FSB FINANCIAL STABILITY BOARD

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

Addendum to the Technical Appendix

1 April 2021

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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 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.

In June 2020 the FSB published a Consultation Report and a Technical Appendix.[1] The latter complemented the consultation report by providing a detailed description of the analytical approaches, data sources and results of the empirical analysis.

[1] See Evaluation of the effects of too-big-to-fail reforms: consultation report (June 2020).

The work of the working group was largely completed before the onset of the COVID-19 pandemic and the period of elevated market stress that it caused in March and April 2020. A number of respondents to the consultation highlighted the fact that an analysis of the market reactions during that period could provide additional relevant information for the evaluation. Therefore, when the original analysis was based on data of sufficiently high frequency, and the working group concluded that the evaluation could benefit from additional work, it updated the analysis it had conducted for the consultation report. These updates were possible in three areas: the dynamics of TLAC debt, the estimation of funding cost advantages (FCAs) and the behaviour of market-based measures of systemic risk.

This addendum to the Technical Appendix contains the results of these updates and should therefore be read alongside the original Technical Appendix.

Table 1 maps the sections in this addendum to the sections in the Technical Appendix.

Table 1: Summary of the updates carried out

Description	Section in the addendum	Section in the technical appendix
TLAC	1 (Market dynamics of TLAC debt)	2.2
Funding cost advantage estimation	2.1 (Estimating FCA using factor pricing)	3.2
	2.2 (FCA using CDS data)	3.3
	2.3 (FCA in Germany)	3.6
	2.4 (FCA using CCM)	3.7
Measures of systemic risk	3 (Market-Based systemic risk measures)	5.8

1. Market dynamics of TLAC debt

1.1. Summary of previous results

The original Technical Appendix showed that most G-SIBs in developed countries already met their final requirements for TLAC during the implementation phase and the debt market had so far absorbed issuance without difficulty in favourable market conditions. Between 2013 and 2016, a shift towards TLAC debt was temporarily observed.

Market observations from the implied recovery of senior non-preferred (SNP) and senior preferred (SP) tranches suggested that bail-in risk is priced by the market. In terms of risk sensitivity, the SNP tranche is priced rather like Tier 2 capital even though the SNP tranche experiences losses only if the bank is a gone concern.

The results also imply that 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, but this may be an artefact due to the nature of the data.

1.2. New data gathered

The evaluation extended the time series of the data on TLAC issuances to observe the behaviour of the market during the financial market turmoil in March 2020 and the following months. Table 1.1 reports the number of TLAC issuances in 2020 (up to the end of October), by region of issuers and by payment hierarchy.

Table 1.1: TLAC issuances in 2020 (Jan-Oct)

Payment hierarchy	Junior Subordinated	Subordinated	Senior Non Preferred	Senior Unsecured	Total
G-SIBs	**21**	**18**	**109**	**578**	**726**
*Asia**	*6*	*4*	*0*	*25*	*35*
European Union	*5*	*13*	*91*	*22*	*131*
*Other European countries***	*5*	*1*	*6*	*71*	*83*
North America	*5*	*0*	*12*	*460*	*477*
Non G-SIBs	**13**	**23**	**606**	**227**	**869**
Asia	*1*	*3*	*0*	*4*	*8*
European Union	*11*	*15*	*597*	*5*	*628*
*Other European countries***	*1*	*3*	*9*	*7*	*20*
North America	*0*	*2*	*0*	*211*	*213*
Total	**34**	**41**	**715**	**805**	**1595**

Source: Bloomberg/Eikon.*Mainly Japanese banks. **UK, Switzerland and Norway.

Most TLAC debt issuance in 2020 came from EU, Canadian and US banks. Regarding TLAC debt issued by banks other than G-SIBs, EU and Canadian banks are those most represented in the sample. This is because Canada and EU require a broader set of banks to issue TLAC debt (MREL in the EU and TLAC requirements for Canadian D-SIBs). US G-SIBs issued mostly senior unsecured debt while senior non-preferred instruments are essentially issued by European banks. Euro and US dollar debt represent almost 90% of the issuance in the sample measured by volume. The analysis therefore focuses on debt issued in these two currencies.

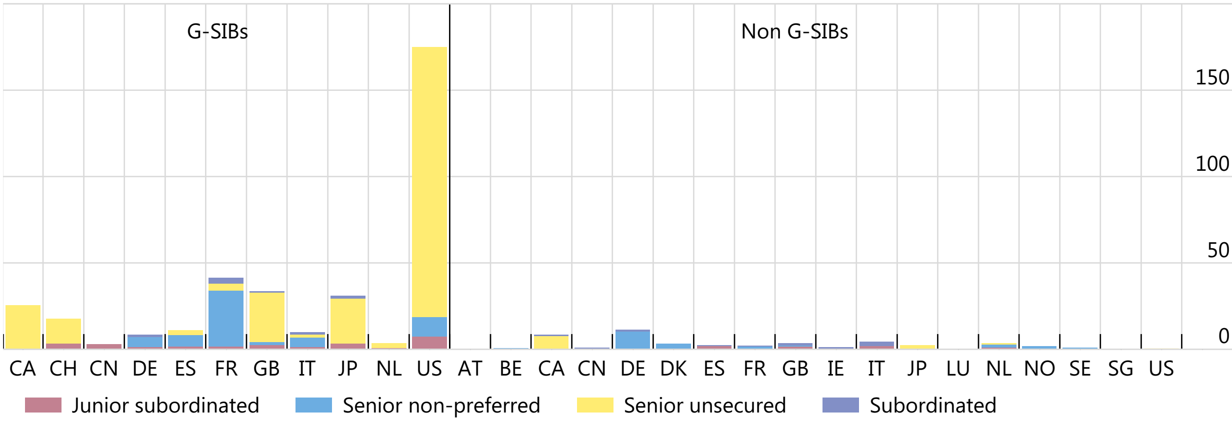
In the same way as the analysis contained in the Technical Appendix, the iBoxx indices of the spread over the benchmark bond by seniority, are used to analyse the secondary market of banks' debt market.

1.3. Results

Senior non-preferred issuances by European banks started 2020 with a strong surge but then dropped significantly following the financial market turmoil in March triggered by the onset of the COVID-19 pandemic. However, this pattern was not present in senior unsecured bonds issued by US G-SIBs, which remained strong. Issuance peaked in March, when 15% of the total US volume took place (Figure 1.1 and 1.2). It is possible that US banks may have been reluctant to change their issuance programs notwithstanding the stress experienced in March.

TLAC issuances in 2020 (until Oct.) by jurisdiction of the issuer and by payment hierarchy

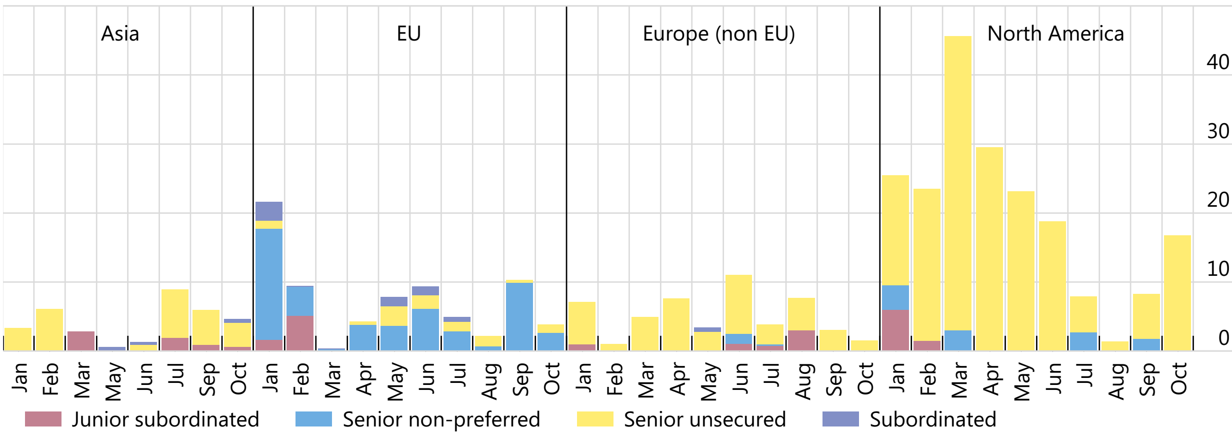
In billions of US dollars **Figure 1.1**



Sources: Bloomberg; Eikon.

G-SIBs TLAC issuances through 2020 (until Oct.) by region of the issuer

In billions of US dollars **Figure 1.2**



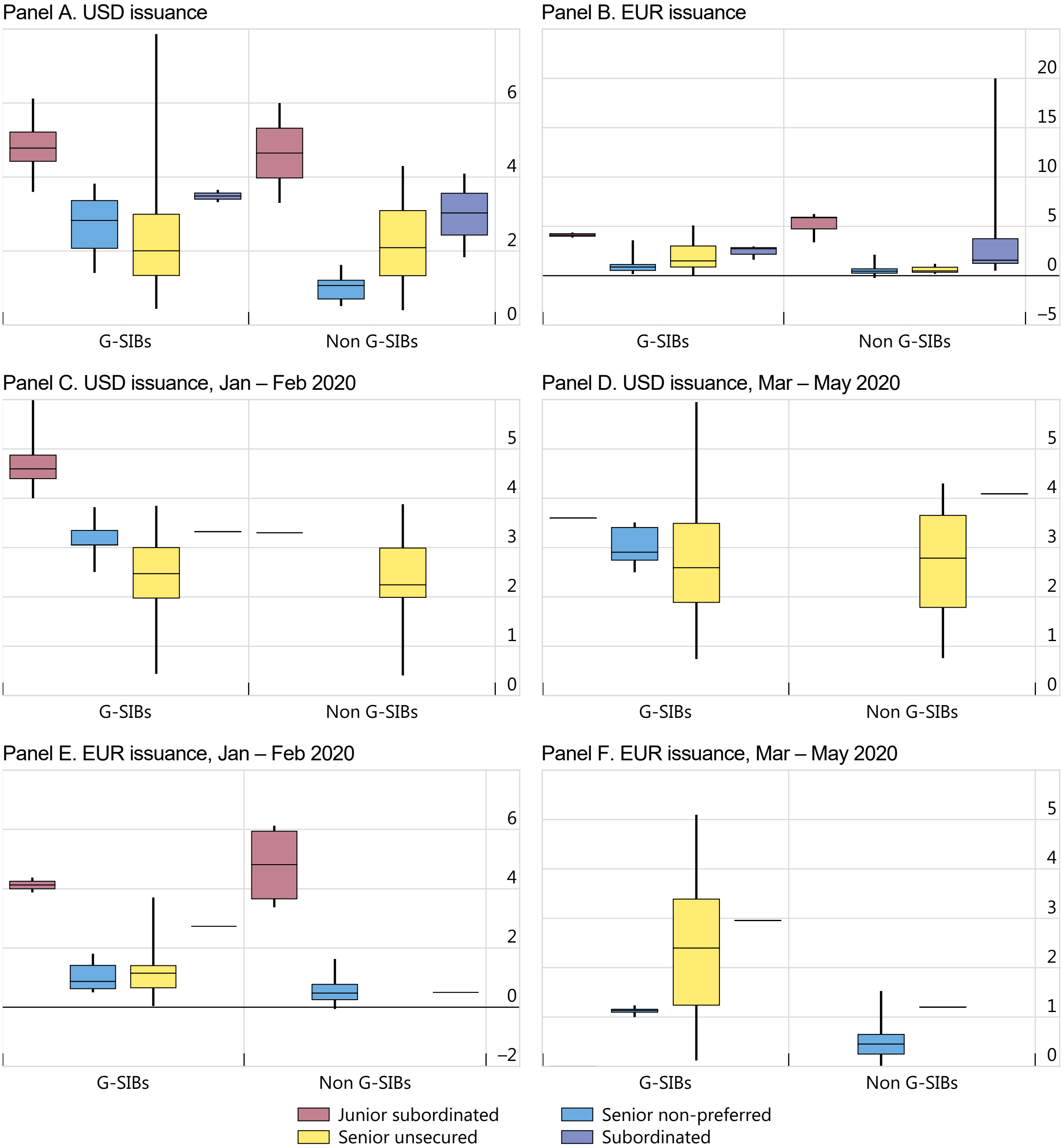
Note: Senior unsecured corresponds to holdco issuances (structurally subordinated) and thus does not include any applicable senior allowance for TLAC.

Sources: Bloomberg; Eikon.

Distribution of the yield at issuance

Yield to maturity, in per cent

Figure 1.3



Sources: Bloomberg; Eikon.

In March 2020, with the exception of those in the US, most banks stopped issuing, and only restarted once the market recovered. No significant increase in the yields has since been observed with one exception. Euro-denominated senior unsecured bonds issued by US banks have experienced an increase in yields, but the sample is small, so it is difficult to derive strong conclusions from this fact (Figure 1.3). In general, it is not possible to identify a generalised change in funding costs. There is considerable heterogeneity among banks, depending on their inherent financial soundness and their funding policy.

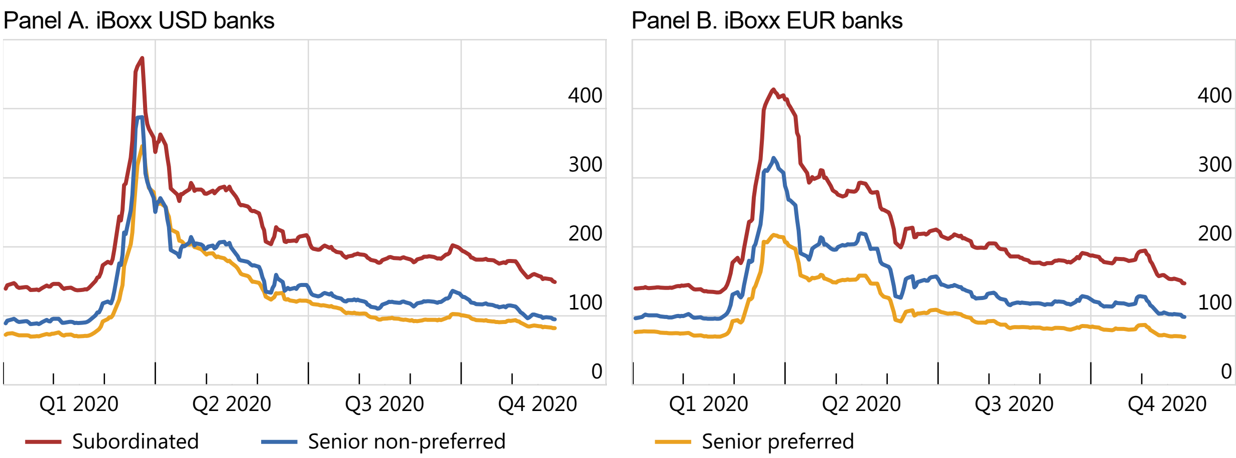
In the secondary market, spreads increased sharply at the beginning of the stress period, reflecting investors' beliefs of greater default risk which, in turn, reduced significantly the demand and supply of bonds (Figure 1.4). However, in the March 2020 case, spreads remained far below those during the peak of the 2008 financial crisis.

The behaviour of the market for bank debt was not dissimilar from that of other markets. Prompt and strong central banks' actions and regulatory responses helped the market to recover. However, investors may remain nervous as the pandemic may still cause greater future loan defaults, which may materialise after government support ends.

Secondary market spreads (USD and EUR issuance)

In basis points

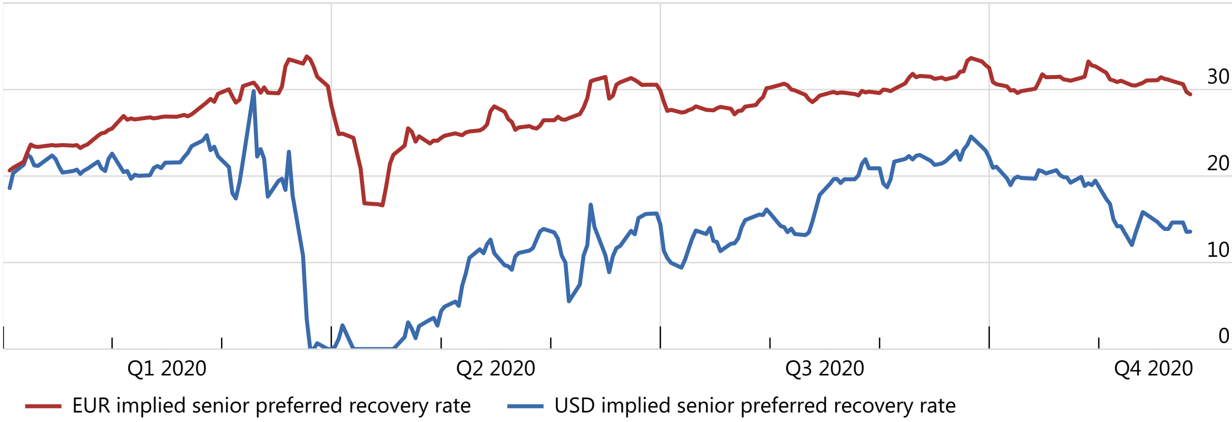
Figure 1.4



Source: Markit.

Maximum implied recovery (priced by the market iBoxx indices) of the senior preferred tranche, assuming zero recovery for the senior non preferred tranche (LGD=100%)

In per cent **Figure 1.5**



Sources: Markit; FSB calculations.

Figure1.5 shows the maximum implied recovery rate of senior preferred debt conditional on a total loss of senior non-preferred debt (LGD=100%). The implied recovery rate drops significantly during the market stress, in particular for USD-denominated debt. By construction, the spread between the senior preferred and the senior is narrower the lower the implied recovery rate. This reduction was particularly large for USD-denominated debt. The spread considerably narrowed during the stress period and even became negative when the indices begun to recover. As observed above, US banks have mainly issued senior unsecured and senior preferred bonds. Relatively to their balance-sheet, they did not hold a large amount of SNP in their TLAC debt compared to EU banks.

