Basel Committee
on Banking Supervision

Evaluation of the impact and efficacy of the Basel III reforms – Annex

December 2022

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Contents

A.1 Reform announcement dates

Global and jurisdictional announcement dates for Basel III standards* — Table A1

	Capital		Liquidity		Resolution
	Risk-based capital	Leverage ratio	LCR	NSFR	TLAC
Global announcement date	16 December 2010				9 November 2015
Standard effective date	1 January 2013	1 January 2018**	1 January 2019	1 January 2018	1 January 2019
Jurisdiction announcement date					
Argentina	9 November 2012	18 July 2014	8 January 2015	25 August 2017	-
Australia	30 March 2012	-	1 September 2014	1 September 2014	8 November 2018
Belgium	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Brazil	17 February 2012	25 July 2014	25 July 2014	19 December 2017	19 December 2018
Canada	3 August 2012	30 July 2014	29 November 2013	8 February 2019	16 June 2017
China	15 August 2011	20 November 2014	11 October 2013	6 December 2017	30 September 2020
France	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Germany	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Hong Kong SAR	10 August 2012	4 September 2017	15 August 2014	1 September 2017	4 October 2018
India	30 December 2011	8 January 2015	21 February 2012	28 May 2015	-
Indonesia	29 January 2016	22 April 2019	30 September 2014	15 March 2017	19 February 2020
Italy	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Japan	7 February 2012	17 December 2014	31 July 2014	25 December 2020	28 December 2018
Korea	27 September 2012	21 November 2014	1 September 2014	26 October 2017	-
Luxembourg	27 June 2013	17 January 2015	17 January 2015	7 June 2019	7 June 2019
Mexico	16 August 2012	11 March 2016	31 October 2014	16 March 2020	20 April 2021
Saudi Arabia	19 December 2012	25 August 2014	10 July 2013	29 December 2014	21 November 2016
Singapore	28 December 2011	25 July 2017	6 August 2014	16 November 2016	9 April 2018
South Africa	28 September 2012	25 July 2014	30 March 2012	30 March 2012	5 December 2019
Spain	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Sweden	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Switzerland	24 October 2011	17 June 2014	17 January 2014	10 January 2017	23 February 2018
The Netherlands	20 July 2011	10 October 2014	10 October 2014	23 November 2016	23 November 2016
Turkey	2 January 2013	7 March 2013	1 June 2013	1 January 2018	
United Kingdom	20 July 2011	10 July 2015	10 October 2014	23 November 2016	23 November 2016
United States	30 August 2012	30 August 2012	29 November 2013	3 May 2016	8 April 2019

* "Global announcement date" refers to the date by which a final standard has been initially published by the Committee. "Jurisdictional announcement date" shows the date when jurisdiction release a proposal of the new domestic rule to implement the internationally-agreed standards. For more information on implementation dates used in this report, see the Committee's Basel III implementation progress update and dashboard (September 2022), www.bis.org/bcbs/implementation/rcap_reports.htm.

** Implementation of the leverage ratio requirements began with bank-level reporting to national supervisors from 1 January 2013, followed by pillar 3 public disclosure of the leverage ratio went into effect on 1 January 2015and finally the Pillar 1 leverage ratio requirement went into effect on 1 January 2018.

Source: Basel Committee on Banking Supervision, Financial Stability Board.

A.2 Additional details on data availability and quality

Table A2.1 reports summary statistics on the availability of the Committee's data and vendor bank data.

Summary statistics on data availability — Table A2.1

	Source	Reporting period		Number of banks		Observations
		Start	End	100% sample	50% sample	
Regulatory ratios						
CET1 ratio	BCBS	2011	2021	50	192	3,602
Tier1 ratio	BCBS	2011	2021	50	194	3,620
Total capital ratio	BCBS	2011	2021	50	192	3,602
Leverage ratio	BCBS	2011	2021	45	194	3,566
LCR	BCBS	2012	2021	82	176	3,102
NSFR	BCBS	2012	2021	96	183	3,276
TLAC ratio	BCBS	2017	2021	33	50	470
Lending amount						
Gross loans	Vendor	2011	2021	28	181	3,461
Retail lending	BCBS	2011	2021	35	182	3,533
SME lending	BCBS	2011	2021	41	182	3,541
NonFinCorp lend.	BCBS	2011	2021	44	182	3,538
Systemic risk						
Delta CoVaR	Vendor	2005	2021	56	66	2,149
Exposure delta CoVaR	Vendor	2005	2021	58	66	2,155
MES	Vendor	2005	2021	58	66	2,159
SRISK	Vendor	2005	2021	36	52	1,661
Other variables						
Tot. assets	Vendor	2005	2021	45	83	2,553
Tot. assets	BCBS	2013	2021	119	187	3,047
Deposit ratio	BCBS	2017	2021	98	174	1,388
RoA	BCBS	2011	2021	66	181	3,573
RWA density	BCBS	2011	2021	78	191	3,793
Cost equity	Vendor	2005	2021	51	69	2,127
Cost debt	Vendor	2005	2021	51	69	2,127
WACC	Vendor	2005	2021	51	69	2,127
NPL ratio	Vendor	2005	2021	5	36	1,196
Cost to income ratio	Vendor	2005	2021	1	66	1,791
Market to book	Vendor	2005	2021	51	67	2,113
Rating	Vendor	2005	2021	58	73	2,326
CDS	Vendor	2005	2021	26	43	1,405
EDF	Vendor	2011	2021	65	71	1,458
PD (BIS)	Vendor	2005	2018	1	26	704

Source: Basel Committee on Banking Supervision.

Some variables have outlier observations, which may imply that these data are not representative of the whole banking sector as they could reflect misreporting or mergers. To mitigate the influence of large outliers, data have been winsorised at the 1% and 99% levels. If the data winsorised at this level still present outliers (observations more than five standard deviations from the median), the data is then winsorised at the 5% and 95% levels. Regulatory ratios have not been winsorised because that would lead to the exclusion of most shortfalls, which are of particular interest for evaluation purposes.

In addition to winsorisation, two filters have been applied to exclude banks for which the business model may be significantly different from others. The first filter restricts the sample to banks with total assets of at least €1 billion at their first appearance, and the second filter restricts the sample to banks whose loans exceed 0.5% of total assets at their first appearance. Through this process, 377 banks remain in the sample.

Table A2.2 reports descriptive statistics of the variables after winsorisation and the two additional exclusions mentioned above.

Descriptive statistics for metrics used in the report — Table A2.2

	mean	SD	min	p25	p50	p75	max
Regulatory ratios							
CET1 ratio	13.75	5.096	4.863	10.95	12.73	15.24	121.8
Tier1 ratio	14.65	5.307	5.335	11.78	13.47	16.16	121.8
Total capital ratio	17.13	5.584	7.632	14.00	15.85	18.68	128.3
Leverage ratio	6.081	2.676	0	4.481	5.485	6.984	34.39
LCR	196.7	313.0	0.0287	116.9	139.5	179.0	7498.8
NSFR	117.2	22.10	16.05	105.2	114.8	125.8	367.3
TLAC ratio	6.392	14.66	0	0	0	7.258	125.4
Lending growth							
Total lending	1.26	11.9	-49.2	-2.69	1.15	5.87	41.4
Retail lending	1.52	14.2	-66.1	-2.3	1.52	6.4	50.9
SME Lending	-0.0839	35	-162	-6.11	0.396	7.83	146.3
NonFinCorp lending	0.364	16.2	-37.9	-6.19	0.406	8.22	34.9
Systemic risk							
Delta CoVaR	111.5	77.26	0	57.05	91.56	153.3	374.7
Exp. delta CoVaR	196.5	151.0	-4.796	94.74	157.2	254.7	801.1
MES	2.726	2.181	-0.349	1.228	2.090	3.704	10.50
SRISK	0.618	2.948	-8.842	-1.073	0.952	2.791	6.099
Other variables							
Cost equity	12.47	3.362	7.338	10.06	11.79	14.22	24.86
Cost debt	1.964	1.478	0.104	0.758	1.660	2.870	5.553
WACC	4.996	2.832	0.706	2.870	4.694	6.438	14.95
log(Total Assets)	25.40	1.747	21.14	24.26	25.33	26.68	28.69
Deposit Ratio	10.34	11.23	0	0.884	7.284	14.82	54.29
RoA	0.357	0.314	0	0.132	0.266	0.503	1.178
RWA density	43.63	16.85	9.444	31.16	41.78	54.48	95.59
NPL ratio	2.175	1.936	0.274	0.880	1.454	2.901	7.458
Cost to income ratio	58.65	14.88	28.14	48.67	57.82	66.67	111.6
Market to book ratio	1.360	0.797	0.253	0.755	1.209	1.785	4.391

d(CDS)	1.932	38.92	-131.3	-13.54	-0.897	17.59	149.0
d(EDF)	-0.0245	0.274	-1.188	-0.0785	-0.0169	0.0504	1.135
d(PD_BIS)	-0.00013	0.0154	-0.0483	-0.00081	0	0	0.0411

Variables for lending growth are calculated as 100*dlog. d() refers to the difference of the variable. Delta Covar, Exp. Delta Covar are scaled by 100. SRISK is divided by total assets and scaled by 100.

Source: Basel Committee on Banking Supervision.

A.3 CET1 ratio and headroom

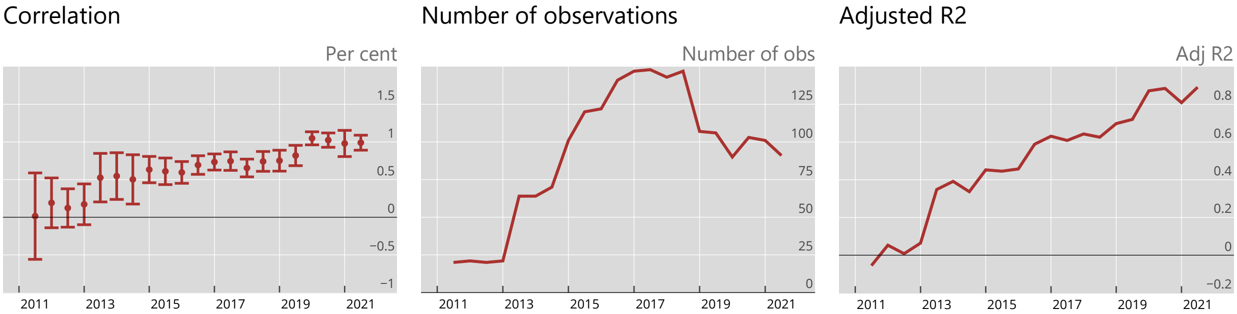
Given limitations to the Committee's data on bank-specific CET1 requirements, CET1 headroom (ie CET1 ratio in excess of requirements) can be constructed only for 20 banks at the beginning of the data sample. Therefore, this report's analyses use the level of the CET1 ratio in some cases as a proxy for the CET1 headroom.

To support the validity of interpretation of CET1 ratios as a measure of headroom, correlation is estimated between the CET1 ratio and the CET1 headroom in each semiannual period with the following regression specification:

$$CET1\_Ratio_i = a + \hat{b} \times CET1\_Headroom_i + e_i,$$

where $CET1\_Ratio_i$ is the CET1 ratio of bank i in a semiannual period, and $CET1\_Headroom_i$ is the bank's CET1 headroom in the same period. The headroom is the difference between the actual capital ratio and the total capital requirements (including all buffer requirements). The regression coefficient, $\hat{b}$ is an estimate of the correlation of interest, and is reported in Graph A3 with the two standard-error bands in Panel A. Panel B provides the number of observations in each regression for each semiannual period in Panel B (which indicates the availability of the CET1 headroom), and the associated adjusted-R^2s are in Panel C. Although the correlation between the CET1 ratio and CET1 headroom is insignificant in early periods, the associated number of observations is very small, suggesting that the insignificance may be due to low power. After 2013, when the number of observations increases to above 50, the correlation between the CET1 ratio and CET1 headroom becomes both statistically and economically significant. Furthermore, the correlation increases over time. Taken together, under the additional assumption of absence of selection bias (ie that banks which do not disclose the headroom ratio are not systematically different from those that do) the evidence in Graph A3 supports the assumption that the CET1 ratio is informative about capital shortfalls of banks.

CET1 Ratio and Headroom CET1 — Graph A3



Source: Basel Committee on Banking Supervision.

A.4 Additional regression results on the relationship of Basel III reforms to resilience measures

Table A4.1 presents the results of additional analysis on the relationship of Basel III reforms to resilience measures, replicating Table 1 of Section 4 using the global announcement date for each reform as the event date instead of jurisdictions' announcement dates. Banks with lower regulatory ratios at the global announcement date for each reform strongly improved those ratios in the years that followed relative to banks with higher regulatory ratios. The strength of these results relative to those in Table 1 could suggest that many banks began adapting to the reforms in the years prior to their jurisdictions' announcement of the specific reforms.

Tables A4.2 and A4.3 present results of the Section 4 regressions, modified to include the impact of all four regulatory reforms simultaneously as control variables. The study's conclusions are relatively unaffected as the regulatory impact measures are not highly correlated with each other.

