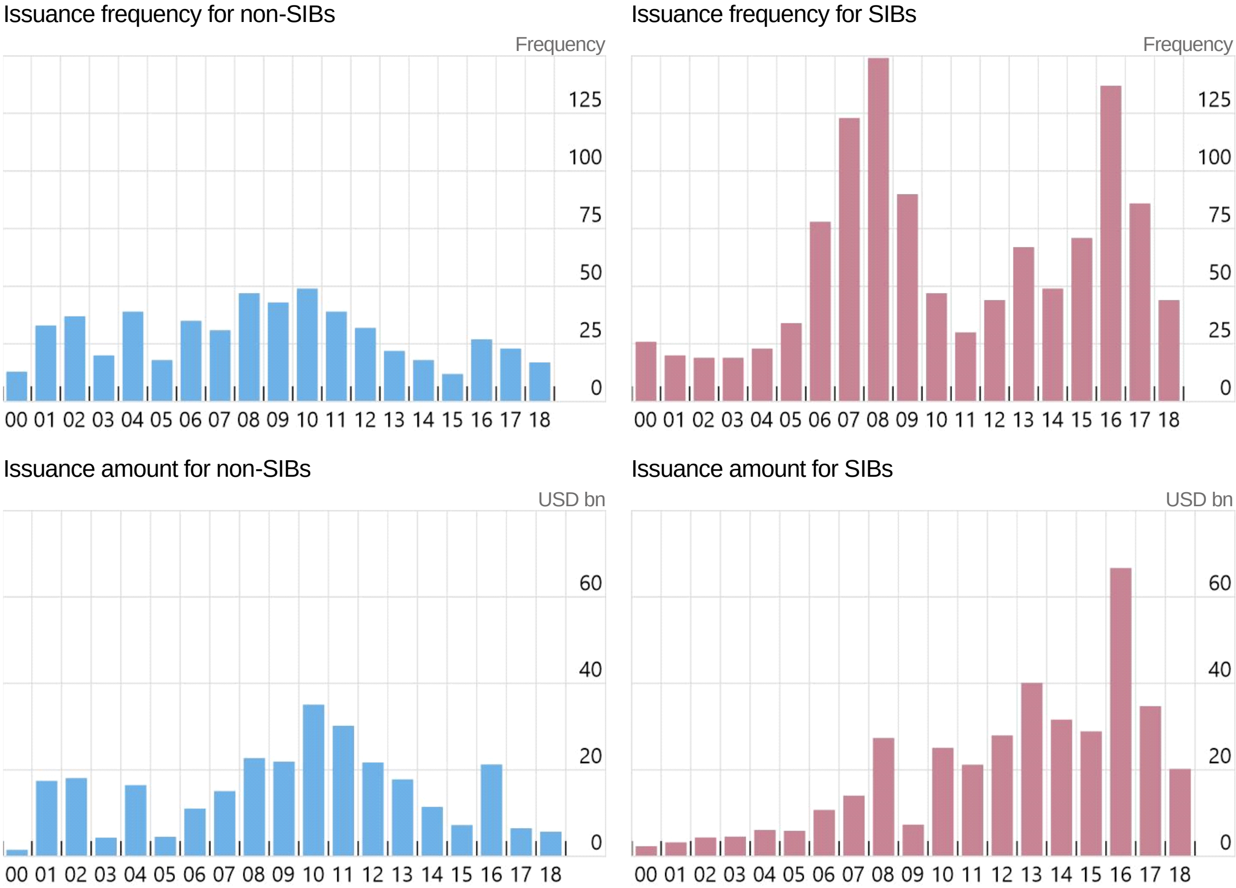
A different aspect that the working group is interested in understanding is the relation between macro and financial conditions and SIBs' funding advantage. In our last set of specifications, we study the relation between bond spreads and the following variables: the monetary policy stance (proxied by the 3-month or the 10-year government yield), the size of the banking sector, the relative share of sovereign debt in GDP, and investor uncertainty (proxied by the VIX). To that end we estimate the following regression:

$$Y_{i,b,t} = \alpha_t + \beta * GSIB_i + \gamma * Post_t + \delta * Macro_t + \theta * GSIB_i * Post_t + \vartheta * Post_t * Macro_t + \pi * GSIB_i * Post_t * Macro_t + \mu * \left(bond\ controls_{i,b,t}\right) + \varphi * \left(issuer\ controls_{i,t}\right) + \epsilon_{i,b,t} \qquad (3)$$

As before, α_t are quarter-time fixed effects, $Post$ is a dummy that is equal to one from 2012 onwards and $Macro$ captures one of the above macro financial variables. Bond and issuer controls are defined similarly as before. Since the results are driven by G-SIBs, we report in Table 3.4.7 the sign and significance of π, the coefficient of interest from the above specification. It captures how G-SIBs' costs are changing with the level of a given macro financial variable during the post reform period. In general, we find that bond spreads move inversely with the size of the banking sector, indicating that G-SIBs benefit from lower costs (compare to the rest) when the banking sector is larger. However, the VIX volatility index is positively associated with bond spreads, indicating that during periods of high uncertainty, G-SIBs face higher funding costs. This result is puzzling because as creditors anticipate bailouts, funding costs should be lower. However, the extent to which this finding is robust remains a topic for further research.

3.4.4. Figures and Tables

Issuance frequency and amounts **Figure 3.4.1**

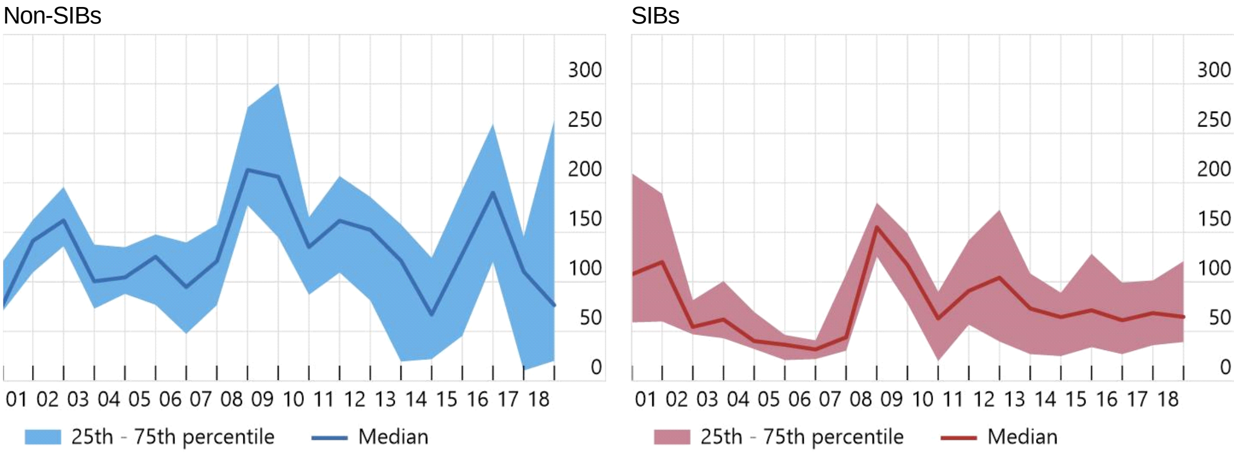


Source: DataScope.

Evolution of spreads

In basis points

Figure 3.4.2

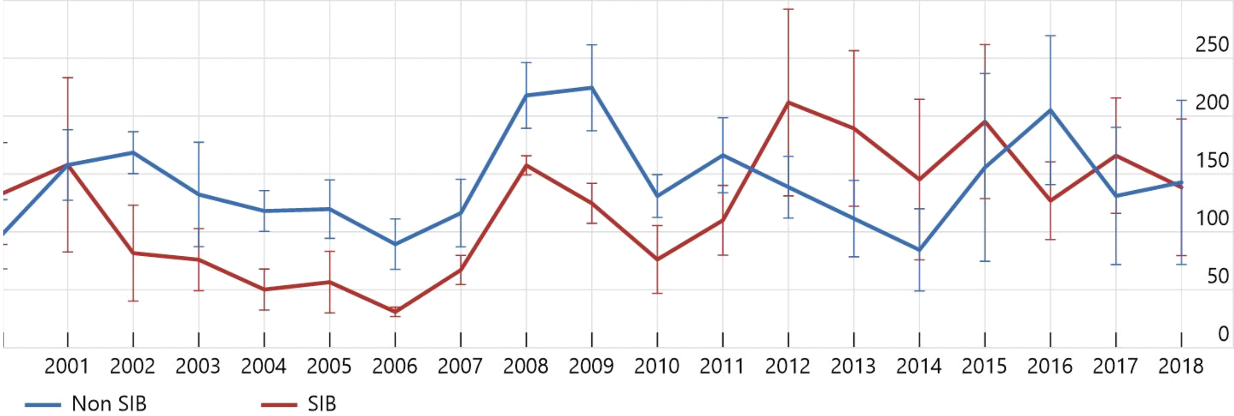


Source: DataScope.

SIBs vs. Non-SIBs funding cost differentials

In basis points

Figure 3.4.3



Note: Figure presents the estimated coefficients (with corresponding 95% confidence intervals) from a regression of the spread on a set of interacted SIB and year dummies.

Source: DataScope.

Table 3.4.1: Summary statistics

Non-SIBs

	N	mean	sd	p25	p50	p75
Spread (in bp)	555	147.37	110.48	82.9	138.7	193.1
Term (in months)	555	169.40	144.73	60	120	360
Bond size ($ mill)	555	522.32	608.51	150	300	648.55
Issued in USD	555	.584	.49	0	1	1
Senior unsecured	555	.699	.45	0	1	1
Issuer rating	555	A3-Baa1	N/A	A3	A3	Baa1
Issuer size ($ bn)	555	37.38	89.50	12	20	29
Issuer cap. ratio	555	.32	.11	.26	.32	.38

SIBs

	N	mean	sd	p25	p50	p75
Spread (in bp)	1156	127.43	184.16	36.4	74.55	132.75
Term (in months)	1156	37.98	32.98	12	24	60
Bond size ($ mill)	1156	330.86	735.10	15	33.05	394.56
Issued in USD	1156	.75	.43	1	1	1
Senior unsecured	1156	.34	.47	0	0	1
Issuer rating	1156	Aa2	N/A	Aa1	Aa2	Aa3
Issuer size ($ bn)	1156	581.22	267.55	380	510	700
Issuer cap. ratio	1156	.05	.01	.04	.04	.05

Table 3.4.2: Yield Spread (in bp) by Group and Year

	Number of Observations		Yield Spread (Mean)			
Year	**Non-SIB**	**SIB**	**Non-SIB**	**SIB**	**Difference**	**p-value**
Overall	555	1156	147.377	127.429	19.948	0.019
2000	13	26	97.902	132.001	-34.100	0.330
2001	33	20	157.766	157.920	-0.154	0.997
2002	37	19	168.438	81.666	86.772	0.000
2003	20	19	132.322	75.984	56.338	0.048
2004	39	23	118.065	50.221	67.844	0.000
2005	18	34	119.648	55.823	63.826	0.004
2006	35	78	71.056	30.942	40.114	0.003
2007	31	123	115.346	66.496	48.850	0.001
2008	47	149	217.836	157.429	60.407	0.000
2009	43	90	224.454	124.660	99.794	0.000
2010	49	47	130.961	76.194	54.767	0.002
2011	39	30	166.033	103.511	62.522	0.015
2012	32	44	138.651	224.321	-85.670	0.134
2013	22	67	111.508	192.410	-80.902	0.198
2014	18	49	84.450	151.914	-67.464	0.299
2015	12	71	155.663	198.778	-43.115	0.621
2016	27	137	199.038	130.616	68.422	0.123
2017	23	86	124.888	165.509	-40.621	0.443
2018	17	44	135.833	142.437	-6.605	0.910

Table 3.4.3: Baseline Yield Spreads Analysis

Sample includes 1156 issuances by SIBs and 555 issuances by non-SIBs between 2000 and 2018q2; spread is the difference between a bond yield and that of a term-matched government instrument; SIB is a dummy =1 if the issuer is either a G-SIB or a D-SIB. *Crisis_08_09* is a dummy =1 for the years 2008 and 2009; *perreform_2010_2011* is a dummy = 1 for the years 2010 and 2011. *Post_reform_2012_2018* is a dummy =1 for the 2012-2018 period. *Lnsize* is the natural log of the bond's issuance amount (in $USD millions). *Lnterm* is the natural log of the bond's term (in months). *Senior_unsecured* is a dummy =1 if the bond is ranked as senior unsecured; *USD* is a dummy = 1 if the bond is issued in US Dollars; *Issuer_rating* is its highest rating at the time of issuance (using Moody's letter grade: Aaa=1, Aa1=2, Aa2=3 … B3=16); *lnTA* and *Capital_ratio* are the corresponding monthly measures for each issuer's total assets (in natural log) and the ratio of equity to total assets; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

	(1)	(2)
VARIABLES	**spread**	**spread**
SIB (=1)	-38.50	
	(65.23)	
SIB_crisis_08_09		-47.63**
		(23.34)
SIB_prereform_10_11		-4.459
		(27.66)
SIB_postreform_12_18		49.09
		(63.40)
crisis_08_09 (=1)		76.01
		(46.95)
pre_reform_10_11 (=1)		101.5*
		(55.08)
post_reform_12_18 (=1)		-59.18
		(93.62)
Lnsize	-33.65**	-28.56**
	(12.87)	(12.39)
Lnterm	-12.05	-21.60
	(22.08)	(22.68)
Senior unsecured (=1)	126.3***	100.4***
	(36.85)	(31.90)
USD (=1)	-16.19*	-0.393
	(9.127)	(7.555)
Issuer_rating	-24.88***	-50.16***
	(8.799)	(17.11)
Lnta	51.30**	1.662
	(21.67)	(25.59)
Capital_ratio	259.1	-20.12
	(183.3)	(190.3)
Constant	-361.8***	-190.6
	(130.3)	(137.7)
Observations	1,711	1,711
Firm FE	No	Yes
Quarter FE	Yes	Yes
Adj R-sq	0.224	0.334

Table 3.4.4: Baseline Yield Spreads Analysis – G-SIBs and D-SIBs

Sample between 2000 and 2018q2 includes 1156 issuances by SIBs, of which 442 are by G-SIBs and 714 are by D-SIBs; there are 555 issuances by non-SIBs; spread is the difference between a bond yield and that of a term-matched government instrument; GSIB is a dummy =1 if the issuer is a G-SIB; DSIB is a dummy =1 if the issuer is a D-SIB; Control variables defined in Table 3.4.3; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)
VARIABLES	**spread**	**spread**
GSIB	78.84	
	(49.54)	
DSIB	0.811	
	(39.62)	
GSIB_crisis_08_09		-32.69
		(29.48)
GSIB_prereform_10_11		-21.20
		(24.88)
GSIB_postreform_12_18		137.7**
		(60.26)
DSIB_crisis_08_09		-56.65*
		(31.01)
DSIB_prereform_10_11		-10.06
		(26.79)
DSIB_postreform_12_18		-12.64
		(31.99)
crisis_08_09		99.62**
		(45.47)
pre_reform_10_11		129.6**
		(49.60)
post_reform_12_18		-17.49
		(82.09)
Constant	-407.8***	-74.19
	(128.8)	(114.5)
Observations	1,711	1,711
Firm FE	No	Yes
Quarter FE	Yes	Yes
Controls	Yes	Yes
Adj R-sq	0.253	0.362

Table 3.4.5: The Resolution Reform Index (RRI) for Canada.

Year	RRI	RRI 1	RRI 2	RRI 3
2010	0.148	0.444	0	0
2011	0.203	0.611	0	0
2012	0.259	0.777	0	0
2013	0.259	0.777	0	0
2014	0.259	0.778	0	0
2015	0.314	0.778	0	0.165
2016	0.481	0.778	0	0.667
2017	0.537	0.833	0.111	0.667
2018	0.716	0.833	0.481	0.833

Table 3.4.6: The Relation between Funding Costs and Rate of Policy Implementation

Sample includes 814 issuances between 2010 and 2018q2 of which 575 are by SIBs and 239 are by non-SIBs; spread is the difference between a bond yield and that of a term-matched government instrument; G-SIB is a dummy =1 if the issuer is a G-SIB; D-SIB is a dummy =1 if the issuer is a D-SIB; the RRI is defined in Table 3.4.5; Control variables defined in Table 3.4.3; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
VARIABLES	**spread**	**spread**	**spread**	**spread**
SIB_rri_overall	-7.773			
	(146.6)			
SIB_rri1		192.6*		
		(108.0)		
SIB_rri2			55.16	
			(141.8)	
SIB_rri3				-51.23
				(88.98)
Constant	411.4	269.7	393.7	490.1
	(294.9)	(233.9)	(313.3)	(307.5)
Observations	814	814	814	814
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Adj R-sq	0.442	0.444	0.442	0.443

Table 3.4.7: The Relation between Spreads and Macro Financial Variables

The table reports the sign and significance of the interaction term between the selected macro financial variable and the Post*GSIB term, as per equation (3). Post = 1 for 2012 onward. The Monetary policy stance is proxied by the 3-month treasury yield. Investor uncertainty is proxied by the VIX. All specifications include a full set of bond and issuer controls (see Table 3), and quarter fixed effects. *** p<0.01, ** p<0.05.

	Banking sector assets to GDP	Sovereign debt to GDP	Monetary policy Stance	Investor uncertainty
Post*GSIB*Macro	-***	Not significant	Not significant	+***

3.5. Bond yield spreads in European primary markets

3.5.1. Introduction

This analysis studies funding costs in the primary bond market before and after the financial crisis of 2007-2009 and the European sovereign debt crisis of 2011-2012. Our contribution to the literature is twofold: we extend previous studies to include the post regulatory reform period, and we examine funding costs using a sample of corporate bond issuances for 28 European countries (EU28[36]).

Our main findings can be summarised as follows. The funding costs for SIBs and non-SIBs displays similar dynamics during the sample period. For both groups, funding costs were very low between 2003 and 2006, increased significantly between 2007 and 2011, and then gradually decreased after 2011, but remained higher than before the crisis. The increase in funding costs during the crisis was larger for SIBs than for non-SIBs, while after the crisis, these dynamics have reversed: funding costs have decreased more quickly for SIBs than for non-SIBs. Taken at face value, this development does not indicate that differences in funding costs have disappeared after the crisis. To control for confounding factors, we conduct regression analyses which take into account bank-specific measures of credit risks as well as unobserved macroeconomic factors. We obtain mixed evidence regarding the funding advantage of SIBs relative to non-SIBs. Relative to non-SIBs, average funding costs of SIBs have not increased in the reform period after 2012 nor after 2014. If we allow for a gradual implementation of specific reform measures instead of using a simple post-reform dummy, we observe a relative increase in funding costs for G-SIBs as resolution reform measures were implemented during this time. Overall, we find evidence consistent with a reduction in the funding advantage of SIBs relative to non-SIBs due to the implementation of resolution reform measures, but we do not find a general effect during the period after announcement of TBTF reforms.

[36] The UK was a member of the EU during the sample period.

Table 3.5.1 Timelines of the reforms

4 November 2011	First list of G-SIBs published
11 October 2012	**Publication of BIS framework for dealing with domestic systemically important banks (D-SIB)**
15 October 2014	Publication of FSB Key Attributes of Effective Resolution Regimes for Financial Institutions
12 June 2014	**Publication of the Bank Recovery and Resolution Directive**
1 January 2015	**Final date for transposition of Bank Recovery and Resolution Directive into national law**
2 November 2015	Publication of future KWG change w.r.t. statutory subordination
9 November 2015	Publication of Principles on Loss-absorbing and Recapitalisation Capacity of G-SIBs in Resolution (TLAC Term Sheet)
1 January 2016	Start of the Single Resolution Mechanism (SRM) & activation of the bail-in tool
1 June 2016	First publication of O-SII list in Germany
1 January 2017	Change to the subordination status of unsecured senior bank bonds in German banking law (KWG) coming into effect (statutory subordination)
June 2017	First cases within the resolution framework in IT and ES

3.5.2. Data and summary statistics

Our data on primary market bond pricing comes from the Centralised Securities Data Base (CSDB), for the issuers from the EU. The CSDB aims to cover all securities relevant for the statistical purposes of the European System of Central Banks (ESCB), including various kinds of debt instruments, equities or options. We describe all data filters to identify the relevant sample in the appendix section. The final sample has 74,980 securities, with issues between the years 2000 and 2019, and includes issues by 9 G-SIBs. In the following discussion, we divide the reporting banks into SIBs (G-SIBs or D-SIBs) and the control group, which comprises the remaining banks.

Figures 3.5.1 and 3.5.2 present the aggregate number of bond issuances over time and the aggregate issue volume (in billions of euro). The number of observations is not uniformly distributed over time with relatively few observations for SIBs before 2008.

The CSDB reports the country in which the issuer of a security is domiciled, and Figure 3.5.3 shows the issuance volume by country for the entire sample period 2000-2019. Among SIBs, German banks dominate, while in the control group, the majority of issues are from German and Italian banks.

Figure 3.5.4 presents the median yield spread over time. The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. Roughly speaking, the evolution of the average spread can be broken down into three periods. Before the crisis, the average spread was close to zero, while it sharply increased during the global financial crisis and the European sovereign debt crisis, peaking at over 200 bp in 2012. After 2012, the spread has decreased considerably, but has not reached pre-crisis levels. These dynamics are very similar for SIBs and the control group.

Figure 3.5.5 presents the median yield spread over time similar to Figure 3.5.4, but separating the banks according to whether the bank as an issuer exhibits a prime-grade rating which is de-fined as AAA or AA+ according to S&P (or the corresponding ratings of Moody's, Fitch or DBRS). The figure highlights that the sharp increase in the yield spread during the crises periods is mostly driven by non-prime rated banks. For non-SIBs the difference is most pronounced as yield spreads for prime-rated non-SIBs are even lower than for prime rated SIBs.

Figure 3.5.6 displays the evolution of the average maturity (in years). If creditors become more risk-sensitive during times of stress, they could not only require a higher return for providing funding, but they could also decide to reduce the maturity. We observe a decline of average maturities for the SIBs during the financial crisis and relatively stable maturities since 2010.

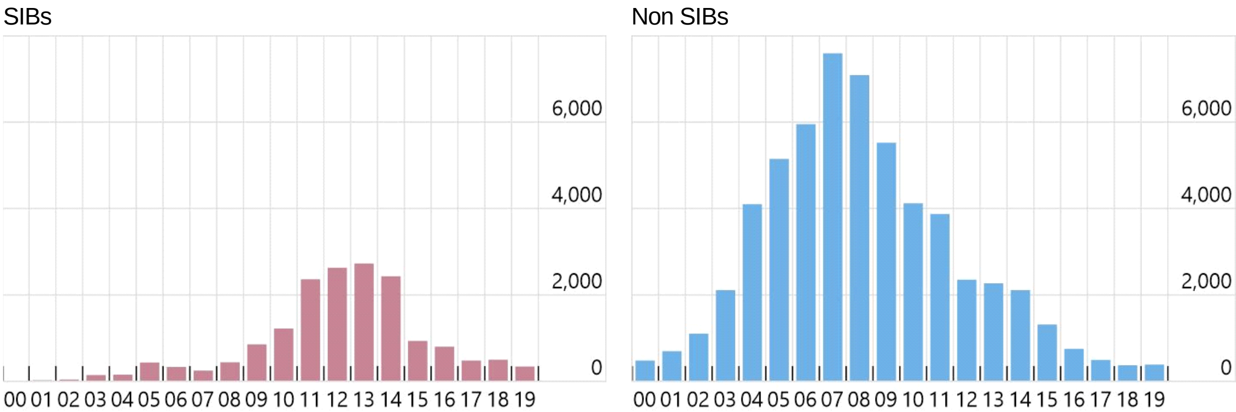
Tables 3.5.2 and Tables 3.5.3 reports summary statistics. For the entire sample 2000-2019, the median yield spread was about 133 bp for SIBs and about 67 bp for the control group. While the maturity of the bonds is very similar for both groups with a median maturity of 4 to 5 years, the groups naturally differ in terms of the issuance volume. The average volume is about EUR 28 mn for SIBs, while it is EUR 4 mn for the control group.

Table 3.5.4 breaks the median yield spread down by the year of issue. The median spread differs significantly between the two groups for most of the sample period (see the last column in Table 3.5.4). This table also reveals that the difference in the average yield spread changes in 2012. While the spread was larger for SIBs before 2012, the opposite is true after 2012. It seems that the average spread of the SIBs has shrunk faster after the crisis relative to the control group.

The number of bond issues in the primary market (European sample, 2000-2019)

Number of bond issues

Figure 3.5.1



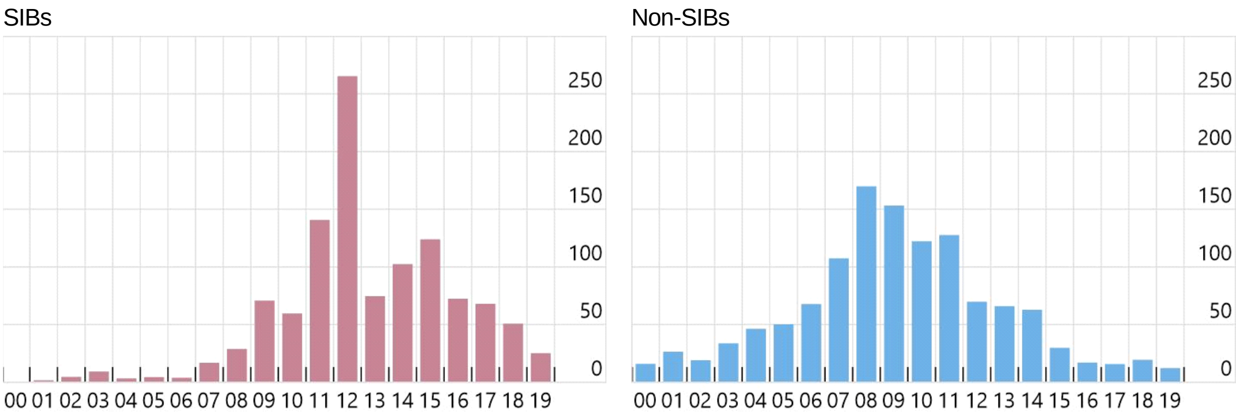
Note: SIB refers to a global or domestic systemically important bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010.

Source: Centralised Securities Data Base (CSDB).

Issue size in the primary market (European sample, 2000-2019)

In billions of EUR

Figure 3.5.2



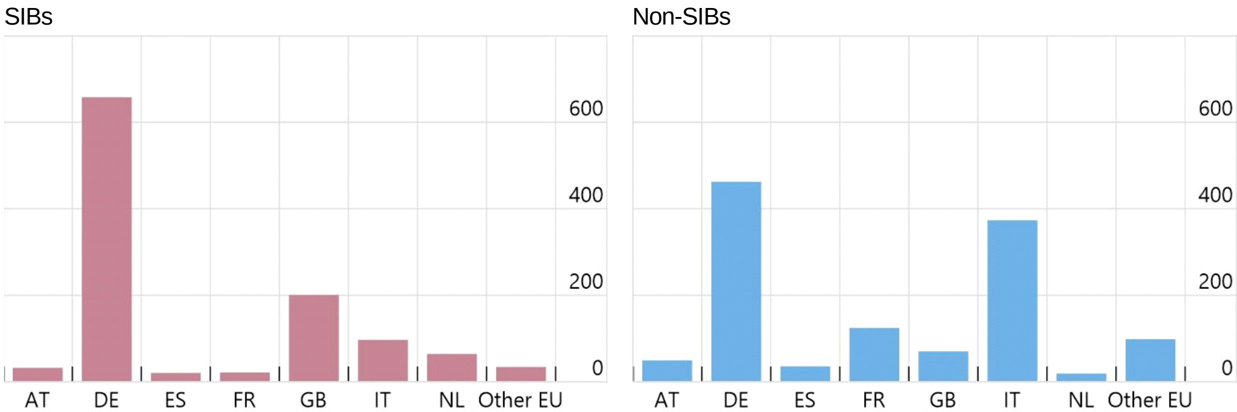
Note: SIB refers to a global or domestic systemically important bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010.

Source: Centralised Securities Data Base (CSDB).

Issue size by country of issuer (2000-2019)

In billions of EUR

Figure 3.5.3



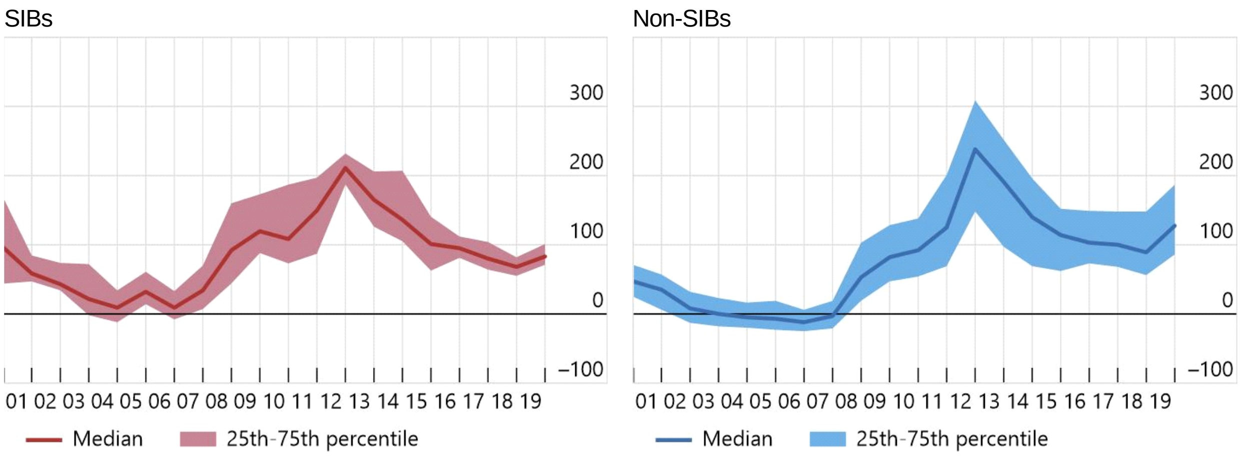
Note: SIB refers to a global or domestic systemically important bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010. The category Other EU comprises issuers in 18 other European countries.

Source: Centralised Securities Data Base (CSDB).

The yield spread in the primary market (European sample, 2000-2019)

In basis points

Figure 3.5.4



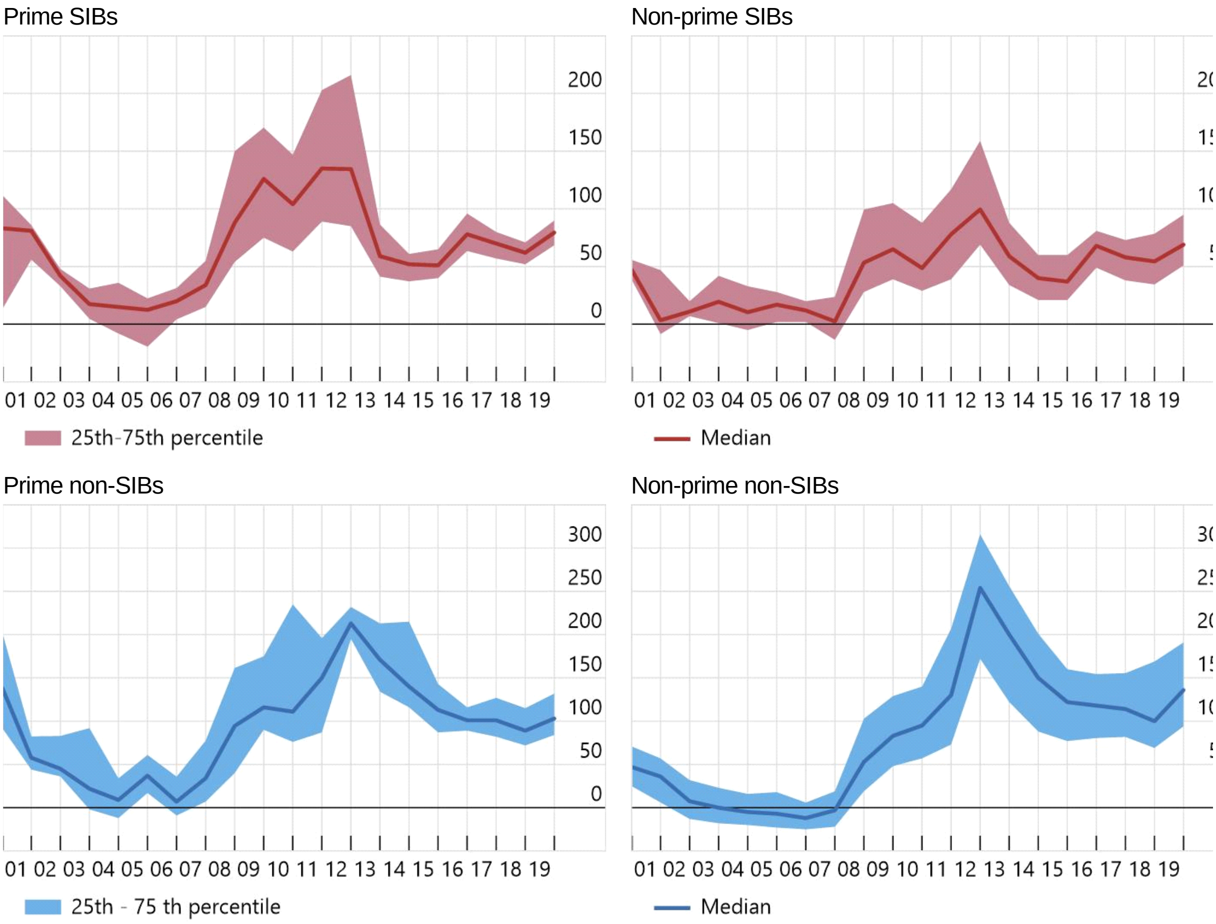
Note: The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. SIB refers to a global or domestic systemically important bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010.

Source: Centralised Securities Data Base (CSDB).

The yield spread and issuers' credit ratings (European sample, 2000-2019)

In basis points

Figure 3.5.5



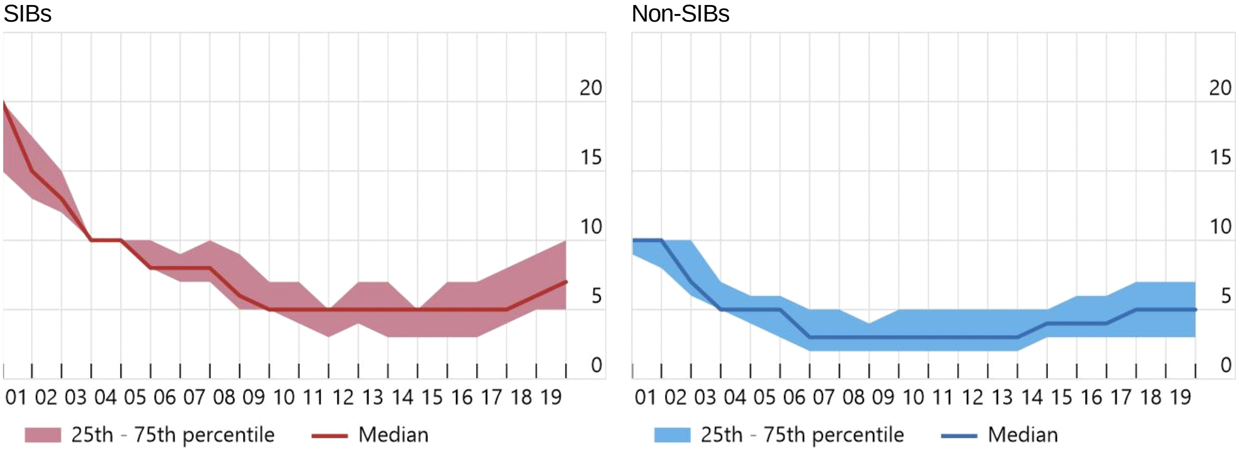
Note: The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. SIB refers to a global or domestic systemically important bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010. An institution is denoted as Prime if it has an AAA or AA+ according to S&P (or the corresponding ratings of Moody's, Fitch or DBRS).

Source: Centralised Securities Data Base (CSDB).

Maturities of issues in the primary market (European sample, 2000-2019)

Years

Figure 3.5.6



Note: SIB refers to a global or domestic systemically important bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010.

Source: Centralised Securities Data Base (CSDB).

Table 3.5.2: Summary statistics (European sample, 2000-2019)

Panel A: Overall

Variable	Number of observations	Mean	Std. Dev.	Percentile 5th	25th	50th	75th	95th
Yield Spread (basis points)	17128	145.0	89.0	15	78	133	203	321
Maturity at issue (years)	17128	5.8	2.7	2	4	5	7	10
Issue size (millions of euro)	6962	162.1	788.1	1.6	10.0	27.5	100.0	500.0

Panel B: Prime

Variable	Number of observations	Mean	Std. Dev.	Percentiles 5th	25th	50th	75th	95th
Yield Spread (in bp)	3465	94,9	73,7	11	52	74	120	257
Maturity at issue (years)	3465	6,4	3,2	2	4	6	9	11
Issue size (EUR mn)	3407	92,4	210,4	2	10	45	100	250

Panel C: Non-Prime

Variable	Number of observations	Mean	Std. Dev.	Percentiles 5th	25th	50th	75th	95th
Yield Spread (in bp)	13663	157,7	88,1	18	96	148	213	327
Maturity at issue (years)	13663	5,6	2,6	3	4	5	7	10
Issue size (EUR mn)	3555	228,9	1079,3	1	10	20	87	1000

Note: This table presents summary statistics for SIB in the European sample. These statistics cover the number of observations at the bond level, mean, standard deviation (Std. Dev.), and the 5th, 25th, 50th, 75th and 95th percentiles. The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. An institution is denoted as *Prime* if it has an AAA or AA+ according to S&P (or the corresponding ratings of Moody's, Fitch or DBRS). For details on the construction of the sample, see the Appendix.

Table 3.5.3: Summary statistics for non-SIBs (European sample, 2000-2019)

Panel A: Overall

Variable	Number of observations	Mean	Std. Dev.	Percentile				
				5th	25th	50th	75th	95th
Yield Spread (basis points)	57852	65.0	91.4	-33	-5	37	110	262
Maturity at issue (years)	57852	4.3	2.5	1	3	4	5	10
Issue size (millions of euro)	49875	24.7	134.4	0.3	1.5	4.0	10.0	75.0

Panel B: Prime

Variable	Number of observations	Mean	Std. Dev.	Percentiles				
				5th	25th	50th	75th	95th
Yield Spread (in bp)	2187	68,7	63,6	-4	28	55	90	197
Maturity at issue (years)	2187	6,0	3,4	2	4	5	8	11
Issue size (EUR mn)	2132	80,3	339,1	1	2	5	20	500

Panel C: Non-Prime

Variable	Number of observations	Mean	Std. Dev.	Percentiles				
				5th	25th	50th	75th	95th
Yield Spread (in bp)	55665	64,862763	92,3610958	-33	-6	36	111	265
Maturity at issue (years)	55665	4,2582233	2,48506714	1	3	4	5	10
Issue size (EUR mn)	47743	22,2562115	116,538789	0	2	4	10	70

Note: This table presents summary statistics for the European sample. These statistics cover the number of observations at the bond level, mean, standard deviation (Std. Dev.), and the 5th, 25th, 50th, 75th and 95th percentiles. The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. An institution is denoted as *Prime* if it has an AAA or AA+ according to S&P (or the corresponding ratings of Moody's, Fitch or DBRS) For details on the construction of the sample, see the Appendix.

Table 3.5.4: Yield Spread (in basis points) by banking group and by year

	Number of observations		Yield Spread (Median)			
Year	**SIB**	**Non-SIB**	**SIB**	**Non-SIB**	**Difference**	***p*-value**
Overall	17128	57839	134	37	97	0,000
2000	12	481	100	47	53	0,000
2001	28	699	59	35	24	0,008
2002	39	1104	43	8	35	0,000
2003	147	2109	21	0	21	0,001
2004	154	4101	9	-5	14	0,060
2005	435	5150	32	-7	39	0,000
2006	335	5951	9	-12	21	0,004
2007	248	7589	34	-3	37	0,000
2008	441	7082	92	53	39	0,000
2009	854	5526	120	82	38	0,000
2010	1224	4123	109	92	17	0,008
2011	2362	3872	150	125	25	0,001
2012	2627	2353	211	238	-27	0,012
2013	2726	2267	165	191	-26	0,080
2014	2432	2111	136	140	-4	0,710
2015	936	1314	101	114	-13	0,493
2016	803	753	95	103	-8	0,495
2017	482	495	80	100	-20	0,069
2018	502	373	68	89	-21	0,012
2019	341	386	83	128	-45	0,007

Notes: SIB refers to a Global or Domestic Systemically Important Bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010. The number of observations indicate the number of bond issuances for each year. The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. The table reports the median yield spread in each of the two groups by year and the difference in medians between the two groups. The last column reports *p*-values for the null hypothesis that the difference in medians is equal to zero. These tests are based on a quantile regression with standard errors clustered at the issuer (i.e. bank) level (Parente and Santos Silva, 2016).

Table 3.5.5: Yield Spread (in basis points) by banking group, rating and year

	Number of observations				Prime: SIB vs. Non-SIB		Non-Prime: SIB vs. Non-SIB	
Year	**SIB Prime**	**SIB Non-Prime**	**Non-SIB Prime**	**Non-SIB Non-Prime**	**Difference in Medians**	***p*-value**	**Difference in Medians**	***p*-value**
Over all	3465	13663	55652	55652	19	0,000	112	0,000
2000	6	6	2	479	18	0,687	53	0,010
2001	9	19	8	691	75	0,012	22	0,000
2002	13	26	6	1098	30	0,000	37	0,000
2003	22	125	18	2091	-2	0,810	22	0,020
2004	25	129	26	4075	2	0,929	14	0,062
2005	56	379	45	5105	-4	0,587	44	0,000
2006	41	294	27	5924	8	0,141	19	0,001
2007	78	170	64	7525	31	0,000	37	0,000
2008	161	280	120	6962	34	0,000	42	0,004
2009	284	570	209	5317	61	0,000	33	0,001
2010	278	946	250	3873	55	0,000	16	0,025
2011	327	2035	253	3619	57	0,000	20	0,009
2012	312	2315	238	2115	35	0,038	-41	0,000
2013	268	2458	188	2079	0	1,000	-29	0,012
2014	241	2191	205	1906	12	0,034	-10	0,279
2015	225	711	157	1157	14	0,208	-9	0,582
2016	265	538	125	628	10	0,090	-17	0,228
2017	257	225	107	388	12	0,047	-13	0,181
2018	341	161	96	277	7	0,425	-11	0,436
2019	256	85	43	343	11	0,208	-33	0,203

Notes: SIB refers to a Global or Domestic Systemically Important Bank (G-SIB or D-SIB). The designation applies to the whole sample period, i.e. if an institution is a SIB at some point after 2010, it is also treated as a SIB before 2010. The number of observations indicate the number of bond issuances for each year. The yield spread is the difference between the yield-to-maturity of a given bank bond at the date of issue and the yield on German bunds with the same maturity on that date. An institution is denoted as *Prime* if it has an AAA or AA+ according to S&P (or the corresponding ratings of Moody's, Fitch or DBRS). The table reports the differences in the median yield spread between SIB and Non-SIB, conditional on the rating status. The table also reports *p*-values for the null hypothesis that the respective differences in medians are equal to zero. These tests are based on a quantile regression with standard errors clustered at the issuer (i.e. bank) level (Parente and Santos Silva, 2016).

3.5.3. Quantitative analyses

Based on the final dataset of bonds issued by European banks we run two types of quantitative analyses. First, we examine potential refinancing advantages of SIBs by using a fixed effects (FE) regression framework. Second, we implement a DiD estimation. The FE models we estimate are as follows:

Included in the main analysis:

$$Y_{bc,t} = \alpha_{c,t} + \beta * SIB_{bc} + \gamma * ln\left(issue\ size_{bc,t}\right) + \delta * ln\left(maturity_{bc,t}\right) + \theta * rating_{bc,t} + \epsilon_{bc,t} \tag{1.1}$$

$$Y_{bc,t} = \alpha_{c,t} + \beta * SIB_{bc} + \gamma * ln\left(issue\ size_{bc,t}\right) + \delta * ln\left(maturity_{bc,t}\right) + \theta * rating_{bc,t} + \vartheta * bank\ controls_{bc,t-1} + \epsilon_{bc,t} \tag{1.2}$$

$$Y_{bc,t} = \alpha_{c,t} + \rho_b + \beta * SIB_{bc} + \gamma * ln\left(issue\ size_{bc,t}\right) + \delta * ln\left(maturity_{bc,t}\right) + \theta * rating_{bc,t} + \vartheta * bank\ controls_{bc,t-1} + \pi * policy_t + \mu * \begin{pmatrix} & policy_t \\ SIB_{bc} * & bank\ controls_{bc,t-1} \\ & macro_{c,t} \end{pmatrix} + \epsilon_{bc,t} \tag{1.3}$$

Not included in the main analyses, but results are available on request:

$$Y_{bc,t} = \alpha_{c,t} + \rho_b + \beta * SIB_{bc} + \gamma * ln\left(issue\ size_{bc,t}\right) + \delta * ln\left(maturity_{bc,t}\right) + \theta * rating_{bc,t} + \vartheta * bank\ controls_{bc,t} + \pi * policy_t + \mu * \begin{pmatrix} & policy_t \\ SIB_b * & bank\ controls_{bc,t-1} \\ & rating_{bc,t} \\ & ln\left(maturity_{bc,t}\right) \end{pmatrix} + \varphi * \begin{pmatrix} & bank\ controls_{bc,t-1} \\ policy_t * & rating_{bc,t} \\ & ln\left(maturity_{bc,t}\right) \end{pmatrix} + \sigma * \begin{pmatrix} & bank\ controls_{bc,t-1} \\ SIB_{bc} * policy_t * & rating_{bc,t} \\ & ln\left(maturity_{bc,t}\right) \end{pmatrix} + \epsilon_{bc,t} \tag{1.4}$$

The dependent variable in all models is $Yield\ spread\ Y_{b,c,t}$ of bank b from country c in year t. The main regressor is SIB which is either a single or a vector of dummy variables taking the value one if the bank has been designated as a Global Systemically Important (G-SIB) or a Domestic Systemically Important (D-SIB) bank once and zero otherwise. Based on the CSDB data, we use issue size (log of issue size in billions euro) and maturity (log of maturity in years) as instrument (i.e. bond) level controls. The CSDB dataset has information on ratings, too. We calculate a dummy variable $rating$ taking the value one if an issuer exhibits a long-term prime grade rating of AAA or AA+ by either Moody's, S&P, Fitch or DBRS and zero otherwise. This variable is time invariant and represents our issuer level controls. Further, we supplement the CSDB data with information on bank balance sheets which come at yearly frequency from SNL Financials and utilise the following $bank\ controls$: size (log of total assets), solvency (Common Equity Tier 1 relative to risk-weighted assets [CET1 ratio]), profitability (return on average equity), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). Data points are available for a maximum of 416 banks only. We fill in missing values with country-year or country averages.[37] Moreover, to ease endogeneity concerns we use $bank\ controls$ with a one-year lag. The variable $policy$ is a set of several dummy variables which are defined as follows:

“Simple” crisis definition:

Pre-crisis dummy equals 1 if year <= 2006

Crisis dummy equals 1 if year = 2007 to 2012

Post-crisis dummy equals 1 if year >= 2013

Alternative definition:

Pre-crisis dummy equals 1 if year <= 2007

Crisis dummy equals 1 if year = 2008 or 2009

Pre reform dummy equals 1 if year = 2010 or 2011

Reform dummy equals 1 if year >= 2012

Year dummy variables equalling 1 for the years 2010, 2012 and 2014

As an alternative to dummy variables, we use the RRI index described in Section 2.1. Moreover, we interact our main variable(s) of interest – the SIB coefficient(s) – with the following set of $macro$ control variables: S-Risk, Engle’s crisis probability data, S-Risk capacity, VIX, Debt-to-GDP and the 10-year government bond yields. Finally, we include in all models country-quarter-time fixed effects $\alpha_c t$ and in the interaction models (1.3) and (1.4) issuer (i.e. bank) fixed effects ρ_b. Results for model (1.4) are not included in the report but are readily available on request.

Table 3.5.6 presents descriptive statistics on the variables above. Estimation results concerning SIB on aggregate are presented in Table 3.5.7 whereas the results for G-SIBs and D-SIBs separately are presented in Table 3.5.8. Table 3.5.9 presents the outcome of the interaction between SIB variable(s) and the RRI indexes. Tables 3.5.10 and 3.5.11 decompose the post-reform/crisis period and Tables 3.5.12 and 3.5.13 present the results of the macro interaction term models.

In summary, our results are as follows. We do not find reliable evidence that SIBs have a funding cost advantage relative to non-SIBs. SIB funding costs are typically higher than that of non-SIBs even prior to the crisis and we do not find evidence of a further increase in their relative funding costs since the implementation of reforms.[38]

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[37] Size is reported for 416 banks, solvency for 378 banks, profitability for 198 banks, liquidity for 335 banks and non-performing loans for 363 banks.

[38] In addition to the results presented here, we also conducted a regression analysis to produce the results shown in Table 2 (Estimated funding cost advantages of G-SIBs) of Chapter 5. We do not report details here. Estimation results are available on request.

The coefficient on the SIB dummy, either all SIBs (Table 3.5.7 column (1) or G-SIBs and D-SIBs separately (Table 3.5.8 column (1)), is significant and positive, indicating higher yield spreads for SIBs relative to non-SIBs on average.[39] When interacted with various sets of crises, pre- and post-crises/reform periods yield spreads increase significantly in the crises periods but decrease in the post-reform and post-crises periods (Table 3.5.7), suggesting an increase in the funding advantage of SIBs during these periods. However, the decrease is a bit lower than the previous increase during the crises period; though small the difference is statistically different from zero, in line with descriptive results that funding costs for SIBs are significantly higher after 2006.

The above results continue to hold true when we split SIBs into G-SIBs and D-SIBs (Table 3.5.8). When we decompose the post-reform period for each year separately (Tables 3.5.10 and 3.5.11) we see significant negative coefficients for each of those years. However, results for G-SIBs are to some extent inconclusive. Table 3.5.9 confirms a negative relationship of SIBs and the RRI indexes. But when considering G-SIBs and D-SIBs separately, we see that D-SIBs are driving this result (see columns (1) to (4)). Hence, results for G-SIBs are consistent with the idea that increased implementation of resolution reforms decrease funding advantages.

Finally, results in Table 3.5.12 indicate a positive correlation of SIB yield spreads with S-Risk, Engle and Ruan's crisis probability, S-Risk capacity, the VIX, Debt-to-GDP and 10-year Government bonds yields. Table 3.5.13 shows that these positive correlations are driven by D-SIBs, as G-SIBs show significant negative coefficients.

To validate the main result of insignificant positive effects of the reforms analysed we implement another methodological approach, namely a DiD estimation similar to Agarwal (2019) where we estimate the following set of models:

Included in the main analysis:

$$\begin{aligned}\Delta Y_{bc,t} &= \bar{Y}_{bc,t+x} - \bar{Y}_{bc,t-z} \\ &= \alpha_c + \beta * SIB_{bc} + \gamma * ln\left(\overline{issue\ size}_{bc,t-z}\right) + \delta * ln\left(\overline{maturity}_{bc,t-z}\right) + \theta * \overline{rating}_{bc,t-z} \\ &\quad + \epsilon_{bc}\end{aligned} \tag{2.1}$$

$$\begin{aligned}\Delta Y_{bc,t} &= \bar{Y}_{bc,t+x} - \bar{Y}_{bc,t-z} \\ &= \alpha_c + \beta * SIB_{bc} + \gamma * ln\left(\overline{issue\ size}_{bc,t-z}\right) + \delta * ln\left(\overline{maturity}_{bc,t-z}\right) + \theta * \overline{rating}_{bc,t-z} \\ &\quad + \vartheta * \overline{bank\ controls}_{bc,t-z} + \epsilon_{bc}\end{aligned} \tag{2.2}$$

Not included in the main analyses, but results are available on request:

[39] This result is robust to model specifications with macro control variables instead of country-quarter-time FE. Moreover, when we split the sample and compare G-SIBs and D-SIBs with the control group separately G-SIBs and D-SIBs exhibit higher yield spreads. And, when we compare G-SIBs with D-SIBs, with latter being the sole control group we see that G-SIBs do not exhibit significantly lower yield spreads compared to D-SIBs.

$$
\begin{aligned}
\Delta Y_{bc,t} = \bar{Y}_{bc,t+x} - \bar{Y}_{bc,t-z} \\
&= \alpha_c + \beta * SIB_{bc} + \gamma * ln(\overline{issue\ size}_{bc,t-z}) + \delta * ln(\overline{maturity}_{bc,t-z}) + \theta * \overline{rating}_{bc,t-z} \\
&+ \vartheta * \overline{bank\ controls}_{bc,t-z} + \mu * \left(SIB_{bc} * \begin{matrix} \overline{rating}_{bc,t-z} \\ \overline{maturity}_{bc,t-z} \\ \overline{bank\ controls}_{bc,t-z} \end{matrix} \right) + \epsilon_{bc}
\end{aligned}
\tag{2.3}
$$

The dependent variable in all models is the difference in yield spreads of a pre- and post-event period.[40] In detail, we estimate various DiD models with the event date t being either 2010, 2011, 2012, 2013, 2014, 2015 or 2016 and pre- and post-event windows with x being either 2, 3, 4, 5, 6, 7, 8 or 9 and z being either 1, 2, 3, 4, 5, 6, 7 or 8. We subsequently show results only for the event dates of 2012 and 2014, and as a placebo test for 2010. We define the event date as a two-year window, because pinning down reforms to one year may be deceptive. Most notably, the BRRD was published on 12 June 2014, but was transposed into national law, i.e. came into effect on 1 January 2015. Moreover, it can take some time for markets to adjust to comprehensive reforms like these. Results are robust across all specifications including a one-year event window. Due to the feature of the DiD approach in lacking a time dimension we utilise country fixed effects α_c, only. Again, results for model 2.3 are not included in the report but are available on request.

Similar to the previous analysis, Table 3.5.14 presents descriptive statistics. Results concerning Systemically Important Banks (SIB) on aggregate are presented in Table 3.5.15 and results for G-SIBs and D-SIBs separately are presented in Table 3.5.16.

In line with the previous regressions results we cannot confirm a significant decrease in funding cost advantages of Systemically Important Banks. The placebo analysis shows insignificant coefficients whereas the event dates show significantly negative ones. Again, the coefficients for G-SIBs are larger in magnitude compared to those of D-SIBs.

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[40] We also estimated models with maturity (in ln years) as the dependent variable (results not reported).

Table 3.5.6: Summary statistics

Variable	Unit	No. observations	Mean	Std. Dev.	25th	50th	75th	Definition	Source
Dependent									
Instrument level									
Yield spread	%	74,980	83.28	96.90	5.00	60.00	140.00	Spread between the yield of the bond and the yield of Bunds with equal maturity	CSDB
Maturity	ln	74,980	1.63	0.44	1.39	1.61	1.95	Maturity of the instrument in years	CSDB
Independent									
Instrument level									
Issue size	ln	56,836	15.40	2.23	14.43	15.42	16.52	Size of the instrument	CSDB
Issuer level									
Rating	0/1	74,980	0.08	0.26	0.00	0.00	0.00	Variable is one if issuer has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS and zero otherwise	CSDB
Bank level									
Size	ln	51,579	25.78	1.06	25.60	26.02	26.27	Total assets of the bank	SNL
Solvency	%	51,579	11.65	3.23	9.68	11.21	14.42	Tier 1 Common Capital (CET1) ratio	SNL
Profitability	%	51,579	3.16	7.33	2.17	3.30	4.74	Return on average equity	SNL
Liquidity	%	51,579	36.63	12.22	26.00	40.74	46.35	Liquid assets (Reported B) to total assets	SNL
Non-performing loans	%	51,579	7.05	5.02	3.75	3.75	11.96	Problem loans to gross customer loans	SNL
Reform level									
RRI overall	0/1	19,502	0.30	0.23	0.11	0.22	0.48	Too-big-to-fail reform index (overall)	FSB
RRI subindex 1	0/1	19,502	0.58	0.29	0.33	0.44	0.94	Too-big-to-fail reform index (sub-index 1)	FSB
RRI subindex 2	0/1	19,502	0.10	0.17	0.00	0.04	0.11	Too-big-to-fail reform index (sub-index 2)	FSB
RRI subindex 3	0/1	19,502	0.23	0.27	0.00	0.17	0.33	Too-big-to-fail reform index (sub-index 3)	FSB

Note: This table reports descriptive statistics of the baseline variables. Data for the yield of the bond, its maturity and size as well as the issuer rating come from the Centralised Securities Database (CSDB). Bank level data come from SNL. Reform level data are provided by the FSB Secretariat: The overall index is the average of sub-indexes 1 to 3. In detail, sub-index 1 includes powers to transfer or sell assets and liabilities, powers to establish a temporary bridge institution, power to impose temporary stay on early termination rights, recovery planning for systemic firms, resolution planning for systemic firms, powers to require changes to firms' structure and operations to improve resolvability and minimum external TLAC requirements for G-SIBs. Sub-index 2 includes public disclosure of bank resolution planning and resolvability assessments, cross-border enforceability of bail-in, early termination of financial contracts (cross-border), operational continuity, funding in resolution, continuity of access to Financial Market Infrastructure (FMIs), valuation capabilities, TLAC Holdings, TLAC Disclosure. Sub-index 3 includes external LAC requirements for SIBs and powers to write down and convert liabilities (bail-in).

Table 3.5.7: Baseline SIB – Yield spreads

	(1)	(2)	(3)	(4)	(5)
Dependent variable	*Y*	*Y*	*Y*	*Y*	*Y*
SIB	24.996***	24.714***	0.000	0.000	0.000
	(0.90)	(1.00)	(.)	(.)	(.)
SIB * $Year_{2010}$	-	-	2.100	-	-
			(2.41)		
SIB * $Year_{2012}$	-	-	-7.135***	-	-
			(2.57)		
SIB * $Year_{2014}$	-	-	-14.509***	-	-
			(2.74)		
SIB * $Crisis_{2007\text{-}2012}$	-	-	-	12.086***	-
				(2.94)	
SIB * $Post\text{-}crisis_{2013\text{-}2019}$	-	-	-	-11.728***	-
				(3.24)	
SIB * $Crisis_{2008\text{-}2009}$	-	-	-	-	14.588***
					(2.79)
SIB * $Pre\text{-}reform_{2010\text{-}2011}$	-	-	-	-	8.535***
					(2.83)
SIB * $Post\text{-}reform_{2012\text{-}2019}$	-	-	-	-	-15.351***
					(2.78)
Instrument controls					
Issue size	2.830***	2.959***	-0.155	-0.179	-0.135
	(0.11)	(0.12)	(0.13)	(0.13)	(0.13)
Maturity	-3.477***	-6.051***	-2.780***	-2.990***	-2.796***
	(0.61)	(0.64)	(0.70)	(0.70)	(0.70)
Issuer controls					
Rating	-8.183***	-6.124***	0.000	0.000	0.000
	(0.99)	(1.07)	(.)	(.)	(.)
Bank controls					
$Size_{t-1}$	-	-2.786***	-2.154*	-1.641	-0.574
		(0.45)	(1.19)	(1.19)	(1.20)
$Solvency_{t-1}$	-	-0.327**	-0.906***	-0.929***	-0.571**
		(0.13)	(0.27)	(0.26)	(0.27)
$Profitability_{t-1}$	-	-0.231***	-0.105***	-0.112***	-0.117***
		(0.03)	(0.03)	(0.03)	(0.03)
$Liquidity_{t-1}$	-	-0.005	0.244*	0.333**	0.275**
		(0.05)	(0.14)	(0.14)	(0.14)
Non-performing $loans_{t-1}$	-	0.800***	-0.111	0.010	-0.017
		(0.11)	(0.19)	(0.19)	(0.19)
Constant	30.579***	105.333***	138.651***	122.120***	92.445***
	(2.00)	(11.66)	(29.25)	(29.19)	(29.65)
Country-quarter-time FE	Yes	Yes	Yes	Yes	Yes
Issuer FE	No	No	Yes	Yes	Yes
No. observations	56629	51027	50701	50701	50701
Adjusted R-squared	0.676	0.676	0.770	0.771	0.771
No. SIB obs	6890	6735	6733	6733	6733
No. Non-SIB obs	49739	44292	43968	43968	43968

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressor is the dummy variable SIB, which takes the value one if the bank has been designated once as a global sistemically important (G-SIB) or domestic systemically important (D-SIB) bank. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). In columns (3) - (6) we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.8: Baseline G-SIB & D-SIB – Yield spreads

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
SIB * RRI overall	-48.109***	-	-	-	-	-	-	-
	(5.29)							
SIB * RRI 1	-	-35.621***	-	-	-	-	-	-
		(4.23)						
SIB * RRI 2	-	-	-55.161***	-	-	-	-	-
			(6.96)					
SIB * RRI 3	-	-	-	-41.823***	-	-	-	-
				(4.55)				
G-SIB * RRI overall	-	-	-	-	35.397***	-	-	-
					(13.72)			
G-SIB * RRI 1	-	-	-	-	-	15.019	-	-
						(10.11)		
G-SIB * RRI 2	-	-	-	-	-	-	85.275***	-
							(20.57)	
G-SIB * RRI 3	-	-	-	-	-	-	-	31.157***
								(11.82)
D-SIB * RRI overall	-	-	-	-	-55.156***	-	-	-
					(5.39)			
D-SIB * RRI 1	-	-	-	-	-	-41.635***	-	-
						(4.36)		
D-SIB * RRI 2	-	-	-	-	-	-	-61.565***	-
							(7.00)	
D-SIB * RRI 3	-	-	-	-	-	-	-	-48.093***
								(4.64)
Constant	141.144***	137.451***	146.711***	141.313***	141.171***	138.951***	140.849***	141.940***
	(49.19)	(49.21)	(49.22)	(49.18)	(49.13)	(49.16)	(49.15)	(49.12)
Main effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instrument controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-quarter-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	18168	18168	18168	18168	18168	18168	18168	18168
Adjusted R-squared	0.707	0.707	0.707	0.707	0.708	0.708	0.708	0.708
No. G-SIB obs	505	505	505	505	505	505	505	505
No. D-SIB obs	4286	4286	4286	4286	4286	4286	4286	4286
No. Non-SIB obs	13377	13377	13377	13377	13377	13377	13377	13377

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressors are the set of dummy variables SIB, G-SIB and D-SIB which take the value one if the bank has been designated once as a global systemically important (G-SIB) or domestic systemically important (D-SIB) bank, respectively. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). In columns (3) - (6) we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.9: FSB RRI index – Yield spreads

	(1)	(2)	(3)	(4)	(5)
Dependent variable	*Y*	*Y*	*Y*	*Y*	*Y*
G-SIB	26.712***	33.801***	0.000	0.000	0.000
	(2.30)	(2.51)	(.)	(.)	(.)
D-SIB	24.784***	23.681***	0.000	0.000	0.000
	(0.94)	(1.03)	(.)	(.)	(.)
G-SIB * $Year_{2010}$	-	-	-19.267***	-	-
			(7.42)		
G-SIB * $Year_{2012}$	-	-	-22.998***	-	-
			(6.28)		
G-SIB * $Year_{2014}$	-	-	-36.016***	-	-
			(7.68)		
G-SIB * $Crisis_{2007\text{-}2012}$	-	-	-	-33.165***	-
				(10.11)	
G-SIB * $Post\text{-}crisis_{2013\text{-}2019}$	-	-	-	-32.239***	-
				(10.46)	
G-SIB * $Crisis_{2008\text{-}2009}$	-	-	-	-	-25.078***
					(9.54)
G-SIB * $Pre\text{-}reform_{2010\text{-}2011}$	-	-	-	-	-43.927***
					(9.57)
G-SIB * $Post\text{-}reform_{2012\text{-}2019}$	-	-	-	-	-40.429***
					(8.84)
D-SIB * $Year_{2010}$	-	-	4.009	-	-
			(2.48)		
D-SIB * $Year_{2012}$	-	-	-4.973*	-	-
			(2.71)		
D-SIB * $Year_{2014}$	-	-	-12.451***	-	-
			(2.82)		
D-SIB * $Crisis_{2007\text{-}2012}$	-	-	-	16.487***	-
				(3.07)	
D-SIB * $Post\text{-}crisis_{2013\text{-}2019}$	-	-	-	-9.702***	-
				(3.36)	
D-SIB * $Crisis_{2008\text{-}2009}$	-	-	-	-	18.122***
					(2.91)
D-SIB * $Pre\text{-}reform_{2010\text{-}2011}$	-	-	-	-	13.139***
					(2.93)
D-SIB * $Post\text{-}reform_{2012\text{-}2019}$	-	-	-	-	-13.214***
					(2.88)
Constant	30.616***	112.997***	135.267***	133.848***	100.620***
	(2.00)	(11.82)	(29.26)	(29.23)	(29.71)
Instrument controls	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes
Bank controls	No	Yes	Yes	Yes	Yes
Country-quarter-time FE	Yes	Yes	Yes	Yes	Yes
Issuer FE	No	No	Yes	Yes	Yes
No. observations	56629	51027	50701	50701	50701
Adjusted R-squared	0.676	0.676	0.770	0.771	0.772
No. G-SIB obs	675	662	662	662	662
No. D-SIB obs	6215	6073	6071	6071	6071
No. Non-SIB obs	49739	44292	43968	43968	43968

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressors are the set of dummy variables G-SIB and D-SIB which take the value one if the bank has been designated once as a global sistemically important (G-SIB) or domestic systemically important (D-SIB) bank, respectively. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). In columns (3) - (6) we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.10: Baseline SIB: Decomposition of Post-reform period – Yield spreads

	(1)
Dependent variable	*Y*
SIB * $Year_{2012}$	-18.731***
	(2.67)
SIB * $Year_{2013}$	-26.400***
	(2.83)
SIB * $Year_{2014}$	-26.030***
	(2.86)
SIB * $Year_{2015}$	-18.073***
	(3.31)
SIB * $Year_{2016}$	-21.549***
	(3.83)
SIB * $Year_{2017}$	-36.161***
	(4.10)
SIB * $Year_{2018}$	-32.989***
	(4.61)
SIB * $Year_{2019}$	-40.330***
	(5.66)
Constant	83.012***
	(29.72)
Main effects	Yes
Instrument controls	Yes
Issuer controls	Yes
Bank controls	Yes
Country-quarter-time FE	Yes
Issuer FE	Yes
No. observations	50701
Adjusted R-squared	0.771
No. SIB obs	6733
No. Non-SIB obs	43968

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressor is the dummy variable SIB, which takes the value one if the bank has been designated once as a global sistemically important (G-SIB) or domestic systemically important (D-SIB) bank. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). Finally, we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.11: Baseline G-SIB & D-SIB Decomposition of Post-reform period – Yield spreads

	(1)
Dependent variable	*Y*
G-SIB * $Year_{2012}$	-23.889***
	(6.52)
G-SIB * $Year_{2013}$	-14.988*
	(7.74)
G-SIB * $Year_{2014}$	-35.585***
	(8.05)
G-SIB * $Year_{2015}$	-21.690***
	(8.02)
G-SIB * $Year_{2016}$	18.237**
	(8.19)
G-SIB * $Year_{2017}$	-1.140
	(8.53)
G-SIB * $Year_{2018}$	9.837
	(10.49)
G-SIB * $Year_{2019}$	117.246***
	(44.98)
D-SIB * $Year_{2012}$	-18.111***
	(2.81)
D-SIB * $Year_{2013}$	-27.623***
	(2.92)
D-SIB * $Year_{2014}$	-25.105***
	(2.94)
D-SIB * $Year_{2015}$	-17.110***
	(3.40)
D-SIB * $Year_{2016}$	-25.332***
	(3.90)
D-SIB * $Year_{2017}$	-39.535***
	(4.18)
D-SIB * $Year_{2018}$	-35.607***
	(4.65)
D-SIB * $Year_{2019}$	-41.614***
	(5.66)
Constant	81.243***
	(29.78)
Main effects	Yes
Instrument controls	Yes
Issuer controls	Yes
Bank controls	Yes
Country-quarter-time FE	Yes
Issuer FE	Yes
No. observations	50701
Adjusted R-squared	0.772
No. G-SIB obs	662
No. D-SIB obs	6071
No. Non-SIB obs	43968

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressors are the set of dummy variables G-SIB and D-SIB which take the value one if the bank has been designated once as a global sistemically important (G-SIB) or domestic systemically important (D-SIB) bank, respectively. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). Finally, we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.12: Baseline SIB: Interaction with macro variables – Yield spreads

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
SIB * SRisk	0.000***	-	-	-	-	-
	(0.00)					
SIB * Crisis probability	-	0.258***	-	-	-	-
		(0.04)				
SIB * SRisk capacity	-	-	0.000***	-	-	-
			(0.00)			
SIB * VIX	-	-	-	1.767***	-	-
				(0.12)		
SIB * Debt-to-GDP	-	-	-	-	0.187*	-
					(0.11)	
SIB * Gov. bonds 10y	-	-	-	-	-	6.972***
						(0.73)
Constant	152.078***	141.662***	133.921***	77.247***	139.618***	116.288***
	(31.58)	(31.57)	(31.57)	(29.64)	(31.97)	(31.87)
Main effects	Yes	Yes	Yes	Yes	Yes	Yes
Instrument controls	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-quarter-time FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	46741	46741	46741	50977	45661	47237
Adjusted R-squared	0.781	0.780	0.780	0.772	0.782	0.777
No. SIB obs	5919	5919	5919	6836	5877	6039
No. Non-SIB obs	40849	40849	40849	44157	39784	41213

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressor is the dummy variable SIB, which takes the value one if the bank has been designated once as a global sistemically important (G-SIB) or domestic systemically important (D-SIB) bank. We interact this variable with a varying set of macroeconomic variables. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). Finally, we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. ∗, ∗∗ and ∗∗∗ indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.13: Baseline G-SIB & D-SIB: Interaction with macro variables– Yield spreads

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
G-SIB * SRisk	-0.000***	-	-	-	-	-
	(0.00)					
G-SIB * Crisis probability	-	-0.248**	-	-	-	-
		(0.10)				
G-SIB * SRisk capacity	-	-	-0.000***	-	-	-
			(0.00)			
G-SIB * VIX	-	-	-	0.454	-	-
				(0.32)		
G-SIB * Debt-to-GDP	-	-	-	-	-2.428***	-
					(0.27)	
G-SIB * Gov. bonds 10y	-	-	-	-	-	1.124
						(1.84)
D-SIB * SRisk	0.000***	-	-	-	-	-
	(0.00)					
D-SIB * Crisis probability	-	0.317***	-	-	-	-
		(0.04)				
D-SIB * SRisk capacity	-	-	0.000***	-	-	-
			(0.00)			
D-SIB * VIX	-	-	-	1.906***	-	-
				(0.12)		
D-SIB * Debt-to-GDP	-	-	-	-	0.544***	-
					(0.12)	
D-SIB * Gov. bonds 10y	-	-	-	-	-	7.477***
						(0.74)
Constant	158.302***	144.339***	128.749***	87.389***	131.002***	121.267***
	(31.55)	(31.56)	(31.54)	(29.72)	(31.94)	(31.90)
Main effects	Yes	Yes	Yes	Yes	Yes	Yes
Instrument controls	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-quarter-time FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	46741	46741	46741	50977	45661	47237
Adjusted R-squared	0.781	0.781	0.781	0.772	0.782	0.777
No. G-SIB obs	555	555	555	663	548	660
No. D-SIB obs	5364	5364	5364	6173	5329	5379
No. Non-SIB obs	40849	40849	40849	44157	39784	41213

Note: The dependent variable is the spread between the yield of the bond and the yield of Bunds with equal maturity. The main regressors are the set of dummy variables G-SIB and D-SIB which take the value one if the bank has been designated once as a global sistemically important (G-SIB) or domestic systemically important (D-SIB) bank, respectively. We interact these variables with a varying set of macroeconomic variables. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country-quarter-time fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). Finally, we add issuer (i.e. bank) fixed effects. Standard errors are shown in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.14: Descriptive statistics

Variable	Unit	No. observations	Mean	Std. Dev.	25th	50th	75th	Description	Source
Dependent									
ΔYield spread$_{2012}$	%	416	7.81	69.94	-30.38	5.83	46.03	Difference of the yield spread of the instrument over Bund yields from 2008-2011 to 2014-2017	CSDB
ΔYield spread$_{2014}$	%	266	-21.85	67.78	-59.12	-19.19	12.02	Difference of the yield spread of the instrument over Bund yields from 2010-2013 to 2016-2019	CSDB
Independent									
Yield spread$_{2012}$	%	2,167	86.10	65.54	39.80	70.33	120.40	Spread between the yield of the bond and the yield of Bunds with equal maturity; average over 2008-2011	CSDB
Yield spread$_{2014}$	%	1,399	133.51	87.66	59.33	120.00	197.50	Spread between the yield of the bond and the yield of Bunds with equal maturity; average over 2010-2013	CSDB
Issue size$_{2012}$	ln	1,361	49.70	187.21	1.67	4.39	14.11	Size of the instrument; average over 2008-2011	CSDB
Issue size$_{2014}$	ln	1,361	49.70	187.21	1.67	4.39	14.11	Size of the instrument; average over 2010-2013	CSDB
Maturity$_{2012}$	ln	2,167	3.71	1.89	2.50	3.13	4.56	Maturity of the instrument in years; average over 2008-2011	CSDB
Maturity$_{2014}$	ln	1,399	3.74	2.03	2.33	3.28	4.65	Maturity of the instrument in years; average over 2010-2013	CSDB
Rating$_{2012}$	0/1	1,399	0.08	0.27	0.00	0.00	0.00	Variable is one if issuer has a prime grade rating (AAA or AA+) and zero otherwise; average over 2008-2011	CSDB
Rating$_{2014}$	0/1	1,399	0.08	0.27	0.00	0.00	0.00	Variable is one if issuer has a prime grade rating (AAA or AA+) and zero otherwise; average over 2010-2013	CSDB
Size$_{2012}$	ln	2,091	26.03	0.94	25.49	26.20	27.09	Total assets of the bank; average over 2008-2011	SNL
Size$_{2014}$	ln	1,343	25.48	1.07	24.68	25.89	26.02	Total assets of the bank; average over 2010-2013	SNL
Solvency$_{2012}$	%	2,091	7.48	1.31	6.61	7.18	7.88	Tier 1 Common Capital (CET1) ratio; average over 2008-2011	SNL
Solvency$_{2014}$	%	1,343	9.25	2.08	7.94	8.96	9.95	Tier 1 Common Capital (CET1) ratio; average over 2010-2013	SNL
Profitability$_{2012}$	%	2,091	5.36	2.32	4.31	5.68	5.97	Return on average equity; average over 2008-2011	SNL
Profitability$_{2014}$	%	1,343	4.67	3.28	3.13	5.18	6.20	Return on average equity; average over 2010-2013	SNL
Liquidity$_{2012}$	%	2,091	33.53	12.81	21.20	38.11	41.92	Liquid assets (Reported B) to total assets; average over 2008-2011	SNL
Liquidity$_{2014}$	%	1,343	28.47	12.77	18.09	27.84	36.20	Liquid assets (Reported B) to total assets; average over 2010-2013	SNL
Non-performing loans$_{2012}$	%	2,091	5.62	3.86	3.44	4.49	7.02	Problem loans to gross customer loans; average over 2008-2011	SNL
Non-performing loans$_{2014}$	%	1,343	7.98	3.62	5.52	6.53	9.64	Problem loans to gross customer loans; average over 2010-2013	SNL

Note: This table reports descriptive statistics of the baseline variables. Data for the yield of the bond, its maturity and size as well as the issuer rating come from the Centralised Securities Database (CSDB). Bank level data come from SNL.