1.4. Conclusions

The COVID-19 outbreak in Mach 2020 led to a significant drop in issuance, in particular in the SNP segment. However, the market recovered quite quickly and the volume of issuances reached almost pre-crisis levels. There is no evidence of an increase in funding costs due to the crisis.

Volatility in the secondary market peaked during the market stress in March. Initially, the market reacted violently and expected serious banks' solvency problems in the short term. However, it calmed down rapidly and indices went back to the level present before the stress. Investors may have believed that banks were strong enough and would not fall into trouble in the short term. Alternatively, investors may have also put weight on the sizeable interventions from governments, and inferred that the public sector interventions would have continued to support banks.

According to the implied recovery rate analysis, whether or not the current amount of TLAC is adequate, investors believed that resolution authorities may decide to activate the bail-in mechanism to absorb the necessary losses if needed.

2. Funding cost advantages estimation

This section presents updated results on the estimates of implicit funding subsidies carried out for the evaluation. Four studies were updated: estimates of the implicit funding subsidies (IFS) using a factor pricing approach (section 2.1), funding cost advantages (FCA) using CDS prices (section 2.2), secondary market corporate bond prices in Germany (section 2.3) and using a contingent claims model (section 2.4). Two studies using primary market corporate bond prices in Canada and Europe were not updated due to data limitations.

In the new analysis, we examine whether, following the disruption of financial markets in March 2020 due to the COVID-19 pandemic, the funding cost advantage to SIBs increased. Unlike the global financial crisis of 2007-2008, the pandemic had severe effects on non-financial sectors of the economy, particularly those involved in face-to-face transactions. That, in turn, reduced the value of banks' loan portfolios because of possible future defaults or due to forbearance that delayed loan repayments. If we fail to estimate higher funding cost advantages, this might suggest that TBTF reforms achieved their intended effects by eliminating market expectations for bank bailouts during crises. However, widespread concerns for waves of bankruptcy in the early days of the pandemic may have increased the funding cost advantage of SIBs in two ways, as described below.

First, there was early and unprecedented government support in the form of fiscal and monetary stimuli and regulatory reliefs. Although this support was geared towards the broader economy and the COVID-affected population of firms rather than banks, investors may have believed that it was unlikely that governments would allow any bank to fail. But given the systemic nature of the pandemic, it was also likely that investors believed that large banks would be supported more than small banks since their failure would have greater negative externalities to the overall economy. If market prices reflected the likelihood of government support, investors may have rationally viewed the support to be greater for larger banks than for smaller ones.

Second, in many countries, the pandemic had a more negative effect on small and medium businesses than on larger businesses. Since small banks tend to make more loans to small businesses than larger banks, they may have suffered a relatively greater losses in market value and greater increases in credit spreads as compared to large banks. In this case, a funding cost advantage may be indicated if differences in large and small bank risk are not adequately accounted for.

Fears of large numbers of bankruptcies in the early period of the pandemic have not yet materialized. This may result in the market's expectation of funding cost advantage to subside, However, if investors remain uncertain as to the longer-term losses on bank loans, then expectations of a funding cost advantage may persist, especially given the uncertain duration of the pandemic.

2.1. Estimating funding advantages using a factor pricing approach

We estimate the IFS for a global portfolio of SIBs comprising five regions: Asia excluding Japan, Canada, Europe, Japan, and the US. The IFS is estimated utilizing a factor pricing approach implemented using equity market prices. Under this approach, we construct a Too-Big-To-Fail (TBTF) factor defined as the return on a portfolio that has a short position on financial firms perceived by market participants as more systemically important and a long position on financial firms perceived as less systemically important.[2] If more systemically important firms benefit from implicit government guarantees, their risk and returns are expected to be lower than less systemically important firms, implying that the TBTF factor return is positive on average.

The IFS is obtained from a regression of the excess equity returns of bank portfolios on the TBTF factor, after accounting for standard risk factors such as size, value and momentum. Since the estimated loading (or beta) on the TBTF factor indicates a firm's exposure to the risk of systemic failures, large non-SIB firms are expected to have higher betas compared to SIBs. The difference in the betas of SIBs and non-SIB large firms, multiplied by the average return on the TBTF factor, is an estimate of the equity market's perception of expected subsidies to SIBs. We express the IFS in annualised percent.[3]

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. Gandhi and Lustig (2015) then construct 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.[4] 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.

We note that, as the TBTF factor compares large and very large financial firms, we may be less likely to find an increased subsidy during the pandemic period. For example, if the subsidy arises due to differential exposures to small and large firm loans by small and large banks (as discussed earlier), we should not expect to find higher subsidies since neither large nor very large banks typically lend to small firms.

2.1.1. Summary of previous results

In our previous analysis, we found that implicit subsidies to SIBs declined following the implementation of TBTF reforms in 2012, as compared to the post-global financial crisis (GFC) pre-reform period of 2009-2011. Moreover, the IFS decreased with greater progress in

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2 This factor differs from the standard SMB factor in that it compares large and very large banks, whereas the SMB factor compares small and large firms. Antill and Sarkar (2018) show that the correlation between the TBTF and SMB factors is essentially zero in the US sample.

3 In the prior analysis, we had also expressed the IFS in US dollars by multiplying the difference in betas by the average market capitalisation of SIBs. For the sake of brevity, we do not report those results here.

4 The TBTF factor includes financial firms, instead of only banks, due to concerns about a mechanical correlation with the SIB portfolio. This issue is further discussed in Section 3.2.2 of the technical appendix, where the determination of the size cut-off for large firms is also described.

implementing resolution reforms, as measured by the Resolution Reform Index.[5] Countries considered by the rating agencies to have more credible resolution regimes are also the ones that typically have larger reductions in the funding advantage.

The evolution of the IFS varied across jurisdictions. While they declined on average in the post-reform period in Europe and the US, this was not the case in other regions. Similarly, the effect of resolution reforms in reducing the IFS was not uniform across jurisdictions.

The IFS varied with financial and macroeconomic conditions such as the ratio of sovereign debt to GDP and the interest rate, the size of the banking sector and investor uncertainty.

2.1.2. New data and methodology

Previously, we obtained the market value of equity and the book value of equity for the five geographical regions from EIKON for the period 2001 to 2019. We further used the five Fama-French factors (Market, Value, Size, Profitability and Investments) and the momentum factor for the five geographical areas as well as the Global portfolio. Since the Fama-French factors are in US dollars, we converted the portfolio returns and the TBTF factor returns into US dollars using monthly exchange rates.[6] For the update, all data series are extended to August 2020.[7]

EIKON data was revised for several years, including the earlier years. Therefore, some results reported in the previous version have changed. This has mainly affected results for Asia ex-Japan and Japan while results for Canada, Europe, US and the Global portfolio remain largely unchanged.

As before, the estimation period starts from July 2002, with the pre-GFC period extending from July 2002 to June 2007 and the GFC period from July 2007 to December 2008. Previously, the post-GFC period was 2009 to 2019 and the reform implementation period was 2012 to 2019. For the update, the end date for the post-GFC and the reform periods is extended to February 2020. We define the COVID-19 period as March 2020 to August 2020.

Updated Methodology

As before, we examine the exposure to TBTF risk using time-series regressions of excess returns of test portfolios on the TBTF factor. These regressions are estimated separately for each region. For test portfolio “i”, region “j” and period “t,” the regression is:

$$ERet_{i,j,t} = \alpha_{i,j} + \beta_{i,j} TBTF_{j,t} + \sum_{k=1}^{6} \gamma_{i,j,k} Factor_{j,k,t} + \varepsilon_{i,j,t} \qquad (1)$$

Where $ERet_{i,j,t}$ is the average value-weighted excess returns of test portfolio “i” in jurisdiction “j” for month “t” and $Factor_{j,k,t}$ k=1,..,6 is one of the five Fama-French and Momentum factors. The test portfolios are the average value-weighted excess returns of SIBs and large non-SIB firms

5 The RRI quantifies the progress of FSB jurisdictions in adopting comprehensive bank resolution reforms since the global financial crisis. It is described in section 2.1.1 of the technical appendix.

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

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

(denoted CON portfolios). There are three CON portfolios: the average value-weighted excess returns of large non-SIB banks, large non-bank non-financial firms, and large non-financial firms, where large firms are those in the top 10% of the market value of the equity distribution in any year.

For jurisdiction *j*, the IFS for SIBs relative to CON is expressed in annualised percent as:

$$\mathrm{IFS}_{\mathrm{SIB,j}} = (\beta_{CON,j} - \beta_{SIB,j}) * average\ TBTF_j\ return, \text{ if } average\ TBTF_j\ return > 0 \quad (2)$$

We require the average TBTF returns (i.e. the systemic risk premia) to be positive since, if they are negative, then the market does not perceive the TBTF firms to benefit from a government guarantee, in which case the IFS is not defined.[8] Conditional on the average TBTF returns being positive, $\mathrm{IFS}_{\mathrm{SIB,j}}>0$ as long as $\beta_{CON,j} > \beta_{SIB,j}$ – that is, SIBs have a lower exposure to TBTF risk than large non-SIB firms. If the estimate of $\beta_{i,j}$ is statistically insignificant, then we consider it to be zero. We annualise the TBTF returns and express IFS in percent per year.

To examine if the subsidy changed during the COVID-19 sample, we estimate (1) over a rolling 5-year window to obtain a time series of subsidies. Then, we estimate the following regression for the change in IFS:

$$\Delta\mathrm{IFS}_{\mathrm{SIB,j,t}} = \alpha_{j,0} + \sum_{k=1}^{6} \beta_{j,k} Month_{k,t} + \varepsilon_{j,t} \quad (3)$$

$Month_k$ is a dummy variable equal to 1 for month "*k*" of 2020 during the COVID-19 sample, where k=1 (March), 2 (April), 3 (May), 4 (June), 5 (July) or 6 (August), and 0 otherwise. Thus, if $\beta_{j,k} > 0$ and statistically significant, then subsidies increased during the *k*-th month of the COVID-19 sample, relative to the pre-COVID period. If $\beta_{j,k} \geq 0$ for successive months, then the COVID-19 effect is persistent. We estimate the regression in changes as we cannot reject the null hypothesis that the IFS has unit roots.

To obtain the average effect of COVID-19 on subsidies, we alternatively estimate:

$$\Delta\mathrm{IFS}_{\mathrm{SIB,j,t}} = \alpha_{j,0} + \beta_j COVID_t + \varepsilon_{j,t} \quad (4)$$

COVID is a dummy variable equal to 1 from March to August 2020, and 0 otherwise.

2.1.3. Results

Evolution of Systemic Risk Premia

The TBTF factor is expected to have positive returns on average if investors perceive that more systemically important financial firms have a higher probability of bailout. This return represents the systemic risk premium – the additional compensation that investors require to hold less systemically important (and therefore more risky) firms. Table 2.1.1 shows descriptive statistics for three samples: the pre-reform sample from 2009 to 2011; the post-reform sample from 2012

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8 This is more likely to happen in short sample periods, and is rare in longer samples. For some countries, the average TBTF returns may be negative, and this is discussed further in section 2.1.3.

(when implementation of TBTF reforms started) to February 2020 (just before COVID-19 disrupted asset markets globally) and the COVID-19 sample (March to August 2020). The average market value of equity (ME) of large financial firms at the TBTF size cutoff (above which firms are viewed as systemically important) is generally lower in 2020 relative to the average of 2012-2019 while the average number of large financial firms above the cutoff is generally higher. This may reflect the equity market declines in 2020.

The last row in each panel of Table 2.1.1 shows that, for all countries except Asia excluding Japan and Canada, the TBTF factor return increased -- and often substantially -- during the COVID-19 sample. For example, for the Global portfolio, TBTF factor returns increased from 2.58% in the post-reform sample to 13.23% in the COVID-19 sample on an annualised basis, although the difference is only weakly significant at the 10% confidence level.[9] These results are generally consistent with investors requiring greater compensation for bearing systemic risk during COVID-19 relative to the pre-COVID-19 period. However, higher TBTF returns by itself need not imply that implicit subsidies increased during the COVID-19 period. For subsidies to increase during the COVID-19 period, SIBs must also have a lower exposure to the TBTF factor relative to other large firms.

Previously, we found evidence that the TBTF factor was informative of returns even after accounting for the Fama-French and momentum factors, since it had small to moderate correlation with the latter factors. This continues to be the case in the COVID-19 period (results are not reported). In other words, the TSIZE factor (intended to capture *systemic* risk) is not reflecting *systematic* risk embodied in standard risk factors.

Estimates of Implied Funding Subsidies

We estimate the funding subsidies implied by the TBTF loadings, expressed as annualised returns using equation (2), for the pre-reform period and the post-reform sample including and excluding the COVID-19 period. Due to the small number of observations in the COVID-19 sample period, it was not possible to estimate regressions for this period separately. The dynamic analysis in the next section provides time-varying estimates of the subsidy during the pandemic. We use a Wald test to compare the subsidies between pre-reform and post-reform periods, when excluding or including the COVID-19 sample.[10]

Table 2.1.2 shows the funding subsidies to SIBs, as implied by their estimated exposures to the TBTF factor, relative to different control portfolios. Panel A of the table reports results using large non-SIB banks as the control portfolio. Asia, Canada and Japan do not have estimates of the pre-reform subsidy as the TBTF factor return was negative during this period. For the Global, Europe and US SIB portfolios, the subsidies are lower in magnitude in the post-reform ex-COVID-19 period than in the pre-reform period, consistent with prior results. The Wald test indicates that the subsidy is significantly lower in the post-reform implementation period. The

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9 TBTF factor returns are often negative for Asia ex-Japan (for example, during the pre-reform period of 2009-2011). This may indicate that our procedure failed to distinguish more and less systemic financial firms in this region, perhaps due to data quality.

10 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 pre-reform and the post-reform periods. We convert the estimated TBTF factor loadings into subsidy estimates for the pre- and post-reform periods using equation (3) and then use the Wald test to compare them.

final row shows the implied subsidies for the post-reform period after including the COVID-19 sample. The implied subsidies are higher for all regions except Asia ex-Japan and Canada. Comparing the pre- and the post-reform subsidies when including the COVID-19 sample, we find that the average subsidy remains lower than in the pre-reform period for the Global and the US SIB portfolios, but not statistically different for Europe. These results suggest that subsidies may have increased during the COVID-19 period.

Panel B of the table reports results using large non-bank financial firms as the control portfolio. The evolution of these subsidies mostly follow a similar pattern as those with respect to large banks. Subsidies are significantly lower in the post-reform period, both excluding and including the COVID-19 period, relative to the pre-reform period for the Global and Europe portfolios. One exception is the US, where subsidies increase following reforms.

Panel C of the table reports results using large non-financial firms as the control portfolio and obtain qualitatively similar results as when using large non-SIB banks as the control group, both in terms of magnitude and statistical significance of subsidies.

Figure 2.1.1 illustrates the funding subsidies to SIBs in the Global portfolio, as implied by their estimated exposures to the TBTF factor, relative to different control portfolios.

In summary, we find significantly lower funding subsidies to SIBs following TBTF reforms both when excluding and when including the COVID-19 period. However, the average funding subsidies to SIBs are higher when including the COVID-19 period than when excluding it, suggesting that subsidies may have increased during the pandemic. Since the static regressions are unable to identify the COVID-19 effects accurately, we next turn to a dynamic analysis.

Dynamics of Subsidies: Pre- and Post-COVID-19 Period

So far, we have estimated the *average* subsidies to SIBs for different periods. This method is not useful for identifying the effect of the COVID-19 pandemic since we have data for just six months of the pandemic sample. Accordingly, we estimate 5-year rolling regressions and calculate the monthly subsidies to SIBs using the average TBTF returns and the corresponding TBTF loadings in the relevant 5-year period. Due to the short estimation period, the TBTF loadings are sometimes insignificant. In order to avoid a series of zero values of the subsidy, we use the estimated loadings even if it is not statistically significant, rather than assume that it is zero, as we did earlier. Further, we only report results for the Global portfolio as the regional portfolios are more likely to have missing estimates when the TBTF factor return is negative for the 5-year window.

Figure 2.1.2 shows the time series of estimated subsidies to SIBs for different control groups in the Global portfolio. Although the levels are different (being smallest relative to large banks and largest relative to large non-financials), the dynamics of subsidies are similar for the different control portfolios. The subsidy peaks between 3% and 7% in February 2009, falls thereafter before spiking again in Q3 and Q4 2011 during the European crisis. Following the European crisis, subsidies mostly decline and bottoms out between September 2016 and December 2018. From 2019 to February 2020, subsidies were flat to slightly increasing, depending on the control portfolio.

Effect of COVID-19 pandemic

Subsidies increased from 0.4% to 1.1% between March and August 2020 when large non-SIB banks are the control group, from 2.1% to 3.1% between March and July 2020 when large non-bank financials are the control group, and from 2.3% to 2.7% between April and August 2020 when large non-financials are the control group. Thus, subsidies increased moderately during the pandemic from a low base.

While subsidies increased during the COVID-19 period, this was in the context of an upward trend in subsidies since 2019. To assess whether the increase in subsidies during the COVID-19 period is statistically significant, we estimate equation (2) by regressing the change in SIBs' funding subsidies on dummy variables for each month from March to August 2020. This specification allows us to identify both the timing and persistence of potential changes in the subsidy during the COVID-19 period.

The estimated dummy coefficients indicate the change in subsidies relative to the post-reform pre-COVID-19 period (the omitted sample). The results are in Table 2.1.3. Panel A of the table shows the estimates by month in the COVID-19 period. For the non-SIB large banks and non-bank financials control portfolios, we find a statistically significant increase in subsidies in April 2020 that persists till July or August 2020 (with a partial reversal in June for the large bank control portfolio). When large non-financials is the control portfolio, we only find increases in the subsidy in May and July 2020.