Table A4.4 extends the results for CDS spreads on subordinated debt and PDs. There is only significant evidence of a relationship between the impact of CET1 ratios and bank resilience as measured by CDS on subordinated debt.

Regressions of regulatory ratios on reforms' impact, by years since the global announcement date

Table A4.1

Dependent variable	Regulatory ratio			
	(1)	(2)	(3)	(4)
Reform considered (pp)	CET1	Leverage	LCR	NSFR
One year after (τ = 1)	0.211*** (0.076)	0.195*** (0.048)	0.203*** (0.043)	0.149*** (0.041)
One year after (τ = 2)	0.239*** (0.083)	0.195*** (0.053)	0.348*** (0.063	0.426*** (0.076)
One year after (τ = 3)	0.319*** (0.081)	0.192*** (0.053)	0.482*** (0.080)	0.492*** (0.081)
One year after (τ = 4)	0.374*** (0.088)	0.218*** (0.056)	0.452*** (0.068)	0.483*** (0.071)
One year after (τ = 5)	0.399*** (0.086)	0.238*** (0.057)	0.610*** (0.074)	0.605*** (0.070)
R^2 (within)	0.316	0.414	0.211	0.363
Observations	2,658	2,660	2,398	2,585
Number of banks	193	194	204	204

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when the regulatory ratios are considered as dependent variables. The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the first available observation in the data (ie H1 2011 for capital reforms and H2 2012 for liquidity reforms). Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged policy rate. Bank and time fixed effects are included. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regressions of regulatory ratios on all reforms' impact, by years since the jurisdictional announcement date

Table A4.2

Dependent variable	Regulatory ratio			
	(1)	(2)	(3)	(4)
Reform considered (pp)	CET1	Leverage	LCR	NSFR
One year after (τ = 1)	0.078**	0.002	0.105***	-0.013
	(0.030)	(0.015)	(0.033)	(0.015)
One year after (τ = 2)	0.093**	-0.033*	0.273***	-0.017
	(0.047)	(0.017)	(0.060)	(0.021)
One year after (τ = 3)	0.093**	-0.033*	0.273***	-0.017
	(0.047)	(0.017)	(0.060)	(0.021)
One year after (τ = 4)	0.149**	-0.011	0.433***	-0.122***
	(0.068)	(0.048)	(0.073)	(0.040)
One year after (τ = 5)	0.149**	-0.051**	0.384***	-0.063**
	(0.062)	(0.021)	(0.074)	(0.031)
R^2 (within)	2,281	2,269	1,951	2,094
Observations	0.354	0.444	0.152	0.316
Number of banks	151	151	151	151

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when the regulatory ratios are considered as dependent variables. The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged policy rate. Bank and time fixed effects are included. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for market-based resilience measures as dependent variable (bp), by years since the jurisdictional announcement date

All reform impacts included as controls simultaneously – coefficients from each regression presented across four columns

Table A4.3

Dependent variable	CDS (senior)		EDF	
CET1	Coefficients	Stand. Errors	Coefficients	Stand. Errors
One year after (τ = 1)	-0.956	(1.053)	-0.144	(0.544)
Two years after (τ = 2)	-3.617**	(1.614)	-0.409	(1.049)
Three years after (τ = 3)	-4.940**	(2.372)	-0.278	(1.380)
Four years after (τ = 4)	-6.513**	(3.122)	-0.114	(1.612)
Five years after (τ = 5)	-7.721**	(3.427)	-1.148	(2.028)
Leverage	Coefficients	Stand. Errors	Coefficients	Stand. Errors
One year after (τ = 1)	-1.359	(1.776)	-1.043	(0.880)
Two years after (τ = 2)	-3.495	(2.200)	-0.498	(0.990)
Three years after (τ = 3)	-3.940	(2.863)	0.486	(1.358)
Four years after (τ = 4)	-2.299	(4.311)	0.690	(1.515)
Five years after (τ = 5)	-4.667	(4.915)	-2.003	(1.698)
LCR	Coefficients	Stand. Errors	Coefficients	Stand. Errors
One year after (τ = 1)	-0.090	(0.096)	-0.003	(0.041)
Two years after (τ = 2)	-0.110	(0.176)	0.009	(0.082)
Three years after (τ = 3)	-0.069	(0.215)	-0.040	(0.107)
Four years after (τ = 4)	-0.170	(0.265)	-0.122	(0.121)
Five years after (τ = 5)	-0.167	(0.330)	-0.124	(0.122)
NSFR	Coefficients	Stand. Errors	Coefficients	Stand. Errors
One year after (τ = 1)	-0.107	(0.226)	0.048	(0.042)
Two years after (τ = 2)	-0.212	(0.484)	-0.022	(0.073)
Three years after (τ = 3)	0.154	(0.922)	-0.121	(0.104)
Four years after (τ = 4)	0.390	(1.465)	-0.189	(0.153)
Five years after (τ = 5)				
R^2 (within)	0.765		0.400	
Observations	592		1,125	
Number of Banks	40		65	

The table shows the regression results for CET1 ratio, leverage ratio, LCR, and NSFR when CDS (senior) is considered as dependent variable in columns (1)–(2), while columns (3)–(4) display the results for EDF as dependent variable. The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged policy rate. Bank and time fixed effects are included. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for market-based resilience measures as dependent variable (bp), by years since jurisdictional announcement date

Table A4.4

Dependent variable	CDS (sub)				PD			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Reform considered	CET1	Leverage	LCR	NSFR	CET1	Leverage	LCR	NSFR
One year after	-4.653***	-4.419	-0.263	-0.232	1.585	-5.364**	0.102	-0.286
(τ = 1)	(1.623)	(3.265)	(0.287)	(0.182)	(2.153)	(2.042)	(0.137)	(0.194)
Two years after	-9.691***	-6.586	-0.320	-0.241	0.658	-4.545**	0.341	-0.368
(τ = 2)	(2.417)	(4.737)	(0.444)	(0.296)	(2.564)	(2.250)	(0.255)	(0.289)
Three years after	-11.326***	-7.021	-0.225	-0.251	-1.611	0.119	0.629	-0.349
(τ = 3)	(3.039)	(6.386)	(0.523)	(0.345)	(2.984)	(8.261)	(0.513)	(0.373)
Four years after	-10.150***	-7.844	-0.296	-0.298	-0.596	-7.041	0.630	
(τ = 4)	(3.666)	(9.590)	(0.604)	(0.465)	(3.521)	(7.756)	(0.518)	
Five years after	-9.815**	-9.679	-0.215	-0.412	-0.578	-15.065***	0.763	
(τ = 5)	(4.207)	(12.511)	(0.617)	(0.636)	(4.209)	(5.450)	(0.520)	
R^2 (within)	0.718	0.705	0.713	0.711	0.319	0.336	0.329	0.323
Observations	578	506	560	560	553	553	531	542
Number of Banks	35	31	34	34	48	48	46	47

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when CDS (sub) is considered as dependent variable in columns (1)–(4), while columns (5)–(8) display the coefficients for PD as dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged policy rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

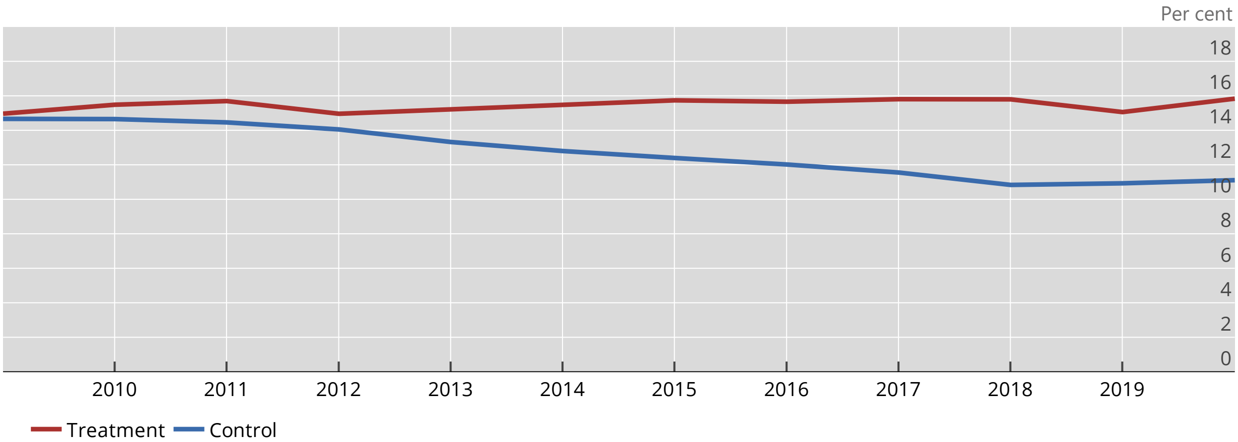
A.5 Case study: Did Japanese banks subject to the Basel III reforms improve their capital ratios?

Japan introduced Basel III reforms related to risk-based capital requirements in March 2013, but these reforms apply only to internationally active banks.[1] Therefore, the changes in risk-based capital ratios of internationally active banks (relative to other Japanese banks) around March 2013 provide an indication of whether the reforms motivated banks to improve their risk-based capital ratios.

For the empirical analysis, annual (fiscal year) financial and market data of (consolidated) Japanese banks provided by the Bank of Japan is used. The sample consists of 56 listed banks (16 of which are internationally active) with total assets above EUR 10 billion as of March 2019 and financial and market data available from 2010 through 2019.[2]

Graph A5 illustrates that total capital ratios for internationally active banks subject to Basel III improved relative to other Japanese banks after Basel III's introduction, which is denoted by the vertical bar in the plot.

Evolution of total capital ratios of Japanese banks | Graph A5



Source: Jurisdictional data.

To further test this insight, a difference-in-differences estimation is conducted, and includes additional bank-specific controls for some alternative drivers of changes in total capital ratios. The regression equation is as follows:

$$RBCRatio_{i,t} = \alpha_i + \mu_t + \beta[PostReform_t \times IntlActive_i] + \sum_{j=1}^{4} \gamma_j B_{j,i,t-1} + \epsilon_{i,t} \quad (1)$$

where i denotes an individual bank, and t denotes a time-period, each of which has a fixed effect on capital ratios in the model, α_i and μ_t respectively. $PostReform_t$ is a dummy variable which takes the value of one starting in FY2013, as Basel III risk-based capital regulation has been effective since March 2013 and zero in earlier periods. $IntlActive_i$ is a dummy variable which takes the value of one for internationally active

1 For example, internationally active banks in Japan are required to maintain a CET1 capital ratio of 4.5%, while domestic banks are required to maintain a ratio of 4% as measured by "core capital".

2 Data from FY2010 is used in order to minimise the effects of Basel II regulations (Basel III reforms were agreed in 2010). The end period of the sample is FY2019 to exclude the impacts of the Covid-19 period.

banks and zero otherwise. Finally, $B_{j,i,t-1}$ is the set of four bank-specific control variables (j denotes type of bank-control variable), and the error term is $\epsilon_{i,t}$.[3]

The coefficient on the interaction of the reform period and internationally active bank dummies, β, is the parameter of interest. In addition to the first equation above, the study also uses a regression equation which measures the difference which emerges between the two types of bank year by year:

$$RBCRatio_{i,t} = \alpha_i + \mu_t + \sum_{t=2011}^{2019} \beta_t [Year_t \times IntlActive_i] + \sum_{j=1}^{4} \gamma_j B_{j,i,t-1} + \epsilon_{i,t} \qquad (2)$$

where $Year_t$ is year-dummy variable. The results of both regression estimates are shown in Table A5.

Difference-in-differences regressions of Japanese banks' total risk-based capital ratios

Table A5

Variables	Total risk-based capital ratio (1)	Total risk-based capital ratio (2)
$PostReform_t \cdot IntlActive_i$	1.426*** (0.387)	
$Year_{2011} \cdot IntlActive_i$		0.672*** (0.234)
$Year_{2012} \cdot IntlActive_i$		0.910** (0.372)
$Year_{2013} \cdot IntlActive_i$		1.186*** (0.376)
$Year_{2014} \cdot IntlActive_i$		1.766*** (0.522)
$Year_{2015} \cdot IntlActive_i$		2.073*** (0.469)
$Year_{2016} \cdot IntlActive_i$		2.208*** (0.573)
$Year_{2017} \cdot IntlActive_i$		2.656*** (0.625)
$Year_{2018} \cdot IntlActive_i$		2.737*** (0.638)
$Year_{2019} \cdot IntlActive_i$		2.277*** (0.655)
R^2	0.349	0.389
Observations	595	595

The table shows the regression estimates for the two difference-in-difference specifications when the total capital ratio is considered as dependent variable. The analysis covers the years 2010 to 2019. Bank-specific controls include log total assets, return on assets, and the loans-to-assets and deposit-to-assets ratios. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Sources: Bloomberg, Published financial statements of banks.