Table 3.5.15: Baseline SIB – Yield spreads

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	ΔY_{2010}	ΔY_{2010}	ΔY_{2012}	ΔY_{2012}	ΔY_{2014}	ΔY_{2014}
SIB	-16.869	-8.471	-27.127***	-34.340***	-30.960***	-33.460***
	(10.34)	(10.45)	(9.32)	(10.67)	(11.16)	(12.06)
Instrument controls						
Issue size	-0.017	-0.021	-0.040*	-0.044*	0.006	-0.009
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Maturity	-3.890	-5.304**	3.586	3.262	-0.017	-0.352
	(2.38)	(2.29)	(3.72)	(3.85)	(2.19)	(2.06)
Issuer controls						
Rating	-15.803*	-9.986	3.700	4.994	-17.401*	-20.076**
	(8.10)	(7.43)	(7.92)	(8.08)	(10.27)	(9.62)
Bank controls						
Size	-	7.672	-	10.612	-	20.316**
		(8.16)		(11.13)		(8.60)
Solvency	-	22.072***	-	0.985	-	-10.013***
		(5.53)		(5.90)		(3.84)
Profitability	-	5.085**	-	-0.279	-	0.775
		(2.50)		(1.48)		(1.48)
Liquidity	-	-2.691*	-	0.309	-	-0.338
		(1.56)		(1.37)		(1.26)
Non-performing loans	-	1.250	-	-1.491	-	-7.641**
		(1.64)		(2.16)		(3.32)
Constant	111.451***	-193.258	-4.007	-279.495	-15.630	-362.549*
	(13.25)	(205.92)	(16.45)	(281.19)	(10.98)	(195.41)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	471	463	399	392	252	248
R-squared	0.557	0.600	0.276	0.287	0.217	0.316
No. SIB	45	39	46	42	29	27
No. Non-SIB	426	424	353	350	223	221

Note: The dependent variable is the difference between the spread between the yield of the bond and the yield of Bunds with equal maturity in the pre and post event period. The event period is a two year window of 2010, 2012 and 2014 and the supsequent year, respectively. The main regressor is the dummy variable SIB, which takes the value one if the bank has been designated once as a global systemically important (G-SIB) or domestic systemically important (D-SIB) bank. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). All control variables are averages over the respective pre event periode of the corresponding event window. Standard errors are shown in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3.5.16: Baseline G-SIB & D-SIB – Yield spreads

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	ΔY_{2010}	ΔY_{2010}	ΔY_{2012}	ΔY_{2012}	ΔY_{2014}	ΔY_{2014}
G-SIB	-16.072	-11.000	-51.431*	-69.748**	-63.726*	-94.790***
	(22.78)	(23.34)	(26.94)	(30.04)	(35.47)	(33.75)
D-SIB	-17.024	-7.986	-22.061**	-26.998***	-26.019**	-24.047**
	(11.16)	(11.10)	(9.42)	(10.23)	(10.96)	(10.31)
Constant	111.449***	-197.205	-3.018	-362.924	-15.667	-496.620**
	(13.27)	(204.52)	(16.17)	(300.66)	(10.90)	(207.21)
Instrument controls	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	No	Yes	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	471	463	399	392	252	248
R-squared	0.557	0.600	0.278	0.291	0.221	0.329
No. G-SIB	6	6	7	7	5	5
No. D-SIB	39	33	39	35	24	22
No. Non-SIB	426	424	353	350	223	221

Note: The dependent variable is the difference between the spread between the yield of the bond and the yield of Bunds with equal maturity in the pre and post event period. The event period is a two year window of 2010, 2012 and 2014 and the supsequent year, respectively. The main regressors are the set of dummy variables G-SIB and D-SIB which take the value one if the bank has been designated once as a global systemically important (G-SIB) or domestic systemically important (D-SIB) bank, respectively. Rating is a dummy variable which takes the value one if the issuer (i.e. bank) has a prime grade rating (AAA or AA+) by either Moody's, S&P, Fitch or DBRS. At the instrument level we add issue size (ln of issue size in bn EURO) and maturity (ln of maturity in years). Further, we add country fixed effects and the following bank controls: size (ln of total assets), solvency (CET1 ratio), profitability (ROEA), liquidity (liquid assets to total assets) and non-performing loans (problem loans to gross customer loans). All control variables are averages over the respective pre event periode of the corresponding event window. Standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

3.5.4. Conclusions

In summary, we do not find reliable evidence that SIBs have a funding cost advantage relative to non-SIBs. SIB funding costs are typically higher than that of non-SIBs even prior to the crisis and we do not find evidence of a further increase in their relative funding costs since the implementation of reforms.

3.5.5. Appendix

3.3.5.3. Construction of the European sample

We obtain bond yields for European banks from the Centralised Securities Database (CSDB). The CSDB aims to cover all securities relevant for the statistical purposes of the European

System of Central Banks (ESCB).[41] We focus on bonds that are denominated in euros and that are issued by banks that are domiciled in one of the member states of the European Union, including the United Kingdom. We restrict the sample period to issuances between 2000 and 2019. This results in a sample of 857,147 bonds, which are identified by their International Securities Identification Number (ISIN).

To analyse funding conditions of banks in the bond market, we focus on issues of medium- to long-term straight bonds, which are the simplest form of wholesale debt financing. The CSDB has a much larger scope, however, and comprises various kinds of debt instruments, as well as equities or options.

Therefore, we apply a series of data filters to exclude convertible bonds, structured products and other instruments that exhibit option-like features. This step requires care, as it is not straightforward to separate the textbook, plain vanilla fixed income security from other, more complex instruments in the data. We proceed as follows:

We use two instrument classification systems that are provided in the CSDB, the so-called Primary Asset Classification and the Classification of Financial Instruments Codes (CFI). Using these systems, we restrict attention to instruments that are designated as straight bonds with a fixed coupon, zero-coupon bonds or medium-term notes. We also restrict the sample to unsecured bonds and bonds that have a fixed maturity and no embedded redemption options. Moreover, we discard securities with short-term maturities of less than one year or very long maturities of over 30 years. We also do not include TLAC instruments in the sample. These filters are in line with related literature (see Acharya et al. (2016) or Santos (2014)) and reduce the sample to 126,481 securities.

Next, we exclude securities with erroneous or inconsistent information or bonds with certain special features: We discard bonds that are designated as a fixed-income security according to the classification systems mentioned above, but for which the coupon rate is missing. We also exclude bonds with a price of less than 1 (in currency or in percent quotation) at issue. This step reduces the number of securities to 115,874.

By inspecting the short name of the security, we observe that there remain some specialised structured products (certificates) or other types of instruments with derivative- or option-like features in the dataset (e.g. credit linked notes or reverse convertible bonds). This can happen as the bond classification systems mentioned in the first step can be too coarse in some cases, such that a convertible bond, say, is simply classified as a bond and may therefore enter the sample. To exclude these instruments, we manually search for keywords or abbreviations in the short name of the instrument that indicate these characteristics. In some cases, the short name is not informative about the characteristics of the instrument. We therefore also set quantitative thresholds to exclude reverse convertible bonds, which are known to have very high coupon rates, see Szymanowska et al (2009), and Batten et al. (2014). We discard securities with coupon rates above 6.5 % and a maturity at issue of less than 2.5 years. After applying these rules, we are left with 87,439 securities.

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[41] See also https://www.ecb.europa.eu/pub/pdf/other/centralisedsecuritiesdatabase201002en.pdf for more information on the CSDB.

We then turn to compute the yield to maturity at the date of the issue of the bond. For coupon bonds that are issued and redeemed at par value, the yield is equal to the coupon rate. For coupon bonds that are issued below par value, we use a spreadsheet routine to compute the yield.

Finally, we compute the spread between the yield of the bond and the yield of Bunds with equal maturity. To ensure that the analysis of the spread is not driven by outliers, we exclude observations in the left (5th percentile) and right (95th percentile) tail of the spread distribution. We therefore obtain a final sample of 74,980 securities. The summary statistics and the regression analysis based on this sample.

3.6. The effects of TBTF reforms on the pricing of bonds in Germany

3.6.1. Introduction

This study uses secondary market yields-to-maturity of a sample of German banks to analyse the effect the TBTF reforms have had on the pricing of bonds issued by SIBs relative to non-SIBs.

Analytical setup

For German banks before 20 July 2018, there has been no distinction within the creditor hierarchy between preferred and non-preferred bonds[42]. It is therefore not possible to identify the individual bail in premium for each issuer bank as the difference in funding costs between these two bonds, such as Giuliana (2019) or Lewrick et al (2019) for the Eurozone. As an alternative, this study employs a DiD approach that compares the development of funding costs, while controlling for possible confounding factors, for a selected set of unsecured bonds. The change in the difference of funding costs of SIBs and Non-SIBs, i.e. the change in FCA, in response to the implementation of TBTF reforms is then used to gauge the impact of reforms.

Reforms

Most studies conducted for the evaluation choose 2012 as the beginning of the *reform implementation period*, which will be used as a baseline assessment. However, as this study focusses on Germany, defining 2012 as a starting point does not capture the relevant reforms that were intended to affect investors' bail-in expectations (for example, Pablos Nuevo 2019 defines January 2016 as the major reform step for a sample of EU banks). Moreover, relying on such a binary identification might be insufficient. As Table 3.6.1 shows, by choosing only a single point in time for defining a reform effect, it is likely that potentially relevant information is ignored. There have been successive reforms on an international, European as well as German level that were all intended to counter the general expectation that some banks are considered to be TBTF. The reform steps identified for this analysis are referring to those

[42] Becoming effective on 20 July 2018, the German Banking Act (Kreditwesengesetz KWG) was adjusted allowing for the issuance of contractually subordinated unsecured bonds (i.e. senior non-preferred). All previously issued "plain vanilla" unsecured bonds are regarded to be senior non-preferred by law (statutory subordination), becoming effective as of 1 January 2017.

institutional and legal changes that have gradually led to the establishment of a resolution framework in Germany. Following Table 3.6.1, we define October 2014, the publication date of the FSB Key Attributes of Effective Resolution Regimes for Financial Institutions, as start of the *reform transition period*. This period ends with a law coming into effect on 1 January 2017, clarifying that all creditors of unsecured senior bank bonds are considered to be “non-preferred”, i.e. subjecting those creditors to a potential bail-in.

Control and treatment group

The treatment group is designated based on the intuition that the reforms are supposed to affect the risk perception of investors regarding the most systemic banks only. Therefore, it is straightforward to base the designation on publicly available information. As treatment group for which the results will be reported throughout the analysis, we therefore use the 10 German O-SIIs (Other Systemically Important Institutions) considered as D-SIBs based on the EU framework[43]. The remaining 26-28 banks depending on the time period for which secondary market bond data could be retrieved, are allocated to the control group. As an alternative treatment group, used for robustness tests, the group of banks under the remit of the Single Resolution Mechanism (SRM) is considered as treated, while the remaining 16-19 banks are designated as control banks (see Table 3.6.2). All of the 10 O-SII are also in the group of banks under the remit of the SRM. The results using the alternative treatment group are not reported but they are readily available upon request.

Furthermore, in order to be able to interpret the empirical results, it is important to understand the specific structure of the German banking sector. It is composed of three pillars: private commercial banks, saving banks and cooperative banks. Both the savings banks and cooperative banks pillars are only operating within regional boundaries and are part of an Institutional Protection Scheme (IPS). This means that in the case of a likely failure, in order to prevent insolvency proceedings, they are instead undergoing a resolution-like process within the IPS, which usually entails merging the struggling entity with another, stronger bank of the same IPS[44]. If, only in rare cases, a bank’s default cannot be prevented in time by merging, all creditors are explicitly secured by the IPS, which are funded through bank levies. Historically, creditors of savings and cooperative banks never had to bear losses. This implies that those banks in fact possess an explicit guarantee as creditors are fully protected while only the owners might carry losses.

43 Landwirtschaftliche Rentenbank and NRW-Bank are excluded because they are development banks. For VW Bank, no bond data could be obtained. G-SIBs (Deutsche Bank and formerly Commerzbank) are also D-SIBs and thus included in the sample.

44 This process is roughly comparable to the Purchase & Assumption tool used by the US FDIC.

Table 3.6.1: Relevant reform steps establishing a resolution framework on the international (I), European (EU) and German (DE) level.

Date	Event	Level
15 October 2014	Publication of FSB Key Attributes of Effective Resolution Regimes for Financial Institutions	I
01 January 2015	Date of transposition of BRRD (Bank Recovery and Resolution Directive) into German law (Sanierungs- und Abwicklungsgesetz, SAG).	EU
2 November 2015	Publication of future KWG change w.r.t. statutory subordination	DE
9 November 2015	Publication of Principles on Loss-absorbing and Recapitalisation Capacity of G-SIBs in Resolution (TLAC Term Sheet)	I
1 January 2016	Start of the Single Resolution Mechanism (SRM) & activation of the bail-in tool	EU
1 June 2016	First publication of O-SII list in Germany	DE
1 January 2017	Change to the subordination status of unsecured senior bank bonds in German Banking Act (KWG) coming into effect (statutory subordination)	DE

3.6.2. Data

The sample of bonds is selected based on information from the Central Securities Database (CSDB). The CSDB contains all capital market instruments that have been issued by financial and non-financial companies in the EU starting in 2009 and provides information on several characteristics of the respective securities. The database is filtered in order to identify "plain vanilla" senior unsecured (non-preferred) bonds that are highly comparable across banks, as they are all at the same rank within the insolvency hierarchy. We used the following filters to obtain a sample of these bonds:

- Issuer sector: Monetary Financial Institutions
- Issuer country: Germany
- Nominal currency: Euro
- Coupon type: Fixed
- Amount issued: at least €10 million
- Type of bond: straight bond, unsecured, unguaranteed
- No embedded options

Using the ISIN from the CSDB, secondary market data at a monthly frequency is obtained from EIKON for a total of 3962 individual bonds issued by 38 banks (see Table 3.6.3). The observation period runs from June 2009 until December 2019. Unfortunately, as the study relies on market data from commercial sources that do not focus on historical time series, there are insufficient observations during the pre-crisis period.

The **dependent variable** is calculated as the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. The yield spread can be regarded as the total credit risk premium, i.e. the funding cost relative to the risk-free rate, for the tranche of "plain vanilla" senior unsecured bonds in the insolvency hierarchy. Figure 3.6.1 shows how the respective group averages of the yield spread evolved over the entire observation period for all maturities[45]. On the face of it, after around 2013 the funding costs of the treatment group has increased relative to those of the control group. This would point to the preliminary conclusion that reforms might have worked as intended.

In order to account for factors that are not related to bail-out expectations, we include a number of control variables. They are intended to control for factors that influence the default risk of the individual issuer (bank-level controls) and the price of the individual security (instrument-level controls) as well as to account for the general macroeconomic environment. Data sources comprise the CSDB, SNL Financial as well as Bundesbank internal databases. Bank-level controls taken from SNL Financial are included at annual frequency and kept constant for all months of the respective year.[46] The choice of variables is generally in line with the literature (Acharya et al. 2016 or Pablos Nuevo 2019). However, for several of the smaller banks in the control group, not all balance sheet information is available for the whole observation period. As an example, instead of using the commonly utilised Common Equity Tier 1 (CET 1) ratio as a measure of bank capitalisation, the total capital ratio is used which is available for all banks during the observation period. Similarly, the z-score is a common measure of a bank's probability of default but it cannot be used, as data on the return on assets for the smaller banks is not always publically available. Instead, we use a measure of a bank's probability of default that is commonly used by the Bundesbank for assessing a counterparty's solvency when conducting open market operations. It exists for all banks in Germany at a quarterly frequency. Besides issuer specific fundamentals captured by bank-level controls, factors at the individual security level also affect the spread demanded by investors. The remaining term to maturity affects the term premium, while tax effects are measured by the coupon rate carried by each bond, as higher coupons create a larger tax burden. It is generally most difficult to fully control for a potential illiquidity premium. In line with the literature, the amount issued as well as the age of a bond are used as proxies. Larger and more recent issuances have been found to be relatively more liquid (Balasubramnian and Cyree 2014). Table 3.6.4 summarises the selected variables, while tables 3.6.5A and 3.6.5B give a descriptive overview.

Below we discuss bank-level variables for the baseline treatment group (O-SII), and their expected effect on funding costs for the selected bank-level variables. The historical development of the variables is depicted in the corresponding figures:

- **PD (probability of default):** The higher the PD, the higher the funding costs needed to compensate for an increased default risk of the issuing bank (see Figure 3.6.2).
- **TCR (total capital ratio):** A higher level of capitalisation is expected to lower the default risk of the bank (see Figure 3.6.3).
- **SUBR (subordinated debt ratio):** As the share of subordinated debt can be regarded as an additional buffer on top of an issuer's capital position before losses are borne by

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45 As a robustness check, we also show results for a restricted sample covering only bonds with less than 6 years left until maturity to reduce potential biases from differences in the term premium between control and treatment group.

46 Using quarterly data would severely restrict the sample size as data at this frequency is typically available only for large banks.

other unsecured creditors, this variable should be negatively related to the default risk of the individual instrument (see Figure 3.6.3).

- **SEC_share (share of secured liabilities):** The higher the share of secured funding, the lower the remaining portion of liabilities that could in principle be bailed-in. Therefore, this variable should be positively related to the default risk of the individual instrument (see Figure 3.6.3).

3.6.3. Econometric approach

The analysis can be separated into three distinct, yet related, research questions.

First, we assess whether systemically important banks, i.e. SIBs, possess a funding cost advantage over the entire observation period relative to the control group. This could be described as the structural FCA of the German banking sector. To answer this question, the following base regression is estimated in different specifications, following Santos (2014):

$$Y_{i,b,t} = \alpha + \boldsymbol{\beta_1} * \boldsymbol{SIB_b} + x_i + x_{i,t} + x_{b,t} + \gamma_t + \epsilon_{i,t} \qquad (1)$$

$Y_{i,b,t}$ denotes the yield-to-maturity of instrument *i* issued by bank *b* in period *t*. SIB_b is a binary variable that equals 1 if bank *b* is part of the treatment group, and is 0 otherwise. The coefficient β_1 then captures the estimated magnitude of a potential FCA for systemically important banks. A negative sign means that funding costs for SIBs are lower than those for non-SIBs, all else equal, and would thus imply a FCA. x_i is a vector of instrument-specific time-invariant controls, while $x_{i,t}$ covers dynamic instrument-level controls. $x_{b,t}$ accounts for time-varying bank-level variables and γ_t are time fixed effects to account for the general macroeconomic environment. In some specifications this time fixed effect is substituted by a set of macroeconomic variables x_t. In further iterations, the vector of time-varying bank-level controls is substituted by the product of a bank and a time fixed effect $\gamma_t * \gamma_b$. This bank-time fixed effect controls for all bank-individual factors that change over time, at a higher frequency than the available set of time-varying bank-level controls. In line with the literature, bank-level controls are included with a one period lag to account for potential concerns of endogeneity. In all regressions standard errors are clustered at the bank-level (see also Acharya et al. 2016).

Second, using a difference-in-differences design, it will be assessed whether the TBTF reforms have had an impact on the FCA of SIBs.

$$Y_{i,b,t} = \alpha + \boldsymbol{\beta_1 SIB_b} * \boldsymbol{reform_t} + x_i + x_{i,t} + x_{b,t} + \gamma_t + \gamma_b + \epsilon_{i,t} \qquad (2a)$$

All variables remain the same as in equation (1). $reform_t$ is a binary variable that equals 1 if the period of observation lies after the date of reform *t*, and is 0 otherwise. Hence β_1, the coefficient of interest, now indicates how funding costs of the treatment group have developed relative to the control group following the reform step in period *t*. Additionally, in all specifications bank-level fixed effects γ_b are added to account for structural differences in the level of funding costs that are caused by bank-specific characteristics. Instead of instrument-level controls, instrument-level fixed effects γ_i are also used in some specifications. The variables SIB_b and $reform_b$ cannot be identified because they are absorbed by the bank-level and the time-level fixed effect respectively and are therefore not included in the equation.

This specification with the full set of fixed effects, i.e. bank-level, instrument-level and time fixed effects, is to be regarded as baseline.

To be in line with the other studies on funding costs, equation 2a will be estimated using January 2012 as the beginning of the *reform implementation period*. Following the discussion above, it is not necessarily meaningful to attribute the timing of reforms to only a single point in time, as several reform steps have been taken that should affect the FCA. Hence, the set of regressions based on equation 2a will be repeated several times with differing starting points for $reform_t$, according to the reform steps identified in Table 3.6.1.

In an additional regression setup, we will distinguish between different sub periods. As explained in Section 3.6.1, this *reform transition period* $(reforms_t)$ will be included in the regression together with a *post-reform period* $(post_t)$ which starts on 1 January 2017. The base period thus lasts until September 2014.

$$Y_{i,b,t} = \alpha + \boldsymbol{\beta_1 SIB_b * reforms_t} + \boldsymbol{\beta_2 SIB_b * post_t} + x_i + x_{i,t} + x_{b,t} + \gamma_t + \gamma_b + \epsilon_{i,t} \quad (2b)$$

β_1 then measures how bond yields of SIBs changed from the start of the period of relevant reforms onwards compared to the base period, while β_2 measures the additional effect on the level of funding costs for SIBs during the *post-reform* period.

As an alternative way to assess the potentially time-varying effect of the successive reform steps, a dynamic difference-in-difference approach will be used that includes all relevant reforms N (see Table 3.6.1) and their interaction with the treatment group. This allows for a time-varying reform effect

$$Y_{i,b,t} = \alpha + \sum_{j=1}^{N} \boldsymbol{\beta_j SIB_b * reform_{j,t}} + x_i + x_{i,t} + x_{b,t} + \gamma_t + \gamma_b + \epsilon_{i,t} \quad (2c)$$

β_j indicates how the introduction of the corresponding $reform_{j,t}$ has altered the funding costs of the treatment group relative to the control group when compared to the base period. As later reforms are included together with earlier reforms, β_j can be interpreted in an additive way, thereby identifying the effect of the gradual introduction of reforms.

Third, there is empirical evidence that the FCA of systemically important banks is not structural, i.e.time-invariant, as has been assumed in equation (1), but instead depends on other factors, such as the macro-financial environment or the prevailing risk sentiment.[47] In order to test if a potential reform effect on the FCA identified previously might be influenced by such factors that are fundamentally unrelated to the reforms, equations (2a), (2b) and (2c) will be augmented with the interaction term $\beta_{N+1} SIB_b * macro_t$, with $macro_t$ referring to either the VIX, annual GDP growth rate or the 10 year Bund yield.

3.6.4. Discussion of results

The results reported are based on using O-SIIs as treatment group, as this group of banks constitutes a subgroup comprising the largest banks under the remit of the SRM. Any reform-

[47] E.g. Lewrick et al (2019) find that favourable market conditions lead to a decline in the difference between the bail-in risk premium on lower-rated banks and higher-rated ones.

induced effect on funding costs is more likely to show for those banks with a relatively higher systemic relevance. Nevertheless, as a robustness check, the regressions have also been estimated using the SRM banks as treatment group, with very similar outcomes.

The results for equation (1) over the entire observation period show that a structural FCA of systemically important banks in Germany can be identified (see Table 3.6.6). When bank-level variables controlling for the time-varying factors of the individual banks' default risk are included, the coefficient turns statistically significant. It is about 10bp, i.e. on average SIBs pay 10bp less on their funding via unsecured bank bonds than non-SIBs. This can (in part) be attributed to the investors' perception of them being TBTF. The majority of banks in the control group, 23 out of 28, are savings and cooperative banks, which are members of Institutional Protection Schemes (IPS). As has been discussed in the introduction, creditors of those banks possess an explicit guarantee that should protect them from losses. Results establishing the existence of a structural FCA stay the same when the control group is limited to include only savings banks, only cooperative banks, or both. This implies that the expectation of creditors of German SIBs to be bailed-out is comparable to the explicit guarantee provided by the IPS. The finding that a FCA for SIBs exists, in spite of the explicit guarantee mentioned, might be attributable to a potentially lower liquidity premium for issuances from larger banks not fully captured by the controls

Turning to the effect of reforms, overall we do not find that the TBTF reforms have significantly reduced the FCA. When using January 2012 as starting date for the reform implementation period, in line with the majority of studies in discussed in this section, in some of the specifications a significant negative effect of the reforms on the funding cost of SIBs can be detected, in the order of approx. 11bp (see Table 3.6.7A). This would imply that the reforms have in fact led to an increase in the FCA. However, as explained above, denoting the entire period starting in 2012 as reform implementation period is misleading for the case of Germany. Moreover, this finding could be attributed to the extraordinary situation of the European sovereign debt crisis, that started prior to 2012 and with major policy interventions only taking place in the succeeding period, which might have reinforced bail-out expectations for SIBs (for similar findings for the Eurozone see IMF 2014).[48]

Instead, when assessing the effect of the reforms identified in Table 3.6.1 that should be better suited for this country study, the results show that the yields-to-maturity of SIBs have risen relative to those of the control group. However, the small effect is statistically insignificant in all specifications. The results presented in Table 3.6.7B date the reform effect on 1 January 2016, which could be regarded as the most relevant reform date as it is the finalization date of the relevant institutional changes by establishing the Single Resolution Mechanism (SRM) in the Eurozone and making the bail-in tool available to the resolution authorities. To account for the different reform steps, equation (2a) has also been estimated using all other relevant reform dates in Table 3.6.1. For all dates, the reform effect is statistically insignificant (see Table 3.6.7C). Only for the first two reform dates, namely the publication of the FSB Key Attributes as well as the final date to transpose the BRRD into national law in the EU, significant positive reform effects in the order of 8bp can be identified. However, this holds only for the specification in the third column using bank-level control variables but without including

48 E.g. the famous "whatever it takes" speech by Mario Draghi took place on 26 July 2012.

instrument-level fixed effects. Hence, there is some evidence that the early reform steps might have led to a decrease of the FCA, which would be in line with the objective of the reforms. This evidence is further strengthened when taking the whole *reform transition period* into account (see Table 3.6.8). Funding costs for SIBs appear to have risen significantly relatively to the *pre-reforms period* (June 2009 – September 2014), which can be interpreted as a narrowing of the FCA enjoyed by SIBs (when comparing it with the identified structural FCA). The additional effect estimated for the *post-reforms period* is however negative and of a similar magnitude as the previous positive effect, but non-significant.

The dynamic difference-in-differences approach might help to shed further light on this seemingly inconclusive results, providing a better understanding of the potentially gradual and cumulative effect of the reforms (see Table 3.6.9). Each reform step appears to have contributed to a narrowing of the FCA, ranging from 2bp to 8bp for each step before June 2016, but the differences being not statistically significant. A simple F-test performed testing the joint significance for the four reform interaction terms prior to June 2016 shows that they are jointly significant for some of the specifications. This underscores the initial intuition that the reform steps, albeit individually insignificant, have jointly contributed to a decrease of the FCA in the range of 13bp to 21bp, depending on the specification. This trend seems to have been reversed by the publication of the O-SII list in June 2016. From this period onwards, we find in all specifications a significantly and economically rather large negative effect on the funding costs of SIBs of about 14bp, relative to non-SIBs. In sum, this leads almost to a complete erosion of the previously detected narrowing of the FCA. It appears counterintuitive that the public announcement of the designation of OSIIs would lead to a reduction of the FCA. The observed adjustment could however be explained by events in the period after June 2016 that have led to an adjustment of investors' expectations with regards to the bail-in risk but were not of a legal nature ("actions speak louder than words", see Schäfer et al 2016)[49].

It is also possible that factors unrelated to the reforms have had an effect on the FCA. Therefore, interaction terms that control for the general effect of the prevailing macroeconomic environment and overall risk sentiment on the FCA are included in the regressions (see Table 3.6.10). Results of the effect of reforms as discussed above are, by and large, robust to the inclusion of these interaction terms, strengthening the evidence against a material impact of TBTF reforms on the FCA to date.

3.6.5. Conclusions

To sum up, this analysis cannot conclude that the TBTF reforms have permanently lowered the FCA enjoyed by German SIBs. While there is some evidence of investors having adjusted their expectation towards an increased bail-in risk temporarily, which could be attributable to the gradual implementation TBTF reforms, they appear to have reversed their perception of the likelihood of being bailed-in subsequently. Such a reversal in expectations might have been caused by events that have negatively affected the credibility of the resolution regime, requiring

[49] It could e.g. linked to the resolution cases of IT and ES banks in June 2017. The effect of those resolution cases on the pricing of secondary market bonds needs to be further investigated. Moreover, the rescue of German NordLB could have reinforced bail-out expectations.

further analysis. Overall, the FCA of German SIBs remains currently unchanged compared to the pre-reform period (June 2009 – September 2014).

3.6.6. Appendix

3.6.6.1. Robustness checks

The following adjustments to the sample of banks, the length of the observations period as well as the variables have been tried with all results largely in line with the ones reported.

- Alternative treatment group (banks subject to SRM);
- Alternative control group (only include savings and / or cooperative banks);
- Restricting sample to begin in January 2010 (“post crisis”);
- Restricting sample to begin in January 2011 (for some of the banks in the control groups, balance sheet data is only available beginning in 2010);
- Remove banks from the sample, that have failed during the observation period and subsequently been restructured (Deutsche Pfandbriefbank AG) or that have exited the market (Eurohypo AG, Westdeutsche ImmobilienBank AG);
- Winsorizing the dependent variable at 1^{st} and 99^{th} percentile.

3.6.6.2. Tables

Table 3.6.2: Number of banks per year and group

YEAR	DSIBs	Non DSIBs	SRM	Non SRM
2009	10	26	18	18
2010	10	27	19	18
2011	10	27	19	18
2012	10	28	19	19
2013	10	28	19	19
2014	10	28	19	19
2015	10	28	19	19
2016	10	27	18	19
2017	10	28	19	19
2018	10	26	19	17
2019	10	25	19	16

Table 3.6.3: Number of observations per year and group

YEAR	DSIBs	Non DSIBs	SRM	Non SRM
2009	4260	2701	5290	1671
2010	12518	6813	15324	4007
2011	11790	5875	14201	3464
2012	10992	5481	12921	3552
2013	9586	4113	10960	2739
2014	8627	3064	9585	2106
2015	8278	2604	9019	1863
2016	8811	2236	9474	1573
2017	10055	2266	10792	1529
2018	9868	1862	10447	1283
2019	9698	1690	10152	1236
Total	**104483**	**38705**	**118165**	**25023**

Table 3.6.4: Description of explanatory variables

Level	Name	Variable	Unit	Source	Freq.
Bank	PD	*Probability of default*	%	Bundesbank (risk controlling)	Q
Bank	TCR	*Total capital rato* TC / RWA	%	SNL	A
Bank	SUBR	*Subordinated debt ratio* Subordinated debt / total liabilities	%	SNL	A
Bank	SEC_share	*Share of secured liabilities* Secured liabilities / (Secured + unsecured liabilities)	%	SNL	A
Bank	TA	*Total assets*	Euro	SNL	A
Instrument	age	*Time since issuance*	Years	CSDB	M
Instrument	termToMaturity	*Term to maturity*	Years	CSDB	M
Instrument	AMOUNT_ISSUED	*Total amount issued*	Euro	CSDB	Static
Instrument	COUPON_RATE	*Rate of fixed coupon*	%	CSDB	Static
Macro	GDP	*GDP annual growth rate*	%	Bundesbank	Q
Macro	BUND_10a	*10 year Bund yield*	%	Bundesbank	M
Macro	VIX	*CBOE volatility index*		EIKON	M

Table 3.6.5A: Descriptive statistics of bank-level variables, by treatment and control group

O-SII:

variable	N	mean	min	p5	p50	p95	max	sd
TCR	100	17.77073	9.695922	12.6587	17.36151	23.3561	30.6	3.507743
SUBR	97	2.046215	.0862656	.1921009	2.240369	5.058738	6.337872	1.272063
SEC_share	95	50.9737	.6097925	15.66935	51.05029	93.28045	94.86739	21.4115

Non O-SII:

variable	N	mean	min	p5	p50	p95	max	sd
TCR	250	16.13576	9.202693	10.1	15.67405	24.38235	36.06962	4.278265
SUBR	217	1.18561	.002726	.1108334	1.030268	2.975743	3.881606	.8730976
SEC_share	221	44.35707	.520517	3.137476	45.97043	82.1384	99.75974	25.26695

Note: O-SII stands for Other Systemically Important Institution. These tables show the distribution of the bank-level variables, separated by treatment and control group. TCR is the total capital ratio in %, SUBR the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC-share is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. The statistics encompass the number of observations, the mean, minimum and maximum value, the 5th, 50th and 95th percentiles and the standard deviation.

Table 3.6.5B: Descriptive statistics of instrument-level variables, by treatment and control group

O-SII:

variable	N	mean	min	p5	p50	p95	max	sd
yield_risk~e	99903	1.037501	.0008247	.4542736	.9277779	1.955211	54.90411	.5734841
termToMatu~y	99903	3.84748	1	1.210959	3.353425	8.30137	14.96712	2.214381
age	96241	3.005294	-.0821918	.2739726	2.534247	7.386302	19.87397	2.257856

Non O-SII:

variable	N	mean	min	p5	p50	p95	max	sd
yield_risk~e	37143	1.087783	.0153092	.4836672	.9804599	2.000266	25.47573	.5703319
termToMatu~y	37143	3.681645	1	1.175342	3.10411	8.068493	16.86027	2.224474
age	34514	3.482535	-.0410959	.4	3.00274	8.076713	15.13425	2.397476

Note: O-SII stands for Other Systemically Important Institution. These tables show the distribution of the instrument-level variables, separated by treatment and control group. Yield_riskfree is the dependent variable which is calculated as the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. termToMaturity is the remaining time left until the maturity date of the respective bond in years, while age is the corresponding time that has passed since the issuance date in years. The statistics encompass the number of observations, the mean, minimum and maximum value, the 5th, 50th and 95th percentiles and the standard deviation.

Table 3.6.6: Regression results of equation (1)

Structural FCA

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
SIB	-0.017	-0.035	-0.116*	-0.127*	-0.072***	-0.118***
	(0.090)	(0.079)	(0.068)	(0.072)	(0.000)	(0.009)
term to maturity		0.031***	0.031***	0.021***		0.035***
		(0.008)	(0.006)	(0.005)		(0.005)
COUPON_RATE		0.109***	0.058***	0.064***		0.049***
		(0.033)	(0.018)	(0.014)		(0.016)
age		-0.030***	-0.018**	-0.028***		-0.017***
		(0.010)	(0.007)	(0.006)		(0.005)
AMOUNT_ISSUED		0.000***	0.000***	0.000***		0.000
		(0.000)	(0.000)	(0.000)		(0.000)
RatingPD			2.509***	2.463***		1.544**
			(0.422)	(0.440)		(0.716)
TCR_lag			0.017*	0.013		
			(0.009)	(0.011)		
SUBR_lag			-0.019	-0.012		
			(0.031)	(0.031)		
SEC_share_lag			-0.001	-0.000		
			(0.001)	(0.001)		
VIX				0.029***		
				(0.002)		
BUND_10				0.026*		
				(0.015)		
GDP				0.030***		
				(0.005)		
Constant	1.064***	0.732***	0.398**	-0.131	1.104***	0.703***
	(0.061)	(0.082)	(0.183)	(0.238)	(0.000)	(0.100)
Observations	137,046	124,507	106,432	105,906	136,687	121,514
R-squared	0.172	0.226	0.390	0.248	0.546	0.567
Time FE	Yes	Yes	Yes	No	No	No
Bank*Time FE	No	No	No	No	Yes	Yes
ISIN FE	No	No	No	No	No	No

Note: The dependent variable YtM is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. SIB is a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise. Among the instrument-level controls, term to maturity is the remaining time left until the maturity date of the respective bond in years, age is the corresponding time that has passed since the issuance date in years, COUPON_RATE is the fixed coupon carried by the bond in %, and AMOUNT_ISSUED is the total volume issued in Euros. Bank-level controls cover the RatingPD which is a measure of the issuer's probability of default in %, TCR_lag is the total capital ratio in %, SUBR_lag the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC_share_lag is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. All variables with the suffix _lag enter the regression with a one period lag to account for potential concerns of endogeneity. The overall macroeconomic environment is accounted for via VIX, a variable that measures market-wide risk appetite on a global level, GDP, which is the annual GDP growth rate, and BUND_10, the 10 year Bund yield in %. The last three rows indicate which fixed effects (FE) have been included. Robust standard errors are clustered at the bank-level and reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3.6.7A: Regression results of equation (2a)

Effect of reform implementation period (starting January 2012)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
post012012_SIB	-0.010	-0.045	-0.053	-0.098**	-0.125**
	(0.067)	(0.060)	(0.049)	(0.048)	(0.053)
term to maturity		0.034***	0.034***		
		(0.005)	(0.004)		
COUPON_RATE		0.055**	0.057***		
		(0.021)	(0.019)		
age		-0.017**	-0.020***		0.202***
		(0.008)	(0.007)		(0.058)
AMOUNT_ISSUED		0.000	0.000		
		(0.000)	(0.000)		
RatingPD			1.455***		0.823***
			(0.330)		(0.283)
TCR_lag			0.004		0.004
			(0.005)		(0.005)
SUBR_lag			-0.049		-0.015
			(0.052)		(0.039)
SEC_share_lag			-0.000		0.001*
			(0.001)		(0.001)
TA_lag			-0.000***		-0.000***
			(0.000)		(0.000)
Constant	1.056***	0.837***	0.858***	1.102***	0.335
	(0.035)	(0.060)	(0.113)	(0.025)	(0.254)
Observations	137,046	124,507	106,432	137,001	111,961
R-squared	0.417	0.435	0.470	0.690	0.694
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	No	No	No	Yes	Yes

Note: The dependent variable YtM is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. post012012_SIB is an interaction term between SIB, a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise; and post012012, a binary variable that equals 1 if the period of observation lies after the date of reform, in this case beginning in January 2012, and is 0 for periods before that date. Among the instrument-level controls, term to maturity is the remaining time left until the maturity date of the respective bond in years, age is the corresponding time that has passed since the issuance date in years, COUPON_RATE is the fixed coupon carried by the bond in %, and AMOUNT_ISSUED is the total volume issued in Euros. Bank-level controls cover the RatingPD which is a measure of the issuer's probability of default in %, TCR_lag is the total capital ratio in %, SUBR_lag the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC_share_lag is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. All variables with the suffix _lag enter the regression with a one period lag to account for potential concerns of endogeneity. The last three rows indicate which fixed effects (FE) have been included. Robust standard errors are clustered at the bank-level and reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3.6.7B: Regression results of equation (2a)

Effect of TBTF reform (1 January 2016)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
post012016_SIB	0.057	0.037	0.038	0.045	0.013
	(0.078)	(0.077)	(0.053)	(0.068)	(0.057)
term to maturity		0.034***	0.034***		
		(0.006)	(0.004)		
COUPON_RATE		0.055**	0.057***		
		(0.021)	(0.019)		
age		-0.017*	-0.020***		0.221***
		(0.008)	(0.007)		(0.055)
AMOUNT_ISSUED		0.000	0.000		
		(0.000)	(0.000)		
RatingPD			1.482***		0.791**
			(0.329)		(0.291)
TCR_lag			0.003		0.003
			(0.005)		(0.004)
SUBR_lag			-0.050		-0.020
			(0.051)		(0.038)
SEC_share_lag			-0.000		0.001
			(0.001)		(0.001)
TA_lag			-0.000***		-0.000**
			(0.000)		(0.000)
Constant	1.036***	0.801***	0.837***	1.039***	0.275
	(0.021)	(0.055)	(0.124)	(0.018)	(0.235)
Observations	137,046	124,507	106,432	137,001	111,961
R-squared	0.418	0.435	0.469	0.689	0.693
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	No	No	No	Yes	Yes

Note: The dependent variable YtM is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. post012016_SIB is an interaction term between SIB, a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise; and post012016, a binary variable that equals 1 if the period of observation lies after the date of reform, in this case beginning in January 2016, and is 0 for periods before that date. Among the instrument-level controls, term to maturity is the remaining time left until the maturity date of the respective bond in years, age is the corresponding time that has passed since the issuance date in years, COUPON_RATE is the fixed coupon carried by the bond in %, and AMOUNT_ISSUED is the total volume issued in Euros. Bank-level controls cover the RatingPD which is a measure of the issuer's probability of default in %, TCR_lag is the total capital ratio in %, SUBR_lag the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC_share_lag is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. All variables with the suffix _lag enter the regression with a one period lag to account for potential concerns of endogeneity. The last three rows indicate which fixed effects (FE) have been included. Robust standard errors are clustered at the bank-level and reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3.6.7C: Regression results of equation (2)

Effect of TBTF reform for different reform dates

Event date	Significant effect
14. October 2014	(specification) + 0.08*
1 January 2015	(specification) + 0.08*
1 November 2015	No
1 June 2016	No
1 January 2017	No

Note: This table gives a brief overview of the regression results of equation (2a) for different reform dates. The same specifications as in table A6.2 are used. The table shows the coefficient on the interaction term between SIB, a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise; and the respective reform date, a binary variable that equals 1 if the period of observation lies after the date of reform defined in the first column, and is 0 for periods before that date. If the coefficient is statistically significant for one of the specifications (1) to (5) in table A6.2, the magnitude is reported. The dependent variable is in all cases the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3.6.8: Regression results of equation (2b). Effect of TBTF reform transition period

	(1)	(2)	(3)
VARIABLES	**YtM**	**YtM**	**YtM**
reforms_SIB	0.192**	0.120**	0.062*
	(0.076)	(0.045)	(0.035)
post_SIB	-0.119	-0.093	-0.047
	(0.078)	(0.057)	(0.037)
SIB	-0.240***		
	(0.079)		
term to maturity	0.031***	0.033***	
	(0.006)	(0.004)	
COUPON_RATE	0.057***	0.058***	
	(0.018)	(0.018)	
age	-0.017**	-0.020***	0.219***
	(0.008)	(0.007)	(0.055)
AMOUNT_ISSUED	0.000**	0.000	
	(0.000)	(0.000)	
RatingPD	2.412***	1.530***	0.813***
	(0.350)	(0.309)	(0.285)
TCR_lag	0.017*	0.003	0.003
	(0.008)	(0.005)	(0.004)
SUBR_lag	0.004	-0.057	-0.024
	(0.026)	(0.049)	(0.037)
SEC_share_lag	-0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)
TA_lag	0.000***	-0.000***	-0.000**
	(0.000)	(0.000)	(0.000)
Constant	0.348*	0.829***	0.270
	(0.187)	(0.126)	(0.234)
Observations	106,432	106,432	111,961
R-squared	0.403	0.470	0.693
Bank FE	No	Yes	Yes
Time FE	Yes	Yes	Yes
ISIN FE	No	No	Yes

Note: The dependent variable YtM is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. reforms_SIB is an interaction term between SIB, a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise; and reforms, a binary variable that equals 1 if the period of observation lies after the starting date of the reform transition period in October 2014, and is 0 for periods before that date. post_SIB is an interaction term between the same variable SIB and post, a binary variable that equals 1 if the period of observation lies after the end date of the reform transition period in January 2017, i.e. the post-reform period, and is 0 for periods before that date. Among the instrument-level controls, term to maturity is the remaining time left until the maturity date of the respective bond in years, age is the corresponding time that has passed since the issuance date in years, COUPON_RATE is the fixed coupon carried by the bond in %, and AMOUNT_ISSUED is the total volume issued in Euros. Bank-level controls cover the RatingPD which is a measure of the issuer's probability of default in %, TCR_lag is the total capital ratio in %, SUBR_lag the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC_share_lag is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. All variables with the suffix _lag enter the regression with a one period lag to account for potential concerns of endogeneity. The last three rows indicate which fixed effects (FE) have been included. Robust standard errors are clustered at the bank-level and reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3.6.9: Regression results of equation (2c). Gradual effect of TBTF reforms

	(1)	(2)	(3)	(4)	(5)
VARIABLES	YtM	YtM	YtM	YtM	YtM
post012017_SIB	0.066	0.091	-0.048	0.084	0.008
	(0.067)	(0.071)	(0.054)	(0.059)	(0.043)
post062016_SIB	-0.147**	-0.178***	-0.136**	-0.131**	-0.138***
	(0.057)	(0.056)	(0.059)	(0.049)	(0.050)
post012016_SIB	0.024	0.026	0.027	0.027	0.018
	(0.034)	(0.038)	(0.051)	(0.035)	(0.047)
post112015_SIB	0.087**	0.082**	0.067	0.079*	0.060
	(0.037)	(0.040)	(0.047)	(0.039)	(0.046)
post012015_SIB	0.028	0.039	0.071	0.032	0.043
	(0.024)	(0.026)	(0.050)	(0.023)	(0.035)
post102014_SIB	0.006	-0.014	0.047	-0.033	0.019
	(0.055)	(0.055)	(0.053)	(0.037)	(0.035)
term to maturity		0.034***	0.033***		
		(0.006)	(0.004)		
COUPON_RATE		0.056**	0.058***		
		(0.021)	(0.018)		
age		-0.017*	-0.020***		0.219***
		(0.008)	(0.007)		(0.054)
AMOUNT_ISSUED		0.000	0.000		
		(0.000)	(0.000)		
RatingPD			1.530***		0.807**
			(0.316)		(0.296)
TCR_lag			0.003		0.003
			(0.005)		(0.004)
SUBR_lag			-0.057		-0.025
			(0.049)		(0.037)
SEC_share_lag			-0.001		0.001
			(0.001)		(0.001)
TA_lag			-0.000***		-0.000**
			(0.000)		(0.000)
Constant	1.032***	0.797***	0.828***	1.038***	0.271
	(0.025)	(0.058)	(0.128)	(0.021)	(0.233)
Observations	137,046	124,507	106,432	137,001	111,961
R-squared	0.418	0.435	0.470	0.689	0.694
Joint significance (p-value)	0.1074	0.1700	0.0099	0.1430	0.1438
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	No	No	No	Yes	Yes

Note: The dependent variable YtM is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. The first six variables, i.e. rows, are interaction terms between SIB, a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise; and different reform dates (postX). The latter are binary variables that equal 1 if the period of observation lies after the starting date of the respective reform date, and is 0 for periods before that date. Among the instrument-level controls, term to maturity is the remaining time left until the maturity date of the respective bond in years, age is the corresponding time that has passed since the issuance date in years, COUPON_RATE is the fixed coupon carried by the bond in %, and AMOUNT_ISSUED is the total volume issued in Euros. Bank-level controls cover the RatingPD which is a measure of the issuer's probability of default in %, TCR_lag is the total capital ratio in %, SUBR_lag the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC_share_lag is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. All variables with the suffix _lag enter the regression with a one period lag to account for potential concerns of endogeneity. The row "Joint significance" shows for each specification the estimated p-values of an F-test performed on the four reform interaction terms prior to June 2016. The last three rows indicate which fixed effects (FE) have been included. Robust standard errors are clustered at the bank-level and reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

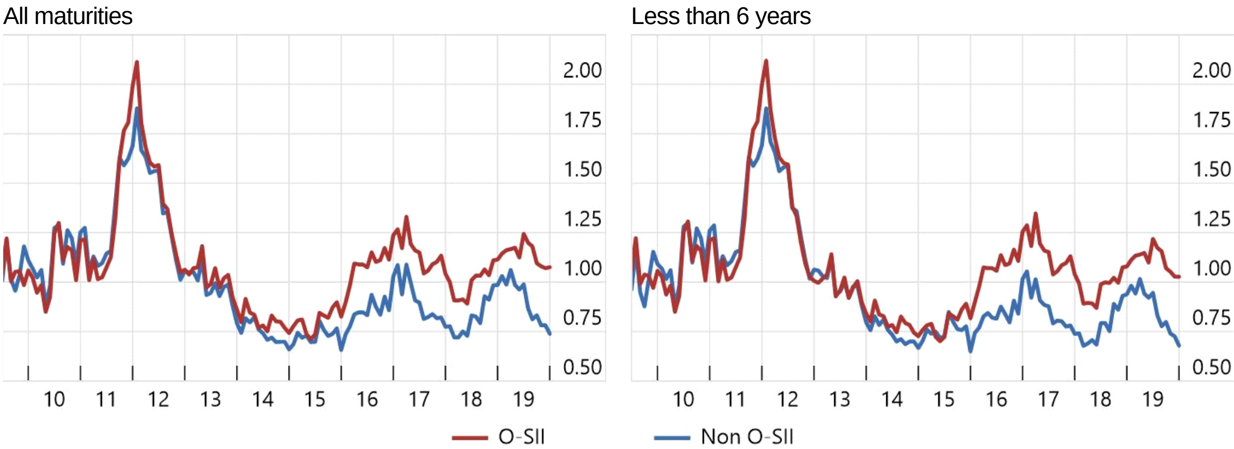
Table 3.6.10: Regression results of equation (3). Reform effect taking into account macro-financial environment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
post012017_SIB			0.009			0.006			-0.012
			(0.043)			(0.043)			(0.044)
post062016_SIB			-0.123**			-0.140***			-0.130**
			(0.050)			(0.050)			(0.048)
post012016_SIB	0.013		0.012	0.006		0.014	0.041		0.040
	(0.056)		(0.049)	(0.058)		(0.048)	(0.048)		(0.039)
post112015_SIB			0.057			0.062			0.054
			(0.045)			(0.046)			(0.044)
post012015_SIB			0.039			0.045			0.054
			(0.034)			(0.036)			(0.039)
post102014_SIB			0.018			0.015			0.074*
			(0.035)			(0.037)			(0.042)
reforms_SIB		0.056			0.057			0.130**	
		(0.035)			(0.035)			(0.052)	
post_SIB		-0.039			-0.051			-0.052	
		(0.035)			(0.038)			(0.038)	
SIB_VIX	0.005*	0.005	0.004						
	(0.003)	(0.003)	(0.003)						
SIB_GDP				0.010	0.010	0.010			
				(0.009)	(0.009)	(0.009)			
SIB_BUND							0.038	0.062	0.063
							(0.030)	(0.038)	(0.037)
age	0.217***	0.215***	0.215***	0.219***	0.217***	0.217***	0.214***	0.206***	0.206***
	(0.056)	(0.055)	(0.055)	(0.055)	(0.054)	(0.054)	(0.057)	(0.057)	(0.057)
RatingPD	0.795**	0.815***	0.809**	0.808***	0.830***	0.824***	0.784**	0.815***	0.815**
	(0.292)	(0.285)	(0.297)	(0.286)	(0.280)	(0.291)	(0.297)	(0.290)	(0.300)
TCR_lag	0.004	0.004	0.004	0.002	0.002	0.002	0.003	0.004	0.004
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
SUBR_lag	-0.019	-0.023	-0.024	-0.022	-0.026	-0.027	-0.016	-0.022	-0.022
	(0.039)	(0.038)	(0.037)	(0.038)	(0.037)	(0.036)	(0.039)	(0.038)	(0.037)
SEC_share_lag	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
TA_lag	-0.000***	-0.000**	-0.000**	-0.000***	-0.000**	-0.000**	-0.000***	-0.000***	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.194	0.193	0.200	0.277	0.272	0.274	0.222	0.177	0.174
	(0.253)	(0.252)	(0.251)	(0.235)	(0.234)	(0.234)	(0.247)	(0.256)	(0.255)
Observations	111,961	111,961	111,961	111,429	111,429	111,429	111,961	111,961	111,961
R-squared	0.694	0.694	0.694	0.695	0.695	0.696	0.693	0.694	0.694
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ISIN FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable YtM is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity. The first six variables, i.e. rows, are interaction terms between SIB, a binary variable that equals 1 if the bank is part of the treatment group, i.e. a German O-SII for the results reported, and is 0 otherwise; and different reform dates (postX). The latter are binary variables that equal 1 if the period of observation lies after the starting date of the respective reform date, and is 0 for periods before that date. reforms_SIB and post_SIB are similar interaction terms between SIB and reforms, a binary variable that equals 1 if the period of observation lies after the starting date of the reform transition period in October 2014, as well as between SIB and post, a binary variable that equals 1 if the period of observation lies after the end date of the reform transition period in January 2017, i.e. the post-reform period. Both binary variables are 0 for periods before the respective dates. SIB_VIX, SIB_GDP and SIB_BUND are interaction terms between SIB and the VIX, the annual GDP growth rate, and the 10 year Bund yield, respectively. Among the instrument-level controls, term to maturity is the remaining time left until the maturity date of the respective bond in years, age is the corresponding time that has passed since the issuance date in years, COUPON_RATE is the fixed coupon carried by the bond in %, and AMOUNT_ISSUED is the total volume issued in Euros. Bank-level controls cover the RatingPD which is a measure of the issuer's probability of default in %, TCR_lag is the total capital ratio in %, SUBR_lag the subordinated debt ratio in %, i.e. the share of subordinated debt in total liabilities, and SEC_share_lag is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities. All variables with the suffix _lag enter the regression with a one period lag to account for potential concerns of endogeneity. The last three rows indicate which fixed effects (FE) have been included. Robust standard errors are clustered at the bank-level and reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

O-SIIs and Non-O-SIIs: risk-free yield to maturity weighed by amounts issued

In basis points **Figure 3.6.1**

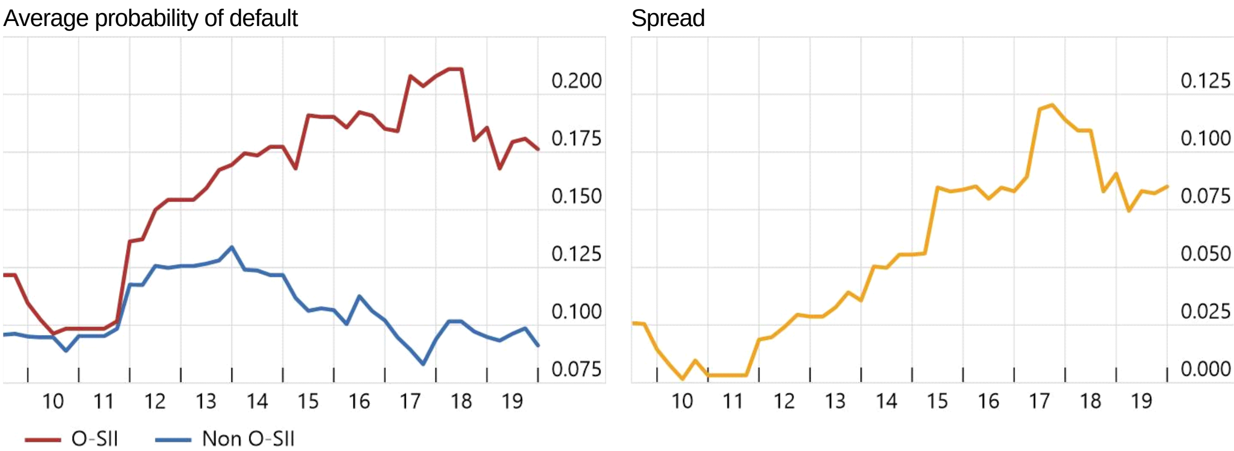


Note: O-SII stands for Other Systemically Important Institution. The risk-free yield is the spread between the yield-to-maturity of a bond obtained from EIKON and the German Bund yield with the same remaining term to maturity.

Source: Central Securities Database (CSDB); Eikon.

Development of the average probability of default of treatment and control group (left) and its spread (right)

In per cent **Figure 3.6.2**



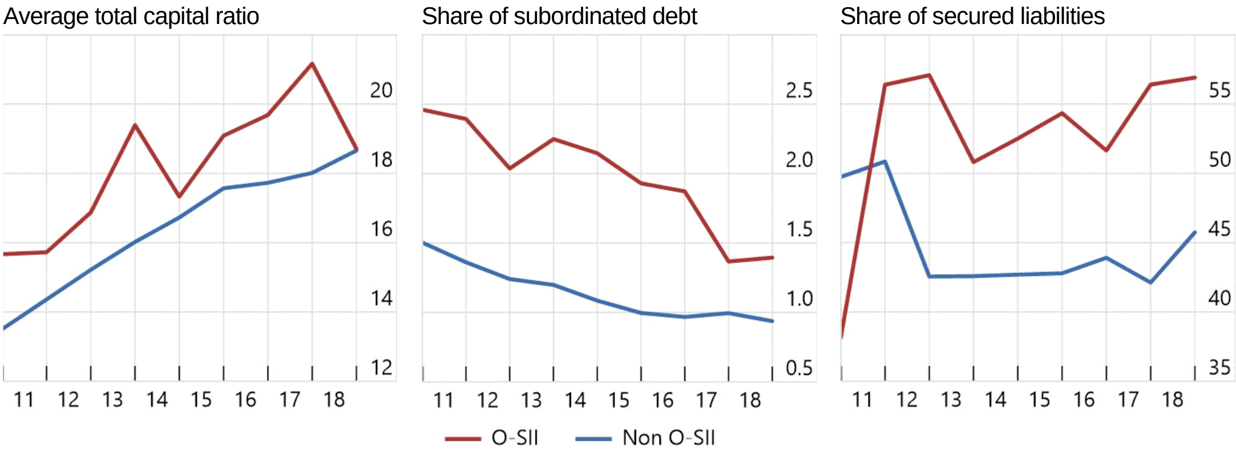
Note: O-SII stands for Other Systemically Important Institution.

Source: Bundesbank.

Average total capital ratio, share of subordinated debt and share of secured liabilities of treatment and control group

In per cent

Figure 3.6.3



Note: O-SII stands for Other Systemically Important Institution. The average total capital ratio is measured in % of risk weighted assets. Share of subordinated debt is the percentage share of subordinated debt in total liabilities. Share of secured liabilities is the percentage of secured liabilities as a share of the sum of secured and unsecured liabilities.

Sources: Central Securities Database (CSDB); SNL.

3.7. The TBTF premium and the impact of resolution reforms

3.7.1. Introduction

We estimate the TBTF premium for a sample of large European and US banks using a contingent claim model (CCM). All the banks in the sample have been recognised as G-SIBs or D-SIBs by their respective authorities. We estimate the premium over one- and a half decades, from 2004 to 2019.

In order to get the TBTF premium, we compare the theoretical CDS spreads based on equity prices and obtained from the CCM model to the observed CDS spreads. The economic intuition behind such a comparison is that observed CDS spreads reflect *both* the probability of bank distress as well as the likelihood and size of government support in case of distress. On their own, equity prices are assumed to contain only information on the probability of distress and do not include the chance of a government bailout of equity holders. As a result, the equity price information allows the calculation of a hypothetical, equity-implied “Fair Value” CDS spreads ($FVCDS$) that is not affected by the probability of bailout. The difference between the model-implied and observed CDS provides a measure of the TBTF premium. Therefore, it is worth mentioning, this approach does not rely on the comparison of funding costs or CDS-spreads between treatment and control groups. It identifies implicit funding subsidies directly.

3.7.2. Modelling approach

The model

The estimation of the equity-implied CDS spreads ($FVCDS$) is based on a Merton-type structural credit pricing model developed by Finger et al. (2002) and applied, among others, in Schweikhard and Tsesmelidakis (2012) and Tsemelidakis and Merton (2013).[50]

As in Merton (1974), equity and debt are valued as contingent claims on the firm value. The distributions of the risk and return of the debt are based only on the firm's *fundamentals,* comprised by the liabilities structure, the equity prices and equity volatility. However, in this benchmark version of the model, default occurs when the asset value falls below a certain default barrier (as in Black and Cox (1976)). The level of the barrier is unknown, but should depend on the liability structure.

To be more precise, let the default barrier be equal to LD where L is the global recovery rate and D is the bank debt. For convenience, the uncertainty in the barrier L is assumed to follow a lognormal distribution with average $\bar{L}$ and standard deviation λ.

The asset value is assumed to evolve accordingly to the following simple differential equation:

$$\frac{dV_t}{V_t} = \mu_V dt + \sigma_V dW_t \tag{1}$$

where W_t is a Brownian motion, σ_V is the asset volatility and μ_V is the asset drift. For simplicity, we assume that μ_V is zero and all changes are related to asset volatility.

The survival probability of the firm depends on both the asset value and default probability and can be shown to be equal to

$$P(t) = \Phi\left(-\frac{A_t}{2} + \frac{\log(d)}{A_t}\right) - d * \Phi\left(-\frac{A_t}{2} - \frac{\log(d)}{A_t}\right) \tag{2}$$

where $d = \frac{S_0 + \bar{L}D}{\bar{L}D} exp\lambda^2$ and $A_t^2 = \sigma_V^2 t + \lambda^2$. Φ denotes the cumulative normal distribution function and σ_V the asset volatility.

The asset volatility is approximated by:

$$\sigma_v = \sigma_S \frac{S}{S + \bar{L}D} ,$$

where S is the equity price, D is the debt per share and σ_S the equity volatility.

Given the metrics above, the $FVCDS$ spread is:

50 More specifically, Schweikhard and Tsesmelidakis (2012) compute the TBTF premium based on a sample of 498 US companies of which 74 financial, from January 2002 to September 2010. The key results is that for the post-crisis period – September 2009 to the end of their sample – the TBTF premium for banks was about 250 basis points and therefore relatively large.

$$FVCDS = r(1-R)\frac{1-P(0)+e^{r\xi}(G(t+\xi)-G(\xi))}{P(0)-P(t)e^{-rt}-e^{r\xi}(G(t+\xi)-G(\xi))} \quad (3)$$

where $\xi = \frac{\lambda^2}{\sigma_V^2}$, r is the deterministic risk-free interest rate, and R is the firm-specific expected recovery rate. The function $G(u)$ is similar to that used in Finger (2002). In this setting, the default barrier changes over time with the capital structure of the firm.

In order to compute the TBTF premium we subtract from the $FVCDS$ the observed CDS spreads, thus

$$TBTF_t^{premium} = FVCDS_{i,t} - CDS_{i,t}^{Observed} \quad (4)$$

Input data and calibration of the model

The computation of the $FVCDS$ requires the following eight input variables: the equity price S, the debt per share D, the risk-free interest rate r, the average default threshold $\bar{L}$, the default threshold uncertainty λ, the recovery rate R, the time to expiration T, and the equity volatility σ_S. Thus, the $FVCDS$ spread can be written in short notation as follows:

$$FVCDS = f(S_t, D_t, r_t, T-t, \sigma_t; R, \bar{L}, \lambda) \quad (5)$$

The three parameters $(R, \bar{L}, \lambda)$ are unobserved. In our main specification, we set λ, the standard deviation of the recovery rate of the firm's debt, to 0.15. In the original model from Finger et al. (2002), the parameter is 0.3, but it was calibrated on a sample of firms from different industries. In Cao, Yu and Zhong (2011) the parameter is calibrated to 0.46, but for a sample of US firms of different sizes that excludes financial institutions. It is reasonable that for financial institutions, and especially for large banks, the standard deviation of the recovery rate should be significantly lower, as also noted in Finger et al. (2002).

We performed robustness checks on the parameters and found that there exists a trade-off between λ and $\bar{L}$ but that, for a given λ, the results are robust to different choices of $\bar{L}$. Therefore, similarly to Schweikhard and Tsesmelidakis (2012), our main specification follows Finger et al. (2002) and we set $\bar{L}$ (and R) to 0.5.

The other model input data are the debt per share D calculated as the balance sheet total liabilities over the number of outstanding shares, the risk-free interest rate r, approximated by the five-year government bond yield, and the equity volatility σ_S, calculated as the historical volatility of equity returns. Results are generally robust to a number of modelling choices. For example, when we chose option-implied volatilities - when available - instead of historical volatilities, the results were qualitatively the same.

With the exception of the observed CDS spread, which is from Markit, all other data are from Bloomberg. We have 14 countries and a total of 33 banks that have been designated as G-SIBs or D-SIBs and for which market data are available over the period 2004-2019. Table 3.7.3 in Appendix shows the list of banks in the sample.

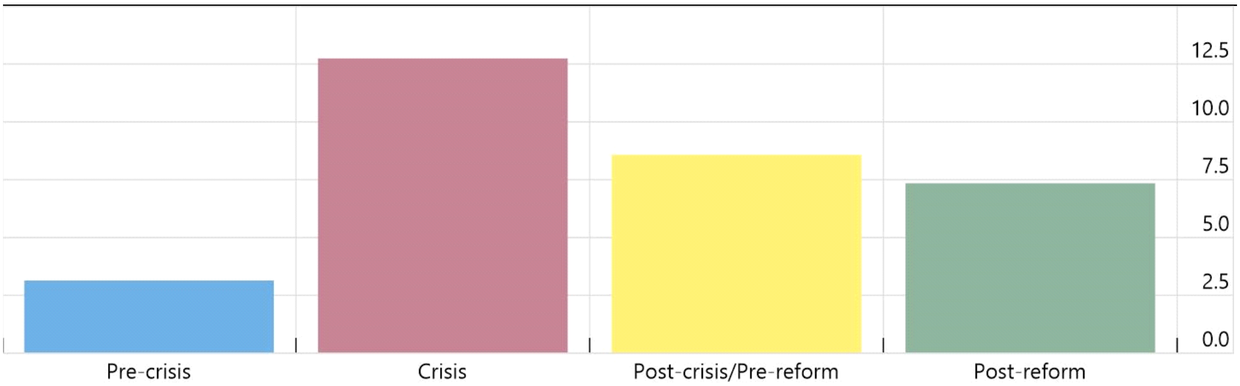
3.7.3. *Changes in the TBTF premium*

In this section, we present the empirical results on the TBTF premium. We split the sample into four sub-periods, corresponding to the pre-crisis (2004-2007), crisis (2008–09), and post-crisis but pre- and post-reform period (2010-2011). The fourth period is the post reform period (2012–19) which coincides with the implementation of resolution reforms.

Average TBTF premium across sub-periods

In per cent

Figure 3.7.1



Sources: Bloomberg; Markit.

There are two key results. First, the TBTF premium has not only declined from the peak of the crisis but it has continued to decline for a few years after the crisis in the post-reform period, see Figure 3.7.1. The average premium has declined from about 13 percent during the crisis to less than 8 percent in the post-reform period. Second, the average level in the post reform period is above the pre-crisis level of about 3 percent.[51]

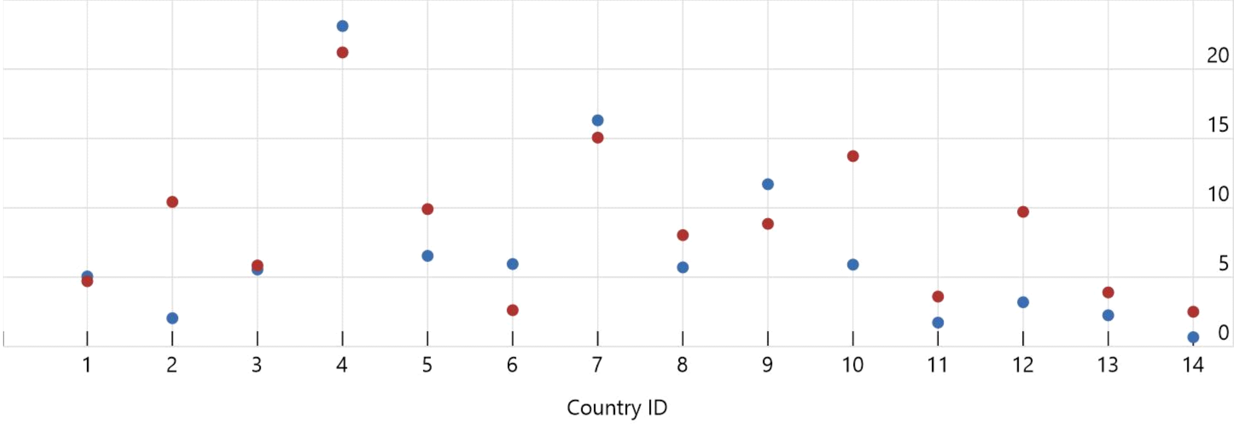
The results from the fourteen countries studied display much heterogeneity. As Figure 3.7.2 shows, the decline in the TBTF premium in the post-reform period is not uniform. The premium has declined in eight countries, stayed the same in two and actually *increased* in four.

[51] The average level is computed for each country for each sub-period and averaged across countries.

Average TBTF premium of selected countries

In per cent

Figure 3.7.2



Sources: Bloomberg; Markit.

3.7.4. Factors driving the TBTF premium

Methodology and variables

To capture the driving factors of the TBTF premium, we have estimated the following general panel regression:

$$TBTF_{i,c,t} = \beta_1 + \beta_2 Macro_{c,t} + \beta_3 Bank_{i,c,t} + \beta_4 Regulation_{c,t} + ProbCr_{c,t} + \gamma_i + \partial_t + \varepsilon_{i,c,t} \quad (6)$$

where $TBTF_{i,c,t}$ is the TBTF-premium of bank *i* in country *c* at time *t*, γ_i represents the cross-sectional fixed effects and ∂_t the time (yearly) fixed effects.[52] The frequency is monthly and we include fixed effects both at the bank and country level, with the index i representing a bank in country c. $ProbCr_{c,t}$ measures the probability of a systemic crisis at each point in time and for each country, as in Engle and Ruan (2019).

$Regulation$ is our key variable vector. It is measured by the RRI defined in Section 2.1.[53] We also use the three sub-indices of the RRI.

We also included a set of explanatory variables - $Macro$ and $Bank$ - to control for macroeconomic developments and bank-specific characteristics that may influence the evolution of the TBTF premium (see Section 3.1).

The $Macro$ vector comprises:

1. Market risk aversion

[52] The TBTF premium as in eq. (1) is computed at daily frequency that we aggregate to monthly for the regression analysis purposes as we also do for daily market data. We keep the quarterly variables at their frequency value. These frequency adjustments do not alter the results qualitatively.

[53] In our robustness checks we also include a dummy variable for the post-reform period in addition to RRI or instead of. We report on the results later in the section.

2. Interest rate term structure
3. Growth rate
4. Size of overall bank sector
5. Size of the systemically important bank subsector
6. Probability of systemic crisis

The variables included in the $Bank$ vector are:

1. Bank capital
2. Bank profitability
3. Leverage

Table 3.7.1 shows the pairwise correlation among the variables as in eq. (6) and key statistics are shown in Appendix.

Table 3.7.1. Pairwise correlation among selected variables

	FVCDS	*TBTF*	*T1R*	*ROE*	*Prob Crisis*	*gov2y*	*Trend gr rate*	*VIX*	*RRI*
FVCDS	1,00								
TBTF	0,99	1,00							
T1R	-0,03	**-0,04**	1,00						
ROE	-0,44	**-0,41**	-0,14	1,00					
Prob Crisis	0,42	**0,34**	-0,02	-0,32	1,00				
gov2y	-0,15	-0,16	-0,65	0,27	-0,12	1,00			
Trend gr rate	-0,24	-0,20	-0,52	0,37	-0,29	0,69	1,00		
VIX	0,39	**0,37**	-0,18	-0,17	0,47	0,08	0,00	1,00	
RRI	-0,25	**-0,21**	0,51	0,04	-0,43	-0,28	-0,32	-0,40	1,00

Note: *TBTF* denotes the TBTF premium

Table 3.7.1 shows the expected result that bank solvency and profitability are negatively correlated with the TBTF premium. It also shows that the probability of crisis and business climate risk are positively related to the premium. Notably, the RRI is negatively correlated to the TBTF premium.

The TBTF premium adjusted by the probability of systemic crisis

As pointed out in Philippon (2019), the estimated impact of the TBTF reforms on bank funding spreads can be biased, notably if the perceived probability of systemic risk has changed considerably in the pre- and post-crisis periods. As a result, adjusting the funding subsidy by the probability of a systemic crisis can reduce the potential bias and therefore reveal the change in bailout probability before and after the TBTF reforms more clearly.