To estimate the average change in subsidies during the COVID-19 period, we estimate equation (3), regressing the change in the IFS on a dummy variable for March to August. The results in Panel B of the table show a statistically significant monthly increase of 13 basis points and 8 basis points in the subsidy relative to large non-SIB banks and large non-financials or a total increase of about 80 and 50 basis points, respectively, over these six months. Since the average subsidy relative to large non-SIB banks and large non-bank financials is about 100 basis points from 2012 to February 2020, the total increase in subsidy from March to August is about 80% and 50% of the average pre-pandemic subsidy, respectively. During the peak pandemic period of April to July 2020, there is a significant increase in subsidies for all three control portfolios of between 11 and 25 basis points per month. As we do not have data after August 2020, and the pandemic is ongoing, the full extent of changes in subsidies remains to be seen.

Benefits to Large Non-financial Firms

As is well-known, the pandemic has been particularly adverse for small and medium-sized (SME) firms and to the relative advantage of large firms in every industry.[11] We explore the hypothesis that the increased subsidies to SIBs is a reflection of a more general increase in the funding advantage of large firms even in the non-financial sectors.

To this end, we create a global non-financial size factor using the same size cutoff of 8% used for the global TBTF factor. Thus, the non-financial size factor is the return spread between largest 8% of non-financial firms and the next largest 8% of non-financial firms globally. Panel A

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[11] See, for example, *America's biggest companies are flourishing during the pandemic and putting thousands of people out of work* Washington Post, December 16, 2020.

of Table 2.1.4 shows that the return to the non-financial size factor was 10% in the pre-reform period, 5% in the pre-COVID period and 8.51% in the COVID period. Thus, similar to the financial sector, investors required relatively more compensation to hold the smaller non-financial firms than the largest non-financial firms.

Since COVID-19 had a heterogeneous effect on different non-financial sectors, we construct the test portfolios at the industry level. In particular, we construct value-weighted excess return portfolios for the following sectors:

- Construction and manufacturing (SIC2 codes 15-17, 20-39, 52)
- Entertainment and hospitality (SIC2 codes 58, 70, 72, 78-79)
- Mining (SIC2 codes 10, 12, 14)
- Oil and Gas (SIC2 codes 13 and 46)
- Professional Services (SIC2 codes 73, 75-76, 80-83, 87)
- Retail (SIC2 codes 53-57, 59)
- Transport, Warehouse and Delivery (SIC2 codes 37, 40-42, 44-45, 47)
- Utility (SIC2 codes 48-49)

Industries particularly affected by COVID-19 are entertainment and hospitality, oil and gas, retail and transportation.[12] Bigger firms may be expected to have a larger *relative* advantage over smaller firms in these industries.

Analogous to SIBs, we estimate the funding advantages to the largest 10% of non-financial firms in each of these sectors, relative to the next 10% large firms in the same sector. Using 5-year rolling regressions, we estimate a monthly series of these funding advantages for each sector. Then we estimate regression (4) and report the results in Panel B of Table 2.1.4. We find that the funding advantage to the largest non-financial firms decreased during the COVID-19 sample for all sectors except for the COVID-19 sensitive sectors oil, transport and retail sectors where the estimated sign is positive -- some evidence that the largest non-financial firms in sectors most affected by the pandemic enjoyed a funding advantage. However, the evidence is not robust as the statistical significance is weak and, notably, the largest firms in the entertainment and hospitality sector do not benefit from a funding advantage. Overall, we find mixed evidence of an increased funding advantage for large non-financial firms in industries susceptible to the COVID-19 shock.

2.1.4. Conclusions

In this study, the IFS is estimated based on a factor pricing approach using equity returns of financial firms. Under this approach, a TBTF risk factor is constructed and the exposure of SIBs

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12 See Sallerson, Peter, "CLO Deal & Manager Exposure Analysis by Industries Impacted Due to Coronovirus (COVID-19)," Moody's Analytics Research, March 2020.

and other large financial firms to this factor is estimated, after accounting for standard risk factors such as size, value and momentum. SIBs benefit from an implicit funding subsidy if they have a lower exposure to the TBTF risk factor than large non-SIB banks, large non-bank financial firms or large non-financial firms.

We create a global portfolio of SIBs covering Asia, Canada, Europe and the US, and find that following the implementation of TBTF reforms, the funding advantage of SIBs has declined, as compared to the pre-reform period. However, the average subsidy to SIBs is higher during the post-reform period when including the COVID-19 period of March to August 2020 than when excluding this period.

To better identify COVID effects, we estimate a monthly series of subsidies using rolling window regressions. The results indicate a statistically significant increase in subsidies of between 50 and 80 basis points during the six months between March and August 2020. However, as subsidies were low in early 2020, between 50 basis points and 250 basis points on an annualised basis, the magnitude of subsidies remained at a moderate level, by historical standards, even after the increase during the COVID sample.

We examine the hypothesis that the increased subsidies to SIBs reflected an increased funding advantage to large firms in all sectors, financial and non-financial and, particularly, in industries that suffered more from the COVID-19 shock. While we find some support for this hypothesis, the evidence is mixed and the statistical significance is rather weak.

2.1.5. Figures and tables

Table 2.1.1: Summary Statistics for TBTF Factor: Post-Crisis Period

The table shows the size percentile above which financial firms are considered systemically important. 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 cutoff. Since the data is annual, for the pre-COVID sample (2012-Feb 2020), these are calculated as averages of 2012-2019. For the COVID sample (March 2020-August 2020), we report the average for 2020. Finally, the table reports the annualised return on the TBTF factor.

Panel A: Global			
	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	8	8	8
Average ME at cutoff ($B)	14.78	18.53	13.32
Average # of firms above cutoff	72.67	87.50	100.00
TBTF average return (%)	4.66	2.58	13.23

Panel B: Asia ex Japan			
	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	5	5	5
Average ME at cutoff ($B)	22.61	32.22	29.26
Average # of firms above cutoff	4.67	6.13	7
TBTF average return (%)	-5.67	2.21	-2.16
Panel C: Canada			
	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	9	9	9
Average ME at cutoff ($B)	26.75	33.39	26.39
Average # of firms above cutoff	4	4.38	5
TBTF average return (%)	-2.66	5.71	2.51
Panel D: Europe			
	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	7	7	7
Average ME at cutoff ($B)	35.59	34.42	23.86
Average # of firms above cutoff	15.33	18.33	21
TBTF average return (%)	5.01	7.10	13.83
Panel E: Japan			
	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	5	5	5
Average ME at cutoff ($B)	15.27	17.53	15.62
Average # of firms above cutoff	5.00	6.25	7
TBTF average return (%)	-0.56	1.31	64.38

Panel F: United States			
	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	6	6	6
Average ME at cutoff ($B)	11.86	17.98	13.80
Average # of firms above cutoff	25.00	30.00	35.00
TBTF average return (%)	9.61	0.10	6.22

Table 2.1.2: Funding Subsidies 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 equal to the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period, conditional on the return being positive. A statistically insignificant exposure is taken to be zero. ***/**/* indicate that difference in funding subsidies between the pre- and post-reform periods excluding the COVID-19 sample (March to August 2020), or the pre- and post-reform periods (including the COVID-19 sample), are significantly from zero at the 1%/5%/10% level or less.

Panel A: Funding Subsidies Relative to Large non-SIB Banks						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
Post-Crisis Pre-Reform Period						
2009-2011	3.87	---	---	2.96	---	4.87
Post-Reform Pre-COVID Period/Wald test: Pre-reform subsidy period = Post-reform Pre-COVID period subsidy						
2012 - February 2020	1.44***	-0.08	0.17	0.22*	0.45	0.10**
Post-Reform Incl. COVID Period/Wald test: Pre-reform period subsidy = Post-reform incl. COVID period subsidy						
2012-August 2020	2.06***	-0.08	-0.20	2.91	1.58	0.43***

Panel B: Funding Subsidies Relative to Large Non-Bank Financials						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
Post-Crisis Pre-Reform Period						
2009-2011	3.87	---	---	5.53	---	-1.07
Post-Reform Pre-COVID Period/Wald test: Pre-reform subsidy period = Post-reform Pre-COVID period subsidy						
2012 - February 2020	1.44**	1.23	4.94	2.64*	0.45	0.10**

Post-Reform Incl. COVID Period/Wald test: Pre-reform period subsidy = Post-reform incl. COVID period subsidy						
2012-August 2020	1.22**	0.88	4.59	2.91*	1.58	0.33

Panel C: Funding Subsidies Relative to Large Non-Financials						
	Global	Asia ex Japan	Canada	Europe	Japan	United States
Post-Crisis Pre-Reform Period						
2009-2011	3.87	---	---	2.96	---	5.35
Post-Reform Pre-COVID Period/Wald test: Pre-reform subsidy period = Post-reform Pre-COVID period subsidy						
2012-February 2020	1.44**	0.99	2.44	2.64	0.45	0.11**
Post-Reform Incl. COVID Period/Wald test: Pre-reform period subsidy = Post-reform incl. COVID period subsidy						
2012-August 2020	2.06**	0.76	6.84	2.91	1.58	0.43***

Table 2.1.3: Effect of COVID on Funding Subsidies to SIBs in the Global Portfolio

This table shows results from a regression of the funding subsidies to SIBs in the global portfolio, on dummy variables for the post-reform pre-COVID period and the COVID period. The omitted sample is the post-reform pre-COVID period of 2012 to February 2020. The funding subsidy 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. The sample is from 2012 to August 2020.

Panel A: Effect of COVID by Month

	Dependent variable: Change in Funding Subsidies to SIBs		
	Control group: large non-SIB banks	Control group: large non-bank financials	Control group: large non-financial firms
March 2020	-0.09***	-0.02	0.04
	(-6.27)	(-0.59)	(1.43)
April 2020	0.59***	0.34***	-0.13***
	(41.01)	(12.92)	(-4.49)
May 2020	0.24***	0.22***	0.23***
	(16.55)	(8.48)	(8.31)
June 2020	-0.19***	0.07**	-0.04
	(-13.25)	(2.52)	(-1.40)
July 2020	0.18***	0.38***	0.39***
	(12.25)	(14.60)	(13.73)
August 2020	0.04**	-0.63***	-0.02
	(2.52)	(-24.19)	(-0.78)

Adjusted R-Squared	0.02	0.05	-0.05

Panel B: Average Effect of COVID

	Control group: large non-SIB banks		Control group: large non-bank financials		Control group: large non-financial firms	
March–August 2020	0.13***	---	0.06	---	0.08**	---
	(5.19)		(0.98)		(2.52)	
March 2020	---	-0.09***		-0.02		0.04
		(-6.28)		(-0.60)		(1.46)
April – July 2020	---	0.20***		0.25***		0.11***
		(4.94)		(7.84)		(3.03)
August 2020	---	0.04**		-0.63***		-0.02
		(2.52)		(-24.51)		(-0.80)
Adjusted R-Squared	0.01	0.00	-0.01	0.07	-0.01	-0.03

Table 2.1.4: Results for Non-Financial Factor: Global Portfolio

Panel A of the table shows the size percentile above which non-financial firms are considered systemically important. We also 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 cutoff. Since the data is annual, for the pre-COVID sample (2012-Feb 2020), these are calculated as averages of 2012-2019. For the COVID sample (March 2020-August 2020), we report the average for 2020. The last row of Panel A reports the annualised return on the non-financial factor. Panel B reports results from a regression of changes in the estimated monthly funding advantages to the largest 10% of non-financial firms in each sector (relative to the next 10% of non-financial firms) on a COVID dummy, equal to 1 between March and August 2020 and 0 otherwise. 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. The sample is from 2012 to August 2020.

Panel A: Summary Statistics for non-financial factor

	2009-2011	2012-February 2020	March 2020 – August 2020
Percentile Cutoff	8	8	8
Average ME at cutoff ($B)	5.07	6.65	7.21
Average # of firms above cutoff	676.00	852.13	949.00
TBTF average return (%)	10.08	5.01	8.51

Panel B: Effect of COVID on Large Non-financial Firm Funding Advantage, by Sector

Dependent variable: Change in Funding Advantage to Large Non-financial firms		
Industry	Estimate of COVID dummy variable	T-Statistics
Construction & manufacturing	-0.19***	-3.27
Entertainment Hospitality	-0.31***	-2.59
Mining	-0.75***	-4.02
Oil	0.14*	1.80
Professional services	-0.27***	-5.86
Retail	0.05	0.54
Transport, Warehouse and Delivery	0.05	0.63
Utility	-0.29***	-5.72

Figure 2.1.1: Funding Subsidies to SIBs in the Global Portfolio (in Return %)

The figure shows the average funding subsidies to SIBs in the Global portfolio for the pre-reform, post-reform/pre-COVID and post-reform including COVID 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 equal to the estimated exposure times the average annualised returns of the TBTF factor in the relevant sample period, conditional on the return being positive

Funding Advantages to SIBs in the Global Portfolio

Portfolio returns (%) **Figure 2.1.1**

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

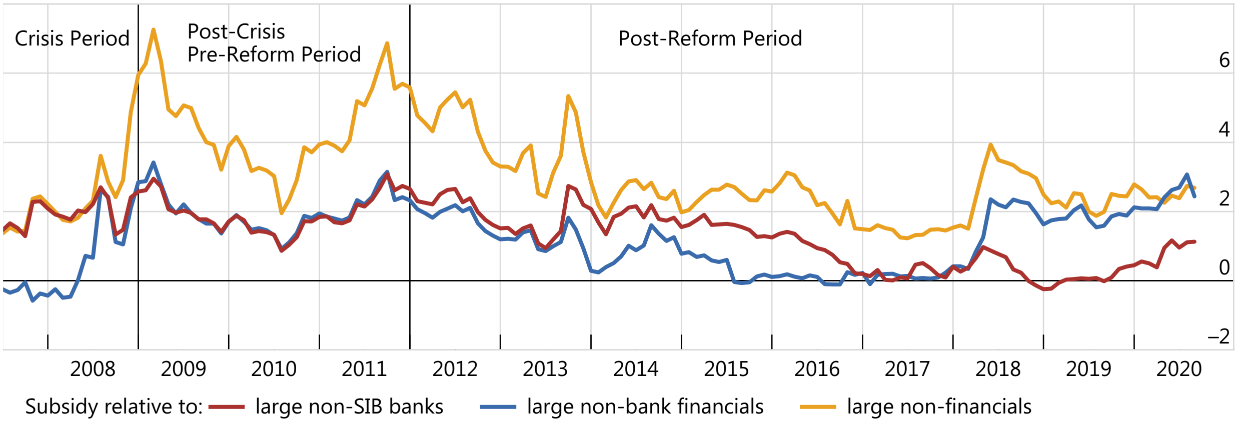
Figure 2.1.2: Dynamics of Funding Subsidies of SIBs in the Global Portfolio (in Return %)

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 subsidies to SIBs are shown relative to large non-SIB banks, large non-bank financials and large non-financials. The subsidy is equal to the estimated exposure to the TBTF factor times the average annualised returns of the TBTF factor in the corresponding window.

Dynamics of Funding Subsidies of SIBs in the Global Portfolio

Portfolio returns (%)

Figure 2.1.2



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

2.2. A funding cost comparison based on CDS data

2.2.1. Summary of previous results

Results from the previous analyses showed that reforms have significantly reduced the funding cost advantage of SIBs, with estimates of the reduction in the range of 27 to 32 bp. By contrast, there is no conclusive evidence that reforms have raised the risk sensitivity of SIBs' CDS spreads. The analysis further found 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 were statistically insignificant.

2.2.2. New data gathered

The update considers the same entities and variables as in the original work. Most importantly, the CDS data now cover the period up to August 2020 (previously until September 2019). Other variables with the exception of the size of the banking sector and the Resolution Reform Index (RRI) were also updated to the extent possible. However, it is important to note that some variables enter the model at the annual frequency (e.g. balance sheet metrics or GDP growth) and not all of them available for the year 2020.[13] Therefore, specifications requiring those variables as inputs were not updated. All other definitions and data processing steps are as described in the Technical Appendix.[14]

Our analyses build on the analytical foundations of our previous work and extend it in two directions. First, we re-estimate selected equations using the longer sample now also covering

[13] However, they may have been updated for the year 2020 if they were missing in the original data (e.g. data for some banks may have been updated and finalised for the year 2019 in the course of 2020). For some variables (e.g. GDP growth) forecast are available but we refrain to use them as the uncertainty around forecasts is currently at very high levels.

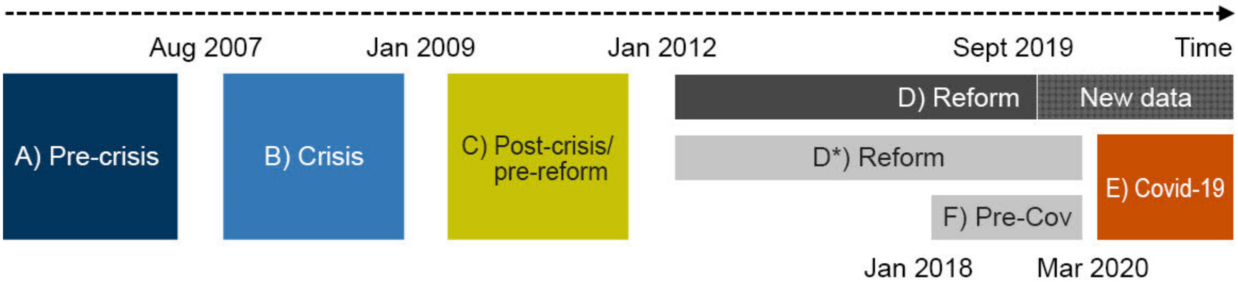
[14] Our data cleaning process involves also a winsorizing of CDS-spreads using the full dataset, including the data post November 2019. Because of this data processing step, adding new data points may have a minor effect on past observations, but this has no bearing on our findings.

the period prior to the March episode. The purpose is to check whether the conclusions derived from the original data until September 2019 are still valid.

Figure 2.2.1: Timing conventions illustrates the new sample periods. The additional data is represented by a dotted rectangle labelled “New Data” to the right of the green box depicting the reform period (D). To check whether our results also hold on the extend time line we now replace the original reform period (D) with extended reform period (D*) shown in grey.