The first column of Table A5 (corresponding to regression equation (1)) shows that internationally active Japanese banks increased their total risk-based capital ratios more – relative to other Japanese banks – by a statistically significant average of about 1.4 percentage points over the post-reform period. The regression in the second column further illustrates that this improvement in risk-based capital occurs

3 Bank-specific controls include log total assets, return on assets, and the loans-to-assets and deposit-to-assets ratios. These controls are lagged by a year to reduce endogeneity problems (eg reverse causality).

gradually over the period following the reforms. This regression also shows that internationally active banks improved their risk-based capital relative to other banks even before 2013, which is consistent with affected banks increasing capital ratios in anticipation of the Basel III reforms. This also highlights the difficulty in identifying when the reforms had an impact on the banks.

A.6 Systemic risk measures

This appendix describes the four measures used in this report to estimate banks' systemic risk: (i) ΔCoVaR; (ii) Exposure-ΔCoVaR; (iii) Marginal Expected Shortfall (MES); and (iv) SRISK.

ΔCoVaR

ΔCoVaR was proposed by Adrian and Brunnermeier (2016) and builds on the value-at-risk (VaR), which is a very common measure to estimate the risk of an individual bank in isolation. In general, the VaR provides the potential loss of a specific bank over a given time period that is not exceeded with a certain probability (95% for this analysis). Since a single bank's risk does not necessarily reflect its contribution to overall systemic risk, Adrian and Brunnermeier (2016) refine the existing VaR measure and create the ΔCoVaR measure to take this into account.

CoVaR, which stands for "conditional" VaR, is the VaR of the whole financial system conditional on the fact that a specific bank is in a particular state. Building on this, ΔCoVaR refers to the difference between the CoVaR conditional on the distress of a certain bank and the CoVaR conditional on the median state of that bank. Usually, the median state refers to the bank being in a solid financial condition. In simple terms, ΔCoVaR provides an estimate of how much the risk of the whole financial system increases when a bank becomes stressed. Following the approach suggested by Adrian and Brunnermeier (2016), ΔCoVaR is computed based on quantile regressions using daily returns on banks' equity market prices.

Exposure-ΔCoVaR

The underlying idea of Exposure-ΔCoVaR is very similar to the first measure. The important difference between those two measures is the reversed conditioning. Whereas ΔCoVaR gives an indication of how much the risk of the whole financial system increases when a specific bank becomes stressed, the Exposure-ΔCoVaR estimates the increase in risk of a specific bank given a system-wide distress.

The relevance of the direction of the conditioning can be illustrated based on an example by Adrian and Brunnermeier (2016): a venture capital firm is very likely also in distress if the overall financial system faces difficulties. On the contrary, the overall financial system may not be severely affected if the venture capital firm is the only institution in distress. In line with the approach used to estimate ΔCoVaR, Exposure-ΔCoVaR is also computed based on short-run returns on banks' equity market prices.

MES

MES is based on the same direction of the conditioning as Exposure-ΔCoVaR but builds on the expected shortfall measure instead of the VaR. In general, the expected shortfall is defined as the expected loss of a specific bank given that the VaR is exceeded, ie in the worst cases. In particular, MES is a bank's expected equity loss when the overall financial market incurs a loss greater than its VaR (Acharya et al (2017)). MES is often understood as the marginal contribution of a given bank to the tail risk of the market.

MES is generally simple to estimate. The average daily returns for each bank are computed for those days when the average daily returns across all the banks in the sample are in their lower fifth quantile, using a two-year window of daily observations.

SRISK

SRISK is the amount of capital that a bank is expected to need to raise in order to function normally if there is another financial crisis (Acharya et al (2012)).[4] Therefore, in contrast to the other systemic risk measures, SRISK looks beyond market prices and takes a more structural approach by computing a potential capital shortfall, which is the difference between available and required capital.

Specifically, available capital is the expected market value of a bank's capital assuming that the market was to fall by more than a given threshold within an assumed period. Required capital is determined as a fraction of deposits and the market value of a bank's capital under market stress. The choice of the fraction determining the required capital is informed by an assumed prudential capital ratio of the bank. In this report, the same values are used as the V-Lab of NYU, which is a value of 5.5%[5] for European banks and 8% for all other banks.[6] Practically, given the frequency of information about bank debt, SRISK is computed at a quarterly frequency.

General data aggregation

Given that Committee's data has a semiannual frequency and the calculated systemic risk measures are of daily or quarterly frequency, there is a need to harmonise the frequency of observations. In particular, to underpin the robustness of the findings, the daily ΔCoVaR, Exposure-ΔCoVaR, MES, and SRISK are aggregated using three ways of aggregation: (i) arithmetic average within a given six-month period (used in baseline regressions); (ii) maximum value during that period; and (iii) end-of-period observation, corresponding to the accounting data from the Committee.

4 For more details, please see V Acharya, R Engle and M Richardson, "Capital shortfall: a new approach to ranking and regulating systemic risks", *American Economic Review*, vol 102, no 3, 2012.

5 The effect of changes in the resolution framework on the sensitivity of systemic risk to capital regulation is beyond the scope of this analysis.

6 BCBS (2014): *Basel III leverage ratio framework and disclosure*.

A.7 Complementary analysis regarding pre- and post-reform trends of systemic risk measures

Table A7.1 reports the results obtained when time fixed effects are added to the baseline specifications in Section 5.2. The table shows that coefficients on reform date dummies are either not significant or positive and somewhat weakly significant.

Regression of systemic risk measures on reform-event time dummies with macroeconomic variables and time fixed effects

Table A7.1

Variables	ΔCoVaR	ΔCoVaR	ΔCoVaR	Exposure ΔCoVaR	Exposure ΔCoVaR	Exposure ΔCoVaR
RBC reform date	0.154			0.509		
	(0.138)			(0.415)		
Leverage reform date		0.0906*			0.106	
		(0.0485)			(0.161)	
LCR reform date			-0.0336			0.346**
			(0.0508)			(0.134)
Constant	1.327***	1.337***	1.327***	2.899***	2.922***	2.933***
	(0.0987)	(0.0913)	(0.0950)	(0.346)	(0.329)	(0.327)
R^2	0.767	0.768	0.765	0.549	0.543	0.546
Observations	1,197	1,197	1,197	1,199	1,199	1,199
Number of banks	68	68	68	68	68	68
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Variables	MES	MES	MES	SRISK/Total Assets	SRISK/Total Assets	SRISK/Total Assets
RBC reform date	0.632			-0.00320		
	(0.584)			(0.00404)		
Leverage reform date		-0.0654			-0.000529	
		(0.267)			(0.00247)	
LCR reform date			0.432**			0.000663
			(0.195)			(0.00162)
Constant	3.783***	3.825***	3.822***	0.0189***	0.0187***	0.0187***
	(0.391)	(0.371)	(0.375)	(0.00436)	(0.00437)	(0.00440)
R^2	0.518	0.512	0.515	0.351	0.349	0.349
Observations	1,204	1,204	1,204	942	942	942
Number of banks	68	68	68	54	54	54
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: Basel Committee on Banking Supervision.

Table A7.2 shows the results of the specification where the four systemic risk measures are regressed on event-time reform dummies, crisis period dummies, and interaction terms that combine reform date and crisis dummies. The regressions also include GDP growth and implied volatility to control for country-specific factors and general market conditions. The crisis dummies are set to "1" in periods where the six-month average of the Financial Stress Index by the Office of Financial Research is above zero. This approach captures four crisis periods: H2 2011, H2 2012 (European sovereign debt crisis), H1 2016 (oil price crisis) and H1 2020 (Covid-19 pandemic) during the extended sample period of H1 2011 to H1 2020 that is used for this specific analysis. As Table A7.2 shows, the coefficient on crises dummies alone is usually positive and significant as expected which shows that systemic risk increases in stress times. Whether systemic risk reaches lower levels during crises post-reform (compared with pre-reform) is determined by adding up the coefficients on the reform date and interaction dummies. Statistical tests show that the sum is significantly negative for risk-based capital, leverage and LCR reforms. This suggests that systemic risk increased less during crises after the introduction of capital and liquidity reforms.

Regression of systemic risk measures on reform-event time dummies, crisis period dummies, and interaction terms that combine reform date and crisis dummies

Table A7.2

Variables	ΔCoVaR	ΔCoVaR	ΔCoVaR	Exposure ΔCoVaR	Exposure ΔCoVaR	Exposure ΔCoVaR
RBC reform date	-0.496***			-0.670***		
	(0.0646)			(0.111)		
Crisis time dummy	0.0433	0.666***	0.600***	0.307**	1.177***	1.126***
	(0.104)	(0.0808)	(0.0819)	(0.128)	(0.218)	(0.202)
Interaction crisis and reform dummies	0.223**	-0.156	-0.245**	0.0386	-0.455**	-0.793***
	(0.0812)	(0.113)	(0.0946)	(0.119)	(0.208)	(0.222)
Leverage reform date		-0.128**			-0.483***	
		(0.0446)			(0.101)	
LCR reform date			-0.156***			-0.383***
			(0.0518)			(0.0964)
Constant	1.655***	1.321***	1.348***	2.741***	2.627***	2.522***
	(0.0837)	(0.122)	(0.0911)	(0.181)	(0.220)	(0.167)
R^2	0.353	0.311	0.333	0.227	0.252	0.278
Observations	1,401	1,401	1,401	1,403	1,403	1,403
Number of banks	68	68	68	68	68	68
Adj. R^2	0.351	0.309	0.331	0.224	0.249	0.275

Variables	MES	MES	MES	SRISK/Total Assets	SRISK/Total Assets	SRISK/Total Assets
RBC reform date	-0.831***			-0.00703**		
	(0.122)			(0.00295)		
Crisis time dummy	0.435**	0.861***	1.142***	0.00487***	0.00764***	0.00789***
	(0.204)	(0.182)	(0.251)	(0.000979)	(0.00140)	(0.00184)
Interaction crisis and reform dummies	0.382*	-0.0338	-0.494*	0.00440**	0.00341	0.00247
	(0.184)	(0.276)	(0.278)	(0.00168)	(0.00197)	(0.00154)
Leverage reform date		-0.531***			-0.00401	

		(0.157)			(0.00290)	
LCR reform date			-0.295**			-0.00359
			(0.119)			(0.00227)
Constant	3.974***	3.731***	3.504***	0.0258***	0.0227***	0.0223***
	(0.286)	(0.351)	(0.256)	(0.00419)	(0.00407)	(0.00360)
R^2	0.220	0.221	0.218	0.248	0.244	0.243
Observations	1,408	1,408	1,408	1,097	1,097	1,097
Number of banks	68	68	68	54	54	54
Adj. R^2	0.217	0.218	0.215	0.245	0.240	0.239

The table shows the regression coefficients for 〖Reform〗_(c,t), concerning the reform-event time dummies, crisis period dummies, and interaction terms that combine reform date and crisis dummies, when one of our four systemic risk measures is considered as dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1. Controls are the lagged GDP growth and lagged implied volatility (VIX/V2X), but not the lagged policy rate. Fixed effects are included at the bank level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

A.8 Regression of systemic risk measures on capital ratios and reform dates with interaction terms and macroeconomic variables

To further investigate the relationship between regulatory ratios and systemic risk, both the reform-date dummy variables ($Reform_{c,t}$) explained in Section 5.2 and the regulatory capital ratios ($RegRatio_{i,t-1}$) are used along with interaction terms combining the two variables. These interaction terms provide evidence on whether the effect of the regulatory ratios on systemic risk differs between the pre- and post-reform periods which can provide additional insights on whether it was indeed the reforms that impacted systemic risk (rather than other factors that may have occurred at the same time).[7]

Macroeconomic control variables are included to account for time-varying factors at the country level. The model reads as follows

$$y_{i,t} = \alpha_i + \gamma\ Macro_{c,t-1} + \ \beta\ RegRatio_{i,t-1} + \text{ɣ}\ Reform_{c,t}\ + \delta\ Reform_{c,t}.RegRatio_{i,t-1} + \ \varepsilon_{i,t}$$

where i denotes the individual bank, c the country, and t the time period. $y_{i,t}$ is the dependent variable of interest, ie one of our four market-based measures of systemic risk (ΔCoVaR, Exposure-ΔCoVaR, MES, and SRISK). $\varepsilon_{i,t}$ is the error term.

The results are presented in Table A8 below. The coefficients on the reform-date dummy variables ($Reform_{c,t}$) are weakly statistically significant with the expected negative sign only for ΔCoVaR. The coefficients on the capital ratios are weakly significantly negative for ΔCoVaR (Tier 1 ratio) and SRISK (CET1 ratio). The coefficients on the interaction terms are mostly not statistically significant, except for the Tier1 risk-based capital reform interaction term in the MES regression. Overall, the results show that there is generally no statistically significant difference between pre- and post-reform response of systemic risk to changes in capital ratios suggesting the causal inferences cannot be drawn based on these results. Specifications that augmented macroeconomic control variables with time fixed effects and obtained similar results were also conducted.