We computed an *adjusted TBTF premium* (Adj-TBTF), where we use the probability of crisis computed by Engle and Ruan (2019) to scale the TBTF premium as in Philippon (2019):

$$Adj - TBTF_{i,t} = \frac{TBTF_{i,t}}{s_{c,t}} \tag{7}$$

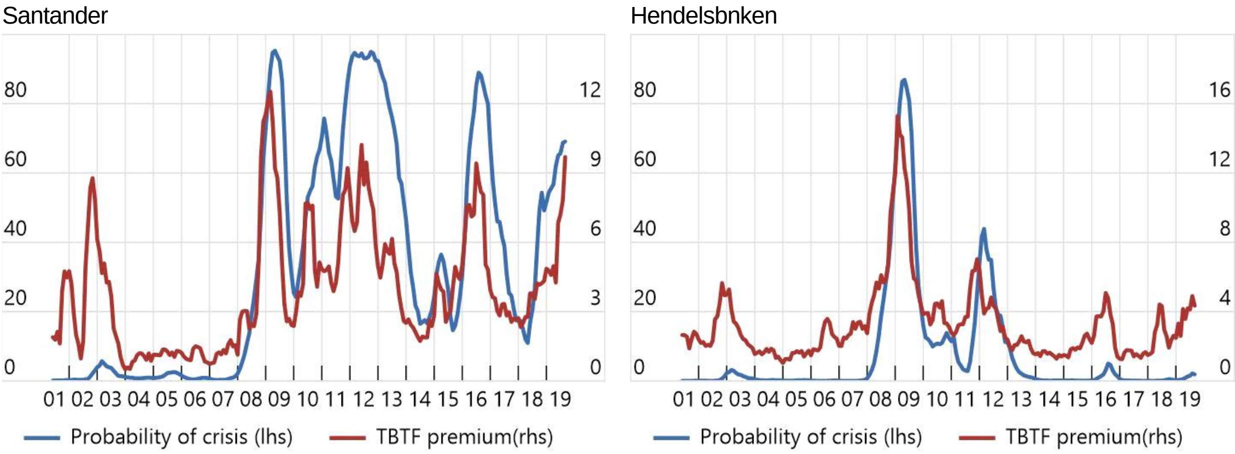
where $s_{c,t}$ is the probability of crisis for country c.

There are two issues to consider. First, the adjustment makes sense only insofar that the probability of a systemic crisis is a good proxy for the probability of systemic risk. The two are of course related, but need not be the same. Second, the Adj-TBTF as in (7) can be meaningfully computed only if the ratio is well-defined. To avoid division by zero, some banks and countries have to be excluded from the Adj-TBTF computation.

Figure 3.7.3 below shows the TBTF-premium and the probability of a crisis and Figure 3.7.4 the Adj-TBTF and the TBTF premium for only two selected banks. However, these patterns tend to be fairly similar for most of the banks for which we could compute the Adj-TBTF.

TBTF premium and probability of a systemic crisis – selected banks

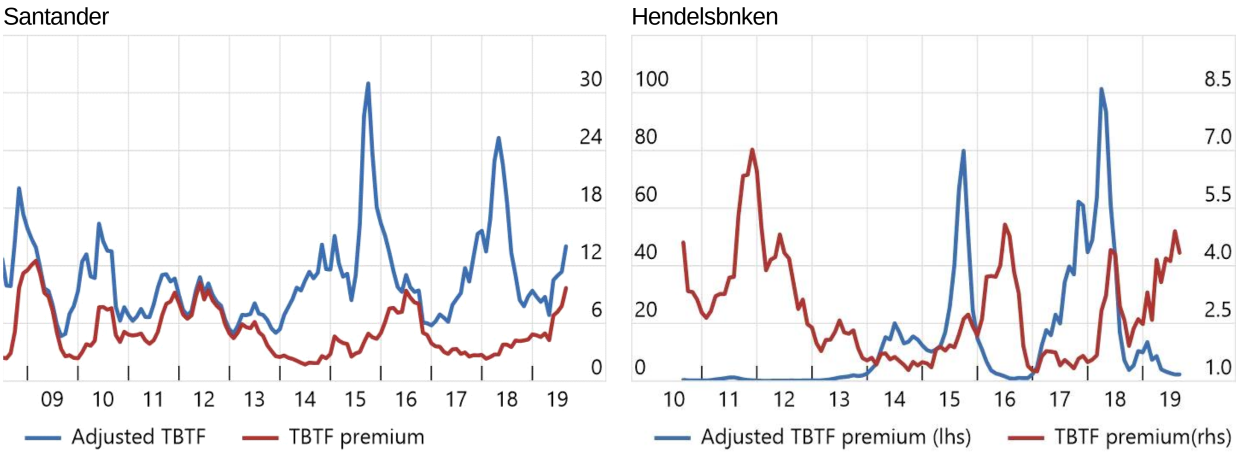
In per cent **Figure 3.7.3**



Sources: Bloomberg; Markit.

TBTF premium vs adjusted TBTF premium– selected banks

In per cent Figure 3.7.4



Sources: Bloomberg; Markit.

Three main results emerge from the comparison:

1. As we showed previously, there is substantial heterogeneity among banks in terms of their TBTF premium but the new evidence in this study shows that this is true also in terms of their country-specific probability of systemic crisis.
2. The computed TBTF and the probability of a crisis tend to co-move, possibly with the TBTF variable anticipating the probability of systemic crisis.
3. The adjusted TBTF premiums tend to be higher than the unadjusted TBTF.

Given the evidence above, the unadjusted TBTF premium could be downward biased and therefore considered as a lower bound measure.

Regression results

We estimate eq. (6) as a panel regression with firm and time fixed effects at monthly frequency. The results of the baseline estimation are reported in Table 3.7.2. In column (1) we regress the too-big-to-fail premium (*TBTF*) on the set of macroeconomic and bank-specific variables.

The results show that the TBTF premium is positively associated with high market risk aversion (*VIX*) and the Engle and Ruan (2019) probability of a systemic crisis. Sovereign risk matters. It is well established that sovereign risk feeds back into bank risk. Countries with sovereigns that are more indebted or where banks have a larger exposure to their own sovereign, suffer from feedback loop effects from sovereign risk into bank risk. We measure sovereign risk by the country debt to GDP ratio and find that higher public debt is associated with a lower TBTF premium, thereby providing further evidence of the sovereign-bank risk feedback loop for the banks in our sample. Trend growth rate shows a negative coefficient, implying that better structural economic conditions lower bank funding subsidies but the coefficient is not statistically significant in some specifications. Finally, both the measure of interest rate structure (*Slope*) and monetary policy (*Gov2y*) turn out to be insignificant in all specification and we omit them from Table 3.7.2.

Among the bank-specific variables, bank capital has the expected negative sign implying that higher bank capital, as measured by total bank capital ratio (*TCR*), lowers the TBTF premium. It is, however, not statistically significant in most of the specifications we use. Bank sector size has a negative sign, implying a lower premium with larger size, possibly reflecting the existence of economies of scale and benefits of diversification but, similarly to bank capital, is not significant. Bank profitability (as measured by *ROE*) is statistically significant and has a negative sign implying that higher bank profitability is associated with lower subsidies.

Effects of Reforms

We include the effect of resolution reforms in the regression analysis using the RRI. The results in Table 3.7.2 in column (2) show that the progress made in resolution reform implementation correlates with the TBTF premium. The sign on the RRI is negative and the coefficient is statistically significant and robust to different specifications of eq. 6. In columns (3) to (5) we include the RRI sub-indices instead. Similarly to the RRI, also these coefficients turn out to be significant and negative.

The results suggest that material progress in resolution reforms may lower the subsidies.

Table 3.7.2. Regression results for the TBTF premium and the FVCDS

VARIABLES	TBTF	TBTF	TBTF	TBTF	TBTF
TCR	-0.08	-0.05	-0.04	-0.2	-0.02
	(0.598)	(0.746)	(0.838)	(0.222)	(0.894)
ROE	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Prob Crisis	0.09***	0.08***	0.09***	0.07***	0.09***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Trend growth rate	-1.78	-2.78*	-2.23	-2.02	-2.58*
	(0.210)	(0.053)	(0.103)	(0.202)	(0.071)
Sov Debt ratio	-0.11**	-0.11**	-0.10**	-0.13**	-0.10*
	(0.041)	(0.029)	(0.046)	(0.020)	(0.056)
VIX	0.21***	0.21***	0.21***	0.23***	0.21***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RRI		-12.61***			
		(0.001)			
RRI1			-4.80**		
			(0.023)		
RRI2				-10.65**	
				(0.018)	
RRI3					-6.75**
					(0.016)
Observations	3,916	3,314	3,314	3,314	3,314
Number of banks	26	26	26	26	26
Year FE	YES	YES	YES	YES	YES
R-squared	0.482	0.499	0.490	0.497	0.489
Adj. R-squared	0.478	0.496	0.487	0.494	0.485

Robust pval in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Robustness checks

The results in Table 3.7.2 are robust to different checks, notably:

- Different specifications of eq. 6, including or excluding different variables. In total, we have 28 specifications.
- Different choices of the variables. For example, when we use Tier I capital ratio (T1R) instead of total capital ratio (TCR) we obtain similar results.
- The panel analysis performed at country level, e.g. we estimate the following:
- $\mathrm{TBTF}_{c,t} = \beta_1 + \beta_2\mathrm{Macro}_{c,t} + \beta_3\mathrm{Bank}_{c,t} + \beta_4\mathrm{Regulation}_{c,t} + \mathrm{ProbCr}_{c,t} + \gamma_i + \partial_t + \varepsilon_{c,t}$ (8),
- where variable vectors are obtained by averaging the input variables for each country. However, due to the availability of data only 7 out of 14 countries are included in the sample.
- The inclusion of a dummy variable for the post-reform period 2011-2019.
- Different periods, i.e. a pre-crisis period from 2004 to 2007, a crisis period from 2008 to 2012 – including the European debt crisis that followed shortly after the global

financial crisis of 2008-2009, and the post crisis period from 2013 to 2019. The solvency measure (T1R) does not seem to matter before and during the crisis, but becomes relevant in the post-crisis period, possibly reflecting a general higher awareness of bank risk and increases in capital ratios. All other results are in line with previous results.

3.7.5. Conclusion

We analyse the evolution of the TBTF premium from 2004 to 2019 for a large sample of G-SIBs and D-SIBs in Europe and US.

We find that the TBTF premium has been declining steadily from the peak of the global financial crisis in 2008–09, but that it remains higher compared to pre-crisis levels. The results are not uniform among countries. For some countries, the premium during the resolution reform implementation period has increased.

To capture the impact that resolution reforms have had on the TBTF premium, we regressed the premium on the RRI. We find that the RRI is statistically significant and negatively associated with the TBTF premium. Although these results need to be interpreted with some caution, they suggest that material progress in resolution reforms can lower the subsidies.

3.7.6. Appendix. Tables and additional figures

Table 3.7.3. List of G-SIBs* and D-SIBs included in the sample

Country	Bank name	Country	Bank name
Austria	ERSTE GROUP	Sweden	SEB
	RAIFFEISEN BANK		HANDELSBANKEN
Belgium	KBC		SWEDBANK
Denmark	DANSKE BANK	Switzerland	CREDIT SUISSE GROUP
Finland	NORDEA*,§		UBS AG
France	BNP PARIBAS*	UK	BARCLAYS*
	CREDIT AGRICOLE*		HSBC*
	SOCIETE GENERALE*		LLOYDS
Germany	COMMERZBANK		RBS*
	DEUTSCHE BANK*		STANDARD CHARTERED*
Italy	UNICREDIT*	USA	BANK OF AMERICA*
	BMPS		GOLDMAN SACHS*
	INTESA SANPAOLO		JP MORGAN CH*
Netherlands	ING*		CITIGROUP*
Norway	DNB		BANK OF NY
Portugal			STATE STREET
Spain	SANTANDER*		WELLS FARGO
	BBVA		
	BANCO POPULAR ESPANOL		
	BANCO DE SABADELL		

Note: *denotes G-SIBs. § Nordea was a Swedish bank up to 2018 when it changed headquarters to Finland. Up to 2018 was designated as a G-SIBs.

Table 3.7.4. Summary statistics of regression variables

	average	variance	st dev.	min	max	no. obs
FVCDS	7,5	67,8	8,2	0,0	57,8	6954
TBTF	6,5	60,5	7,8	-1,8	57,0	6770
T1R	12,1	15,0	3,9	1,5	28,7	6650
TCR	15,0	15,9	4,0	2,8	32,5	6661
ROA	0,8	0,5	0,7	-7,6	4,8	6851
ROE	13,2	177,5	13,3	-173,8	54,8	6851
Lev	19,4	502,8	22,4	5,3	1002,0	6898
Prob Crisis	25,2	819,3	28,6	0,0	98,9	6956
Slope	1,3	0,7	0,8	-6,4	4,2	6956
gov2y	1,6	3,0	1,7	-1,1	18,3	6956
Trend gr rate	1,1	0,7	0,8	-0,1	2,7	5640
SizeBankSec	118,2	1691,5	41,1	56,4	222,2	6192
SizeSIB	71,8	236,1	15,4	49,5	97,8	5580
VIX	18,3	69,2	8,3	10,1	62,6	6956
RRI	0,6	0,1	0,2	0,0	1,0	3248

3.8. Bank bail-in events: an EU event study

3.8.1. Introduction

The evaluation replicated and expanded the analysis in "*Expecting Bail-in? Evidence from European Banks*". That study focuses on bail-in events, but also considers and assesses the impact of a broader and more recent set of relevant events and announcements (e.g. the resolution of Banco Popular). The purpose of the study is to estimate the short term reaction of equity and CDS prices of a sample of European banks to various events and announcements, such as bail-ins, recapitalisations, and the proposal and final agreement of the EU reform package of prudential and resolution rules in banking ("banking package").

The following section summarises the results. The full paper is available as a JRC Technical Report by M. Bellia and S. Maccaferri *"Banks' bail-in and the new banking regulation: an EU event study"* (forthcoming), to which we refer for additional details, statistics and explanations.

3.8.2. Description of the data

The paper by Schäfer et al (2017) makes use of daily equity returns and CDS spreads for both junior and senior tranches. Quotes are from Datastream and cover banks from the European Union plus banks located in the UK, Norway, Switzerland and Lithuania. Their final sample, after inactive or not continuously traded banks were deleted, is made of 64 banks for senior CDS spreads, 40 for junior CDS spreads and 85 banks for stock returns. The market model that enters the formulas to estimate the stocks' returns is proxied by the Stoxx Global 1800.

In order to replicate the exercise, the evaluation reconstructed the database used by Schäfer et al. on a best-efforts basis. Bank stock data are downloaded from Bloomberg and include total returns including dividends; senior and junior CDS spreads are downloaded from Thomson Reuters Eikon and Thomson Reuters Datastream. Quotes are in euros, with

Modified Modified (MM) restructuring clause,[54] 5-year maturity and mid-spread close. For some banks, CDS quotes are not available in Thomson Reuters and thus quotes from Intercontinental Exchange (ICE) of CMA Datavision are used.

Data available to the present analysis spans the period 2010-2019, though following the approach by Schäfer et al., only quotes starting 80 days before each analysed event are considered. We attempt to include the same banks as in Schäfer et al. (2017). Unfortunately, it is not possible to fully reconstruct such a dataset, since senior CDS spreads data are available for 59 banks (out of 64), stock data are available for 84 banks (out of 85) and junior CDS spreads are available for 39 (out of 40) using the data providers described above. While stock datasets are generally aligned and for the majority of the banks these statistics coincide, the CDS datasets seem to diverge in some instances. We decided not to apply any trimming or winsorization procedure, and to keep the data as they have been downloaded from the data provider, since in general the results of the replication exercise are consistent with Schäfer et al (2017).

3.8.2.1 Selected Events

This section aims at assessing how stock and debt markets responded to selected bail-in/resolution events and to regulatory announcements and decisions. The set of selected events follows the selection evaluated in the paper by Schäfer et al (2017) and expands it to more recent events. Schäfer et al (2017) analysed five bail-in cases in Europe, namely in Denmark (2011), Spain (2012), Netherlands (2013), Cyprus (2013) and Portugal (2014). The paper also considered the creation of the Single Resolution Mechanism (SRM), which occurred in 2013-2014 and the analysis focused on the key events, from the EU ministers' agreement on the Bank Recovery and Resolution Directive (BRRD) to the legislative steps to adopt the legal text. The present work extends this set of events focusing on the following:

- The "precautionary recapitalisation" of Banca Monte dei Paschi di Siena (MPS) as of 29th December 2016. A precautionary recapitalisation is a measure foreseen by the BRRD under exceptional conditions to remedy a serious disturbance in the economy and to tackle serious threats to the financial stability of a Member State. The intervention is a temporary and extraordinary state aid, and must be compliant with state aid rules. In the case of MPS, the precautionary recapitalisation amounted to €8.8 billion. On 23 June 2017, the European Commission announced the approval of the precautionary recapitalisation.
- The resolution of Banco Popular by the Single Resolution Board (SRB) on the 6-7 June 2017.
- The adoption of the banking package proposed by the European Commission on 23 November 2016 and published on 7 June 2019 in the Official Journal of the EU. The package aims at reducing risks in the banking sector and strengthening the resilience and resolvability of EU banks.

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[54] For CDS, all events prior to 2014 are estimated using the 2003 Protocol, for consistency with the original paper. However, a major change occurred in October 2014, when the new MM protocol was implemented. The new protocol provides full insurance on subordinated debt, reflecting the full protection of the derivative including the case of bail-in. For that reason, all events after October 2014 are evaluated using the MM14 protocol. The 2014 Protocol is a set of new standards for CDS transactions. They reflect, among other things, the introduction of the bail-in mechanism as foreseen by the EU Regulation. More details on the Protocol can be found at https://www.isda.org/a/ydiDE/isda-2014-credit-definitions-faq-v12-clean.pdf

- The SRB decision not to take resolution actions for Banca Popolare di Vicenza and Veneto Banca on 23 June 2017, the SRB concluded that for these two banks, resolution actions were not warranted in the public interest and the winding up of the banks took place under national insolvency proceedings.
- The European Commission decision on German Norddeutsche Landesbank – Girozentrale NordLB recapitalisation as of 5 December 2019. The European Commission found Germany's measures to improve the capital position of state-owned NordLB to be free of any state aid. These measures involved a direct investment of €2.8 billion and additional investments to ensure the functioning of the bank.

3.8.3. Empirical analysis

The empirical analysis applied in this report closely follows the one applied in Schäfer et al (2016a), Schäfer et al (2016b) and Schäfer et al (2017), and consists of estimating a system of equations with a technique called Seemingly Unrelated Regression (SUR), introduced by Zellner (1962). The advantage of this technique is to assume that the error terms are correlated across equations. However, it is worth mentioning that since the explanatory variables are the same across all the banks in the sample, the estimated coefficients of the SUR are identical to ordinary least squares. One clear advantage of using SUR is that it allows to directly test linear combinations of coefficients, even if it is possible to obtain the same tests using alternative methodologies.[55] Additional details of the model can be found in Bellia and Maccaferri (2020).

Each event is analysed separately for all banks in the sample. The overall reaction is estimated by calculating the average beta coefficient across banks for each event. The same test is carried out on the cumulative return, calculated summing the beta coefficient for the event day plus the coefficient of the following day.

The analysis is run on the full sample and considering different subgroups of banks (G-SIBs vs non-G-SIBs, and GIIPS (Greece, Ireland, Italy, Portugal and Spain) vs non-GIIPs) as in Schäfer et al (2017). The significance of the differences between groups is assessed using a *t-test* where the two samples are unequal (different number of components of the groups) and with different variances.

3.8.4. Results

The results reported in this paragraph are related only to the new events included in the analysis, introduced in Section 3.8.2. The overall results for senior CDS and stock returns are in line with those of Schäfer et al (2017): the majority of events classified as significant by the JRC were also identified as significant by the study. We discuss the individual events related to a bank and collective regulatory events. The analysis that follows is carried out using the CDS with protocol MM14, released after October 2014, that includes also bail-in as a credit event.

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[55] Seaks (1990) provides an alternative way to calculate the covariance matrix needed to test cross-equation linear combination of coefficients. However, since the number of banks in our sample is relatively small, we do not have computational issues that justify the simplifications assumed by the author. We thank George Pennacchi for pointing this out.

On 6 June 2017 the ECB agreed that the SRB should start a resolution procedure for Banco Popular, given its liquidity situation, and on 7 June the SRB transferred all shares of Banco Popular to Banco Santander. Overall, markets do not seem to have abnormal reactions (see Table 3.8.1). Results show that the full sample of banks (without the Spanish banks) face no statistically significant reaction of CDS spreads to the SRB intervention. The stock market reveals significant reaction only for the differences between GIIPS and non-GIIPS, albeit individually the two groups are not statistically significant. One possible explanation might be that Banco Popular's stock was traded below €1 (the purchase price paid by Santander for the shares and capital instruments of Banco Popular) even before the final decision on resolution by ECB and SRB and thus the markets already knew that the bank was insolvent. The analysis of the differences between junior and senior CDS spreads does not give additional insights with respect to the other two markets: there are no significant differences in the groups of banks for that event.

Table 3.8.1

Panel A: Abnormal banks CDS spreads – Resolution of Banco Popular

Event Date		Full sample	G-SIB	Non-G-SIB	G-SIB vs Non-G-SIB	GIIPS	Non GIIPS	GIIPS vs Non-GIIPS
06 Jun 2017	Average	0.807	1.438	0.534	0.904	0.938	0.772	0.166
	Cum.Av.	-0.15	-0.353	-0.062	-0.291	0.602	-0.349	0.951

Panel B: Abnormal banks stock returns – Resolution of Banco Popular

Event Date		Full sample	G-SIB	Non-G-SIB	G-SIB vs Non-G-SIB	GIIPS	Non GIIPS	GIIPS vs Non-GIIPS
06 Jun 2017	Average	-0.549%	-0.518%	-0.557%	0.039%	-0.794%	-0.471%	-0.323%
	Cum.Av.	-0.432%	0.07%	-0.558%	0.628%	-2.02%	0.077%	**-2.097%****

Panel C: Abnormal banks CDS Junior vs Senior Spread Resolution of Banco Popular

Event Date		Full sample	G-SIB	Non-G-SIB	G-SIB vs Non-G-SIB	GIIPS	Non GIIPS	GIIPS vs Non-GIIPS
06 Jun 2017	Average	0.637	-0.413	1.049	-1.462	1.499	0.414	1.085
	Cum.Av.	0.86	0.474	1.012	-0.538	2.066	0.549	1.517

Notes: The tables show the average coefficient across banks after the estimation of the SUR regression model. Average refers to the value at the event date, while the cumulated average (Cum.Av.) includes also the day after the event. The significance is assessed with a t-test. Values statistically different from zero are in bold. ***, **, * corresponds to statistical significance at 1%, 5%, and 10%, respectively.

In November 2016, the European Commission proposed the banking reform package. It is a broad initiative meant to further progress towards reducing the risk of the EU banking sector and completing the Banking Union. The entire process has been complex as it covered different reforms. Six main events were identified and the analysis assessed how markets reacted to them. The following table recap the events, the date, and the Event ID used in the results.

Event ID	Date	Description
(1)	23 Nov 2016	EC proposes banking reform package
(2)	25 May 2018	The Council of the European Union reaches a general approach on the banking package
(3)	19 Jun 2018	The EP votes the amended text on the banking package
(4)	16 Apr 2019	Final political agreement on the banking package
(5)	7 Jun 2019	Publication of legislative text on the Official Journal of the EU
(6)	27 Jun 2019	Applications of MREL requirements

Results show that CDS spreads (Table 3.8.2 Panel A) did not react when the European Commission proposed the reform package (November 2016, Event 1) but strongly reacted with positive coefficients when the Council of the EU reached a general approach on the package (May 2018, Event 2), an important milestone because it provided the Council Presidency with the mandate to start negotiations with the European Parliament. During this event, stock returns reported significant drops of around 1-5% (Table 3.8.2 Panel B). The differences between junior and senior CDS mimic the reaction of CDS and equity for the second event (Banking Package of 25/05/18), but also significantly react for the first event of this list, namely the proposal of a reform package. This result appears to be driven by the over-reaction of non-G-SIB and GIIPS banks, as reported in Table 3.8.2 Panel C. The average difference is pretty high, especially for GIIPS banks (around 29 bp). All the remaining events are mostly non-significant, with some sporadic exception for equity and the difference between Junior and Senior CDS.

Table 3.8.2

Panel A: Abnormal banks CDS spreads – European Commission Banking Package

Event ID		Full sample	G-SIB	Non-G-SIB	G-SIB vs Non-G-SIB	GIIPS	Non GIIPS	GIIPS vs Non-GIIPS
(1)	Average	0.458	0.877	0.274	0.604	0.597	0.403	0.195
	Cum.Av.	0.111	0.498	-0.06	0.558	-0.125	0.205	-0.329
(2)	Average	**3.39*** **	**4.698*** **	**2.774*** **	1.924	**7.883*** **	**1.464***	**6.419*** **
	Cum.Av.	**3.273** **	**4.429** **	**2.73** **	1.699	**8.832*** **	0.891	**7.941*** **
(3)	Average	0.643	1.107	0.424	0.683	1.165	0.419	0.746
	Cum.Av.	-0.302	-0.253	-0.325	0.072	-0.427	-0.249	-0.178
(4)	Average	0.211	0.519	0.067	**0.451** **	0.33	0.161	0.169
	Cum.Av.	0.17	0.412	0.056	0.355	0.151	0.178	-0.027
(5)	Average	-0.903	-1.456	-0.651	-0.805	-1.234	-0.752	-0.481
	Cum.Av.	-1.628	-2.219	-1.36	-0.859	-2.665	-1.157	-1.508
(6)	Average	-0.48	-0.81	-0.326	-0.484	-1.029	-0.247	-0.782
	Cum.Av.	-0.72	-1.309	-0.445	-0.864	-1.608	-0.344	-1.265

Panel B: Abnormal banks stock returns – European Commission Banking Package

Event ID		Full sample	G-SIB	Non-G-SIB	G-SIB vs Non-G-SIB	GIIPS	Non GIIPS	GIIPS vs Non-GIIPS
(1)	Average	-0.841%	-0.916%	-0.822%	-0.094%	-0.996%	-0.77%	-0.225%
	Cum.Av.	-1.238%	-1.335%	-1.214%	-0.122%	-1.817%	-0.98%	-0.839%
(2)	Average	-1.146%	-1.091%	-1.16%*	0.07%	**-3.36%*** **	-0.226%	**-3.14%*** **
	Cum.Av.	**-2.2%** **	**-2.18%***	**-2.21%** **	0.034%	**-5.80%*** **	-0.708%	**-5.10%*** **
(3)	Average	0.302%	0.602%	0.221%	0.381%	0.707%	0.134%	0.573%
	Cum.Av.	0.755%	1.164%	0.644%	0.52%	1.761%	0.338%	**1.423%** **
(4)	Average	0.172%	0.855%	-0.016%	**0.87%** **	0.201%	0.161%	0.041%
	Cum.Av.	0.591%	1.629%	0.305%	**1.32%** **	0.952%	0.449%	0.503%
(5)	Average	-0.177%	-0.445%	-0.101%	-0.343%	-0.67%	0.01%	**-0.679%***
	Cum.Av.	0.517%	0.241%	0.594%	-0.353%	1.71%	0.066%	**1.643%*** **
(6)	Average	0.548%	0.489%	0.565%	-0.077%	0.634%	0.516%	0.119%
	Cum.Av.	0.775%	0.777%	0.775%	0.002%	1.212%	0.611%	0.601%

Panel C: Abnormal banks CDS Junior vs. Senior Spread

European Commission Banking Package

Event ID		Full sample	G-SIB	Non-G-SIB	G-SIB vs Non-G-SIB	GIIPS	Non GIIPS	GIIPS vs Non-GIIPS
(1)	Average	**8.422*****	-0.294	**11.963*****	-12.258	**28.992*****	0.065	28.927
	Cum.Av.	2.536	-0.817	3.898	-4.715	8.914	-0.055	8.969
(2)	Average	**2.156****	**2.449****	**2.029****	0.42	**5.177****	0.835	**4.342****
	Cum.Av.	0.176	2.392	-0.794	3.185	-2.709	**1.437***	-4.146
(3)	Average	-0.213	-1.1	0.176	-1.276	-0.526	-0.076	-0.451
	Cum.Av.	0.916	-1.692	2.057	-3.749	4.001	-0.434	4.435
(4)	Average	-0.088	0.746	-0.438	**1.184****	-1.001	0.295	-1.296
	Cum.Av.	-0.299	0.694	-0.716	**1.411****	-1.243	0.096	-1.34
(5)	Average	-0.892	-2.118	-0.394	-1.724	-1.476	-0.629	-0.847
	Cum.Av.	-1.109	-2.356	-0.603	-1.753	-1.546	-0.912	-0.634
(6)	Average	-0.129	-1.582	0.48	-2.061	1.787	-0.933	2.72
	Cum.Av.	-0.727	-2.975	0.215	-3.19	1.066	-1.479	2.544

The tables show the average coefficient across banks after the estimation of the SUR regression model. Average refers to the value at the event date, while the cumulated average (Cum.Av.) includes also the day after the event. The significance is assessed with a t-test. Values statistically different from zero are in bold. ***, **, * corresponds to statistical significance at 1%, 5%, and 10%, respectively.

We further analyse three events related to Italian banks. Two events relate to MPS bank, neither of which show a significant market reaction. Third, the European Banking Authority (EBA) published the results of the stress test at EU level in July 2016. MPS failed the stress test, and needed to implement a set of measures to meet the solvency criteria under the stress test scenario, which includes the sale of all bad loans and an increase of the coverage of the loans unlikely to pay. Around €8.8 billion was granted by the Italian Government under the "precautionary recapitalisation" measures provided under the BRRD. The recapitalisation was approved by the European Commission on 4 July 2017 (Event 2). Both events related to MPS display no significant reaction across markets in the sample of banks (Italian banks are excluded from the sample[56]), with very few exceptions. Thus, no abnormal consistent reaction of the banking sector was triggered by the precautionary recapitalisation of MPS.

Between the two MPS events, two banks located in the North of Italy, Banca Popolare di Vicenza S.p.A. and Veneto Banca S.p.A were declared by the ECB on 23 June 2017 to be "failing or likely to fail" (Event 3). The SRB decided that resolution for these banks was not warranted in the public interest. Thus, the two banks entered domestic insolvency proceedings. The evidence for both Senior CDS and Equity show no significant reaction to the event.

[56] The regressions implemented for each selected event have been run by removing the banks belonging to the country where the event took place. The main reason is to exclude potential biased data from the sample, as banks in that country might have abnormal reactions.

However, for the difference between Junior and Senior CDS, there is a significant deviation for the day of the event, with an average negative sign, significant for the entire sample, for both G-SIB and non-G-SIB, but not for the GIIPS banks. A negative difference implies that the Junior CDS price went down more than the Senior, implying a reduction in the cost of buying a CDS on the Junior liabilities. One potential explanation of this effect might be due to the new 2014 MM restructuring clause, which covers also the bail-in event. In fact, with the previous regime, junior debt is likely to be first to be called-in in case of a bail-in, and this will be reflected in an increase of the risk premium for the CDS. In this case, both senior and junior CDS have the same level of protection, and the markets now recognise a lower risk premium for the junior tranche.

The last event in our sample covers a German event on 5 December 2019. This event involves a state-owned bank, Norddeutsche Landesbank – Girozentrale (NordLB), that required additional capital. The European Commission declared the direct investment by the Government free of any State aid, since it was granted at market conditions (i.e., with remuneration in line with the market). Markets, overall, do not react abnormally to this event.The fiscal strength of the country might have played a role, since no significant spillover effects occurs across the banks in the sample.

3.8.5. Conclusions

Results on senior CDS spreads and stock market returns confirm those by Schäfer et al (2017), as the majority of events classified as statistically significant by the JRC are also identified as statistically significant by the original paper. Also the sign and magnitude of the coefficients, although not identical, are similar. As in Schäfer et al (2017), the results suggest that the expectations of a bail-out are reduced since the introduction of the new restructuring regime of bail-in.

The JRC report also analyses the markets' reactions to more recent events not analysed in the paper by Schäfer et al (2017), namely the resolution of Banco Popular in 2017, the introduction of the new Banking Package by the European Commission spanning the period 2016-2019, the precautionary recapitalisation of MPS, the decision not to resolve the Italian Banca Popolare di Vicenza S.p.A. and Veneto Banca S.p.A, and finally the direct investment by the German Government in NordLB.

This report provides evidence that, taken as a whole, events and announcements no longer seem to trigger abnormal reactions in bank funding markets after the bank prudential and resolution reforms were implemented as of 2016, with the notable exception of the banking package Council agreement of May 2018 (which further tightens the applicable prudential and resolution rules). This event triggers a sharp negative reaction for the CDS market, where prices for protection increase, and a negative response of the equity market, where stock prices decrease.

4. Banks' responses to reforms

4.1. The input of the Basel Committee on Banking Supervision

4.1.1. Introduction

This section summarises the main findings of the Macroprudential Supervision Group (MPG) of the Basel Committee on Banking Supervision (BCBS). A more detailed description will be provided by the BCBS in the context of its evaluation of the framework for global systemically important banks.

The MPG used bank balance sheet data to evaluate the impact of the G-SIB designation on G-SIBs' balance sheets and to examine behavioural responses, including banks' risk taking behaviour which may also be affected as a consequence of the framework. The analysis attempts to assess whether the results are consistent with the intended objectives of the framework of reducing the probability of failure and reducing systemic importance, and also whether any unintended effects are observed. The academic work of Violon et al. (2018) is most closely related to the MPG's work. Similar to that methodology, the evidence presented here includes regression analyses that relate potential changes in banks' balance sheets and behaviour to the introduction of the G-SIB framework.

4.1.2. Description of the data

The analysis was conducted using annual balance sheet and income statement data from Standard & Poor's Global Market Intelligence (S&P Global MI). The sample comprises bank data on a consolidated level for the period 2005-18 for banks with total assets exceeding €200 billion as of end-2017. The analysis excludes banks that do not pursue a typical bank business; and banks from the G-SIB assessment sample which were not found in the S&P Global MI query. G-SIBs are defined as banks which have been listed at least once in one of the FSB G-SIB lists in the period 2011-18.[57] Out of the 105 banks in the sample, 34 have been classified as G-SIBs and 71 as non-G-SIBs. Moreover, it is assumed that banks which have been classified as G-SIBs maintain their status for the whole time period after the introduction of the G-SIB framework, i.e. 2012-18.[58]

4.1.3. Empirical analysis

The analysis intends to identify changes in behaviour upon receiving a G-SIB surcharge compared with (otherwise identical) bank behaviour in the absence of G-SIB designation. As one cannot observe how G-SIB-designated banks would have behaved had they not been assigned G-SIB status, the best proxy attainable is a comparison with the behaviour of banks that are not G-SIBs but are similar in characteristics to the group of G-SIB-designated banks. Thus, the evaluation assumes that G-SIBs would on average have displayed similar dynamics

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57 However, Dexia is excluded as a G-SIB because of the bailout in 2011.

58 The reason for this assumption is that G-SIBs are designated well before they have to fulfil the requirements and it is thus difficult to allocate shifts in positions to individual years.

to those of their non-G-SIB counterparts had the G-SIB framework never been introduced (commonly referred as 'parallel trends' assumption). Unlike in randomised medical trials, the 'treatment' (G-SIB status) and 'control' (non-G-SIB) groups will generally differ in more aspects than just their G-SIB status. The MPG performed several tests and robustness checks to verify the validity of the parallel trend assumption, which will be described in more detail in the BCBS publication.

The statistical identification strategy is a DiD approach (see section 1.2) that analyses changes in the treatment group after subtracting simultaneous changes in the control group. The analysis uses several balance sheet, risk and profitability measures as dependent variables. It relies on a full panel specification since the time dimension provides important information and supports the identification of the treatment effect. The specification includes bank fixed effects that account for time-invariant differences between banks across the sample. Dummy variables for the introduction of Basel II (in 2007) and Basel III (in 2013) standards allow to capture structural shifts in the level of the dependent variable. Including a number of additional variables in the regression that are known drivers of bank behaviour ('control variables') further helps with the identification of the isolated impact ('marginal effect') of receiving a G-SIB surcharge. Thus, the baseline setting at the regression equation is:

$$Y_{i,k,t} = \alpha_0 + \alpha_{\mathrm{i}} + \tau_{\{G-SIB\}} + \beta_1 \cdot \tau_{\{G-SIB\}} \cdot \iota_{\{G-SIB\}} + \sum_{j=1}^{J} \gamma_j \cdot B_{j,i,t} + \sum_{m=1}^{M} \delta_m \cdot C_{m,k,t} + \tau_{\{B\ II\}} + \tau_{\{B\ III\}} + \varepsilon_{i,k,t}$$

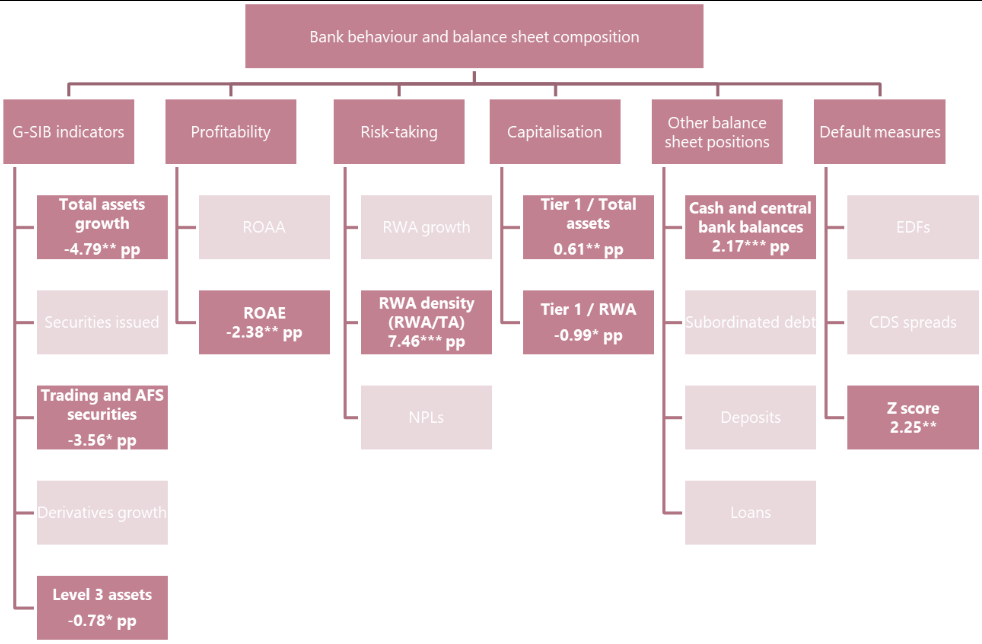
where $Y_{i,k,t}$ is the variable under consideration for bank i in country k during period t, α_0 is a constant, α_{i} are the bank fixed effects, $\tau_{\{G-SIB\}}$ is a time dummy for the introduction of the G-SIB framework at the beginning of 2012, $\iota_{\{G-SIB\}}$ is an indicator variable for all G-SIBs, β_1 is the DiD coefficient that addresses the empirical hypothesis, $B_{\mathrm{j}}, j = \{1, \dots, J\}$, are bank-specific control variables (including Tier 1 capital / total assets, NPLs / total loans, cost-to-income ratio, return on average assets, (deposits - loans) / total assets and net interest income / operating income), $C_{\mathrm{m}}, m = \{1, \dots, M\}$, are country-specific control variables (including real GDP growth, log of real GDP per capita, inflation, public debt to GDP ratio, growth rate of credit to the private non-financial sector, the ten-year sovereign bond yield and the growth rate of the nominal exchange rate against the Euro), $\tau_{\{B\ II\}}$ and $\tau_{\{B\ III\}}$ are time dummies for the introduction of Basel II and Basel III, respectively, and $\varepsilon_{i,k,t}$ is the regression error term. All time dummy variables $\tau_{\{.\}}$ show a value of '1' from the period of inception of the denoted regime onwards and '0' before, while the G-SIB indicator $\iota_{\{G-SIB\}}$ shows a value of 1 for all G-SIBs (and '0' for non-G-SIBs). The error term $\varepsilon_{i,k,t}$ is clustered at country level as banks within the same jurisdiction can be expected to display stronger correlation than across jurisdictions. Moreover, within-country residual correlation is further induced by employing country-specific (i.e. macroeconomic) regressors.

Owing to the comprehensive list of control variables and deterministic terms in the specification used in these analyses, the coefficient β_1 of the interaction term $\tau_{\{G-SIB\}} \cdot \iota_{\{G-SIB\}}$ will report changes in the dependent variable Y that are related to the assignment of G-SIB status and cannot be explained by any of the other factors included in the regression. Hence the sign and significance level of β_1 will show the direction and statistical significance of the impact that G-SIB status had on average on the dependent variable Y relative to the control sample.

4.1.4. *Results*

This section discusses the regression results. Figure 4.1.1 gives an overview of the variables analysed and indicates in bold which of these variables have been affected by G-SIB designation (also providing the estimate of the relevant coefficient, β_1). In contrast, if no impact is shown, then the variable is not statistically significantly related to the G-SIB designation.

Overview of the main findings **Figure 4.1.1**



A variable is marked bold and the economic impact is shown if the variable proved to be significantly related to the G-SIB designation. If no impact is shown, then the variable has no statistically significant impact. The symbols *, ** and *** indicate significance at the 10%, 5% and 1% levels. Positions from the asset (liability) side are standardised by the total assets (liabilities). An exception is the item NPLs (which is standardised by total loans). Moreover, the evaluation used the growth rate for off-balance sheet positions and the aggregates total assets and RWAs.

In sum, the analysis shows that the following outcomes, relative to non-G-SIBs, can be associated with the G-SIB designation:

- a slowdown in the growth rate of total assets;
- fewer Level 3 assets and fewer trading and available for sale securities;
- higher unweighted capital ratios;
- stable return on average assets (ROAA), but declining profitability as measured by the return on average equity (ROAE). This is consistent with higher unweighted capital ratios;
- a slower reduction of average risk-weights, along with a relatively lower risk-weighted capital ratio;
- no contraction in lending; and
- a tendency for reduction of default risk, noting that promotion of moral hazard cannot be identified.

The MPG performed numerous robustness checks and also descriptive analysis that broadly confirmed the results and will be described in detail in the BCBS publication. Moreover, the results do not seem to be driven by a single region.

4.1.5. Conclusions

Although causality cannot be proved, the analysis provides some evidence that is consistent with the objectives of the G-SIB framework. Specifically, G-SIB designation appears to be correlated with a slowdown in the growth rate of total assets and reductions in instruments considered in the complexity category, specifically lower volumes of Level 3 assets and Trading/AFS securities. Moreover, the unweighted capital ratio increased after a bank has been designated as a G-SIB. This could be a direct consequence of the higher loss absorbency requirement of the G-SIB framework.

After a bank was designated as a G-SIB, there was a decline in profitability as measured by the ROAE, consistent with the increases in the unweighted capital ratio. Notwithstanding the fact that in the years 2012 onwards banks decreased their average risk weights (RWA density), G-SIBs appeared to reduce their average RWAs significantly more slowly than their peers. This could point to attempts to counter declining profitability or higher funding costs, although RWA density is an imperfect measure of risk-taking. Moreover, one can link G-SIB designation to more pronounced increases in cash and central bank balances. However, this may be driven by considerably lower volumes of these positions held by G-SIBs in the years before the adoption of the framework, expansionary monetary policy and increased liquidity requirements. Most importantly, lending has not appeared to contract after the G-SIB designation, thus, on aggregate, there is no evidence for negative spill-overs to the real economy.

Default measures generally indicate consistent results, suggesting a decrease in the probability of default for G-SIBs. Specifically, a significant correlation with respect to the balance sheet-based default z-score measure was identified. The descriptive statistics of the market-based measures, EDFs and CDS spreads, indicate a higher reduction in default risk for G-SIBs than for non-G-SIBs. However, this reduction proves to be statistically insignificant in the regressions.

However, some have argued that designation as a G-SIB signals that a bank is too big to fail, which could induce moral hazard. But no measure of default risk supports this hypothesis.

4.2. The evolution of SIB capital ratios and balance sheet structures

4.2.1. Introduction

To assess how SIB balance sheet and structures have evolved in the post-reform period, the TBTF evaluation heavily relied on input from the BCBS described in the previous section. Building on this work, the evaluation expanded the analysis in several ways. This included a broadening of the sample to enhance geographical coverage, further analysis on the effects of D-SIB designation, and additional robustness tests and alterations of the empirical setup.

4.2.2. Description of the data

The main data set for the analysis is obtained from SNL Financial, provided by S&P Market Intelligence (S&P MI). The data set is an unbalanced panel of annual frequency and includes balance sheet and income statement information for a broad set of banks. It covers the years from 2005 to 2018 and is generally at the consolidated bank level, with the exception of foreign subsidiaries that are also included in the baseline version of the data set.[59] Besides the pure balance sheet and income statement variables, we also use the data to construct proxy measures for five of the twelve indicators which are used to measure systemic importance in the G-SIB framework.

Data for the twelve G-SIB indicators is publicly available only for the period from 2013 to 2018, which is too short to do a pre- vs. post analysis for the reforms under consideration. To circumvent this issue, we use balance sheet data in order to construct proxy measures for those indicators where this is possible. In particular, we use total asset growth as a proxy for the growth in total leverage ratio exposure of the size category, securities issued as a proxy for securities outstanding of the interconnectedness category, and trading and available for sale (AFS) securities, the derivatives growth rate and the share of derivative in total assets as well as the share of Level 3 assets (or alternatively, the share of non-Level 1 assets) in total assets as proxies for their respective counterparts in the complexity category. Variables to proxy other G-SIB indicators were either unavailable or exhibiting insufficient data coverage.

To arrive at a consistent data set that includes SIBs and non-SIBs for all jurisdictions under consideration, we do not include banks with total assets of less than €10 billion, with the exception of Argentina and Singapore for which we also include smaller banks to have both SIBs and non-SIBs in the sample.[60] Overall, this leads to a sample of 667 banks from 24 different countries.[61] Descriptive statistics for the variables included in the data set are provided in Table 4.2.2.

4.2.3. Empirical analysis

Main specification: The main empirical approach of the subgroup is a DiD approach, where we are estimating equations of the following type:

$$Y_{i,k,t} = \alpha_{\mathrm{i}} + \alpha_{\mathrm{kt}} + \beta_1 \cdot \tau_{\{reform\}} \cdot \iota_{\{SIB\}} + \beta_2 \cdot \tau_{\{reform\}} \cdot \iota_{\{G-SIB\}} + \sum_{j=1}^{J} \gamma_j \cdot B_{j,i,t-1} + \varepsilon_{i,k,t} \qquad (1)$$

where i denotes the individual bank, k the bank's domicile, and t the year (all our regressions are based on yearly data). $Y_{i,k,t}$ is the dependent variable of interest, characterising bank balance sheets, risk or profitability; $B_{j,i,t-1}$ comprises bank-specific control variables, lagged by one period and including the logarithm of total assets, the Tier 1 capital ratio, the return on average assets, the ratio of non-performing loans to total loans, and the ratio of net income to operating income. Bank fixed effects – α_{i} –control for heterogeneity across banks, and country-year interactions – α_{kt} – control for time-varying heterogeneity across countries. Finally,

59 The inclusion of foreign subsidiaries implies some degree of double counting of information. For this reason, we also conduct robustness checks in which we exclude all subsidiaries from the estimation sample. However, foreign subsidiaries are included in the baseline version since some countries have banking markets that are largely dominated by them. Restricting the analysis to the consolidated level only would effectively exclude these countries from the analysis, or imply that inference for them is based on a sample that covers only a small portion of the overall market.

60 For these two countries, all banks identified as being potentially eligible for the control sample by the member jurisdictions were included in the sample.

61 To test the robustness of our results with respect to the type and number of banks that are included in the control group, we also consider three alternative data sets: (i) S&P MI data with a size threshold of EUR 50 bn; (ii) FitchConnect data with a size threshold of EUR 10 bn;[61] (iii) S&P MI data with a size threshold of EUR 200 bn (this corresponds to the MPG's baseline approach; since almost all banks in this sample are D-SIBs or 'near'-SIBs, only differentiation between G-SIBs and non G-SIBs is possible).

standard errors, $\varepsilon_{i,k,t}$, are clustered at the bank and the country-year level in order to control for potential correlation of error terms (for robustness, we also cluster standard errors at the country, which typically results in lower statistical significance).

The variables of interest are the two interaction terms between a reform dummy and dummy variables indicating whether the bank is a SIB and/or a G-SIB. Further information on the definition of these dummy variables is provided below. The coefficient β_1 indicates any differential effect of the reforms on D-SIBs, relative to the non-SIBs in the control group. Since the dummy variable $\iota_{\{SIB\}}$ is equal to one also for G-SIBs, the coefficient β_2 indicates whether there are any additional differential effects of the reforms for G-SIBs when compared with D-SIBs.[62] Therefore, to see the effect of the reforms for G-SIBs relative to the banks in the control group, the coefficients β_1 and β_2 need to be added.

Reform date: Our baseline approach for the reform date is to use a dummy that switches from 0 to 1 at the beginning of 2012. That is, we take the publication of the international G-SIB Framework (and the FSB Key Attributes) at the end of 2011 as a 'straw man' for testing the effects of all the reforms that followed. This reform variable is homogeneous across countries, and we assume that it exerted a treatment effect on all SIBs (including G-SIBs and D-SIBs). The reason for the latter assumption is that D-SIBs (i) were directly affected by the resolution reforms that would be applicable also to them; (ii) knew already at the time of the publication of the G-SIB framework that there would likely be higher requirements also for them, according to similar methodologies to those included in the G-SIB framework.

In alternative specifications we use as reform variable (i) the resolution reform index described in Section 2.1; (ii) the domestic implementation date for the D-SIB framework.[63]

Treatment and control group: As specified above, we assume that both G-SIBs and D-SIBs were treated (i.e., affected) by the reforms and also test for potential differential effects for the two groups of treated banks (see Equation (1)).[64] All other banks in the sample are included in the control group. There is, however, a special group of banks that can be considered as 'partially treated'. These are banks which authorities did not designate as G-SIBs or D-SIBs but which nevertheless – on account of their size or complexity – are subjected to (i) higher loss absorbency requirements; (ii) recovery and resolution planning requirements; and/or (iii) TLAC requirements.

Putting these banks together with the other banks in the control group could potentially bias the regression coefficients. To address this concern, we also estimated an amended version of Equation (1), including an additional interaction term for 'partially treated' banks:

$$Y_{i,k,t} = \alpha_{\mathrm{i}} + \alpha_{\mathrm{kt}} + \beta_1 \cdot \tau_{\{reform\}} \cdot \iota_{\{SIB\}} + \beta_2 \cdot \tau_{\{reform\}} \cdot \iota_{\{G-SIB\}} + \beta_3 \cdot \tau_{\{reform\}} \cdot \iota_{\{partial\}} + \sum_{j=1}^{J} \gamma_j \cdot B_{j,i,t-1} + \varepsilon_{i,k,t} \qquad (2)$$

62 In unreported alternative specifications, we do not include the second interaction term and differentiate only between SIBs and non-SIBs (or between G-SIBs and non G-SIBs for the sample including only banks with assets greater than EUR 200 bn).

63 For the domestic implementation of the D-SIB framework, we used a variable taking the value of 0 when draft rules had not yet been published, the value of 0.33 when draft rules had been published, the value of 0.67 when the final rules had been published but were not yet in force, and the value of 1 when the final rules had been published and were in force.

64 We include banks in the group of G-SIBs if they appear on one of the G-SIB lists that have been published by the FSB since end-2011 on an annual basis. Similarly, banks are included in the group of D-SIBs if they have been designated as D-SIB in at least one of the years in the post-reform period.

In this equation, $\iota_{\{partial\}}$ is an indicator equal to one for banks fulfilling either of the three criteria listed above and zero for all other banks, and all other variables are defined as in Equation (1).

Parallel trends assumption: A key condition for the DiD estimations to yield meaningful results is that the parallel trends assumption holds. The difference-in-differences approach assumes that the difference between the 'treatment' and the 'control' group was constant over time in the pre-treatment period, and would have remained constant in the absence of a treatment. If the parallel trend assumption does not hold, estimates of the causal effects of the treatment would be biased.

Visual inspection is useful for assessing whether the assumption may be violated. The charts in Figure 4.2.1 illustrate the evolution for selected dependent variables over the sample horizon. Although for most variables trends for banks in treatment and control groups tend to align in the pre-treatment period, some variables diverge, especially in the period ahead of the global financial crisis. We aim to mitigate potential problems arising from a violation of the parallel trends assumption in three ways: first, we create a synthetic control group in order to control for differences between treatment and control groups; second, we conduct a robustness check where we shorten the sample period and exclude the period ahead of the crisis, where trends tend to diverge most strongly; third, we conduct dynamic DiD regressions to further study the evolution of the variables of interest for treatment and control group around the reform date.

Synthetic control group methodology: The synthetic control methodology (SCM) (Abadie and Gardeazabal, 2003; Abadie et al., 2010) is a data-driven approach to small-sample comparative case-studies for estimating treatment effects. Similar to a DiD design, SCM investigates differences between treated and untreated banks in the post-reform period. However, in contrast to a DiD design, SCM does not require that the entire group of control banks follows a parallel trend with the treatment group in the pre-reform period. Instead, it weights the untreated banks in order to create, for each bank in the treatment group, a synthetic control bank that closely matches the treated bank over the pre-treatment period. Outcomes for these synthetic control banks are then projected into the post-treatment period by using the weights identified from the pre-treatment comparison, and this projection is used as the counterfactual for the treated unit.[65]

For implementing the approach, we follow Cetorelli and Traina (2018) and make use of the *synth_runner* Stata package developed by Galiani and Quistorff (2016), which automates synthetic control estimation. For these tests, we include data from 2007 to 2018, and can only keep banks for which the variable in question is observed for all periods (since the method works only for balanced panels). The method compares the variable of interest for each treated bank separately to a weighted average of control group banks. Banks from the control group and their weights are chosen such that they match as closely as possible a set of characteristics of the treated unit in the pre-event period. As characteristics we use key

[65] Inference is conducted by applying the same approach to placebo units (units that were not actually treated) and then comparing the estimated effect for the treated units with the one for the placebo units.

business model indicators (the ratio of customer loans to total assets and the ratio of deposits to total liabilities) and the outcome variable on two pre-event dates (2007 and 2010).[66] To obtain the overall treatment effect estimate, we average the paths of the variables of interest for all treated banks and their respective synthetic controls. The method is applied in two versions, corresponding to the two interaction coefficients in Equation 2:

1. (G-SIBs and D-SIBs) vs. (non-SIBs)
2. (G-SIBs) vs. (D-SIBs)

Given that the method is computationally intensive, we limit ourselves to a set of key outcome variables. To account for structural differences in levels between treated banks and banks in the control group, some of the variables are normalised to their level in 2011.[67]

In contrast to the DiD analysis, SCM does not feature additional control variables and does not require the banks forming the synthetic control to be from the same country as the treated bank (while the DiD analysis always includes country-by-year effects). Along with the differential weighting of the control group banks, these differences may explain possible variation in the results obtained via the different methodologies.

Additional tests and robustness checks: We also conduct a number of additional tests to gain insights on the drivers of our findings and to further assess their robustness. First, we split the sample into Europe, North America, Asia/Pacific, and emerging economies, to assess whether any of the results are stronger or weaker in any specific region. Second, we seek to exploit treatment intensity to further improve identification. We do this by testing whether differential effects (if any) are stronger for banks that initially had lower capital ratios (and therefore should feel higher pressure to adjust in response to an increase in capital requirements). Finally, we also estimate dynamic difference-in-differences equations of the following form:

$$Y_{i,k,t} = \alpha_{\mathrm{i}} + \alpha_{\mathrm{kt}} + \sum_{l=2005}^{2018} \beta_l \cdot year_l \cdot \iota_{\{SIB\}} + \sum_{j=1}^{J} \gamma_j \cdot B_{j,i,t-1} + \varepsilon_{i,k,t} \qquad (3)$$

Where the variables $year_l$ are dummy variables indicating the respective year and everything else is defined as above. The specification shows, for each year in the sample period, whether there are any significant differences between SIBs and non-SIBs in the variable of interest. The dynamic setting allows assessing whether divergent patterns (if any) emerged before or after the reforms and thus potentially helps with attribution of effects. The specification also allows us to explore whether any differential effects following the reform are temporary (if only the first few interaction terms post-reform are significant) or permanent (if all or interactions terms post-reform are significant).

Caveats: There are many confounding factors during the period under consideration – notably including the 2007-08 global financial crisis and the extraordinary government support

[66] The weights of the different characteristics are chosen such that they maximise the pre-event fit; see Galiani and Quistorff (2018) for details. We remove treated banks from the sample if their overall pre-event fit is poor (three times median pre event root mean square prediction error, following Abadie 2019). Nevertheless, for some outcomes the figures shown later indicate that it is difficult to find banks from the control group that are close to the treated banks, in which case the resulting treatment effects should be interpreted with more caution.

[67] Specifically, this applies to the logarithm of total assets, the logarithm of derivative assets, derivatives to total assets, non-Level 1 assets to total assets, and the net interest margin.

measures and monetary stimulus that followed – that could potentially affect SIBs and non-SIBs in different ways. It is thus difficult to attribute observed patterns to the TBTF reforms. Moreover, the strength, and in some cases also the direction, of the observed effects depends on the specification and sample being used. In particular, effects tend to vary with respect to:

- The methodology (e.g., difference-in-differences or synthetic control group);
- The econometric specification (e.g., whether or not control variables are included, whether simple time dummies or country-specific time dummies are used, etc.)
- The level of clustering, with generally more significant results for more granular levels of clustering (e.g., bank and country-year instead of country level clustering);
- The sample being used, i.e. the source of the data (S&P MI, Fitch), the size cut-off imposed for banks in the control group (€10, €50, €200 bn), and the sample period;
- The approach to 'partially treated' banks (i.e., whether or not an additional interaction term is included in the regression);
- The reform variable being used (i.e., publication of the international G-SIB framework in 2012, resolution index, date of implementation of the D-SIB framework).

The observation that results tend to vary across specifications – in combination with the general challenges associated with the sample period – should caution against over-interpretation of any specific effect. In particular, results should not be seen as providing definite answers on the causal effect of TBTF reforms on SIB behaviour and structures, but rather as tentative interpretation of observed relative patterns in recent years.

4.2.4. Results

This section presents results for the main specifications in Equations (1) and (2) as well as the synthetic control group methodology. As indicated, while general patterns can be derived, results tend vary depending on the exact specification and sample being used, which should caution against over-interpreting any specific result.

Table 4.2.1 provides a high-level overview on the direction of the results. A more detailed overview including more specific variables and different data sets and specifications is provided in Tables 4.2.4 to 4.2.6.

Table 4.2.1: High-level overview of results

	Changes (pre- vs. post reform)	
	G-SIBs (relative to D-SIBs)	**D-SIBs (relative to non-SIBs)**
Capital ratios (RWA)	~	+
Leverage ratios	~	+
G-SIB indicators	-	~
Risk	-	~
Profitability	-	~
Lending	~	~

Legend: "+" or "-" indicate substantial differences in variable adjustment between the different groups of banks based on either of the following: (i) the descriptive evidence in Table 4.2.3; (ii) the DiD analysis in Tables 4.2.4 to 4.2.6; (iii) the SCM methodology in Figure 4.2.4. "~" indicates variables for which neither of the analyses indicates substantial differences in adjustment between the different groups of banks. The indicated sign involves judgment and only gives an overview on where the majority of results are pointing. To obtain the effect for G-SIBs relative to non-SIBs, the two columns need to be added up. For example, the row on capital ratios (RWA) should be read as follows: D-SIBs exhibited a substantial increase relative to banks in the control group, and the same applies to G-SIBs (since there is no substantial difference between G-SIBs and D-SIBs).

How have SIBs' balance sheets evolved after the TBTF reforms?

Both D-SIBs and G-SIBs tended to increase their unweighted Tier1 capital ratios (i.e., their ratios of Tier 1 capital over total assets) and risk-weighted capital ratios relative to other banks, although the differences are not always significant in a regression setup. Notably, definitions of risk-weighted capital ratios have changed in the post-reform period (e.g. because certain items can no longer be included in regulatory capital), so that pure movements in ratios understate the true increase in resilience associated with higher risk-weighted capital ratios (this applies to both G-SIBs/D-SIBs and banks in the control group).

As shown in Table 4.2.3, comparing the periods 2005-11 and 2012-18, unweighted capital ratios increased from 7.1% to 8.4% for D-SIBs and from 4.6% to 5.5% for G-SIBs on average, whereas the average increase for banks in the control group and for partially treated banks was less pronounced (from 7.1% to 7.3% and from 6.9% to 7.1%, respectively). Similarly, risk-weighted capital ratios on average increased from 12.3% to 14.8% for D-SIBs, from 10.6% to 14.3% for G-SIBs, from 11.5% to 14.8% for partially treated banks, and from 11.7% to 12.8% for banks in the control group.

Of course the descriptive statistics are only indicative and do not allow causal inference.[68] Running the DiD regressions explained in Section 4.2.3, we often do not find significant

68 For example, country-specific factors are likely to exert an impact on the evolution of capital ratios, and since the distribution of G-SIBs, D-SIBs and banks in the control group is not balanced across countries this can explain parts of the differences

differences between D-SIBs and banks in the control group or between G-SIBs and D-SIBs (Table 4.2.4). Moreover, the synthetic control group methodology suggests a substantial increase in unweighted capital ratios for SIBs relative to banks in the control group, with no indication of an additional difference between G-SIBs and D-SIBs and no clear pattern for risk-weighted capital ratios (see Figure 4.2.4).

Overall, the evidence on capital ratios suggests that SIBs have been catching up with other banks, although in particular G-SIBs continue to exhibit substantially lower unweighted capital ratios. While capital ratios have increased since the crisis, we do not observe significant differences between SIBs and non-SIBs in many specifications. A possible reason for this is that many other reforms have been implemented in parallel – for example including the Basel III reforms more generally or additional requirements arising from stress tests and/or under Pillar 2 – and these reform elements induced both SIBs and non-SIBs to increase regulatory capital ratios. This relates to a general point observed in the call for public feedback, namely that it seems to be difficult to attribute changes in bank behaviour and structures observed in recent years to individual reforms, given the many confounding factors. This is an important caveat.

For other balance sheet variables (besides those that are used as proxies for the G-SIB indicators, which will be discussed below), the findings generally do not suggest major differences between D-SIBs and non-SIBs or between G-SIBs and D-SIBs. In particular, we generally do not observe any differential adjustments for the share of customer loans in total assets (see Annex 2 for a more granular analysis based on loan-level data), for the share of liquid assets in total assets, for the share of wholesale funding in total liabilities, and for the share of subordinated debt in total liabilities.

There are some differential adjustments for the share of deposits in total liabilities (which increased more for G-SIBs when compared with D-SIBs, starting from lower average levels; see Tables 4.2.3 and 4.2.4) and for the share of cash and central bank reserves in total assets (which increased more for G-SIBs and D-SIBs compared with other banks). Moreover, while all SIBs tended to decrease the share of net loans to banks in total assets, the regressions suggest that this decrease was significantly less pronounced for G-SIBs when compared with D-SIBs (as indicated by the positive coefficient for the G-SIB interaction term).

Overall, the initial findings do not indicate any strong patterns with respect to differential balance sheet adjustments for D-SIBs relative to non-SIBs (or for G-SIBs relative to D-SIBs). In those cases where we do observe differential adjustments those could also be due to other confounding factors rather than the reforms themselves.

between the different groups of banks that we observe. In the regression setup we control for this issue by including country-year interactions, ensuring that we compare the evolution of capital ratios for SIBs and non-SIBs (or between G-SIBs and D-SIBs) *within the same country*.

How have indicators of systemic importance of SIBs evolved?

The findings suggest a relative reduction in some (but not all) of the G-SIB indicator proxy variables that we are using, in particular for G-SIBs relative to D-SIBs.[69]

First, comparing the periods 2005-11 and 2012-18, average total asset growth fell from 11.1 to 2.1% for D-SIBs, from 9.7% to -1.5% for G-SIBs, from 9.4% to 3.1% for partially treated banks, and from 12.3% to 6.7% for other banks in the control group (see Table 4.2.3 for these descriptives on total asset growth and all other variables we are analysing). The regressions tend to show that the reduction in growth rate was particularly pronounced for G-SIBs, since only the coefficient indicating the differential effect for G-SIBs relative to D-SIBs comes out significant in most cases (Table 4.2.5). In contrast, the synthetic control group analysis suggests significant differences between SIBs and banks in the control group, particularly towards the end of the sample period.

Second, we observe a relative reduction for the share of derivatives in total assets. This holds in particular for G-SIBs, which start from, and remain at, a much higher level. Specifically, the share of derivatives in total assets falls from 10.0% to 8.7% for G-SIBs when comparing the periods 2005-11 and 2012-18, whereas it remains relatively constant and at levels between 1.2% and 2.6% on average for the remaining groups of banks. Also in the regressions, only the difference between G-SIBs and D-SIBs tends to be significant.

Third, we tend to a see a relative reduction in the share of non-Level 1 assets for G-SIBs, although this effect is less pronounced than for total assets and derivatives and again the share of non-Level 1 assets remains at materially higher levels for G-SIBs in the post-reform period. Specifically, for G-SIBs the average share falls from 36.2% to 28.0%, while for other banks it falls only slightly and is always below 15%. The difference between G-SIBs and D-SIBs is significant in some, but not all of the regressions. Moreover, while an absolute reduction for G-SIBs can be observed when looking at the share of Level 3 assets (from 2.1% to 1.1% of total assets on average), the evolution is similar for other banks and we do not observe significant differences in a regression.

For the other variables considered, including the share of securities issued in total liabilities and the share of trading and available for sale securities in total assets, we do not observe any significant differential adjustment for SIBs and non-SIBs (or for G-SIBs and D-SIBs).

Overall, combining this evidence with that in other studies (e.g. the MPG's work, Violon et al. 2017, BCBS 2019, Goel et al. 2019), SIBs tended to reduce some of the variables included as indicators in the G-SIB framework, although there is heterogeneity across indicators, banks, and regions. Where there is a reduction, it tends to be driven by G-SIBs.

How have SIBs' risk and profitability evolved?

Partly reflecting the increase in capital ratios documented abov,e we observe a tendency for a reduction in bank risk in the post-reform period, in some cases more pronounced for G-SIBs.

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[69] In contrast to the actual indicators in the G-SIB framework, our proxy variables are not normalised by the sample totals of the respective indicator across all banks in the sample. That is, we are looking at absolute rather than relative indicators, contrasting with the G-SIB framework (see BCBS 2018 for further information on the latter).

Since bank risk is inherently difficult to measure and quantify, we use a variety of indicators to arrive at this conclusion.

First, we estimate probabilities of distress using a simple logit model for the period 2005-11 and 2012-18.[70] We observe substantial reductions in this measure for all banks, and in particular for G-SIBs (see Table 4.2.3). The large reduction for G-SIBs is confirmed when looking at Moody's Expected Default Frequencies (EDFs). Despite this descriptive evidence, differences in the evolution of probabilities of distress between G-SIBs and D-SIBs (and between D-SIBs and non-SIBs) tend to be insignificant in a regression setup (see Table 4.2.6). A likely explanation for this is that the regressions include e.g. the Tier 1 capital ratio as a control variable, which exerts significant explanatory power and captures part of the differences between G-SIBs/D-SIBs and banks in the control group (since Tier 1 capital ratios tended to increase more for G-SIB/D-SIBs, see above).

Second, z-scores – measuring loss absorbing capacity in relation to return volatility[71] – tended to improve for all banks in the post-reform period, and we do not observe any significant differences in adjustment between SIBs and non-SIBs (or between G-SIBs and D-SIBs). In terms of levels, z-scores continue to be higher for banks in the control group on average, which means that these banks have higher ability to absorb the shocks to earnings that are usually observed for them (although there is significant heterogeneity in z-scores within all groups, as indicated by the high standard deviations in Table 4.2.3).

Third, we observe a strong relative reduction in the growth of risk weighted assets, in particular for G-SIBs. However, this is likely driven by the reduction in asset growth documented above (since risk-weighted assets are the product of risk weights and assets). There are no strong and consistent patterns for the evolution of the risk density (i.e., the ratio of risk-weighted assets to total assets). The risk density remains substantially lower for G-SIBs when compared with other banks, likely reflecting differences in the business model and the type of activity which the banks engage in. In any case, changes in risk-weighted assets reflect several things, including changes in the volume and the composition of the bank's portfolio, changes in the riskiness of individual assets, and changes in the approaches and methodologies that are used to calculate risk weights. For this reason, they are a very imperfect measure of risk–taking, which cautions against putting strong emphasis on these results.

Fourth, non-performing loan (NPL) ratios tended to fall, and the regressions suggest that these falls were more significant for G-SIBs when compared with D-SIBs. Moreover, also the share of Level 3 (or Level 2 and Level 3) liabilities in total liabilities tended to decline for all banks, where we do not observe significant differences in adjustment between D-SIBs and non-SIBs or between G-SIBs and D-SIBs. Structurally, this share remains much higher for G-SIBs than for other banks.

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70 The estimates are obtained from the model described in Goel et al. (2019). PDs are estimated based on a logit model: $PD_{i,j,t} = F(\tau + \beta_t X_{i,j,t})$, where F is the logit transformation, and X are the predictors (including the CET1 ratio, deposit-to-liability ratio, cash-to-asset ratio, cost-to-income ratio, non-performing-loans ratio, credit-to-GDP gap, and debt-service-ratio gap). Distress is defined as a 50% decline in the stock price or a rating downgrade to non-investment grade within the next year. A bank's observations are dropped from the sample for eight quarters following a distress event. Estimates are based on an unbalanced sample of 500 banks using quarterly data from 2005–18.

71 We use the following definitions (where means and standard deviations are calculated over three years, respectively):

$$zscore_1 = \frac{Tier1\ Ratio + mean(ROA)}{SD(ROA)} \qquad zscore_2 = \frac{CET1\ Ratio + mean(ROA)}{SD(ROA)}$$

Finally, findings on profitability are consistent with lower risk and a potential reduction in funding cost subsidies, in particular for G-SIBs. The descriptive statistics in Table 4.2.3 show that G-SIBs are generally somewhat less profitable then other banks, particularly when measured in terms of return on assets (RoA). Again, this is likely reflecting differences in business model, with G-SIB engaging in certain activities that have relatively low risk (and hence low return) but make up a substantial portion of the balance sheet (compare with results on risk density). The DiD estimations suggest that both the RoA and the return on equity (RoE) declined for G-SIBs in the post-reform period, relative to D-SIBs. The latter finding is consistent with the relative increase in the unweighted capital ratio that we documented above.[72]

The synthetic control group methodology yields a different picture, as it does not reveal significant differences between G-SIBs and D-SIBs (in terms of either RoA or RoE). However, RoE falls for D-SIBs (and hence also G-SIBs) relative to non-SIBs, and there is no clear pattern for the RoA differential between SIBs and non-SIBs. Finally, both descriptive statistics and regression analysis suggest that net interest margins tended to increase for D-SIBs relative to non-SIBs (while G-SIBs tended to evolve more in line with banks in the control group, as indicated by the negative sign for the G-SIB interaction term).

Overall, the findings in this section point towards a reduction in risk for banks in recent years, which tended to be more pronounced for G-SIBs in some cases. Consistent with the decline in risk and a potential reduction in funding subsidies, profitability also tended to decline for G-SIBs in relative terms, although this effect is not robust across all estimations.

4.2.5. Robustness checks and other evidence

In this section we briefly discuss a number of additional and robustness tests.

Using the resolution reform index as reform variable: When using the resolution reform index as a reform variable (instead of the reform dummy switching from 0 to 1 in 2012), results remains broadly consistent with the baseline results discussed above. Results for the baseline version of the index are included in the overview Tables 4.2.4 to 4.2.6. The signs for the interaction terms remain generally the same as for the simple reform dummy, although the significance level changes in some cases (becoming sometimes more, sometimes less significant). Also when using different versions of the index, results remain broadly stable (see Table 4.2.7; besides the baseline version of the index, we also use a version with equal weights for each component, as well as the three sub-indices on resolution powers as well as recovery and resolution, policies and guidance, and loss allocation (bail-in)).

Using the implementation of the D-SIB framework as a reform variable: when using the local implementation of the D-SIB framework as reform variable (i.e., a dummy variable that switches from 0 to 1 whenever the D-SIB framework was implemented in domestic legislation within the relevant jurisdiction), results tend to remain broadly stable (see Tables 4.2.4 to 4.2.6; although significance changes in some cases).

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72 Abstracting from Modigliani and Miller considerations, RoE is simply the product of RoA and leverage (defined as assets over equity). Therefore, ceteris paribus, if leverage decreases, RoE goes down.