Second, we add a new COVID-19 period, labelled (E) in the figure below, which starts in March 2020 and extends until the end of our data. Finally, as a robustness check we conduct an experiment for which we define a shorter pre-COVID-19 period, labelled (F), which starts in January 2018 and ends in February 2020.

Figure 2.2.1: Timing conventions



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) and D*) reform periods from January 2012 to the end of the estimation sample (September 2019 or February 2020). The two periods D* and F (grey) extend from January 2012 and January 2018 until February 2020. Period E starts in March 2020 and extends until the end of the estimation period (31 August 2020).

2.2.3. Results

Descriptive statistics

Table 2.2.1 shows the averages of CDS spreads and expected default frequencies (EDFs) for G-SIBs, D-SIBs, and Non-SIBs. Most notably, the average CDS spreads declined from 2018 to 2019 across the board, with somewhat larger declines for SIBs. EDFs also declined for D-SIBs and non-SIBs, but not for G-SIBs. In 2020, CDS for SIBs reverted to levels observed in 2018 while CDS spreads for Non-SIBs increased significantly above levels seen in 2018. The same holds with respect to the dynamics of EDF: after a decline in 2018, the increase in 2020 is more pronounced for Non-SIBs.

Table2.2.1: Descriptive statistics

		CDS-Spread				Edf1			
		2018	2019	2020	%∆	2018	2019	2020	%∆
1a GSIB (2018)	mean	60.02	54.73	62.99	5%	0.38	0.39	0.41	8%
	sd	28.09	26.09	31.56		0.17	0 .24	0.22	
1b DSIB (2018)	mean	90.8	80.96	87.22	-4%	0.45	0.42	0.45	0%
	sd	70.86	58.7	75		0.25	0.29	0.31	
1d Non-SIB	mean	123.91	119.91	133.56	8%	0.55	0.51	0.62	13%
	sd	13 7.64	126.43	157.14		0 .47	0.39	0.44	
Total	mean	100.46	93.28	102.56	2%	0.47	0.44	0.5	7%
	sd	105.89	95.37	117.21		0.35	0.32	0.36	

Notes: %∆ refers to the percentage change in the respective statistic between 2018 and 2020.

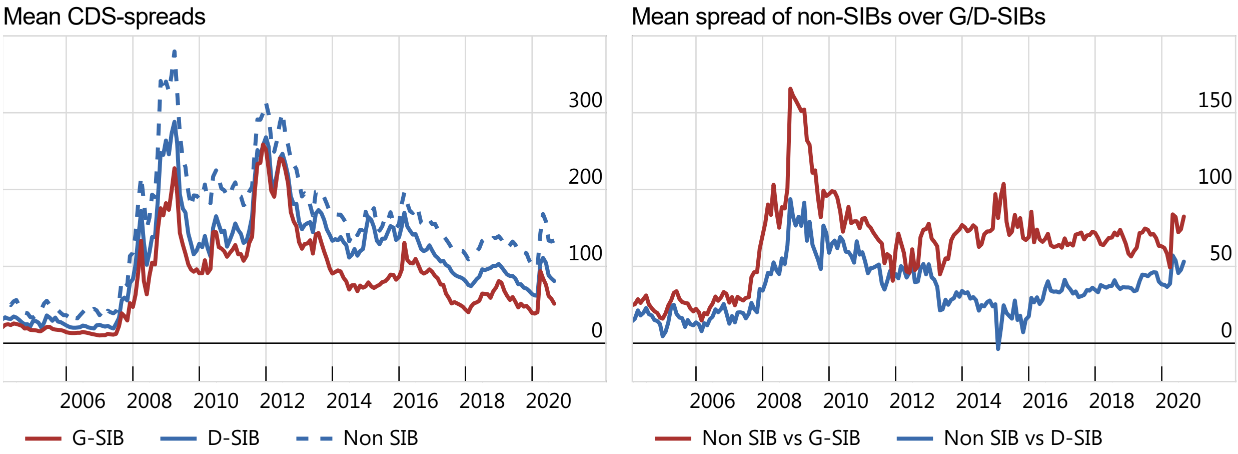
The left panel of **Error! Reference source not found.** shows the time-series plot of CDS spreads for G-SIBs, D-SIBs and Non-SIBs. The right panel displays the CDS-spreads of Non-SIBs relative to the CDS spreads of G-SIBs or D-SIBs. The figure shows that the spreads rose strongly in March for all groups. For Non-SIBs, however, the CDS spreads rose on average more strongly than those of G-SIBs or D-SIBs. While this observation is compatible with an increase in funding cost advantages of SIBs, the figure reveals that a comparison of unweighted averages masks important heterogeneity across groups. The graphs show that the relatively stronger increase in CDS spreads of Non-SIBs relative to the two other groups stems primarily from some relatively large increases for entities in the group of Non-SIBs, as evidenced by the larger distance between median and mean (Figure 2.2.3). By contrast, mean and median CDS spreads for G-SIBs are virtually identical. As a consequence, a comparison of median CDS spreads (lower right corner) shows that that the spread of Non-SIBs over SIBs decreased initially but recovered to pre-COVID-19-levels towards the end our sample.

Further, bank risk as proxied by EDF rose much more for non-SIBs than for G-SIBs or D-SIBs since the start of the ongoing crisis and it remains elevated (**Error! Reference source not found.**).[15] This widening in the non-SIB – SIB-spread for EDF seems, in contrast to CDS spreads, robust to heterogeneous behaviour of banks within group. Another interesting observation is that the COVID-19 induced increase in CDS spreads and EDFs is much smaller than in the GFC.

[15] We assume that EDF is a measure of bank risk, on which bailout expectations have little effect. The rationale is that EDF is computed from share prices, and that equity owners are unlikely to benefit much from implicit guarantees that will only apply when a firm's equity has lost most of its value. A weaker version of this assumption requires that equity benefits less than debt from bail-out expectations.

Average CDS spreads by bank type

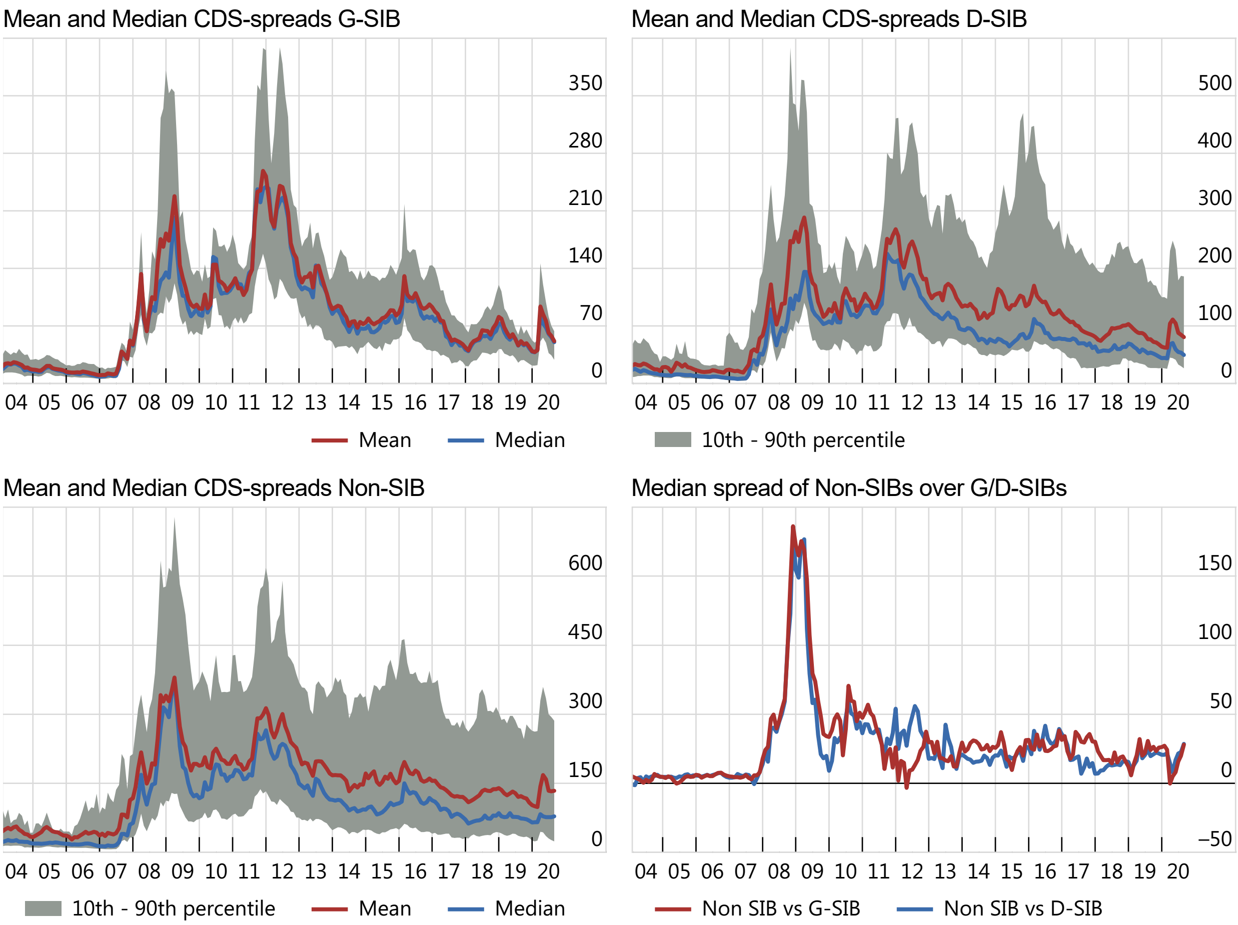
In basis points **Figure 2.2.2**



Source: Markit.

CDS-Spread by type of bank

In basis points **Figure 2.2.3**

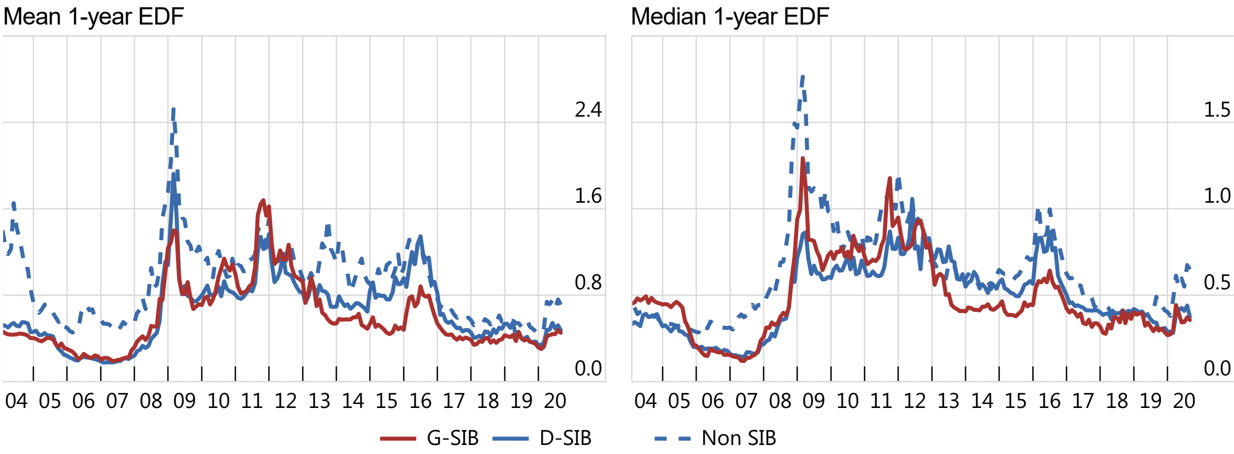


Source: Markit.

EDF by bank type

In per cent

Figure 2.2.4



Source: Moody's.

Regression analysis

To estimate changes in the FCA on the updated data we follow our specification (1) from the original work. In addition to the dummy variable $Post_t$ (D*; 2012:01 until 2020:02) from our original specification we now include the dummy $Corona_t$ (E) which has a value of one for all observations from March 2020 onwards and zero otherwise. The regression equation (1) then then becomes (1*)

$$Y_{i,t} = \alpha_0 + \boldsymbol{\beta_1} \cdot \boldsymbol{SIB_i} \cdot \boldsymbol{Post} + \boldsymbol{\beta_2} \cdot \boldsymbol{SIB_i} \cdot \boldsymbol{Corona_t} + \delta_1 \cdot SIB_i + \delta_3 \cdot Post_t + \delta_2 \cdot Corona_t + \beta_x \cdot x_{i,t-12} + \gamma_{c,t} + \gamma_i + \epsilon_{i,t}. \qquad (1^*)$$

with all variables as defined in the original Technical Appendix. The variable $x_{i,t-12}$ is a vector of bank-level control variables that are lagged by 12 months, except for the EDF which is lagged by a single month.[16] Note that we cannot estimate specifications with contemporaneous annual macroeconomic control variables as they are not yet available for 2020. Therefore, our preferred specification is one with period-times-country fixed effects ($\{\gamma_{c,t}\}_{c=1\ldots C,t=1\ldots T}$). It is important to emphasise that only this specification correctly accounts for country-specific trends affecting control and treatment group in the same way. Note that both dummies ($Corona_t$ and $Post_t$) measure the change relative to the post-crisis/pre-reform period (C). All regressions are estimated on the global sample.

For the first analysis, i.e. the extension of the time horizon and the inclusion of the COVID-dummy, we find that a statistically significant and positive coefficient for the reform effect ($Post_t$; β_1) (column 1, C vs. D*). This confirms our previous finding that reforms have reduced SIBs' funding cost advantage. This holds irrespective of whether we estimate the model using

16 In our original specification we lagged the EDF also by 12 month for consistency reasons and to reduce the risk of endogeneity. In the extension we shorted this lag to 1 month in order to capture the effect of recent changes in the EDF (which we would ignore with a lag of one year). This shift has of course some quantitative impact it has, however, no bearing on the conclusions.

SIBs (Table 2.2.2) or G-SIBs (Table 2.2.3) as the treatment group. Similarly, the coefficient on the COVID-19-crisis ($Corona_t$; β_2) is significant and positive, and it is of a similar magnitude to β_1. This means that funding cost advantages have not changed by much compared to the preceding period, the extended reform implementation period D*. The difference between β_1 and β_2 is not statistically significant (see p-value for an F-test at the bottom of the table). This result is in favour of intended reform effect as the crisis did not lead to rising FCA which would be reflected in a smaller coefficient β_2.

Our results are similar when we use other pre-treatment and post-treatment periods (columns 2-4): (i) FCA has significantly declined in the reform implementation period (D*) compared to the longer pre-treatment period that starts in 2004 (A+B+C). We do not find a significant change between the pre-crisis period (A) and the reform period (D*) or the post-crisis period (C+D*). Regarding the COVID-19-period (E) we never find that the FCA is statistically different from the reform implementation period (D*). However, such tests may not be very powerful in the context of relatively short time periods.

Risk sensitivity

The second object of interest is risk sensitivity, by which we mean the reaction of CDS spreads to changes in the risk metric (EDF in this setup[17]). We proceed as above. First, we estimate our original regression (2) by only extending the time horizon and adding the additional Corona-triple-interaction in addition to the interaction with $Post_t$ and test for statistical difference. Then, we use the shorter pre-COVID-period (F) as a baseline in order to capture shorter-term responses within the period (E).

$$Y_{i,t} = \alpha_0 + \beta_1 \cdot SIB_{i,t} \cdot Corona_t + \boldsymbol{\beta_2 \cdot SIB_{i,t} \cdot Post_t \cdot EDF_{i,t}} + \delta_1 \cdot SIB_i + \delta_2 \cdot Corona_t + \delta_3 \cdot EDF_{i,t} + \delta_4 \cdot SIB_i \cdot EDF_{i,t} + \delta_5 \cdot Corona_t \cdot EDF_{i,t} + \boldsymbol{\beta_3 \cdot SIB_{i,t} \cdot Corona_t \cdot EDF_{i,t}} + [\dots] + \beta_x \cdot x_{i,t} + \gamma_{c,t} + \gamma_i + \epsilon_{i,t} \qquad (2^*)$$

with the two coefficients of interest being β_2 for the reform effect and β_3 for the COVID-19-effect.

Theory gives us little guidance on the interpretation of effects (and expectations) regarding the effects of the COVID-19-crisis on risk sensitivity. On the one hand, if risk sensitivity is time-invariant or if it is affected by reforms, we should not observe any COVID-19-induced change. On the other hand, it is conceivable that risk-sensitivity changes in crisis times. Lower risk sensitivity might then be interpreted as regulation becoming less effective in incentivising markets to price risks appropriately.

Our conclusions regarding SIBs are largely unchanged: in some specifications, we find that risk sensitivity has increased in the reform implementation period, but this finding is only statistically significant in some cases. Compared to our original results, the statistical significance of these results has increased somewhat, potentially due to the longer estimation sample.

Our conclusions on the effect of the COVID-19-crisis are in line with our findings from the previous section on the change in the level of FCA. We find that risk sensitivity during this period (E) does not significantly differ from the reform implementation period (D*). For G-SIBs we find

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[17] Technically, this is the interaction between EDF, SIB and the post-dummies.

that the coefficients are in general smaller for the COVID-19-period, which suggests that risk sensitivity may have declined during the crisis. Coefficients are, however, never significantly different from zero or different from the reform implementation period (D*).

Robustness checks

We check the robustness of our results by comparing the COVID19-crisis to a shorter Pre-COVID-19-period. This shorter period (denoted F) starts in January 2018 and runs through February 2020. The strength of this analysis is that it can pick up developments which are "averaged out" in computations with longer period. At the same time, it suffers, on the one hand, from the problem of a relatively short time series, as we compare 8 months of crisis to 2 years pre-crisis only. On the other hand, the pre-COVID-19-period was characterised by low market volatility, low interest rates and exceptionally favourable macroeconomic conditions.