Regression of systemic risk measures on capital ratios and reform dates with interaction terms and macroeconomic variables

Table A8

Variables	ΔCoVaR	ΔCoVaR	Exp. ΔCoVaR	Exp. ΔCoVaR	MES	MES	SRISK/Tot. Assets	SRISK/Tot. Assets
Tier 1 ratio	-0.0412*		-0.0481		-0.0115		-0.00103	
	(0.0224)		(0.0495)		(0.0553)		(0.000658)	
RBC reform date	-0.608*	-0.367	-0.261	-0.461	0.139	-0.427	-0.00355	-0.00707
	(0.304)	(0.215)	(0.770)	(0.660)	(0.949)	(0.902)	(0.0107)	(0.0120)
Interaction Tier 1 RBC reform date	-0.00341		-0.0638		-0.118*		-0.000702	
	(0.0234)		(0.0556)		(0.0642)		(0.000689)	
CET1 ratio		-0.0127		-0.0467		-0.0496		-0.00118*
		(0.0200)		(0.0495)		(0.0631)		(0.000631)
Interaction CET1 RBC date		-0.0268		-0.0548		-0.0801		-0.000490
		(0.0189)		(0.0483)		(0.0638)		(0.000816)

7 The effect of changes in the resolution framework on the sensitivity of systemic risk to capital regulation is beyond the scope of this analysis.

R^2	0.336	0.327	0.258	0.246	0.190	0.186	0.275	0.262
Observations	1,065	1,065	1,066	1,066	1,071	1,071	839	839
Number of banks	68	68	68	68	68	68	54	54
Macro controls (GDP, volatility)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The table shows the regression coefficients for $RegRatio_{i,t-1}$, $Reform_{c,t}$, and their interaction, either concerning the Tier 1 or CET1 risk-based capital ratio, when one of our four systemic risk measures is considered as a dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1. Controls are the lagged GDP and stock market volatility. Fixed effects are included at the bank level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

A.9 Impact of accounting differences on the leverage ratio

A.9.1 Evolution of the Basel III leverage ratio definition

In 2010, the Committee introduced the leverage ratio which has been deliberated and re-calibrated on several occasions over the course of the last decade. In 2014, the Committee published a revised standard,[8] which states that the exposure measure should generally follow the accounting value for all balance sheet assets – other than on-balance sheet derivative and securities financing transactions (SFT) – subject to certain provisions.[9] A bank's exposure measure should reflect the sum of the following: (i) on-balance sheet exposures; (ii) derivatives exposure; (iii) SFT exposures; and (iv) off-balance sheet items. Under the 2014 standard, the SFT exposure is calculated by taking the sum of gross SFT assets (with no recognition of accounting netting) and a counterparty credit risk (CCR) measure, defined as the current exposure without an add-on for potential future exposure (PFE) in cases where the bank is acting as a principal. In December 2017, the Committee published a finalised Basel III agreement that introduced additional refinements to the 2014 standard.[10] The 2017 standard adopted a modified standardised approach for counterparty credit risk (modified SA-CCR) for measuring derivatives exposures but maintained the 2014 standard's treatment for SFTs.

Under IFRS, offsetting of a financial asset against a financial liability is allowed when, and only when, an entity (i) currently has a legally enforceable right of set-off and (ii) intends to settle on net basis or to realise the financial asset and settle the financial liability simultaneously. The US GAAP model, while similar, provides an option to present derivative assets and liabilities subject to a Master Netting Agreement (MNA) on a net basis, even if the entity does not have a current right or intention to settle net. This position existed at the time of finalising the leverage ratio proposal and continues to date. [11]

Graph A9.1 compares the average Basel III 2017 leverage ratio (purple line) and the total accounting assets ratio (TAR) (blue line) for a balanced data set of banks, distinguishing between those banks that apply US generally accepted accounting principles (GAAP) (left-hand panel), international financial reporting standards (IFRS) (centre panel) and other national accounting standards (ONAS) (right-hand panel). The period of observation begins in H2 2017, the date at which QIS data for the Basel III 2017 leverage ratio is first available.

Up to the end of 2019, the wedge between the Basel III 2017 leverage ratio and the TAR is most pronounced for US GAAP banks, reflecting the difference in the treatment of derivatives and SFT under the leverage ratio and the US GAAP accounting standard. ONAS banks also exhibit TARs above their leverage ratio, whereas the wedge is smallest for IFRS banks. In 2020, the wedge for US GAAP banks narrows, before it widens again, indicative of a strong impact of the Covid-19 crisis on banks' derivatives and SFT positions. For ONAS banks, the wedge closes, whereas for IFRS banks, TARs move below the reported leverage ratio.

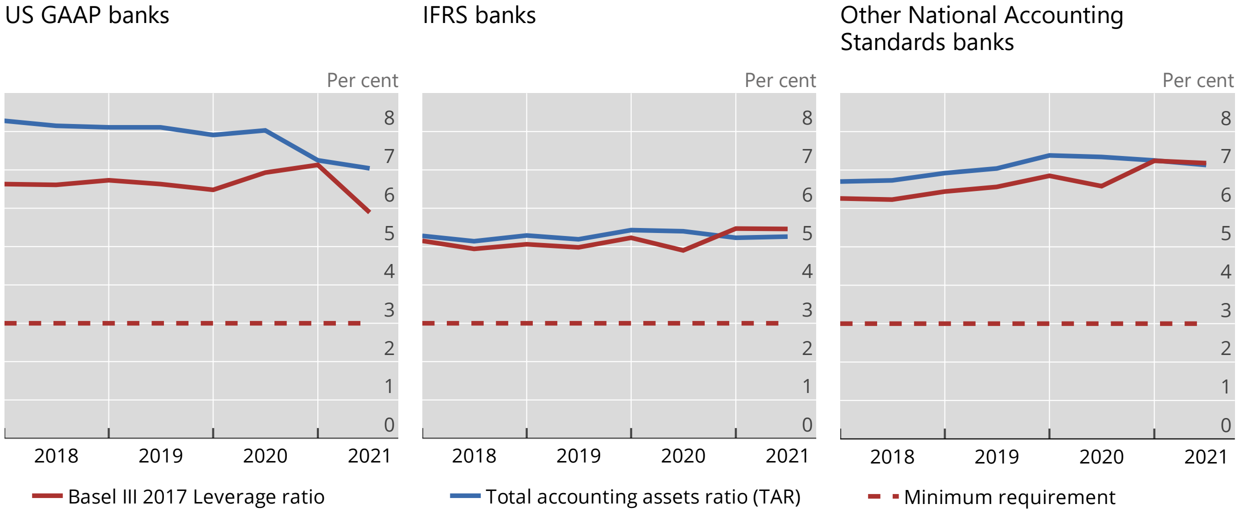
8 BCBS, *Basel III leverage ratio framework and disclosure requirements*, January 2014.

9 These provisions imply that (1) on-balance sheet, non-derivative exposures are included in the exposure measure net of specific provisions or accounting valuation adjustments (eg accounting credit valuation adjustments); and (2) netting of loans and deposits is not allowed.

10 BCBS, *Basel III: Finalising post-crisis reforms*, December 2017.

11 Under both IFRS and US GAAP, the practice is to recognise cash collateral received on the balance sheet, whereas securities received as collateral are generally off-balance sheet. Under US GAAP, the contra-liability recognised for the cash collateral received is available for offsetting against the net derivatives position, whereas under IFRS the same is generally shown on a gross basis. This position remains unchanged since the 2012 note.

Leverage ratio and total accounting assets ratio by accounting standard Graph A9.1



Source: Basel Committee on Banking Supervision.

The reduction in US GAAP banks' measured ratio when moving from TAR to the Basel III 2017 leverage ratio is indicative of regulatory adjustments reducing differences across banks that arise from netting of assets under US GAAP that is not is allowed under IFRS or ONAS.

A.9.2 Empirical analysis of the leverage ratio under different accounting standards

The empirical analysis builds on the following regression:

$$\mathrm{LR}_{it} = \alpha + \beta_1\, US\text{-}GAAP_{it} + \beta_2\, ONAS_{it} + \gamma\, X_{t-1} + \delta_t + \varepsilon_{it}.$$

LR_{it} is equal to bank *i*'s leverage ratio at half-year *t*. Two measures are compared to clarify the impact of the specific treatments in the Basel standard on the leverage ratio. The first one is the ratio of total assets to Tier 1 capital (TAR).[12] The second one is the leverage ratio (LR) based on the Basel III standards, using the 2014 definition of the LR exposure measure up to the first half of the year 2017, and the 2017 definition thereafter. The regression distinguishes three categories of accounting standards: Banks that apply IFRS represent the reference case. $US\text{-}GAAP_{it}$ is a dummy variable, equal to one for banks that apply US GAAP at time t (and zero otherwise). $ONAS_{it}$ is the corresponding dummy variable for banks that Other National Accounting Standards (ONAS). X_{t-1} comprises time-varying bank controls.[13] α is the constant term, whereas δ_t captures time fixed effects at the semiannual level and ε_{it} represents the error term.[14] The coefficients of interest are β_1 and β_2, which seek to measure whether the leverage ratio is different for US GAAP or ONAS banks, relative to banks subject to IFRS standards. The period of

12 For the purpose of this analysis, Tier 1 capital is measured based on the definition of capital as per the final Basel III standards (ie "fully-loaded" capital).

13 The dummy variables are time-variant. However, only a small number of sample banks switch to a different accounting standard during the period of observation. Bank controls comprise log total assets, six-month trailing return-on-assets, gross loans (% of total assets)), total deposits (% of total assets), interbank lending (% of total exposure), stable funding (% of total assets), wholesale funding (% of total assets) and trading book exposure (% of total exposure). The controls are lagged by one period to address any potential endogeneity concerns. For example, a bank that anticipates a significant decline in its return-on-assets (RoA) in a given half-year may decide to contemporaneously raise its LR to mitigate creditor concerns and avoid an increase in funding costs. This would bias the coefficient estimate on RoA.

14 The high correlation between banks' domicile and the choice of the accounting standard prevents the inclusion of country fixed effects. All standard errors are double clustered by bank and half-year throughout this analysis.

observation is from H1 2014 to H2 2019. It excludes the Covid-19 period and any following observations to avoid picking up any pandemic-related effects (as documented in Graph A9.1).

Table A9.2 reports the coefficient estimates of interest. Columns (1) and (2) present the estimated impact on the TAR of banks applying US GAAP or ONAS relative to the application of IFRS, while controlling for differences in bank characteristics; columns (3) and (4) do the same for the leverage ratio. Columns (1) and (3) are based on the entire period (2014–19), whereas columns (2) and (4) are based on observations as of H2 2017, when the calculation of the leverage ratio is based on the final Basel III definition for most banks.

Impact of accounting standards on total accounting assets ratio (TAR) and leverage ratio (LR)

Table A9.2

	(1)	(2)	(3)	(4)
Dependent variable:	TAR	TAR	Basel III LR	Basel III LR
US GAAP	1.604**	0.999	0.762*	0.260
	(0.548)	(0.578)	(0.411)	(0.426)
ONAS	1.554*	1.398	1.326*	1.157
	(0.758)	(0.753)	(0.693)	(0.666)
Observations	626	258	626	258
R^2	0.512	0.512	0.485	0.503
Bank controls & half-year fixed effects	Yes	Yes	Yes	Yes
Period of observation	H1 2014-H2 2019	H2 2017-H2 2019	H1 2014-H2 2019	H2 2017-H2 2019
Total exposure measure	Total assets	Total assets	Basel III LR	Basel III LR

*/**/*** indicate statistical significance at the 10/5/1% level based on robust standard errors clustered by bank and half-year (standard errors in parentheses). Bank controls comprise the first lag of the following variables: logarithm of total assets, six-month trailing return-on-assets, gross loans (% of total assets (TA)), total deposits (% of TA), interbank lending (% of total exposure), stable funding (% of TA), wholesale funding (% of TA) and trading book exposure (% of total exposure). All variables are two-sided winsorised at 1%.

Sources: Source: Basel Committee on Banking Supervision.; Fitch; SNL authors' calculations.

The results suggest that differences in the TAR observed across banks that apply different accounting standards are mitigated by the regulatory adjustments that underpin the Basel III leverage ratio. The application of US GAAP is estimated to raise the TAR by 1.6 percentage points relative to an IFRS bank. The effect is similar for ONAS. When limiting the period of observation to H2 2017 (column (2)), the impact on the TAR persists, but declines and becomes statistically insignificant which, however, could be due to the significant decline in the number of observations and the resulting loss in statistical power.

Turning to the LR, the impact of differences across accounting standards declines. For the regression based on the longer period of observation (column 3), the impact of applying US GAAP is more than halved compared with the results based on the TAR in column 1. For ONAS banks, however, the impact declines only modestly to about 1.3 percentage points. For regressions based on the shorter period of observation (column 4), the estimated impact of accounting differences declines further. It amounts to less than 0.3 percentage points for US GAAP banks, while it remains economically significant for ONAS banks at around 1.2 percentage points. While both coefficient estimates are statistically insignificant, the short period of observation represents an important caveat to draw any firm conclusions on the impact of differences in accounting standards on the leverage ratio.