Using different samples: Compared with altering the reform variable, altering the sample considered for the regression has a much bigger impact on the significance and in some cases also the direction of the results. Tables 4.2.4 to 4.2.6 provide an overview also for the different estimation samples we have been using. Besides the baseline sample based on S&P MI with a size cutoff of €10 bn, these also include i) S&P MI data with a size cutoff of €50 bn (MPG2); (ii) FitchConnect data with a size threshold of €10 bn (Fitch); and (iii) S&P MI data with a size threshold of €200 bn (MPG1). As is visible from the overview tables, significance levels can vary substantially across the different estimation sample, which again cautions against over-interpreting any specific result. On the other hand, some results tend to come out quite consistently across most specifications (e.g., for total asset growth, derivatives over total assets, or net loans to banks), which enhances the robustness of these results.[73]

Geographical breakdown: The overview tables also include a geographical breakdown of the results, which illustrates some interesting differences across regions (all findings are relative to either D-SIBs or banks in the control group, as in the main part of the analysis):

- Unweighted capital ratios increased in particular for G-SIBs in Europe (relative to D-SIBs), presumably because they started off very highly leveraged and the leverage ratio was a new requirement in Europe;
- Risk-weighted capital ratios increased relative to other banks in particular for G-SIBs in North America and for SIBs in Asia/Pacific; in other regions, risk-weighted ratios for G-SIBs and D-SIBs also increased, but they also increased by more for other banks, so that differences between the different groups tend to be insignificant;
- The share of customer loans in total assets for SIBs (in particular G-SIBs) strongly increased in emerging economies (relative to other banks);
- Asset growth for G-SIBs was negative across all regions relative to D-SIBs and other banks, except for Asia/Pacific where differences between G-SIBs and other banks are insignificant;
- Non-Level 1/Level 3 assets declined in particular for G-SIBs in North America (when compared with the development for other domestic banks);
- Relative declines in profitability tend to be more significant for North American G-SIBs when compared to their domestic peers. A main driver for this result is that the evolution of the profitability of North American non-SIBs tended to be more positive than for non-SIBs in other regions. The profitability of North American G-SIBs evolved in a similar manner or more positively when compared with profitability of G-SIBs in other regions.

Dynamic difference-in-differences regressions: Results for the dynamic DiD regressions are presented in Figure 4.2.7 to 4.2.9. The Figures show regression coefficients for the following equation:

$$Y_{i,k,t} = \alpha_{\mathrm{i}} + \alpha_{\mathrm{kt}} + \sum_{l=2005}^{2018} \beta_l \cdot year_l \cdot \iota_{\{SIB\}} + \sum_{j=1}^{J} \gamma_j \cdot B_{j,i,t-1} + \varepsilon_{i,k,t}$$

[73] Not surprisingly, results using the MPG1 sample are closest to the baseline results of the BCBS MPG. They are not exactly the same, since we use a slightly different estimation equation, for example including country-year fixed effects that systematically account for time-varying country-specific heterogeneity instead of macro control variables.

where $\iota_{\{SIB\}}$ is a dummy equal to 1 for G-SIBs and D-SIBs and zero otherwise and Y is the variable of interest.

For most of the variables differences between SIBs and non-SIBs are either relatively stable, or there is a general trend over the entire sample period. There are no indications for a strong divergence in trends in the post-reform period, which is consistent with the findings in the main analysis and illustrates the attribution challenges which the evaluation faced.[74]

Treatment intensity: As mentioned above, the evaluation also tested whether differential effects (if any) are stronger for SIBs that initially had lower capital ratios (and therefore should feel higher pressure to adjust in response to an increase in capital requirements). Generally, the analysis does not reveal any divergent patterns in this respect. The only exception is that SIBs with risk-weighted or unweighted capital ratios in the lowest quartile of the distribution prior to the reform experienced smaller increases in their ratios in the post-reform period. A possible explanation for this counterintuitive result is that these banks have a general preference for operating with lower capital ratios and are therefore less willing or able to increase their capital ratios following the reforms.

4.2.6. Conclusions

Overall, SIBs increased their capital ratios by more than other banks, although this difference is not always statistically significant. G-SIBs continue to be much more leveraged than other banks. Other than this, the analysis does not reveal any strong balance-sheet patterns for G-SIBs relative to D-SIBs or for D-SIBs relative to other banks. In those cases where we do observe differential adjustments those could also be due to other confounding factors rather than the reforms themselves.

There are some indications that SIBs reduced systemic importance along some of the dimensions captured by the G-SIB framework, although the pattern varies across indicators, banks, and regions. The reduction (where there is one) tends to be driven by G-SIBs.

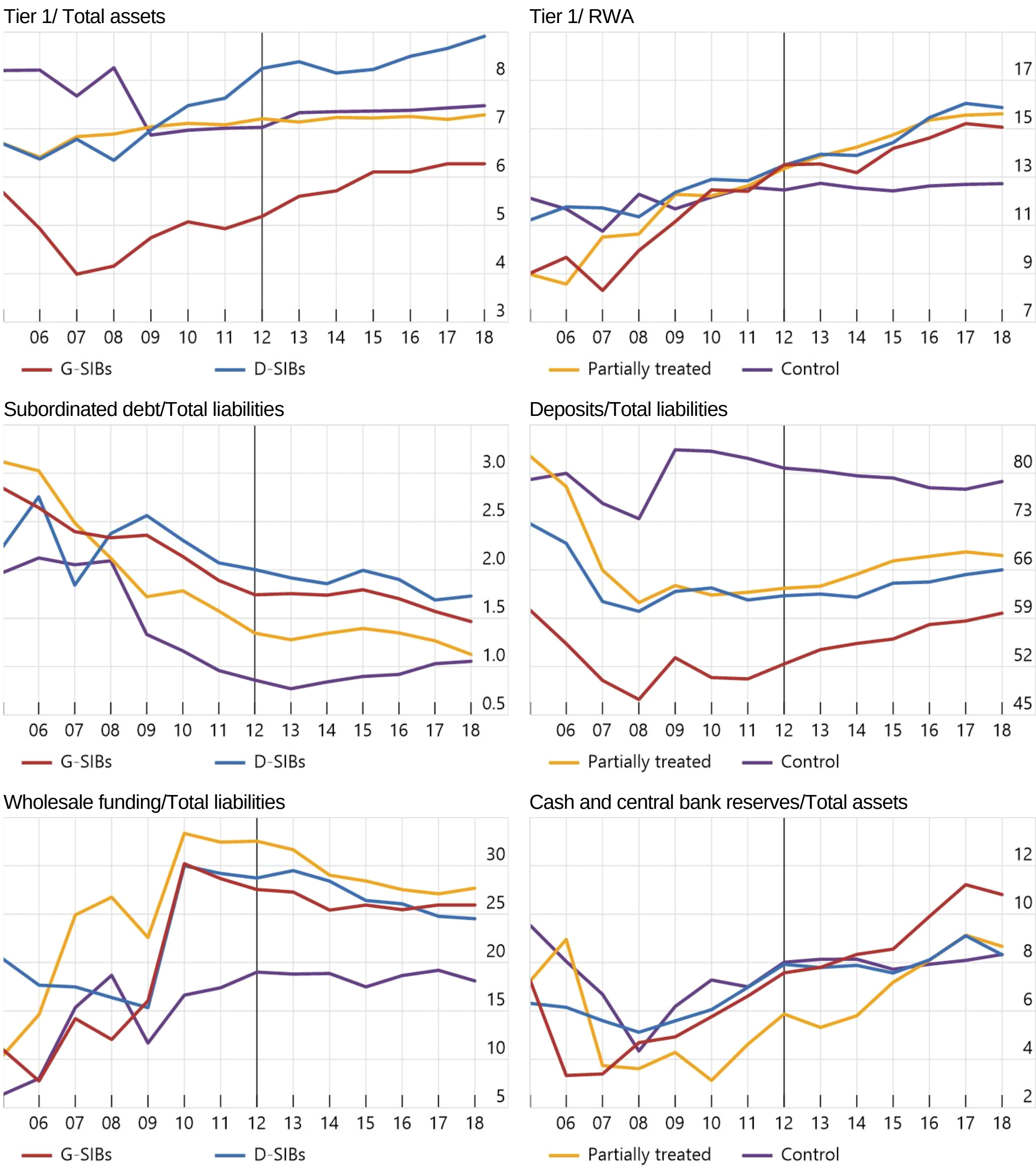
[74] As mentioned before, our data set is an unbalanced panel, with the number of observations per year increasing over time. This may explain why some variables exhibit relatively volatile patterns at the beginning of the sample period.

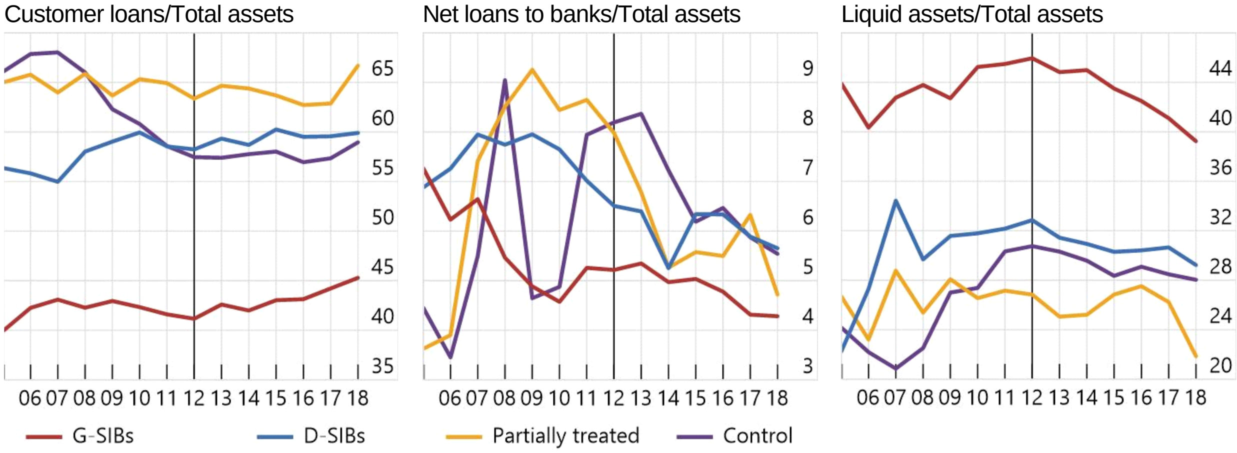
4.2.7. *Figures and Tables*

Figure 4.2.1 – 4.2.3: Evolution of dependent variables over time

Evolution of dependent variables over time: capital and balance sheet variables

In per cent **Figure 4.2.1**



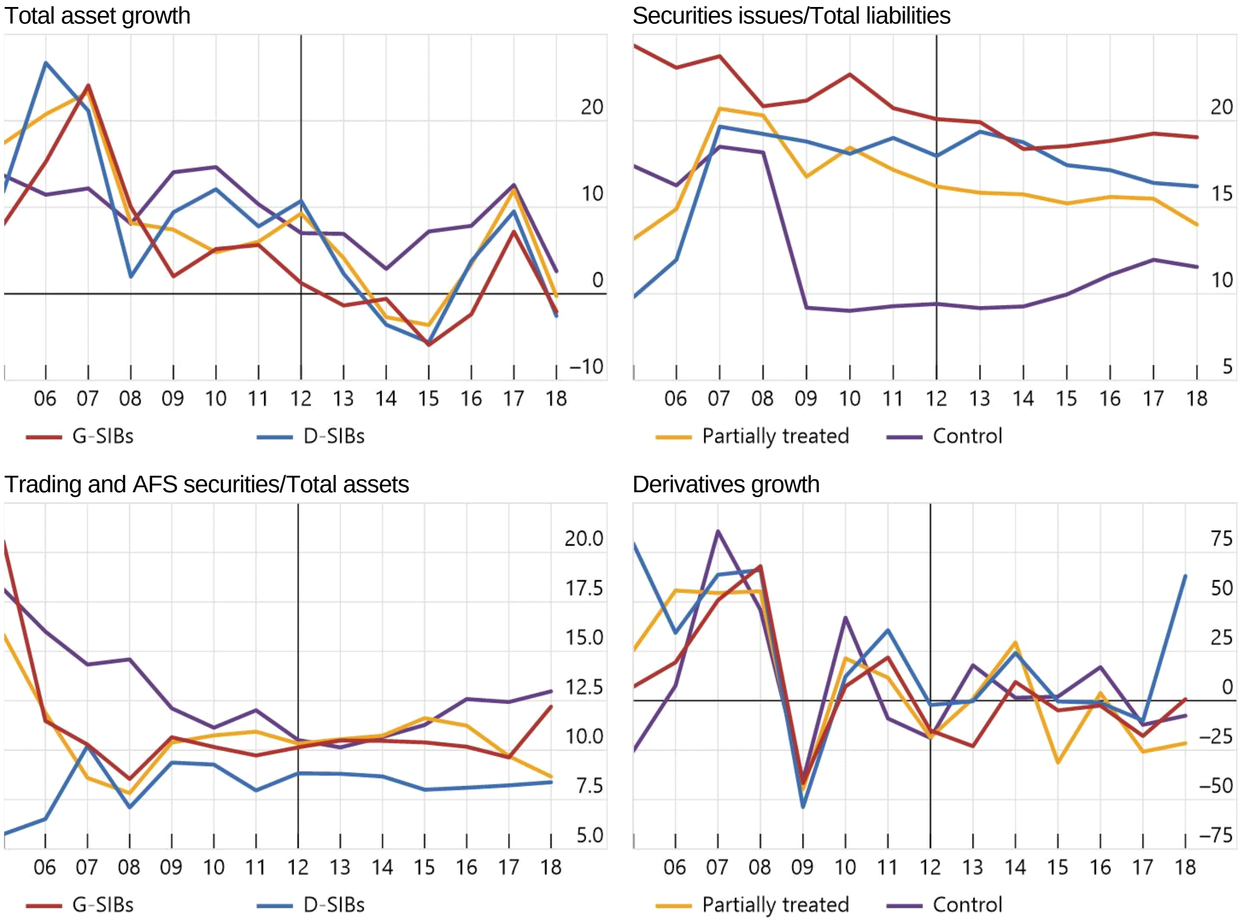


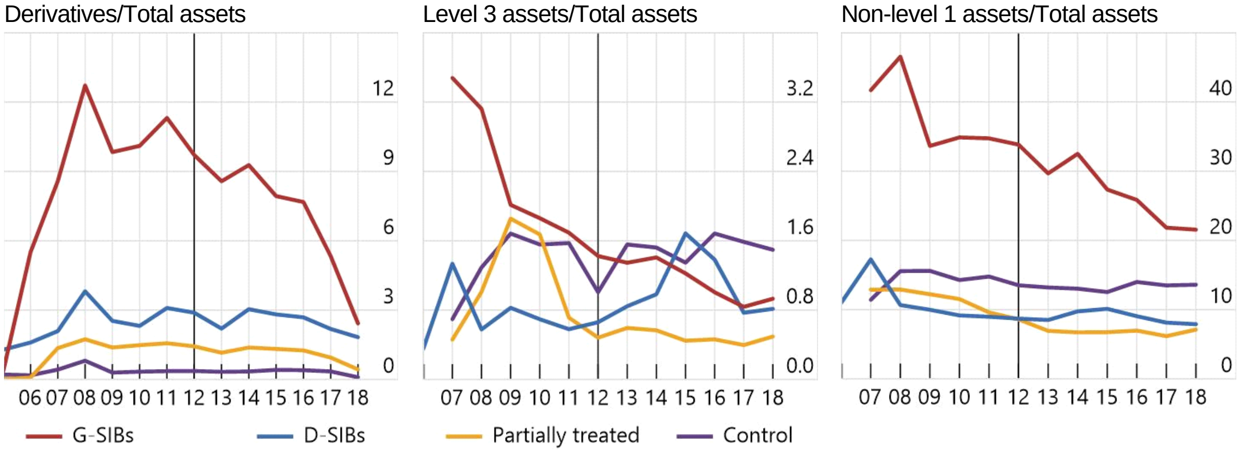
Source: SNL.

Evolution of dependent variables over time: G-SIB indicators

In per cent

Figure 4.2.2



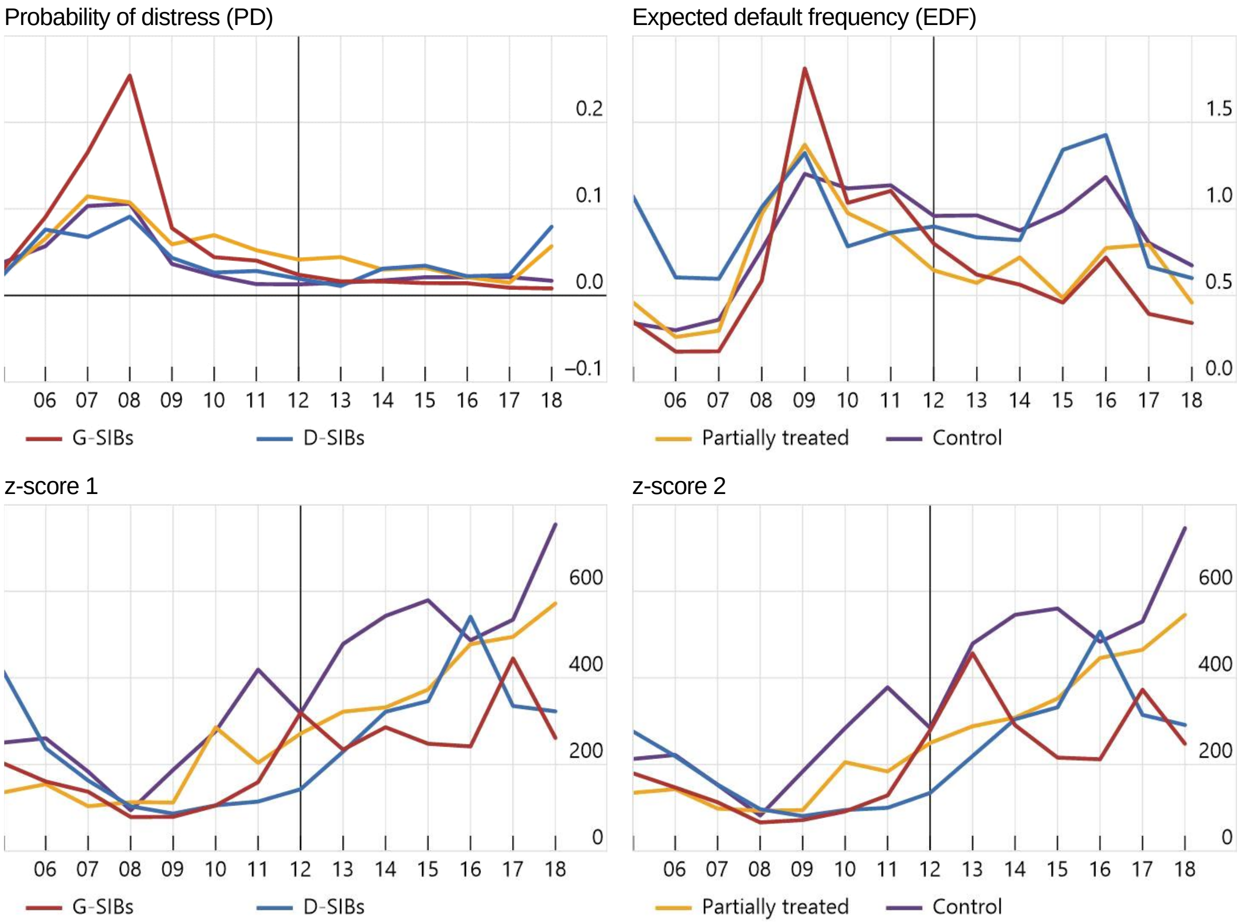


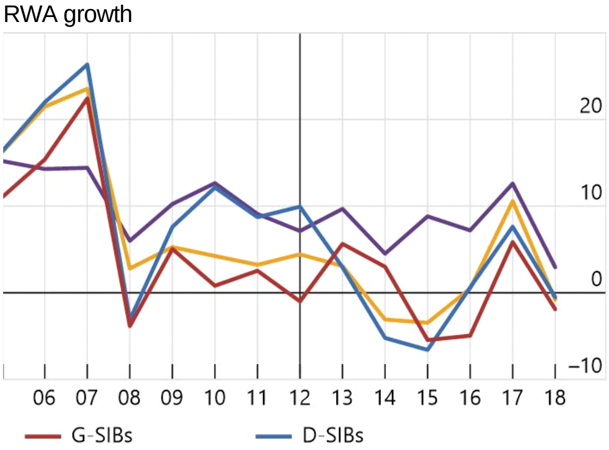
Source: SNL.

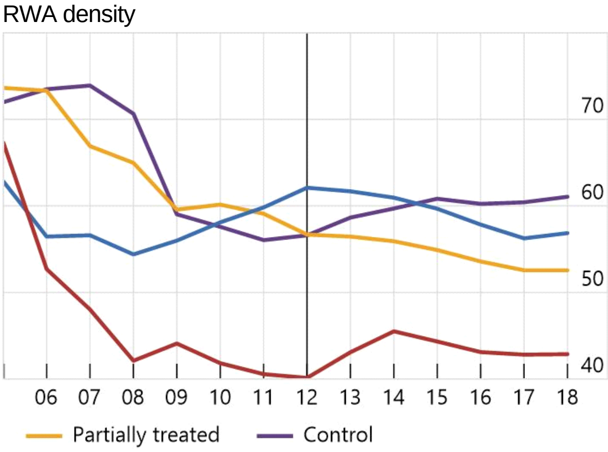
Evolution of dependent variables over time: : Risk and profitability variables

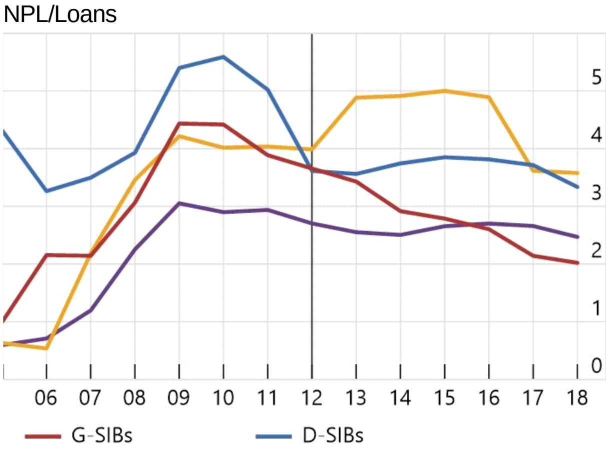
In per cent

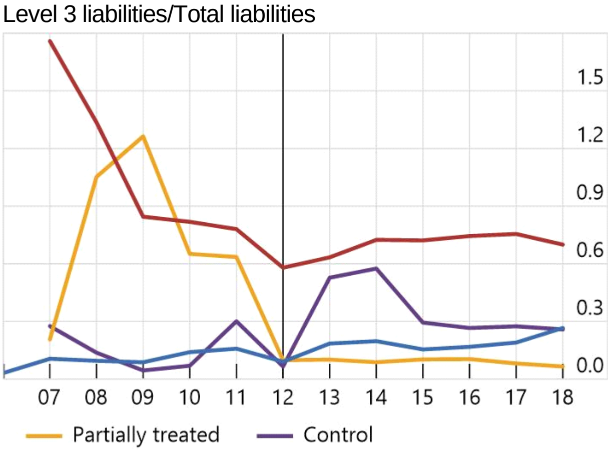
Figure 4.2.3

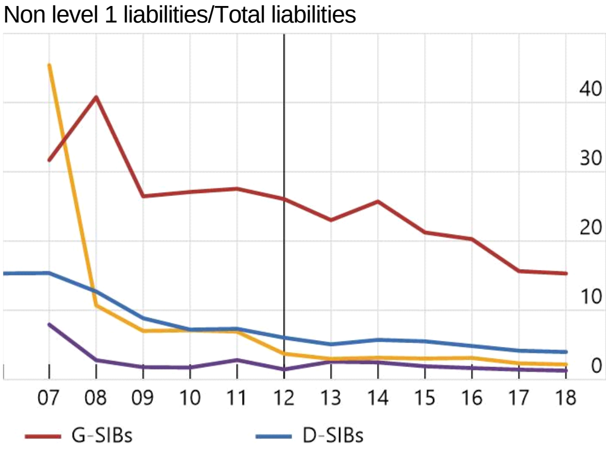


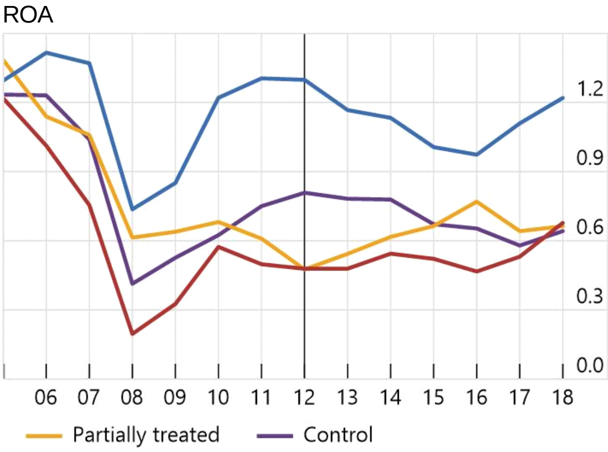

RWA growth
20
10
0
−10
06 07 08 09 10 11 12 13 14 15 16 17 18
G-SIBs
D-SIBs

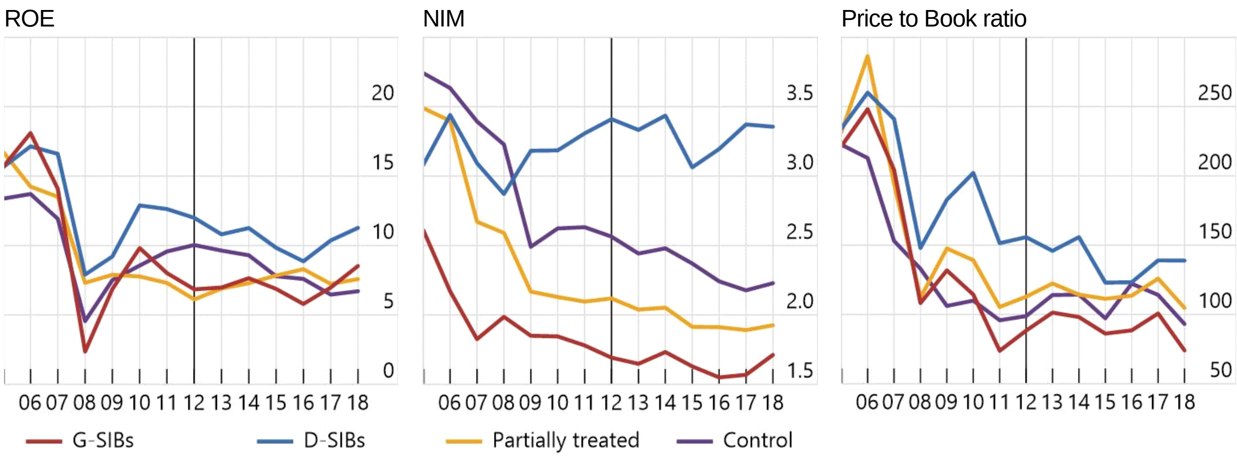

RWA density
70
60
50
40
06 07 08 09 10 11 12 13 14 15 16 17 18
Partially treated
Control


NPL/Loans
5
4
3
2
1
0
06 07 08 09 10 11 12 13 14 15 16 17 18
G-SIBs
D-SIBs


Level 3 liabilities/Total liabilities
1.5
1.2
0.9
0.6
0.3
0.0
07 08 09 10 11 12 13 14 15 16 17 18
Partially treated
Control


Non level 1 liabilities/Total liabilities
40
30
20
10
0
07 08 09 10 11 12 13 14 15 16 17 18
G-SIBs
D-SIBs


ROA
1.2
0.9
0.6
0.3
0.0
06 07 08 09 10 11 12 13 14 15 16 17 18
Partially treated
Control



Source: SNL.

Figure 4.2.4 – 4.2.6: Synthetic control group methodology

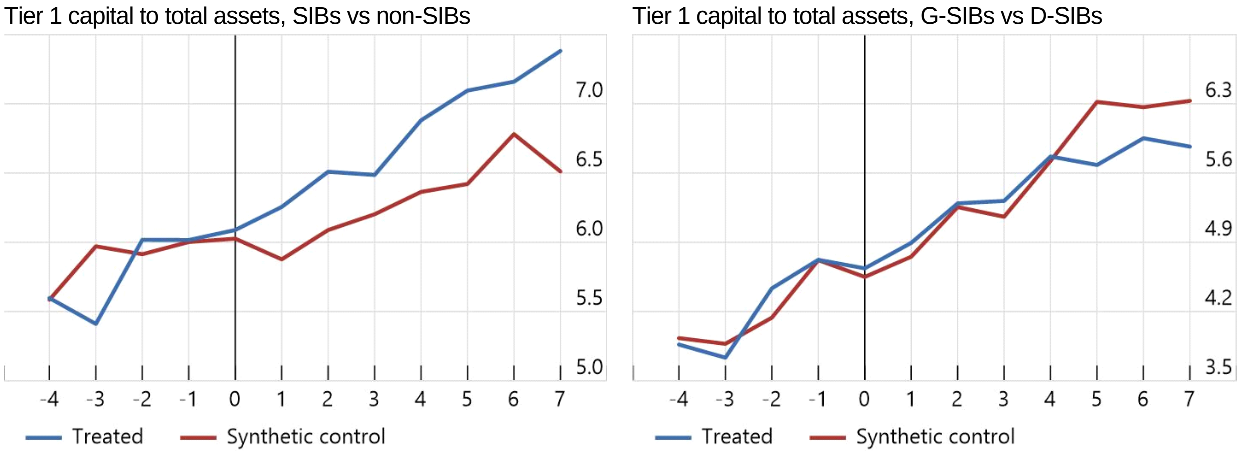
In all charts:

- Left panel: SIBs vs. non-SIBs
- Right panel: G-SIBs vs. D-SIBs
- X-axis refers to the number of years relative to 2011 (the last year of the pre-reform period, indicated by the vertical red line)
- If a chart title features “vs11”, this means that the variable that is being analysed is expressed in changes relative to 2011. This was mostly done to eliminate level differences between treated and control groups.

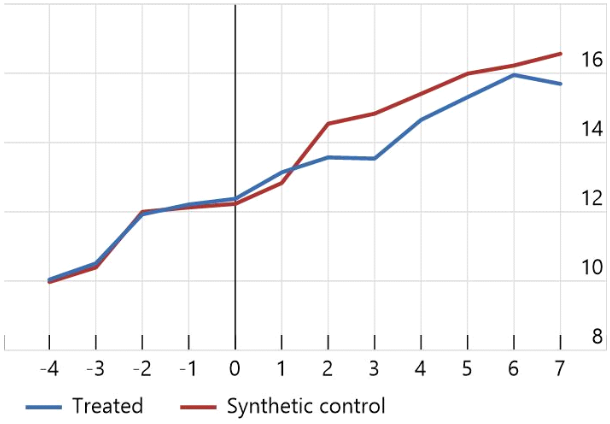
Synthetic control group methodology: Capital

In per cent

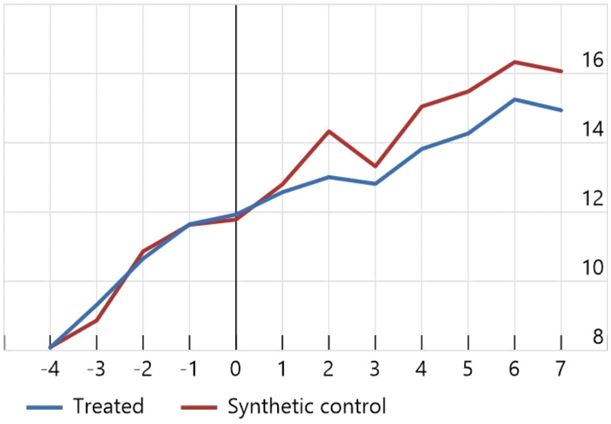
Figure 4.2.4



Tier 1 capital to RWAs, SIBs vs non-SIBs



Tier 1 capital to RWAs, G-SIBs vs D-SIBs



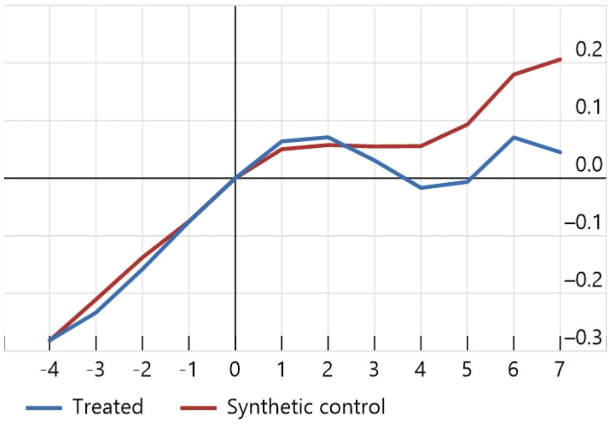
Source: SNL.

Synthetic control group methodology: Total assets and G-SIB indicators

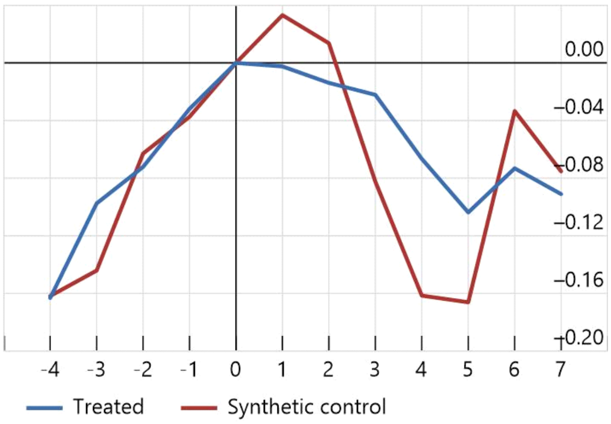
In per cent

Figure 4.2.5

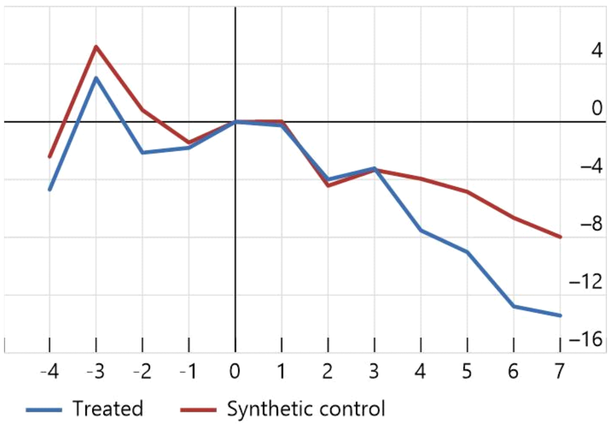
Log total assets vs2011, SIBs vs non-SIBs



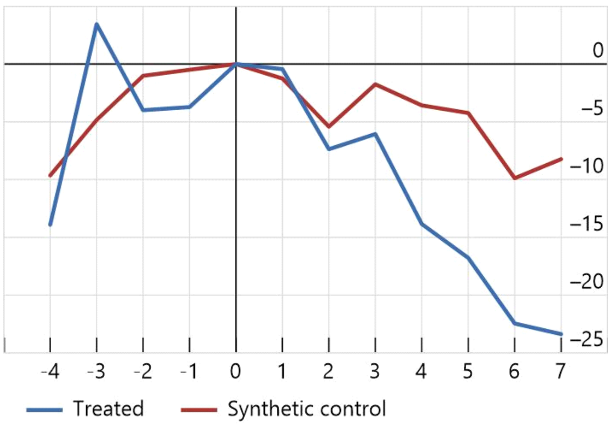
Log total assets vs2011, G-SIBs vs D-SIBs



Non-level1 assets to total assets vs2011, SIBs vs non-SIBs



Non-level1 assets to total assets vs 2011, G-SIBs vs D-SIBs

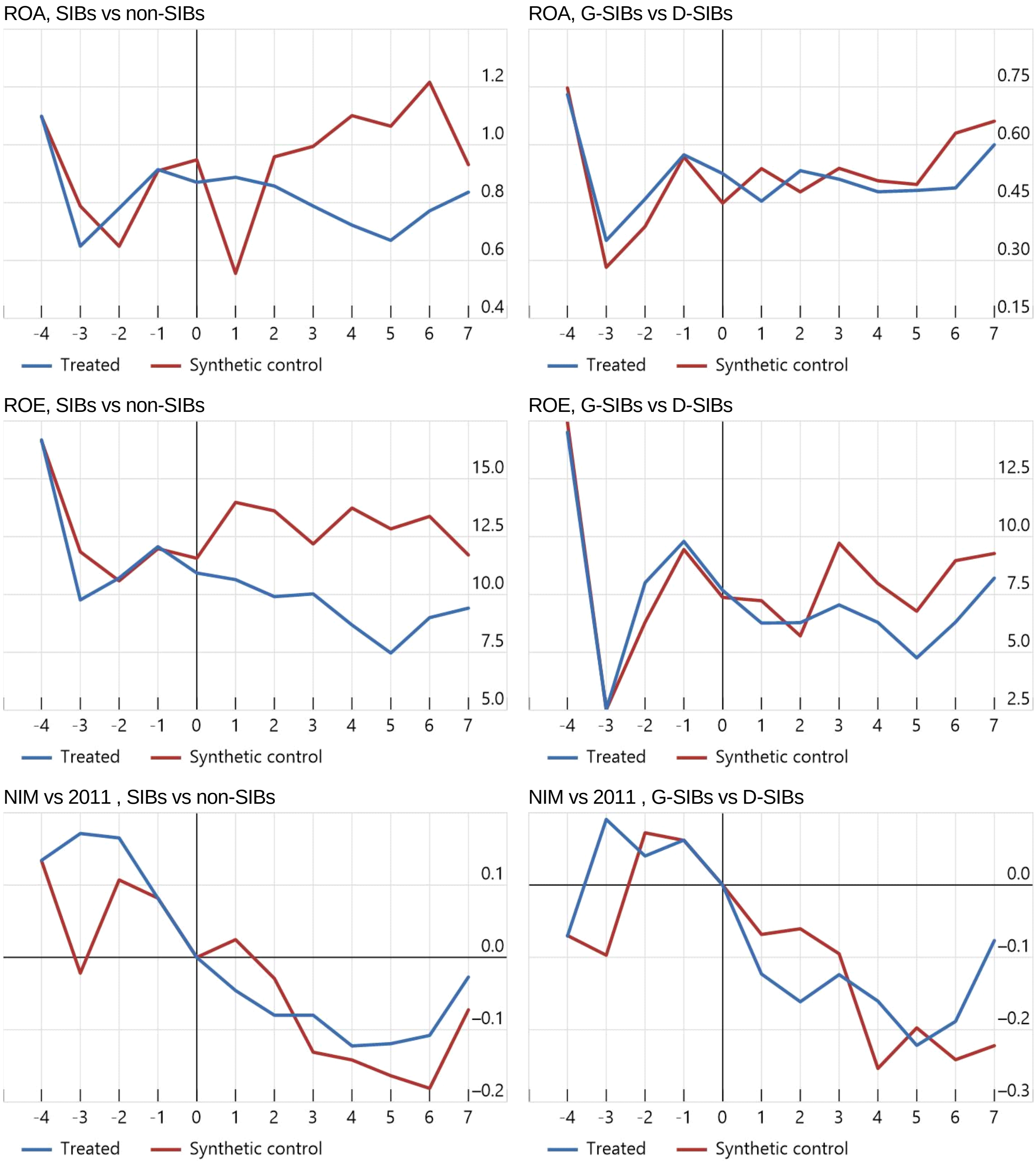


Source: SNL.

Synthetic control group methodology: Profitability

In per cent

Figure 4.2.6



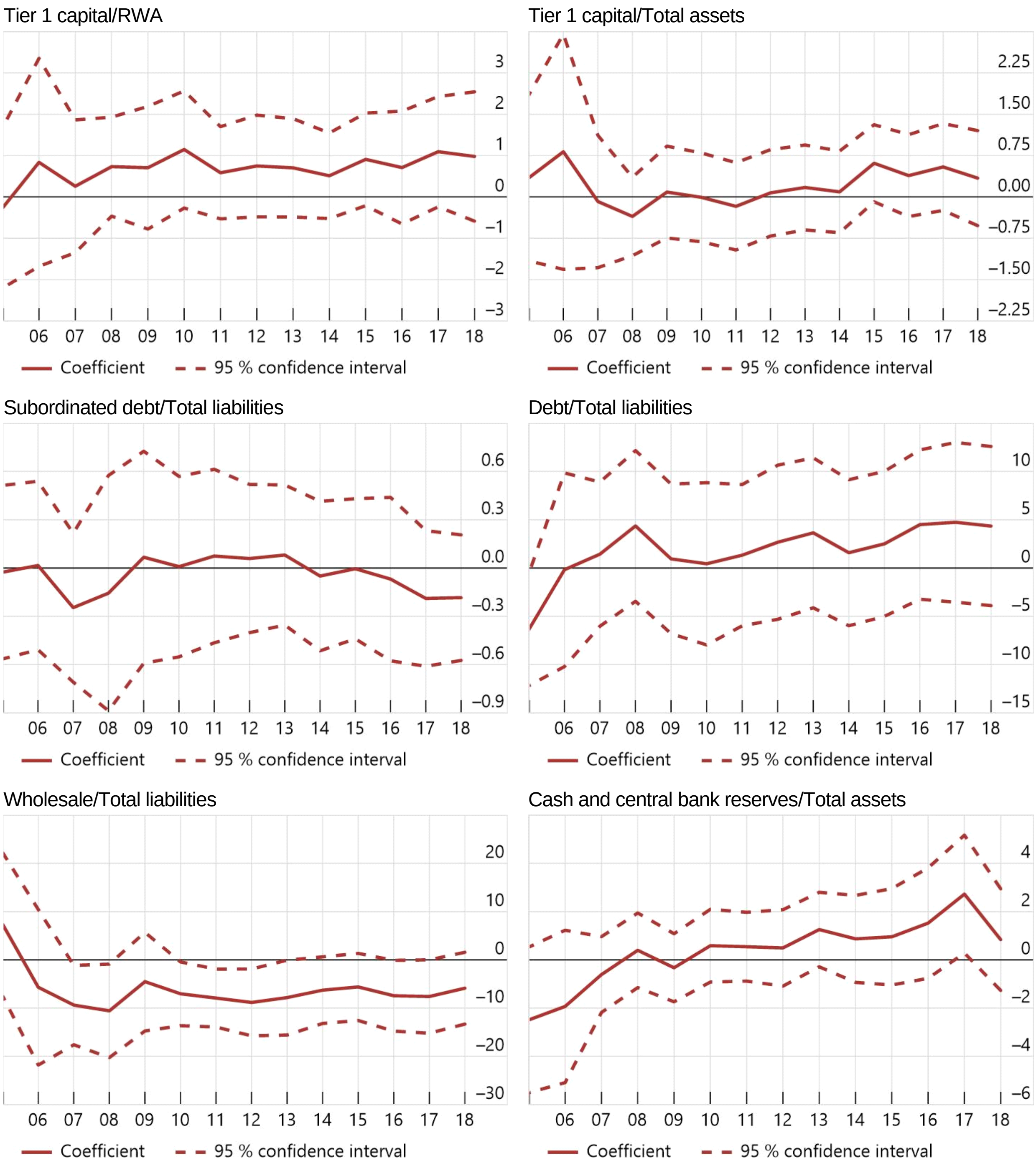
Source: SNL.

Figure 4.2.7 – 4.2.9: Dynamic difference-in-differences results

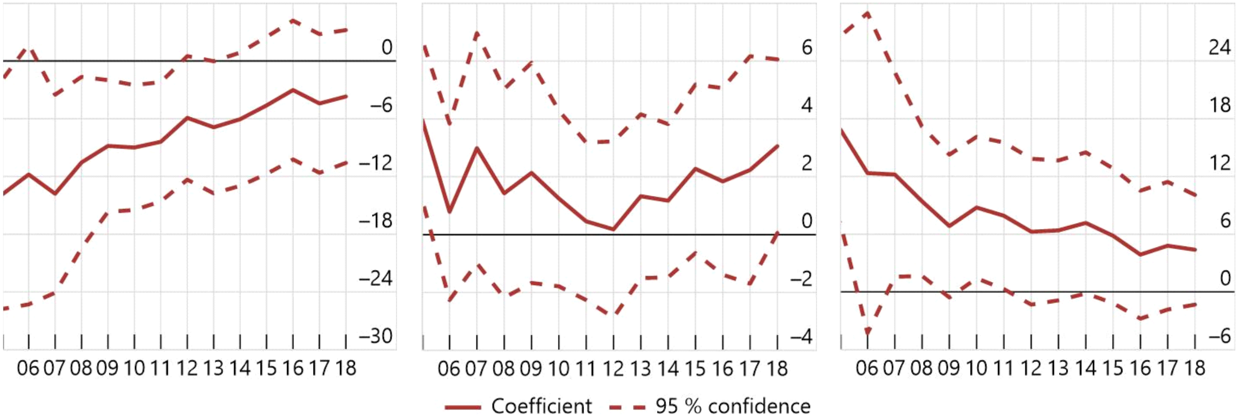
Dynamic difference-in-differences results: Balance sheet variables

Coefficient

Figure 4.2.7



Customer loans/Total assets | Net loans to banks/Total assets | Liquid assets/Total assets



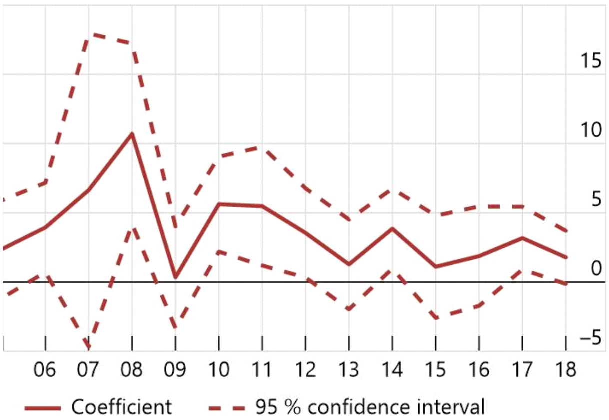
Source: SNL.

Dynamic difference-in-differences results: G-SIB indicators

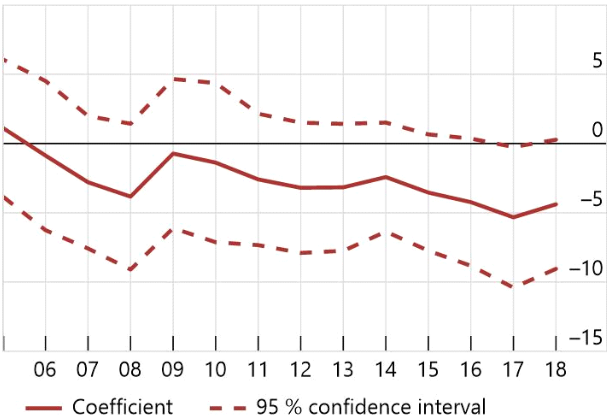
Coefficient

Figure 4.2.8

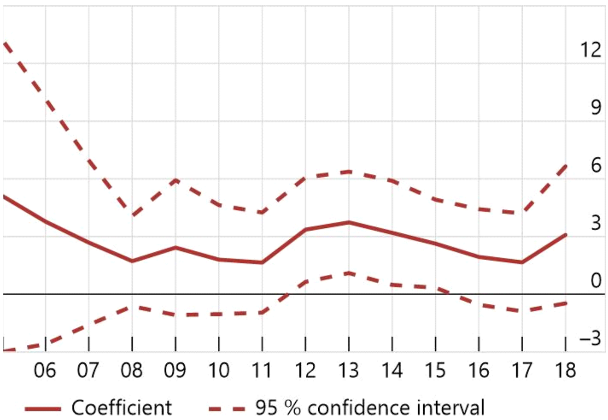
Total assets growth



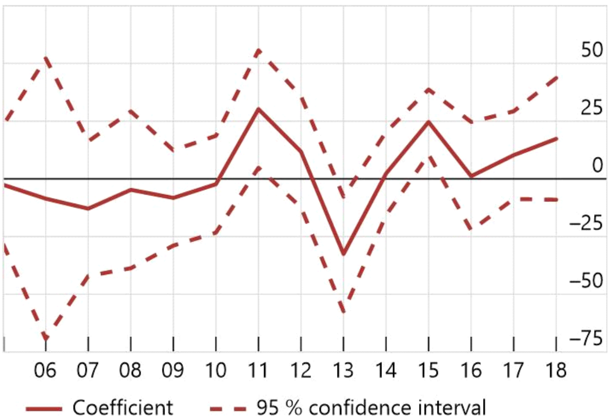
Securities issues/Total liabilities



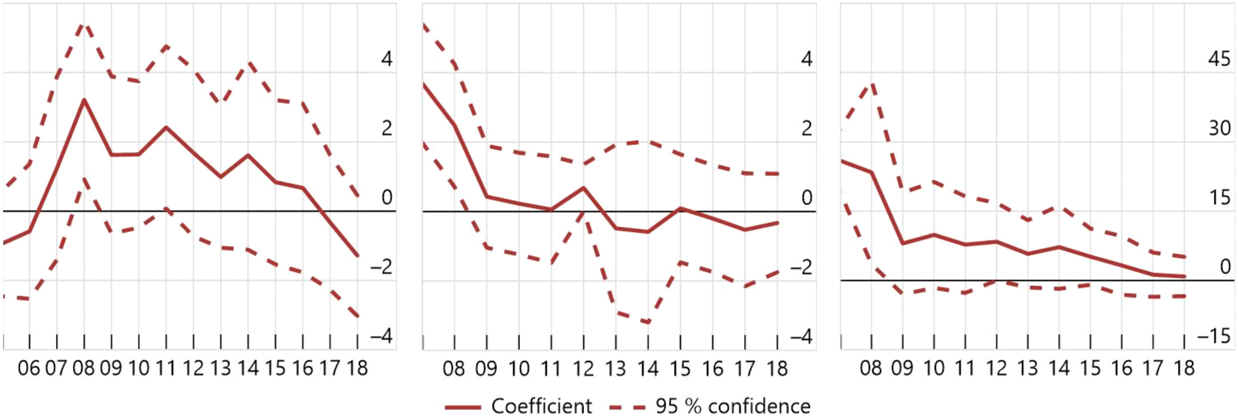
Trading and AFS securities/Total assets



Derivatives growth



Derivatives/Total assets | Level 3 assets/Total assets | Non level 1 assets/Total assets



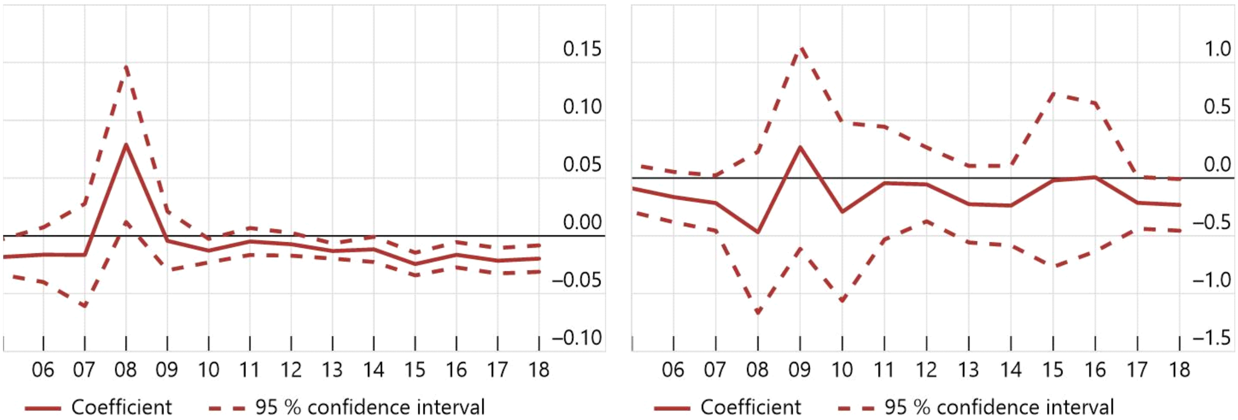
Source: SNL.

Dynamic difference-in-differences results: Risk and profitability variables

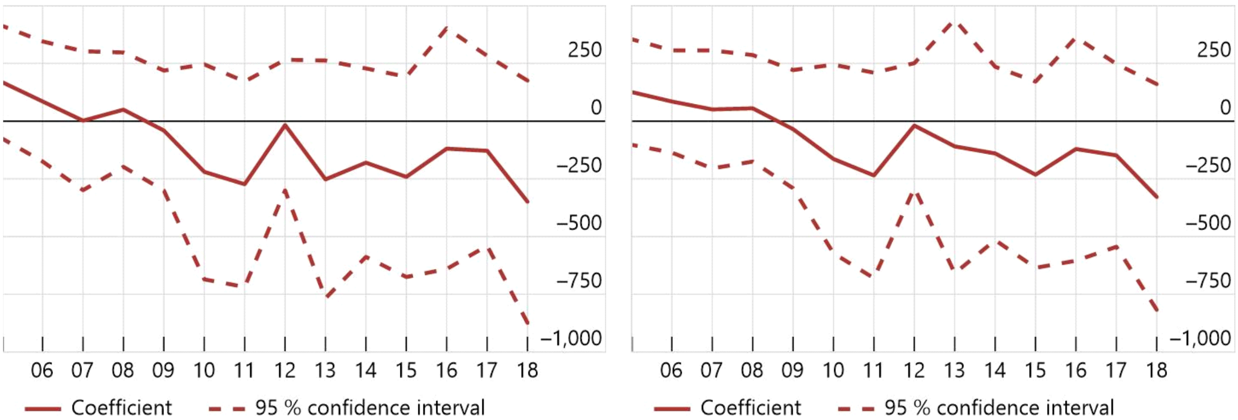
Coefficient

Figure 4.2.9

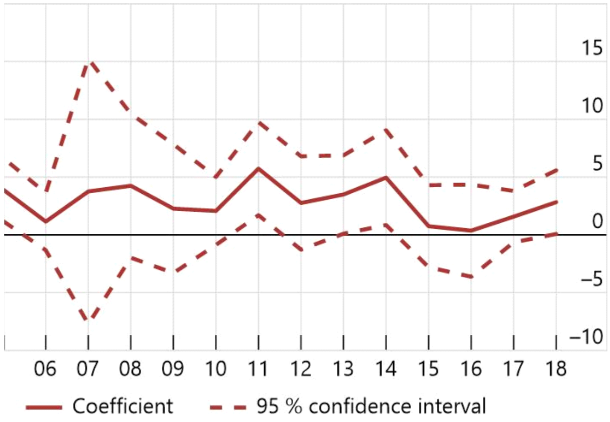
Probability of distress | Expected default frequency (EDF)



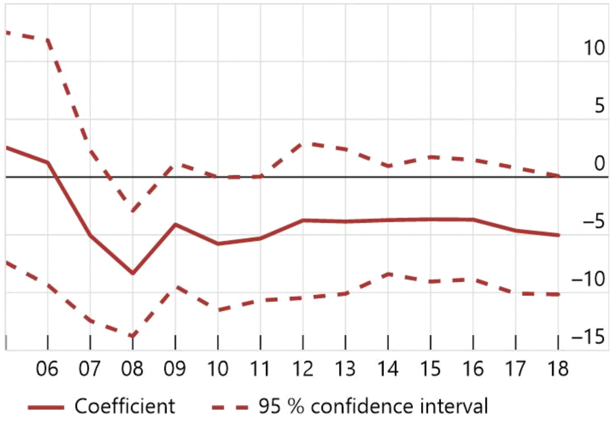
z-score 1 | z-score 2



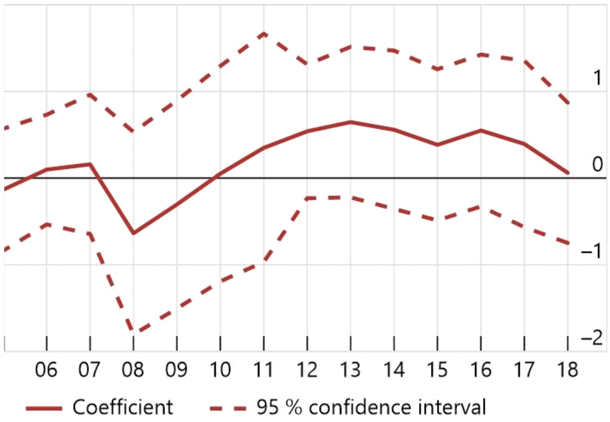
RWA growth



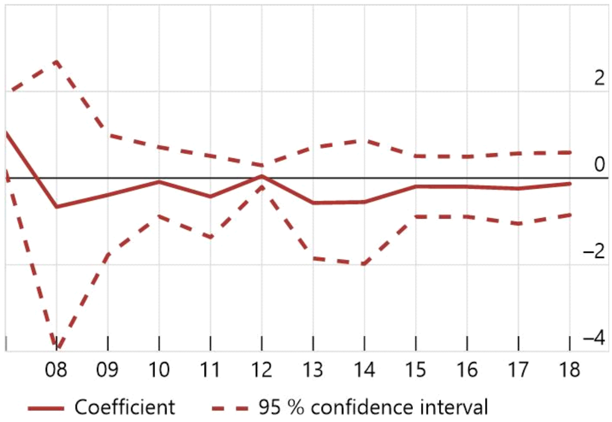
RWA density



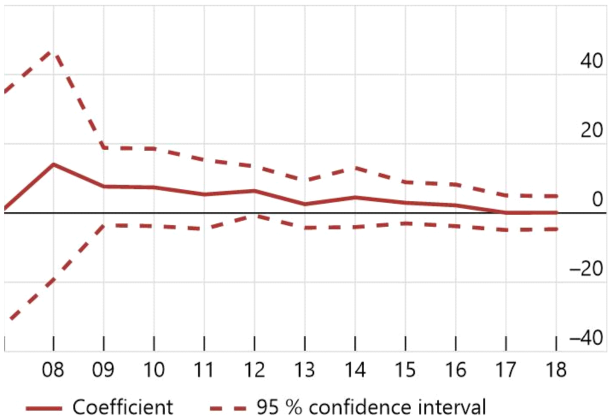
NPLs/Loans



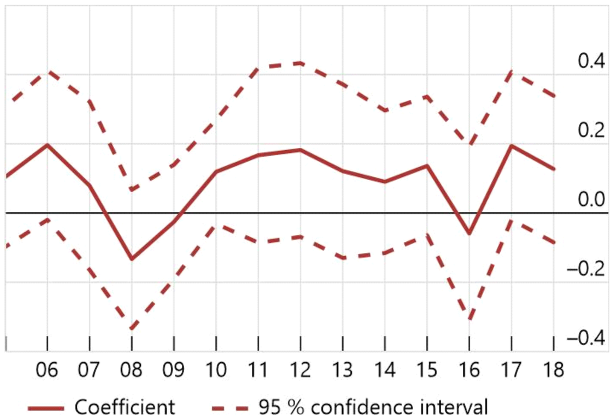
Level 3 liabilities/Total liabilities

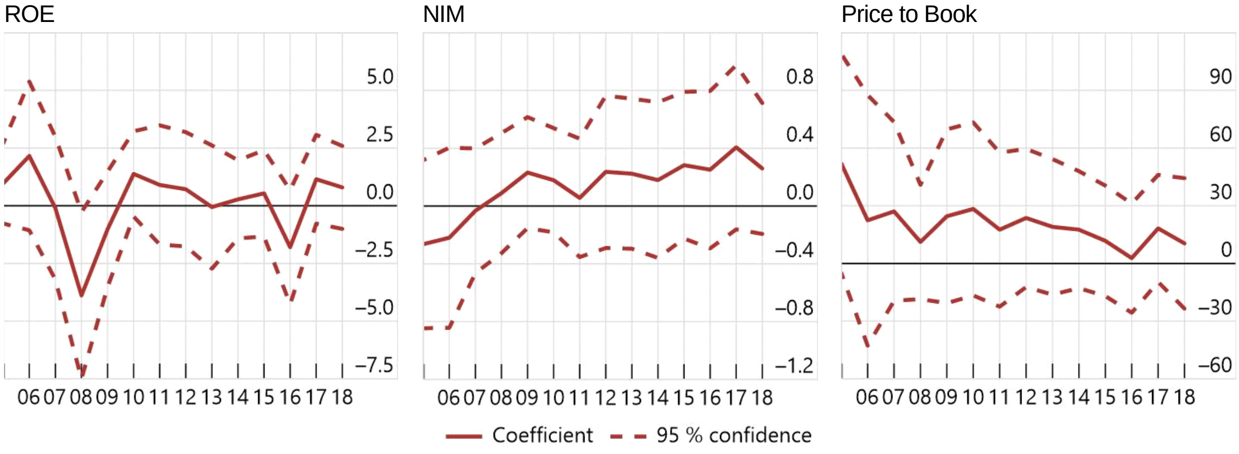


Non level 1 liabilities/Total liabilities



ROA




ROE
5.0
2.5
0.0
−2.5
−5.0
−7.5
NIM
0.8
0.4
0.0
−0.4
−0.8
−1.2
Price to Book
90
60
30
0
−30
−60
06 07 08 09 10 11 12 13 14 15 16 17 18
Coefficient
95 % confidence

Source: SNL.

Table 4.2.2: Descriptive statistics for full SNL sample (€10 bn size cut-off)

	Mean	Median	10th percentile	90th percentile	N
Capital					
Tier 1 / TA	7.27	6.85	4.00	10.79	6144
Tier 1 / RWAs	12.85	11.98	8.59	17.90	6116
Other Balance Sheet items					
Subordinated Debt / Total Liabilities	1.34	1.08	0.00	3.12	5714
Deposits / Total Liabilities	73.54	78.60	43.14	95.00	6055
Wholesale Funding / Total Liabilities	21.73	17.72	3.50	43.98	4796
Cash And Central Bank Reserves / Total Assets	7.41	5.99	0.76	15.92	4685
Customer Loans / Total Assets	58.85	61.48	37.13	78.69	5967
Net Loans To Banks / Total Assets	6.55	3.60	0.18	16.34	4685
Liquid Assets / Total Assets	29.49	27.12	13.50	49.33	5077
G-SIB indicators					
Total Asset Growth	7.13	5.43	-8.41	24.18	6069
Securities Issues / Total Liabilities	13.25	9.68	1.02	28.66	6035
Trading and AFS Securities / Total Assets	11.05	9.11	0.71	23.37	4408
Derivatives Growth	5.49	-0.30	-67.36	89.30	1977
Derivatives / Total Assets	1.70	0.07	0.00	5.64	3183
Level 3 Assets / Total Assets	1.23	0.32	0.00	2.79	3019
Non-Level 1 Assets / Total Assets	13.42	10.10	1.20	28.17	3015
Risk & Profit					
PD	0.03	0.01	0.00	0.07	5269
EDF	0.86	0.52	0.22	1.66	3287
z-score 1	405.17	135.79	27.24	782.69	5488
z-score 2	392.83	127.61	25.11	739.40	5296
RWA Growth	6.83	5.44	-10.48	25.82	6007
RWA Density	58.57	58.98	34.29	82.18	6004
NPL / Loans	3.05	1.86	0.40	6.47	6091
Level 3 Liabilities / Total Liabilities	0.32	0.00	0.00	0.50	3088
Non Level 1 Liabilities / Total Liabilities	5.39	0.50	0.00	16.24	3087
ROA	0.75	0.67	0.10	1.62	6375
ROE	8.72	8.17	1.74	18.94	6372
NIM	2.50	2.21	0.96	4.43	5922
Price to Book	123.74	106.39	41.56	223.12	3640
Control variables*					
Tier1 / RWA	12.74	11.81	8.29	17.71	6069
NPL / Loans	3.11	1.92	0.39	6.47	6069
RoA	0.77	0.69	0.11	1.64	6069
Net Income/Operating Income	21.17	22.51	5.32	40.39	6069
Log(TA)	10.52	10.17	8.99	12.81	6069

* Based on the sample used in the regression for Total Asset Growth and lagged relative to the dependent variables

Table 4.2.3: Descriptive statistics for pre vs. post-reform periods

	G-SIBs		D-SIBs		Partially Treated		Control	
	2005-2011	2012-2018	2005-2011	2012-2018	2005-2011	2012-2018	2005-2011	2012-2018
Capital								
Tier1 / TA	4.62	5.46	7.06	8.44	6.85	7.10	7.10	7.28
Tier1 / RWA	10.64	14.35	12.26	14.75	11.51	14.77	11.67	12.82
Other Balance Sheet items								
Subordinated Debt / Total Liabilities	2.29	1.73	2.27	1.87	1.93	1.28	1.41	0.91
Deposits / Total Liabilities	52.45	56.68	62.93	63.81	64.62	66.44	81.36	78.50
Wholesale Funding / Total Liabilities	25.48	27.31	25.32	26.86	30.97	29.23	16.57	19.01
Cash And Central Bank Reserves / Total Assets	5.02	8.49	6.01	8.11	4.14	7.12	6.62	7.84
Customer Loans / Total Assets	42.39	41.88	58.15	59.36	64.88	64.09	62.04	56.25
Net Loans To Banks / Total Assets	5.41	4.90	7.54	6.05	8.34	5.99	6.88	8.43
Liquid Assets / Total Assets	43.34	44.71	31.29	30.84	27.15	26.00	26.88	30.93
G-SIB indicators								
Total Asset Growth	9.72	-1.46	11.12	2.14	9.37	3.06	12.26	6.71
Securities Issues / Total Liabilities	21.09	18.81	18.12	17.59	17.48	14.98	11.82	10.94
Trading and AFS Securities / Total Assets	10.65	10.81	8.49	8.41	10.20	10.69	13.06	11.68
Derivatives Growth	19.54	-12.36	23.85	3.94	12.89	-7.45	9.27	0.31
Derivatives / Total Assets	9.95	8.68	2.65	2.60	1.45	1.23	0.35	0.33
Level 3 Assets / Total Assets	2.12	1.05	0.70	1.02	1.29	0.47	1.51	1.48
Non-Level 1 Assets / Total Assets	36.20	27.95	9.78	8.86	11.09	6.90	14.84	13.10
Risk & Profit								
PD	0.11	0.01	0.05	0.03	0.07	0.03	0.04	0.02
EDF	0.87	0.57	0.91	0.94	0.86	0.65	0.92	0.94
ZScore 1	119.39	286.46	124.43	326.15	181.46	417.31	277.59	562.60
ZScore 2	105.29	300.83	108.79	305.77	154.42	395.36	259.33	562.91
RWA Growth	6.59	-0.68	10.75	1.32	7.54	1.47	10.72	7.62
RWA Density	44.86	39.82	57.50	59.28	61.86	53.50	61.46	58.70
NPL / Loans	3.44	3.04	4.67	3.67	3.49	4.54	2.54	2.66
Level 3 Liabilities / Total Liabilities	0.95	0.63	0.13	0.18	0.88	0.09	0.15	0.33
Non Level 1 Liabilities / Total Liabilities	29.31	22.19	8.66	5.02	8.13	3.06	2.29	1.78
RoA	0.55	0.44	1.14	1.13	0.74	0.59	0.66	0.68
RoE	9.60	6.13	12.36	10.61	9.16	7.10	8.70	8.12
NIM	1.90	1.54	3.16	3.31	2.29	1.89	2.81	2.27
Price to Book	140.96	91.27	190.89	139.82	152.80	113.59	126.25	103.90

Table 4.2.4: Overview table for balance sheet variables

	Interaction (reform#)	Baseline: Standard errors clustered by Bank, Country x Year	Country	Country x Year	Incl. Partially treated	2009-18	Excl. crisis years	D-SIB implem.	Resolution index	Geographical Breakdown: Europe	NA	AsiaPacific	Emerging	Alternative samples: MPG1	MPG2	Fitch
Tier1 / TA	#G-SIB	+	+	+	+	+	+	+**	+**	+***	+	-	-	+***	+**	+
	#SIB	+	+	+	+	+	+	+	-	-		+	+*		-	+**
	#partial				-*											
Tier1 / RWA	#G-SIB	-	-	-	-	-	-	-	-	-	+***	-	+	-	-	-*
	#SIB	+	+	+**	+**	+	+	+	-	-		+**	+		+	+***
	#partial				+*											
Subordinated Debt / Total Liabilities	#G-SIB	+	+	+	+	+	+	+	+	+	-	+	-	+	+***	+
	#SIB	-	-	-*	-**	-	+	-*	-	-		-	+		-*	-
	#partial				-***											
Deposits / Total Liabilities	#G-SIB	+**	+*	+***	-**	+***	+**	+**	+**	+	+**	+	+***	+	+	-
	#SIB	-	-	-**	-	-	-	-	-	-		+	-***		+	-
	#partial				-											
Wholesale Funding / Total Liabilities	#G-SIB	-	-	-*	-	-	-	-	-	+	-	-	-***	+	-	+
	#SIB	+	+	+	+	+	+	+	+	+		+	+		-	-*
	#partial				-											
Cash And Central Bank Reserves / Total Assets	#G-SIB	+	+	+	+	+	+	+	+					+	+	
	#SIB	+*	+	+***	-**	+	+*	+	+*						+**	
	#partial				-**											
Customer Loans / Total Assets	#G-SIB	-	-	-	-	-	-	-	-	-	-	-	+**	-	+	
	#SIB	+	+	+**	+	+	+	+	+	-		+	+***		+	
	#partial				-*											
Net Loans To Banks / Total Assets	#G-SIB	+***	+***	+***	+***	+***	+***	+***	+*					+***	+***	
	#SIB	-	-	-	-	-	-	-	+						-	
	#partial				-											
Liquid Assets / Total Assets	#G-SIB	+	+	+**	+	+	+	+	+	+	+	+	+*	+**	+	+*
	#SIB	-	-	-	+	-	-	-	-	+		-	-***		+	+
	#partial				+**											

Table 4.2.5: Overview table for G-SIB indicators

	Interaction (reform#)	Baseline – Standard errors clustered by: Bank, Country x Year	Country	Country x Year	Incl. Partially treated	2009-18	Excl. crisis years	D-SIB implem.	Resolution index	Geographical Breakdown: Europe	NA	AsiaPacific	Emerging	Alternative samples: MPG1	MPG2	Fitch
Total Asset Growth	#G-SIB	-***	-***	-***	-***	-***	-***	-***	-**	-***	-***	-	-**	-***	-***	-***
	#SIB	-	-	-	-	+	+	-	-*	-		+	+		+**	-*
	#partial				-*											
Securities Issues / Total Liabilities	#G-SIB	-	-	-	-	-	-	-	+	+	-	-	-**	+	+	-
	#SIB	+	+	+	+	+	+	-	-	-		-	+**		-*	-
	#partial				+											
Trading and AFS Securities / Total Assets	#G-SIB	+	+	+	+	+	+	+	+	+	-		-	+	-	+*
	#SIB	-	-	-	+	-	-	-*	-	+		+	-		-	-
	#partial				+											
Derivatives Growth	#G-SIB	+	+	+	+	+	+	-	+					-	-	+
	#SIB	+	+	+	+	-	-	+	-						+	-
	#partial				+											
Derivatives / Total Assets	#G-SIB	-***	-**	-***	-***	-**	-**	-***	-						-**	-***
	#SIB	-	-	-	-	-	-	-	-**						-	+
	#partial				+											
Level 3 Assets / Total Assets	#G-SIB	+	+	+	+	+	+	-	-	+	-**		+	-	-*	-***
	#SIB	-	-	-	-	-	-	+	-	+		-	-		-	
	#partial				-											
Non-Level 1 Assets / Total Assets	#G-SIB	-*	-	-**	-*	-	-	-**	-*	-	-**		-	-	-*	-***
	#SIB	-	-	-	-	-	-	-	-*	+		+	+		-	
	#partial				-											

Table 4.2.6: Overview table for risk and profitability

	Interaction (reform#)	Baseline Standard errors clustered by Bank, Country x Year	Country	Country x Year	Incl. Partially treated	2009-18	Excl. crisis years	D-SIB implem.	Resolution index	Geographical Breakdown Europe	NA	AsiaPacific	Emerging	Alternative samples MPG1	MPG2	Fitch
PD	#G-SIB	-	-	-*	-	-	-	-*	+	-**	+		+	-**	-	+
	#SIB	-	-	-	-	-	-	-	-	-		+	-		+	-**
	#partial				+											
EDF	#G-SIB	+	+	+	+	-	-	-	+	+*	-	-***		-	+	-
	#SIB	-	-	-	-	-	-	+	-	-		-	-		-*	+
	#partial				-											
ZScore 1	#G-SIB	-	-	-	-	+	+	-	+	-	+	+	+**	-	-	-
	#SIB	+	+	+	+	+	+	+	+	+		-	+		+	+
	#partial				+											
ZScore 2	#G-SIB	+	+	+	+	+	+	-	+	-	+		+**	-	-	-
	#SIB	+	+	+	+	+	+	+	+	-		-	+		+	+
	#partial				+											
RWA Growth	#G-SIB	-***	-***	-***	-***	-**	-**	-***	-***	-**	-**	-	-	-	-***	-**
	#SIB	+	+	+	-	+	+	+	+	+		+	+		+**	-
	#partial				-***											
RWA Density	#G-SIB	+	+	+	+	+	+	+	+	+***	-	+	-**	+*	+**	+
	#SIB	-	-	-*	-***	-	-	-	-	-		-	+		-	-
	#partial				-***											
NPL / Loans	#G-SIB	-**	-*	-***	-**	-	-*	-	-	-**	+	-	-	-	-	-
	#SIB	+	+	+***	+*	+	+	+	+	+**		+	+		+	+**
	#partial				+											
Level 3 Liabilities / Total Liabilities	#G-SIB	+	+	+	+	+	+	+	+	+	-**		-	-	-**	-*
	#SIB	+	+	+	-	-	-	+	+	+		-	+		-	
	#partial				-*											
Non Level 1 Liabilities / Total Liabilities	#G-SIB	-	-	-	+	+	+	-	-	+	-*		-	-	-	+
	#SIB	-	-	-	-	-*	-*	-	-**	-		-	+		-***	
	#partial				-											

	Interaction (reformi#)	Baseline			Incl. Partially treated	2009-18	Excl. crisis years	D-SIB implem.	Resolution index	Geographical Breakdown				Alternative samples		
		Standard errors clustered by														
		Bank, Country x Year	Country	Country x Year						Europe	NA	AsiaPacific	Emerging	MPG1	MPG2	Fitch
ROA	#G-SIB	-**	-*	-***	-**	-***	-***	-	-**	-	-***	-*	-	-	-***	-*
	#SIB	+	+	+	+	+	+	+	+	-		+*	+		+	+
	#partial				-											
ROE	#G-SIB	-**	-*	-***	-**	-***	-***	-*	-**	-*	-***	-	+	-	-**	-
	#SIB	+	+	+	+	+	+	+	+	-		+	+		+	-
	#partial				+											
NIM	#G-SIB	-***	-*	-***	-***	-***	-***	-**	-*	-	-**	+	-**	-	-	-
	#SIB	+**	+	+***	+	+**	+**	+*	+	-		+	+***		-	+
	#partial				-											
Price to Book	#G-SIB	-	-	-	-	-	-	-	-**	-***	-*	-	+	+	-***	
	#SIB	-	-	-	-	+	+	-	+	+***		+	-		+**	
	#partial				+											

Table 4.2.7: Additional robustness tests using the resolution reform index

		Resolution reform index				
		RRI	RRIEE	RRIsub1	RRIsub2	RRIsub3
Tier1 / TA	#G-SIB	+**	+**	+	+*	+*
	#SIB	-	-	-	-	-
	#partial					
Tier1 / RWA	#G-SIB	-	-	-	-	-
	#SIB	-	+	+	+	-
	#partial					
Subordinated Debt / Total Liabilities	#G-SIB	+	+	+	+	+
	#SIB	-	-	-**	-	-
	#partial					
Deposits / Total Liabilities	#G-SIB	+**	+**	+	+***	+
	#SIB	-	-	-	-	-
	#partial					
Wholesale Funding / Total Liabilities	#G-SIB	-	-	-	-	+
	#SIB	+	+	+	+	+
	#partial					
Cash And Central Bank Reserves / Total Assets	#G-SIB	+	+	+	-	-
	#SIB	+*	+*	+	+**	+
	#partial					
Customer Loans / Total Assets	#G-SIB	-	-	-	-	-
	#SIB	+	+	+	+	+
	#partial					
Net Loans To Banks / Total Assets	#G-SIB	+*	+*	+**	+	+
	#SIB	+	+	+	+	+
	#partial					
Liquid Assets / Total Assets	#G-SIB	+	-	+	-	+
	#SIB	+	+	+	+	-
	#partial					
Total Asset Growth	#G-SIB	-**	-**	-	-**	-**
	#SIB	-*	-**	-	-***	-
	#partial					

		Resolution reform index				
		RRI	RRIEE	RRIsub1	RRIsub2	RRIsub3
Securities Issues / Total Liabilities	#G-SIB	+	-	+	-	+
	#SIB	-	-	-	-	-
	#partial					
Trading and AFS Securities / Total Assets	#G-SIB	+	+	+	+	+
	#SIB	-	-	-	-	-
	#partial					
Derivatives Growth	#G-SIB	+	+	+	-	+
	#SIB	-	-	-	-	-
	#partial					
Derivatives / Total Assets	#G-SIB	-	-	-	-	-
	#SIB	-**	-**	-	-**	-***
	#partial					
Level 3 Assets / Total Assets	#G-SIB	-	-	-	-	+
	#SIB	-	-	-	-	-
	#partial					
Non-Level 1 Assets / Total Assets	#G-SIB	-*	-**	-	-**	-
	#SIB	-*	-**	-	-**	-*
	#partial					
PD	#G-SIB	+	+	-	+	+
	#SIB	-	-	-	-	-
	#partial					
EDF	#G-SIB	+	+	-	+*	+
	#SIB	-	-	-	-*	-
	#partial					
ZScore 1	#G-SIB	+	+	+	+	-
	#SIB	+	+	+	-	+
	#partial					
ZScore 2	#G-SIB	+	+	-	+	-
	#SIB	+	+	+	-	+
	#partial					

		Resolution reform index				
		RRI	RRIEE	RRIsub1	RRIsub2	RRIsub3
RWA Growth	#G-SIB	-***	-***	-*	-***	-***
	#SIB	+	+	+	+	+
	#partial					
RWA Density	#G-SIB	+	+	+	+	+
	#SIB	-	-	-	+	-
	#partial					
NPL / Loans	#G-SIB	-	-	-*	-	-
	#SIB	+	+	+	+	+
	#partial					
Level 3 Liabilities / Total Liabilities	#G-SIB	+	+	+	-	+
	#SIB	+	+	+	+	+
	#partial					
Non Level 1 Liabilities / Total Liabilities	#G-SIB	-	-	+	-	+
	#SIB	-**	-**	-	-***	-*
	#partial					
ROA	#G-SIB	-**	-**	-	-*	-**
	#SIB	+	+	-	+	+
	#partial					
ROE	#G-SIB	-**	-**	-**	-	-**
	#SIB	+	+	+	+	+
	#partial					
NIM	#G-SIB	-*	-*	-	-*	-
	#SIB	+	+	+	+	+
	#partial					
Price to Book	#G-SIB	-**	-*	-	-*	-**
	#SIB	+	+	+	+*	+*
	#partial					

4.3. SIBs’ lending and credit allocation: analysis of syndicated loans

4.3.1. Introduction

In this study we examine whether and how G-SIB reforms have affected the lending behaviour of G-SIBs (relative to other banks) by analysing the international market for syndicated loans granted to the private non-financial sector. The reason for focusing on syndicated loans – which represent only a subset of total business loans – is that there is a global loan-level data set (obtained from Dealogic Loanware) that allows us to run a consistent cross-country study. The granularity of the data enables us to study the potential effects of the reforms along various dimensions. In addition to overall credit supply, we look for compositional changes in the portfolios of the affected banks. Specifically, we are interested in the riskiness of the borrowers, the amount of secured lending, and the amount of domestic lending versus foreign lending. We also analyse the impact on interest rates and maturities. The empirical analysis uses a difference-in-differences approach.