To estimate changes in the level of the FCA on the shorter sample, we use the difference-in-differences specification from above but omit the dummy variable $Post_t$. The dummy variable $Corona_t$ refers now to the period after February 2020 and (E) will compared to the shorter Pre-COVID-19 period (F)

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

In another robustness check we replace country times period fixed effects estimate with country fixed effects and three (country-level) time-varying macro variables, namely the VIX, the Engle-Ruan probability of systemic crisis, and the slope of the yield curve (10 year minus 3 months government bond yield). Results are in 7. Here again we confirm our finding that funding cost advantages have not changed significantly between the shorter pre-COVID-19 period (F) and the COVID-19-period (E). When using macro controls (columns 2 and 4) instead of our preferred fixed-effects specification (coluns 1 and 3) we find an increase in FCA, but it is not significant.[18] The sign of the macro variables is as expected.

We also run a specification(of which we do not show the results) in which we exclude our single "high frequency" bank risk measure (EDF). We find that the higher EDFs of Non-SIBs explain part of the rise in their average CDS spreads. As a result, the specification without EDFs shows – relative to a specification with EDF – a smaller decline in the FCA due to reforms (and for COVID-19). However, once we include the industry-standard fixed effects from our preferred specification this effect is not strong enough to overturn the results and let the FCA increase due to CoOVID-19.

For the risk sensitivity analyses, we also re-run the regressions on the shorter Pre-COVID-19 sample (F vs. E) and omit the triple interaction with $Post_t$ from regression (2*), i.e. we compare only the COVID-19-period (E) with the immediately preceding period (F). We do not display the equation here for the sake of brevity. In short, our results documented in

[18] We conduct a battery of other robustness checks e.g. including the CDS spreads of the sovereign (together with the other three variables and alone) and country times year FE (instead of country times year-month FE). Our conclusion is qualitatively unchanged: we find that it is important to account for time-varying cross-country heterogeneity. Results are available upon request.

Table2.2.7: Risk sensitivity specifications (SIBs vs G-SIBs8 suggest that when using a shorter Pre-COVID-19-sample as a benchmark, risk sensitivity may have declined somewhat (as the coefficient is negative).[19] However, the decline is not significant.

A comparison of CDS spreads of holding versus operating companies

Some reforms, such as external and internal TLAC requirements at the global level, MREL in the EU or ring-fencing in the UK, could differentially affect investors' expectations of the probability of bail-in of bonds issued by holding companies (HoldCo) and operating companies (OpCo). In short, this is because 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 Hold-Co level to address the loss-absorption and recapitalisation needs of the resolution group, without subjecting the OpCo to statutory resolution proceedings. As this increases the risk of taking losses at the HoldCo's level, it could then drive a wedge between the pricing of HoldCo and OpCo debt. An increasing spread between HoldCos and OpCos could be interpreted as an intended reform effect, as it can be understood as markets pricing the reform-induced differential risk between the two. This approach has the advantage that the comparison is within a banking group and (unobserved) group characteristics are absent, but it suffers from a small number of observations (see Table 8 in the original Technical Appendix). While the structural disadvantage of the small sample size cannot be eliminated, we show the evolution of mean and median HoldCo-OpCo spreads to account for the potentially distorting effect of outliers. We also provide results for the ISDA 2003 and ISDA 2014 CDS conventions separately. However, as the differential for the 2003 convention can be calculated only for three banking groups after the introduction of the 2014 clause, it is unlikely to be representative.

Figure 2.2.5 show the average CDS spreads of HoldCos and OpCos for the global sample, separately for the 2003/2014 contract types. Figure 2.2.6 plots the distance between the CDS spreads, including 10/90 per cent and the median values. The measure including 2003 and 2014-contract types shows that in the first phase of the COVID-19-crisis the spread of HoldCos over OpCos increased (mean and median). There seems to be a reversion to immediate Pre-COVID-19-levels during the summer.

The observed dynamics during the COVID-19-period are qualitatively similar across regions (Figure 2.2.7). The spread of HoldCos widened more than for OpCos everywhere, although the reaction is less pronounced for the US banking groups. Moreover, the dispersion for the US banks is in general much larger. The mean value is likely to be influenced by outliers. The difference between the median and mean HoldCo-OpCo spreads (especially for the US) suggests the presence of outliers in the data, but they do not change our conclusions.

This analysis suggests that markets perceived HoldCos' default probability to have increased more than of OpCos. Against the background of this analysis this is in line with the reforms' intended effects.

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[19] The reduction in risk sensitivity seems to be smaller in our preferred specification with fixed effects.

2.2.4. Conclusions

In our descriptive analyses, we find that, at the beginning of the COVID-19-crisis, the average CDS spread in the group of Non-SIBs has increased more strongly than in the group of SIBs, to some extent driven by outliers. While this observation is compatible with an increase in SIBs' FCA, our further analyses suggest a different explanation: according to average EDFs, the bank-level risk of non-SIBs has increased considerably more than for SIBs. This suggests that the sample of non-SIBs has been more vulnerable to COVID-19-related risks than the SIB-sample and may partly explain the increase in raw CDS-spreads.[20] Our regression results point in a similar direction. If we control both for bank-level risk and for unobserved time-varying factors that equally affect a country's SIBs and non-SIBs, we do not find that funding cost advantages are higher in the COVID-19-crisis than they were before. Our result is robust to the in/exclusion of bank risk if we account for unobserved time varying country-level macro factors.[21] In terms of reform effects, this is an encouraging result: assuming (1) that an implicit guarantee is more valuable when bank-level risk is higher and (2) that implicit guarantees are still important, we should observe a rise in funding cost advantages when bank-level risk rises as it did in the COVID19-crisis. The fact that we do not find a significant rise in FCA, is thus indirect evidence of the intended reform effects. Regarding the risk-sensitivity of SIBs' CDS spreads, we confirm our earlier finding that there is no conclusive evidence for reforms having raised the risk sensitivity of SIBs' CDS spreads.

Table 2.2.2: Diff-in-diff specifications (SIBs vs. non-SIBs)

	(1) C vs D*/E	(2) A+B+C vs D*/E	(3) A vs D*/E	(4) A vs C+D*
Post X treat	34.9**	27.8**	-2.4	-14.2
Corona X treat	45.8**	38.8**	6.6	
L12.CET1/RWA	-2.6*	-1.3	0.1	0.2
L12.SUB/DEBT	8.7	4.9	6.1**	6.7
L.EDF(1Y)	12.9***	14.1***	5.6**	13.5***
Constant	136.2***	121.6***	112.4***	121.2***
N	8296	9680	7242	8642
Adj. R-squared	0.93	0.92	0.96	0.93
Adj. R-squared, within	0.091	0.065	0.031	0.055
p-val Post/Corona-diff	0.18	0.17	0.24	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "p-val Post/Corona-diff" denotes the p-value of an F-test for the coefficients "Post X treat" and "Corona X treat". "treat" refers to the treatment group as defined in the heading of the table. „Post" refers to the reform implementation period (D*) and „Corona" refers to the period after March 2020 (E); see Figure in section 2.2.2.

[20] Note that it is our working hypothesis that EDFs are a measure of bank-level risk that is only mildly affected by bail-out expectations. This is because EDFs are primarily inferred from share price information and prior literature has shown that shares are not likely to benefit much from implicit bailout guarantees.

[21] By this we mean either the inclusion of country times time fixed effects or time-varying macroeconomic variables; see above.

Table 2.2.3: Diff-in-diff specifications (G-SIBs vs. non-SIBs)

	(1) C vs D*/E	(2) A+B+C vs D*/E	(3) A vs D*/E	(4) A vs C+D*
Post X treat	39.1*	32.0***	-9.3	-22.6
Corona X treat	37.0	31.9**	-12.4	
L12.CET1/RWA	-3.3*	-1.3	1.1	0.8
L12.SUB/DEBT	11.3	6.0	6.5**	10.1*
L.EDF(1Y)	11.7***	12.9***	6.1***	12.6***
Constant	147.1***	123.8***	106.6***	113.7***
N	5582	6644	4897	5895
Adj. R-squared	0.93	0.91	0.97	0.93
Adj. R-squared, within	0.12	0.074	0.039	0.075
p-val Post/Corona-diff	0.83	0.99	0.74	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “p-val Post/Corona-diff” denotes the p-value of an F-test for the coefficients “Post X treat” and “Corona X treat”. “treat” refers to the treatment group as defined in the heading of the table. „Post“ refers to the reform implementation period (D*) and „Corona“ refers to the period after March 2020 (E); see Figure in section 2.2.2.

Table 2.2.4: Risk sensitivity specifications (SIBs vs. Non-SIBs)

	(1) C vs D*	(2) A+B+C vs D*/E	(3) A vs D*/E	(4) A vs C+D*
Post X treat X EDF	9.1	15.8*	18.8	35.2
Corona X treat X EDF	33.1	42.6	45.1	
Post X treat	25.4	15.9	-7.4	-18.8
Post X EDF	-22.8**	-25.0***	-25.3	-22.0
treat X EDF	-9.6	-15.9	-11.9	-38.9
Corona X treat	22.2	11.7	-11.3	
Corona X EDF	-47.6	-48.5*	-47.9**	
L12.CET1/RWA	-3.4**	-2.0	-0.1	-0.3
L12.SUB/DEBT	8.8	4.9	5.8**	6.7
Constant	152.4***	136.4***	119.4***	130.0***
N	8299	9685	7247	8647
Adj. R-squared	0.93	0.92	0.96	0.93
Adj. R-squared, within	0.11	0.086	0.037	0.053
p-val Post/Corona-diff	0.30	0.22	0.088	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. “p-val Post/Corona-diff” denotes the p-value of an F-test for the coefficients “Post X treat” and “Corona X treat”. “treat” refers to the treatment group as defined in the heading of the table. „Post“ refers to the reform implementation period (D*) and „Corona“ refers to the period after March 2020 (E); see Figure in section 2.2.2.

Table 2.2.5: Risk sensitivity specifications (G-SIBs vs. Non-SIBs)

	(1) C vs D*	(2) A+B+C vs D*/E	(3) A vs D*/E	(4) A vs C+D*
Post X treat X EDF	19.7**	28.2***	53.7**	74.5
Corona X treat X EDF	6.7	22.1	48.9	
Post X treat	24.6	15.9	-21.5***	-33.7***
Post X EDF	-26.1***	-29.3***	-23.4	-23.4
treat X EDF	-15.5**	-24.2**	-43.9	-81.2
Corona X treat	28.0	18.1	-21.6	
Corona X EDF	-30.3	-39.2	-31.2	
L12.CET1/RWA	-4.3**	-2.3	0.7	0.01
L12.SUB/DEBT	10.9	5.7	6.3**	9.7
Constant	166.3***	141.5***	118.2***	128.4***
N	5583	6647	4900	5898
Adj. R-squared	0.93	0.91	0.97	0.93
Adj. R-squared, within	0.14	0.10	0.047	0.075
p-val Post/Corona-diff	0.70	0.83	0.80	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. "treat" refers to the treatment group as defined in the heading of the table. „Post" refers to the reform implementation period (D*) and „Corona" refers to the period after March 2020 (E); see Figure in section 2.2.2.

Table 2.2.6: Diff-in-diff specifications with bank-level & macro controls (SIBs vs. G-SIBs)

	(1) Bank-SIB	(2) Bank/Macro-SIB	(3) Bank-GSIB	(4) Bank/Macro-GSIB
Corona X treat	8.8	-22.2	4.5	-16.8
L12.CET1/RWA	-3.5	-1.0	-3.4	-0.8
L12.SUB/DEBT	-0.6	15.5	-3.3	14.1
L.EDF(1Y)	-10.4	0.8	-21.7**	-15.2
3m Gov't bond yield		-3.1		-3.1*
10y Gov't bond yield		40.1***		43.6***
Pr(Financial Cris.)		1.4***		1.6***
VIX		1.3***		1.3***
Constant	166.5***	-25.6	183.5***	-29.1
N	2128	1530	1359	1126
Adj. R-squared	1.0	0.9	1.0	0.9
Adj. R-squared, within	0.04	0.4	0.06	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. "Corona" refers to the period since March 2020 (E).

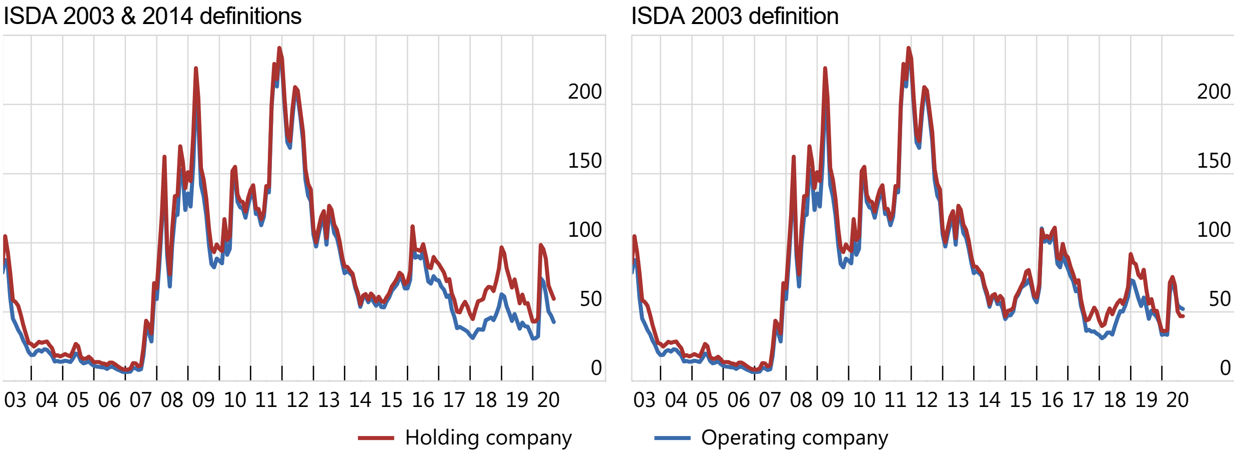
Table2.2.7: Risk sensitivity specifications (SIBs vs G-SIBs)

	(1)	(2)	(3)	(4)
	Bank-SIB	Bank/Macro-SIB	Bank-GSIB	Bank/Macro-GSIB
Corona X treat X EDF	-2.2	-24.1	-30.9	-10.4
Corona X treat	8.5	-13.1	15.4	-14.5
Corona X EDF	6.4	52.3	28.8	45.9
treat X EDF	35.9***	82.3***	36.0***	92.6***
L12.CET1/RWA	-1.9	0.4	-3.0	2.4
L12.SUB/DEBT	1.9	16.3	3.2	16.5
3m Gov't bond yield		-0.5		-1.1
10y Gov't bond yield		37.5***		42.1***
Pr(Financial Cris.)		1.3***		1.5***
VIX		1.3***		1.3***
Constant	141.0***	-42.4	165.2***	-76.8
N	2128	1530	1359	1126
Adj. R-squared	1.0	0.9	1.0	0.9
Adj. R-squared, within	0.08	0.5	0.08	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. "Corona" refers to the period since March 2020 (E).

Time series CDS spread for two different credit event definitions

In basis points **Figure 2.2.5**

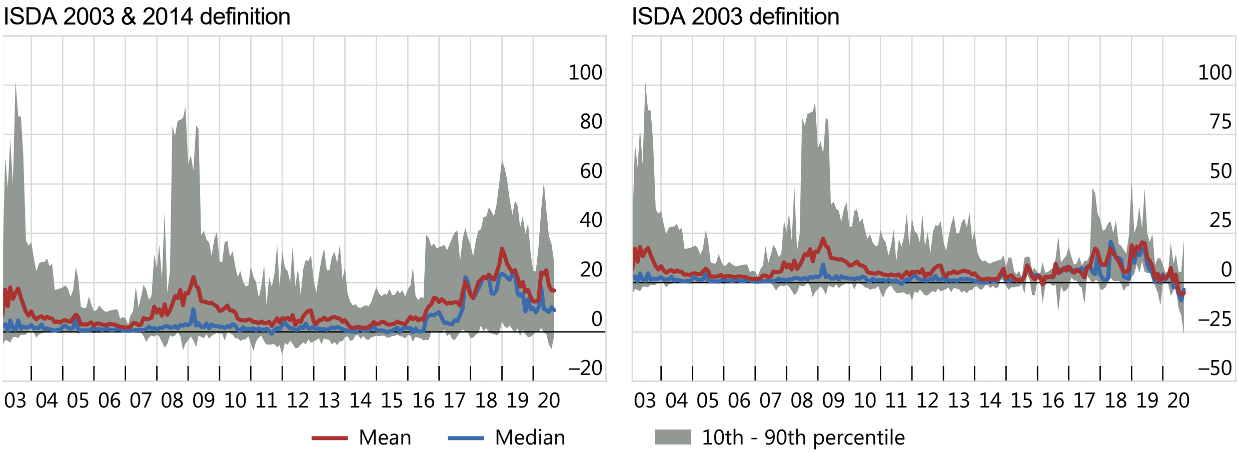


Source: Markit.

Difference of spread between holding and operating company

In basis points

Figure 2.2.6

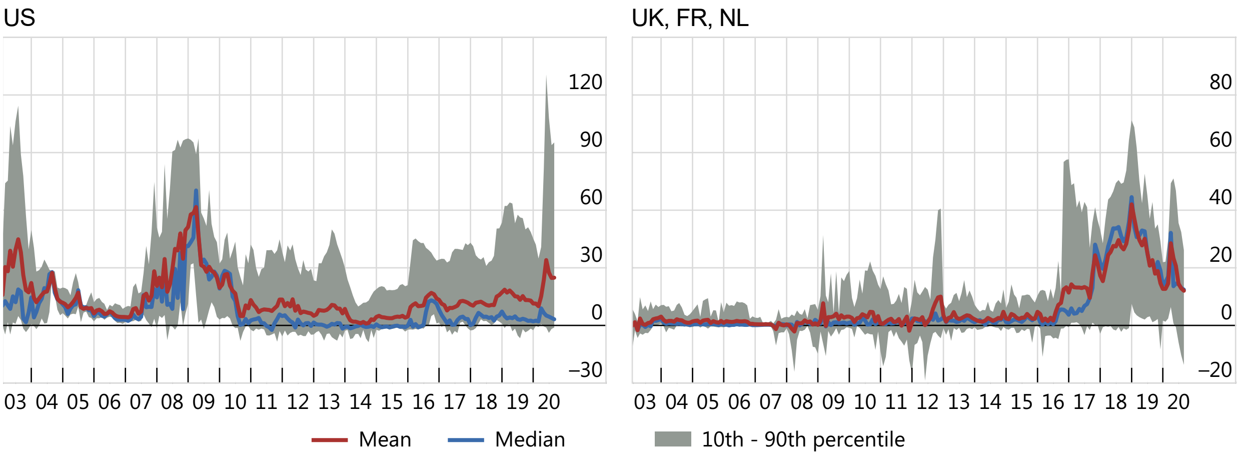


Source: Markit.