Overall, the analysis suggests that the amendment of the Basel III leverage ratio standard that was finalised in 2017 is likely to have mitigated differences in banks' leverage ratios that stem from accounting differences between US GAAP and IFRS, and to a lesser extent for banks that apply other national accounting standards. This analysis is in line with the descriptive findings in Annex A9.1.

A.10 Central bank reserves leverage ratio exemption analysis

The July 2021 BCBS report examined the impact of leverage ratio on financial intermediation and expressed that the treatment of central bank reserves in the leverage ratio is one of the areas that may warrant further consideration. This section examines the relationship between central bank reserves and leverage ratio exposures over the years, and the impact of the implementation of central bank reserves exemptions in multiple jurisdictions. The assessment focuses on the experience of the six jurisdictions, where central bank reserves have been exempted from leverage ratio exposures (ie Canada, the ECB Single Supervisory Mechanism (SSM), Japan, Switzerland, the United Kingdom and the United States).

A.10.1 Growth of the share of central bank reserves to leverage ratio exposures due to quantitative easing and the impact of the pandemic

When the Committee introduced its leverage ratio framework in 2014, the share of central bank reserves to leverage ratio exposures was on average around 8% for Group 1 banks. In the following years, the average ratios of Group 1 banks have increased in the six jurisdictions to over/around 10% in Germany and the United Kingdom, and over 20% in Japan (see Table A10.1).

Central bank reserves as a share of total leverage ratio exposures — Table A10.1

	H2 2017	H1 2018	H2 2018	H1 2019	H2 2019	H1 2020	H2 2020	H1 2021
Canada	1.99	2.53	2.50	2.34	2.94	3.04	5.72	7.00
France	7.13	6.57	6.51	5.81	6.18	5.46	10.47	13.45
Germany	13.65	13.90	12.68	11.97	10.19	9.54	13.49	
Japan	21.36	22.41	22.20	20.20	19.96	19.45	20.06	21.43
Netherlands	5.05	5.81	6.78	6.18	6.32	6.00	14.73	16.02
United Kingdom	10.83	10.27	10.06	9.54	9.25	9.07	12.10	15.72
United States	5.40	5.63	5.91	5.70	5.40	5.79	8.94	9.30

Note: For H1 2020, total central bank reserves and central bank reserves eligible for deduction are data from H2 2019, as the data were not collected by the Committee for H1 2020 due to the Covid-19 pandemic.

Source: Basel Committee on Banking Supervision.

During this period, central bank reserves have increased in many jurisdictions. First, in the jurisdictions analysed, central banks enacted quantitative easing. When central banks purchase financial assets from non-bank financial institutions, and the cash obtained by these institutions is deposited at banks, the leverage ratio exposures of these banks will increase. Also, in refinancing operations, when a bank borrows against eligible collateral, the corresponding amount is credited to the bidding bank's account at the central bank. Second, during the pandemic, banks experienced aggregate deposit growth. This was attributed to a range of factors, including: (i) a "flight to quality", with funds moving out of risky assets into bank deposits; (ii) corporations drawing on commitments and re-depositing proceeds in the banking sector; (iii) reduced spending by corporations and households; and (iv) deposit creation as a result of monetary and fiscal expansion.

A.10.2 Different practices and impacts of central bank reserve exemptions

The Basel standard (LEV 30.4) allows the temporary exemption of central bank reserves from leverage exposure under exceptional macroeconomic circumstances. In 2016, the United Kingdom was the first jurisdiction to exempt central bank reserves to ensure that the leverage ratio framework would not act as a barrier to the effective implementation of a monetary policy action that would lead to an increase in central bank reserves. During the pandemic period, five additional jurisdictions exempted central bank reserves to facilitate the implementation of their monetary policies. In some jurisdictions, government bonds also were exempted to support market intermediation (Canada and the United States), and/or loans guaranteed by their government to support bank lending under specific programmes (the United Kingdom and the United States).

Jurisdictional exemptions of central bank reserves from the leverage ratio — Table A10.2.1

	Period	Exemptions	Objectives
Canada	9 Apr 2020 to 1 Apr 2023	Central bank reserves and sovereign-issued securities (the latter only until 31 Dec 2021)	Support the implementation of monetary policy measures and support bank lending and financial intermediary activities.
ECB SSM	16 Sep 2020 to 31 Mar 2022[(1)]	All eligible central bank exposures (central bank deposits, central bank reserves, coins and banknotes)	Support the implementation of monetary policy measures and lending to the real economy.
Japan	30 Jun 2020 to 31 Mar 2024	Bank deposits held at the Bank of Japan	Support the implementation of monetary policy measures and contribute to the supply of bank credit.
Switzerland	25 Mar 2020 to 1 Jan 2021	Bank deposits held at the Swiss National Bank and at foreign central banks in all currencies	Signal willingness to support the economy.
United Kingdom	Since 4 May 2020	Certain loans guaranteed by the government to SMEs;[(2)] deposit-matched central bank reserves (exempted since 2016); and liability-matched central bank reserves (exempted since January 2022)	Foster additional lending and facilitate the implementation of monetary policy.
United States	1 Apr 2020 to 31 Mar 2021	US Treasury securities; bank deposits at the US Federal Reserve;[(3)] and certain loans guaranteed by the government to SMEs;[(4)] and exposures related to the money market mutual fund liquidity facility (MMLF)	Ease the supply-demand imbalance in the US Treasury market, increase banking organisations' ability to accept the sudden influx of deposits, and facilitate certain lending programmes.

(1) The first period of the exemption was from 17 September 2020 to 27 June 2021, when the leverage ratio was not yet a binding Pillar 1 requirement (but only a reporting and disclosure requirement). The second period of the exemption was from 28 June 2021 to 31 March 2022, when the leverage ratio became a binding a Pillar 1 requirement.

(2) Loans made under the Bounce Back Loan Scheme (BBLS) in the United Kingdom and under similar European Economic Area 100% government-backed guarantee schemes are exempted. The BBLS scheme was open until March 2021, and no new EEA loans are eligible for the exclusion. These loans remain exempt and will eventually reach maturity and roll off from banks' balance sheets.

(3) Certain central bank deposits of custodial banking organisations had already been exempted in a separate rule announced on 27 January 2020.

(4) Loans that were issued under the Paycheck Protection Program (PPP) are exempted once those were pledged as collateral to the Federal Reserve's liquidity facility (PPPLF).

Source: Jurisdictional information.

Since the pandemic has created uncertainty and macroeconomic circumstances are different in each jurisdiction, the duration of such temporary measures varies. In the United Kingdom, while a sunset clause is not provided, the authorities keep the continued appropriateness of the measure under review The other jurisdictions set ending dates of the exemption measures; however, most jurisdictions extended the originally planned ending dates. For example, in Switzerland, the exemption was originally planned to end in July 2020, but was later extended to 1 January 2021. In Japan, the exemption was extended from March 2021 to March 2022, and further extended to March 2024. In the ECB SSM, the original exemption was introduced when the LR requirement was still not a regulatory requirement, and the second exemption was introduced when its requirement came into force in June 2021. Authorities that decided to end the exemption measures considered, for example, banks' capital level, economic and market conditions, and the expiration of other emergency policy measures that had been set up during the pandemic.

The materiality of leverage ratio exemptions in these jurisdictions over time is illustrated in Table A10.2.2 below. As a result of the exemptions, mean leverage ratios were 80–110 basis points higher in Japan and the Netherlands, 30–50 basis points higher in France and the United Kingdom, and less than 30 basis points higher in other jurisdictions in H2 2020 and H1 2021. While no banks would have fallen below the level of leverage ratio requirements even if exemption measures had not been introduced, the measures made some banks less leverage ratio-constrained relative to the risk-weighted requirement. For example, in Japan, six out of 19 internationally active banks were more constrained by the leverage ratio requirement before the exemption, but, after the exemption, only one of them was more constrained by the leverage ratio as of June 2020. In ECB SSM, nine out of 115 banks were more constrained by the leverage ratio requirement, but the number fell to five after the exemption as of September 2021.

Impact of central bank reserve exemption on weighted average leverage ratios — Table A10.2.2

		H2 2017	H1 2018	H2 2018	H1 2019	H2 2019	H2 2020	H1 2021
Canada	Original						4.11	4.21
	Exempted						4.18	4.28
France	Original						5.09	4.80
	Exempted						5.37	5.34
Germany	Original						4.79	-
	Exempted						5.05	-
Japan	Original						5.81	5.70
	Exempted						6.64	6.86
Netherlands	Original						6.22	5.93
	Exempted						7.22	7.08
Spain	Original						5.78	6.31
	Exempted						6.01	6.53
United Kingdom	Original	5.40	4.91	4.88	4.88	4.89	4.50	4.88
	Exempted	5.88	5.36	5.33	5.17	5.16	4.83	5.35
United States	Original						6.79	6.53
	Exempted						6.92	6.64

The table shows the impact of central bank reserve exemption on weighted average leverage ratio for leverage ratios without exemption measures, called "original", and for ratios that excludes central bank reserves from their leverage ratio exposures, called "exempted". Note that QIS was not performed for H1 2020 and the data of H1 2021 is not available for Germany.

Source: Basel Committee on Banking Supervision.

When trying to understand the effect of these exemptions, the differences in exemption design are worth noting. For example, in some jurisdictions, banks were required to disclose the impact that exemptions have had along with the ongoing leverage ratio without exemptions. Such disclosure requirements allow investors and other external stakeholders to better asses a bank's risk profile.

Furthermore, in some jurisdictions, the minimum leverage ratio requirement was increased to offset the impact of exempting central bank reserves. For example, in the EU, the leverage ratio requirement was increased such that only central bank reserves accumulated after a certain reference date are exempted. In the United Kingdom, the PRA increased the minimum leverage ratio requirement from 3% to 3.25%, which was intended to maintain the simplicity of the leverage ratio framework. No recalibration was made in Canada, Japan, Switzerland and the United States.

Characteristics of exemptions of central bank reserves from the leverage ratio

Table A10.2.3

	Recalibration of the minimum leverage ratio requirement to offset the impact of exempting central bank reserves.	**Disclosure** of the impact of leverage ratio exemption.
Canada	No recalibration.	Amount of exempted exposures (including central bank reserves).
ECB SSM	In the first exemption (until June 2021), there was no recalibration as the leverage ratio was not yet a Pillar1 requirement at the time. In the second exemption (from June 2021), banks were required to recalibrate their leverage ratio requirement so to offset the impact of the exclusion on central bank reserves that existed before the crisis period.[15] This implies that, even though all eligible central bank exposures continued to be exempted from the total exposures measure; due to the recalibration of the leverage ratio only those exposures accumulated since the beginning of the pandemic would in effect benefit from the leverage ratio relief.	Leverage ratio with exemption and leverage ratio without exemption (from September 2020). Recalibrated leverage ratio requirement (from June 2021).
Japan	No recalibration.	Amount of central bank reserves, leverage ratio exposures without exemption, leverage ratio with exemption, and leverage ratio without exemption.
Switzerland	No recalibration	Leverage ratio with exemption.
United Kingdom	The PRA increased the minimum LR requirement from 3% to 3.25% across the board. This recalibration ensures that in aggregate firms have sufficient additional capital to compensate for the exclusion of central bank reserves from the leverage exposure measure. This approach maintains the simplicity of the leverage ratio framework.	Leverage ratio with exemption and leverage ratio without exemption.
United States	No recalibration	Amount of total exempted exposures from the supplementary leverage ratio.

Source: Jurisdictional information.

15 The ECB set the "reference date" of when the exceptional circumstances are deemed to have started as 31 December 2019. This date was chosen as it was the latest quarter-end reporting date before the start of the pandemic as well as the supervisory and monetary policy measures taken in March 2020.

A.11 Descriptive statistics of the variables used for LCR and NSFR analysis

Descriptive statistics of the variables used for LCR analysis — Table A11.1

Variable	Mean	SD	Min	P25	P50	P75	Max	N
Change in LCR subcomponents as a proportion of total assets								
$(Subcomponent_{i,t}/TA_{i,t})*100 – (Subcomponent_{i,t-1}/TA_{i,t-1})*100$								
HQLA	0.463	2.748	-8.385	-0.927	0.291	1.691	9.609	2625
Level 1 assets	0.481	2.711	-7.647	-0.893	0.292	1.732	10.05	2639
Cash and reserves	0.446	2.466	-7.418	-0.568	0.127	1.243	10.01	2661
Other Level 1 assets	0.0221	2.113	-7.072	-0.824	0.000	0.922	7.885	2639
Level 2A assets	-0.0107	0.503	-2.508	-0.0893	0	0.0923	1.664	2656
Level 2B assets	0.000719	0.175	-0.769	-0.0162	0	0.0201	0.756	2643
Net outflows	0.156	2.070	-6.970	-0.794	0.128	1.073	7.568	2538
Total outflows	0.142	2.658	-10.29	-0.874	0.136	1.117	10.07	2651
Total inflows	0.00275	1.811	-7.204	-0.600	0.00136	0.631	6.709	2564
Retail deposits	0.0354	0.326	-1.199	-0.0667	0.0121	0.114	1.747	2663
Unsecured wholesale	0.0793	1.713	-5.984	-0.574	0.0285	0.712	6.371	2663
Secured wholesale	-0.0199	0.346	-1.553	-0.0322	0	0.0190	1.326	1899
Contingent funding	0.0463	0.757	-2.870	-0.0779	0	0.130	3.651	2661
Additional funding	0.00275	1.811	-7.204	-0.600	0.00136	0.631	6.709	2564
Liquidity Coverage Ratio								
LCR	156.7	62.51	0.0287	118.3	139.9	179.5	300	2990
Shortfall to a 100% LCR	2.839	10.67	0	0	0	0	99.97	2990
Surplus above 100% LCR	59.51	58.79	0	18.29	39.90	79.54	200	2990

The tables shows mean, standard deviation (SD), the minimum (Min) and the maximum (Max) as well as the 25th, 50th, and 75th percentiles of the variables used for the LCR analysis. N is the number of observations. The subcomponents of the LCR as well as the bank-specific control variables are winsorised at the 1st and 99th levels. LCR is capped at 300%.