4.3.2. Description of the data

Our empirical analysis relies on data from the international syndicated loan market. A syndicated loan is granted jointly by a group of banks, with one or more lead banks and several participating banks. Before the loan agreement is signed the lead banks have to assess the quality of the borrower and negotiate the conditions. Once the main conditions are met, lead banks offer parts of the loan to participating banks, though they remain responsible for monitoring the borrower. Typically, a deal over a loan syndication is issued in several tranches. Tranches can be seen as separate lines of credit, which vary by volume, terms, conditions and interest rate payments. The composition of the syndicate might change within a given deal (including several tranches). For that reason, we choose the tranche as the main unit of observation in our analysis.

Dealogic Loanware serves as our primary source for tranche-level data. It provides a comprehensive overview of the global syndicated loan market, including tranche-level information on lender and borrower-specific terms and loan specific characteristics like volume, pricing and maturity. Dealogic Loanware has been widely used for studying the international syndicated loan market (e.g. Esty and Megginson (2003), Carey and Nini (2007), Popov and Van Horen (2015)). The database does not provide information on the amounts lent by each participant in the tranche. Consistent with the previous literature (e.g. Giannetti and Laeven (2012), Ivashina and Scharfstein (2010)) we allocate the entire tranche volume to the lead banks, using an equal weight whenever a given loan is extended by more than one lead bank.[75]

[75] Dealogic Loanware does not provide sufficient information on how the tranche volume is distributed among the lead banks, nor on what proportion of the tranche is allocated to the participating banks. However, according to Simons (1993) lead banks keep a substantial stake of the loan in their own portfolio.

Our study focuses exclusively on lending to the private non-financial sector.[76] Figure 4.3.1 illustrates how aggregate loan volumes for G-SIBs and other banks have evolved over time. Over the last 20 years, G-SIBs have issued substantially higher loan volumes than the group of all other banks. The ratio between both lines indicates a clear structural break in the run-up to and during the 2007-08 global financial crisis, where G-SIBs strongly reduced loan volumes both in absolute and in relative terms. For that reason, we focus on the period between 2010 and 2018 in the empirical analysis.[77]

We provide an overview of the tranche-level data in Table 4.3.1. The average tranche size for G-SIBs is $88 million, which is substantially higher than the average tranche size for other banks ($60 million). While both groups of banks charge similar interest rates, G-SIBs tend to lend with a shorter average maturity to slightly better-rated companies and collateralise loans less frequently. Not surprisingly, G-SIBs are much more involved in foreign lending, with almost 53% of tranches being granted to borrowers abroad. The last row indicates that the average tranche structure does not substantially differ across both groups. On average, a tranche is originated by 4.7-4.8 lead banks.

The granularity of our dataset allows us to obtain a very detailed picture of the borrowing parties. Our sample covers a total of 20,232 distinct firms from 147 different countries. Figure 4.3.2 provides an overview of the predominant borrowing countries and industries. Furthermore, we have information on the creditworthiness of the companies in our sample. In particular, we end up with external credit ratings for 2,035 companies at the time of the signing of the deal, representing around 25% of the observations in our overall sample.[78] Figure 4.3.3 illustrates the lending allocation with respect to the borrower's credit rating. In general, most of the loans are granted to medium-graded, non-investment speculative and highly speculative graded companies. The structural difference between the G-SIB and the non-G-SIB group is quite apparent: G-SIBs tend to serve more medium-graded borrowers and are also occasionally involved in high-grade and prime lending. In contrast to that, other banks predominantly deal with more risky companies.

In a next step, we want to detect whether and how banks take into account the riskiness of the borrower. By doing this, we focus on the interest payment a debtor is obliged to pay.[79] As shown in Figure 4.3.4, interest rates vary substantially across risk classes. Both groups of banks demand higher interest rates from poorly-rated borrowers.[80] Thus, banks are clearly demanding compensation for taking on more risk.

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[76] We do this mainly for two reasons. First, we want to include interbank lending since these flows do not reflect loan provision to the real economy. Secondly, we do not want to include loan volumes granted to the public sector as these loans might be potentially subject to subsidised credit, special agreements and hidden guarantees.

[77] In robustness checks, we have also estimated all specification on the full sample ranging from 2000 to 2018, where results tend to be robust.

[78] We take a simple average of the credit rating from Moody's Corporation and Standard & Poor's Financial Services LLC. When one is missing, we rely solely on the other (non-missing) rating. Firms for which we are unable to obtain any information on the rating are excluded from the corresponding regressions on borrower risk.

[79] For the baseline setting we use the overall margin which includes all incurred costs whereas later on we also distinguish between the fee and the pure interest rate margin component.

[80] Interestingly, the interest rates for extremely poor risk classes appear to be stagnating or, in some cases, even slightly declining. Given the extremely low credit volume in this area, we do not consider this effect to be substantial.

We match the syndicated loan data with bank balance sheet and P&L data from SNL Financial (provided by S&P Global Market Intelligence). Unfortunately, Dealogic Loanware and SNL Financial do not share a common identifier, which makes the matching process challenging as the only commonality lies in the name of the bank. To improve the matching, we make use of a web search-based matching method in the spirit of Autor et. al. (2016).[81] Our final sample comprises 689 banks from 83 different countries, which account for 86% of total lending in the Dealogic database. In Table 4.3.2 we provide summary statistics for the lending banks in our matched sample. Not surprisingly, G-SIBs are much larger: total assets of the median G-SIB exceed the median counterpart of the control group by a factor of 29. Moreover, G-SIBs are less involved in providing loans, which is evident by the consistently lower loan-to-deposit (oand loan-to-asset) ratio and the lower net interest income relative to total assets. The problem of non-performing loans is also less severe. Finally, syndicated loans account for approximately 6.3% of the total loan portfolio of the median G-SIB, while this share is at about one percent for the median non-G-SIB.

4.3.3. Empirical analysis

We use a difference-in-differences methodology to assess whether G-SIB designation affected the lending behaviour of banks that were designated as G-SIBs. We divide the sample into a treatment and a control group, where the former includes all banks that were designated as G-SIBs at least once in the period between 2012 and 2016 and the latter includes all other banks in the sample.

Of course, G-SIB status was not randomly assigned and G-SIBs differ systematically from other banks in terms of size, complexity, and systemic importance more generally. To control for these structural differences across both groups, we use bank-specific fixed effects and control for time-varying differences by including control variables.

4.3.3.1. Effect on Lending Volumes

Our data set differs from the credit register data that is often used in the credit supply literature because each loan is recorded only once – at the time of issuance, so that it is not possible to track a loan over time. For this reason, we need to aggregate the data over various dimensions in order to draw conclusions about loan volumes. Running loan volume regressions at tranche level would only allow us to assess how average tranche size has evolved, while ignoring the fact that banks can also change the number of loans granted. For the syndicated loan market it is particularly important to account for the latter, since changes in total bank lending are mainly caused by changes in the number of loans granted, according to Giannetti and Laeven (2012).

Against this background, we start the empirical analysis by aggregating lending volumes by bank-quarter and then estimating the following equation:[82]

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[81] See Appendix A for further details.

[82] Note that the dummy variables $GSIB_i$ and $Post2012_t$ are themselves not included in the regression, since they would be absorbed by the bank and time fixed effects (which systematically control for any observed and unobserved heterogeneity across banks and over time), respectively.

$$Log\left(Lending_{i,t}\right) = \beta_1\, GSIB_i \times Post2012_t + \beta_2 BankControls_{i,t} + \lambda_i + \lambda_t + u_{i,t} \qquad (1)$$

$Log\left(Lending_{i,t}\right)$ is the logarithm of the total loan volume bank *i* originates over quarter *t*. $GSIB_i$ is a dummy variable, which takes the value 1 if the name of the corresponding bank has been on the G-SIB list at least once between 2012 and 2016. $Post2012_t$ is another binary variable, which is equal to 1 for all observations occurring after 2011Q4 and zero otherwise. To control for structural differences across banks we include bank fixed effects and time-varying bank controls. We use measures of bank size, profitability and capital adequacy as bank controls in our baseline specification. λ_t displays quarter fixed effects. The stochastic error terms $u_{i,t}$ are clustered at the bank-level. The coefficient of interest is β_1 which indicates how G-SIBs change their average lending behaviour after 2012, relative to the control group.

As we are interested in the supply side of credit it is important to control for possible demand effects. If G-SIBs were lending to completely different sectors or different countries compared to other banks, it would be difficult to estimate the true supply-driven effect with β_1 (for example, a particular industry or national economy could have experienced a boom or a recession before or after 2012 and therefore demanded more or fewer loans). To address this issue, we estimate a modified version of the Khwaja and Mian (2008) estimator, where we aggregate lending volumes by bank, time and country-industry ("*natind*") of the borrowing firm and include country-industry-time fixed effects in our regression to absorb time-varying credit demand shocks that are specific to a given country-industry. In principle, the disaggregated structure of our data would have allowed us to conduct analysis at the level of the individual borrower, including firm fixed effects. However, we follow the literature[83] and choose country-industries instead since the average number of syndicated loans granted to a specific firm is relatively small, particularly within a gven time period. Considering all this, our second set of regressions looks as follows:

$$\begin{aligned} Log\left(Lending_{i,t,natind}\right) &= \beta_1 GSIB_i \times Post2012_t + \beta_2 BankControls_{i,t} \\ &\quad + \lambda_i + \lambda_{t,natind} + u_{i,t,natind} \qquad (2) \end{aligned}$$

$Log\left(Lending_{i,t,natind}\right)$ is the logarithm of the total loan volume which a specific bank *i* grants over quarter *t* to a specific country-industry *natind*. Besides the different level of aggregation and the inclusion of more granular FE, all other variables in the regressions are defined as above. Moreover, standard errors in these regressions are double-clustered at the bank and country-quarter level.

4.3.3.2. Effects on Portfolio Composition

In a next step, we analyse whether the reforms had different effects on portfolio allocations for G-SIBs relative to other banks. Specifically, we are interested in the riskiness of the borrower, the amount of secured lending, and the amount of domestic lending versus foreign lending.

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[83] See e.g. Gropp et al. (2019), Berg et al. (2016), Acharya et al. (2017). In addition, Degryse et al. (2019) show that borrower fixed effects based on firm clusters yield bank credit supply shocks that are comparable to those obtained using firm-time fixed effects.

(i) Borrower risk

To analyse whether G-SIBs shifted lending towards safer or riskier borrowers following the reforms, we aggregate tranche volumes by bank *i*, quarter *t*, company rating *rat* and borrower country *c* and set up the following regression equation:[84]

$$Log\left(Lending_{i,t,rat,c}\right) = \beta_1 GSIB_i \times Post2012_t \times Rating_{rat} + \lambda_{i,t} + \lambda_{t,rat,c} + \lambda_{i,rat,c} + u_{i,t,rat,c} \qquad (3)$$

$Log\left(Lending_{i,t,rat,c}\right)$ refers to the amount of all loans which a given bank *i* grants to companies with a given rating *rat* in a given country *c* at time *t*. The variable *Rating* was created by dividing the companies in our sample into four different risk classes based on their official credit rating, whereby a lower value corresponds to a riskier rating.[85] All other variables are defined as above. The coefficient of the triple interaction term β_1 indicates whether G-SIBs differentially adjusted their lending relative to the control group after 2012, depending on the riskiness of the borrower. A positive coefficient would indicate that the reform has encouraged G-SIBs, relative to other banks, to shift lending from risky to less risky borrowers.[86] The use of multi-dimensional fixed effects allows us to shut down a multitude of channels that might have an effect on the risk-taking behaviour of banks. Bank-quarter fixed effects absorb all time-varying bank-specific factors that affect loans in different risk classes to the same extent. Quarter-rating-country fixed effects control for time-varying demand shocks on the country-rating level. These are particularly relevant if a specific rating class in a given country suddenly changes its demand for syndicated loans. On top of that, bank-rating-country fixed effects absorb all structural differences in the banks' preferences for specific risk-profiles within a geographical destination. Again, standard errors are double-clustered at the bank and country-quarter level.

As some banks extend loans only to a single rating class within a given quarter (so that these observations are absorbed by the bank-quarter fixed effects and do not help to identify β_1), we also estimate an alternative specification that allows us to increase the number of identifying observations. We replace bank-quarter fixed effects with bank controls and estimate Equation 3 again. In addition, we also aggregate our data on annual instead of quarterly frequency to obtain more variation within a given bank-time.

(ii) Secured vs unsecured lending

In addition to the borrower's credit risk we also analyse whether G-SIBs have taken more collateral since 2012. For each tranche in our dataset it is indicated whether this tranche is secured.[87] We aggregate lending volumes by bank *i*, quarter *t*, status of collateralisation *sec* and borrowing country *c*. Then, we estimate a modified version of Equation 3 where we replace

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84 As information on the companies' credit ratings are often missing, we are confronted with a reduced number of observations now. On top of that, by introducing the rating dimension we obtain an additional level of aggregation which further thins out the number of identifying observations within a fixed effect cluster. In order to regain a bit of explanatory power, we set up borrower fixed effects on the country instead of country-industry level.

85 See Appendix B for more information on the four risk classes.

86 It is important to keep in mind that all findings are relative to the control group. Even if it is a positive coefficient, it could still be the case that G-SIBs shift towards riskier borrowers in absolute terms – but by less than the controls.

87 Unfortunately, we do not have any further information as to what amount of the outstanding loan is secured and what the equivalent value is. We only know whether an outstanding tranche is secured.

the rating classification by a binary variable that indicates the status of collateralisation. A requirement for collateral may depend on the credit rating of the borrower, and we would therefore run into an omitted variable problem if we ignore the role of borrower risk. We therefore also aggregate lending volumes by bank, quarter, status of collateralisation and credit rating and estimate the effect on secured lending within a particular risk class.

(iii) Domestic versus foreign lending

To test whether G-SIBs have changed the geographical composition of their loans relative to other banks in the post-reform period we aggregate lending volumes at the bank-quarter-borrower country level and estimate the following equation:

$$Log\left(Lending_{i,t,c}\right) = \beta_1 GSIB_i \times Post2012_t \times Domestic + \beta_2 BankControls_{i,t} + \lambda_i + \lambda_{t,c} + u_{i,t,c} \qquad (4)$$

$Log\left(Lending_{i,t,c}\right)$ specifies the amount of all loans which a given bank *i* grants to companies in a given country *c* at time *t*. *Domestic* is a binary variable which is 1 if the nationality of the bank coincides with the nationality of the country of the borrower. We include bank controls, bank fixed effects and quarter-country fixed effects to improve identification. In this equation, the coefficient β_1 captures whether G-SIBs differentially adjusted their domestic or foreign lending activities relative to the control group. A positive coefficient for β_1 would imply that G-SIBs have increased domestic lending since 2012 relative to other banks.

4.3.3.3. Effects on interest rate margins and maturity

Besides lending volumes, we also want to examine whether and how G-SIBs adjust their pricing behaviour and the maturity of loans in the post-reform period. In contrast to the lending regressions, this question can be examined directly at the level of the tranche, the smallest unit of observation in our dataset. The reason for this is that in these regressions we are interested in how average margins and maturities for the originated loans have evolved, so it is not necessary to aggregate as in the regressions on loan amounts (note that loan terms and conditions vary at the tranche level within a given loan). Our most saturated regression equation takes the following form:

$$X_{i,tranche} = \beta_1 GSIB_i \times Post2012_t + \beta_2 TrancheCharacteristics_{tranche} + \beta_3 BankControls_{i,t} + \lambda_i + \lambda_{t,natind} + u_{i,tranche} \qquad (5)$$

with $X \in (Log(Margin), Maturity)$.[88] The coefficient β_1 measures how G-SIBs change their pricing behaviour and the average maturity of originated tranches compared to all other banks. To improve identification we include bank controls, bank fixed effects and country-industry-quarter fixed effects. On top of that, we control for a number of tranche characteristics which might have an effect on the contractual interest payment and the maturity (including the tranche amount, the status of collateralisation, the credit rating of the borrowing firm and the tranche

[88] To better capture the right-skewed distribution of interest rate margins, we take logarithms of the dependent variable.

maturity (in the case where we use the margin as dependent variable)). We double-cluster standard errors at the bank and country-quarter level in our baseline specification.

4.3.3.4. Effects on the pricing sensitivity to risk

In a further step, we are interested in the extent to which G-SIBs are changing their pricing behaviour in terms of borrower risk. To shed light on that question, we estimate the following regression equation:

$$Log(Margin)_{i,tranche} = \beta_1 GSIB_i \times Post2012_t \times Rating_{rat} + \beta_2\, TrancheCharacteristics_{tranche} + \lambda_{i,t} + \lambda_{t,rat,c} + \lambda_{i,rat,c} + u_{i,tranche} \qquad (6)$$

$Log(Margin)_{i,tranche}$ is the logarithm of the interest rate which the borrower has to pay on the respective tranche. We use tranche characteristics and include multiple high-dimensional fixed effects to control for other factors than the intended effect. Bank-quarter fixed effects absorb all factors that affect the bank-quarter level. Quarter-rating-country fixed effects absorb time-varying demand shocks at the country-rating level. Bank-rating-country fixed effects control for heterogeneity in the banks country-specific risk preferences. A positive coefficient for β_1 would imply that G-SIBs reduce the pricing differential for risk in the post-reform era compared to the control group. To increase the number of identifying observations, we also replace bank-quarter fixed effects by bank controls and estimate Equation 6 again.

4.3.4. Results

4.3.4.1. Effects on lending volumes

Table 4.3.3 displays the results for a variety of specifications when we analyse the impact of the reforms on bank lending. We do not identify a significantly different effect on the lending volumes of G-SIBs relative to the control group in any of these specifications. Column 1 shows the results of estimating Equation 1, where we aggregate lending volumes at bank and quarter level. For the rest of the table, we aggregate loan volumes at bank, quarter and country-industry level. That is, column 2–4 make use of the Khwaja and Mian (2008)-type estimator outlined in Equation 2, where we control for time-varying demand shocks at the country-industry level. While in Column 2 we analyse lending with respect to the intensive margin, we include zero-observations and capture both extensive and intensive margin in Columns 3 and 4. In addition to the loan amount, we use the number of deals as a dependent variable in Column 4. In the last column, we test for the extensive margin separately by estimating a linear probability model.[89]

4.3.4.2. Effects on portfolio composition

Next, we examine whether the reform has led to compositional changes in the banks' loan portfolios. We start by analysing lending volumes with respect to borrower risk.

[89] The dependent variable in this regression is a dummy variable equal to one if the respective bank extended a loan to the respective country-industry in the relevant time period, and zero otherwise.

(i) Borrower risk

Figure 4.3.5 illustrates that for both groups of banks the (value-weighted) average credit rating of the borrower (at origination) falls until 2012. Since then, average borrower risk, as measured by ratings, continued to increase for other banks, while it stabilised for G-SIBs. Table 4.3.4 complements the descriptive evidence in Figure 4.3.5 with a formal regression analysis. In Column 1-3 in Panel A, we aggregate lending volumes by bank, quarter, credit rating and borrower country. Column 1 includes the full set of multidimensional fixed effects (Equation 3) and is therefore our most stringent specification. The significant coefficient indicates that non-G-SIBs tended to shift more funds towards risker borrowers in the post-reform period, relative to G-SIBs. In Column 3 we replace bank-quarter fixed effects by bank controls which helps us to increase the number of identifying observations.[90] The coefficient still shares the same sign, although we lose some statistical significance. In Column 2 we take the fixed sample from Column 1 (which we therefore call *Condensed Sample*) and estimate the specification from Column 3. The coefficient is positive and significant at the 10% level. To obtain more rating variation within a given bank-time, we also aggregate lending volumes by bank, year (instead of quarter), credit rating and borrower country and apply exactly the same estimation procedure. Results are given in Column 4-6 of Panel A. We find a positive significant coefficient throughout all specifications and the effect is slightly more pronounced. Overall, these results suggest that G-SIBs shifted lending towards less risky companies compared to the control group.

In a next step, we split the sample into less risky and more risky borrowers to test whether differential adjustments between G-SIBs and other banks are stronger in any specific segment of loans.[91] The results from Panel B reveal that the relative adjustment mainly took place in the segment of less risky borrowers, i.e. loans to companies with a credit rating of at least "BB+". The coefficient in Column 1 indicates that since 2012 G-SIBs, compared to other banks, have granted approximately 24% more loans to companies which share a credit rating in the upper segment. In the more risky segment, we cannot see any significant differences.

(ii) Secured vs unsecured lending

In a further step, we analyse the role of secured lending. In general, requiring collateral helps to mitigate the impact of possible borrower defaults and therefore reduces the risk of the loan portfolio. Moreover, it helps with both ex ante and ex post frictions arising from asymmetric information problems e.g., adverse selection and moral hazard. Figure 4.3.6 shows that for most of the sample period G-SIBs collateralise around 20-25% of their loans by volume. From 2015 onwards, however, there is a sharp rise in the collateralisation ratio to 40%. This jump seems to have occurred also to a similar extent, but at higher levels, for the control group. Moreover, other banks started to request collateral on more syndicated loans during the financial crisis while G-SIBs did not adjust at that time. That is, G-SIBs have been catching up with other banks in the post-reform period.

Turning to the regression analysis, we analyse this issue in more detail. In Column 1-3 of Table 4.3.5 we aggregate lending volumes by bank, quarter, borrower country and status of

90 Note that the number of banks in our sample almost doubles.

91 The sample is split based on the rating variable explained in Appendix B.

collateralisation.[92] Our estimation procedure follows Table 4.3.4 very closely. Column 1 makes use of the full set of multidimensional fixed effects and is therefore our preferred specification. According to the coefficient, G-SIBs have increased the proportion of new loans that are secured by roughly 21% since 2012 compared to the control group. The effect weakens and becomes insignificant when we replace bank-quarter fixed effects with bank controls (see columns 2-3). Since the majority of secured tranches are issued to borrowers with low credit ratings and we have already found that G-SIBs are increasingly lending to better-rated companies, the question arises whether we have not underestimated the true effect on secured lending.[93] To fully isolate the effect on collateralised lending, we add up loan volumes by bank, quarter, status of collateralisation and credit rating and estimate the effect within a given risk class. The results from Column 4-6 demonstrate that the effect is indeed stronger if we control for the default risk of the debtors. Coefficients are highly significant and have tripled in size compared to Column 1-3.

(iii) Domestic versus foreign lending

Next, we examine whether G-SIBs have reduced their global footprint as a result of the regulatory changes. In a first step, we compare how the domestic share of G-SIBs and that of other banks has evolved.[94] Figure 4.3.7 shows that G-SIBs are much more involved in lending to foreign borowers: the share of G-SIBs' loans that are domestic is consistently lower than that of other banks (between 35% and 45% for G-SIBs, and between 60% and 70% for other banks). In the run-up to the global financial crisis, G-SIBs considerably increased the proportion of loans granted to borrowers in other countries. Since then, however, it can be seen from the green line that lending to foreign borrowers has evolved largely in line with the other banks.

Our regression analysis in Table 4.3.6 underlines this tendency, as we do not obtain a clear direction for the regression coefficient (which is in any case always insignificant) in a variety of different specifications. In Columns 1-3 we aggregate lending volumes by bank, quarter and borrower country. This allows us to account for time-varying demand shocks at the country level. On top of that, we also include zero observations to capture the situation where banks enter completely new countries or withdraw from specific markets. The order of our estimation follows the procedure of the previous chapters. Column 1 is our most conservative specification where we control for the entire set of two dimensional fixed effects. In Column 2 we use the sample from Column 1 and replace bank-quarter fixed effects by bank controls, while in Column 3 we apply the full sample for that specification. For robustness, we aggregate lending volumes by bank, quarter and domestic-or-foreign exposures and estimate the effect on foreign lending activities again.[95] According to Column 4-6, results remain insignificant.

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[92] This is either secured or unsecured loans.

[93] We face a classic omitted variable problem where the credit rating simultaneously determines the lending of G-SIBs and the requirement for collateral.

[94] We construct the domestic share by dividing for each bank the amount of domestic loans issued by the total loan volume.

[95] This coarser aggregation does not allow us to control for country-specific demand effects.

4.3.4.3. Effects on pricing behaviour

Figure 4.3.8 gives descriptive evidence for the evolution of contractual interest payments over time. Overall, loan margins declined universally after 2012, in line with the low interest rate environment in the aftermath of the financial crisis, which also has a significant impact on the costs of corporate financing. Furthermore, on average G-SIBs charged lower interest ratesthan other banks before 2012. However, the lower panel indicates that this pricing gap seems to have narrowed after 2012, in particular for the most highly-rated borrowers.

To further elaborate on this trend, we use the panel dimension in our data and run various versions of the linear regression model specified in Equation 5. Since our observational unit is the tranche level now, we include tranche characteristics (Amount, Maturity, Rating and Status of Collateralisation) as further controls.[96] In Column 1-3 of Table 4.3.7, we successively decrease the coarseness of the fixed effect clusters. While in Column 1 we use quarter fixed effects to capture time-varying trends in pricing, we include quarter-country fixed effects in Column 2 and quarter-country-industry fixed effects in Column 3. Throughout all specifications in Table 4.3.7 we obtain a positive effect (which becomes insignificant in the most stringent specification in Column 3). The coefficient in Column 2 indicates that other banks, compared to G-SIBs, lowered their average margin per loan by 7.3% more after the reforms, after controlling for credit risk and other loan terms.[97] In other words, G-SIBs have become more conservative in pricing their loans, which is consistent with a potential reduction in funding cost subsidies. Such subsidies may have discouraged G-SIBs from adequately pricing the risk in their loans in the pre-reform period, and their reduction in the post-reform period may have narrowed the gap in pricing relative to other banks (as evidenced in the lower panel of Figure 4.3.8, although non-SIBs have lowered their prices relative to G-SIBs in the post-reform era, they remain slightly higher on average).

Next, we examine the sensitivity of pricing to risk. As shown in Figure 4.3.8, after 2012 other banks lowered their margins, in particular for the least risky borrowers, i.e. in a risk-sensitive manner. To analyse the effect formally, we estimate Equation 6 and show the results in Table 4.3.8. The first column of Panel A is the most saturated specification as it contains the full set of multidimensional fixed effects. Column 2 and 3 replace bank-quarter fixed effects by bank controls, where we hold for Column 2 the sample from Column 1 fixed. The positive coefficient for the triple interaction suggests that other banks have increased differentiation between less and more and risky borrowers when pricing their loans in the post-reform period, relative to G-SIBs. In a final step, we want to ascertain where on the risk scale margins have been adjusted. In order to get information about this, we estimate the effect on the margin for each risk segment separately. Panel B shows that the adjustment mostly took place in the segment of the most highly-rated borrowers (in line with Figure 4.3.8), while we do not detect any different behaviour for the lower-rated borrowers. The coefficient of Column 1 indicates that other banks decreased their margins on less risky loans by 9.4% compared with G-SIBs.

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96 As one tranche could be originated by more than one lead bank, our observation unit is strictly speaking the tranche bank level.

97 The granularity of our data allows us to further decompose the interest rate charged by the banks into a fee component and a pure interest component. We find suggestive evidence that the higher pricing of loans relative to Non-G-SIBs was mainly due to an increase in the pure interest component, whereas an adjustment in the fee structure hardly took place. Instead of the margin, we use the fee component as a dependent variable and estimate Equation 5 again. We do not find any significant effects for a number of different specifications. To save on space we do not show results here.

One possible explanation for these different effects on pricing could be that prime borrowers are more eager to do business with G-SIBs, so that G-SIBs have more pricing power with them and therefore do not have to reduce interest rates on their loans so much. Such demand-side effects would make it difficult for other banks to gain market share of lending to safer borrowers and could hence also explain the volume effects discussed in Section 4.2 (which illustrated that other banks gained market share on the risky segments, in relative terms). Of course, this is just one potential explanation and others are possible. Identifying the mechanism behind our findings would require further information and is beyond the scope of this study.

4.3.4.4. Effects on maturities

Figure 4.3.9 illustrates the value-weighted maturity for both groups of banks over time. G-SIBs grant loans with shorter maturities with a structural break becoming particularly evident during the global financial crisis. From an aggregated point of view, however, there does not seem to have been any differential development over the last 10 years. To gain more confidence on that question, we use our tranche-level data and investigate the relationship by estimating Equation 5. Indeed, the results from Table 4.3.9 do not reveal any significant differences. From Column 1 to 3 we successively decrease the coarseness of the fixed effect clusters. Starting with quarter fixed effects in Column 1, we include quarter-country fixed effects in Column 2 and quarter-country-industry fixed effects in Column 3. The two remaining columns are for robustness. In Column 4 we take logarithms of the dependent variable. In Column 5 we omit the credit rating as control variable, which allows us to more than double our sample size.[98] All estimates are insignificant and do not even share the same sign, which let us to conclude that there has been no differential adjustment in tranche maturities in the post-reform era.

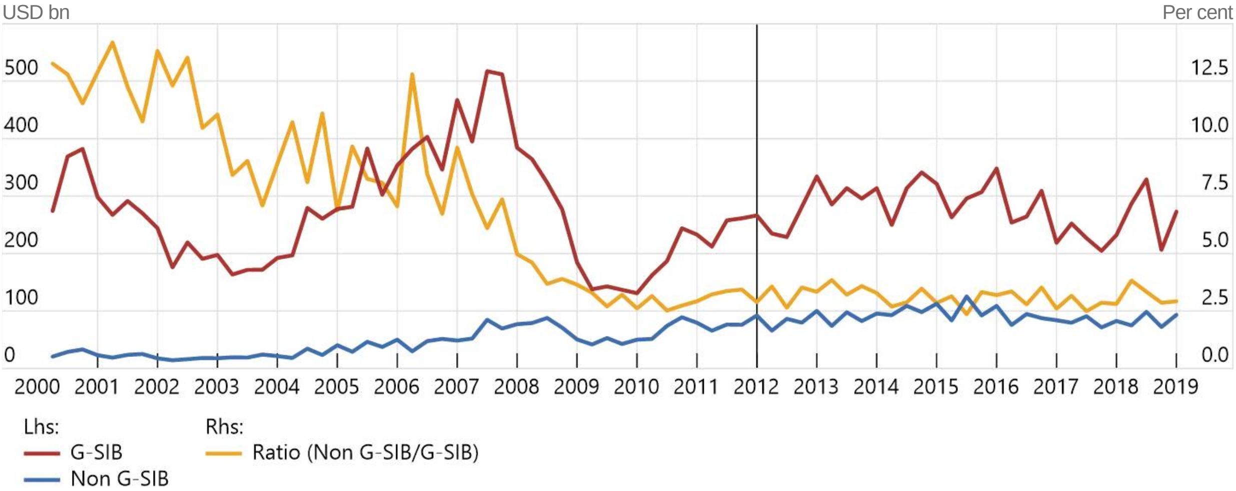
4.3.5. Conclusions

This section assesses the impact of the G-SIB designation on the lending behaviour of G-SIBs. Overall, we find no effect on the overall credit supply of the affected banks. This holds true for a number of different specifications and alternative estimation techniques. However, our results point to changes in portfolio composition. Relative to the control group, G-SIBs shifted more funds to less risky borrowers and also increased the amount of secured lending. We do not observe any differential effects on the decision whether to grant loans abroad or in the home country. On top of that, we analyse interest rates and maturities of the originated loans. We find suggestive evidence that G-SIBs, relative to the control group, increased their loan margins. This effect is particularly pronounced for tranches granted to well-rated companies, which, overall, implies a decrease in the sensitivity of pricing to risk for G-SIBs. We detect no differential effects on the maturity of loans granted.

[98] It should be noted that by including margins we are still able to control for counterparty risk.

4.3.6. Figures and tables

Aggregate loan volumes over time **Figure 4.3.1**

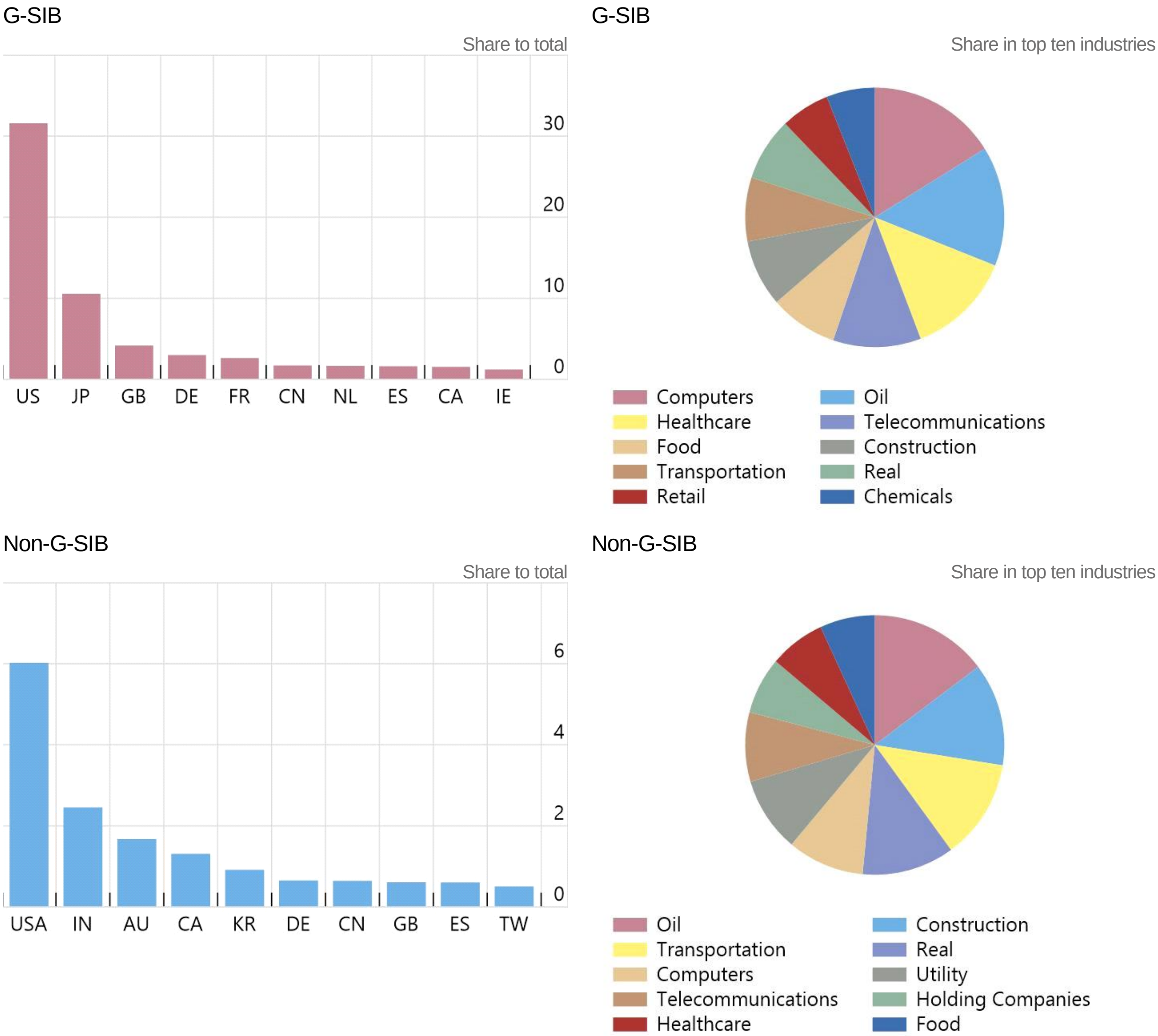


Notes: Lending volumes are aggregated by quarter and group of G-SIBs/non-G-SIBs. For the ratio, both volumes are divided in a given quarter.

Source: Dealogic Loanware.

Geographical and industry breakdown of lending volume

In per cent **Figure 4.3.2**



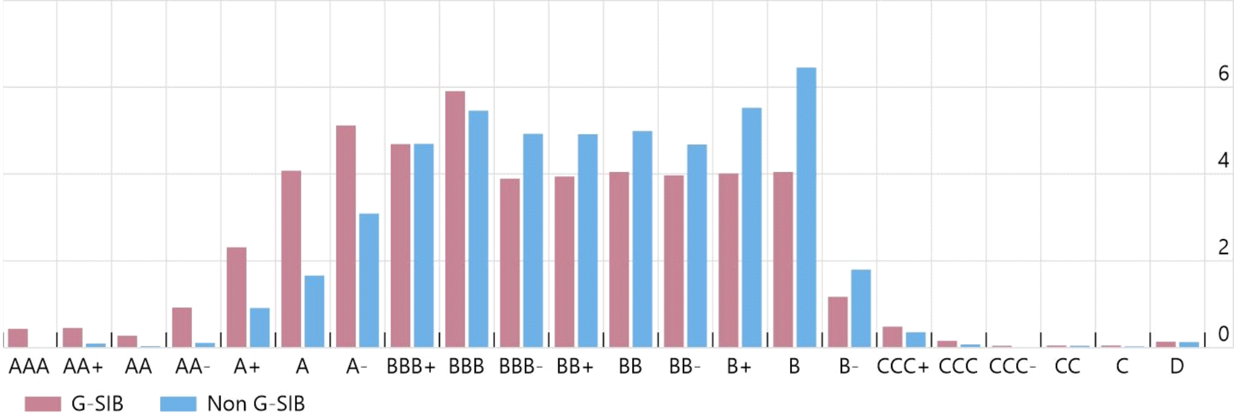
Notes: The left panel shows the geographical breakdown of lending volumes for G-SIBs (top) and Non-G-SIBs (bottom) for the period 2010 – 2018. The right panel illustrates lending volumes by industry for G-SIBs (top) and Non-G-SIBs (bottom) for the same period. For illustration purposes we focus on the 10 largest countries/industries in each panel.

Source: Dealogic Loanware.

Share of lending volume by risk-class

In per cent

Figure 4.3.3



Notes: We aggregate lending volumes by credit rating and group of G-SIBs/Non-G-SIBs. Then, we calculate the respective portfolio share for each group of banks.

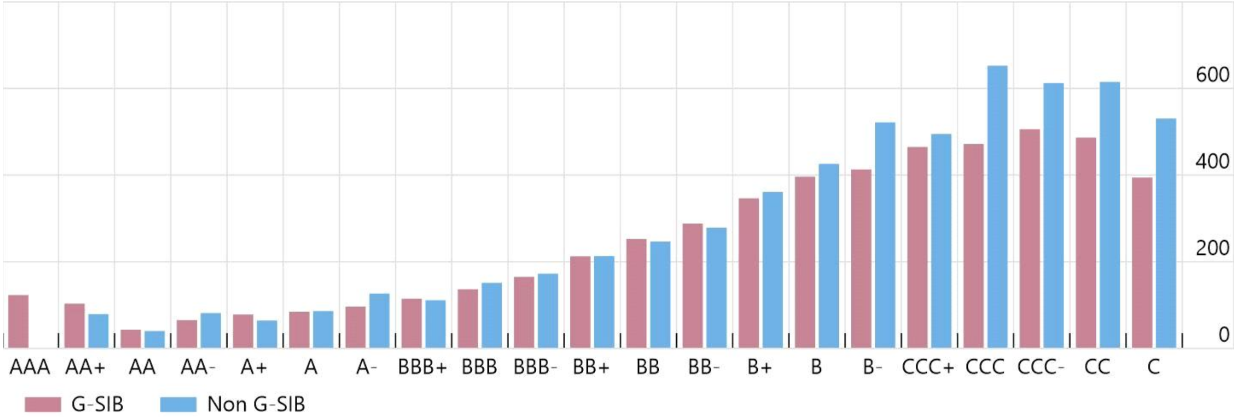
Source: Dealogic Loanware.

Pricing by risk class

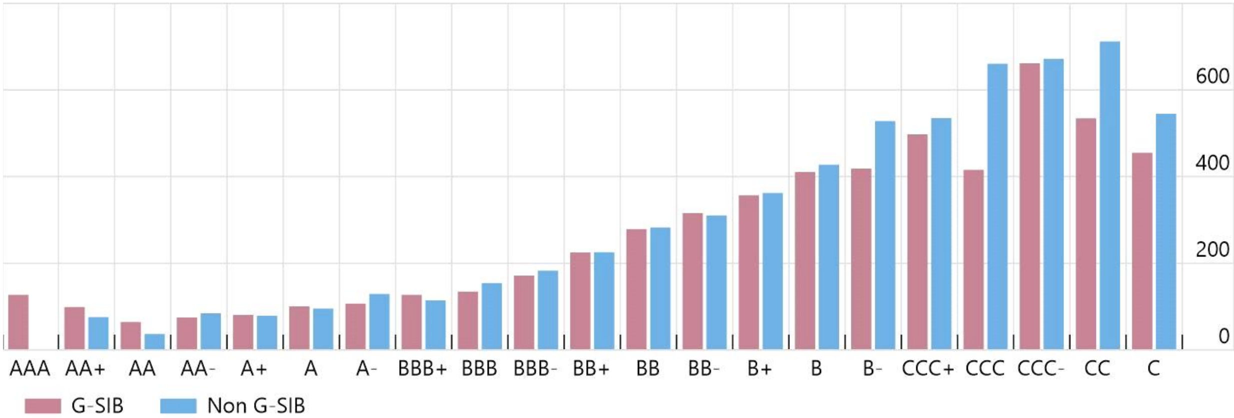
In basis points

Figure 4.3.4

Equally-weighted



Value-weighted

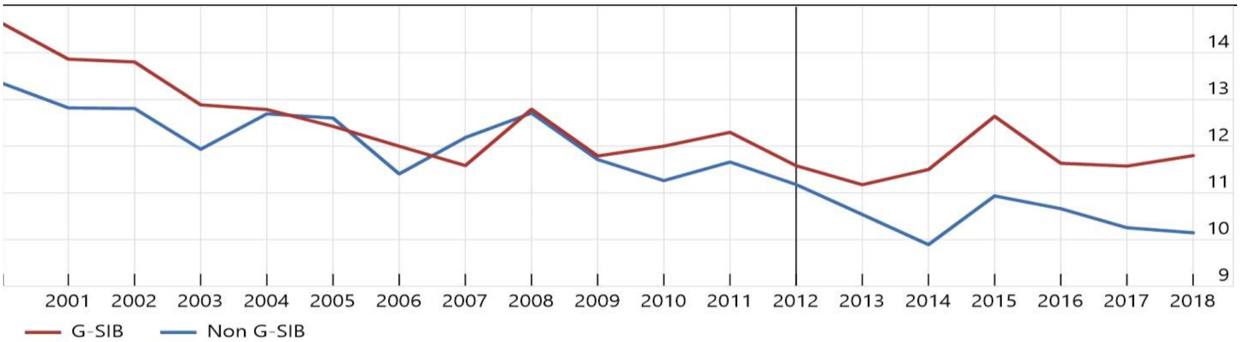


Notes: For each group of banks, we calculate the margin per credit rating by applying an unweighted mean in the top panel and a value-weighted average in the bottom panel.

Source: Dealogic Loanware.

Value-weighted portfolio-rating over time

Rating **Figure 4.3.5**

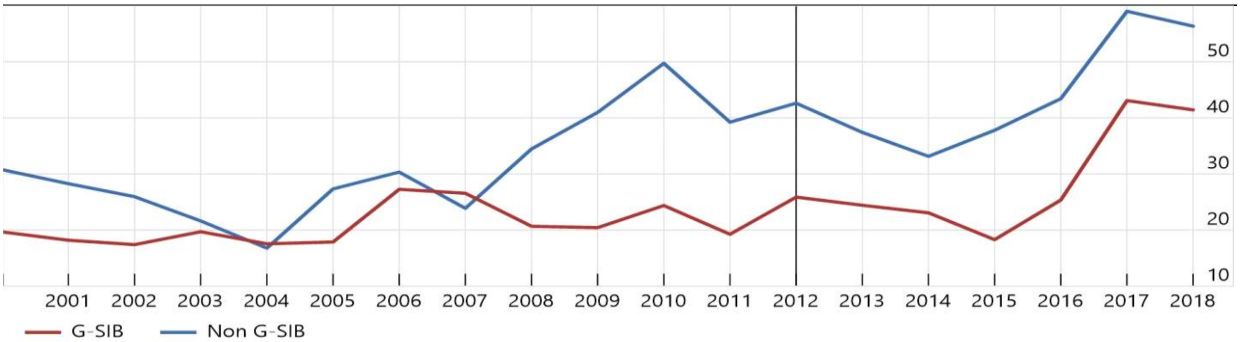


Notes: For both G-SIBs and non-G-SIBs we calculate the share of funds which is attributed to a specific rating class in a given year. We transform the credit ratings to a numerical Standard & Poor's scale with "0" representing "D" up to "22" representing "AAA" and compute a weighted average. For illustration purpose, we leave the labels of the y-axis with the original rating classification.

Source: Dealogic Loanware.

Share of new loans that are secured

In per cent **Figure 4.3.6**

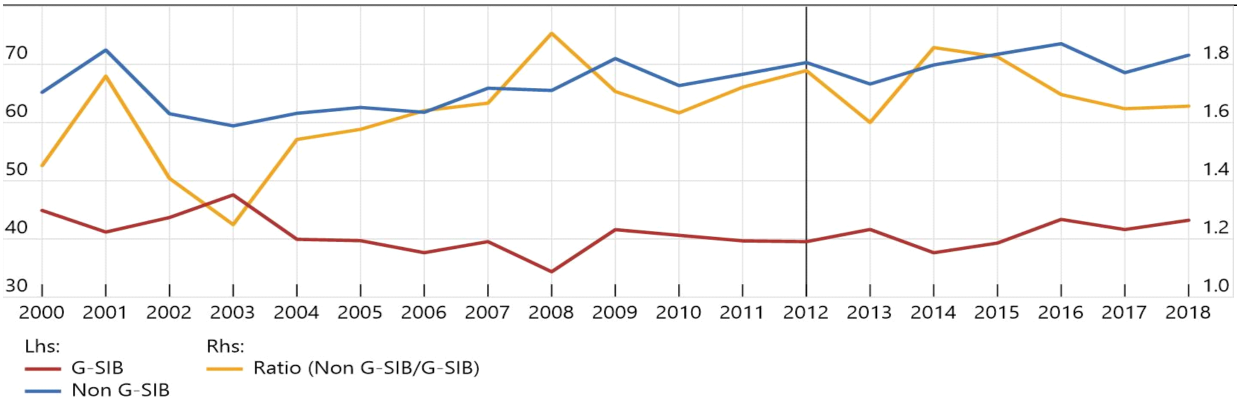


Notes: For both G-SIBs and non-G-SIBs we calculate the share of funds which is secured by collateral in a given year.

Source: Dealogic Loanware.

Share of lending that is to borrowers in the same jurisdiction as the lender

In per cent **Figure 4.3.7**



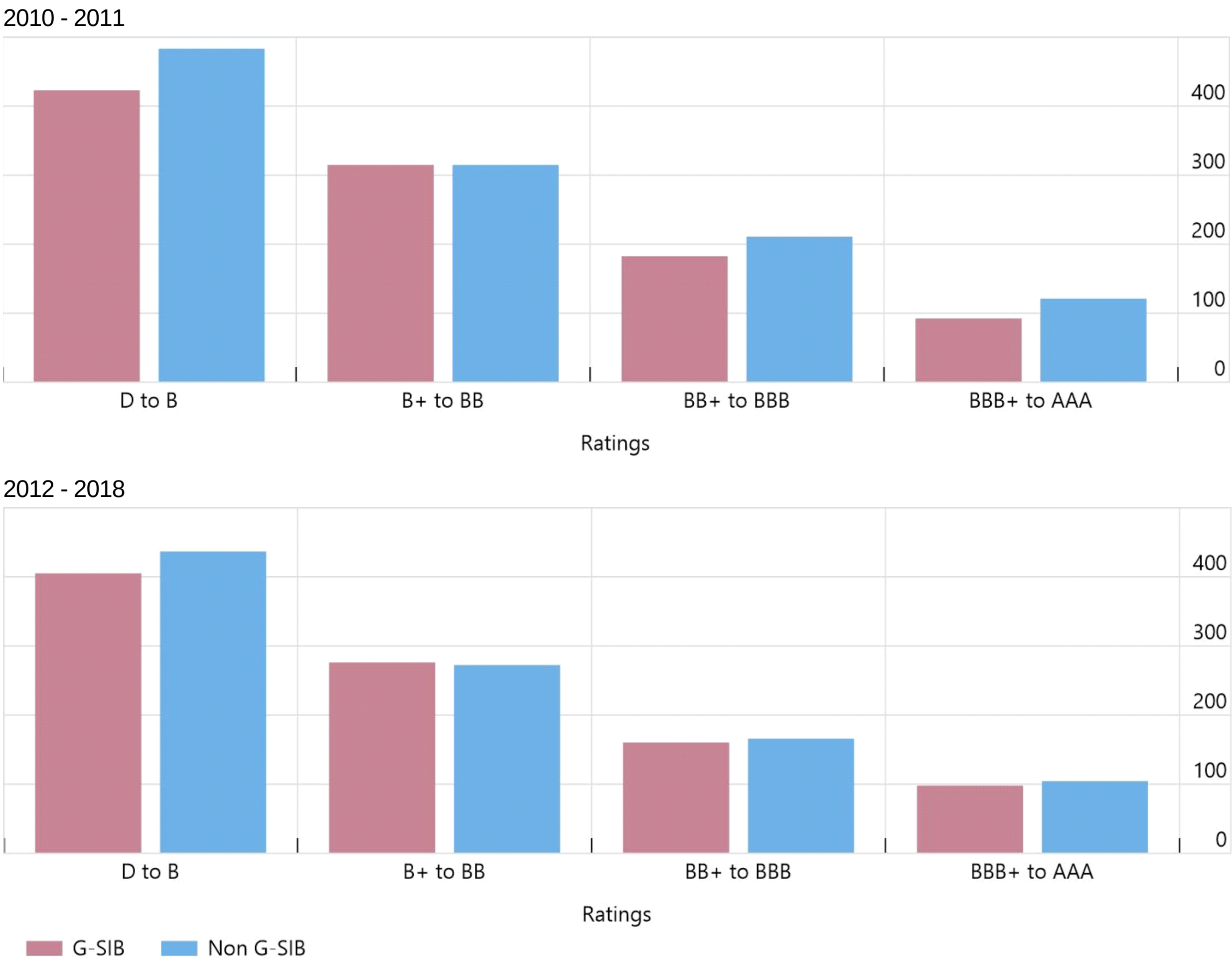
Notes: For each bank, we compute the domestic loan share by dividing the amount of domestic loans issued by the total loan volume. We then calculate an average across the individual banks.

Source: Dealogic Loanware.

Margin over risk-free rates by risk class

In basis points

Figure 4.3.8

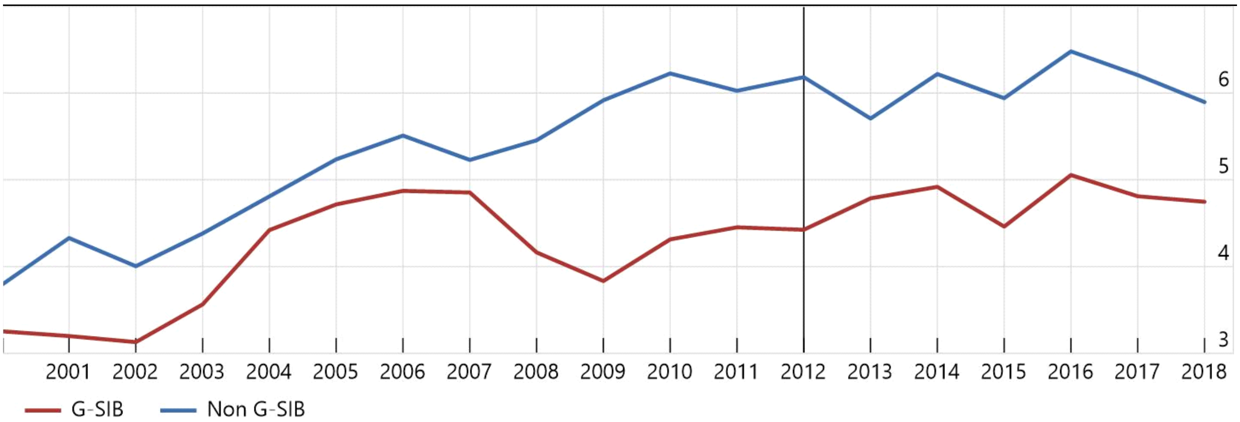


Source: Dealogic Loanware.

Value weighted maturity

In year

Figure 4.3.9



Notes: For both G-SIBs and Non-G-SIBs we calculate the share of funds which is attributed to a specific maturity in a given year. We then use these weights to compute a value-weighted maturity for each group of banks.

Source: Dealogic Loanware.

Tables

Table 4.3.1: Syndicated loan market – Tranche-level information

	GSIBs			Non-GSIBs		
	N	Mean	std. dev.	N	Mean	std. dev.
Tranche Size (in Tsd. US-$)	108,929	88230.1	142901.7	52,354	59527.5	104141.6
Margin (in bp)	51,251	270.01	154.52	20,646	264.13	163.61
Maturity (in yrs)	106,051	5.0036	3.3155	49,941	5.6395	4.1000
Rating	33,223	10.5550	3.3146	7,838	10.0995	3.0446
Secured Y/N	108,818	0.3240	0.4680	52,331	0.4481	0.4973
Domestic Y/N	108,929	0.4792	0.4996	52,354	0.6071	0.4884
Number of Lead Banks	108,929	4.8064	4.6359	52,354	4.6796	4.3375

Notes: This table summarises tranche-level data for the period 2010 - 2018. We calculate summary statistics for the rating variable by transforming the S&P rating scale to a numerical scale starting with "0" representing "D" up to "22" representing "AAA". A rating of "10" corresponds to "BB".

Table 4.3.2: Summary statisticss of balance sheet items and P&L metrics

(a) GSIBs

	N	Mean	P10	P50	P90	std. dev.
Total Assets (in Bln. US-$)	289	1598.6	663.50	1578.5	2589.8	756.93
Total Net Loans (in Bln. US-$)	286	673.39	125.72	700.63	1040.3	380.52
Total Deposits (in Bln. US-$)	286	819.53	187.82	721.94	1668.0	552.39
Net Interest Income (in Bln. US-$)	266	24.634	6.3566	18.534	49.483	16.903
Loan-to-Deposit Ratio	286	0.9099	0.5670	0.7681	1.2551	0.4909
Leverage Ratio	44	0.07848	0.05760	0.08135	0.09450	0.01354
Tier 1 Capital Ratio	248	0.1369	0.1088	0.1319	0.1722	0.02503
NPL Ratio	198	0.01377	0.001728	0.008733	0.02831	0.01570
Return on Average Assets (in %)	287	0.4978	-0.02963	0.4433	1.1692	0.4926
Return on Average Equity (in %)	287	7.0174	-0.5670	7.4592	14.022	6.8253
Synd Loan Volume to Total Net Loans (in %)	275	9.3828	0.9624	6.2810	21.1448	10.3666
Synd Loan Volume to Total Assets (in %)	289	3.4121	0.3251	2.6795	7.6815	2.6075

(b) Non-GSIBs

	N	Mean	P10	P50	P90	std. dev.
Total Assets (in Bln. US-$)	2,805	135.14	8.2008	53.814	379.85	218.44
Total Net Loans (in Bln. US-$)	2,709	77.103	4.0488	32.262	208.64	126.85
Total Deposits (in Bln. US-$)	2,557	78.459	5.8299	37.117	212.24	124.54
Net Interest Income (in Bln. US-$)	2,651	2.5750	0.1677	0.9744	6.0348	4.3862
Loan-to-Deposit Ratio	2,557	1.0701	0.6237	0.8994	1.6136	0.6461
Leverage Ratio	277	0.09203	0.08090	0.09190	0.1063	0.009003
Tier 1 Capital Ratio	2,406	0.1283	0.08667	0.1232	0.1764	0.03406
NPL Ratio	1,999	0.02042	0.002344	0.01291	0.05191	0.02149
Return on Average Assets (in %)	2,713	0.8745	0.09135	0.8140	1.9729	0.7408
Return on Average Equity (in %)	2,692	9.0532	1.3918	9.2618	17.631	6.9655
Synd Loan Volume to Total Net Loans (in %)	2,618	2.6772	0.2964	0.9577	5.7481	6.0013
Synd Loan Volume to Total Assets (in %)	2,780	2.0209	0.1530	0.5594	3.8150	6.0103

Notes: In each subtable, row 1-10 show summary statistics for annual bank-specific financial indicators obtained from SNL Financial for the period 2010 - 2018. For the last two rows we sum up tranche volumes of syndicated loans (provided by Dealogic Loanware) by bank-year and divide them by the respective SNL item.

Table 4.3.3: Effects of the G-SIB reforms on lending volumes

VARIABLES	(1) Log(Lending)	(2) Log(Lending)	(3) Log(Lending)	(4) Log(# of Deals)	(5) 1(Lending > 0)
Post2012 x GSIB	0.0595	-0.0229	0.0246	0.00761	0.000875
	(0.0972)	(0.0513)	(0.123)	(0.00542)	(0.00651)
Observations	6,145	52,820	693,996	693,996	693,996
R-squared	0.801	0.656	0.215	0.138	0.215
Bank Controls	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	No	No	No	No
Quarter x Borr-Country x Industry FE	No	Yes	Yes	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018
Clustering	Bank	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Ind x Qtr
Margin	Int	Int	Ext & Int	Ext & Int	Ext
Model	Log w/o zeros	Log w/o zeros	Log w/ zeros	Log w/ zeros	LPM
Frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Unit of Obs	Bank x Qtr	Bank x Qtr x Ctr x Ind	Bank x Qtr x Ctr x Ind	Bank x Qtr x Ctr x Ind	Bank x Qtr x Ctr x Ind
Nr. of Banks	377	375	541	541	541

Notes: Table 4.3.3 estimates the effect on lending volumes. Column 1 includes quarter FE, Column 2 quarter-country-industry FE, Column 3 focuses on both intensive and extensive margin. Column 4 uses number of deals as dependent variable and Column 5 estimates a Linear Probability Model. Significance levels are indicated by stars with *** p < 0.01, ** p < 0.05, * < 0.1.

Table 4.3.4: Effects of the G-SIB reforms on portfolio riskiness

(a) Lending Sensitivity to Risk

VARIABLES	(1) Log(Lending)	(2) Log(Lending)	(3) Log(Lending)	(4) Log(Lending)	(5) Log(Lending)	(6) Log(Lending)
Post2012 × GSIB × Rat	0.208**	0.179*	0.105	0.221*	0.313***	0.268**
	(0.0986)	(0.101)	(0.0996)	(0.111)	(0.116)	(0.114)
Post2012 × GSIB		-0.517*	-0.249		-0.851***	-0.606*
		(0.294)	(0.308)		(0.295)	(0.310)
Observations	9,288	9,288	10,042	6,125	6,125	6,389
R-squared	0.855	0.819	0.818	0.819	0.795	0.795
Bank Controls	No	Yes	Yes	No	Yes	Yes
Bank x Time FE	Yes	No	No	Yes	No	No
Rat x Ctr x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank x Rat x Ctr FE	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Yr	Bank & Ctr x Yr	Bank & Ctr x Yr
Frequency	Quarterly	Quarterly	Quarterly	Yearly	Yearly	Yearly
Sample	Full	Condensed	Full	Full	Condensed	Full
Unit of Obs	Bank x Qtr x Rat x Ctr	Bank x Qtr x Rat x Ctr	Bank x Qtr x Rat x Ctr	Bank x Yr x Rat x Ctr	Bank x Yr x Rat x Ctr	Bank x Yr x Rat x Ctr
Nr. of Banks	62	62	123	67	67	121

(b) Breakdown by Risk Segment

VARIABLES	(1) Log(Lending)	(2) Log(Lending)	(3) Log(Lending)	(4) Log(Lending)
Post2012 × GSIB	0.236*	-0.199	0.437***	-0.0281
	(0.123)	(0.184)	(0.151)	(0.192)
Observations	5,616	3,964	3,568	2,606
R-squared	0.691	0.691	0.545	0.610
Bank Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Country x Time FE	Yes	Yes	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Yr	Bank & Ctr x Yr
Frequency	Quarterly	Quarterly	Yearly	Yearly
Risk Segment	Safe	Risky	Safe	Risky
Unit of Obs	Bank x Qtr x Ctr	Bank x Qtr x Ctr	Bank x Yr x Ctr	Bank x Yr x Ctr
Nr. of Banks	108	109	108	111

Notes: Panel A estimates the effect on the lending sensitivity to risk. In Columns 1–3 we aggregate lending volumes by bank, risk class and quarter, in Columns 4–6 we aggregate by bank, risk class and year. *Rating* is our own-created, quartile-based rating variable. In Panel B we estimate the effect for a particular risk segment, where the safe segment includes all companies with a credit rating of BB+ or higher. The risky segment contains the respective bottom half of the credit ratings. Significance levels are indicated by stars with *** p < 0.01, ** p < 0.05, * < 0.1.

Table 4.3.5: Effects of the G-SIB reforms on securitised lending

VARIABLES	(1) Log(Lending)	(2) Log(Lending)	(3) Log(Lending)	(4) Log(Lending)	(5) Log(Lending)	(6) Log(Lending)
Post2012 x GSIB x Secured	0.207**	0.144	0.107	0.578***	0.602***	0.714***
	(0.0956)	(0.0949)	(0.0906)	(0.215)	(0.214)	(0.193)
Post2012 x GSIB		-0.0588	0.0172		-0.227**	-0.234*
		(0.0775)	(0.0721)		(0.108)	(0.127)
Observations	27,409	27,409	30,075	5,302	5,302	6,123
R-squared	0.725	0.671	0.668	0.733	0.615	0.623
Bank Controls	No	Yes	Yes	No	Yes	Yes
Bank x Quarter FE	Yes	No	No	Yes	No	No
Secured x Country x Quarter FE	Yes	Yes	Yes	No	No	No
Bank x Secured x Country FE	Yes	Yes	Yes	No	No	No
Secured x Rating x Quarter FE	No	No	No	Yes	Yes	Yes
Bank x Secured x Rating FE	No	No	No	Yes	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Rat x Qtr	Bank & Rat x Qtr	Bank & Rat x Qtr
Frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Sample	Full	Condensed	Full	Full	Condensed	Full
Time	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018
Unit of Obs	Bank x Qtr x Sec x Ctr	Bank x Qtr x Sec x Ctr	Bank x Qtr x Sec x Ctr	Bank x Qtr x Sec x Rat	Bank x Qtr x Sec x Rat	Bank x Qtr x Sec x Rat
Nr. of Banks	173	173	344	62	62	129

Notes: Table 4.3.5 estimates the effect on secured lending. In Columns 1 – 3 we aggregate lending volumes by bank, quarter, status of collateralization and borrower country and estimate the effect within a given borrower country. In Columns 4 - 6 we aggregate by bank, quarter, status of collateralization and rating class and estimate the effect within rating class. *Secured* is a binary variable, which is one, if lending volumes are secured and zero otherwise. Significance levels are indicated by stars with *** p < 0.01, ** p < 0.05, * < 0.1.

Table 4.3.6: Effects of the G-SIB reforms on foreign lending

VARIABLES	(1) Log(Lending)	(2) Log(Lending)	(3) Log(Lending)	(4) Log(Lending)	(5) Log(Lending)	(6) Log(Lending)
Post2012 x GSIB x Domestic	0.0755	0.0800	0.0765	-0.774	-0.774	-0.463
	(0.459)	(0.462)	(0.460)	(0.592)	(0.592)	(0.572)
Post2012 x GSIB		-0.143	-0.150		0.253	0.108
		(0.171)	(0.171)		(0.576)	(0.586)
Observations	167,996	167,996	175,732	20,272	20,272	28,416
R-squared	0.510	0.478	0.473	0.834	0.644	0.645
Bank Controls	No	Yes	Yes	No	Yes	Yes
Bank x Quarter FE	Yes	No	No	Yes	No	No
Domestic x Quarter FE	No	No	No	Yes	Yes	Yes
Bank x Domestic FE	No	No	No	Yes	Yes	Yes
Country x Quarter FE	Yes	Yes	Yes	No	No	No
Bank x Country FE	Yes	Yes	Yes	No	No	No
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank	Bank	Bank
Frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Time	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018
Margin	Ext & Int	Ext & Int	Ext & Int	Ext & Int	Ext & Int	Ext & Int
Sample	Full	Condensed	Full	Full	Condensed	Full
Unit of Obs	Bank x Qtr x Ctr	Bank x Qtr x Ctr	Bank x Qtr x Ctr	Bank x Qtr x Dom	Bank x Qtr x Dom	Bank x Qtr x Dom
Nr. of Banks	315	315	543	303	303	543

Notes: Table 4.3.6 estimates the effect on foreign lending. In Columns 1 – 3 we aggregate lending volumes by bank, quarter and borrower country. In Columns 4 – 6 we aggregate by bank, quarter and domestic/foreign lending. *Domestic* is a binary variable, which is one if the nationality of the parent bank and the country of incorporation of the borrowing company coincide and zero otherwise. Significance levels are indicated by stars with *** p < 0.01, ** p < 0.05, * < 0.1.

Table 4.3.7: Effects of the G-SIB reforms on the pricing of tranches

VARIABLES	(1) Log(Margin (in bp))	(2) Log(Margin (in bp))	(3) Log(Margin (in bp))
Post2012 x GSIB	0.0874**	0.0727**	0.0359
	(0.0387)	(0.0351)	(0.0321)
Amount	0.0218***	0.0208***	0.0135***
	(0.00582)	(0.00552)	(0.00488)
Maturity	0.0460***	0.0502***	0.0519***
	(0.00699)	(0.00601)	(0.00642)
Rating	-0.149***	-0.141***	-0.137***
	(0.00619)	(0.00506)	(0.00512)
Secured	0.0270	0.00732	-0.00516
	(0.0219)	(0.0226)	(0.0227)
Observations	25,177	25,118	24,978
R-squared	0.656	0.748	0.827
Bank Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Quarter FE	Yes	No	No
Quarter x Borr-Country FE	No	Yes	No
Quarter x Borr-Country x Industry FE	No	No	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018	2010 - 2018
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr
Unit of Obs	Tranche x Bank	Tranche x Bank	Tranche x Bank
Nr. of Banks	119	119	118

Notes: Table 4.3.7 estimates the effect on charged interest rates. In Column 1 we include quarter FE, in Column 2 quarter-country FE and in Column 3 quarter-country-industry FE. Significance levels are indicated by stars with *** p < 0.01, ** p < 0.05, * < 0.1.