Difference of spread between holding and operating company, regional samples, ISDA 2003 & 2014 definition

In basis points

Figure 2.2.7



Source: Markit.

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

2.3.1. Summary of previous results

The original analysis was based on a sample of observations starting in June 2009 and ending in December 2019. For German Systemically Important Banks (SIBs), a structural funding cost advantage could be identified. Using gradual reform steps specifically tailored to the situation in Germany the analysis could however not conclude that the TBTF reforms have permanently lowered the funding cost advantage of German SIBs. While there is some evidence of investors having adjusted their expectation towards an increased bail-in risk temporarily, they appear to have reversed their perceptions subsequently. Such a reversal in expectations might have been caused by events that have negatively affected the credibility of the resolution regime, but are not attributable to institutional or legal changes.

2.3.2. New data gathered

The sample has been extended by an additional 9 months up to the end of September 2020. No new ISINs have been added, as issuance activity in Germany was generally low compared to previous years, but none of the ISINs that were still active in December 2019 have matured since. However, for some of those ISINs no new data points could be retrieved from the commercial database (see Table 2.3.1). All ISIN-level explanatory variables (age, term to maturity, amount issued, coupon rates) could be updated as well as all bank level variables from public sources (total capital ratio, subordinated debt ratio, share of secured liabilities, total assets). The latter are only available at the end of each year, but those variables enter the regressions with a lag of one year. The measure of an individual bank's probability of default from Bundesbank's internal risk controlling with quarterly frequency is available until the third quarter. Also the three variables used in the study to control for macro-financial conditions – VIX, the 10 year Bund yield and annual GDP growth rate, at monthly and quarterly frequency, respectively – could be extended until the end of the sample.

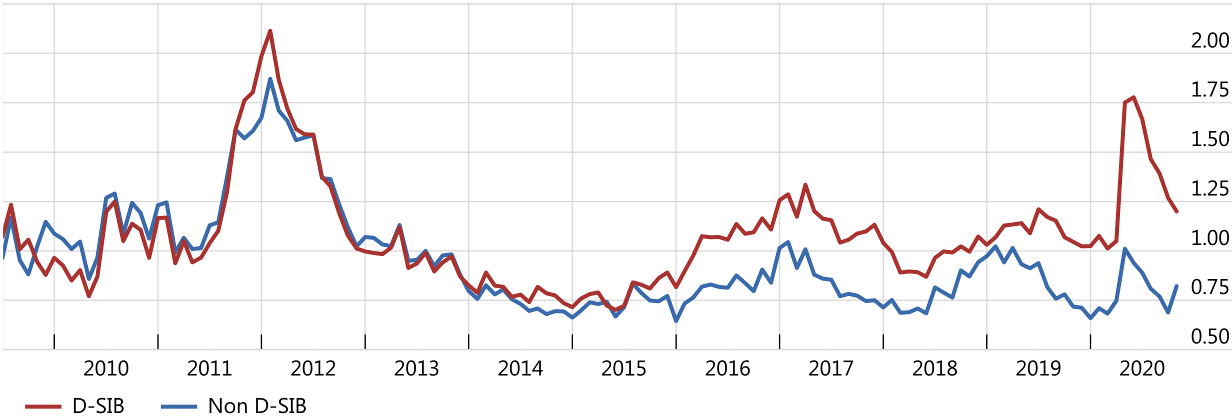
Table 2.3.1: Number of banks and observations by year and group

YEAR	Number of banks		Number of observations	
	DSIBs	Non DSIBs	DSIBs	Non DSIBs
2009	10	26	4260	2701
2010	10	27	12518	6813
2011	10	27	11790	5875
2012	10	28	10992	5481
2013	10	28	9586	4113
2014	10	28	8627	3064
2015	10	28	8278	2604
2016	10	27	8811	2236
2017	10	28	10055	2266
2018	10	26	9868	1862
2019	10	25	9698	1690
2020	**10**	**20**	**6569**	**1259**

The weighted average yield-to-maturity of both the treatment and control groups is defined as the spread between the yield-to-maturity of a bond and the German Bund yield with the same remaining term to maturity. It increased rapidly beginning in March 2020, but reversed right after the initial shock (see figure 2.3.1). During this initial surge, the average yield of German domestic SIBs (D-SIBs) increased by 66%, while the yield of non-DSIBs increased by 50% on average. At the end of September it appears that the yields for both groups are on a fast track to converge back towards levels that had been observed before the pandemic hit, with a similar average differential between the level of the two groups. This trend would be in line with the evolution of the average probability of default variable used in this analysis, which has remained unchanged since the start of the crisis (see figure 2.3.2). The strong increase in the yields of unsecured bonds during the first weeks of the market turmoil appears decoupled from the default risk, as assessed by rating agencies, on whose appraisal the probability of default variable used in this study is based. There is evidence that this decoupling is attributable to an illiquidity premium, as market liquidity dried up in the entire financial system.[22]

Yield to maturity, weighted by amounts issued

In basis points **Figure 2.3.1**



Note: The yield-to-maturity is defined as the spread between the yield-to-maturity of a bond and the German Bund yield with the same remaining term to maturity.

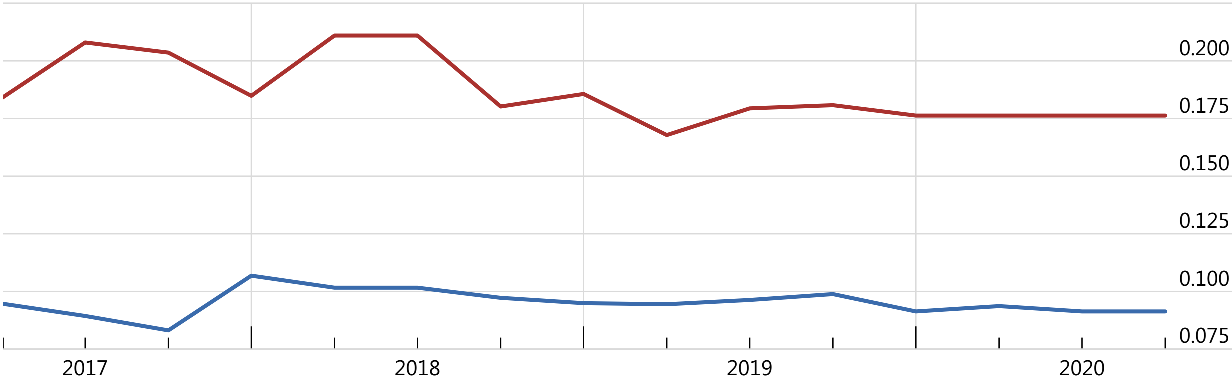
Sources: Central Securities Database (CSDB); Eikon.

[22] "Diverging corporate sector bond spreads and credit default swap (CDS) spreads signalled that bond spreads widened beyond the rise in perceived default risk. […] In short, key parts of the financial system froze. Liquidity dried up and price discovery was impaired. Given the exceptional nature of the shock, some of these developments may have been unsurprising."; cf. *COVID-19 and the liquidity crisis of non-banks: lessons for the future", Speech by Isabel Schnabel, Member of the Executive Board of the ECB, Financial Stability Conference on "Stress, Contagion, and Transmission" organised by the Federal Reserve Bank of Cleveland and the Office of Financial Research, Frankfurt am Main, 19 November 2020.*

Evolution of the average probability of default since 2017

In per cent

Figure 2.3.2



Sources:Bundesbank

2.3.3. Results

As a first step, all the regressions from the original study are re-estimated using the extended sample with 9 additional months. In order to take into account that the COVID-19 shock might have affected the funding cost advantage of German SIBs, the original equations (2a), (2b), and (2c) assessing the effects of the reforms are augmented by including controls for this period beginning in March 2020. Therefore an additional interaction term $\boldsymbol{SIB_b * corona_t}$ is added, here $corona_t$ is a binary variable which takes the value 1 from March 2020 onwards.

The results of the previous analysis are robust to extending the sample until September 2020 and adding a control for any potential impact of the COVID-19 shock on the funding cost advantage. Interpretations are therefore the same as reported in the Technical Appendix. The results of the estimations can be found in the annex at the end of section 2.3.. Previously, testing for the effect of individual reform steps (equation 2a), in two specifications including interaction terms with the first two reform dates, namely the publication of the FSB Key Attributes and the final date to transpose the BRRD into national law in the EU, significant positive reform effects could be identified. With the extended sample, those significant effects can no longer be found. These findings to some extent reinforce the original conclusion that the resolution reforms did not lead to a sustained decrease in the funding cost advantage of German SIBs. This is further corroborated when taking the whole *reform transition period* into account (equation 2b). In the last specification reported, including a full set of fixed effects, for each ISIN, bank and time period, the effect of reforms on lowering the funding cost advantage disappears, in contrast to the original results (see table 2.3.3 in the annex). In all estimations, the coefficient of the newly added interaction term $\boldsymbol{SIB_b * corona_t}$ is not statistically significant, which suggests that the overall FCA has been unaffected.

As a robustness test and second step, the effect of the COVID-19 shock on the funding costs of SIBs compared to non-SIBs during the post-reform period alone is assessed, i.e. after the last reform step on 1 January 2017. To test this, the original difference-in-difference equation (2a) is slightly altered, with the interaction term $\boldsymbol{SIB_b} * corona_t$ instead of previously $\boldsymbol{SIB_b} * reform_t$ In its most comprehensive specification, the regression is estimated using bank-level, instrument-level and time fixed effects, as well as controls for time-varying ISIN and bank characteristics.

$$Y_{i,b,t} = \alpha + \boldsymbol{\beta_1 SIB_b corona_t} + x_{i,t} + x_{b,t} + \gamma_t + \gamma_b + \gamma_i + \epsilon_{i,t} \qquad \text{(I)}$$

Equation (I) is estimated on three different sample lengths, to take different developments prior to the treatment into account: starting in January 2017, starting in January 2019; and starting in December 2019. If bail-out expectations of investors in unsecured debt of systemically important banks were still in place and if the individual default risk of systemically relevant banks rose, the funding cost advantage should also rise following the COVID-19 shock, i.e. $\beta_1 < 0$, as, the value of the implicit state guarantee increases.

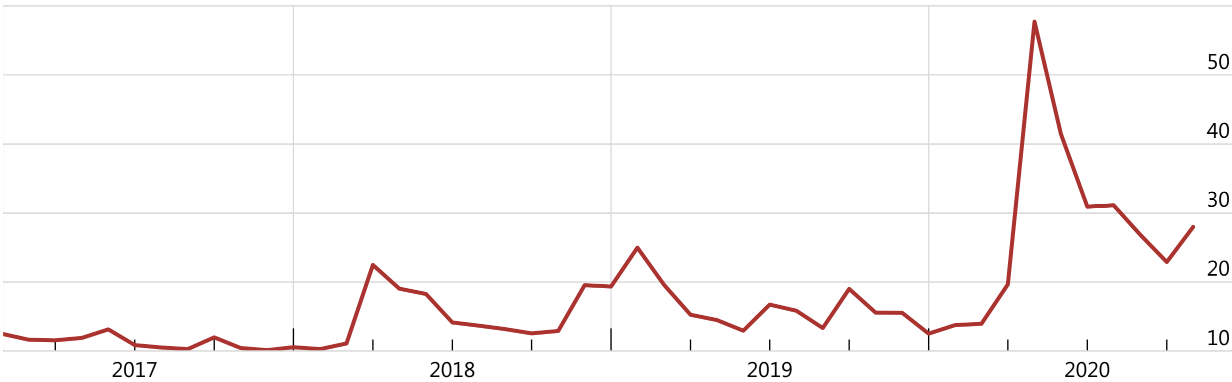
Alternatively, measures of the overall risk perception of market participants can be used as proxies for worsening real economic factors and heightened uncertainty about the future. In an additional setup, the binary variable SIB_b is thus interacted with the VIX, one of the macro-financial variables that is also available at monthly frequency. As figure 3 shows, in terms of the VIX, markets have been rather calm in the period succeeding the reform transition period, beginning January 2017, and prior to the COVID-19 shock.

$$Y_{i,b,t} = \alpha + \boldsymbol{\beta_1 SIB_b VIX_t} + x_{b,t} + \gamma_t + \gamma_b + \gamma_i + \epsilon_{i,t} \qquad \text{(II)}$$

Evolution of the VIX since 2017

In percentage points

Figure 2.3.3



Source: Bloomberg.

Turning to the new results focusing solely on the post-reform period, there is no empirical evidence that the COVID-19 shock had a different effect on the funding costs of SIBs compared to non-SIBs in Germany. This holds across all of the three sample lengths tested, and within each sample across all specifications (see Tables 2.3.5, 2.3.6, 2.3.7 in the annex to this section). The coefficient on the interaction term is in all cases negative, but insignificant, and thus supports the findings of the first step using augmented regressions of the original analysis.

In order to shed light on the overall effect of the COVID-19 shock on funding costs, equation (I) has also been estimated substituting the time fixed effect γ_t with the three macro-financial variables x_t and including the dummy variable $corona_t$ on its own.[23] Funding costs for all banks have clearly increased following the shock, as the coefficient on $corona_t$ in specification (6) in each of the tables mentioned earlier is positive and highly significant in the order between 42bp and 54bp. This general increase in level cannot be ascribed to changes in the fundamental

23 ISIN-level fixed effects have also been dropped for this specification to achieve a sufficiently large number of degrees of freedom.

probability of default, as figure 2 as well as the statistical insignificance of PD as explanatory variable in all specifications of equations (I) and (II), in contrast to the original estimations over the entire sample period, show.

When the insignificant coefficient of the interaction term is taken into account, the results imply that funding costs increased equally following the COVID-19 shock for SIBs and non-SIBs alike.

Using the VIX as a proxy for the effects of COVID-19, following equation (II), can confirm those results. Secondary market yields of unsecured bonds of German SIBs do not react differently to a change in general risk perception during the post-reform period than those of non-SIBs (see table 2.3.8 in the annex).

2.3.4. Conclusions

At first glance, the finding that yields have increased equally for SIBs and non-SIBs alike following the COVID-19 shock suggests that reforms might in fact have been successful in adjusting investors' expectations towards a higher risk of being bailed in in the event of the failure of a systemically important bank.

However, although there is evidence that investors perceive the general risk in the entire banking sector to be higher than before the shock, which could in part be explained by an overall market illiquidity premium, the probability of default as assessed by the rating agencies for the individual banks has, on average, remained more or less unchanged throughout the current crisis (see figure 2.3.2). This is most likely because credit deterioration has not yet materialised for the banking sector, which can at least partly be attributed to the unprecedented fiscal and monetary measures implemented right the initial shock. In Germany, the first national fiscal support package was announced on 23 March 2020, i.e. during the first month of the pandemic period used in this analysis. Among those measures the permission to suspend filing for bankruptcy for all non-financial firms that are facing insolvency or illiquidity issues as a consequence of the pandemic as well as public guarantees on newly issued loans are likely to have the strongest dampening effect on the credit risk of banks.

Because of the rapid policy response the assumed value of implicit government subsidies remains unchanged, which can explain why the funding cost advantage of SIBs in Germany has not been affected. Therefore it is currently not possible to infer any additional evidence on the state of the effectiveness of the resolution regime in Germany, compared to the original analysis.