Source: Basel Committee on Banking Supervision.

Descriptive statistics of the variables used for NSFR analysis								Table A11.2
Variable	Mean	SD	Min	P25	P50	P75	Max	N
Change in NSFR subcomponents as a proportion of total assets								
$(Subcomponent_{i,t}/TA_{i,t})*100 – (Subcomponent_{i,t-1}/TA_{i,t-1})*100$								
ASF	1.022	4.690	-9.981	-1.274	0.306	2.214	19.68	2451
Capital ASF	0.114	0.795	-2.590	-0.232	0.0591	0.398	3.188	2074
Retail & Small Bus ASF	0.0444	2.308	-9.531	-0.783	0.0540	0.906	9.045	2078
Non-Fin Corp ASF	0.0282	1.221	-5.441	-0.309	0.0187	0.453	4.613	2078
Cent Banks & Sov ASF	0.0188	1.650	-7.306	-0.270	0	0.318	7.582	2078
Financial ASF	-0.0160	1.984	-9.077	-0.681	-0.00580	0.563	8.053	2078
Other Liab ASF	-0.0695	1.721	-7.602	-0.187	0	0.126	9.442	2078
RSF	0.0236	4.454	-14.57	-1.866	-0.0515	1.669	17.20	2463
HQLA RSF	-0.00301	0.827	-3.162	-0.198	0.000937	0.187	4.170	1529
Residential Mortg RSF	0.0909	1.316	-5.126	-0.181	0	0.344	5.919	1535
Loans > 1 Year RSF	0.459	3.614	-14.88	-0.523	0.0275	0.900	20.37	1535
Loans < 1 1 Year RSF	-0.0316	1.176	-5.428	-0.307	-0.00276	0.288	5.122	1535
Financial Firm Loans RSF	0.0437	0.893	-3.027	-0.224	0	0.257	4.897	1535
Other Assets RSF	-0.591	3.683	-21.05	-1.053	-0.211	0.492	10.30	1534
Derivatives RSF	-0.0356	0.423	-1.730	-0.137	0	0.0829	1.782	1535
Off-Balance Sheet RSF	0.00921	0.145	-0.614	-0.0259	0.00229	0.0344	0.709	1535
NSFR								
NSFR	115.9	21.89	16.05	104.0	113.6	124.9	288.6	2806
Shortfall to a 100% NSFR	1.850	6.260	0	0	0	0	83.95	2806
Surplus above 100% NSFR	17.75	19.35	0	4.018	13.59	24.87	188.6	2806

The tables shows mean, standard deviation (SD), the minimum (Min) and the maximum (Max) as well as the 25th, 50th, and 75th percentiles of the variables used for the NSFR analysis. N is the number of observations. The subcomponents of the LCR as well as the bank-specific control variables are winsorised at the 1st and 99th levels. Descriptive statistics for bank control variables presented in Table LIQ1a.

Source: Basel Committee on Banking Supervision.

A.12 Materiality of Level 2A and 2B assets as a proportion of LCR HQLA and NSFR RSF

The LCR time series contain 18 end-of-semesters, from H2 2012 to H1 2021, summarised in Table A12.1.

Descriptive statistics of Level 2A and Level 2B assets as proportions of LCR HQLA

Table A12.1

Variable	Mean	SD	Min	P25	P50	P75	P95	P99	Max	N
Level 2A	0.078	0.131	0.000	0.004	0.031	0.091	0.312	0.639	1.686	3067
Level 2B	0.019	0.038	0.000	0.000	0.005	0.024	0.084	0.171	0.575	3057

The tables shows mean, standard deviation (SD), the minimum (Min) and the maximum (Max) as well as the 25th, 50th, 75th , 95th and 99th percentiles of Level 2A and Level 2B assets as proportions of LCR HQLA. N is the number of observations.

Level 2 and Level 2B proportions irrespective of LCR cap restrictions.

Source: Basel Committee on Banking Supervision.

The NSFR time series contain 16 end-of-semester, from H2 2013 to H1 2021, summarised in Table A12.2.

Descriptive statistics of Level 2A and Level 2B assets as proportions of NSFR RSF

Table A12.2

Variable	Mean	SD	Min	P25	P50	P75	P95	P99	Max	N
Level 2A	0.008	0.014	0.000	0.000	0.002	0.008	0.035	0.072	0.253	2455
Level 2B	0.008	0.014	0.000	0.000	0.002	0.009	0.034	0.062	0.196	2822

The tables shows mean, standard deviation (SD), the minimum (Min) and the maximum (Max) as well as the 25th, 50th, 75th , 95th and 99th percentiles of Level 2A and Level 2B assets as proportions of NSFR RSF. N is the number of observations.

Source: Basel Committee on Banking Supervision.

A.13 Details of HLBA analysis

The distribution of the measures of cyclicality (eg these measures for each firm in the sample) will show in the tail how much HLBA has increased for the most affected firms. The tail is important because *on average* the impact might be negligible, but some firms may be significantly more affected.

The change in LCR[16] percentage points due to an increase in HLBA using *backward-looking* LCR (not allowing for a general increase in HQLA over H1 2020) is calculated as follows:

$$\frac{HQLA_{2019\ Q4}}{Net\ Outflows_{2019\ Q4} + HLBA_{2020\ Q2} - HLBA_{2019\ Q4}} - \frac{HQLA_{2019\ Q4}}{Net\ Outflows_{2019\ Q4}}$$

HLBA has been winsorised at the 99% level as measured by HLBA as a proportion of Net Outflows. If an observation was in the 99th percentile of HLBA/Net Outflows over the entire sample period, the HLBA was replaced by the 99th percentile proportion (eg 47.7% of firm/period specific net outflows). This controls for the possibility of reporting errors and also removes genuine outliers that may skew the sample.

LCR change in percentage points due to HLBA increase (133 firms): Table A13

Split		Mean	Median	1st	5th	10th	25th
Total		-7.92	0.00	-27.96	-8.56	-5.27	-1.95
Group	1	-1.39	-0.19	-8.68	-7.89	-5.27	-2.04
	2	-16.63	0.00	-904.33	-22.78	-5.69	-0.56
Region	AM	-2.36	-0.89	-8.56	-8.22	-7.89	-4.83
	EU	-13.63	0.00	-904.33	-17.29	-5.69	-1.90
	RW	-0.52	-0.07	-3.78	-3.54	-2.44	-0.43
Committee's data set Business Model	1	-1.46	-0.12	-10.89	-8.22	-5.69	-2.78
	2	-17.27	0.00	-904.33	-4.19	-2.34	-0.52
BIS Business Model (56 firms)	R	-1.72	-0.28	-8.56	-8.56	-6.05	-3.10
	T	-3.58	-2.90	-8.22	-8.22	-8.05	-6.81
	U	-1.37	-0.29	-8.68	-7.87	-4.83	-2.72
	W	-1.96	-1.47	-5.27	-5.27	-5.27	-3.84

Source: Basel Committee on Banking Supervision.

[16] This may be dampened by banks' management decisions on HQLA (eg if a bank holds 300% LCR, the impact of HLBA increasing net outflows by 10% will be 3 LCR percentage points).

A.14 Measures of derivative portfolio size

Six measures of derivative portfolio size are used. Non-netted measures are used as these may be a better reflection of total derivatives activity (netting derivative assets and liabilities may yield a very small estimate of firms' derivative activity if they are running a balanced strategy). Both asset and liability measures are used to account for any imbalances in a firm's books.

These measures are highly correlated to each other on both a consistent and inconsistent basis with correlation coefficients between 0.85 and 1. A balanced data set fixes the population (only banks which have an observation in each time period are considered) while inconsistent allows for all banks (as long as they have two observations to correlate) to be in the sample. However, there is an exception in the unbalanced data set where the G-SIB indicator has lower correlation coefficients (between 0.55 and 0.70) with the FitchConnect indicators. This may be due to the fact that the G-SIB data use an OTC measure. The correlation between the size of the portfolio and the amount of outflows calculated via HLBA approach is not impacted by the type of derivatives (OTC vs cleared) as both produce variation margin (VM) flows.

Table A14.1

Measure	Description	Vendor
Positive replacement: derivative assets (€)	Total positive fair value derivatives as reported in the fair value breakdown of derivatives. For IFRS-compliant companies, the positive replacement value will mirror the derivative asset value on the balance sheet.	SNL
Negative replacement: derivative liabilities (€)	Total negative fair value derivatives as reported in the fair value breakdown of derivatives. For IFRS-compliant companies, the negative replacement value will mirror the derivative asset value on the balance sheet.	SNL
Notional amount of derivatives (€)	Contract value of all derivatives.	SNL
Derivatives (assets)	The positive value of in-the-money derivative contracts as reported by the entity, at fair value.	FitchConnect
Derivatives (liabilities)	The negative value of out-of-the-money derivative contracts, measured at fair value.	FitchConnect
Notional amount of OTC derivatives indicator	Notional amount of OTC derivatives.	G-SIB Public Data[17]

Within bank correlation (balanced data set – 30 banks, count of 206) Table A14.2

Correlation with HLBA:	Correlation coefficient
Positive replacement: derivative assets (SNL)	.0533
Negative replacement: derivative liabilities (SNL)	.0571
Notional amount of derivatives (SNL)	.0903
Derivatives (assets) (FitchConnect)	.0858
Derivatives (liabilities) (FitchConnect)	.0626
Notional amount of OTC derivatives indicator (G-SIB)	.0582

[17] G-SIB data are collected only on an annual basis, so this is only an annual measure. All other measures are semiannual in line with the Committee's data.

A.15 Data on debt buybacks and CCP derivative initial margins

Debt buybacks — Table A15.1

Jurisdiction (anonymised)	Materialised outflow rate	LCR impact
1	6–8%	1–5 percentage points (pp)
2[18]	10–12%	1 pp
3	12%	N/A
4	N/A	1.5 pp

Source: Jurisdictional data.

Initial margin outflows to CCPs on house positions[19] — Table A15.2

Jurisdiction (anonymised)	Increase in IM posted	LCR impact
1	Mean: 41%[20]	3.4 pp
2[21]	Mean: 51%[22]	2.7 pp

Source: Jurisdictional data.

[18] These numbers are calculated on slightly different samples. The materialised outflow rate is calculated for all of the jurisdictions' G-SIBs and certain foreign subsidiary operations. The LCR Impact number is calculated only for G-SIBs.

[19] Clearing members must satisfy calls for IM for transactions executed on their own account (eg house positions) and those executed on behalf of customers. However, IM pledged on behalf of customers is generally reimbursed by those customers. Therefore, unless the customer defaults, clearing members do not face longer-term liquidity needs related to customer IM requirements.

[20] Results varied by bank. At the consolidated level a sample of nine banks had an interquartile range between 23% and 60%.

[21] These numbers are calculated on slightly different samples. The materialised outflow rate is calculated for all of the jurisdictions' G-SIBs and certain foreign subsidiary operations. The LCR Impact number is calculated only for G-SIBs.

[22] Results varied by bank. At the consolidated level, the interquartile range is from 40% to 102% (median 76%).

A.16 Drawdown data for credit facilities by customer segment

Non-financial and public sector – 0% is applied in LCR calculation

Table A16.1

	Jurisdiction (anonymised)							
	1	2	3	4	5	6	7	8
February 2020	1.0%	-1.8%	2.5%	5.4%	0.2%	-1,9%	0.7%	0.1%
March 2020	-11.3%	-12.6%	-4.6%	-4.7%	-4.6%	-4.1%	-4.6%	-16.7%
April 2020	7.6%	0.3%	-2.2%	-0.1%	5.9%	-1,5%	-3.3%	-2.4%
May 2020	1.7%	8.7%	25.7%	2.6%	8.5%	-1.0%	3.1%	4.5%
June 2020	1.9%	6.8%	9.3%	1.9%	7.0%	-1.4%	4.0%	6.4%
July 2020	1.0%	2.3%	3.5%	4.9%	-0.4%	-1.0%	1.2%	N.A.