Table 4.3.8: Effects of the G-SIB reforms on the pricing sensitivity to risk

(a) Pricing Sensitivity to Risk

VARIABLES	(1) Log(Margin (in bp))	(2) Log(Margin (in bp))	(3) Log(Margin (in bp))
Post2012 x GSIB x Rating	0.0903***	0.0704**	0.0669**
	(0.0260)	(0.0347)	(0.0335)
Post2012 x GSIB		-0.0910**	-0.0891**
		(0.0419)	(0.0429)
Amount	0.0180***	0.0187***	0.0188***
	(0.00513)	(0.00555)	(0.00549)
Maturity	0.0494***	0.0497***	0.0495***
	(0.00638)	(0.00635)	(0.00634)
Secured	0.00989	0.00634	0.00589
	(0.0201)	(0.0200)	(0.0199)
Observations	24,349	24,349	24,557
R-squared	0.782	0.768	0.772
Bank Controls	No	Yes	Yes
Bank x Quarter FE	Yes	No	No
Rating x Country x Quarter FE	Yes	Yes	Yes
Bank x Rating x Country FE	Yes	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018	2010 - 2018
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr
Sample	Full	Condensed	Full
Unit of Obs	Tranche x Bank	Tranche x Bank	Tranche x Bank
Nr. of Banks	102	102	111

(b) Breakdown by Risk Segment

VARIABLES	(1) Log(Margin (in bp))	(2) Log(Margin (in bp))
Post2012 x GSIB	0.0937*	0.0227
	(0.0508)	(0.0330)
Amount	0.0326***	0.0133**
	(0.00900)	(0.00652)
Maturity	0.0253***	0.0611***
	(0.00725)	(0.00870)
Secured	0.110**	-0.0563**
	(0.0442)	(0.0249)
Rating	-0.139***	-0.112***
	(0.00892)	(0.00741)
Observations	8,635	16,425
R-squared	0.804	0.411
Bank Controls	Yes	Yes
Bank FE	Yes	Yes
Quarter x Country FE	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018
Clustering	Bank & Country x Quarter	Bank & Country x Quarter
Unit of Obs	Tranche x Bank	Tranche x Bank
Risk Segment	Safe	Risky
Nr. of Banks	91	93

Notes: Panel A estimates the effect on the pricing sensitivity to risk. *Rating* is our own-created, quartile-based rating variable. In Panel B we estimate the effect for a particular risk segment, where the safe segment includes all companies with a credit rating of BB+ or higher. The risky segment contains the respective bottom half of the credit ratings. Significance levels are indicated by stars with *** p < 0.01, ** p < 0.05, * < 0.1.

Table 4.3.9: Effects of the G-SIB reforms on the tranche maturity

VARIABLES	(1) Maturity	(2) Maturity	(3) Maturity	(4) Log(Maturity)	(5) Maturity
Post2012 x GSIB	0.0280	-0.00238	-0.0634	-0.0194	0.00952
	(0.125)	(0.0705)	(0.0515)	(0.0173)	(0.0691)
Amount	0.0169	0.0134	0.0573**	-0.00990	0.121***
	(0.0245)	(0.0241)	(0.0222)	(0.00610)	(0.0269)
Margin	0.00205***	0.00222***	0.00231***	0.000252**	0.00214***
	(0.000308)	(0.000305)	(0.000335)	(0.000101)	(0.000251)
Rating	-0.0583***	-0.0533***	-0.0685***	-0.0307***	
	(0.0172)	(0.0151)	(0.0153)	(0.00492)	
Secured	0.582***	0.481***	0.435***	0.110***	0.553***
	(0.0921)	(0.0909)	(0.0984)	(0.0311)	(0.0956)
Observations	25,177	25,118	24,978	24,978	63,935
R-squared	0.193	0.352	0.513	0.480	0.589
Bank Controls	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	No	No	No	No
Quarter x Borr-Country FE	No	Yes	No	No	No
Quarter x Borr-Country x Industry FE	No	No	Yes	Yes	Yes
Firms	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind	Priv Sec Ind
Time	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018	2010 - 2018
Clustering	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr	Bank & Ctr x Qtr
Unit of Obs	Tranche x Bank	Tranche x Bank	Tranche x Bank	Tranche x Bank	Tranche x Bank
Nr. of Banks	119	119	118	118	271

Notes: Table 4.3.9 estimates the effect on tranche maturities. In Column 1 we include quarter FE, in Column 2 quarter-country FE and in Column 3 quarter-country-industry FE. In Column 4 we use the logarithmized maturity (in yrs) as dependent variable. In Column 5 we omit the credit rating as control variable. Significance levels are indicated by stars with *** $p < 0.01$, ** $p < 0.05$, * < 0.1.

Appendix A: Web-based matching procedure

We have to deal with the 'classical' string match problem, where one particular bank just differs by its spelling. One example would be the public regulated Bavarian State Bank. While in Dealogic Loanware this bank is listed as "BayernLB", it is listed as "Bayerische Landesbank AöR" in SNL Financial. In addition, complex ownership structures and the existence of holdings can further complicate the matching (e.g. Dealogic Loanware provides syndicated loan data for NatWest Markets, which is the investment banking arm of The Royal Bank of Scotland (RBS), whereas in SNL Financial only information for RBS is available). In both cases traditional methods of fuzzy string matching would have limited results.

Therefore, we apply the following matching algorithm. In a first round we match banks by their punctuation-free names. This traditional method already leaves us with 441 matches. In further rounds, we match banks based on a common URL address. We collect the URLs of the top five hits when we run an internet search engine with the bank's name and look for cases where cleaned URL addresses coincide. We consider a bank pair as matched when at least one particular combination of the top five URLs matches. By applying several combinations we are able to match additional 250 banks. In a last step, all matches are checked for plausibility by hand.

Appendix B: Classification of credit risk

We divide the sample into four groups based on the borrower rating. We do this in a way that captures the underlying distribution of the official credit ratings, which is quite unevenly distributed across the S&P’s rating scale in our sample (e.g. 84% of all companies share a rating between B- and BBB+). We group companies with a credit rating of BBB+ or higher at the top quarter of the scale and they therefore share a rating of 4. The second safest group includes companies with a credit rating between BB+ and BBB is assigned a rating of 3. The next group includes companies with credit ratings between B+ and BB and are rated with 2. Companies with a credit rating worse than B+ are grouped in the first rating class. Below is an overview for how the observations are distributed over these four risk classes.

Distribution of Observations across Rating Class

	GSIB		Non-GSIB	
	before 2012	after 2012	before 2012	after 2012
Rating Class	Freq (Percent)	Freq (Percent)	Freq (Percent)	Freq (Percent)
1	913	6,185	155	1,886
	(16.46)	(22.35)	(14.78)	(27.78)
2	1,632	9,503	284	2,298
	(29.42)	(34.34)	(27.07)	(33.85)
3	1,560	6,305	367	1,564
	(28.12)	(22.78)	(34.99)	(23.04)
4	1,443	5,682	243	1,041
	(26.01)	(20.53)	(23.16)	(15.33)
Total	5548	27675	1049	6789

Note: this table illustrates the distribution of observations across the constructed rating scale for GSIBs (before/after 2012) and Non-GSIBs (before/after 2012) separately. Therefore columns sum up to 100%.

4.4. Systemic importance and complexity of SIBs

4.4.1. Introduction

This section describes the evolution of the number of G-SIBs' majority-owned subsidiaries over time. The number of subsidiaries is one measure of corporate complexity but unfortunately, the lack of consistent disclosure on banks' corporate structures makes it difficult to broaden the analysis, for example to include branches.

4.4.2. Methodological issues and caveats

Two important caveats are worth mentioning at the outset. First, although the number of subsidiaries is arguably a relevant factor when assessing corporate complexity, as a more complex (and potentially opaque) web of subsidiaries can make supervision more difficult ex-ante and can make crisis management particularly challenging ex-post, as shown by the Lehman Brothers bankruptcy, it is not the only relevant factor.[99] For example, separate from this "organisational complexity" (i.e. the number of separate legal entities), "business complexity" (i.e. the scope and concentration of activities and products) is also important to

99 The disorderly failure of Lehman Brothers was exacerbated by the complexity of its corporate structure, comprising hundreds of legal entities, the interconnections among those group entities, the lack of adequate information on how lines of business mapped into legal entities the breadth of Lehman's counterparty connections, and the complexity of the products that the company owned. Geographical dispersion added to complexity, as Lehman Brothers had subsidiaries all around the globe, creating formidable coordination challenges among the different authorities involved across different jurisdictions. The complexity of its corporate structure contributed to the disorderly failure of Lehman Brothers and to the ensuing systemic spillovers. When considering the number of subsidiaries of Lehman Brothers, it was not even one of the most complex financial institutions at that time, suggesting that problems might have been further magnified if another, even more complex financial institution had failed. On corporate complexity and the Lehman Brothers failure, see Carmassi and Herring (2015).

consider when assessing complexity. Possible indicators of business complexity include, for example, the combination of bank, non-bank and non-financial activities, differences in funding models (e.g. reliance on local or foreign funding), interconnections and interdependencies between different entities within a group, such as shared services relied on by the group for purposes of continuing critical operations in resolution; or the number of business industries in which subsidiaries operate. Geographical complexity, e.g. the number of countries in which a G-SIB operates, also matters.[100]

A second caveat is that measuring the number of G-SIB subsidiaries presents significant data challenges. The analysis below relies on a dataset provided from a private vendor, Bureau Van Dijk (BvD). For US G-SIBs, this analysis leads to different conclusions than data available through the US National Information Center (NIC)/Federal Reserve data. Overall, any attempt to summarise corporate structures with a single number involves assumptions and some degree of judgment. However, corporate complexity remains relevant.

The numbers on corporate complexity presented in this note refer to majority-owned subsidiaries only, which are those for which a G-SIB is the ultimate owner with a minimum control path of 50.01% in each node of the control chain. Before analysing the data, it is useful to highlight three important methodological issues. First, the approach used to determine control can be regarded as conservative, as control can be exercised with lower ownership levels: applying a lower threshold to define control, e.g. 25%, could increase the count of subsidiaries.

Second, it is also important to note that the universe of subsidiaries covered includes entities active in a wide range of business, spanning from banking to insurance, from funds to vehicles and also to non-financial firms (e.g. real estate, energy, etc.). As shown in Section 4.4.3, the share of subsidiaries active in the banking business is quite low (5%), as well as the share of insurance subsidiaries (1%) – this should be kept in mind when analysing numbers and trends on the overall number of subsidiaries. Most subsidiaries are involved in other financial businesses or in non-financial business. However, this does not mean that G-SIBs are primarily involved in these businesses, because the count of legal entities does not necessarily convey information on their importance within a group. Unfortunately, the lack of sufficient public disclosure makes it difficult to develop a systematic analysis of the financials of the non-banking and non-insurance subsidiaries.

Third, branches also matter for corporate complexity,[101] but information on branches is much more fragmented and difficult to obtain in a systematic way than the information on subsidiaries (see Appendix for a general discussion on data challenges).[102] As a consequence, the analysis

[100] Bonfim and Félix (2019) showed that corporate and geographical complexity are positively associated with banks' risk-taking; Bussierey, Meunierz and Pedronox (2019) found that corporate and geographical complexity increases risk and the cost of equity.

[101] In particular, foreign branches may be relevant for resolution purposes if the host authority decides to ring-fence and treat a foreign branch as a subsidiary.

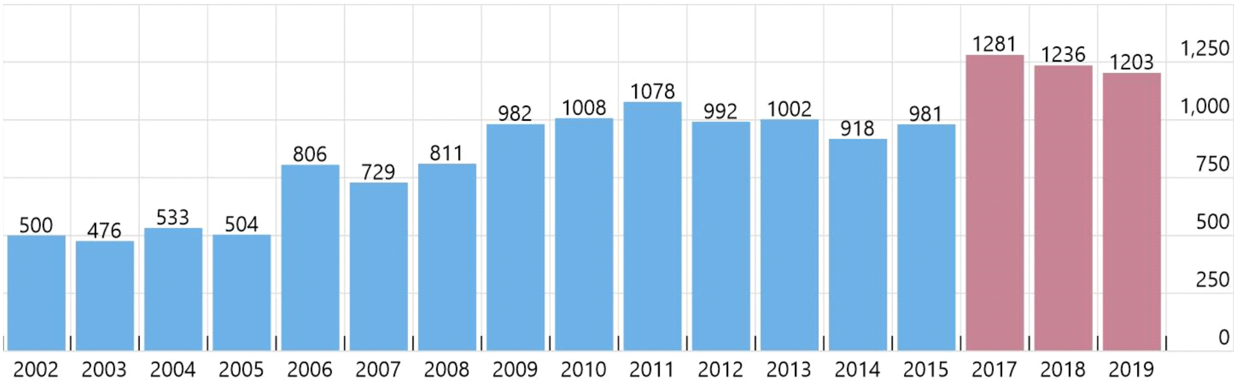
[102] It should be noted that the number of legal entities or branches might overestimate corporate complexity to the extent that some of them might not be material from a supervision or resolution angle. The overall number of subsidiaries and branches could therefore be adjusted by excluding those entities that would not pose any significant threat to effective supervision and resolution. Furthermore, the number of subsidiaries alone cannot catch some important additional information such as the interconnections between different entities within a group, or the mapping of business lines into legal entities, or the effectiveness of within-group arrangement to protect and ensure the continuity of critical functions and services. Unfortunately,

in this section is focused on subsidiaries only and not on branches, because of a lack of data. Additionally, requirements in certain jurisdictions to operate via subsidiaries rather than branches could in principle lead to a shift from branches to subsidiaries, which however should not be necessarily and per se interpreted as increasing the corporate complexity of G-SIBs. Unfortunately, it is challenging to quantify the magnitude of this potential effect, given current data availability.

4.4.3. Empirical analysis

Turning to data analysis, the corporate complexity of G-SIBs, measured according to the number of majority-owned subsidiaries based on the Bureau Van Dijk (BvD) dataset, significantly increased in the run-up to the 2008 global financial crisis and in the following years until 2011. Figure 4.4.1 displays the evolution in the average number of majority-owned subsidiaries of G-SIBs between 2002 and 2019, based on data from a private vendor, BvD.

Number of majority-owned subsidiaries of G-SIBs (2002-2019) **Figure 4.4.1**



Notes: Sample of 29 banking groups designated as G-SIBs by the FSB in November 2013. Data refer to a specific month for each year. Data for 2016 are missing as they were not collected during that year and only current data can be retrieved from BvD for each point in time. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain. Orange bars for 2017, 2018 and 2019 indicate years for which Bureau van Dijk data were based on an expanded data coverage for US banks.

Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Notes: sample of 29 banking groups designated as G-SIBs by the FSB in November 2013. Data refer to a specific month for each year. Data for 2016 are missing as they were not collected during that year and only current data can be retrieved from BvD for each point in time. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain. Orange bars for 2017, 2018 and 2019 indicate years for which Bureau van Dijk data were based on an expanded data coverage for US banks. Source: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

This average rose from 500 in 2002 to 1,078 at year-end 2011. Several crisis-related acquisition deals contributed to further increase corporate complexity during the crisis, and it took some years to slightly reverse that trend.[103] Starting in 2017, the average number of subsidiaries increased again, mostly due to a significant increase for US G-SIBs in the data reported by BvD, due to an expansion in the source of information/coverage on subsidiaries for US banks. The FED/NIC data, however, show a decrease in the number of subsidiaries. Unfortunately, publicly available data are not sufficient to reconcile the two sources, as

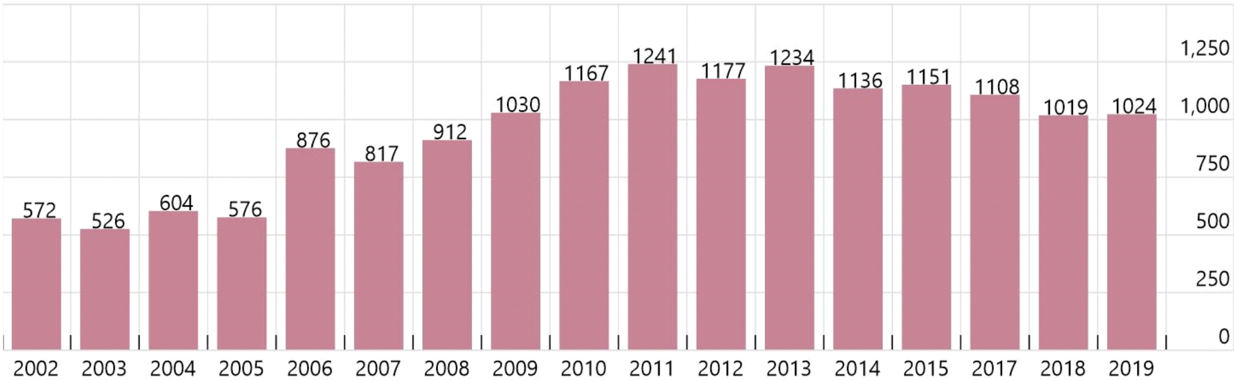
much of this additional information is difficult to collect, and in a consistent/systematic way. In any case, notwithstanding all these caveats and qualitative limitations, the number of subsidiaries remains a relevant factor affecting bank corporate complexity.

[103] Carmassi and Herring (2016) found that large M&A deals tend to have a persistent and significant impact on corporate complexity, while mere size tends to lose significance when time effects are considered.

discussed below. As of November 2019, the average number of majority-owned subsidiaries for the sample of G-SIBs was 1,203 (with significant heterogeneity across institutions, with a maximum of 3,649 and a minimum of 89).

Figure 4.4.2 shows the average number of majority-owned subsidiaries for European G-SIBs, indicating a 21% reduction as of November 2019 relative to the peak of December 2011. Post-crisis regulatory measures, including the resolution planning process, are likely to have played a role in reducing corporate complexity, for example by pushing banks to simplify their structures in order to facilitate effective resolution – however, complexity remains overall still quite high. Figure 4.4.3 displays the average number of majority-owned subsidiaries for the Japanese and Chinese G-SIBs: this number is much lower than for US and European G-SIBs, although it has doubled over the last ten years.

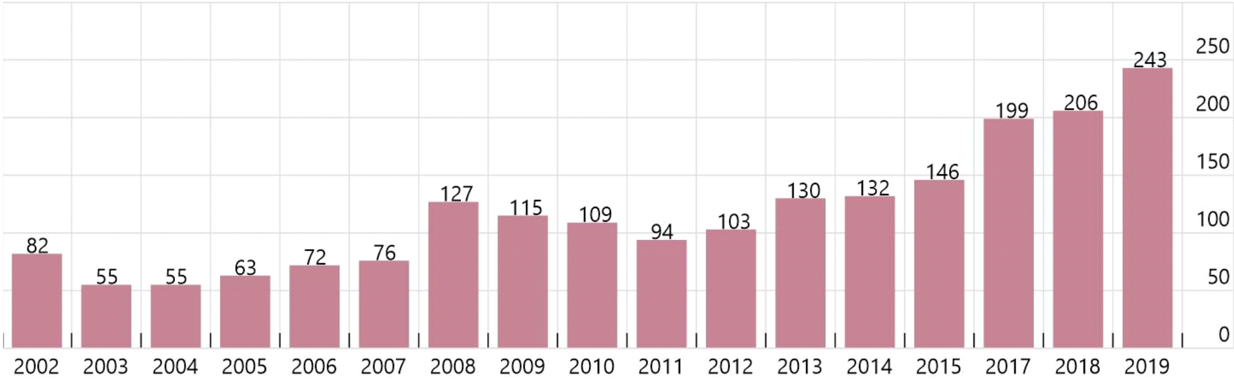
Number of majority-owned subsidiaries of European G-SIBs (2002-2019) **Figure 4.4.2**



Notes: G-SIBs in the sample are Barclays, BBVA, BNP Paribas, BPCE SA, Crédit Agricole SA, Credit Suisse, Deutsche Bank, HSBC, ING, Nordea, Royal Bank of Scotland, Santander, Société Générale, Standard Chartered, UBS, Unicredit. Data refer to a specific month for each year. Data for 2016 are missing as they were not collected during that year and only current data can be retrieved from BvD for each point in time. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain.

Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Number of majority-owned subsidiaries of Asian G-SIBs (2002-2019) **Figure 4.4.3**



Notes: G-SIBs in the sample are Bank of China, ICBC, Mitsubishi UFJ, Mizuho, Sumitomo Mitsui. Data refer to a specific month for each year. Data for 2016 are missing as they were not collected during that year and only current data can be retrieved from BvD for each point in time. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain.

Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Figure 4.4.4 shows the average number of majority-owned subsidiaries of US G-SIBs, based on the BvD dataset. The abrupt increase that is observable for 2017 is due to a data discontinuity: BvD expanded their source of information for the coverage of subsidiaries for US banks only, which resulted in a significant increase in the number of majority-owned subsidiaries of US G-SIBs. This could imply that the BvD number of majority-owned subsidiaries could have been higher until 2015, if the same broader coverage had been applied also in previous years. However, it is not possible to confirm this nor to estimate the magnitude of this possible effect. On the other hand, the number of subsidiaries according to the National Information Center public dataset shows a continuous trend of significant reduction since the global financial crisis, with a 51% decrease between 2009 (2,333) and 2019 (1,134). Figure 4.4.5 offers a comparison of BvD and FED/NIC data. The latter show a jump in 2008 because Goldman Sachs and Morgan Stanley (both having a relatively high number of subsidiaries) became Bank Holding Companies and only then started to be covered by Fed/NIC data – before this, the dataset did not cover these two G-SIBs as they were not under Fed supervision.

Number of majority-owned subsidiaries of US G-SIBs (2002-2019) **Figure 4.4.4**

Notes: G-SIBs in the sample are Bank of America, Bank of New York Mellon, Citigroup, Goldman Sachs, JPMorgan Chase, Morgan Stanley, State Street Corporation, Wells Fargo. Data refer to a specific month for each year. Data for 2016 are missing as they were not collected during that year and only current data can be retrieved from BvD for each point in time. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain. Orange bars for 2017, 2018 and 2019 indicate years for which Bureau van Dijk data were based on an expanded data coverage for US banks.

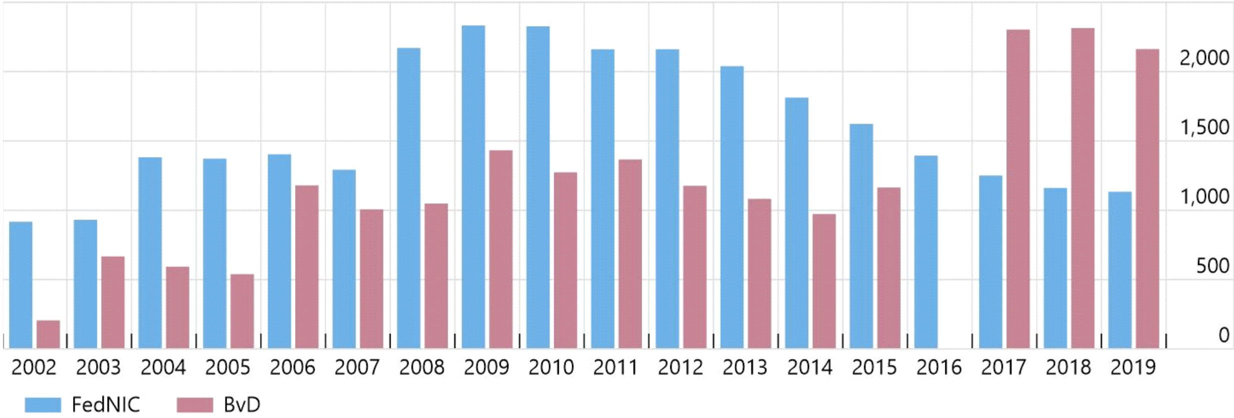
Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

A key difference between the two datasets is the definition of control. For the Fed/NIC data, the definition of control in Regulation Y applies, which is basically a 25% threshold for control. The BvD dataset allows using either a 25% or a 50% threshold: all numbers displayed in this section are based on the 50% threshold, which is applied at each node in the control chain, i.e. subsidiaries are considered to be majority-owned only if the control path from the parent/holding to the subsidiaries is above 50% in each node of the control chain. The higher threshold of control used for BvD data could explain, at least in part, why BvD data are much lower than FED/NIC data until 2017, when BvD increased the coverage for US banks. However, the comparison is made difficult by the fact that the Fed/NIC data also include entities that meet FR Y-10/10F "reportability criteria", as well as entities for which the relationship is "of interest to the Federal Reserve". Based on the available information, it is difficult to fully understand the implications of the use of these additional criteria.

Finally, it is important to stress that the Fed/NIC dataset covers only US banks and US operations of non-US banks. Therefore, it cannot be used for a comprehensive and systematic coverage of all G-SIBs. On the other hand, the BvD dataset offers a worldwide coverage, and therefore it seems particularly useful for a systematic analysis of G-SIBs.

Number of majority-owned subsidiaries of US G-SIBs according to BvD and FED/NIC dataset (2002-2019)

Figure 4.4.5



Note: G-SIBs in the sample are Bank of America, Bank of New York Mellon, Citigroup, Goldman Sachs, JPMorgan Chase, Morgan Stanley, State Street Corporation, Wells Fargo. For BvD, data refer to a specific month for each year (see Figures 1-4); BvD data for 2016 are missing as they were not collected during that year and only current data can be retrieved from BvD for each point in time. FED/NIC data displayed in the Figure all refer to yearend. For BvD data, majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain. For FED/NIC data, the definition of control under Regulation Y, which is essentially a 25% control, applies. However, additional entities that meet FR Y-10/10F "reportability criteria" are included, as well as entities for which the relationship is "of interest to the Federal Reserve".

Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Majority-owned subsidiaries of G-SIBs: geographical complexity over time

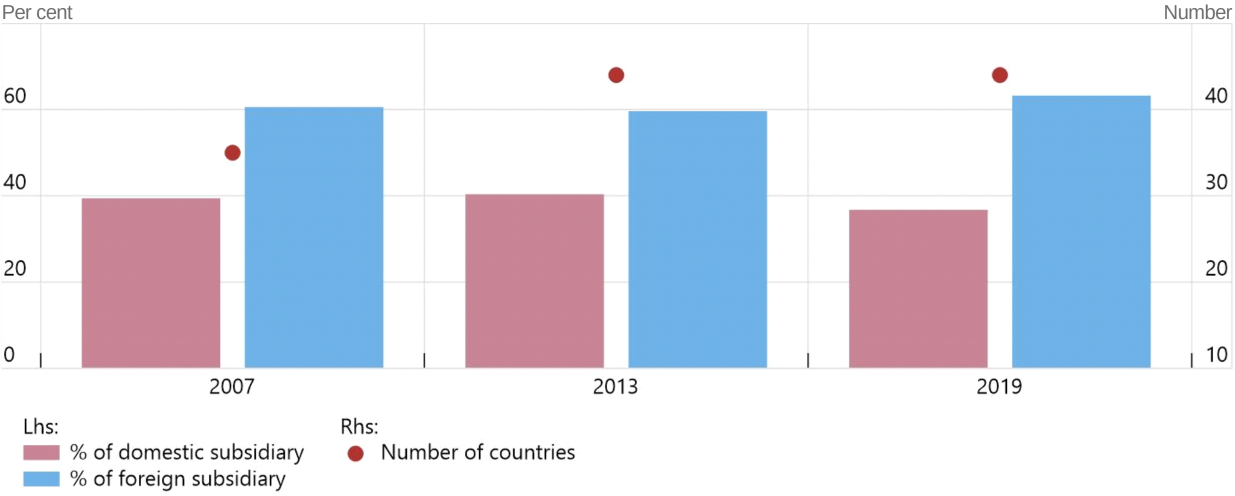
The geographic diversification in the corporate structure also matters for complexity, both for supervision and resolution. For example, a bank with 1,000 subsidiaries all located in its home jurisdiction might be different, from a corporate complexity perspective, from a bank with 1,000 subsidiaries located in 90 different jurisdictions around the globe.[104] Figure 4.4.6 shows several key metrics of geographical complexity of G-SIBs' subsidiaries for three points in time: 2007, i.e. just before the global financial crisis; 2013, i.e. five years after the crisis; and 2019, i.e. eleven years after the crisis. On average, as of November 2019 G-SIBs were present with subsidiaries in 44 different jurisdictions, with maximum of 83 (Citigroup) and a minimum of 15 (Nordea). The average number of jurisdictions has not changed relative to 2013, where the average was also 44, but has increased relative to 2007, when the number was 35. This seems to indicate a trend of further geographical complexity after the crisis – although it should be stressed that the number of majority-owned subsidiaries is only one indicator of such complexity and other geographical metrics could be used. Additionally, it could also be argued that geographical expansion could be conducive to potential benefits of geographical diversification, i.e a better capacity of banks to withstand local or global shocks (as found by Aldasoro, Hardy and Jager, 2019).[105] However, an increase in the number of jurisdictions where a G-SIB operates is still likely to add complexity to both supervision and resolution, for example in case this entails an increase the number of host authorities involved in supervision

[104] Of course, the number of majority-owned subsidiaries is only one metric to assess geographical complexity and other metrics also matter, for example the materiality of subsidiaries and the type of businesses activities performed.

[105] Marinelli, Nobili and Palazzo (2019) found that more geographically complex banks pursue ex-ante more cautious lending standards.

and resolution; [106] or, as found by Aldasoro, Hardy and Jager (2019), geographical complexity may be exploited to circumvent the tightening of prudential regulation.

Geographical complexity of G-SIBs, before and after the global financial crisis **Figure 4.4.6**



Notes: sample of 29 banking groups designated as G-SIBs by the FSB in November 2013. Data refer to November or December 2007, May 2013 and November 2019. BPCE and Bank of New York Mellon are not included for 2007, respectively because BPCE was formed in 2009 and because of data unavailability. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain.

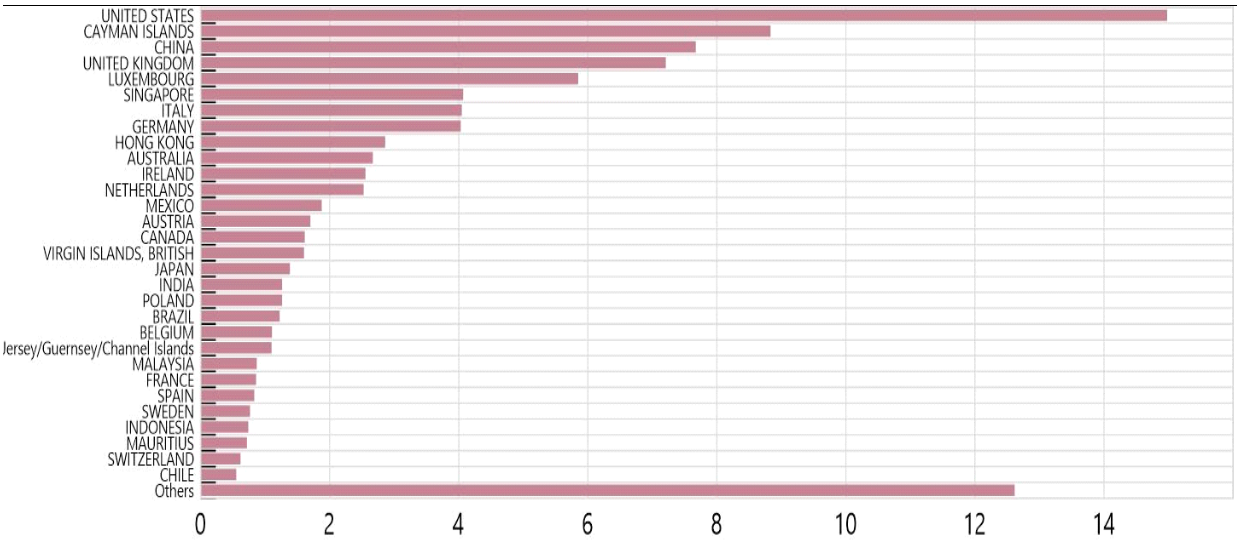
Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Turning to the average share of foreign subsidiaries of G-SIBs, Figure 4.4.6 shows that such share is quite stable over time at about 60%. However, this share is very heterogeneous across G-SIBs: for example, as of November 2019 over 90% of the subsidiaries of Credit Suisse, Nordea, Standard Chartered and UBS were incorporated elsewhere, while BNP Paribas, HSBC and Mitsubishi UFJ had over 80% of foreign subsidiaries. On the other hand, some G-SIBs have a predominant share of domestic subsidiaries (e.g. Bank of America: 83%; Wells Fargo: 93%). Finally, for some G-SIBs the share of domestic and foreign subsidiaries is balanced (e.g. Goldman Sachs: 50% domestic vs 50% foreign; Citigroup: 52% domestic vs 48% foreign).[107]

[106] This partly motivates the inclusion of the cross-jurisdictional indicators in the international G-SIB framework.

[107] See Carmassi and Herring (2019) for additional bank by bank data on the corporate structures of G-SIBs.

Geographical distribution of foreign majority-owned subsidiaries of G-SIBs, November 2019, % by country/jurisdiction **Figure 4.4.7**



Notes: foreign subsidiaries of the sample of 29 banking groups designated as G-SIBs by the FSB in November 2013. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain.

Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Figure 4.4.7 shows the distribution of foreign majority-owned subsidiaries of G-SIBs. The country with the highest number is the Unites States, with a share of 15% of the total (2,739 entities). The thirty jurisdictions displayed in the figure account overall for 87% of all G-SIBs' foreign subsidiaries, and each of them has at least 100 subsidiaries of foreign G-SIBs established in its territory. Some of the jurisdictions shown in Figure 4.4.7 are included in lists of Offshore Centres/tax havens. Together with regulation, taxation is likely to be one of the external factors driving the choice of G-SIBs to set up a high number of subsidiaries. [108]

Majority-owned subsidiaries of G-SIBs: industry breakdown over time

Figure 4.4.8 provides information on the breakdown of G-SIBs' majority-owned subsidiaries by industry. The industry breakdown is based on the classification offered by the BvD dataset (with some minor adjustments, see note to Figure 4.4.7). The points in time considered are the same used for the analysis of geographical complexity above, i.e. 2007, 2013 and 2019. The average share of bank and insurance subsidiaries is quite low for all the points in time considered, respectively 5% and 1%/2%. The category including mutual and pension funds, nominees, trusts and trustees account for around 20% of the total in all three points in time, while the category including other financial subsidiaries decreased from close to 30% in 2007 and 2013 to 16% in 2019; conversely, the share of non-financial subsidiaries, which was already well above 40% in 2007 and 2013, increased up to 57% as of November 2019.[109]

[108] See Goldberg and Meehl (2020) and Carmassi and Herring (2019) for data on subsidiaries in Offshore Centres/low tax jurisdictions.

[109] The relevance of the number of non-financial subsidiaries was identified by several studies including Herring and Carmassi (2010), Avraham, Selvaggi and Vickery (2012) and Cetorelli and Goldberg (2014). Goldberg and Meehl (2020) found that US Bank Holding Companies have on average 40% of their subsidiaries engaged in non-financial business, with a strong role of

It should be stressed that the number of subsidiaries per se cannot provide exhaustive information on the business of a bank: in fact, banking subsidiaries tend generally to hold most of the assets of each G-SIB, despite being relatively few in terms of number of entities.[110] Unfortunately, for a vast part of the subsidiaries, the financials or total assets are not available or easily retrievable – which makes it challenging to develop a fully-fledged and consistent analysis of the relevance of the various types of subsidiaries across G-SIBs, including for the non-financial subsidiaries.

With regard to non-financial subsidiaries, there can be several possible drivers for their proliferation:

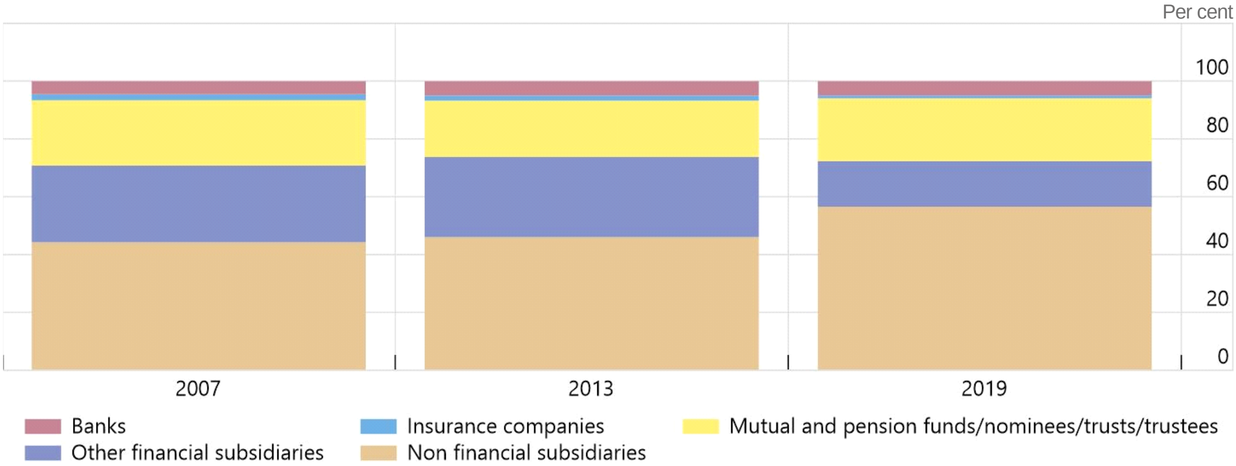
- first, it may be the result of an acquisition of a non-financial corporation which in turn owns many subsidiaries;
- second, non-financial subsidiaries could be set up to mitigate litigation risk: for example in case of a foreclosure on a property, e.g. a hotel, the latter may be decomposed into multiple separate entities (e.g., one for the garage, one the swimming pool, etc.) to prevent a lawsuit against one entity from jeopardizing the viability of other parts of the hotel complex or creating a financial burden for the parent (Carmassi and Herring, 2015),
- third, non-financial subsidiaries may be related to fiduciary services offered by one or more subsidiaries of the group – in which case they should be excluded from the count of subsidiaries of the G-SIB, because most likely these entities will not pose risks or challenges in supervision and resolution. Unfortunately, disentangling these subsidiaries in a systematic, comprehensive and consistent way is not feasible with the current disclosures and datasets (Carmassi and Herring, 2019).
- Fourth, the establishment of separate entities providing key services and critical functions to the group (e.g. IT services) may drive the number of subsidiaries, but on this issue as well it is challenging to identify these subsidiaries systematically (although the public section of resolution plans in the US provide useful information in this regard). It can be argued, anyway, that the setting up of this type of subsidiaries could indeed facilitate the operations and the possible resolution of a G-SIB.

real estate activities. Bonfim and Félix (2019) found, for a sample of Portuguese banks, that on average the number of non-bank affiliates of systemically important banks is more than four times higher than for non-systemically important banks. They also found, more broadly, that systemically important banks are more complex that non-systemically important banks; a similar result was obtained for French banks by Bussierey, Meunierz and Pedronox (2019).

[110] Avraham, Selvaggi and Vickery (2012) showed, for US Bank Holding Companies, that indeed most of the assets are concentrated in banking entities, although non-financial subsidiaries represent a relevant share in terms of number of entities.

Breakdown by industry of subsidiaries of G-SIBs, before and after the global financial crisis

Figure 4.4.8



Notes: sample of 29 banking groups designated as G-SIBs by the FSB in November 2013. Data refer to December 2007, May 2013 and November 2019. Due to data availability, the sample for 2007 includes 13 banking groups. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain. 'Other financial subsidiaries' include hedge funds, private equity and venture capital subsidiaries. 'Non-financial subsidiaries' include "all companies that are neither banks nor insurance companies nor financial companies. They can be involved in manufacturing activities but also in trading activities (wholesalers, retailers, brokers, etc.)" (BvD definition). Foundations and research institutes have been allocated to this category as well.

Sources: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

Notes: sample of 29 banking groups designated as G-SIBs by the FSB in November 2013. Data refer to December 2007, May 2013 and November 2019. Due to data availability, the sample for 2007 includes 13 banking groups. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each node of the control chain. 'Other financial subsidiaries' include hedge funds, private equity and venture capital subsidiaries. 'Non-financial subsidiaries' include "all companies that are neither banks nor insurance companies nor financial companies. They can be involved in manufacturing activities but also in trading activities (wholesalers, retailers, brokers, etc.)" (BvD definition). Foundations and research institutes have been allocated to this category as well. Source: Carmassi and Herring on Bankscope, Orbis and BankFocus data.

In general, it may difficult to fully understand the implications of the proliferation of non-financial subsidiaries, as this depends on their nature and on a number of information which are hardly available, for example of their interconnections within a banking group and on the possible spillovers on other entities of the group. In principle, all the four cases described above might be not problematic, but in practice more information would be needed to be able to make a robust assessment. Overall, better disclosures and future research might be helpful to shed more light on the relevance of non-financial subsidiaries within G-SIBs.

4.4.4. Conclusions

This section provides an overview of the corporate complexity of G-SIBs, with a focus on the number of majority-owned subsidiaries. Of course, the number of subsidiaries and the share of subsidiaries across jurisdictions and across business sectors are only some of the factors that may influence corporate complexity; others include the structure of the groups, the number of business lines and their mapping into legal entities, and intragroup interdependencies. However, while the number of subsidiaries is not the only relevant metric when assessing organisational complexity, and G-SIBs' complexity more broadly, it remains an important measure. Everything else being equal, a more complex web of subsidiaries can jeopardise effective supervision and resolution of a G-SIB. The lack of sufficient and consistent disclosure makes it challenging to broaden the analysis, for example to include branches – on which the available information across banks is not systematic nor consistent.

The evidence shown in this section indicates that G-SIBs are on average highly complex when it comes to their number of majority-owned subsidiaries. Such complexity increased significantly in the run-up to the 2008 global financial crisis, but showed some reduction after the crisis, probably also thanks to post-crisis measures (e.g. legal entities rationalisation requested by authorities). However, the number of subsidiaries remain overall quite high. The geographical complexity and the business complexity, measured again on the basis of the count of majority-owned subsidiaries, were also very high before the crisis and have remained high.

The lack of sufficient disclosures impedes to develop deeper analyses on some open issues, including branches but also several other elements related to subsidiaries: these include, among others, the interconnections between subdsidiaries within a banking group, the mapping of business lines into legal entities and the information on the entities providing critical services to the rest of the group. Although the public sections of resolution plans of banks operating in the US provide useful information on these elements, it is extremely challenging – and hardly feasible – to carry out a systematic and consistent analysis across G-SIBs.

Furthermore, while there is anecdotal evidence that G-SIBs in some jurisdictions have made substantial progress in rationalising their corporate structures, measuring such progress in a consistent or systematic way is very difficult. Enhanced transparency as well as consistent methodologies would help to improve the understanding and the assessment of the corporate structure of G-SIBs.

4.4.5. Appendix

Data challenges with respect to information on G-SIB subsidiaries / branches

The challenges related to data collection on bank corporate complexity appear very significant, at least on the basis of current disclosure and publicly available information. Starting with the simplest type of information, the number of subsidiaries and branches, currently there is no official/public dataset providing comprehensive and systematic information and in a consistent way for all banks across different jurisdictions. The only dataset offering comprehensive data for all banks, and with a consistent methodology, is provided by a private vendor (Bankscope in the past, then Orbis and BankFocus, all produced by Bureau van Dijk). These data are extremely detailed and are likely to be the best source currently available – however they also present some shortcomings: the dataset does not allow retrieving historical series, and much information including on basic financials of subsidiaries (e.g. total assets) is missing, not because the dataset does not report those data but because in most cases those data are simply not available. Additionally, while the dataset provides very detailed information on the corporate hierarchy and the chain of control as well as on the industry/business of each subsidiary, it is hard - where possible at all - to extract meaningful information on interconnections, on the provision of critical services and functions, on the mapping of business lines into legal entities. Finally, while the dataset does also provide information on branches, the lists of branches do not seem to be complete.

Other datasets provide less useful information, either because the data/subsidiaries coverage is narrower, or because the geographical scope is limited, as in the case of the publicly available NIC dataset. This dataset is focused on US banks and on US operations of non-US banks and therefore it cannot be used meaningfully for non-US banks. Additionally, the data for US G-SIBs can be substantially different from those provided by BvD, but publicly available information is not sufficient to reconcile the two sources.

Information and data on other elements relevant for corporate complexity other than the number of subsidiaries and branches pose even bigger challenges. Public disclosure on elements such as within group interconnections, mapping of business lines into legal entities or on the provision of critical services/functions is currently quite limited and fragmented. To date, only the US has introduced a requirement for a public section of the resolution plans, which contain useful information to help the market understand key factors regarding the resolvability of banks. While the UK has also recently taken preliminary steps in this direction, this is not the case for other jurisdictions.

5. Broader effects of reforms

5.1. Global banking network: evolution of the structure of the financial system

5.1.1. Introduction

In this section, we replicate the analysis of the Global Banking Network (GBN) performed by Minoiu and Reyes (2013) extending the period analysed to 2018 (instead of 1978-2010). We also extend their analysis by considering additional alternatives on how the core-periphery web is defined. It is difficult to attribute changes in the GBN to specific TBTF reforms, however analysing time series indicators of network connectivity helps identifying changes in patterns during the post reform period. The main finding is that network indicators reached peak values at the onset of the financial crisis. After a sharp drop, they have now returned to or surpassed their pre-crisis levels.

5.1.2. Description of the data

The data for analysis comes from the BIS Locational Banking Statistics (LBS), which contains cross-border lending of banks (both SIBs and non-SIBs) domiciled in the BIS reporting countries,[111] channelled through the banking system, and aggregated at the country level (Wooldridge, 2002). These cross-border lending data include loans, deposits, debt securities, and other bank assets. We update Minoiu and Reyes (2013) by considering cross-border bank claims from 1978 to 2018, rather than 2010 as in the original study. Cross-border flows are estimated as changes in cross-border stocks and are adjusted for fluctuations in exchange rates.[112]

[111] BIS reporting countries are defined as countries in which an authority participates in a BIS-organised data collection. Reporting countries are contained in the website: www.bis.org/statistics/rep_countries.htm.

[112] The adjusted change approximates the flow between two points in time. In the LBS, the adjusted change is calculated by first converting US dollar-equivalent amounts outstanding into their original currency using end-of-period exchange rates, then calculating the difference in amounts outstanding in the original currency, and finally converting the difference into a US dollar-equivalent change using average period exchange rates.

We focus on flows from 12 BIS reporting countries ("core" countries) to these same countries and other 195 jurisdictions ("periphery" countries). These core countries are advanced economies which have been reporting cross-border positions since 1978. Each year is treated as a separate network. The links in the network are flows between countries, after repayments have been considered. Only positive cross-border banking flows are considered; negative flows are ignored (i.e., replaced with zeros).[113]

5.1.3. Empirical analysis

We compute *network connectivity*, a measure of network density. It is defined as the ratio of links observed over the total possible number of links in the network, representing the likelihood of a connection between two countries picked at random. *Node degree* is the number of links that correspond to each node. *Out-degree* is defined as the number of outgoing links from the lender country perspective, and *in-degree* as the number of incoming links from the borrower country perspective.

Binary clustering is defined as the ratio between the number of triangles with a given flow pattern among countries that the node actually forms and the total possible number of the same pattern that the node can form.[114] In addition, the *node Herfindahl-Hirschmann Index* (HHI) allows us to assess concentration or diversification of a given jurisdiction (nodes) lending and borrowing activities. The sum of a borrower's squared share in each lender's total outflows is defined as *out-HHI*, in contrast, *in-HHI* is defined as the sum of a lender squared share in each borrower total inflows. Higher concentration in lender and borrowing (in-HHI and out-HHI) may rise potential risks associated with a node (Martínez-Jaramillo et al., 2011).

In order to account for the weight of the links, we computed *node strength*, defined as the total value of flows a node holds. It depends on the direction of the link. *Out-strength* is the total amount of cross-border flows a country lends, and *in-strength* in a node is the total amount of flows a country borrows. W*eighted clustering* is defined as the binary clustering ratio times the size of the flows of the triangle.

5.1.4. Results

Table 5.1.1 shows descriptive statistics and network indicators for selected years: a few years before the crisis (2000), just before the financial crisis (2007), and at the end of our sample. The panels show three different interactions: full network, core-periphery network, and core-core network.

In order to account for the weight of the links, we computed *node strength*, defined as the total value of flows a node holds. It depends on the direction of the link. *Out-strength* is the total amount of cross-border flows a country lends, and *in-strength* in a node is the total amount of

[113] The 12 BIS reporting countries included are: Belgium, Denmark, France, Germany, Ireland, Japan, Luxembourg, Netherlands, Sweden, Switzerland, the United Kingdom and the United States. Minoiu and Reyes (2013) had access to a larger dataset (not publicly available) including Austria, Canada, and Italy.

[114] The binary clustering indicator depends on the network that is being analysed. For the core-core network, a triangle is made of bi-directional links among three nodes (countries) a-b-c; for the core-periphery we use two core countries and one periphery, such that the core countries have a uni/bi-directional relationship and both lend the periphery country (a-b-c) with countries a and b part of the core and c on the periphery

flows a country borrows. W*eighted clustering* is defined as the binary clustering ratio times the size of the flows of the triangle.

Table 5.1.1. Summary Statistics

SUMMARY STATISTICS																
		2000					2007					2018				
FULL NETWORK																
	Units	**Mean**	**Median**	**S.D**	**Min**	**Max**	**Mean**	**Median**	**S.D**	**Min**	**Max**	**Mean**	**Median**	**S.D**	**Min**	**Max**
Density	[0,1]	0.016					0.022					0.021				
In-degree	#links	3.74	3.00	2.24	1.00	10.00	5.00	5.00	2.81	1.00	12.00	4.58	4.00	2.09	1.00	11.00
Out-degree	#links	55.50	53.50	24.39	10.00	95.00	78.33	80.00	22.76	30.00	107.00	75.50	74.50	32.63	20.00	139.00
In-strength	USD bn	4.92	0.05	25.00	0.00	2603.70	13.19	0.16	67.30	0.00	813.12	11.43	0.10	111.04	0.00	1551.99
Out-strength	USD bn	73.05	76.43	38.16	8.86	146.38	206.57	196.64	94.22	90.13	469.82	188.60	215.97	125.65	22.55	355.09
In-HHI	[0,1]	0.52	0.49	0.31	0.00	1.00	0.49	0.45	0.29	0.00	1.00	0.58	0.53	0.28	0.00	1.00
Out-HHI	[0,1]	0.30	0.33	0.16	0.13	0.68	0.29	0.27	0.14	0.09	0.55	0.48	0.36	0.25	0.10	0.78
Binary clustering	[0,1]	0.43	0.00	0.02	0.00	0.31	0.72	0.00	0.01	0.00	0.14	0.79	0.00	0.01	0.00	0.08
CORE-PERIPHERY NETWORK																
	Units	**Mean**	**Median**	**S.D**	**Min**	**Max**	**Mean**	**Median**	**S.D**	**Min**	**Max**	**Mean**	**Median**	**S.D**	**Min**	**Max**
Density	[0,1]	0.01					0.02					0.02				
In-degree	#links	3.58	3.00	2.14	1.00	10.00	6.54	6.00	3.37	1.00	13.00	7.90	8.00	3.24	1.00	14.00
Out-degree	#links	49.50	46.00	23.83	5.00	38.83	52.79	47.00	30.10	1.00	95.00	64.86	71.50	33.05	3.00	106.00
In-strength	USD bn	1.13	0.04	3.78	0.00	27.31	0.91	0.06	4.17	0.00	40.63	0.56	0.07	1.55	0.00	9.92
Out-strength	USD bn	15.67	7.65	16.43	1.60	46.89	7.31	5.57	6.29	0.35	21.27	4.61	3.10	4.34	0.14	13.35
In-HHI	[0,1]	0.53	0.50	0.31	0.00	1.00	0.50	0.46	0.29	0.00	1.00	0.59	0.54	0.28	0.00	1.00
Out-HHI	[0,1]	0.20	0.15	0.11	0.09	0.42	0.15	0.13	0.07	0.06	0.28	0.28	0.21	0.15	0.08	0.57
CORE-CORE NETWORK																
	Units	**Mean**	**Median**	**S.D**	**Min**	**Max**	**Mean**	**Median**	**S.D**	**Min**	**Max**	**Mean**	**Median**	**S.D**	**Min**	**Max**
Density	[0,1]	0.545					0.697					0.561				
In-degree	#links	6.00	6.50	2.45	2.00	9.00	7.67	7.50	1.97	5.00	11.00	6.17	6.00	2.41	3.00	11.00
Out-degree	#links	6.00	6.00	1.60	3.00	9.00	7.67	8.00	1.50	5.00	10.00	6.17	5.50	2.48	3.00	10.00
In-strength	USD bn	57.38	25.94	81.36	1.51	260.37	159.53	66.61	225.37	8.82	813.12	165.45	20.29	439.22	2.38	1551.99
Out-strength	USD bn	57.38	56.73	28.76	3.70	102.08	159.53	142.14	71.84	83.04	348.06	165.45	184.10	121.43	15.25	288.64
In-HHI	[0,1]	0.34	0.30	0.17	0.12	0.56	0.34	0.26	0.18	0.13	0.87	0.39	0.34	0.19	0.13	0.78
Out-HHI	[0,1]	0.42	0.41	0.13	0.26	0.80	0.40	0.39	0.14	0.22	0.70	0.62	0.70	0.21	0.18	0.84
Binary clustering (in)	[0,1]	0.52	0.52	0.10	0.37	0.67	0.61	0.62	0.05	0.52	0.70	0.50	0.51	0.23	0.00	0.83

The time-series of network indicators show that these are pro-cyclical, reached peak values at the onset of the 2007-08 global financial crisis and, after a sharp drop in 2008, values of indicators returned to or surpassed their pre-crisis levels. For example, connectivity over the full network has returned to pre-crisis levels (see Figure 5.1.1, panel A). However, it is interesting to note that connectivity between core countries decreased and remained lower in the aftermath of the global financial crisis, while core-periphery connectivity has increased and surpassed pre-crisis levels (see Figure 5.1.1, panels B and C).[115]

The increased connectivity after the global financial crisis, between core-periphery countries does not seem to be driven by increased risk-taking of banks in the core. In particular, when we analyse changes in the network to see whether increased connectivity (in the core-periphery network) is driven by relationships with jurisdictions whose sovereigns have been assigned a non-investment-grade rating by rating agencies we find that connectivity core-NIG has not increased.[116]

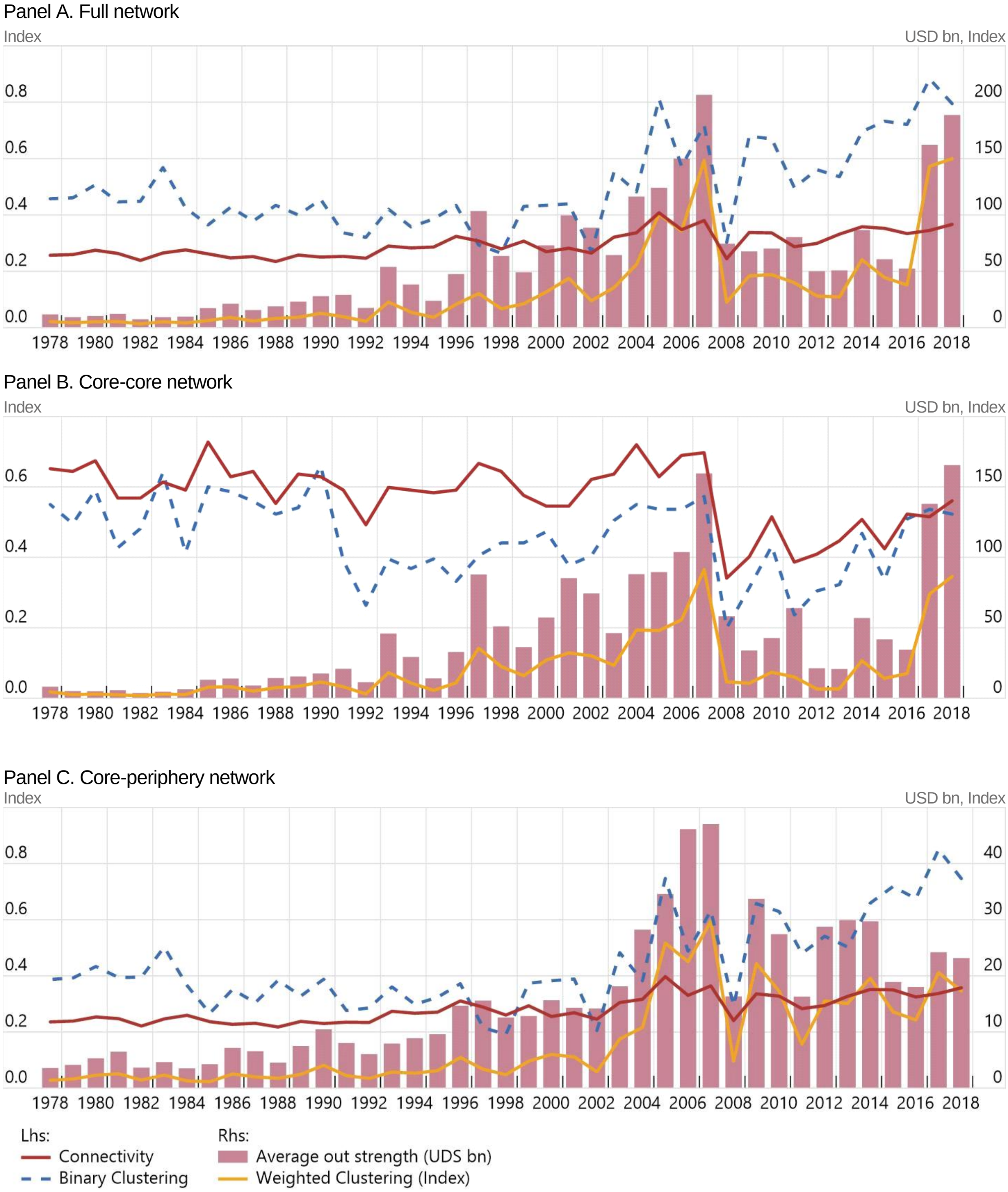
Lastly, in line with Aldasoro and Ehlers (2019), we also found that concentration has risen (see Figure 5.1.2). A higher value of the HHI reflects a higher concentration of lending or borrowing.

115 This is in line with the retrenchment in cross-border credit by European banks (whose home countries form the majority of the core countries). In addition, cross-border flows to and from China have greatly increased.

116 For this analysis we used data for 2004-2018 to be able to incorporate information about additional BIS reporting countries (the “new core” includes 23 jurisdictions in total, instead of 15, their sovereigns have investment grade credit ratings). Among periphery countries, there are 117 jurisdictions whose sovereigns have a non-investment-grade credit rating.

5.1.5. *Figures*

Network Indicators: 1978 – 2018 **Figure 5.1.1**



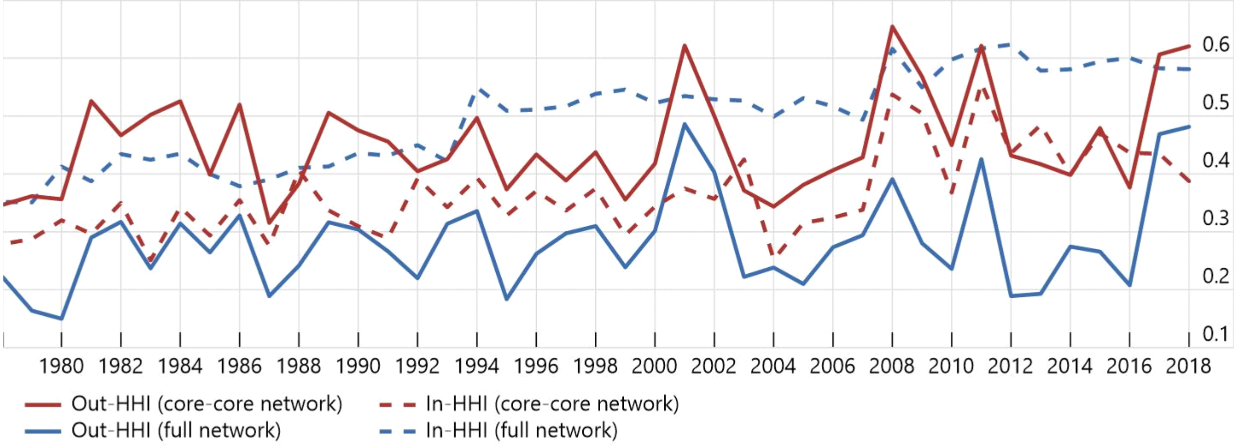
Notes: Connectivity characterises the density of links observed over the total possible number of links. Average out-strength shows the average value of outflows originated in a given link. BE, CH, DE, DK, FR, IE, JP, LU, NL, SE, UK, and US are covered.

Source: BIS.

Herfindahl- Hirschmann Index: 1978 – 2018

Index

Figure 5.1.2



Note: BE, CH, DE, DK, FR, IE, JP, LU, NL, SE, UK, and US are covered.

Source: BIS.

5.2. Changes highlighted by the FSB NBFI monitoring exercise

5.2.1. Introduction

In order to capture potential effects of TBTF reforms on the broader financial system, data collected by the FSB to enhance the resilience of non-bank financial intermediaries (NBFI) are helpful. The annual FSB NBFI monitoring exercise compares the size and trends of financial sectors in aggregate and across jurisdictions. The FSB focuses particularly on those parts of the NBFI sector that may pose bank-like financial stability risks and/or create opportunities for regulatory arbitrage.

5.2.2. Description of the data

The analysis is based on a subset of the FSB *Non-Bank Monitoring Experts Group* (*NMEG) dataset for the 2019 NBFI global monitoring exercise*, covering jurisdictions participating in the TBTF exercise and two additional jurisdictions that contributed data for this analysis. The adjusted dataset comprises 20 jurisdictions (14 advanced economies [AE-14] and 6 emerging markets [EM-6]).[117] Euro area time series were available but had to be excluded because the data were incomplete. As six euro area economies (all with large financial sectors) are among the 14 AEs, we use the data available for these instead.

For the purpose of the analysis, the financial subsectors are aggregated into the *four sectors* “DTC” (“deposit-taking corporations”, for entities commonly referred to as banks), “NBFI” (“non-bank financial institutions”),[118] “CB” (central banks), and “PFI” (“public financial institutions”,

[117] Advanced economies (AE) comprise AU, CA, CH, HK JP, SG, UK, US and six Euro area countries (DE, ES, FR, IE, IT, NL). Emerging economies comprise AR, BR, CN, IN, MX and SA.

[118] NBFIs are defined as the sum of “other financial institutions” (OFI), “insurance corporations” (IC), “pension funds” (PF), and “financial auxiliaries” (FA).

the only remaining financial subsector). No distinction can be made between G-SIBs, D-SIBs and other banks, which are all contained in the DTC sector.

Financial subsectors can be compared in terms of their relative size within the financial system in terms of four financial asset aggregates, that is, "total assets", "credit assets", "deposits" and "loans".[119]

Data is annual, covering the years 2002 to 2018. It would be useful to separate the data series into three periods: "2002 to 2008" largely covers the run-up to the global financial crisis. But unfortunately, in our analysis, this period has to be disregarded as data coverage is materially increasing within this period and may thus be driving the aggregates. "2008 to 2011" is used as the period before the announcement of TBTF reforms when the dataset is sufficiently stable and "2011 to 2018" is used as the period after the announcement of TBTF reforms.

5.2.3. Descriptive analysis

Descriptive analysis of the NMEG dataset was undertaken to test the following two hypotheses, which are not mutually exclusive:

Hypothesis 1: "There has been a structural change in the financial system with a decline in market shares of (G-)SIBs, relative to other banks and non-bank financial intermediaries (NBFIs), and market based finance (e.g. corporate bonds and syndicated loans)."

Hypothesis 2: "In some market segments, there has been a relative shift in the provision of lending activities from (G-)SIBs to other banks and NBFIs that has resulted in a change in total lending."

To do so, the structural changes in the composition of the financial system had to be reviewed, with a particular interest in shifts in participation by (G-)SIBs and other financial institutions. The major challenge in testing the hypotheses was the lack of data specifically on (G-)SIBs) in a flow-of-funds-type dataset covering the entire financial system, as (G-)SIBs (as well as D-SIBs and other SIBs) are an inseparable part of the DTC sector (deposit-taking corporations) in the NMEG dataset.

Therefore, the analysis had to be based on the qualitative assessment or descriptive analysis of the available data. This meant evaluating shifts between the DTC (instead of G-SIBs, SIBs, and other banks) and NBFI sectors, that is, simultaneous changes in relative weights of these sectors.[120]

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[119] Refer to the definitions in the FSB's 2020 Global NBFI Monitoring Report. For total assets ("total global financial assets") refer to Section 2.1 of the report; for credit assets, loans, deposits refer to Section 2.3. https://www.fsb.org/wp-content/uploads/P190120.pdf

[120] For a shift in relative weights, the changes in weights need to have opposite signs. For an economic shift between two sectors to occur, more conditions need to be met. The two sectors need to have the same or at least comparable activities. These assumed to be "lending" or "credit intermediation" for the NMEG NBFI monitoring exercise. In this context, "credit intermediation" amounts to any provision of debt. This implies that banks providing loans and e.g. mutual funds investing in bonds incur in comparable activities.

5.2.4. Results

Overall, levels for all four variables (total assets, credit assets, loans, deposits)[121] have risen between 2011 and 2018 for DTCs, NBFIs and the financial sector as a whole, in all three country sets (World-20, AE-14, EM-6), with the only exception of other financial institutions (OFI) deposits in AE-14 (marked decrease) and World-20 (almost constant). In other words, DTCs / banks and OFIs / NBFIs have grown on average after the TBTF reform announcement. However, growth at different rates led to shifts in market shares, as measured by the sector shares (or "market shares") for the four variables.

Table 5.2.1: Variable levels for world (20 jurisdictions), 2018 values in terms of 2011 = 100

2018 % 2011	Total Financial Assets	Credit Assets	Loans	Deposits
DTC	128,0	129,9	141,1	110,2
NBFI:OFI	155,3	128,4	115,1	99,9
NBFI:ICPF	140,9	138,1	130,4	113,8
NBFI:FA	131,4	n.a.	n.a.	n.a.
CB	177,7	n.a.	n.a.	n.a.
PFI	130,5	n.a.	n.a.	n.a.
memo: NBFI	*148,6*	*132,3*	*117,5*	*103,7*
Total	140,1	130,8	136,7	108,4

Regarding total assets (the "macro" variable in the NMEG exercise) between 2011 and 2018, the DTC share has been decreasing while the NBFI share has been increasing worldwide (+2.6 percentage points), in AEs and in EMs alike (+3.7 and +11.3 pp, respectively).[122] In isolation, this could be interpreted as supporting hypothesis 1. However, NBFI sector growth is largely driven by valuation gains in the investment fund sector (contained in the OFI subsector). This is the result of two factors. First, investment funds account for the largest share of OFI assets. As investment fund assets are largely marked to market, valuation gains due to rising asset prices tend to drive asset growth.[123] In addition, we cannot rule out that the

[121] Please refer to the definitions in the FSB's 2020 Global NBFI Monitoring Report. For total assets ("total global financial assets") please refer to Section 2.1 of the report; for credit assets, loans, deposits please refer to Section 2.3. https://www.fsb.org/wp-content/uploads/P190120.pdf

[122] The fact that the world NBFI sector has grown at a higher rate than both the AE and EME NBFI sectors results from a composition effect. The NBFI share in EMEs is much lower than in AEs, while the overall weight of EMEs has grown vis-à-vis the AEs. From this perspective, the growing global weight of DTC-dominated EME financial systems dampened global growth of the NBFI sector share.

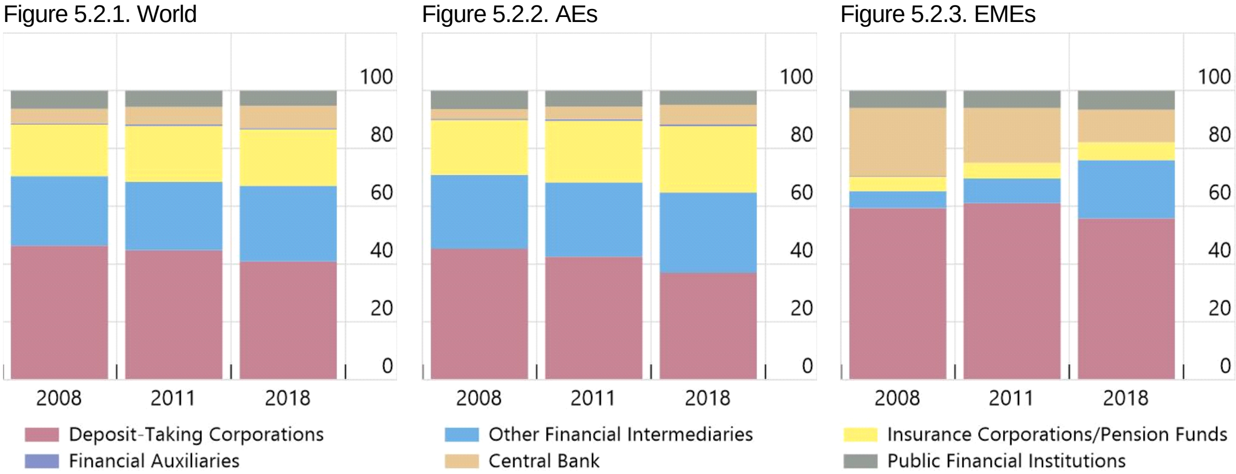
[123] Refer to the case study focusing on investment funds in the FSB's 2020 Global NBFI Monitoring Report: "Distinguishing between flow and valuation effects in the investment fund sector", p. 68. https://www.fsb.org/wp-content/uploads/P190120.pdf

data series is also driven by reporting improvements increasing the coverage of the Chinese financial sector.[124]

Total financial assets

In per cent

Figure 5.2.1 - 5.2.3



Source: FSB, Global Monitoring Report on Non-Bank Financial Intermediation 2019.

Regarding sector share dynamics of credit assets between 2011 and 2018, there was a small shift from DTC to NBFI sector share (by 0.4 pp). Within the NBFI sector, there was a slight decrease in the global OFI share, which was overcompensated by a gain in the insurance corporations an pension funds (ICPF) share (+0.8 pp), largely driven by ICPF growth in the US and UK. This masks a strong shift in weight from DTC to NBFI in emerging economies which was largely offset by relatively unchanged shares in the advanced economies and a composition effect following from the growing global weight of the relatively bank-dominated emerging market economies.

Looking only at loans between 2011 and 2018, the DTC share grew (+2.7 pp) at the expense of the NBFI share worldwide (-2.7 pp), which in turn was almost exclusively the result of a decreasing OFI share worldwide (-2.5 pp), which seems to contradict the hypotheses. In absolute terms, the DTC sector displayed strong positive growth and the OFI sector only slightly positive growth.[125] Yet, as our dataset only contains aggregate data, we cannot observe potential shifts in market shares within the banking sector. The global DTC market share gain was driven by the advanced economies, while the opposite happened in emerging markets, where a DTC-to-NBFI shift took place. Similar trends can be observed when studying deposits.

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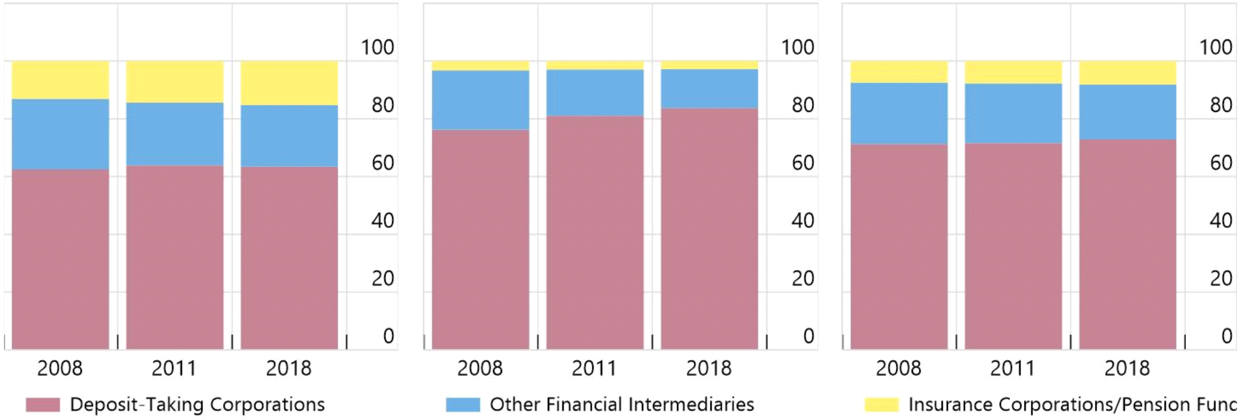
[124] The increasing coverage of the Chinese financial sector over time is a challenging feature of the NMEG dataset. Leaving China out would miss an important global trend (the advent of China as an economic power) and render the remaining EMEs aggregates too small to have a material impact on global aggregates. Keeping China in the dataset adds noise that impedes a proper identification of shifts in DTC and NBFI sector weights.

[125] The slight worldwide OFI sector growth is partly the net effect of two countervailing trends, that is, a shrinking securitisation business (SFV subsector, mostly in AEs) and stronger growth of the trust company subsector (mostly in EMEs).

Credit assets, loans, and deposits (world)

In per cent **Figure 5.2.4 - 5.2.6**

Figure 5.2.4. Credit assets Figure 5.2.5. Loans Figure 5.2.6. Deposit



Source: FSB, Global Monitoring Report on Non-Bank Financial Intermediation 2019.

Instead of studying sector shares, the data can be analysed in terms of average annual growth rates in the pre- and post-announcement periods (2008 to 2011, 2011 to 2018). The growth rates of total assets were greater in the NBFI sector than in the DTC sector in both periods, and growth in both sectors was faster after 2011 than before. Based on loans and deposits, worldwide DTC growth was consistently higher than NBFI growth, and based on credit assets as a whole, DTC growth was only slightly slower than NBFI growth. Growth accelerated for loans and decelerated for deposits.[126] It strongly accelerated for NBFI credit assets. This does not seem to support hypothesis 1, contrary to the finding based on total assets. Therefore, NBFI growth in terms of total assets may be a reflection of valuation effects due to booming asset markets.

Table 5.2.2: Annual average sector growth rates

World(20)	Total assets		Credit assets		Loans		Deposits	
	DTC	NBFI	DTC	NBFI	DTC	NBFI	DTC	NBFI
Annual growth 2008 to 2011	2,5%	4,7%	3,9%	1,8%	3,4%	-6,2%	3,5%	2,9%
Annual growth 2011 to 2018	3,6%	5,8%	3,8%	4,1%	5,0%	2,3%	1,4%	0,5%

5.2.5. Conclusions

The findings do not contradict the hypothesis that a shift from banks (inseparably including G-SIBs) to non-bank financial intermediaries and market-based financing may have occurred. Finally, looking only at loans, there is no evidence that NBFI have gained market share at the expense of banks.