Annex

Table 2.3.1: Regression results of augmented equation (2a) – Effect of reform implementation period (starting January 2012), extended sample

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
post012012_OSII	-0.011	-0.045	-0.057	-0.098**	-0.131**
	(0.066)	(0.059)	(0.049)	(0.047)	(0.053)

corona_OSII	0.054	0.005	-0.061	0.003	-0.109
	(0.144)	(0.189)	(0.300)	(0.151)	(0.302)
term to maturity		0.035***	0.034***		
		(0.006)	(0.004)		
COUPON_RATE		0.053**	0.056***		
		(0.021)	(0.018)		
age		-0.015	-0.019***		0.205***
		(0.009)	(0.007)		(0.061)
AMOUNT_ISSUED		-0.000	0.000		
		(0.000)	(0.000)		
RatingPD			1.582***		1.012***
			(0.374)		(0.361)
TCR_lag			0.000		0.000
			(0.000)		(0.000)
SUBR_lag			-0.046		-0.013
			(0.048)		(0.036)
SEC_share_lag			-0.000		0.001*
			(0.001)		(0.001)
TA_lag			-0.000***		-0.000***
			(0.000)		(0.000)
Constant	1.064***	0.843***	0.890***	1.113***	0.325
	(0.037)	(0.060)	(0.116)	(0.027)	(0.251)
Observations	144,765	131,296	109,968	144,720	115,895
R-squared	0.419	0.440	0.479	0.689	0.692
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	No	No	No	Yes	Yes

Table 2.3.2: Regression results of augmented equation (2a) – Effect of TBTF reform (1 January 2016), extended sample

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
post012016_OSII	0.054	0.035	0.030	0.030	-0.008

	(0.077)	(0.077)	(0.051)	(0.072)	(0.064)
corona_OSII	0.019	-0.024	-0.087	-0.001	-0.110
	(0.128)	(0.171)	(0.296)	(0.147)	(0.297)
term to maturity		0.035***	0.034***		
		(0.006)	(0.004)		
COUPON_RATE		0.054**	0.056***		
		(0.021)	(0.018)		
age		-0.014	-0.019**		0.225***
		(0.009)	(0.007)		(0.059)
AMOUNT_ISSUED		-0.000	0.000		
		(0.000)	(0.000)		
RatingPD			1.606***		0.974**
			(0.372)		(0.373)
TCR_lag			0.000		0.000
			(0.000)		(0.000)
SUBR_lag			-0.047		-0.019
			(0.048)		(0.036)
SEC_share_lag			-0.000		0.001
			(0.001)		(0.001)
TA_lag			-0.000***		-0.000***
			(0.000)		(0.000)
Constant	1.043***	0.806***	0.872***	1.051***	0.264
	(0.024)	(0.057)	(0.128)	(0.024)	(0.231)
Observations	144,765	131,296	109,968	144,720	115,895
R-squared	0.419	0.440	0.479	0.689	0.692
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	No	No	No	Yes	Yes

Table 2.3.3: Regression results of augmented equation (2b) – Effect of TBTF reform transition period, extended sample

VARIABLES	(1) YtM	(2) YtM	(3) YtM
reforms_OSII	0.199**	0.113**	0.056
	(0.079)	(0.044)	(0.035)
post_OSII	-0.129	-0.096	-0.078
	(0.081)	(0.058)	(0.051)
German OSII	-0.238***		
	(0.079)		
corona_OSII	-0.081	-0.059	-0.098
	(0.270)	(0.297)	(0.293)
term to maturity	0.032***	0.034***	
	(0.006)	(0.004)	
COUPON_RATE	0.057***	0.057***	
	(0.018)	(0.018)	
age	-0.016*	-0.019**	0.222***
	(0.008)	(0.007)	(0.058)
AMOUNT_ISSUED	0.000**	0.000	
	(0.000)	(0.000)	
RatingPD	2.592***	1.651***	0.999***
	(0.374)	(0.354)	(0.365)
TCR_lag	0.000*	0.000	0.000
	(0.000)	(0.000)	(0.000)
SUBR_lag	-0.001	-0.054	-0.023
	(0.025)	(0.046)	(0.035)
SEC_share_lag	-0.001	-0.000	0.001
	(0.001)	(0.001)	(0.001)
TA_lag	0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
Constant	0.346*	0.867***	0.262
	(0.186)	(0.130)	(0.231)
Observations	109,968	109,968	115,895
R-squared	0.413	0.479	0.692

Bank FE	No	Yes	Yes
Time FE	Yes	Yes	Yes
ISIN FE	No	No	Yes

Table 2.3.4: Regression results of augmented equation (2c) – Gradual effect of TBTF reforms, extended sample

VARIABLES	(1) YtM	(2) YtM	(3) YtM	(4) YtM	(5) YtM
post012017_OSII	0.068	0.092	-0.051	0.074	-0.020
	(0.067)	(0.071)	(0.059)	(0.060)	(0.043)
post062016_OSII	-0.148**	-0.177***	-0.135**	-0.137***	-0.141***
	(0.057)	(0.056)	(0.061)	(0.048)	(0.051)
post012016_OSII	0.023	0.025	0.027	0.025	0.018
	(0.033)	(0.037)	(0.051)	(0.035)	(0.048)
post112015_OSII	0.086**	0.081*	0.066	0.078*	0.058
	(0.037)	(0.040)	(0.048)	(0.039)	(0.046)
post012015_OSII	0.028	0.038	0.070	0.030	0.043
	(0.024)	(0.026)	(0.051)	(0.023)	(0.037)
post102014_OSII	0.004	-0.016	0.041	-0.035	0.016
	(0.055)	(0.055)	(0.056)	(0.037)	(0.037)
corona_OSII	0.018	-0.028	-0.059	-0.004	-0.098
	(0.127)	(0.168)	(0.297)	(0.145)	(0.293)
term to maturity		0.035***	0.034***		
		(0.006)	(0.004)		
COUPON_RATE		0.054**	0.057***		
		(0.021)	(0.018)		
age		-0.014	-0.019**		0.222***
		(0.009)	(0.007)		(0.058)
AMOUNT_ISSUED		-0.000	0.000		
		(0.000)	(0.000)		
RatingPD			1.651***		0.992**
			(0.360)		(0.376)
TCR_lag			0.000		0.000
			(0.000)		(0.000)

SUBR_lag			-0.054		-0.024
			(0.046)		(0.035)
SEC_share_lag			-0.000		0.001
			(0.001)		(0.001)
TA_lag			-0.000***		-0.000***
			(0.000)		(0.000)
Constant	1.039***	0.803***	0.866***	1.051***	0.264
	(0.028)	(0.060)	(0.131)	(0.027)	(0.230)
Observations	144,765	131,296	109,968	144,720	115,895
R-squared	0.420	0.440	0.480	0.689	0.692
Joint significance (p-value)	0.1152	0.1803	0.0099	0.1860	0.1757
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	No	No	No	Yes	Yes

Table 2.3.5: Regression results of equation (I): Starting in January 2017

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
corona_OSII	0.016	-0.044	-0.095	-0.003	-0.078	-0.044
	(0.134)	(0.168)	(0.300)	(0.138)	(0.283)	(0.173)
corona						0.425**
						(0.192)
term to maturity		0.055***	0.041***			0.053***
		(0.008)	(0.007)			(0.009)
COUPON_RATE		0.000	0.023			0.015
		(0.020)	(0.019)			(0.023)
age		0.023	0.003			0.016
		(0.014)	(0.010)			(0.015)
AMOUNT_ISSUED		-0.000	-0.000			-0.000*
		(0.000)	(0.000)			(0.000)
RatingPD			0.769*		0.711	0.159
			(0.376)		(0.450)	(1.159)
TCR_lag			-0.000		-0.000	

			(0.000)		(0.000)	
SUBR_lag			0.095		0.112	
			(0.154)		(0.175)	
SEC_share_lag			-0.000		-0.002	
			(0.002)		(0.003)	
TA_lag			-0.000***		-0.000***	
			(0.000)		(0.000)	
VIX						0.001
						(0.003)
BUND_10Y						-0.187***
						(0.044)
GDP						0.020***
						(0.005)
Constant	1.054***	0.744***	1.705***	1.056***	1.921***	0.677***
	(0.014)	(0.071)	(0.266)	(0.015)	(0.279)	(0.202)
Observations	40,794	37,477	24,851	40,787	25,463	37,477
R-squared	0.421	0.454	0.425	0.581	0.537	0.439
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	No
ISIN FE	No	No	No	Yes	Yes	No

Table 2.3.6: Regression results of equation (I) – Starting in January 2019

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
corona_OSII	-0.011	-0.051	-0.084	-0.016	-0.088	-0.050
	(0.104)	(0.122)	(0.194)	(0.107)	(0.188)	(0.117)
corona						0.543***
						(0.109)
term to maturity		0.064***	0.054***			0.063***
		(0.006)	(0.005)			(0.005)
COUPON_RATE		0.033	0.068			0.036
		(0.030)	(0.051)			(0.030)
age		0.024	-0.001			0.022

		(0.017)	(0.012)			(0.016)
AMOUNT_ISSUED		-0.000	-0.000			-0.000
		(0.000)	(0.000)			(0.000)
RatingPD			-0.095		-0.092	2.124*
			(1.406)		(1.484)	(1.191)
TCR_lag			-0.000		-0.000	
			(0.000)		(0.000)	
SUBR_lag			1.115		1.198*	
			(0.731)		(0.686)	
SEC_share_lag			-0.044**		-0.046**	
			(0.019)		(0.018)	
TA_lag			-0.000***		-0.000***	
			(0.000)		(0.000)	
VIX						0.000
						(0.003)
BUND_10Y						0.071
						(0.066)
GDP						0.028***
						(0.003)
Constant	1.138***	0.750***	5.909***	1.140***	5.975***	0.366*
	(0.026)	(0.078)	(1.744)	(0.026)	(1.551)	(0.191)
Observations	17,755	16,137	8,747	17,739	9,288	16,137
R-squared	0.349	0.386	0.322	0.613	0.559	0.384
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	No
ISIN FE	No	No	No	Yes	Yes	No

Table 2.3.7: Regression results of equation (I) – Starting in December 2019

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
corona_OSII	0.014	-0.009	-0.037	-0.004	-0.059	-0.009
	(0.111)	(0.140)	(0.263)	(0.119)	(0.248)	(0.140)
corona						0.521***

						(0.130)
term to maturity		0.072***	0.059***			0.071***
		(0.010)	(0.011)			(0.010)
COUPON_RATE		0.009	0.046			0.012
		(0.034)	(0.050)			(0.033)
age		0.019	-0.014			0.018
		(0.021)	(0.018)			(0.021)
AMOUNT_ISSUED		-0.000	-0.000			-0.000
		(0.000)	(0.000)			(0.000)
VIX						0.000
						(0.003)
BUND_10Y						-0.018
						(0.148)
GDP						0.028***
						(0.003)
Constant	1.207***	0.841***	1.016***	1.218***	1.220***	0.618***
	(0.063)	(0.131)	(0.155)	(0.068)	(0.143)	(0.100)
Observations	7,719	6,789	3,387	7,699	3,765	6,789
R-squared	0.628	0.742	0.747	0.842	0.818	0.737
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	No
ISIN FE	No	No	No	Yes	Yes	No

Table 2.3.8: Regression results of equation (II)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**YtM**	**YtM**	**YtM**	**YtM**	**YtM**
	Start Jan 2017		Start Jan 2019	Start Dec 2019	
OSII_VIX	0.001	-0.001	-0.000	-0.002	0.001
	(0.005)	(0.007)	(0.004)	(0.007)	(0.005)
RatingPD	0.396	0.803	1.496	-0.046	
	(1.032)	(0.496)	(1.203)	(1.496)	
TCR_lag		-0.000		-0.000	
		(0.000)		(0.000)	

SUBR_lag		0.156		0.821	
		(0.190)		(0.581)	
SEC_share_lag		-0.002		-0.036**	
		(0.002)		(0.014)	
TA_lag		-0.000***		-0.000***	
		(0.000)		(0.000)	
Constant	0.979***	1.843***	0.932***	5.412***	1.201***
	(0.196)	(0.315)	(0.115)	(1.265)	(0.107)
Observations	40,787	27,212	17,739	9,746	7,699
R-squared	0.581	0.543	0.613	0.560	0.842
Time FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
ISIN FE	Yes	Yes	Yes	Yes	Yes

2.4. The TBTF premium and the impact of resolution reforms

2.4.1. Summary of previous results

We analysed the evolution of the TBTF premium from January 2004 to September 2019 for twenty-six G-SIBs and D-SIBs in Europe and the US.

We showed that the TBTF premium had broadly been declining from the peak of the global financial crisis in 2008–09, but that it remained at a higher level compared to the pre-crisis levels in the resolution reform implementation period, i.e. during 2012–19. But, behind the trend, there are important country differences. For some, the TBTF premium even increased during the reform implementation period.

The impact of resolution reforms on the TBTF premium was measured by regressing the premium on the Resolution Reform Index (RRI). The RRI was statistically significant and negatively associated with the TBTF premium, suggesting that material progress in resolution reforms can lower the subsidies.

2.4.2. New data gathered

We updated all data to October 2020. For the RRI no update was available and therefore we the last observation available was used throughout October 2020, as no substantial change in relevant regulation has occurred for the countries in our sample. Definitions and data processing are those described in the Technical Appendix of the original report.

As we did for the original report, we compute the TBTF premium on a monthly frequency by using an equity-based contingent claims model and CDS spreads. Figure 2.4.1 shows the TBTF premium averaged across countries from January to October 2020. During the first two months of January and February, the TBTF premium was at a level comparable to the average level in 2019. It then increased in March and stayed at an elevated level up to June. From June it has started to slowly decline and in October it is a little lower than in March.

2.4.3. Results

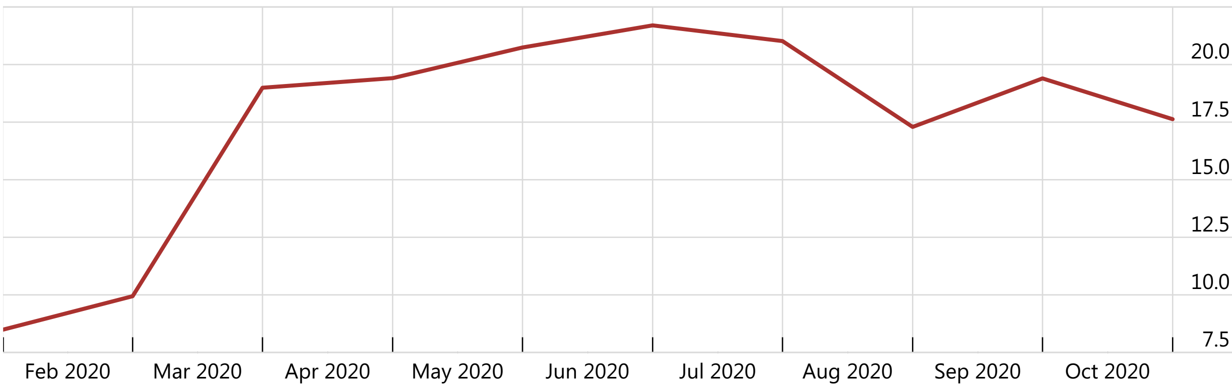
In order to analyse the impact that the COVID-19 pandemic had on the TBTF premium we re-estimate the panel regression as in the original specification but augmented it with the variable Cov , as follows:

$$TBTF_{i,c,t} = \beta_1 + \beta_2 Macro_{c,t} + \beta_3 Bank_{i,c,t} + \beta_4 Regulation_{c,t} + \beta_5 ProbCr_{c,t} + \beta_6 Cov_t + \gamma_i + \partial_t + \varepsilon_{i,c,t} \quad (1)$$

Cov is a dummy variable that takes value 1 from March to October 2020 and zero otherwise. In Table 2.4.1 we report the results. Column 1 shows the results updated until February 2020, i.e. before the COVID-19 turmoil. These results are qualitatively similar to those showed in the original report. In column 2 we report the results with the time period extended to October 2020. As expected, the variable Cov turns to be positive and statistically significant, in line with the descriptive evidence in Figure 1.

The TBTF premium during 2020

In per cent **Figure 2.4.1**



Sources: Bloomberg; Markit.

Being D-SIBs or G-SIBs matters

Column (2) in Table 2.4.1 also shows that regulation - RRI - remains significant when we take into account the COVID-19 period. A standard assumption in the literature and policy previous work is that SIBs are a fairly homogeneous group. However, there is increasing evidence that the COVID-19 crisis has impacted non-financial firms differently. Could this be the case also for financial firms and in particular D-SIBs and G-SIBS?

To shed light on what might be driving the results for the SIBs as a whole, we separated them in two groups of D-SIBS and G-SIBs.[24] We redo the analysis as in equation 1 for the two groups separately. Columns (3) and (4) in the table show the results.

We find an inverse relationship between the RRI and the TBTF premium for both groups in the pre-COVID period, i.e. between January 2004 and February 2020. However, the size of the coefficient for D-SIBs is much larger and statistically significant whereas the impact of regulation turns out to be relatively small and not statistically significant for G-SIBs. When we extend the sample to October 2020 and therefore include the pandemic period from March to October 2020, we find that the RRI remains insignificant for G-SIBs. It turns to be slightly insignificant for DSIBs, but the size and sign of the coefficients tend to confirm the results of the pre-COVID period. These results suggest that D-SIBs and G-SIBs had a differentiated response to regulation and that the TBTF premium of G-SIBs was affected much less than that of D-SIBs by the implementation of resolution reforms.[25]

We also find a positive and statistically significant relationship between the TBTF premium and the variable Cov for both groups. Again, there are differences between the G-SIBs and D-SIBs. The Cov variable is statistically significant only for the G-SIBs, suggesting that G-SIBs were relatively more affected during the COVID-19 crisis than D-SIBs. Intuitively, these results are in line with the results on regulation; if the G-SIBs were not much affected by regulation and much less than D-SIBs, we would expect to see only the premium of G-SIBs to be strongly affected by a new shock, such as the COVID-19 crisis.

These results are somewhat surprising. G-SIBs may be thought to experience a similar - if not higher - impact than D-SIBs from regulations that ultimately were designed for them. G-SIBs and D-SIBs might have also been predicted to be affected in a similar way by the COVID-19 crisis. But the results in Table 2.4.1 suggest that there is heterogeneity within the SIB group and that GSIBs are significantly different from D-SIBs both in terms of the impact of regulation and the reaction to the COVID-19 crisis.

Our results come with some caveats. For example, market microstructure, liquidity issues and other phenomena such as the differential impact of public support measures could affect G-SIBs and D-SIBS differently. In addition, the limited period of the COVID-19 crisis and general data limitations leave several mechanisms unexplored. Even so, our rather coarse analysis helps us understand how the TBTF premium of SIBs responded differentially to regulation implemented after the global financial crisis to address the TBTF issue.

Coupled with the finding of a significant heterogeneity among countries we showed in the original report, these new results leave an interesting and potentially important set of issues that needed to be further explored to be fully explained. A deeper understanding of the differences between DSIBs and GSIBs and generalising those differences beyond the rather peculiar impact of the pandemic is needed.

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[24] We refer to the original work we report for the list of GSIBs and DSIBS included in our sample.

[25] Similarly to the results shown in the original work, these updated estimates are robust to the choice of different regressors and shorter sample periods

2.4.4. Conclusions

In this update we present new results on the impact of regulation (RRI) and on the impact of COVID on the TBTF premium of D-SIBs versus G-SIBs. In the academic literature and previous policy work SIBs are often implicitly assumed to be a homogeneous group.

Our results show that D-SIBs and G-SIBs have had a differentiated response to regulation. The results suggest that the implementation of resolution reforms did not materially affect the TBTF premium of G-SIBs. For G-SIBs, the estimates are not statistically significant and the value on their TBTF premium is an order of magnitude smaller than for D-SIBs.

These new set of results of differentiated reactions of G-SIBs versus D-SIBs are new and intriguing. They need to be taken with care given the data limitation and the relatively short period of time analysed.