*drawdowns are expressed as negative numbers.

Source: Jurisdictional data.

Financial customers – 40% is applied in LCR calculation

Table A16.2

	Jurisdiction (anonymised)						
	1	2	3	4	5	7	8
February 2020	-0.5%	-3.9%	6.8%	0.5%	-1.1%	5.9%	1.9%
March 2020	-1.4%	-0.6%	-21.3%	1.9%	-6.7%	-7.2%	-8.9%
April 2020	2.5%	3.6%	18.5%	-0.1%	0.8%	6.2%	5.5%
May 2020	2.1%	13.1%	-27.7%	3.2%	3.6%	3.6%	2.2%
June 2020	-3.1%	0.7%	-11.6%	9.2%	4.2%	2.0%	4.1%
July 2020	3.0%	-0.4%	-2.4%	4.1%	-0.1%	-0.5%	N.A.

*drawdown is expressed as negative numbers

Source: Jurisdictional data.

Retail customers – 5% is applied in LCR calculation

Table A16.3

	Jurisdiction (anonymised)							
	1	2	3	4	5	6	7	8
February 2020	1.8%	-0.7%	0.5%	0.1%	93.3%	-2,6%	6.2%	-3.2%
March 2020	1.0%	-0.6%	-1.0%	2.6%	19.7%	-2,1%	12.6%	-7.6%
April 2020	1.0%	6.9%	-24.1%	-3.0%	17.6%	-1,6%	-15.3%	10.1%
May 2020	-3.6%	0.5%	32%	-0.9%	-3.6%	-2,1%	0.7%	5.4%
June 2020	2.7%	1.0%	3.9%	5.0%	9.6%	-2,6%	-0.8%	-0.9%
July 2020	0.8%	3.8%	5.7%	5.4%	-0.2%	-2,8%	2.1%	N.A.

*drawdown is expressed as negative numbers

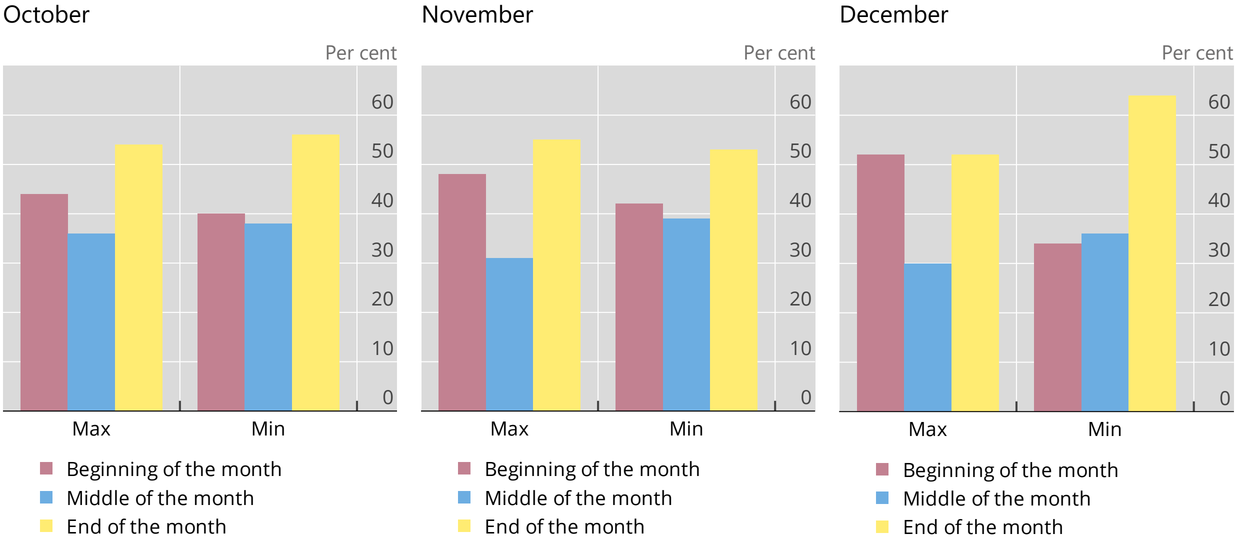
Source: Jurisdictional data.

A.17 LCR window-dressing

Data collected by the Committee covering Q4 2019 do not provide strong evidence of window-dressing of the LCR. In terms of the maximum ratio, the data for example do not show evidence of LCR ratios being systematically higher at the end of December 2019.

Number of banks that report max/min LCR at the beginning, middle or end of the month

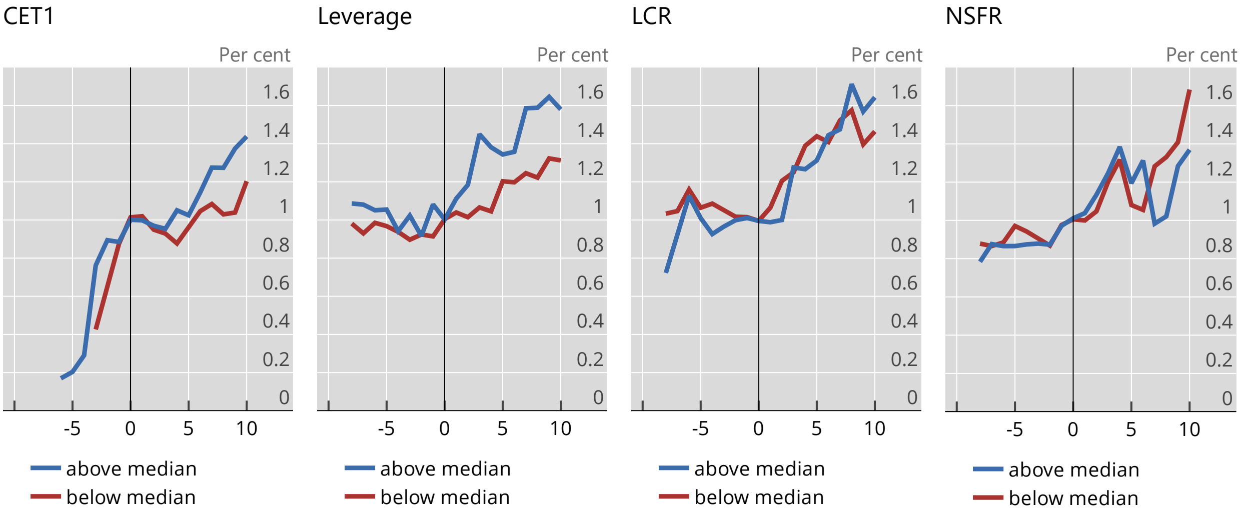
Graph A17



Source: Basel Committee on Banking Supervision.

A.18 Evolution of lending in the banks with capital and liquidity ratios above and below global medians

Evolution of lending in the groups of more and less affected banks — Graph A18



The chart shows the evolution of total lending in the group of more affected banks (red line) and the control group of banks (blue line) with regard to the CET1 ratio, leverage ratio, LCR, and NSFR. 〖Impact〗_i is measured by the individual regulatory ratio at the jurisdiction-specific draft rule publication date. Lending volume is normalised to the jurisdiction-specific draft rule publication date, and the lines display lending for a balanced data set of banks.

Source: Basel Committee on Banking Supervision.

A.19 Effects of the Basel III reforms on bank lending and cost of capital

Regression results for total lending as dependent variable, by years since global announcement date

Table A19.1

Dependent variable	Total lending			
	(1)	(2)	(3)	(4)
Reform considered	CET1	Leverage	LCR	NSFR
One year after	-0.0498***	-0.0941***	-0.0002*	-0.0011
(τ = 1)	(0.0172)	(0.0322)	(0.0001)	(0.0007)
Two years after	-0.0601***	-0.1150***	0.0000	-0.0020**
(τ = 2)	(0.0183)	(0.0356)	(0.0001)	(0.0008)
Three years after	-0.0574***	-0.0956**	0.0000	-0.0015
(τ = 3)	(0.0187)	(0.0393)	(0.0003)	(0.0012)
Four years after	-0.0605***	-0.1185***	-0.0003	-0.0014
(τ = 4)	(0.0183)	(0.0362)	(0.0003)	(0.0013)
Five years after	-0.0677***	-0.1169***	-0.0003	-0.0009
(τ = 5)	(0.0192)	(0.0379)	(0.0003)	(0.0015)
Coeff. for τ < 0	No	No	Yes	Yes
R^2 (within)	0.0891	0.1031	0.0862	0.0830
Observations	2,482	2,488	2,606	2,606
Number of banks	192	193	203	203

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when total lending is considered as dependent variable in columns (1)–(4). The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the first available observation in the data (ie H1 2011 for capital reforms and H2 2012 for liquidity reforms). Controls are the lagged GDP growth, lagged market-implied volatility (VIX/V2X), and the lagged policy rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for total lending as dependent variable, by years since jurisdictional announcement date when all reforms enter the regression jointly

Table A19.2

Dependent variable	Total lending	
CET1	Coefficients	Stand. Errors
One year after (τ = 1)	-0.001	(0.0031)
Two years after (τ = 2)	-0.0127***	(0.0042)
Three years after (τ = 3)	-0.0176***	(0.0056)
Four years after (τ = 4)	-0.0170**	(0.0074)
Five years after (τ = 5)	-0.0184**	(0.0092)
Leverage	Coefficients	Stand. Errors
One year after (τ = 1)	0.0050*	(0.0029)
Two years after (τ = 2)	0.0106**	(0.0053)
Three years after (τ = 3)	0.0244***	(0.0081)
Four years after (τ = 4)	0.0427***	(0.0143)
Five years after (τ = 5)	0.0661***	(0.0220)
LCR	Coefficients	Stand. Errors
One year after (τ = 1)	-0.0003**	(0.0001)
Two years after (τ = 2)	-0.0005**	(0.0002)
Three years after (τ = 3)	-0.0008**	(0.0003)
Four years after (τ = 4)	-0.0014***	(0.0005)
Five years after (τ = 5)	-0.0023**	(0.0010)
NSFR	Coefficients	Stand. Errors
One year after (τ = 1)	0.0004	(0.0004)
Two years after (τ = 2)	0.0013*	(0.0008)
Three years after (τ = 3)	0.0028*	(0.0015)
Four years after (τ = 4)	0.0164**	(0.0066)
Five years after (τ = 5)	0.0249***	(0.0060)
Coeff. for τ < 0	Yes	
R^2 (within)	0.3789	
Observations	2,133	
Number of banks	150	

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when all four reforms enter the regression jointly and total lending is considered as dependent variable. The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged market-implied volatility (VIX/V2X), and the lagged policy rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for total lending to retail borrowers as dependent variable, by years since jurisdictional announcement date

Table A19.3

Dependent variable	Total lending to retail borrowers			
	(1)	(2)	(3)	(4)
Reform considered	CET1	Leverage	LCR	NSFR
One year after	0.0036	0.0103**	-0.0002	0.0003
(τ = 1)	(0.0034)	(0.0045)	(0.0002)	(0.0006)
Two years after	-0.0007	0.0174	-0.0003	0.0012
(τ = 2)	(0.0070)	(0.0110)	(0.0004)	(0.0012)
Three years after	0.0066	0.0261	-0.0002	0.0026
(τ = 3)	(0.0097)	(0.0167)	(0.0007)	(0.0025)
Four years after	0.0209	0.0605	0.0001	0.0053
(τ = 4)	(0.0155)	(0.0377)	(0.0010)	(0.0068)
Five years after	0.0315	0.0705	0.0004	0.0123
(τ = 5)	(0.0215)	(0.0522)	(0.0008)	(0.0107)
Coeff. for τ < 0	Yes	Yes	Yes	Yes
R^2 (within)	0.1003	0.0949	0.0603	0.1119
Observations	2,510	2,528	2,429	2,504
Number of banks	191	191	186	185

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when lending to retail borrowers is considered as dependent variable in columns (1)–(4). The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged inflation rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for total lending to SME borrowers as dependent variable, by years since jurisdictional announcement date

Table A19.4

Dependent variable	Total lending to SME borrowers			
	(1)	(2)	(3)	(4)
Reform considered	CET1	Leverage	LCR	NSFR
One year after	-0.0158	-0.0478**	0.0008*	-0.0020**
(τ = 1)	(0.0099)	(0.0196)	(0.0004)	(0.0009)
Two years after	-0.0263*	-0.0723**	0.0004	-0.0044**
(τ = 2)	(0.0135)	(0.0278)	(0.0006)	(0.0020)
Three years after	-0.0184	-0.0882**	0.0009	-0.0074***
(τ = 3)	(0.0160)	(0.0376)	(0.0008)	(0.0028)
Four years after	-0.0216	-0.1243**	0.0011	-0.0149***
(τ = 4)	(0.0190)	(0.0525)	(0.0011)	(0.0048)
Five years after	-0.0324	-0.1853***	-0.0005	-0.0251***
(τ = 5)	(0.0245)	(0.0699)	(0.0017)	(0.0087)
Coeff. for τ < 0	Yes	Yes	Yes	Yes
R^2 (within)	0.0504	0.0746	0.0583	0.0736
Observations	2,133	2,124	2,092	2,101
Number of banks	173	175	172	167