[126] Note that deposits do not fulfil the same economic purpose for DTCs (banks) and all NBFIs (e.g. money market funds) alike. Deposits are bank liabilities. For MMFs, they are high-quality assets.

5.3. Domestic lending and the TBTF reforms

5.3.1. Introduction

One important question is whether there has been any been any structural change in the financial system that has affected the supply of credit to the real economy. It is possible that following the introduction of tighter prudential requirements, G-SIBs could reduce their risk-taking – including through lending – to achieve compliance. From a policy perspective, it is important to assess how credit has changed after the introduction of the reforms, as different policy implications could follow for economic and financial stability. If G-SIBs had lowered their contribution to credit growth in an environment where the level of credit relative to GDP was not too high, and this could therefore have resulted in insufficient credit, such a development could be detrimental for growth. In this case a substitution between G-SIBs and other sources of credit (banks and non-banks) would be welcome. A shift of activities to intermediaries less regulated and supervised than banks could, however, raise financial stability concerns. If instead G-SIBs had lowered their contribution to credit growth in an environment where lending had been higher than optimal – a feature of the period that preceded the global financial crisis – a gradual reduction in credit would be beneficial from a welfare and financial stability perspective (Cecchetti et al., 2011).

Credit is granted by G-SIBs and other banks in their domestic market and in the host countries where they are active. This section sheds light on the dynamics of credit in the domestic market. It looks in particular at credit growth to the domestic non-financial sector relative to GDP growth and in relation to the announcement of the TBTF reforms. It does not aim to assess whether the level of credit is optimal.

This section compares the contribution of G-SIBs to the aggregate domestic credit growth to the contribution of D-SIBs, non-systemic banks, and other sources of domestic non-bank credit, including bonds. Showing causality on the effects of the TBTF reforms is not possible.

The most relevant results is that the TBTF reforms, as expected, seem to have been temporarily associated with a somewhat lower credit provision by G-SIBs. And that the contribution by G-SIBs to domestic credit is inversely related to the progress in the implementation of the TBTF resolution reforms. This change has not resulted in a reduction in the supply of credit overall, as other players have picked up the slack.

5.3.2. Data and methodological framework

Data

The analysis considers 19 FSB member jurisdictions. G-SIBs are headquartered in 10 of these jurisdictions. Credit supply in countries that are not home to G-SIBs can also be affected G-SIBs’ choices, as domestic players could react in response to foreign G-SIBs’ behaviour. The dataset covers the period from 2010 to 2018, with an annual frequency.

The information on credit is based on two sources of data: information collected by the FSB in the context of the evaluation (henceforth referenced as "survey")[127] and publicly available information from the BIS (Dembiermont et al., 2013).[128] The survey data include information by jurisdiction on domestic loans to customers granted by domestic G-SIBs, domestic D-SIBs, and domestic non-systemic banks. The sum of these three components of credit supply is a reasonable proxy for total bank domestic credit to the private sector. As such this proxy should be comparable with the BIS data on "bank credit to the non-financial private sector". Based on this comparability, a proxy for domestic NBFI credit is built in two steps: i) a broad aggregate of NBFI and foreign bank and non-bank credit is calculated as the difference between the BIS "total credit to the non-financial private sector" and the credit from the FSB survey; ii) NBFI credit is calculated as the difference between this aggregate and the BIS data on foreign credit to the non-bank sector. The resulting NBFI credit includes therefore domestic credit granted by non-bank financial institutions, non-financial corporations, households, and government. In terms of instruments, it includes loans and bonds.[129]

TBTF reforms

All the TBTF reforms are likely to affect G-SIBs lending decisions. For the purpose of this analysis two reforms related information are considered: i) the November 2011 FSB announcement of a set of Policy Measures to Address Systemically Important Financial Institutions which included the first FSB designation of G-SIBs, as the key date after which banks have likely started to respond to the new and forthcoming requirements by reducing risk taking., and ii) the progress in the implementation of resolution reforms across jurisdictions, proxied by the Resolution Reform Index (RRI).

Methodology

The analysis is based on two analytical approaches discussed in turn.

Shift-share

To assess the relative contribution of the different credit providers relative to the GDP growth the analysis focuses on the credit-to-GDP ratio. Considering credit without accounting for GDP would not allow to discern the extent to which a given change in credit by a certain sector (e.g. G-SIBs) is related to changes in GDP (and hence correlated with demand). As a first step the ratio of credit-to-GDP is therefore computed at country level.

To evaluate the relative contributions of the different credit providers as well as of GDP the changes of the credit-to-GDP ratio for each country are decomposed using a standard

[127] The following jurisdictions have provided data: Argentina, Australia, Brazil, Canada, China, France, Germany, Hong Kong, India, Italy, Japan, Mexico, Russia, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, the Netherlands, the United Kingdom and the United States.

[128] https://www.bis.org/statistics/totcredit.htm

[129] The consistency of the reconstructed total credit (FSB survey credit plus proxied NBFI credit plus foreign claims) is checked against the data on total credit published by the BIS. The two sources are consistent for 20 out of 21 countries. One jurisdiction (Singapore) shows large differences and is not considered in the analysis. Another jurisdiction (Brazil) also shows a significant difference but the discrepancy is of a lower magnitude hence it is included. In addition, in the FSB survey data two countries (Argentina and Russia) show positive values for credit by domestic G-SIBs although they are not home to any G-SIBs. These values are conventionally set to zero.

analytical technique known as shift-share. Shift-share was first applied by Dunn (1960) and is often used in regional science, urban economic research, and political economy to describe how much of the growth rate of a local variable can be attributed to national and regional factors. This technique provides a simple and intuitive way to identify the contribution of the different factors that influence a variable change.[130] Its main limitation however is that it cannot be used to figure out the determinants of economic trends. The application of this approach is appealing in this case of aggregate perspective of the analysis, which renders the identification of causality an extremely hard task even if a much more complex framework were applied.

Shift-share allows explaining what portion of the observed change in the credit-to-GDP ratio is attributable to its different components. A change can be due to a variation in credit and/or in GDP. Within the former, it can stem from all possible combinations of changes in credit by different finance providers. More formally, be *C* the level of credit and *GDP* the country gross domestic product, the change in the credit-to-GDP ratio over one period can be decomposed as follows:

$$\Delta \frac{C}{GDP}_{t,t-1} = \frac{C_t}{GDP_t} - \frac{C_{t-1}}{GDP_{t-1}} = \sum_{i=1}^{4} \frac{C_{i,t}-C_{i,t-1}}{GDP_{t-1}} + C_{t-1}\left(\frac{1}{GDP_t} - \frac{1}{GDP_{t-1}}\right) + (C_t - C_{t-1})\left(\frac{1}{GDP_t} - \frac{1}{GDP_{t-1}}\right) \quad (1)$$

where *i* indicates respectively G-SIBs, D-SIBs, other banks, and NBFI. $\frac{C_{i,t}-C_{i,t-1}}{GDP_{t-1}}$ is the "credit by *i* effect", $C_{t-1}\left(\frac{1}{GDP_t} - \frac{1}{GDP_{t-1}}\right)$ is "GDP effect", $(C_t - C_{t-1})\left(\frac{1}{GDP_t} - \frac{1}{GDP_{t-1}}\right)$ is the "residual effect".

The sum of all the effects, including the residual effect add up to the actual change in the credit-to-GDP ratio. Negative values of the components indicate their negative contribution to the change in the credit-to-GDP ratio relative to the previous period while positive values indicate a positive contribution.

Responding to an external shock by adjusting bank balance sheet implies a revision of the lending policies that inevitably takes time. It could take even more time for the effects to be visible at the aggregate level. Two post-reforms periods are therefore considered: a two year period after the TBTF reforms announcement (2011 to 2013), considered the minimum time to be able to observe, at aggregate level, any sign of banks' reaction; and a medium-term period (2011 to 2018), to account for the possibility that effects on G-SIBs credit could take place over a longer period, also due to the timing and phase in of the various TBTF reforms. Data at year-end 2011 are a proxy for the level of the credit-to-GDP ratio before the FSB announcement, which took place in November 2011.

Econometric analysis

The qualitative evidence provided by the shift-share analysis is complemented by a simple panel regression exercise, which aims to provide evidence of statistical and economic significance for the qualitative findings. It is not meant to show causal effects of the TBTF reforms on credit. The analysis is carried out with the following econometric set-up:

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[130] Shi and Yang (2008) and Stevens and Moore (1980) provide a review of the literature on the shift-share technique.

$$\frac{C_{i,t}}{GDP_{i,t}} = \beta \frac{C_{i,t-1}}{GDP_{i,t-1}} + \delta RRI_{i,t} + \alpha_i + \lambda_t + \varepsilon_i \quad (2)$$

where the level of G-SIBs' domestic credit in country *i* and at time *t* relative to GDP of country *i* at time *t* is regressed on its own lag and on the Resolution Reform Index (RRI) for country *i* at time *t*. The regression is estimated with country and time fixed effects to control for general time-varying developments and for country specific time-invariant effects. Taking credit as the ratio to GDP allows also to control for the country specific time varying economic conditions.

As alternative specifications, two additional regressors have been included: a) a TBTF reform dummy which is equal to 0 in 2010 and 2011, and equal to 1 from 2012 to 2018 for all countries; and b) the lagged level of credit by other credit providers, to capture for possible substitutions effects.

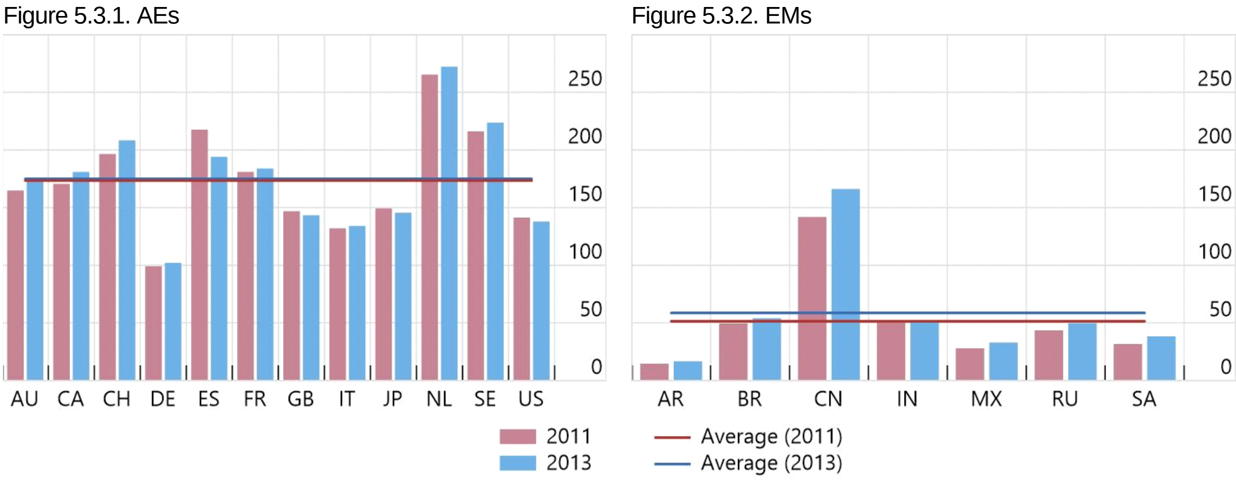
5.3.3. Descriptive statistics for the credit-to-GDP ratio

For 2011-2013 period the unweighted average credit-to-GDP ratio remains almost unchanged in AEs (Figure 5.3.1) – where most of the G-SIBs are headquartered – while in EMs it grows visibly (Figure 5.3.2). More in detail, the ratio has decreased in 1/3 of the AEs (Spain, United Kingdom, Japan, and United States) while it has increased in all the seven EMs.

Total domestic credit-to-GDP ratio by AEs countries in 2011 and 2013

In per cent

Figure 5.3.1 & 5.3.2



Note: Data includes Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, Russia, Saudi Arabia, Sweden, Switzerland, the United Kingdom and the United States.

Sources: national data; FSB survey.

Considering the full time span available in the dataset, i.e. from 2010 to 2018, with 2010 and 2011 being pre-reform dates, the credit-to-GDP ratio for the whole group of 19 countries in USD dollar terms has increased between 2010 and 2018, from 139% to 143%. The aggregate G-SIBs domestic credit-to-GDP ratio has been essentially unchanged at about 25%, with limited variations from a minimum of 23% in 2014 and a peak of 26% in 2017. The other credit providers' aggregate credit-to-GDP ratio has increased during the period by 4 percentage points, to 118% (Figure 5.3.3). These aggregated cross-country figures are informative but still largely impressionistic. If on one side they account for the countries' relative weightings on the other they are biased by the exchange rate movements as all countries' figures on credit and GDP are expressed in US dollars.

Looking at data by country, in local currency, allows overcoming this limitation. The change in the credit-to-GDP ratio between 2010 and in 2018 shows a significant heterogeneity, with remarkable differences both between and within advanced and emerging economies (Figure 5.3.4). The unweighted average credit-to-GDP ratio has increased from 173% to 178% in advanced economies (AEs) and from 52% to 64% in emerging economies (EMs).

Within AEs, the credit-to-GDP ratio has risen significantly in five out of 10 countries, by an unweighted average of 34 percentage points. It has changed only marginally, with modest increases or decreases, in four countries, and has declined significantly in three countries. Within EMs the ratio has increased in five countries, although with a high dispersion, from a minimum of 5 percentage points and maximum of 48 percentage points. It has marginally increased in two countries.

Domestic credit-to-GDP

In per cent

Figure 5.3.3 & 5.3.4

Figure 5.3.3. Aggregate domestic credit-to-GDP ratio

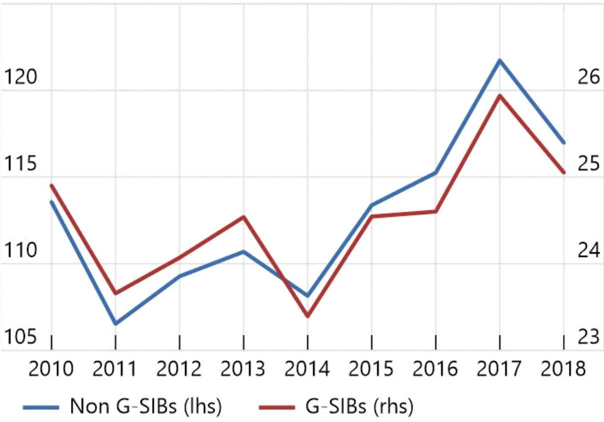
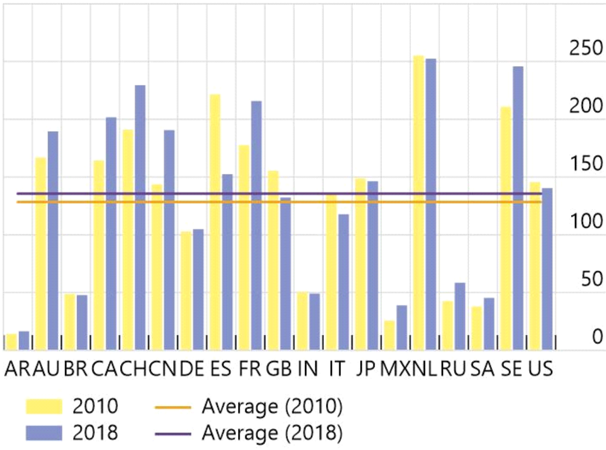


Figure 5.3.4. Domestic credit-to-GDP by country



Note: Data includes Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, Netherlands, Russia, Saudi Arabia, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Sources: national data; FSB survey.

5.3.4. Results

Decomposing changes in the credit-to-GDP ratio

Pre-TBTF reform period

To put in context the evidence that will be shown for the post reforms period, it is useful to observe the developments in the year before the TBTF reforms, i.e. from 2010 to 2011. Over this short period, in the AEs G-SIBs have had on average a muted contribution to credit-to-GDP growth against the backdrop of a similarly muted contribution to domestic credit by the other players, with the exception of D-SIBs, which show a positive average value and a large dispersion of country level observations mostly in the area of positive contributions (Figure 5.3.5). In the EMs the situation is different, with G-SIBs (headquartered only in one EM) being the largest contributors, followed by positive contributions by the other players (Figure 5.3.6).

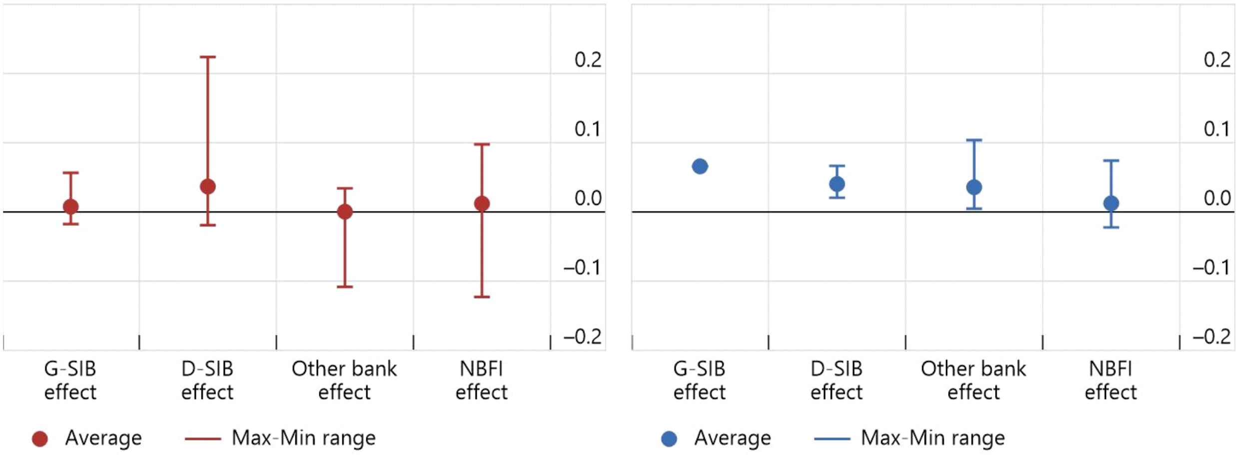
Decomposition of changes in the ratio of loans to GDP

In per cent

Figure 5.3.5 & 5.3.6

Figure 5.3.5. AEs: 2010 - 2011

Figure 5.3.6. EMDEs: 2010 - 2011



Notes: Maximum, minimum and average values shown. Percentage points. GDP contributions and residual effects are not shown. AEs includes Australia, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. EMDEs includes Argentina, Brazil, China, India, Mexico, Russia, Saudi Arabia.

Sources: BIS; FSB survey.

Post-TBTF reforms: short-term

For the two years after the TBTF reforms announcement, in AEs the results are on average similar to those shown for the pre-TBTF reform year, as the contribution by G-SIBs remains close to zero (Figure 5.3.7). It is worth noting though that the number of countries with a modest G-SIBs contribution is higher, as shown by the lower dispersion (max-min range). The contribution by D-SIBs is lower than before the reforms announcement, with fewer countries showing a positive value, while that by NBFIs has become positive. This suggests that, in the context of a generally growing GDP, a possible structural change occurred in credit provision, at least in some countries. Caution is necessary in linking these dynamics to the TBTF reforms since country specific conditions could have also influenced G-SIBs' domestic behaviour. For instance, in some countries the negative contribution by G-SIBs has been accompanied by a negative contribution by D-SIBs and/or by other banks, in the context of declining GDP. It is clearly problematic therefore to disentangle any TBTF reforms effect from the implications of macroeconomic developments and of other policy measures being implemented in parallel.[131] In EMs (Figure 5.3.8) the situation remains different, as all sources of credit are still positive contributors, with G-SIBs still having the higher contribution.

The contribution by G-SIBs in AEs improves somewhat if the observation period is lengthened by one year, to year end 2014 (results not shown for parsimony). This suggests that any possible announcement effect of the of the TBTF reforms diminished somewhat in the third year after the event, when capital surcharges had not yet been phased-in yet (phase in began in 2016) and the TLAC requirements had not been published yet.

[131] Both jurisdiction-specific (e.g. monetary policy) and sector-specific (post-crisis reforms referring to other parts of the banking and financial sector).

Decomposition of changes in the ratio of loans to GDP

In per cent

Figure 5.3.7 & 5.3.8

Figure 5.3.7. AEs: 2011 - 2013

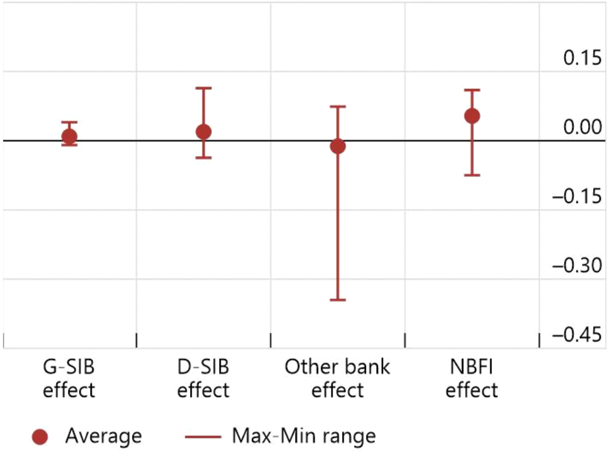
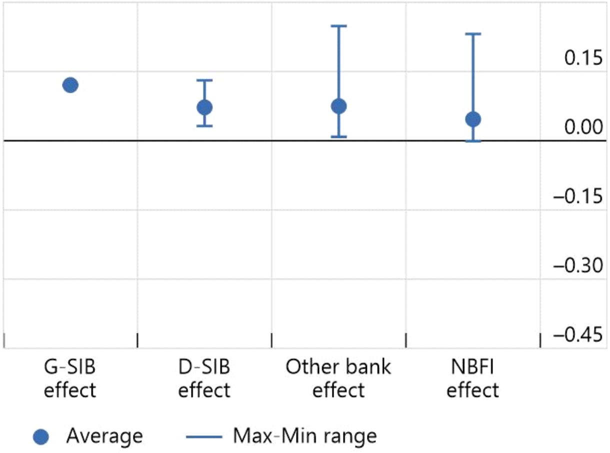


Figure 5.3.8. EMDEs: 2011 – 2013



Notes: Maximum, minimum and average values shown. Percentage points. GDP contributions and residual effects are not shown. AEs includes Australia, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States and United States. EMDEs includes Argentina, Brazil, China, India, Mexico, Russia, Saudi Arabia.

Sources: BIS; FSB survey

Post-TBTF reforms: medium-term

Broadening the perspective to the medium term, i.e. 2011-18, provides useful information for a more complete picture of any possible development in aggregate credit provision. The analysis for AEs shows that G-SIBs' contribution increases on average only marginally and with a higher dispersion across countries, mostly in negative territory (Figure 5.3.9). The contributions from the other sources are positive and higher than that of G-SIBs, with NBFIs having the largest contribution. The differences across countries are, however, notable, as shown by the dispersion bars. Hence in AEs G-SIBs "underperformed" other agents in providing credit. The extent to which this can be significantly linked to the TBTF reforms will be discussed in the next section. In the case of EMs, the contribution by G-SIBs remains positive and on average higher than that of the other credit providers, making it difficult to argue that TBTF reforms have had an effect (Figure 5.3.10).

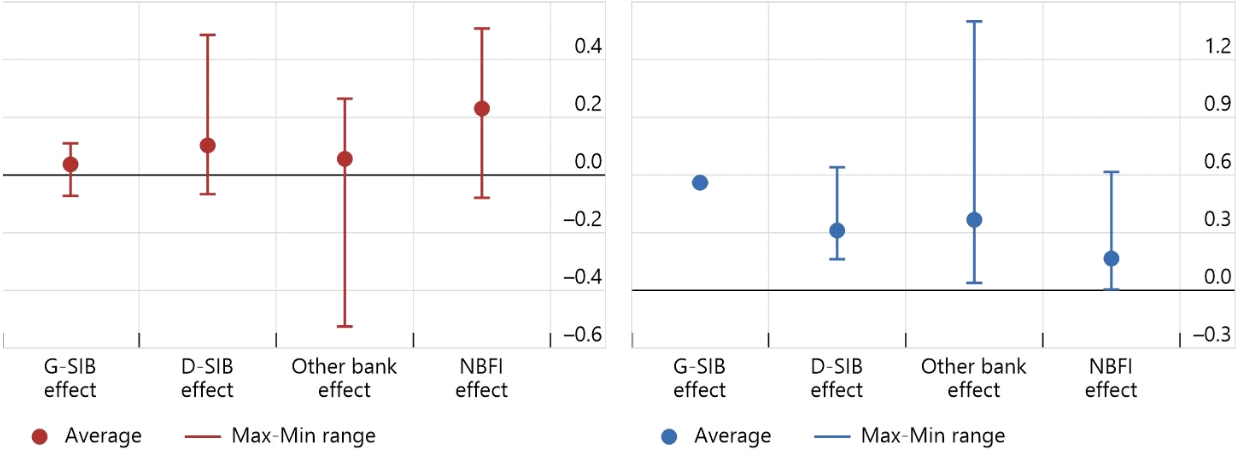
Decomposition of changes in the ratio of loans to GDP

In per cent

Figure 5.3.9 & 5.3.10

Figure 5.3.9. AEs: 2011 - 2018

Figure 5.3.10. EMDEs: 2011 – 2018



Notes: Maximum, minimum and average values shown. Percentage points. GDP contributions and residual effects are not shown. AEs includes Australia, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. EMDEs includes Argentina, Brazil, China, India, Mexico, Russia, Saudi Arabia.

Sources: BIS; FSB survey

The results of this section compare favourably with the existing literature. For instance, Cohen and Scatigna (2016) find a decline in G-SIBs lending in the aftermath of the GFC (2009-2012), a result consistent with the short-term evidence provided here. Violon et al. (2018), using data to 2016, find that the ability of G-SIBs to provide loans to the real economy remained unchanged after their designation as systemically important banks, a finding broadly consistent with the evidence provided for the medium-term.

Statistical and economic significance: regression results

The results from the estimation of equation (2) are shown in Table 5.3.1. The findings sub (i) show that the level of G-SIBs' domestic credit relative to GDP is negatively related to the resolution reforms index. The more advanced is the implementation of the resolution reforms the lower is the level of G-SIBs' credit-to-GDP. In the specification sub (ii) the lagged value of credit by D-SIBs, Other banks, and NBFIs as a share of GDP is included as regressor. The results show that Other banks' credit is negatively related to G-SIBs' credit, which hints at the possibility of a substitution effect between Other banks and G-SIBs.[132]

The results are economically significant. For the specification sub (i), a one standard deviation increase in the RRI (i.e. an increase in the index by 0.26 on average) is associated with a 1 percentage point lower ratio of G-SIBs' domestic credit to GDP.

One additional specification is carried out by including the TBTF reforms dummy. The results, not reported, show that the dummy is not statistically significant. This is not surprising, nor

[132] As a robustness test to the results, the logarithm of G-SIBs credit is regressed on the logarithm of GDP and on the RRI. The results, not shown for brevity, confirm the finding in Table 1, with the RRI negatively related to G-SIBs credit. The relationship between G-SIBs credit and GDP is a positive one, as expected.

necessarily a robust result, as the period covered by the dataset has only two pre-reform observations versus seven in the post-reform period.

Finally, if instead of considering G-SIBs' credit-to-GDP as a dependent variable, credit by other players (i.e. D-SIBs, Other banks, and NBFI) is used in equation (2), the coefficient on RRI is never significant, as shown in Table 5.3.2. This implies is the absence of any relation between these agents' aggregate credit supply and the TBTF related reforms.

Table 5.3.1: G-SIBs credit and RRI

VARIABLES	(i)	(ii)
G-SIBs credit-to-GDP t-1	0.714***	0.667***
	(0.121)	(0.093)
D-SIBs credit-to-GDP t-1		0.044
		(0.076)
Other banks credit-to-GDP t-1		-0.047**
		(0.016)
DNB credit-to-GDP t-1		0.010
		(0.054)
Resolution Reform Index t	-0.034*	-0.040*
	(0.016)	(0.021)
Observations	88	88
R-squared	0.995	0.995
TIME FE	Yes	Yes
COUNTRY FE	Yes	Yes

Standard errors clustered by country in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

Table 5.3.2: Non G-SIBs credit and RRI

VARIABLES	(i) (D-SIBs)	(ii) (Other banks)	(iii) (NBFIs)
Dependent variable t-1	0.696***	0.752***	0.692***
	(0.112)	(0.060)	(0.089)
Resolution Reform Index t	-0.007	-0.038	0.015
	(0.046)	(0.029)	(0.025)
Observations	160	160	160
R-squared	0.996	0.996	0.996
TIME FE	Yes	Yes	Yes
COUNTRY FE	Yes	Yes	Yes

Standard errors clustered by country in parenthesis.
*** p<0.01, ** p<0.05, * p<0.

5.3.5. Conclusions

In the first two years after the FSB policy announcement about G-SIFIs in November 2011, there was a negative or muted contribution of G-SIBs to domestic credit growth in several countries. This resulted in a decline in total credit relative to the size of the economy. This could have been an expected effect of the announcement of the TBTF reforms on G-SIBs' risk assets. In the following years, with TBTF measures still in the implementation phase in several countries, the contribution of G-SIBs to domestic credit growth relative to GDP has, on average, turned marginally positive. However, their contribution to the growth of credit relative to GDP has been lower than that of other players and the level of credit by G-SIBs is lower, the more advanced is the implementation to the TBTF resolution reforms. In response to the small but positive contribution to credit growth by G-SIBs, other financial intermediaries, in particular of NBFIs and non-systemic banks, have picked up the slack.

Despite the rebalancing of the contributions to credit growth between G-SIBs and other players, the aggregate level of credit has been largely in line with GDP, with no significant reduction in financing for the economy.

The less prominent role of G-SIBs compared to other players could be due to a different impact of the TBTF reforms between the G-SIBs and other intermediaries. It is not possible however to make an uncontroversial attribution to the TBTF reforms. There is no counterfactual to which the observed changes can be compared, nor there is there a long enough pre-TBTF reforms period to use as benchmark. Overall, interpreting variation in credit to GDP is also difficult because high credit-to-GDP levels prior to the global financial crisis do not necessarily reflect an optimal level of credit but might have been inflated by excessive risk-taking.

5.4. The effects of SIB frameworks on credit provision in Latin America

Identifying reforms as drivers of observed outcomes or changes in banks' behaviour is not straightforward. This is also the case for the TBTF reforms. The reason is that observed outcomes reflect changes in behaviour of both banks and customers. To analyse accurately the effects of TBTF reforms on, for example, credit provision by banks, it is necessary to disentangle loan demand from loan supply effects.

The aim of this analysis is to evaluate if the implementation of the framework identifying G-SIBs' credit provision in Latin American countries. This analysis exploits granular data that allows researchers to control for supply and demand effects using banks' and firms' characteristics. This exercise builds on previous work[133] carried out by the BIS Consultative Council for the Americas through a working group of the Consultative Group of Directors of Financial Stability. Their research focused on how different bank characteristics and business models and their evolution have affected credit dynamics and banks' responses to different economic shocks. For this evaluation, their framework has been modified to identify the effects of TBTF reforms. This approach is useful to add evidence for the evaluation since these countries are host to subsidiaries of several G-SIBs and have also implemented the framework for D-SIBs.

Section 4 of this Appendix reports that evidence about the impact of TBTF reforms on the growth of banks' lending outside their home market is mixed. This section looks at whether the rate of growth of credit granted by banking subsidiaries of G-SIBs operating in five Latin American countries was different from those of other banks in the region following the announcement of the G-SIB capital surcharge. In three countries it was not. In two countries credit growth was lower, although still positive, for subsidiaries of foreign G-SIBs. The remainder of this section describes the analysis behind these findings.

5.4.1. Data.

The participating central banks were the Central Bank of Brazil, the Central Bank of Chile, the Central Bank of Colombia, Bank of Mexico and the Central Reserve Bank of Peru. The main data source is the credit registry in each jurisdiction, which provides detailed loan-level information about bank loans to commercial firms. Each jurisdiction used quarterly information over a period spanning (in some cases) the years 2000-18. The (confidential) data available includes the identity of the lending bank and the borrowing firm paired with credit conditions (e.g., amount, interest rate, maturity) and firms´ characteristics such as size, location, and

[133] Researchers from the BIS and other central banks in participating jurisdictions analysed the way in which bank-characteristics affect the transmission channel of domestic and foreign shocks to bank lending and their role in amplifying or dampening shocks. See Cantú et al (2020).

industry in which it operates.[134] Credit registry information is complemented with supervisory data about banks' assets, capital, liquidity, profitability and funding.

Financial and economic conditions in these countries are diverse. Latin American banking systems grew at a steady pace after the great financial crisis. Total credit to the non-financial private sector and banks' assets as a share of GDP showed a rising trend. However, while financial system growth outpaced credit growth, with the exception of Chile, total credit over GDP is still below the level in other advanced and emerging market economies (Cantú et al (2020)).

Banking systems in these countries are highly concentrated: the ten largest banks usually own more than 75% of total banking assets. The importance of G-SIBs in these countries varies widely. For example in Peru, subsidiaries of foreign banks have a relatively low participation (market share of assets), while in Colombia and Brazil one of the D-SIBs is owned by a foreign bank that may be either a G-SIB or a D-SIB in the parent country. Finally, in Mexico, three subsidiaries of G-SIBs own more than a third of banking sector assets.

5.4.2. Methodology

The analysis follows a common baseline model specification to allow country-to-country comparisons. In some cases the methodology was adapted to take into account specific institutional details, for example, by distinguishing the currency of denomination (domestic or foreign) of the loans. Additionally, each country team contributed a narrative specific to their national experience. The econometric specifications rely on DiD estimations.

To find if the implementation of the framework identifying G-SIBs affected credit provision in these countries the following equation is estimated:[135]

$$\Delta \log \text{Loan}_{fbt} = \alpha_b + \beta_1 R_t + \beta_2 R_t * SIB_b + \gamma X_{bt-1} + \lambda\, firm_{ft-1} + \alpha_f + q_t + \varepsilon_{fbt} \quad (1)$$

The dependent variable $\Delta \log \text{Loan}_{fbt}$ is the change in the logarithm of outstanding loans by bank b to firm f at time t. X_{bt-1} is a vector of (lagged) bank-specific characteristics as described in Table 5.4.1,[136] α_b are bank time-invariant fixed effects, $firm_{ft-1}$ is a vector of firm controls (e.g., size, credit rating), α_f are firm fixed effects, q_t are quarterly dummies to adjust for seasonality. R_t is a dummy variable indicating the period after the announcement of the G-SIB framework (November 2011), and SIB_b is a dummy variable indicating that bank b or its parent was identified as a G-SIB. As it is usual ε_{fbt} is an error term.

As in other parts of the evaluation, the main approach takes the publication of the international G-SIB framework and the FSB Key Attributes at the end of 2011 as a baseline for testing the effects of reforms that followed. An alternative specification was also used, constructing R_t

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[134] The length of the time series for each jurisdiction is different. Not all firm variables are available in the five participating jurisdictions.

[135] This equation also follows the approach used in other parts of the evaluation, for example, the analysis about effects of TBTF reforms on syndicated loans.

[136] This table summarises the information used. Not all bank characteristics were used for estimating equation (1).

using the date of the local jurisdiction announcement of the framework for identifying SIBs, and using SIB_b to indicate when bank b or its parent was identified as a G/D-SIB. [137]

Table 5.4.1: Bank Characteristics used in the analysis

Indicator	Bank characteristics
General	Size (log of total assets), bank capital ratio (equity-to-total assets), and bank liquidity ratio (cash and securities over total assets or liquidity coverage ratio).
Risk	Loan-loss provisions as a share of total loans, share of nonperforming loans, and share of write-offs.
Revenue mix	Diversification ratio (non-interest income to total income), trading income as a share of operating income, assets held for trading as a share of total assets, number of foreign subsidiaries, net fees and commission income as a share of operating income, retail loans as a share of total loans, broad credit to total assets.
Funding sources	Share of deposits over total liabilities, share of short-term funding, share of long-term funding, wholesale funding ratio, funding in foreign currency, and funding from foreign sources.
Profitability	Return on assets, return on equity, efficiency ratio (operating costs to total income), and number of employees per total assets.

Following Khwaja and Mian (2008), equation (1) was estimated using only information from firms with loans from multiple banks to account for firm-demand drivers. This approach allows to find whether a firm borrowing from different banks is subject to a larger decline in lending by banks identified as G-SIBs after the regulation was implemented.

5.4.3. Results

The rate of credit growth by banking subsidiaries of G-SIBs operating in these Latin American countries was not consistently different from those of other banks in the region (including domestic SIBs) after the SIB framework was implemented. In two countries, Colombia and Peru, lending growth by subsidiaries of G-SIBs was lower than for other banks, this slowdown was temporary (about 4 quarters) in Colombia where it was also found that G-SIBs decreased lending growth rates for riskier firms.[138] While bank lending in these two economies has increased since the financial crisis, there is evidence that the credit growth of the subsidiaries of G-SIBs has not risen as quickly.

[137] The group also estimated a model where R_t was substituted for a dummy indicating the period in which the regulation was announced together with different lags of this indicator variable to explore differences between treatment and control groups over time.

[138] Loan maturity was also slightly reduced, and interest rates for riskier firms increased.

5.5. TBTF reforms and the size distribution of banks

5.5.1. Introduction

Bremus et al (2018) show that the banking sector features a small number of very large banks and a large number of small/medium-sized banks and that bank size follows a power law distribution. If bank size follows a power law distribution, idiosyncratic shocks to large banks can have aggregate effects. This analysis looks at whether the size distribution of the banking sector in 29 countries has changed since the reforms, and whether the vulnerability of the real economy to idiosyncratic banking shocks has changed.

5.5.2. Description of the data

Bank-level data are from Bankscope and its successor Bankfocus. Aggregate data is taken from the World Bank's World Development Indicators (WDI). These data are available on an annual basis. Our sample for the empirical analysis includes annual data spanning the period 2005 to 2018, thus covering a symmetric window of seven years before and after the introduction of the reform transition period in 2012 for 29 countries.

5.5.3. Empirical analysis

Hypothesis

"TBTF reforms have reduced the vulnerability of the real economy to idiosyncratic banking shocks"

Analysis

The goal of this analysis is to show whether the size distribution of the banking sector has changed since the reforms. To this end, we fit power law distributions to banking data to measure the thickness of the tails of the distribution of bank sizes. Granularity occurs when the tail exhibits power-law properties, implying a Pareto distribution of bank size with a dispersion or shape parameter ζ less than 2.

We use maximum likelihood estimation to fit an un-truncated Pareto distribution to the bank size distribution. The un-truncated Pareto distribution is given by:

$$\Pr(L(\alpha) > l) = L_{min}^{\zeta} L(\alpha)^{-\zeta}$$

Table 5.5.1 shows the results of this exercise. Column (1) shows the shape parameter of the distributions for the entire sample period. To investigate any potential change in the shape parameter over time, we also fit the Pareto distribution to the bank size distribution of the years 2011 and 2018, shown in column (2) and column (3), respectively.

The results indicate that the shape parameter ζ is always less than two and highly statistically significant, hence indicating that the distribution of bank sizes displays fat tails. Overall, throughout the sample, the distribution of bank size shows power-law properties, despite some smaller changes in the point estimate.

Table 5.5.1: Estimates of power-law coefficient

Estimates of Power-Law Coefficient			
	Full sample	2011	2018
	(1)	(2)	(3)
ζ-parameter	0.183***	0.205***	0.165***
	[0.000714]	[0.00151]	[0.000907]

Given that bank size distribution exhibits power-law properties, idiosyncratic shocks to banks might have aggregate real effects. To investigate this issue, we draw on the notion of the banking granular residual (BGR). Following Bremus et al. (2018), we extract idiosyncratic shocks to banks from bank-balance sheet data according to

$$u_{jit} = \Delta Credit_{jit} - \sum_{\substack{k=1 \\ k \neq j}}^{K} \Delta Credit_{kit}$$

du_{jit} represent differences between bank-$j$specific and average loan growth in country i (where the average excludes bank j) at time t as a measure of idiosyncratic, bank-specific loan growth shocks.

The following sum gives the granular residual for each country i at time t

$$BGR_{it} = \sum_{j=1}^{J} du_{jit} \frac{credit_{ijt}}{credit_{it}}.$$

Here we do not take any stance about whether the size of shocks is linked to the size of banks: large banks may have more or less volatile loan supply than smaller banks. To prevent any heterogeneous responses of banks to aggregate shocks from showing up as idiosyncratic variation, we compute - as a robustness test - the bank granular residual (BGR) based on idiosyncratic credit growth shocks controlling for individual bank size.

We examine the effect of a shock to BGR_{it} on aggregate bank lending and real economic activity using the following set of regressions:

$$y_{i,t+1} - y_{i,t} = \alpha_i + \alpha_t + \beta x_{t-1} + \gamma BGR_{it-1} + \epsilon_{t+h} \qquad (1)$$

$y_{i,t}$ is either log domestic credit or log GDP. $x_{i,t}$ is a vector of control variables. The parameter estimates γ yields the response of $y_{i,t}$ to a shock to BGR_{it}.

To investigate if idiosyncratic shocks to G-SIBs transmit differently to the real economy since the announcement of TBTF reforms, we estimate equation (1) separately over the pre-reform period from 2005 to 2011 and over the post-reform period from 2012 to 2018. Table 5.5.2 shows the effect of idiosyncratic banking shocks on real credit growth for the period before the reform (columns 1 and 2) and after the start of the reform transition period (columns 3 and 4), separately. Table 5.5.3 replicates the analysis from Table 5.5.2, but uses growth in real GDP per capita as the dependent variable.

Table 5.5.2: Determinants of aggregate growth fluctuations: growth in log credit

Determinants of Aggregate Growth Fluctuations: Growth in Log Credit

	Pre-reform		Post-reform	
	(1)	(2)	(3)	(4)
BGR (assets, differences, w/o bank j)	0.1808**		0.0748	
	(0.0714)		(0.0772)	
BGR (loans, differences, controlling for bank size)		0.2019**		0.0915
		(0.0795)		(0.0782)
Log GDP per capita	0.1029**	0.1072**	0.1518**	0.1508**
	(0.0451)	(0.0441)	(0.0564)	(0.0558)
Inflation, GDP deflator (annual &)	-0.0037	-0.0038	0.0001	0.0001
	(0.0040)	(0.0040)	(0.0026)	(0.0026)
Money and quasi money (M2) as % of GDP	0.0020***	0.0019***	0.0019***	0.0019***
	(0.0006)	(0.0006)	(0.0007)	(0.0007)
(Exports + Imports)/GDP	-0.0005	-0.0005	0.0015***	0.0015***
	(0.0005)	(0.0005)	(0.0004)	(0.0004)
Domestic credit provided by banking sector (% of GDP)	0.0019***	0.0019***	-0.0010	-0.0010
	(0.0007)	(0.0007)	(0.0010)	(0.0010)
Net Foreign Assets/GDP	-0.0000**	-0.0000**	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank risk (z-score)	0.0003	0.0003	0.0005	0.0005
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Constant	-1.2419***	-1.2824***	-1.6406***	-1.6303***
	(0.4037)	(0.3946)	(0.5577)	(0.5513)
Observations	195	195	195	195
R-squared	0.312	0.314	0.316	0.317
Number of countries	30	30	29	29

Figure 5.5.1 depicts the fitted Pareto distribution against the bank size histogram (density) observed in the data for the pooled sample. We omit the top 10% of observations to enhance the visibility of the results.

Panel A and Panel B show the fitted distribution and the histogram for the pre-reform period and the post-reform period, respectively.

In both sample periods, the power-law (Pareto) distribution fits the observed size distribution very closely, indicating tail thickness in the bank size distribution in both sample periods. This is consistent with the presence of a very large number of small banks and very few, very big banks. Hence, too big-to-fail reforms did not materially affect the size distribution in the banking sector. If anything, the bank size distribution exhibits slightly more tail thickness in the period after 2012.[139]

[139] This visual inspection is also supported by the estimated shape parameters: The shape parameter in the post-reform period is slightly smaller compared to the pre-reform period.

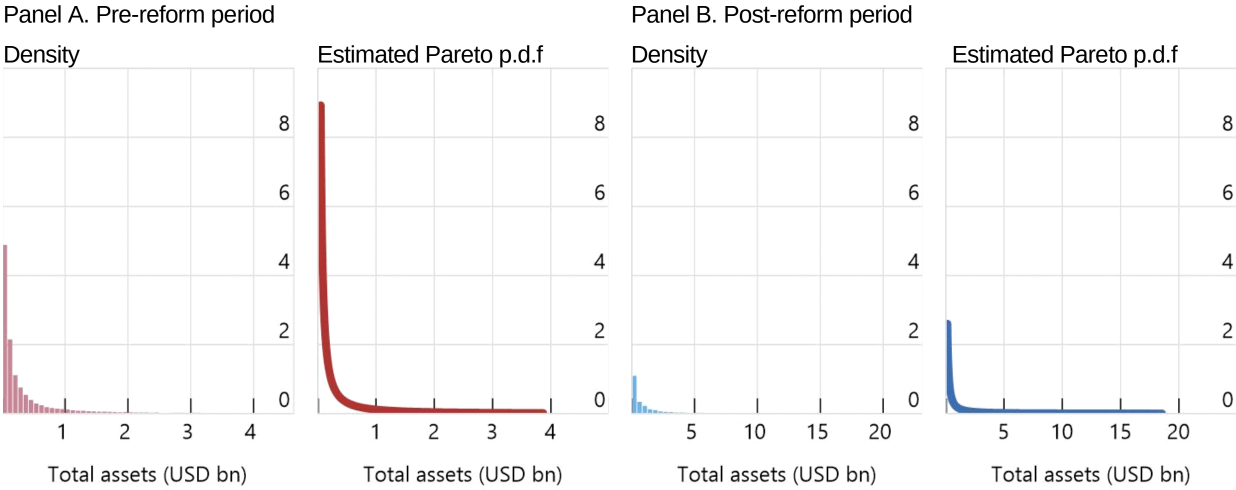
Table 5.5.3: Determinants of aggregate growth fluctuations: growth in log GDP

Determinants of Aggregate Growth Fluctuations: Growth in Log GDP

	Pre-reform		Post-reform	
	(1)	(2)	(3)	(4)
BGR (assets, differences, w/o bank j)	0.1645*		-0.1909	
	(0.0833)		(0.1512)	
BGR (loans, differences, controlling for bank size)		0.2341***		-0.1292
		(0.0849)		(0.1626)
Log GDP per capita	0.1285***	0.1321***	0.1560**	0.1553**
	(0.0448)	(0.0463)	(0.0613)	(0.0596)
Inflation, GDP deflator (annual &)	0.0003	0.0002	-0.0163***	-0.0163***
	(0.0036)	(0.0036)	(0.0044)	(0.0043)
Money and quasi money (M2) as % of GDP	0.0016**	0.0016*	-0.0009	-0.0008
	(0.0008)	(0.0008)	(0.0007)	(0.0007)
(Exports + Imports)/GDP	-0.0006	-0.0006	0.0007*	0.0007*
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Domestic credit provided by banking sector (% of GDP)	-0.0032***	-0.0032***	-0.0015	-0.0016
	(0.0011)	(0.0011)	(0.0012)	(0.0013)
Net Foreign Assets/GDP	0.0000	0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank risk (z-score)	-0.0004	-0.0004	0.0016	0.0018
	(0.0006)	(0.0006)	(0.0015)	(0.0015)
Constant	-0.8854*	-0.9180*	-1.2316*	-1.2335**
	(0.4379)	(0.4510)	(0.6087)	(0.5942)
Observations	195	195	196	196
R-squared	0.669	0.675	0.616	0.613
Number of countries	30	30	29	29

Distribution of bank size

Density **Figure 5.5.1**



Notes: This figure displays the distribution of bank size (A = total assets in billion USD) against the density. The red line is the estimated Pareto p.d.f.. Estimates are performed excluding the bottom quartile of observations, using robust standard errors, and clustering observations at the bank level. In order to enhance visibility, the top 10% of banks in terms of size are not plotted but are included in the estimates of the probability density function.

Sources: World Bank's World Development Indicators (WDI); Bankscope.

5.5.4. Results

For the pre-reform period from 2005 to 2011 we find a positive and statistically significant effect of idiosyncratic banking shocks on credit growth. This holds true also if we compute the BGR controlling for bank size. In terms of economic significance, over the pre-reform period the beta coefficient for the BGR is between 0.15 and 0.16, meaning the BGR accounts for about 15% of the variation in aggregate credit growth in our panel.[140] By contrast, over the post-reform period the effect of idiosyncratic bank shocks on credit growth turns insignificant. Table II shows similar results using growth in GDP per capita as the dependent variable. The beta coefficient for the pre-reform period reveals that the variation in the BGR contributes about 9-12% to the variation in GDP per capita growth.

5.5.5. Conclusions

Our findings suggest that the reforms implemented in the years after 2011 have changed the structural relation between idiosyncratic banking shocks and the dynamics of the real economy. Prior to the reforms the economy was vulnerable to these banking shocks: they explained a non-negligible share of the variation of the real economy. Since the reforms, the macro economy seems to be shielded from idiosyncratic banking shocks. Note, however, that this analysis cannot causally attribute this structural change to the TBTF reforms. Furthermore, the presence of the financial crisis in the data in the pre-reform period makes attribution of the effects even more complex.

5.6. Estimating global bank interconnectedness using stock returns

5.6.1. Introduction

The concept of *connectedness* is central in modern financial markets. Complex linkages among market participants represent a distinguishing feature of the global financial system. Agents engage in different types of financial transactions – including across geographic and market boundaries – creating convoluted network structures. The recent experience of the financial crisis indicates that interconnectedness may increase suddenly following large shocks. In such cases, propagation may be highly non-linear and take place through different channels, including for instance trade, bank loans and investment flows.

The academic literature has not yet provided a definitive assessment on the role of interconnectedness for financial stability. A seminal paper by Allen and Gale (2000) argued that interconnectedness is associated with higher financial stability. In this model, more complete structures may be more robust to the transmission of shocks than incomplete ones, due to the fact that there are better diversification opportunities when a shock occurs. However, this finding holds only as long as the magnitude of negative shocks is sufficiently small; beyond a certain point, a dense network may amplify the transmission of shocks, leading to a more fragile financial system (Acemoglu, Ozdaglar, and Tahbaz-Salehi, 2015). Along similar lines,

[140] The beta coefficient is calculated as the coefficient estimate, multiplied with the standard deviation of the explanatory variable, divided by the standard deviation of the dependent variable.

Gai, Haldane, and Kapadia (2011) show that in a network of interbank lending, greater complexity and concentration may amplify the fragility of the system. In a similar vein, Castiglionesi, Feriozzi, and Lorenzoni (2019), show that a higher degree of financial integration leads to more stable interbank rates in normal times, but to larger spikes during distress.[141]

Recent experience – most importantly the global financial crisis of 2007-08 – has demonstrated that complicated linkages among financial intermediaries may contribute to shock propagation, amplifying the effects of information asymmetries, market frictions, and other externalities. Following the crisis, policy-makers promoted an ambitious regulatory reforms agenda, aimed at addressing – among others – interconnectedness and systemic risks. The G-SIB assessment framework, for instance, measures interconnectedness by using three indicators: (i) intra-financial system assets; (ii) intra-financial system liabilities; and (iii) securities outstanding.[142] In addition, the deduction approach to banks' investments in other banks' capital and external TLAC also aims to limit interconnectedness.[143]

In this section we apply the framework developed by Diebold and Yılmaz (DY) in several papers to measure banks' connectedness over time. The methodology uses stock market returns and return volatilities and is based on the notion of variance decomposition from an N-variable VAR (Sims, 1980). Intuitively, returns and volatility connectedness record how much of the H-step-ahead forecast error variance of some variable, i, is due to innovations in another variable, j. This approach, while providing an indirect measurement of connectedness, is closely related both to network theory and to measures of systemic risk (Diebold and Yılmaz, 2014).

We focus on systemically important banks (both G-SIBs and D-SIBs) given their relevance for the financial system and their role in the last financial crisis. We discuss the results in connection with the announcement and/or implementation of TBTF reforms as the hypothesis tested is whether regulatory initiatives have contributed to lower interconnections among systemic banks. We will address this question considering both returns and volatility connectedness. Admittedly, this is not an easy task, for the following reasons: first, over the period considered there are many confounding factors; second, the methodology does not allow to interpret the results in a causal manner. Nonetheless, we derive some anecdotal evidence and comment on changes in connectedness (if any) in relation to TBTF reforms. The main result can be summarised as follows: volatility connectedness among systemic banks, both G-SIBs and D-SIBs, has slightly reduced since the outbreak of the financial crisis of 2007-08, but remains at level higher than before the crisis. This implies that the propagation mechanism of volatility shocks among systemic banks is less influential than during the peak of the financial crisis in 2008; however, interconnectedness measures are now higher than they were in the years leading up to the crisis (2005-07). Importantly, the described patterns do not appear much related to key dates in the FSB roadmap of regulatory reforms. Comparing the evolution of interconnectedness in our sample against the same metrics for global stock markets is informative. Trends in interconnectedness are similar: for global stock markets

[141] Other contributions include (not exhaustive list): Acharya, Pedersen, Philippon, and Richardson (2017), Billio, Getmansky, Lo, and Pelizzon (2012), Allen, Bali, and Tang (2012).

[142] BCBS (2013).

[143] BCBS (2016).

volatility interconnectedness has also slightly decreased from the peak of the financial crisis, though it remains at higher levels compared to the pre-crisis period.

We proceed as follows. In Section 5.6.2 we introduce the methodological framework. In Section 5.6.3 we describe the dataset. In Section 5.6.4, we discuss the results on connectedness for G-SIBs and D-SIBs. We conclude in Section 5.6.5. Robustness checks are presented in the Appendix.

5.6.2. Methodological framework

The methodology is based on assessing shares of forecast error variation at any given horizon *h* in various areas – e.g. markets, sector, countries, institutions – due to shocks arising elsewhere in the system. Measures of connectedness are based on "cross" variance decompositions, or similarly spill-overs, which represent the fraction of the *h*-step ahead error variances in forecasting variable *i* due to a shock in variable *j*, for all *i, j = 1,…, n* where *i≠j*. Following Diebold and Yilmaz, we use stock market returns and volatility of returns to measure financial institutions' connectedness. For variance decomposition, we use the generalised variance decomposition (GVD) approach developed in Pesaran and Shin (1998).[144]

The set of variance decompositions computed for each pair of variables constitutes the building blocks of the connectedness table (Table 5.6.1). We denote by d_{ij}^{h} for all *i, j =1,…,n* the fraction of variable *i*'s *h*-step forecast error variance due to shock in variable *j* which is part of the system under analysis. The off-diagonal entries d_{ij}^{h} can be interpreted as a measure of the spill-over effect on variable *i* due to a shock to variable *j* (**pairwise directional connectedness**). Through this scheme it is possible to aggregate bottom-up pairwise connectedness, thus obtaining a measure of system-wide connectedness, i.e. **total connectedness,** the lower-right cell in the connectedness table.

From this table, it is possible to compute additional metrics: 1) the **total directional connectedness from others to *i***, which can be interpreted as the total exposure of variable *i* to shocks arising elsewhere in the system; 2) the **total directional connectedness to others from *j***, which is a measure of the shock from variable *j* to the rest of the system; 3) the **net directional connectedness –** which is calculated as the difference between (1) and (2); a positive value is evidence of variable *i* being a net provider of shocks to the rest of the system (*"outward spill-over effect"*), while a negative measure is evidence of variable *i* being a net recipient of shocks from others (*"inward spill-over effect"*).

The methodology can be applied in both a static and dynamic fashion.[145] In this analysis, we focus on the latter as our interest is in investigating whether connectedness has changed over time and, if so, to what extent this change may be related to TBTF reforms.

[144] The GVD methodology allows obtaining an identification scheme with order-invariant variance decompositions.

[145] While the static approach provides an "average" characterization of connectedness over time, it fails to capture important changes occurred during the observation period..

Table 5.6.1: Connectedness table

i ↓ j →	x_1	x_2	x_3		…	x_n	*From others*	
x_1	d_{11}^h	d_{12}^h	d_{13}^h		…	d_{1n}^h	$\sum_{j=1}^{n} d_{1j}^{h}$	$j \neq 1$
x_2	d_{21}^h	d_{22}^h	d_{23}^h		…	d_{2n}^h	$\sum_{j=1}^{n} d_{2j}^{h}$	$j \neq 2$
x_3	d_{31}^h	d_{32}^h	d_{33}^h		…	d_{3n}^h	$\sum_{j=1}^{n} d_{3j}^{h}$	$j \neq 3$
….	…	…	…		…	…	….	…
x_n	d_{n1}^h	d_{n2}^h	d_{n3}^h			d_{nn}^h	$\sum_{j=1}^{n} d_{nj}^{h}$	$j \neq n$
To others	$\sum_{i=1}^{n} d_{i1}^{h}$	$\sum_{i=1}^{n} d_{i2}^{h}$	$\sum_{i=1}^{n} d_{i3}^{h}$			$\sum_{i=1}^{n} d_{in}^{h}$	$1/_{n} \sum_{i,j=1}^{n} d_{ij}^{h}$	
	$i \neq 1$	$i \neq 2$	$i \neq 3$			$i \neq n$	$i \neq j$	

5.6.3. *Description of the data*

We consider G-SIBs and D-SIBs – 31 and 74 respectively – from the following 25 jurisdictions: i) Canada and United States (**North America**), ii) Germany, Spain, France, Italy, Netherlands, Switzerland, Sweden and the United Kingdom (**Europe**), iii) Japan, Korea, Singapore, Australia, Hong Kong (**Asia-Pacific**), iv) Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Turkey, South Africa (**Rest of the world**).[146] Underlying data from

[146] A bank is classified as G-SIBs if, at any time since 2011, it has been included in the FSB list of global systemically important banks. To our purposes, it is irrelevant if a bank looses its G-SIBs *status* over time due, for instance, to declining systemic importance. G-SIBs are located in the following jurisdictions: Canada, United States, Germany, Spain, France, Italy, Switzerland, Sweden, United Kingdom, China and Japan. The list of D-SIBs covers all domestic systemically important banks from 21 countries (all countries previously listed, excluding United States, Switzerland, China and France).

Refinitiv covers daily stock prices the period January 2000 - December 2019 for all banks included in our analysis.

We calculate weekly stock returns as the change in log closing price Friday-to-Friday. Returns are then converted from nominal to real terms using the consumer price indexes, monthly basis, from the "BIS long consumer prices database". Assuming that the monthly inflation rate is constant within the month, we compute weekly inflation rates and apply the following formula to obtain real returns: $(1+i_t)/(1+\pi_t^w)-1$, where i_t and π_t^w are, respectively, the weekly nominal return and the inflation rate.[147] Real returns are winsorized, with cut-off percentiles at 1% and 99% , to exclude bias from outliers. Volatility is computed as the standard deviation of weekly returns, with a rolling window equal to 10 weeks. This approach is different from DY, who suggest computing either a measure of realised volatility (Andersen et al., 2010, 2013), or volatility estimators based on opening, closing, high and low prices (Garman and Klass, 1980; Alizadeh et al., 2002). Because of data availability and quality, the above measures cannot be computed. We therefore use a simple measure of historical volatility, which is nevertheless useful to infer some information on volatility dynamics.

5.6.4. Results

In this section, we describe the results applying the Diebold-Yilmaz framework to our dataset. First of all, we compute a dynamic measures of total connectedness – i.e. the lower-right cell in the connectedness table – for G-SIBs and D-SIBs considering a rolling window equal to 100 weeks.[148] As relevant policy dates at global level, we have highlighted: i) **April 2009** (London summit), when the G20 announced its resolution to strengthen financial supervision and regulation; ii) **September 2009** (Pittsburgh summit), when the G20 decided, among other things, to address the issue of cross-border resolutions and systemically important financial institutions by end-2010; iii) **November 2011**, when the FSB published the list of G-SIBs for the first time iv) October 2012, when the D-SIBs framework by the BCBS was established and v) January 2016, when the implementation phase for the G-SIBs surcharge started.

G-SIBs sample

In order to strike a balance between the sample coverage and the time-series dimension, we have considered three subsamples: *a)* all G-SIBs (31 banks, June 2012 to December 2019), *b)* all G-SIBs excluding intermediaries from China (27 banks, February 2005 to December 2019), and *c)* all G-SIBs excluding intermediaries from China and Japan (24 banks, January 2000 to December 2019).[149] In this section, we will discuss the results for sample *b*, which we believe contains most of the information as it both extends over a relatively long period, which includes the financial crisis, and keeps a good coverage of banks (Figure 5.6.1). The plots for total connectedness on the other samples are presented in Appendix A; results are broadly consistent across all samples considered.

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[147] If we observe missing data, we use recursively the last available observation in the week.

[148] Applications in DY (2014, 2017, 2009) consider rolling windows of 100 days, 150 days and 200 weeks respectively.

[149] To estimate the VAR model we need complete time-series for all banks included in the sample. All Chinese banks were publicly traded in September 2015 only; Bank of China Limited was the first Chinese bank to be listed on the stock market in December 2010. Stock prices for Japanese banks are observed since March 2003 (Mitsubishi UFJ Financial Group); quotes for all banks are available since February 2005.

The first interesting feature is that returns and volatility connectedness have similar magnitudes, although volatility total connectedness is slightly lower. This evidence – which is in line with several applications in DY – reflects the fact that while stock market returns tend to make synchronous movements in response to both positive and negative shocks, volatility shows a degree of asymmetry, with significant jumps across markets, especially in bad times. The second relevant point is that volatility connectedness responds more rapidly to economic shocks, thus being a more useful tool than returns connectedness to gauge the degree of simultaneous movements in times of crisis.

Total Connectedness (All G-SIBs ex. China)

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Figure 5.6.1

Notes: Red vertical line indicates Lehman collapse (15 September 2008). Black vertical lines indicate G20 meetings (April 2009 and September 2009), the establishment of the D-SIB framework (October 2012), and the beginning of implementation phase for the G-SIB surcharge (January 2016).

Sources: Refinitiv; BIS; FSB calculations.

The third insight is that both returns and volatility connectedness among G-SIBs increased largely before the outbreak of the financial crisis of 2007-08 (though from low levels).[150] Since then, volatility connectedness among G-SIBs has slightly declined amid some cycles. In contrast, returns connectedness does not display any specific pattern and its most recent level is higher than the value estimated at the beginning of the crisis. In both cases, interconnectedness is higher than before the crisis. A t-test on the time series before and after 2008 indicates that the means in the two periods are statistically different. To gauge the evolution of the interconnectedness in our sample, we have considered as a baseline the same metrics for global stock markets, i.e. markets where G-SIBs are located. Interestingly, also in this case volatility interconnectedness has slightly decreased from the peak of the financial crisis, though it remains at higher levels compared to the pre-crisis period (Appendix B).

To check the robustness of the above results, we run the analysis: *i*) considering a longer window, i.e. 200 weeks, which should give us information on a more medium/long term perspective;[151] *ii)* considering a different winsorising interval; *iii)* Aggregating banks by

[150] Interestingly, the increasing cycle in global banks' interconnectedness started already in 2006, probably related to the Fed's unexpected decision to tighten monetary policy in May and June 2006; volatility connectedness then started slowly building up in anticipation of the forthcoming great financial crisis (DY, 2017).

[151] While a shorter window like 100 weeks allows tracking movements in returns and volatility with more resolution, it also provides more irregular patterns. It is also noted that some of the drops in connectedness do not necessarily reflect specific economic events, but are rather the result of the rolling window mechanics, i.e. particularly meaningful observations leaving the rolling sample after 100 weeks.

geographic areas, i.e. North-America, Europe, Asia-Pacific. In the latter case, the goal is to reduce the dimensionality of the VAR model, which may be a problem for the robustness of the estimates.[152,153] The estimation results confirm previous findings: since the beginning of the great financial crisis, volatility connectedness, albeit some cycles, has declined. In the case of both returns and volatility, recent levels are higher now than they were in the years leading up to the financial crisis. Patterns do not appear correlated with the key events in the FSB roadmap of regulatory reforms.

D-SIBs sample

In the case of D-SIBs, the issue of the VAR dimensionality is more pressing than for G-SIBs, given that we have to deal with a far larger number of banks (74 vs. 31). In addition, stock price data are often missing, especially in some countries, thus making it difficult to select a sufficiently long common sample to run the analysis. For these reasons, we created regional indexes of D-SIBs, i.e. North-America, Europe, Asia-Pacific and rest of the world (see Section 5.6.3), aggregating data by means of simple averages. The spillover plots for total connectedness, with a 100-week rolling window, are presented in Figure 5.6.2.

Total connectedness (all D-SIBs, 100-week rolling window)

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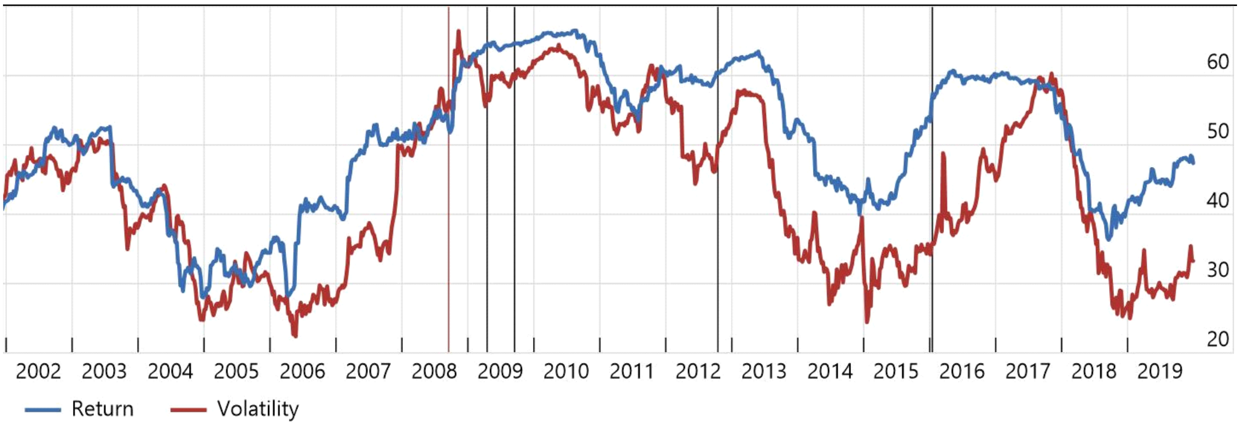
Figure 5.6.2



Notes: Red vertical line indicates Lehman collapse (15 September 2008). Black vertical lines indicate G20 meetings (April 2009 and September 2009), the establishment of D-SIB framework (October 2012), and the beginning of implementation phase for the G-SIB surcharge (January 2016).

Sources: Refinitiv; BIS; FSB calculations.

In the case of D-SIBs, both returns and volatility connectedness have decreased since the outbreak of the great financial crisis and are close to levels seen before 2008. Interestingly, the estimated level of connectedness among D-SIBs is lower compared to G-SIBs, thus indicating a more limited role for contagion for this type of bank. Results are robust to a longer window interval (Appendix C).

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[152] We compute a time-series for each geographic area by taking a simple average of real returns for all banks from that area. The area “Rest of the world” includes Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Turkey and South Africa. Among these countries, China is the only jurisdictions where G-SIBs are located. However, due to the fact that we have decided to run the analysis on sample (ii), which excludes Chinese banks, we only cover G-SIBs located in North America, Europe and Asia-Pacific.

[153] The use of the GVD framework in alternative to the traditional Cholesky factorization already provides a robust identification scheme with order-invariant variance decompositions. Nonetheless, robustness of the estimates may still be an issue.

5.6.5. Conclusion

This section investigates the dynamics of returns and volatility connectedness for a sample of G-SIBs and D-SIBs. The findings – robust across a number of specifications – point to the fact that volatility connectedness for all systemic banks has slightly reduced since the global financial crisis, thus implying that propagation mechanism of volatility shocks among systemic banks are less powerful since then. This finding does not apply to stock returns of G-SIBs. Yet the most recent estimates for interconnectedness point to higher levels compared to pre-crisis magnitudes, which could be the effect of the large integration process occurred in financial markets over time.

It is difficult to assess whether the decreasing degree of volatility connectedness is attributable to TBTF reforms. First, over the period considered there are many confounding factors, such as the extraordinary monetary policy measures undertaken globally in response to the financial crisis and many regulatory reforms covering different areas of the financial system. Second, the methodology is agnostic as to how connectedness arises or changes. It is therefore not straightforward to establish a causal link between TBTF reforms and changes in interconnectedness. Nonetheless, the estimated dynamics are not very correlated with the key policy dates of the TBTF reforms.

5.6.6. Appendix

Total connectedness

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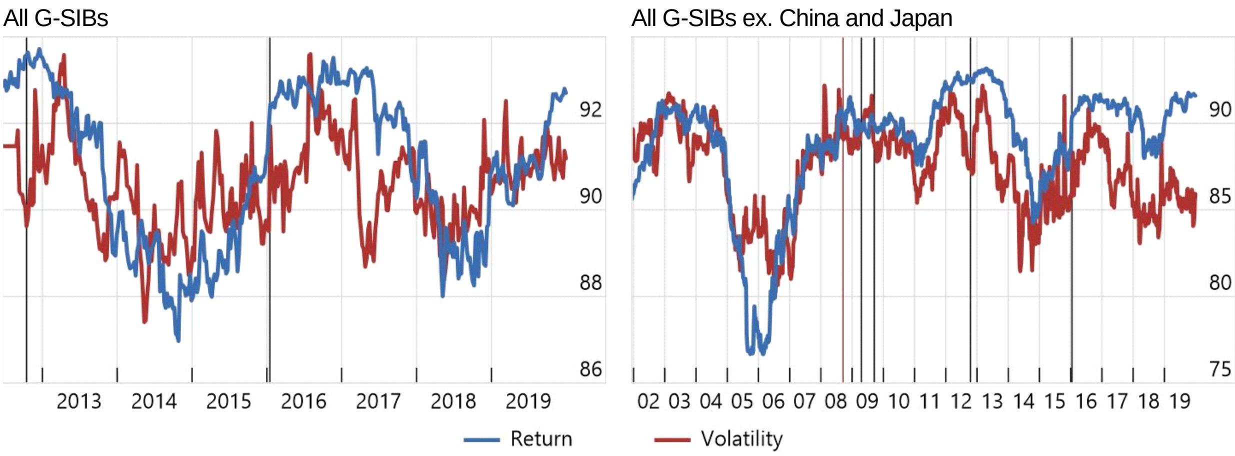
Figure 5.6.3



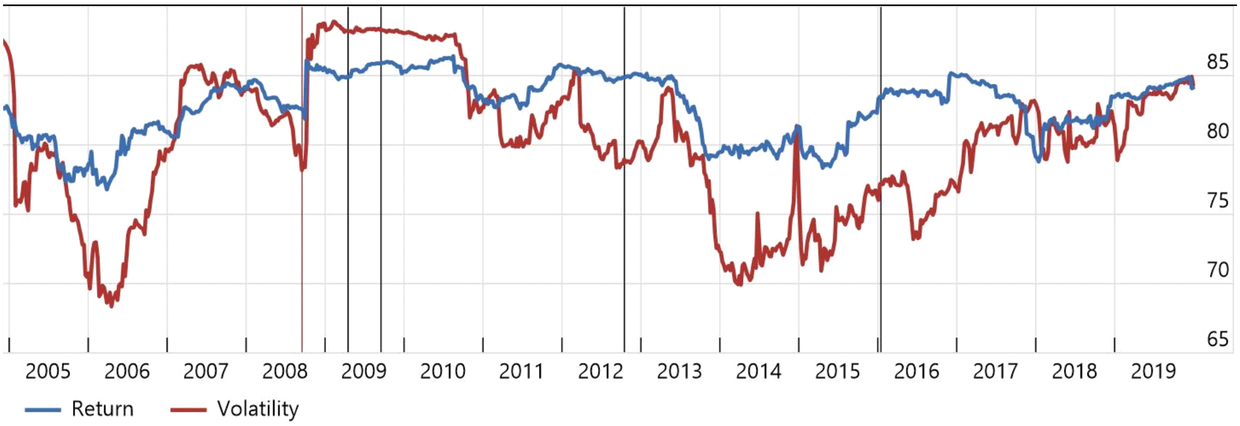
Notes: Red vertical line indicates Lehman collapse (15 September 2008). Black vertical lines indicate G20 meetings (April 2009 and September 2009), the establishment of D-SIB framework (October 2012), and the beginning of implementation phase for the G-SIB surcharge (January 2016). Left hand panel contains only lines corresponding to October 2012 and January 2016.

Sources: Refinitiv; BIS; FSB calculations.

Total connectedness (global stock markets, 100-week rolling window)

Index

Figure 5.6.4



Notes: Red vertical line indicates Lehman collapse (15 September 2008). Black vertical lines indicate G20 meetings (April 2009 and September 2009), the establishment of D-SIB framework (October 2012), and the beginning of implementation phase for the G-SIB surcharge (January 2016).

Sources: Refinitiv; BIS; FSB calculations.