Even so, our rather coarse analysis helps us understand how the TBTF premium of SIBs responded differentially to regulation implemented after the global financial crisis to address the TBTF issue. These results need to be explored more, but they warrant some caution when drawing conclusions on the impact of regulation on SIBs.

Table 2.4.1: Updated regression results

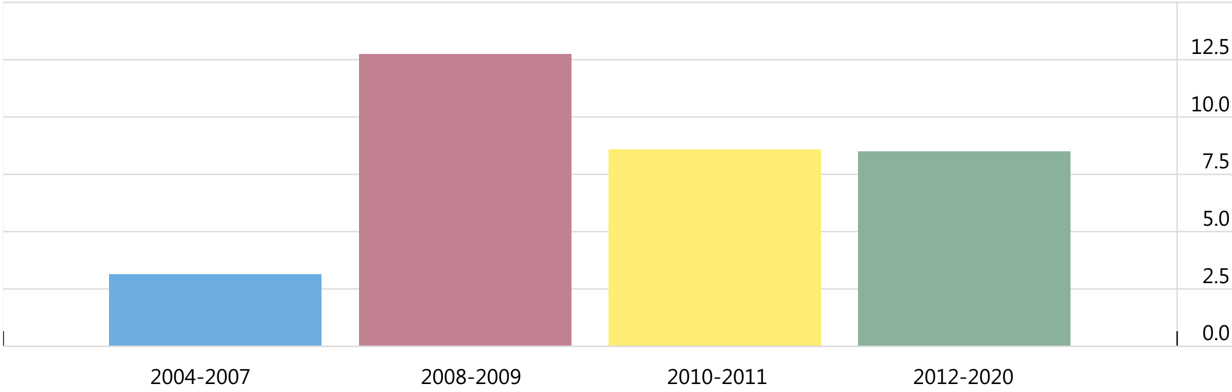
	(1)	(2)	(3)	(4)	(5)	(6)
	SIB		***DSIB***		***GSIB***	
	pre-COVID	full	pre-COVID	full	pre-COVID	full
VARIABLES	TBTF	TBTF	TBTF	TBTF	TBTF	TBTF
TCR	-0.06	-0.01	-0.31	0.11	-0.01	-0.10
	(0.746)	(0.978)	(0.268)	(0.730)	(0.979)	(0.815)
ROE	-0.18***	-0.18***	-0.09***	-0.20***	-0.07*	-0.12*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.055)	(0.081)
ProbC	0.07***	0.08***	0.11***	0.12**	0.03	0.04*
	(0.004)	(0.004)	(0.006)	(0.017)	(0.224)	(0.099)
ShadR	-1.92*	-0.51	-0.58	1.81	-3.89**	-1.87
	(0.073)	(0.687)	(0.660)	(0.339)	(0.041)	(0.286)
VIX	0.24***	0.23***	0.15**	0.16*	0.27***	0.28***
	(0.000)	(0.000)	(0.034)	(0.063)	(0.000)	(0.000)
RRI	**-10.61*** **	**-6.50***	**-13.60****	-10.16	-5.84	-2.61
	(0.001)	(0.054)	(0.022)	(0.101)	(0.253)	(0.563)
Cov		**6.16*****		5.93		**6.51****
		(0.002)		(0.107)		(0.011)
Observations	4,570	4,736	1,758	1,989	2,364	2,747
Number of SIBs	26	26	11	11	15	15
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.488	0.504	0.445	0.521	0.480	0.531
Adj. R-squared	0.485	0.501	0.436	0.515	0.474	0.526

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

2.4.5. *Appendix.*

The TBTF premium averaged across countries

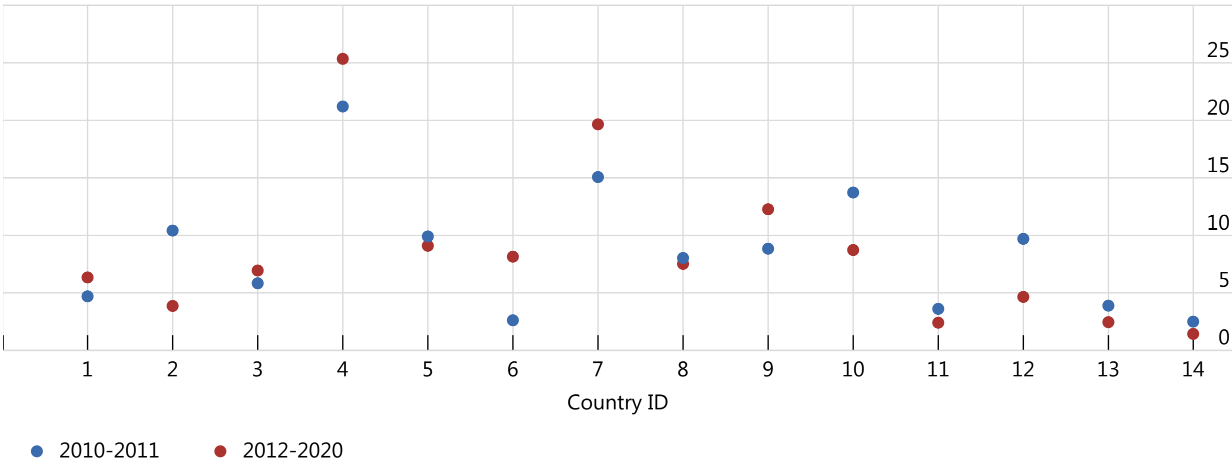
In per cent **Figure A1**



Sources: Bloomberg; Markit.

The average TBTF premium by country ID

In per cent **Figure A2**



Sources: Bloomberg; Markit.

3. Market-based systemic risk measures

3.1. Summary of previous results

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 analysis in the original Technical Appendix of both ΔCoVaR and SRISK suggests that the TBTF reforms have been associated with a reduction in G-SIBs' systemic risks. ΔCoVaR in the post-reform period declined more relative to the pre-crisis period for G-SIBs than for other banks.

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.[26]

3.2. New data gathered

In this section, we update the analysis of ΔCoVaR using market capitalisation data from Bloomberg, and SRISK using data of individual institutions provided by the Volatility Laboratory of the NYU Stern Volatility and Risk Institute (V-Lab). Both datasets cover the period up to the end of November 2020.

3.3. Results

ΔCoVaR

In 2020, ΔCoVaR experienced a sharp rise and exceeded the record-high level seen during the Global Financial Crisis (Figure 3.1 Panel A.). The VIX also shot up at the same time, suggesting that there was a high degree of uncertainty in financial markets.

By decomposing ΔCoVaR into individual institutions' tail risks (ΔVaR) and the systemic risk coefficient (γ), we observe that the systemic coefficient surpassed all-time highs while individual institutions' tail risks remained lower than the level during the GFC (Figure 3.1 Panels B and C). This exercise confirms that the pandemic resulted in an unprecedented level of systemic risk by acting as a common global shock that affected many financial institutions.

The distribution of individual financial institutions' ΔCoVaRs in 2020 appears very similar to that in 2008: the increase in ΔCoVaR in 2020 is not limited to a certain group of institutions (Figure 3.1 Panel D).

ΔCoVaR also exhibits trends similar to those during the GFC when we aggregate by region or by bank type (Figure 3.2 Panels A and B).

SRISK

The ratio of SRISK to GDP with a balanced sample increased by about 2 percentage points in 2020 from around 3% to 5%, reaching the highest level since around 2013, but remained lower than during GFC (Figure 3.3 Panel A) in particular for G-SIBs (Figure 3.3 Panel B).

On the other hand, it may be reasonable to subtract TLAC eligible debt from the SRISK of individual institutions to evaluate systemic risk to take into account that large banks have enhanced their capacity to absorb losses by issuing TLAC-eligible bonds since the TBTF reforms. Doing so we observe that systemic risk still rose in 2020 but only to a level comparable

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[26] For a more complete and quantitative analysis on how systemic risk has changed following the TBTF reforms, see Furukawa et al. (2021).

to 2016, suggesting that the enhanced loss absorbing capacities of banks have contributed to reducing systemic risk (Figure 3.4).

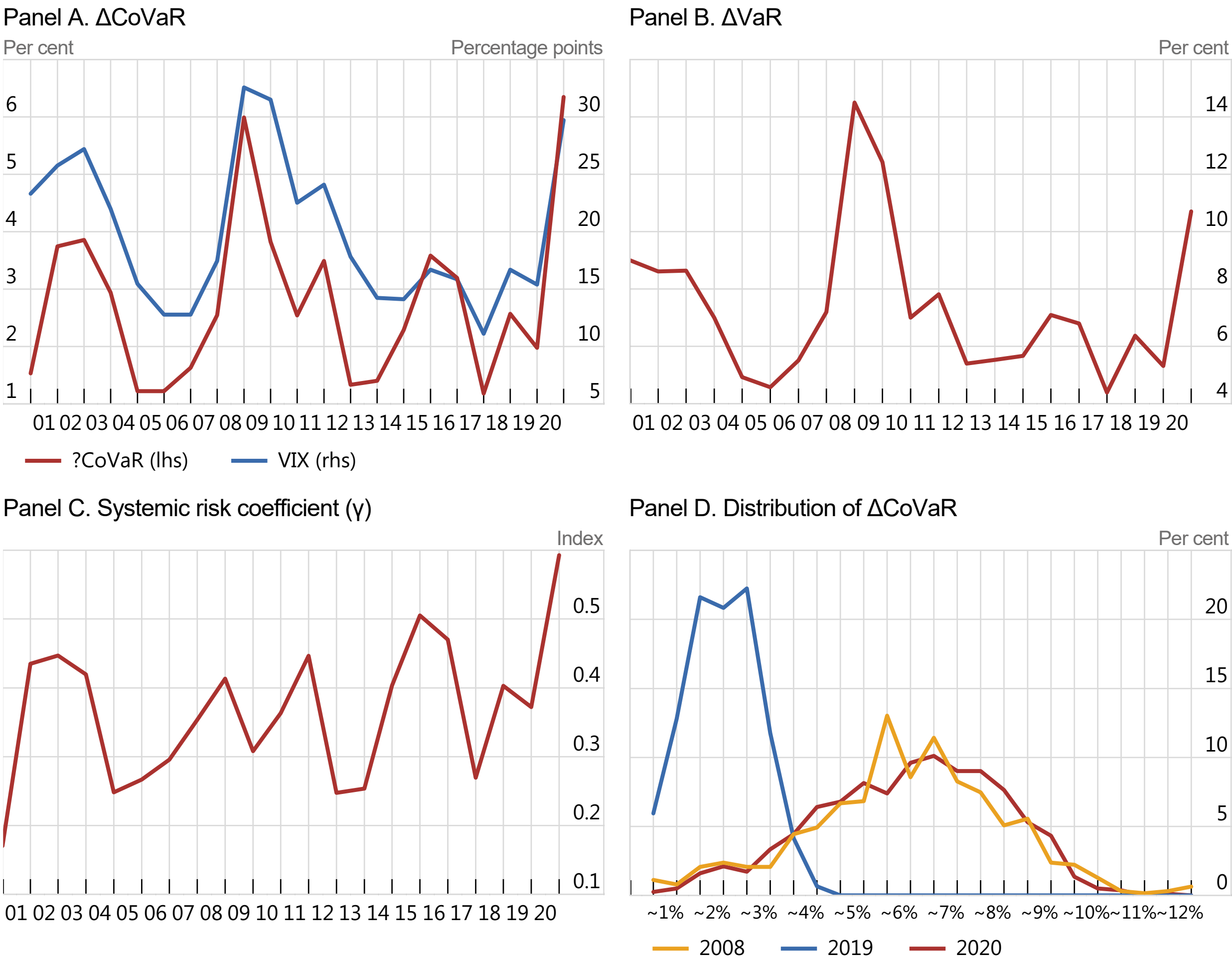
3.4. Conclusions

Those findings from our additional analysis suggest no need to change our conclusion in the original Technical Appendix. Despite the large increases in 2020, systemic risk measures have declined, as a trend, after the TBTF reforms.

Although ΔCoVaR shows a sharp rise in 2020, exceeding the record-high level during the Global Financial Crisis, it was mainly attributable to the pandemic, which is an unprecedented systemic risk that acted as a common global shock affecting many financial institutions.

The SRISK to GDP ratio with a balanced sample also increased significantly in 2020, but remained lower than during GFC, in particular for G-SIBs. Furthermore, SRISK adjusted for TLAC-eligible debt suggests the enhanced loss absorbing capacities of banks, contributing to reducing the systemic risk.

Systemic risk measures **Figure 3.1**



Sources: Bloomberg.

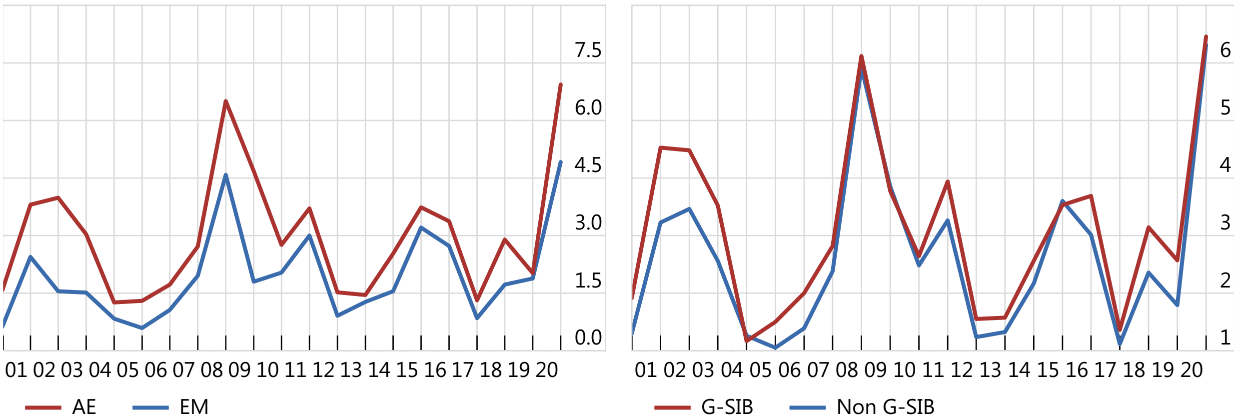
ΔCoVaR by region and bank type

In per cent

Figure 3.2

Panel A. ΔCoVaR by region

Panel B. ΔCoVaR by bank type



Source: Bloomberg.

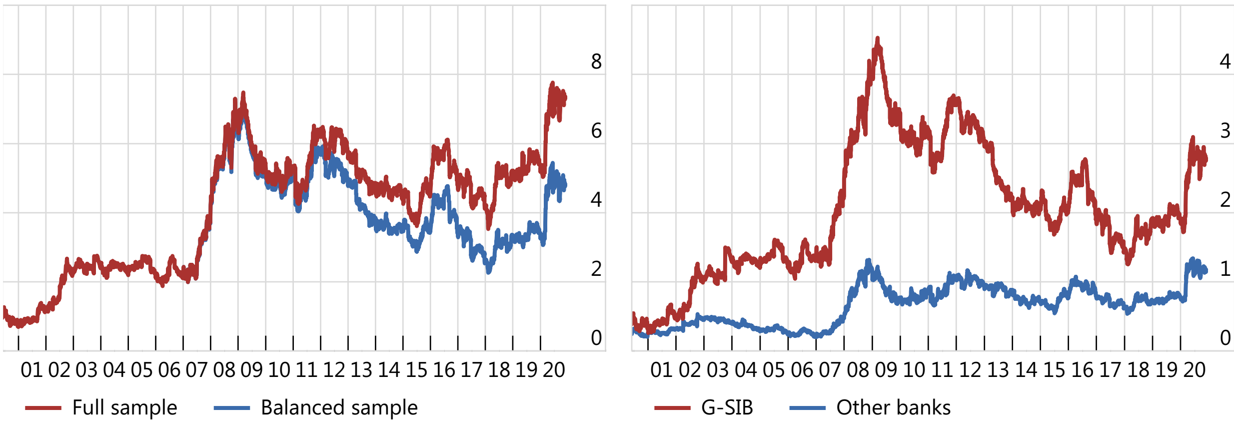
Ratio of SRISK to GDP

In per cent

Figure 3.3

Panel A. Full and balanced sample

Panel B. By bank type

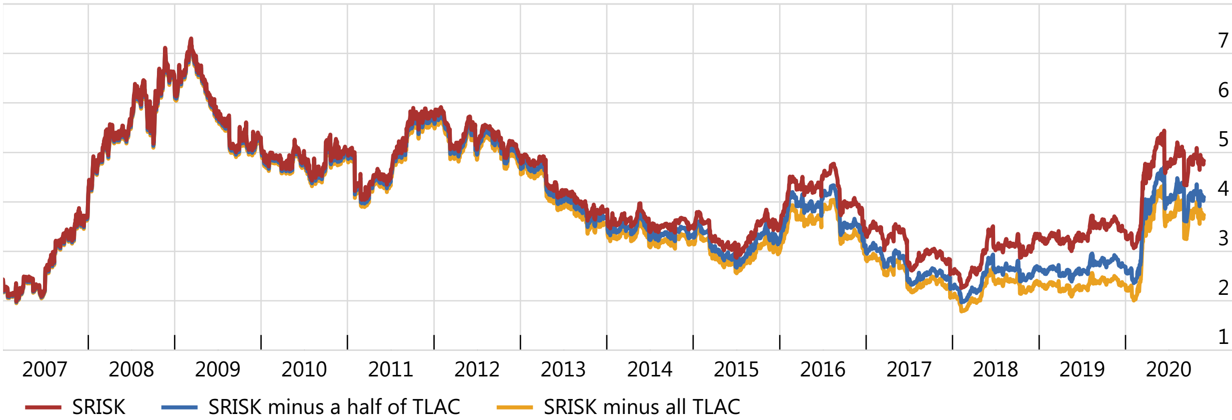


Sources: IMF; V-lab.

SRISK adjusted for TLAC-eligible debt

Balanced sample, in percentage of GDP

Figure 3.4



Source: V-Lab.