Total connectedness (200-week rolling window)

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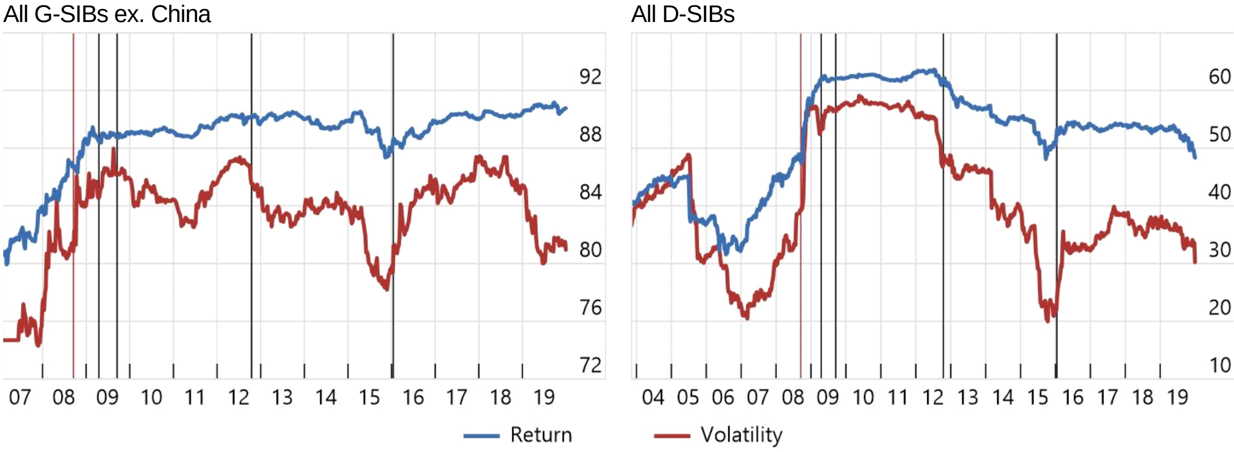
Figure 5.6.5



Notes: Red vertical line indicates Lehman collapse (15 September 2008). Two black vertical lines indicate G20 meetings (April 2009 and September 2009).

Sources: Refinitiv; BIS; FSB calculations.

Total connectedness (200-week rolling window)

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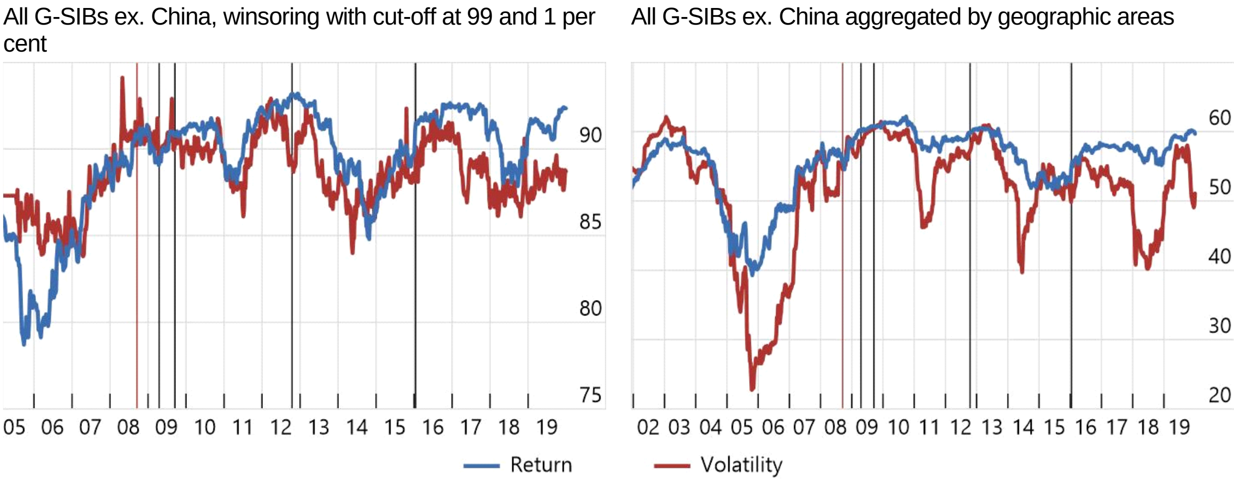
Figure 5.6.6



Notes: Red vertical line indicates Lehman collapse (15 September 2008). Black vertical lines indicate G20 meetings (April 2009 and September 2009), the establishment of D-SIB framework (October 2012), and the beginning of implementation phase for the G-SIB surcharge (January 2016).

Sources: Refinitiv; BIS; FSB calculations.

5.7. Portfolio similarity across G-SIBs

5.7.1. Introduction

Interconnections between financial institutions can have both direct and indirect transmission channels. Bilateral exposures across institutions via contractual obligations may represent direct transmission mechanisms of shocks within a financial network (Allen and Babus, 2009; Gorton and Metrick, 2012; Giglio, 2013). Indirect contagion in contrast occurs when firms' actions generate spillover effects that in turn affect other firms through non-contractual channels. Indirect linkages may also arise from exposure to common risk factors, which can increase the likelihood and impact of simultaneous bank failures.

Holding common or correlated assets, for instance, may expose financial intermediaries to the same type of shocks. In such a scenario, a forced sale of assets could lead to a larger fall in prices, which in turn may affect other financial institutions that hold similar assets. These institutions may then be forced to sell assets as well, thus reinforcing the downward price movement. The specific contagion mechanism in this case occurs on the asset side of the balance sheet and examines whether overlapping investment portfolios can increase systemic risk through fire-sales (Greenwood et al., 2015 and Eisenbach et al., 2015). The assumption in this case is that financial intermediaries, in response to a common shock, will re-balance their portfolios similarly, thereby transmitting risks to other sectors of the economy. In these types of models, a bank experiencing a negative shock may decide to sell assets to adjust to target leverage. Under the assumptions that potential buyers are limited, asset sales reduce prices with ultimate negative effects on other banks' capital. Such a spillover may trigger additional rounds of sales, further weighing on prices and capital.

The empirical literature on asset commonality in financial intermediaries' portfolios is rapidly growing, with applications covering the insurance (Getmansky et al, 2016), the asset management (Reca et al. 2014) and the banking industry (Abad et al., 2017; Blei and Ergashev, 2014). Cai et al. (2018) finds that their measure of interconnectedness, which is derived considering the distance between two banks' syndicated loan portfolios, is positively related to different measures of systemic risk.

A key question in the evaluation of TBTF reforms is whether they have contributed to change G-SIBs' activities/business models in a way that leads to G-SIBs having more homogeneous asset structures. The underlying mechanism could be a similar response to the incentives introduced by the new regulatory framework, which may have induced G-SIBs to optimise their reactions, ending up with more similar asset allocations. If this is the case, G-SIBs may be exposed to common shocks in a way that leaves the aggregate provision of financial services more volatile. The hypothesis tested in this section is the following: *"TBTF reforms have driven changes in SIBs activity such that bank portfolios have become more similar to each other".*

The metric considered in this section to appraise the level of closeness of G-SIBs portfolios is the cosine similarity (CS). This measure is widely used in the empirical literature on assets commonality. The degree of portfolio overlap between bank *i*'s and bank *j*'s portfolio weights, at time *t*, is measured based on the following formula:

$$CS\ (bank_{it},\ bank_{jt}) = \sum_{k=1}^{N} w_{ikt} w_{j,k,t} \Big/ \left(\sqrt{\sum_{k=1}^{N} w_{ikt}^2}\ \sqrt{\sum_{k=1}^{N} w_{jkt}^2} \right)$$

Intuitively, this metric measures the angle between two non-zero vectors; it is equal to 1 when the vectors have the same orientation (complete similarity) and 0 when the vectors are oriented at 90 degrees relative to each other (no similarity).

5.7.2. Description of the data

In this section, we have used G-SIBs' yearly balance sheet data from FitchConnect covering the period 2000-18 from 12 jurisdictions (Canada, United States, Germany, Spain, France, Italy, Netherlands, Switzerland, United Kingdom, Sweden, Japan and China). The following asset classes are included in the analysis: i) residential mortgages, ii) commercial real estate mortgages, iii) corporate loans, iv) loans to monetary financial institutions (MFI), v) other retail loans, vi) other loans, vii) derivatives and viii) government securities. Weights are computed relative to total assets. Two data-related issues need to be highlighted: first, the panel is unbalanced, as data are not available for all G-SIBs every year; second, a more detailed breakdown of assets – including for instance currency, country, maturity, issuer, security – is not available, thus limiting to some extent the information that can be obtained from the analysis. A more granular dataset could provide more details to investigate the degree of overlapping across banks' portfolios.

The evolution of the average G-SIB's portfolio is represented in Figure 5.7.1.[154] The share of residential mortgage loans, commercial real estate, government securities and derivatives has

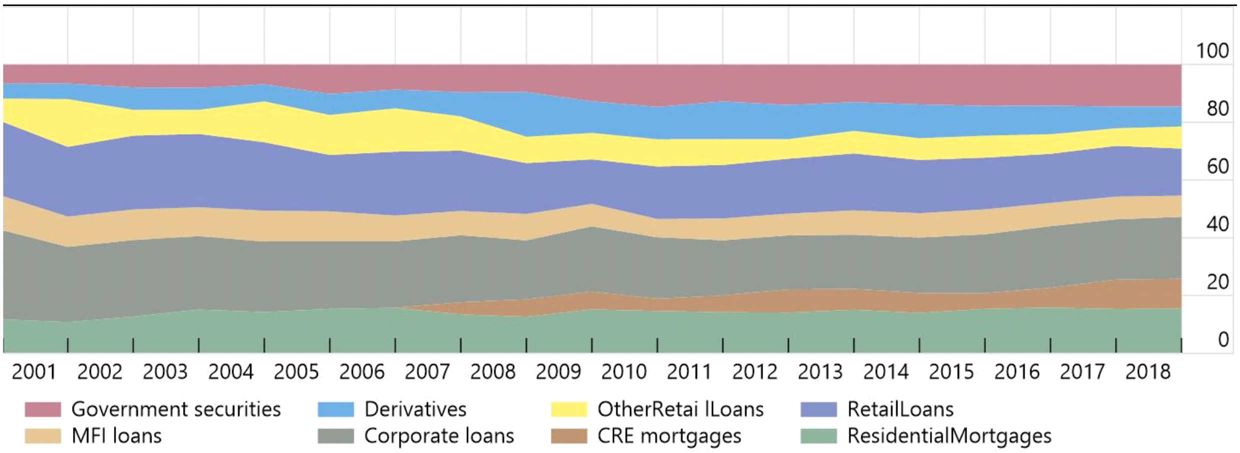
[154] In Figure 5.7.1, for the sake of simplicity, it is assumed that the portfolio is composed by the eight asset classes mentioned in this section. In other words, no asset class other than the eight considered are included in this figure.

increased since 2000; in contrast, the percentage of corporate, MFI, loans and retail loans has decreased and that of other retail loans has remained unchanged.

Evolution of the average G-SIB portfolio

In per cent

Figure 5.7.1



Sources: FitchConnect; FSB calculations.

To gauge the progress of implementation in FSB jurisdictions over time, we have used the RRI. For the analysis, we have used a simple average of the three sub-indexes. More detailed statistics are presented in Table 5.7.1.

Table 5.7.1: Descriptive statistics

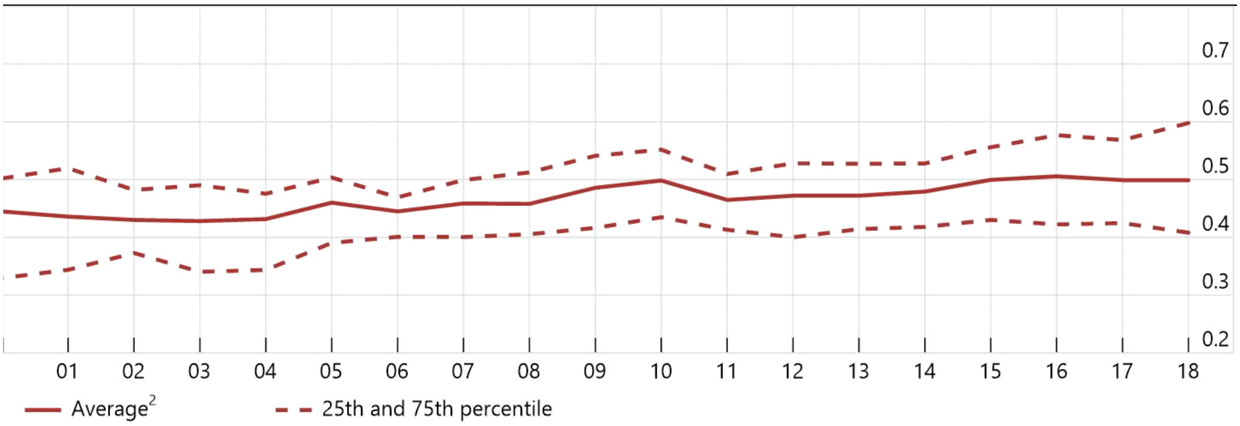
	N. banks	Resolution Index			Cosine similarity			
		mean	*min*	*max*	*mean*	*min*	*max*	*st. deviation*
Canada	1	0.35	0.15	0.72	0.52	0.45	0.62	0.04
China	4	0.12	0.02	0.19	0.50	0.39	0.60	0.05
France	4	0.52	0.14	0.72	0.43	0.29	0.64	0.08
Germany	2	0.43	0.11	0.72	0.47	0.33	0.58	0.07
Great Britain	5	0.46	0.15	0.80	0.49	0.31	0.67	0.10
Italy	1	0.39	0.09	0.70	0.39	0.31	0.53	0.07
Japan	3	0.30	0.11	0.56	0.46	0.31	0.56	0.06
Netherlands	1	0.42	0.06	0.68	0.41	0.32	0.52	0.07
Spain	2	0.47	0.22	0.68	0.46	0.31	0.66	0.09
Sweden	1	-	-	-	0.51	0.38	0.58	0.05
Switzwerland	2	0.60	0.48	0.81	0.46	0.05	0.56	0.11
United States	8	0.70	0.51	0.86	0.47	0.19	0.63	0.09
Total	***34***							

Results on cosine similarity are reported in Figure 5.7.2. The measure represented below is the average similarity computed across all G-SIBs at each point in time; the 25th and 75th percentile are also included. The first key insight is that, since 2000, G-SIBs' portfolios have on average changed in the direction of higher similarity; this shift may be related to the patterns observed in Figure 5.7.1, which points to a gradual reallocation of G-SIBs' portfolio shares towards residential mortgage loans, commercial real estate, government securities and derivatives.

Measures of G-SIBs' portfolio similarity[1]

Index

Figure 5.7.2



[1] Measured by cosine similarity. [2] All G-SIBs are covered as long as data is available for each year.

Sources: FitchConnect; FSB calculations.

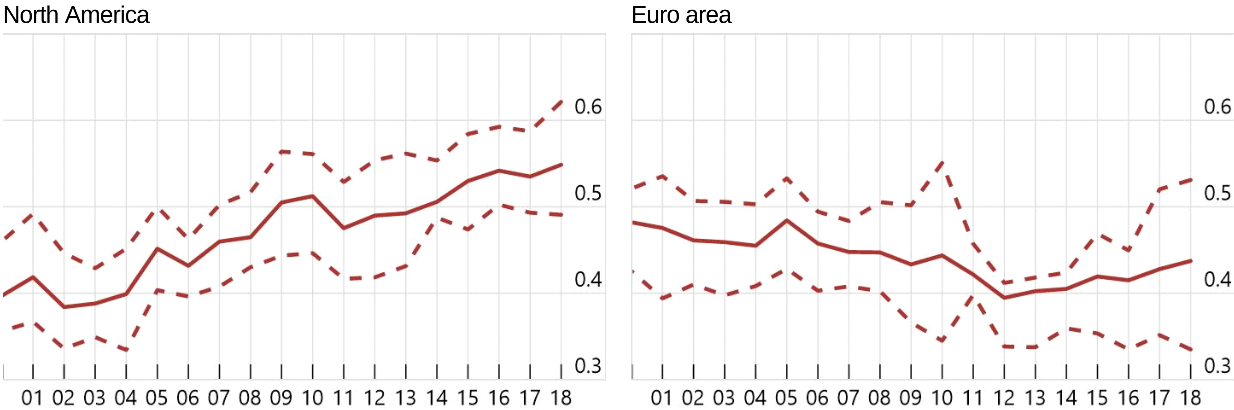
This evidence suggests that some assets commonality exists, and actually increased gradually from early 2000s. The aggregate increase for the average portfolio, though statistically significant at 5% confidence level, is low in magnitude.[155]

An interesting feature is that portfolio similarity for G-SIBs varies across geographical areas. For G-SIBs located in the euro area (France, Germany, Italy, Netherlands and Spain), asset commonality appears unchanged over time. In contrast, increasing overlapping is observed for G-SIBs located in North America (United States and Canada), elsewhere in Europe (Sweden, Switzerland and the United Kingdom) and Asia (China and Japan). In this last area, data indicates a rapid increase between 2008 and 2010, followed by a more gradual dynamics.

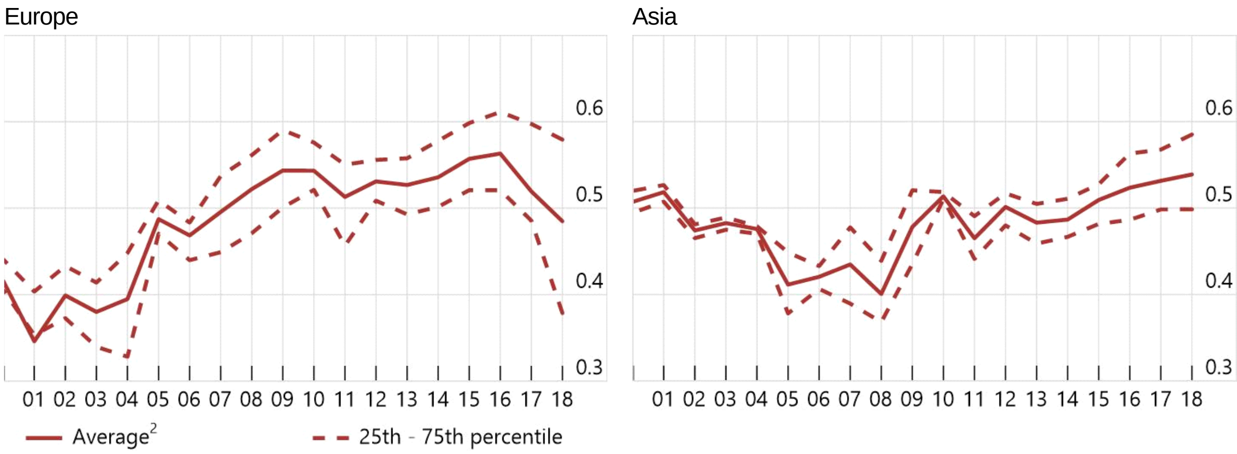
Measures of G-SIBs' portfolio similarity[1] by geographic areas

Index

Figure 5.7.3



[155] Interestingly, the level of G-SIBs' portfolios concentration – as measured by the Herfindahl index – has decreased over the period considered (see Appendix B). This finding, i.e. higher similarity and less concentration, is consistent with a growing body of literature showing that diversification of portfolio holdings, while optimal at individual level, may be associated with higher systemic risk due to the fact that financial intermediaries invest in more similar assets (Wagner, 2010; Ibragimov et al., 2011).



[1] Measured by cosine similarity. [2] All G-SIBs are covered as long as data is available for each year.

Sources: FitchConnect; FSB calculations.

5.7.3. Empirical analysis and results

It is not easy to identify a causal link between TBTF reforms and portfolio similarity metrics. Over the period considered, many confounding factors are at work. Furthermore, reallocations of G-SIBs' portfolios may be unrelated to TBTF reforms and could instead be the effect of a multi-faceted response to the rapidly changing economic environment. In addition the use of annual data, with limited granularity, makes it hard to precisely identify whether changes occurred in conjunction with the announcement and/or implementation of TBTF reforms.

Yet we try to investigate the relation between G-SIBs assets' commonality and TBTF reforms by means of the following simple baseline regression:

$$CS_{ijct} = \alpha RRI_{ct} + \gamma GDP_{ct} + \eta_c + \vartheta_t + \varphi_i + \varepsilon_{ict} \qquad (1)$$

where, CS_{ijct} is cosine similarity for bank *i* vis-à-vis all other G-SIBs in the sample (*j*) located in country *c* at time *t*, RRI_{ct} is the resolution reform index for country *c* at time *t*, and GDP_{ct} is the GDP growth rate to account for the economic cycle. We consider a panel regression with fixed effects – at country, time and bank level – and robust/clustered standard errors. In a further specification, we include geographical dummies, i.e. euro area, North-America and Asia, to investigate whether portfolio similarity differs significantly across geographical areas. Results are reported in Table 5.7.2.

Table 5.7.2: Portfolio similarity and TBTF reforms

	(1)	(2)
RRI	-0.255***	-0.255***
	(0.072)	(0.072)
GDP growth rate	0.002	0.002
	(0.002)	(0.002)
Euro area		0.120***
		(0.002)
North America		0.212***
		(0.017)
Asia		0.018
		(0.034)
Constant	0.479***	0.462***
	(0.030)	(0.013)
Observations	297	297
R-squared	0.736	0.736
Time FE	YES	YES
Country FE	YES	NO
Bank FE	YES	YES

The estimated coefficient on the RRI is always significant and negative, indicating that advances in implementation of the resolution framework are related to a lower level of similarity in G-SIBs' portfolios. The GDP growth rate does not help to explain the level of asset commonality. Interestingly, the coefficients for the geographical dummies are significant in almost all cases and indicate the existence of heterogeneous patterns across areas.

5.7.4. Conclusion

Since 2000, G-SIBs' portfolios have on average become more similar. This trend is statistically significant and confirms the fact that G-SIBs' balance sheet composition has become more homogeneous over time. However, the change has been small overall and does not raise serious concerns in terms of systemic risks.

Interestingly, the regression analysis indicates that advances in TBTF reforms – as measured by the RRI – are associated with a lower degree of similarity across G-SIBs' portfolios. The estimation also indicates the existence of significant heterogeneity across geographical areas, which suggests that regional factors may be relevant to explain the evolution of G-SIBs' portfolios. Regional macro financial developments – e.g. monetary policy, economic and business cycle – may in fact have driven changes in G-SIBs' business models and/or portfolio allocation choices, which eventually would be unrelated to TBTF reforms. While the analysis conducted in this work provides some first insights on the relation of TBTF reforms on portfolio similarity, it is not conclusive. A more granular database would be necessary to draw more robust conclusions.

5.7.5. Appendices

Appendix A

The Euclidean distance (ED) is an alternative measure to gauge the degree of closeness of portfolios. The ED between bank *i*'s and bank *j*'s portfolios, at time *t* is given by the formula:

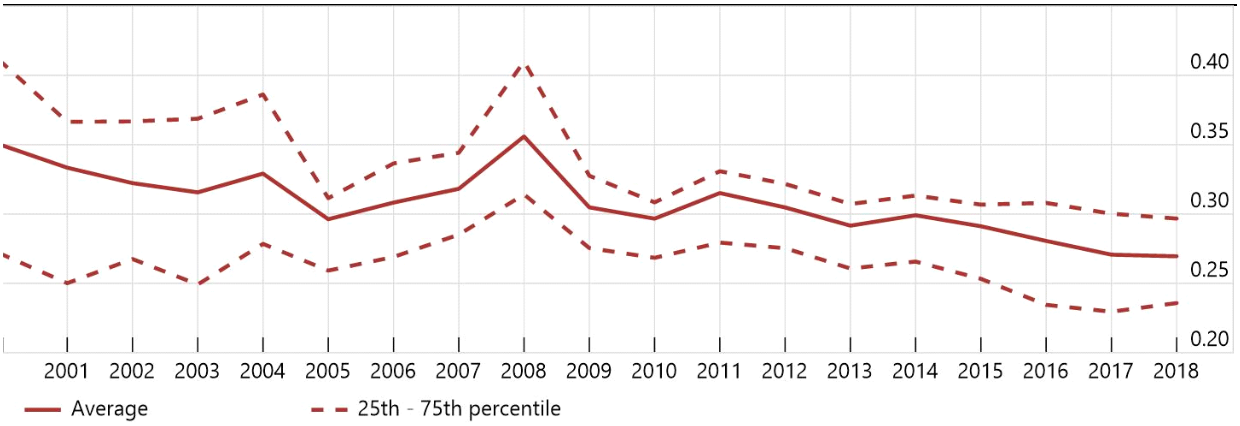
$$ED\ (bank_{it},\ bank_{jt}) = \sqrt{\sum_{k=1}^{N}(w_{ikt} - w_{jkt})^2}$$

where *k=1,…, N* is the total number of asset classes considered, w_{ikt} is bank *i*'s portfolio weight in security *k* at time *t*, and w_{jkt} is bank *j*'s portfolio weight in security *k*. The ED is bounded between 0 and 1; higher values imply a larger distance between two portfolios.

Alternative measure of closeness of portfolios: Euclidean distance

Index

Figure 5.7.4



Sources: FitchConnect; FSB calculations.

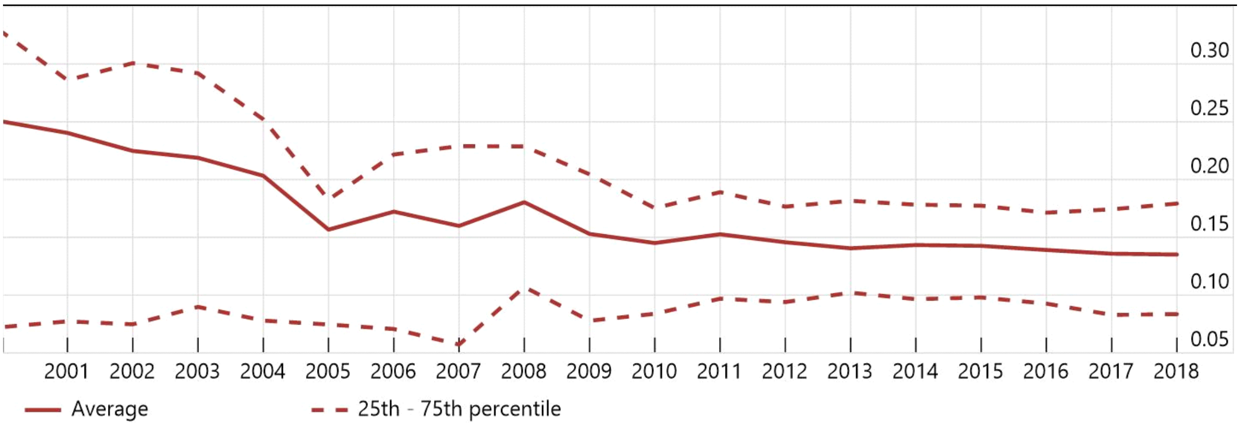
Appendix B

The level of portfolio concentration is measured by the Herfindahl index, computed according to the following formula: *HHI(bank$_{it}$)* = $\sum_{k=1}^{N} w_{i,k,t}^2$, where *k=1,…, N* is the total number of asset classes considered, w_{ikt} is bank *i*'s portfolio weight in security *k* at time *t*. Weights are computed relatively to total assets.

Concentration index

Index

Figure 5.7.5



Sources: FitchConnect; FSB calculations.

5.8. Market-based systemic risk measures

5.8.1. *Introduction*

Market-based systemic risk measures can be used to assess whether the systemic risk contribution of SIBs and aggregate systemic risk have changed following the TBTF reforms. The measures used are ΔCoVaR and SRISK, the details of which are shown below. [156] Since these measures are subject to measurement errors, in particular for individual financial institutions, we focus on trends of aggregate indicators and changes in distributions.

5.8.2. *CoVaR*

5.8.2.1. *Analytical approach*

ΔCoVaR is proposed by Adrian and Brunnermeier (2016). Formally, $CoVaR_{it}^{m|\mathbb{C}(r_{it})}(\alpha)$ is defined as the value at risk (VaR) of the market return r_{mt} conditional on some event $\mathbb{C}(r_{it})$ observed for institution i:

$$\Pr\left(-r_{mt} \leq CoVaR_{it}^{m|\mathbb{C}(r_{it})}(\alpha) \middle| \mathbb{C}(r_{it})\right) = \alpha\%$$

Given this, ΔCoVaR is defined as:

$$\Delta CoVaR_{it}(\alpha) = CoVaR_{it}^{m|-r_{it}=VaR_{it}(\alpha)} - CoVaR_{it}^{m|-r_{it}=VaR_{it}(50)}$$

where $VaR_{it}(\alpha)$ is the VaR of institution i as:

$$\Pr\left(-r_{it} \leq VaR_{it}(\alpha)\right) = \alpha\%$$

156 For more details, see Furukawa et al. (forthcoming).

We first calculate ΔCoVaR for individual institutions, and then compute the aggregate ΔCoVaR for particular groups of institutions by averaging their ΔCoVaR with weights equal to their market equity values.[157]

In the subsequent exercise, we also decompose ΔCoVaR into two components as follows:

$$\Delta CoVaR_{it}(\alpha) = \gamma_{it}(\alpha) \cdot \Delta VaR_{it}(\alpha)$$

where $\Delta VaR_{it}(\alpha) \equiv VaR_{it}(\alpha) - VaR_{it}(50)$ represents institutions' own tail risk. Hirakata et al. (forthcoming) call $\gamma_{it}(\alpha)$ the systemic risk coefficient, while Benoit et al. (2017) find that time-series properties of ΔCoVaR are very similar to those of ΔVaR. This decomposition helps us identify whether a change in ΔCoVaR is attributable to a change in individual institutions' tail risks, represented by ΔVaR, or to a change in their interactions, represented by γ. The aggregate ΔVaR is computed with weights of the market equity values, as when we compute the aggregate $\Delta\mathrm{CoVaR}$. The aggregate γ is computed as the ratio of the aggregate $\Delta\mathrm{CoVaR}$ to the aggregate ΔVaR.

In this analysis we set $\alpha = 95$. We estimate the financial institutions' systemic risks with regard to the global financial system, not the domestic system. ΔCoVaR is estimated via quantile regressions.

5.8.2.2. Description of the data

We use market capitalisation data of all actively traded financial institutions (FIs) with market capitalisation greater than €10 billion as of 2018 FY. As a result, our sample includes 832 FIs across 67 jurisdictions. The data is daily and spans between 1/1/2000 and 12/31/2019. The FIs are categorised according to Bloomberg Industry Classification Standards. Daily data is missing when the share is not traded. Moreover, some institutions have data available only after certain dates, possibly in part due to initial public offerings. Therefore, our sample is an unbalanced panel with occasionally missing data.

When some data are missing, we assume that the data are the same as those in the previous date up to six days. Then, we compute weekly returns, which serves to alleviate the problem that arises when we use data from different time zones. For instance, consider two banks whose shares are traded in New York and Tokyo. Since New York and Tokyo are in different time zones, the equity returns of the banks on a particular day are calculated on different points in time, reflecting different sets of events. In contrast, weekly returns of FIs across different regions likely reflect more similar sets of information.

Some data show extreme patterns, for instance a decrease by over 90% and an increase by over 300% from previous dates, which are possibly due to poor quality of data, dividend payments, or mergers and acquisitions. In order to control for these irregularities, we winsorise the data at 99.99% and 0.01% of returns.

[157] Note that ΔCoVaR is not size dependent. To compare across differently sized institutions, Adrian and Brunnermeier (2016) define Δ$ CoVaR as ΔCoVaR times the market equity. Giglio, Kelly, and Pruitt (2016) construct an aggregate measure by computing the systemic risk contribution for each of the 20 largest institutions in each period and taking an equal weighted average.

We next divide our samples into time periods for which we want to calculate ΔCoVaR. While the baseline analysis uses one calendar year as the time period, we also checked the robustness of the results to changing the time period. Due to the unbalanced nature of the data, we only include those institutions for which we have data for more than 100 days during each estimation window. To construct the overall global financial system market portfolio and calculate the market return, we simply add the values of those FIs included in each estimation window.

5.8.2.3. Results

Global ΔCoVaR has declined since its peak in the 2008 crisis, and while it is volatile, there is no clear trend from 2002 to 2019 (Figure 5.8.1, panel A). The lower peaks in 2002, 2011, 2015 and 2018 coincide with spikes in the VIX. Overall, global ΔCoVaR tends to rise when there is high uncertainty in the financial market. Although ΔCoVaR has fluctuated, there is no clear change in the average levels between pre financial crisis period (2002~2007) and post TBTF reform period (2012~2019).[158]

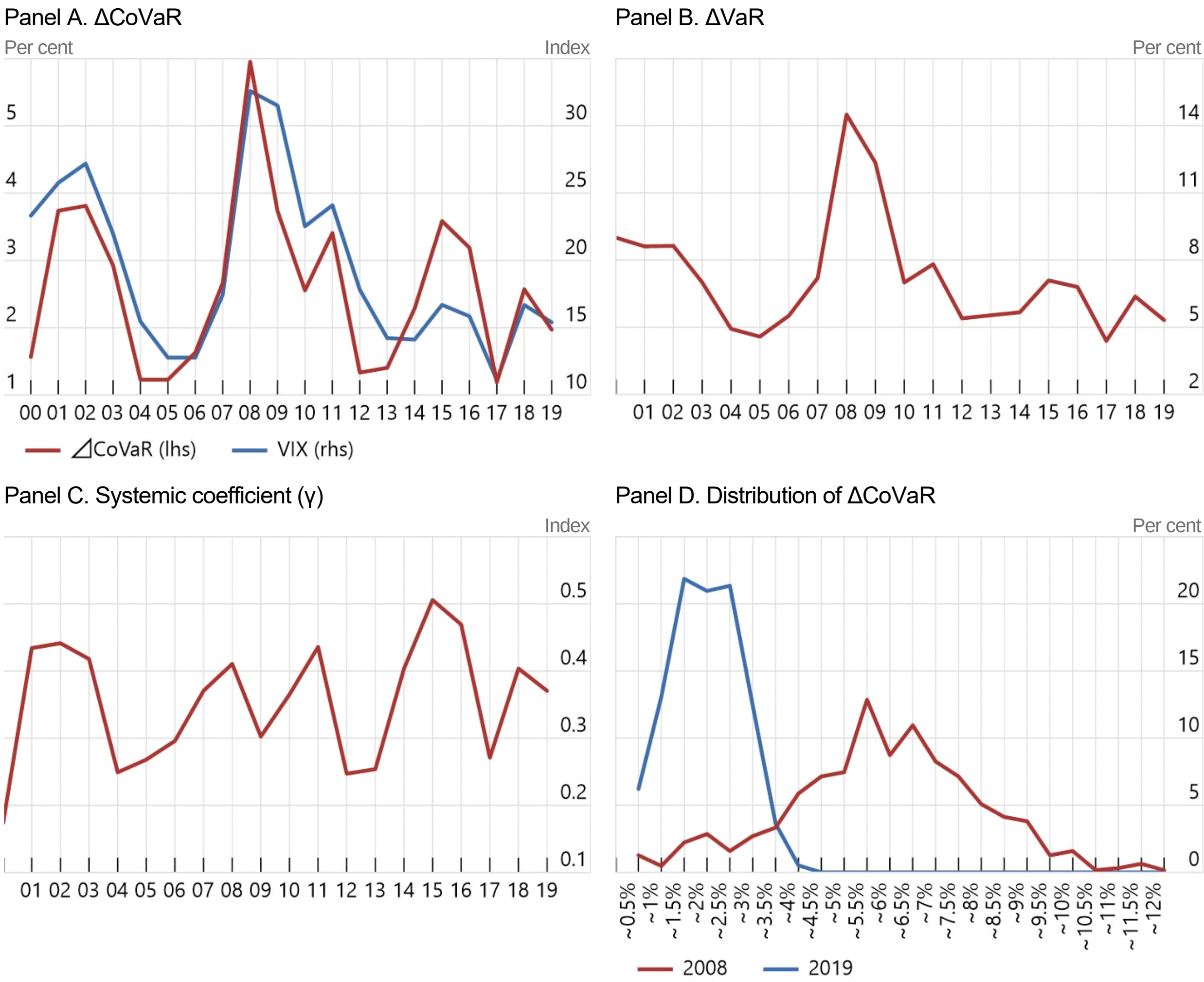
To analyse where change in ΔCoVaR is coming from, we decompose ΔCoVaR into individual institutions' tail risks (ΔVaR) and the systemic risk coefficient (γ) (panel B, C). ΔVaR has significantly declined since the financial crisis, while the systemic risk coefficient has been more or less flat. As a result, we conclude the post-crisis reduction in ΔCoVaR is mainly attributable to a decline in individual FIs' tail risk, as opposed to a change in the interactions of those risks.

The post-crisis decline in ΔCoVaR is not limited to a certain group of institutions. Indeed if we look at the changes of individual institutions' ΔCoVaR between 2008 and 2019, we find that most institutions saw reduction in their ΔCoVaR (panel D).

---

[158] The pre-crisis period is defined, following Sarin and Summers (2016). The finding here is broadly consistent with the existing literature. For example, Adrian and Brunnermeier (2016) and Benoit et al. (2017) show that ΔCoVaR was high during the crisis while it has been low in both pre- and post-crisis periods.

Decomposition and distribution of ΔCoVaR **Figure 5.8.1**



Source: Bloomberg.

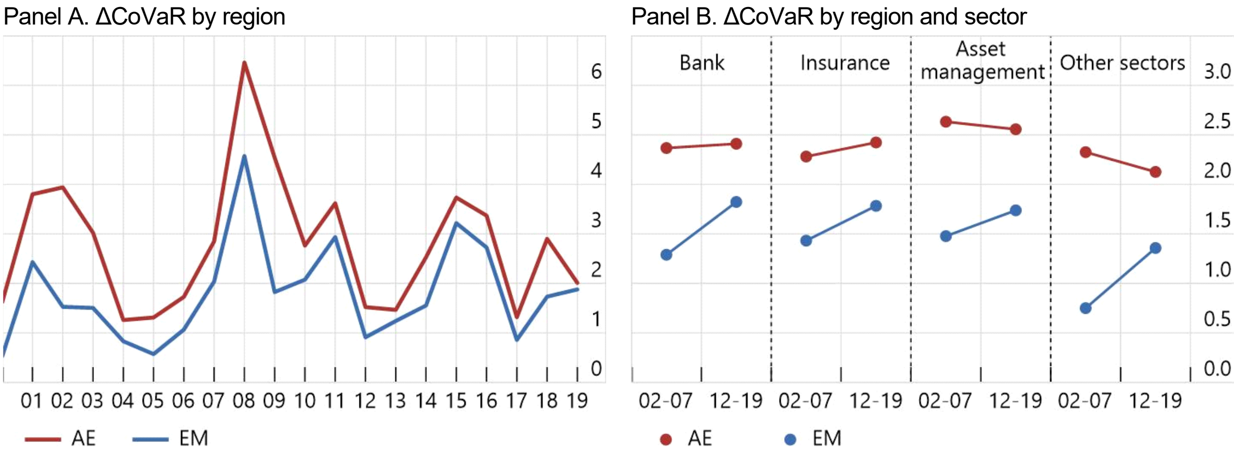
If we compute the weighted averages of ΔCoVaR of FIs in advanced economies (AE) and emerging markets (EM) separately, we observe that ΔCoVaR has been lower for EM over time (Figure 5.8.2, panel A). To look at differences across types of financial institutions[159] we again divide the samples into AE and EM. Given that the ΔCoVaR has fluctuated year by year and the crisis period seems to be exceptional, the analysis here compares the averages in pre-crisis and post-reform periods (panel B). Consistent with what we found in panel A, all sectors exhibit higher ΔCoVaR in AE than in EM. Moreover, all sectors either reduced or very marginally raised ΔCoVaR in AE, while they clearly increased in EM. This reflects the increasing share of FIs in EM in the global financial market; as EM becomes larger, its contribution to the global systemic risk gets larger not only because of the higher share itself but also of the tighter interactions with the global market.

[159] The other sectors consist of real estate, institutional financial services and speciality finance.

ΔCoVaR by region and sector

In per cent

Figure 5.8.2



Source: Bloomberg.

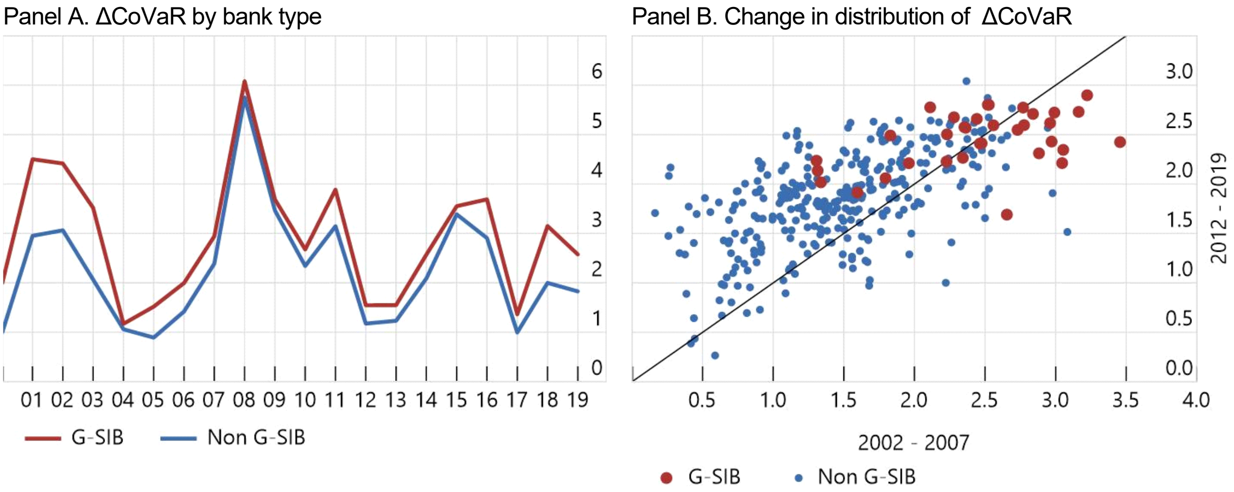
We next turn to ΔCoVaR of G-SIBs and non-G-SIBs (Figure 5.8.3).[160] As expected, ΔCoVaR has been constantly higher for G-SIBs than for non G-SIBs (panel A). Although G-SIBs continued to be the important contributor to the aggregate ΔCoVaR throughout the sample period, there is some evidence that the market has undergone a structural change since the TBTF reforms. If we take a detailed look at individual banks and plot their ΔCoVaR post-reform against those pre-crisis, around 50% of G-SIBs saw a decline in their ΔCoVaR while only around 20% of non G-SIBs decreased ΔCoVaR between the two periods (panel B). The fact that a larger share of G-SIBs decreased ΔCoVaR compared to non G-SIBs suggests that the TBTF reforms indeed have had the intended effect of reducing G-SIBs' systemic risks. Another indication of the impacts of the reforms comes from an apparent tendency that G-SIBs with higher ΔCoVar before the crisis have reduced their risk to a larger extent, as illustrated by the red dots below the 45 degree line for higher values of ΔCoVaR.

[160] A G-SIB is defined as a financial group that has been designated as a G-SIB at any point in time since the initial publication in 2011.

ΔCoVaR of G-SIBs/non G-SIBs

In per cent

Figure 5.8.3



Source: Bloomberg.

5.8.3. SRISK

5.8.3.1. Analytical approach

SRISK was introduced by Brownlees and Engle (2017). $SRISK_{it}$ of financial institution i at time t is defined as the expected capital shortfall conditional on a systemic event.[161] In other words, it is the amount of capital that the government would have to provide to bail out the particular financial institution. This analysis examines aggregate SRISK for a category of jurisdictions and sectors. Specifically, the total amount of systemic risk of a particular category of FIs C is measured as:

$$SRISK_t = \sum_{i \in C} \max(SRISK_{it}, 0)$$

Note that in the computation of aggregate SRISK, the contribution of negative capital shortfall (that is capital surpluses) is ignored. This is because in a crisis, it is unlikely that surplus capital will be easily mobilised to support failing FIs.

5.8.3.2. Description of the data

Estimates of SRISK of individual institutions have been provided by the Volatility Laboratory of the NYU Stern Volatility and Risk Institute (V-Lab).[162] V-Lab computes different types of SRISK. The focus of this analysis is on SRISK computed with a global market index return, which can be interpreted as the expected capital shortfall faced by an institution in a global financial crisis in the future. The analysis here covers only FIs in FSB jurisdictions. The dataset

[161] Brownlees and Engle (2017) compute SRISK for US banks, insurers, and other types of FIs. Engle and Ruan (2019) compute SRISK of FIs in many jurisdictions.

[162] The systemic risk event is defined as a more than 40% market drop over six months, as in Engle and Ruan (2019).

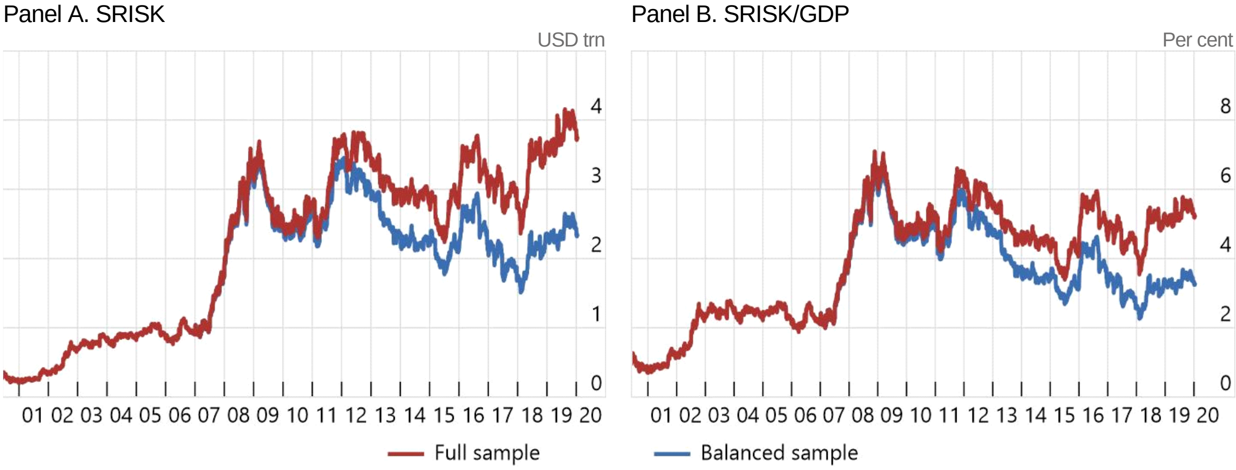
includes an indicator of whether an institution is "alive" or "dead". The usual data cleansing is applied; for instance, when a SRISK estimate is missing, it is assumed equal to that of the previous date as long as the institution is "alive". The classification of sectors is based on Bloomberg Industrial Classification Standards.[163]

5.8.3.3. Results

SRISK aggregated for FSB jurisdictions soared in 2008 and has been more or less flat since then (Figure 5.8.4, panel A, full sample). However, an improvement in data coverage, perhaps in part due to initial public offerings, may have also had an impact on the time-series. To control for such factors, we compute SRISK based on firms that have remained in the sample since 2007 (Figure 5.8.4, panel A, balanced sample). The balanced sample reveals that SRISK has declined overall from the peak in 2009. Furthermore, if we normalise the data by measuring SRISK as a ratio to the aggregate GDP of FSB jurisdictions, again we find SRISK following a declining trend for both samples, although the recent levels are still higher than pre-crisis levels (Figure 5.8.4, panel B).

To deal with the potential data coverage issue discussed above, the subsequent analyses are based both on the full sample without normalisation and on a balanced sample normalised using GDP. The discussion below focuses particularly on relative trends, in addition to absolute levels of different categories.

SRISK aggregated for FSB jurisdictions **Figure 5.8.4**

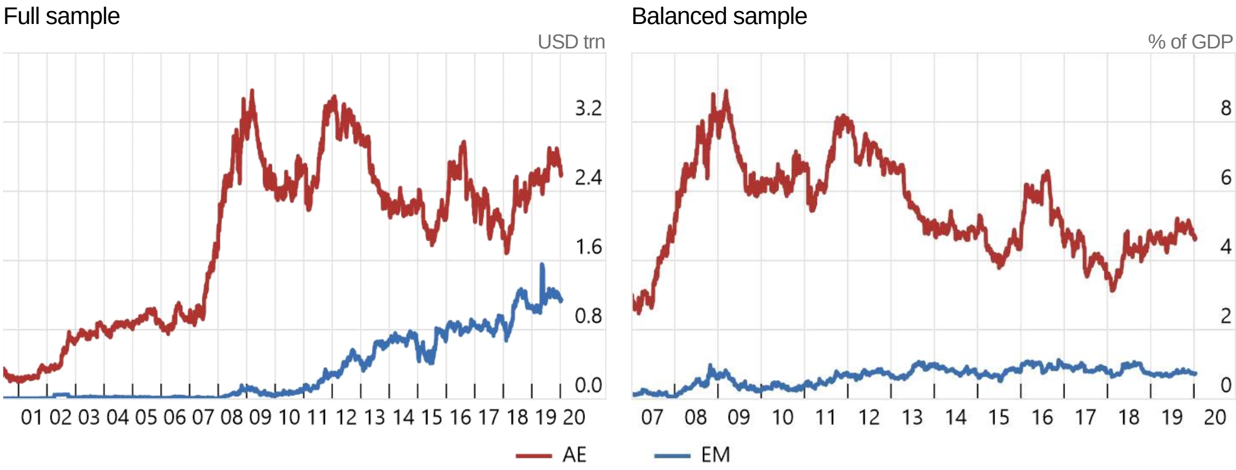


Sources: IMF; V-Lab.

[163] "Other" includes Institutional financial services, asset management, real estate, speciality finance (according to Bloomberg Industrial Classification Standards). G-SIBs are defined as banks that have been listed as G-SIBs at any point in time since the initial publication in 2011.

Figure 5.8.5 looks at the data by region. The relative trend of emerging markets (EM) has been stronger post-crisis, whilst AE have shown a gradual decline.

SRISK by economic region **Figure 5.8.5**



Sources: IMF; V-Lab.

A further look into SRISK by type of sector highlights that banks have been the predominant contributor to SRISK in both AE and EM (Figure 5.8.6). In particular, the rapid increasing trend of EM banks stands out. The insurance sector and, to a lesser extent, other nonbanks have contributed to a certain degree in AE, but not in EM. One reason for the insignificance of the non-bank sector in EMs could be due to the abundance of unlisted firms. Focusing on banks, we observe that SRISK for G-SIBs has relatively trended downwards following the crisis, narrowing the gap between G-SIBs and other banks (Figure 5.8.7). This suggests a shift in risk from G-SIBs to other banks.

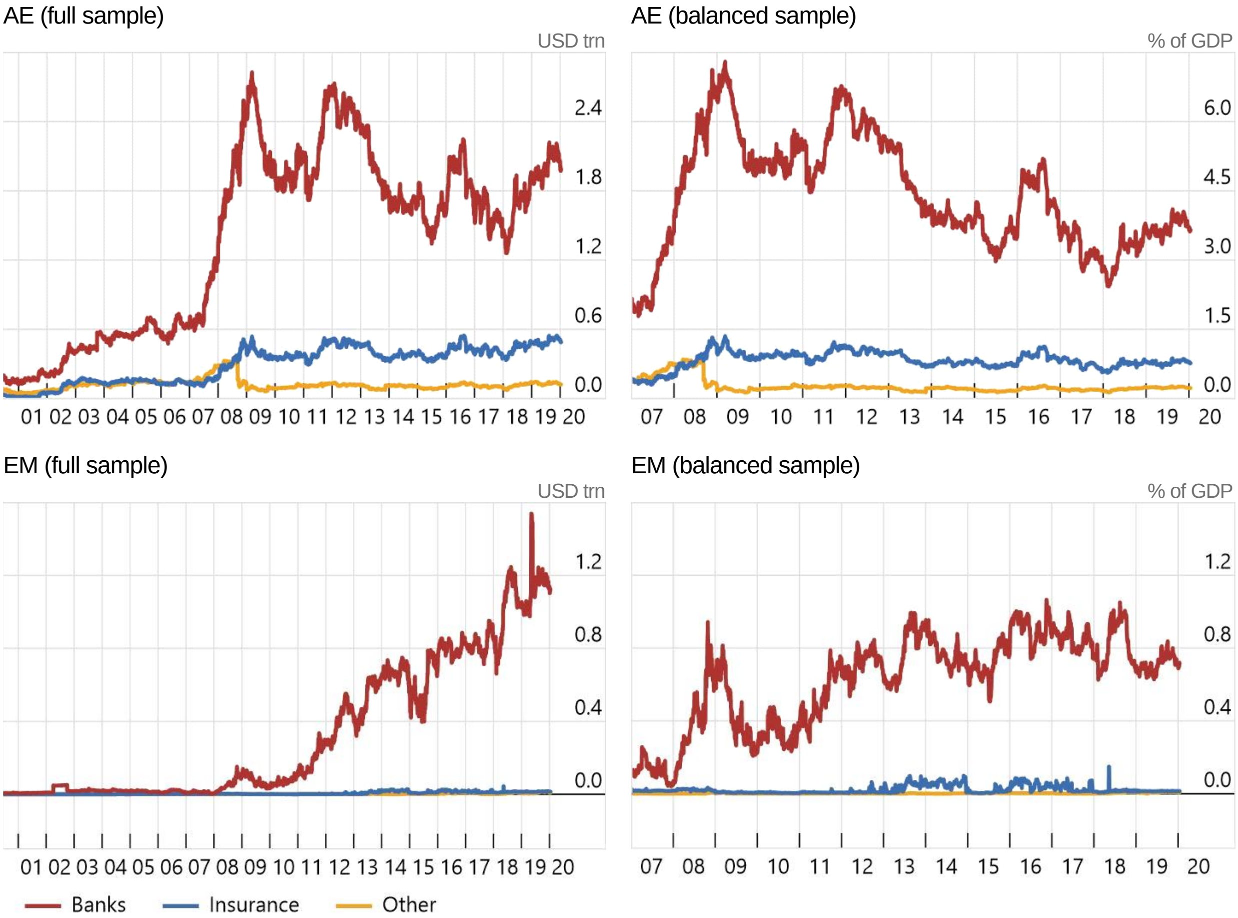
Nonetheless, G-SIBs' systemic risk is still higher than at pre-crisis levels. By definition, SRISK[164] tends to highly correlate with the leverage or the debt-to-market capitalisation ratio. This tendency is confirmed even in our samples (Figure 5.8.8). Thus, the high leverage can be seen to have contributed to high SRISK.[165] On the other hand, SRISK may overestimate systemic risk since V-Lab computes SRISK with an assumption that only equity could be used to absorb the losses and the government would have to cover the remaining losses.

[164] $\mathrm{SRISK} = \mathrm{k} \cdot \mathrm{Debt} - (1 - \mathrm{k}) \cdot \mathrm{Equity} \cdot (1 - \mathrm{LRMES})$ where k is the capital requirement (in general, V-Lab assumes 8%), LRMES is the Long-Run Marginal Expected Shortfall, Equity is the current market capitalization, and Debt is the book value of debt.

[165] Sarin and Summers (2016) highlight that the ratio of the market value of common equity to assets has declined significantly from pre-crisis period to the post-crisis period for most major banks. As a consequence, banks are more vulnerable to adverse shocks, according to their argument.

SRISK by sector and region

Figure 5.8.6

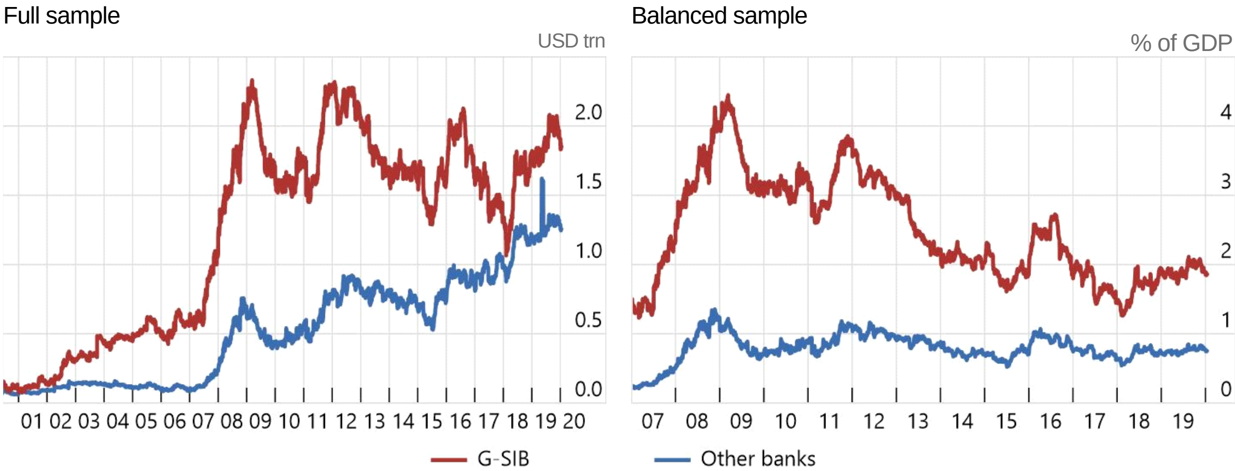


Sources: IMF; V-Lab.

In reality, however, large banks have enhanced their capacity to absorb losses by issuing TLAC-eligible bonds after the TBTF reforms. Thus, it may be reasonable to subtract TLAC-eligible debt from the SRISK of individual institutions to evaluate systemic risk. This will be an important part of future work.

SRISK within banking sector

Figure 5.8.7

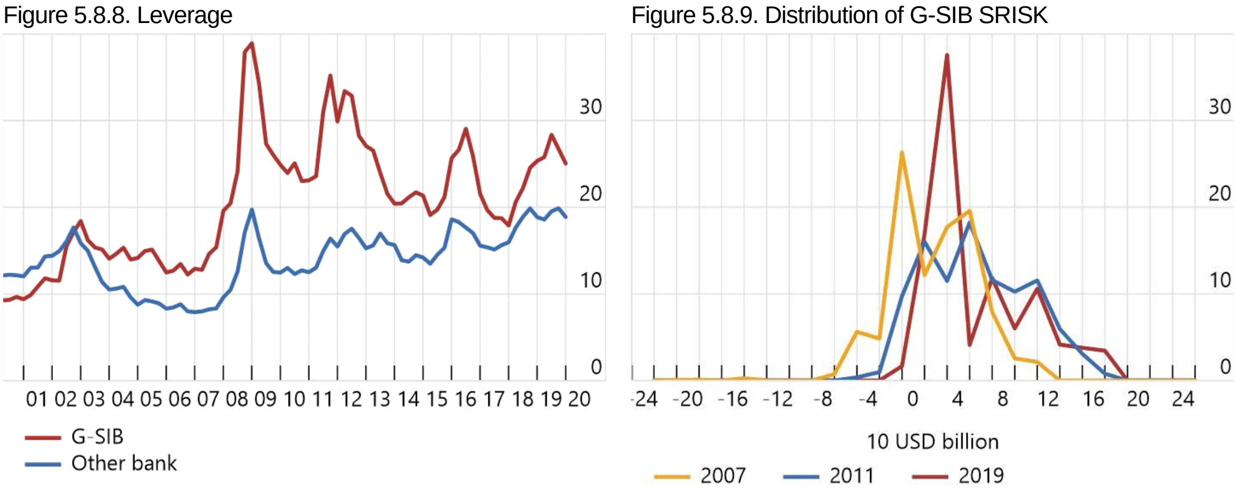


Sources: IMF; V-Lab.

Leverage and distribution of G-SIB SRISK

In per cent

Figure 5.8.8 & 5.8.9



Note: Leverage = (Debt + Market Capitalisation)/ Market Capitalisation.

Sources: IMF; V-Lab.

When we look at the SRISK distribution of G-SIBs, we observe that the tails to the right hand side fattened after the crisis (2011), commensurate with the aggregate build-up of risk (Figure 5.8.9). From 2011 to 2019, the tails narrowed, with a convergence at capital shortfalls of under $20 billion (the scales have been set at $20 billion due to the wide distribution).

5.8.4. Conclusions

The findings suggest that the TBTF reforms have been associated with a reduction in G-SIBs' systemic risks. Although the global aggregate ΔCoVaR has been broadly stable from 2000 to 2019, except around the global financial crisis, ΔCoVaR in the post-reform period declined more relative to the pre-crisis period for G-SIBs than for other banks. In addition, the ΔCoVaR of G-SIBs with higher ΔCoVaR before the crisis decreased more than for other G-SIBs.

The analysis of SRISK produces similar results. On the basis of the balanced sample, the ratio of SRISK to GDP increased in the run-up to the financial crisis and then declined. While for G-SIBs the ratio of SRISK to GDP has trended down following the reforms, it has been broadly flat for other banks. Since SRISK may overestimate systemic risk by ignoring loss-absorbing capacity of TLAC-eligible debt, which has been issued by large banks after the TBTF reforms, it may be reasonable to subtract TLAC-eligible debt from SRISK of individual institutions.

5.9. Social costs and benefits of the reforms

The framework developed by the BCBS (2010) to assess the social costs and benefits points to sizeable net benefits of raising capital requirements for banks. That framework also underpins the analysis in the FSB TLAC Impact Assessment Studies (2015). The framework is based on two building blocks: social benefits and social costs.

In this framework, social benefits arise from two separate sources: a decrease in the likelihood of a financial crisis and a reduction in its severity. Higher bank capital ratios are assumed to reduce the probability of a financial crisis. Crises are socially costly because they cause a short-term contraction in GDP as a result of disruptions to the supply of credit and a possibly permanent reduction in GDP due to forgone investment during the crisis. The social benefits of raising bank capital ratios are represented by the reduction in these costs.

Social costs are due to the decline in GDP implied by an increase in the cost of funding for banks. The framework assumes that an increase in bank capital ratios increases banks' cost of funding, which banks pass through to borrowers. The resulting increase in credit spreads on bank loans reduces investment and thus GDP. This is the social cost associated with raising bank capital ratios in the framework.

The framework arguably does not incorporate all costs and benefits associated with TBTF, for instance it does not include compliance costs or potential changes to the structure of the financial system. Nonetheless, it provides a useful benchmark for the assessment of social costs and benefits.

5.9.1. Empirical analysis and results

The TBTF evaluation took a conservative approach to the estimation of the net benefits of the reforms. The framework requires many assumptions, and the TBTF evaluation consistently picked reasonable but conservative ones. The point estimate presented below can therefore be interpreted as biased downwards, in a way that underestimates the net benefits. The evaluation also presents alternative results using less conservative assumptions.[166]

In the baseline approach, the evaluation used the following assumptions:

- **Only the effects due to changes in banks' capital requirements and loss-absorbing capacity are accounted for**. The framework does not include the effects

[166] Details on the calculations are in a spreadsheet published alongside the Technical Appendix.

of increased supervision, or the effects of the TBTF reforms on banks' risk-taking or on the riskiness of the financial system as a whole.

- All **costs of increased capital requirements are assumed to be fully passed on to borrowers**, assuming that borrowers are unable to switch to alternative funding sources. This is contradicted by evidence presented in the consultation report: G-SIBs lost domestic market share but other lenders picked up the slack.
- **The framework assesses the net benefits that arise in the new steady state.** It refrains from considering how the new steady state will be reached and the costs or benefits that may accrue in the transition phase. For example, banks might temporarily reduce credit supply to meet higher capital requirements.
- **The reduced probability and severity of financial crises do not reduce the spread borrowers must pay when issuing risky assets of any kind.** The reforms are intended to reduce the probability of failures of systemically important banks, which in turn should reduce the probability of financial crises. The return on risky assets such as debt and equity is a function of the risk-free rate and a risk premium and studies such as Rietz (1988) and Barro (2006) suggest that the probability of rare disasters explains much of the risk premia demanded by risk-adverse investors. Financial crises are an example of such a rare disaster. In theory, reducing the frequency and severity of crises could reduce the cost of capital across the economy, thereby increasing investment and growth.
- **The withdrawal of implicit subsidies does not improve the quality of a bank's assets.** In theory, the optimal level of risk taken by TBTF banks from a private perspective is higher than the socially efficient level of risk taking. This is because owners of banks fully reap potential profits but only partially bear risks because of the expected government bailout in case of distress. Academic research such as Boissay and Collard (2016) and Gropp et al (2019) also suggests that regulation can improve welfare by shifting credit towards more productive lending.
- **The framework does not take into account the compliance costs of the reforms,** such as enhanced resolution planning. They are assumed to be small compared to the effect on funding costs.
- There are **no effects on the cost of bank non-TLAC debt** from the increase in safety and soundness of banks. Other adaptations of the framework assumed a 'Modigliani-Miller offset' which would reduce the estimated effect of the reforms on bank funding cost.[167]

A shortcoming of the framework is that it does not consider the build-up of systemic risks outside the banking sector at all. Such risks could raise the probability of a financial crisis. For example, the COVID-19 pandemic demonstrates how economic crises can occur from sources outside the banking system. Higher levels of capital may have permitted banks to act as a stabilising force, and potentially avoided the current crisis becoming a banking crisis.

This section also presents results that are still conservative, but less so than the baseline scenario discussed above. In one scenario we assume a 'Modigliani-Miller offset' of 50%,

[167] The relationship between the cost and the MM offset is approximately linear, so this would cut the cost of the TBTF reforms in half. Also see Gimber and Rajan (2019).

which is more consistent with the empirical evidence. This reduces the estimated effect of the reforms on banks' funding cost as it assumes that it becomes cheaper to issue non-TLAC debt becomes cheaper. An additional scenario assumes a larger decline in crisis costs as a result of the introduction of TLAC, based on a higher probability of successful bail-in. This results in a reduction in the cost of a crisis. Finally, the section presents results in which both these assumptions are relaxed at the same time.

5.9.2. The baseline scenario

5.9.2.1. Benefit of TBTF reforms: reduced probability of a crisis

According to the BCBS framework, a financial crisis becomes less likely if banks are better capitalised. Increased capital requirements due to the TBTF reforms thus decrease the probability of a financial crisis. Based on the requirements detailed in the 2019 G-SIB list, G-SIB capital surcharges increase minimum CET1/RWA requirements by approximately 1.4 percentage points. Using the methodology from Fender and Lewrick (2016), the G-SIB leverage ratio buffer requirement, an element of the finalised Basel III package agreed in 2017, is estimated to further increase CET1/RWA ratios by 0.7 percentage points, for a total increase of 2.1 percentage points. Aggregate RWAs of G-SIBs in FSB reporting jurisdictions amount to 28% of aggregate RWAs in those jurisdictions, which is used to approximate the G-SIBs' market share. This implies an increase in aggregate CET1/RWA ratios due to G-SIB capital surcharges in FSB reporting jurisdictions of approximately 0.59 percentage points.

Using the relationship between a financial crisis and bank capital levels as mapped into Basel III measures of CET1/RWA by Fender and Lewrick (2016), and a minimum CET1/RWA ratio of 7% applicable to all banks (the sum of Basel III minimum CET1 requirements and the Capital Conservation Buffer) implies that the G-SIB capital surcharges reduce the annual probability of a crisis from 1.6% to 1.3%.

5.9.2.2. Benefit of TBTF reforms: reduced cost of crisis

Within the framework, there are two ways in which the TBTF reforms may reduce the cost of future financial crises: by strengthening market discipline on banks and by accelerating the resolution and recapitalisation of banks during a crisis.[168]

The original TLAC assessment estimated that a change in risk-taking by banks would reduce the cost of a future crisis by 5.4% of GDP in present value. For example, Sections 4.2 and 4.3 of this appendix present evidence that G-SIBs have reduced their risk-taking relative to their peers as a result of the reforms.

Poorly capitalised banks lend less,[169] which can create a credit crunch under stressed conditions that in turn worsens a financial crisis. Analysis of prompt recapitalisation of banks

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[168] Both of these approaches, as is common in the literature, calculate present values with a 5% discount rate. In the current low-interest rate environment, a lower discount rate is arguably appropriate. The higher discount rate reduces both costs and benefits in present value terms.

[169] See for example Carlson et al (2013).

during crises, as discussed in Firestone et al. (2019),[170] implies that a successful quick recapitalisation can shorten the most intense period of a crisis, thereby reducing its cost by 10.5% of GDP. Separately, work by Jorda et al (2017) implies that the present value of the benefits from having a well-capitalised banking system during a financial crisis are approximately 11.5% of GDP. Both approaches assume an immediate and successful recapitalisation. Work described elsewhere in this report implies that such an event is a possibility, but not a certainty. Conservatively assuming a 50% chance of such a successful and rapid bail-in yields a similar expected reduction cost of 5.5% of GDP in present value.

As mentioned above, in our baseline scenario we rely on conservative assumptions and use the lower bound of 5.4% of GDP in present value. Crisis costs are assumed to equal 63% of GDP in net present value terms, consistent with the original BCBS estimate. The difference of the products of crisis cost and crisis probability under this scenario and the one with the reforms yield the TBTF reforms' expected net present value benefit. This is equivalent to approximately 0.30% of GDP.

5.9.2.3. Cost of TBTF reforms

The framework assumes that an increase in banks' capital ratios increases the cost of bank credit and thereby reduces GDP. As mentioned above, the reforms increase the required CET1/RWA ratio in the banking system by 0.59 percentage points.

The effect of TLAC requirements on GDP can only be estimated subject to significant uncertainty. To model these effects, we calculate the amount of additional CET1 capital that would impose the same increase on banks' funding costs as the TLAC requirement, and use the standard approach to calculate the effect of that assumed increase in capital requirements on GDP. We are limited to data from Europe to estimate the marginal cost of TLAC debt relative to other forms of bank debt. For consistency, we also use European data on the spread between debt and equity.

Analysis of S&P Capital IQ data for the fourth quarter of 2018 indicates that the median spread between return on equity (RoE) and the yield on senior unsecured bank debt for Europe was 4.6%. The median ratio of RWAs to assets was 36%.[171] The spread of TLAC-eligible senior bonds yields over comparable non TLAC-eligible bonds is approximately 0.30% for European banks (Lewrick et al., 2019). When G-SIBs meet their TLAC requirement,[172] which is currently 16% of RWAs, it is equivalent in cost to an additional CET1 requirement of 0.52% of RWAs.[173] Again applying the 28% G-SIB market share, this implies a system-wide increase in CET1 of 0.15% of RWAs.

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[170] Firestone et al. (2019) combine results in Homar and Wijnbergen (2017) and Romer and Romer (2017).

[171] This assumes a return on equity of 6.1%. The corresponding numbers for Asia, North America, and the UK are 6.4%, 10.8%, and 5.4%, respectively. Higher RoE numbers correspond to a smaller corresponding TLAC effect, so 6.1% is towards the lower end of the range. For RWA density (average risk weights), the corresponding numbers for Asia, North America, and the UK are 62%, 50%, and 25% respectively. A higher RWA density implies a larger effect for TLAC requirements, as it increases the required ratio of TLAC to assets and thus the total extra interest expense. Using the maximum Asian RWA density while holding all else constant increases the bottom line cost of the TBTF reforms by one basis point.

[172] We assume that, starting with total regulatory capital ratio of 8% of RWAs, they issue TLAC-eligible debt of 8% of RWAs in order to meet their minimum TLAC requirement.

[173] For advanced economy G-SIBs TLAC requirements will increase to 18% of RWA as of 2022. The analysis is based on the current TLAC requirements for consistency with the remainder of the analysis.

Section 4.2 of this appendix found a decrease in RoE for G-SIBs relative to other banks, which suggests that G-SIBs cannot pass the full cost of higher capital requirements onto their customers. Loan spreads thus increased less than assumed by the original framework, which implies lower social costs. However, in line with our conservative approach, it is assumed that required returns on debt and equity remain unchanged, and the increase in funding cost is fully shifted to borrowers.

The original BCBS study of 2010 suggests that every 1% increase in the banking system's CET1 ratio reduces the net present value of future GDP by 12 basis points, after controlling for the effect of the liquidity reforms.[174] This implies that the increase in capital requirements and TLAC reduces the present value of future GDP by approximately 0.09%.

5.9.3. Alternative scenarios

BCBS (2010) assumes that yields demanded by creditors do not change when a bank increases its equity capital. This is not borne out in the literature (see BCBS, 2019). Table 5.9.1 presents the results obtained by relaxing the assumptions with respect to the Modigliani-Miller offset and the probability of successful bail in.

Introducing a 50% Modigliani-Miller offset increases net benefits to 0.25%, while increasing the probability of successful bail-in to 75% increases them to 0.24%.[175] Relaxing both assumptions at the same time results in net benefits of 0.28%.

Table 5.9.1: Costs and benefits under varying assumptions.

	Baseline	50% MM offset	Higher bail-in success rate	MM offset and higher bail-in success rate
Costs	0.09%	0.04%	0.09%	0.04%
Benefits	0.30%	0.30%	0.33%	0.33%
Net effect	0.21%	0.25%	0.24%	0.28%

Note: the table reports the estimated costs and benefits under the baseline scenario and the two scenarios described in the main text. Figures are rounded to two decimal places.

5.9.4. Conclusions

Based on the BCBS methodology, we provide a conservative estimate for the net benefits of the TBTF reforms, given the conservatism of the framework's underlying assumptions. The present value of the benefits of the reforms, in the form of reduced expected crisis cost, is 0.30% of GDP. The present value of the cost of the reforms is approximately 0.09% of GDP. This implies positive net benefits even on a conservative estimate, with a present value of net

[174] BCBS (2010) provides an estimate of the elasticity of GDP with respect to the ratio of tangible equity to Basel II RWAs. Fender and Lewrick (2016) provide a mapping into Basel III CET1/RWAs, which is applied here.

[175] The offset reduces the social costs by 50%. The increase in the bail-in success probability reduces crisis costs by an additional 2.5 percentage points of GDP, thereby raising social benefits.

macroeconomic benefits of 0.21% of GDP. To place this in context, the aggregate GDP of FSB member jurisdictions amounted in 2019 to $72.05 trillion. Estimated gross benefits would then equal $216bn and estimated gross costs would equal $65bn. Slightly less conservative assumptions raise net macroeconomic benefits to 0.28% of GDP.

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