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when lending to SME borrowers is considered as dependent variable in columns (1)–(4). The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged inflation rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for total lending to non-financial corporates as dependent variable, by years since jurisdictional announcement date

Table A19.5

Dependent variable	Total lending to non-financial companies			
	(1)	(2)	(3)	(4)
Reform considered	CET1	Leverage	LCR	NSFR
One year after	0.0031	0.0067	-0.0002	0.0009
(τ = 1)	(0.0038)	(0.0048)	(0.0003)	(0.0007)
Two years after	-0.0101*	0.0150	-0.0007**	0.0022*
(τ = 2)	(0.0060)	(0.0096)	(0.0004)	(0.0012)
Three years after	-0.0126	0.0214	-0.0008	0.0039*
(τ = 3)	(0.0094)	(0.0159)	(0.0005)	(0.0022)
Four years after	-0.0090	0.0277	-0.0011*	0.0047
(τ = 4)	(0.0112)	(0.0210)	(0.0006)	(0.0029)
Five years after	-0.0135	0.0547	-0.0016**	0.0185*
(τ = 5)	(0.0134)	(0.0479)	(0.0007)	(0.0112)
Coeff. for τ < 0	Yes	Yes	Yes	Yes
R^2 (within)	0.0384	0.0350	0.0470	0.0704
Observations	2,516	2,555	2,449	2,525
Number of banks	193	196	190	189

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when lending to non-financial companies borrowers is considered as dependent variable in columns (1)–(4). The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged inflation rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

Regression results for weighted average capital cost as dependent variable, by years since jurisdictional announcement date

Table A19.6

Dependent variable	Weighted average capital cost			
	(1)	(2)	(3)	(4)
Reform considered	CET1	Leverage	LCR	NSFR
One year after	-0.0131	-0.0083	0.0008	0.0003
(τ = 1)	(0.0096)	(0.0202)	(0.0008)	(0.0014)
Two years after	-0.0578**	0.0521**	0.0010	0.0008
(τ = 2)	(0.0220)	(0.0253)	(0.0017)	(0.0027)
Three years after	-0.1058***	0.0473	-0.0012	0.0017
(τ = 3)	(0.0316)	(0.0419)	(0.0027)	(0.0040)
Four years after	-0.1071***	0.0470	-0.0070**	0.0071
(τ = 4)	(0.0340)	(0.0502)	(0.0033)	(0.0053)
Five years after	-0.0644*	0.0637	-0.0100***	0.0127*
(τ = 5)	(0.0335)	(0.0618)	(0.0036)	(0.0072)
Coeff. for $\tau < 0$	Yes	Yes	Yes	Yes
R^2 (within)	0.3919	0.3214	0.3684	0.3625
Observations	1,229	1,157	1,184	1,211
Number of banks	69	65	66	68

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR, and NSFR when the weighted average capital cost is considered as dependent variable in columns (1)–(4). The analysis covers the years 2011 to 2019. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1, the methodology is presented in Section 3.2 $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X), and the lagged policy rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% level.

Source: Basel Committee on Banking Supervision.

A.20 Effects of the Basel III reforms on bank business models

A.20.1 Defining business models

To analyse banks' business models and their interaction with the Basel reforms, one must first precisely define "business model." Broadly, this is taken to be an attribute of a bank at a point in time, based on some combination of the bank's activities and holdings. However, there is no consensus view on the conceptual approach to assigning a business model categorisation. Moreover, given a conceptual framework, one must then obtain data on the relevant aspects of the banks to be studied; depending upon the indicators or the notion of business model under consideration, these data challenges can be significant.

Several methodologies were considered for classifying banks into business models. This search focused on methods with the following three attributes: (i) transparent and economically intuitive classification methods; (ii) methods relying on data sufficiently available to allow for the classification of enough banks in the Committee's data set for statistical analysis; and (iii) a classification with enough transitions in our sample period for statistical analysis.

These criteria apply best to the business model classification scheme from Roengpitya et al (2017), which was implemented on our data (see Section 3 for details). Roengpitya et al (2017) apply a clustering methodology to between three and eight bank balance sheet ratios in order to separate banks into four "clusters" intuitively named to correspond to the predominant activities of the bank. The authors' baseline model uses three financial ratios: gross loans, interbank lending, and wholesale debt, each as a share of assets. The baseline method classifies banks into four groups:

- Retail [funded] (R) banks have relatively high share of assets invested in gross loans and relatively low interbank lending and wholesale borrowing activity. Focusing on indicators not used in the clustering analysis, these banks also tend to have stable, deposit-heavy funding and small trading books.
- Wholesale [funded] (W) banks also exhibit high shares of gross loans and low levels of interbank lending, but are relatively reliant on wholesale debt for funding. These banks also tend to have small trading books, and lower levels of deposit funding than retail banks.
- Trading banks (T) hold a small share of total assets as gross loans, make substantial amounts of interbank loans, and are fairly reliant on wholesale debt. They also have a large share of assets in the trading book.
- Universal (U) banks lie somewhere between the others, with moderate levels of gross loans, trading book assets, interbank and wholesale market activity, and deposit funding.

This classification methodology is conceptually similar to several other business model classification approaches in the literature, though the specific data used, number of identified business models, and methods for inferring classifications from ratios varies (see, among others, Altunbas et al (2011), Ayadi et al (2016) and Mergaerts and Vander Vennet (2016)). Relative to these other papers, the Roengpitya et al method requires less detailed data (a large benefit) while still providing a transparent and intuitive classification. Unfortunately, the original Roengpitya et al (2017) classification covers relatively few QIS-reporting banks. It was also originally run on BankScope data, which were not available to TFE researchers. The number of banks in the sample that are also present in the Roengpitya et al (2017) results is limited to 50. As the Roengpitya et al (2017) algorithm is complex and requires expert judgment, it was not operationally possible to run it on all the banks in the sample. It was decided to extend the definition of Roengpitya et al (2017) business model by a simpler process based on the average values of the relevant balance sheet ratios.

To extend the classification, vendor data from Fitch were utilised and banks were tied to the closest of the original business model categories. Specifically, data were obtained on gross loans and wholesale debt as a share of assets for as many banks as possible. The third variable in Roengpitya et al (2017), namely interbank lending, was not used as the coverage of this variable is very limited. Using these two variables, bank b was assigned to the closest (least distant) cluster i, defining distance as:

$$Distance_{\{i,b\}} = \left(\frac{(Gross\ Loan\ Ratio_b - Average\ Gross\ Loan\ Ratio_i)}{StdDev(Gross\ Loan\ Ratio_i)}\right)^2 + \left(\frac{(Wholesale\ Debt\ Ratio_b - Average\ Wholesale\ Debt\ Ratio_i)}{StdDev(Wholesale\ Debt\ Ratio_i)}\right)^2$$

Finally, the expansion allowed us to assign a business model to 85 banks. The variable extension methodology erodes the stability of the business model for a given bank over time. In particular, we observe some rapid and undesirable changes (moving from one category to another, then back to the original category quickly). In order to stabilise the variable, the variable was smoothed by removing transient changes (return to the previous category in fewer than two semesters) and switching to annual data (removal of data on the first semester). Several other approaches to classification were considered. Fitch and SNL databases have pre-existing business model classifications, but these both suffer from two significant drawbacks: the methodology behind the classifications is opaque and, importantly, they are almost entirely unchanged. As such, they are not suitable for analysing changes in business models. The Committee's data collection also includes a self-reported business model indicator, but again the methodology is opaque and nearly all observations are clustered into two categories (universal and retail/commercial). Moreover, there are again few transitions between business models according to this classification; only 11% of banks ever change their business model.

The extension of the classification of banks is broadly consistent with the Roengpitya et al (2017) classification where they overlap and also with the self-reported classification in the Committee's database. Table A20.1 indicates that 84% of bank half-year observations remain in the same category (ie are concentrated on the diagonal), plus our measure classifies a number of banks not covered in the original analysis.

Repartition of bank-half-year observations by expanded business model categories and by original Roengpitya et al (2017) categories — Table A20.1

Original indicator	Expanded business model indicator					
	R	T	U	W	Unclassified.	Total
Retail-funded bank (R)	93	0	21	20	4	138
Trading bank (T)	0	92	7	0	8	107
Universal bank (U)	1	38	269	9	17	334
Wholesale-funded bank (W)	6	0	16	160	2	184
Unclassified	268	375	744	417	6454	8258
Total	368	505	1057	606	6485	9021

Source: Basel Committee on Banking Supervision.

A.20.2 Characteristics of different business models

As indicated in Table A20.2, the usual descriptive statistics of variables of interest show a large difference between the business models defined above. Universal banks are significantly larger than the others, with higher levels of CET1 capital, total assets and gross loans. Among the other three categories, trading banks are also larger than wholesale-funded or retail-funded banks, except in terms of the amount of gross loans.

Universal banks also have a higher return-on-assets (RoA) and return-on-equity (RoE) than other banks. Among the other three categories, there are no significant differences on RoA, but the average RoE of wholesale banks is higher due to the presence of high RoE at the tail end of the distribution.

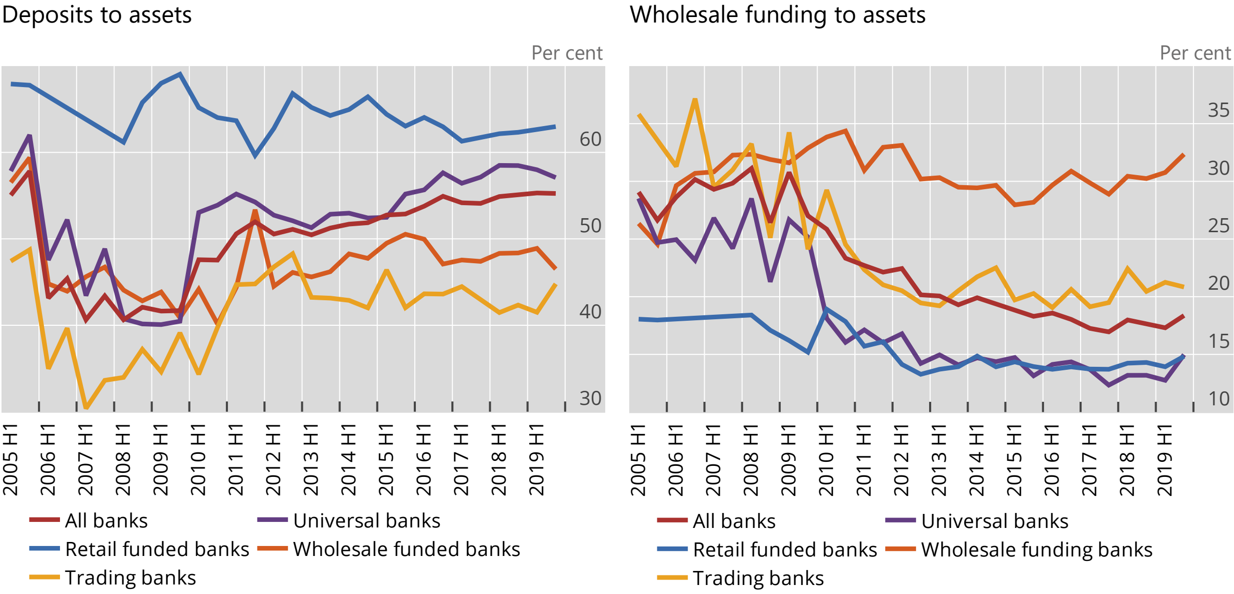
Statistics on the ratios used for clustering logically confirm the differences between business models. The gross loan ratio is higher for retail-funded and wholesale-funded banks, while the wholesale funding ratio is higher for wholesale-funded banks and to a lesser extent for trading banks. Universal banks are significantly larger than the others, with higher levels of CET1 capital, total assets and gross loans. Graph A20.2 provides some additional detail on the evolution of deposit and wholesale funding, as well as on the share of assets invested in loans or the trading book over time.

Statistics of main variables by business model category (all bank-year observations, sample fixed with banks classified in 2012) – average over 2005–19 Table A20.2

Mean of variables	Retail-funded bank (R)	Trading bank (T)	Universal bank (U)	Wholesale-funded bank (W)
CET1 (€, billions)	21.0	33.0	56.1	18.7
Yearly RoA (%)	0.52%	0.56%	0.69%	0.54%
Yearly RoE (%)	7.90%	7.98%	13.85%	11.09%
RWA density (%)	46.0%	33.0%	39.5%	35.0%
Total assets (€, billions)	374.9	806.4	931.5	388.7
Gross loans (€, billions)	230.3	218.4	436.3	258.8
Wholesale funding(€, billions)	56.9	192.2	135.5	115.4
Gross loans/Total assets (ratio, %)	0.62%	0.24%	0.47%	0.68%
Wholesale funding/Total assets (ratio, %)	0.15%	0.24%	0.16%	0.31%

Source: Basel Committee on Banking Supervision.

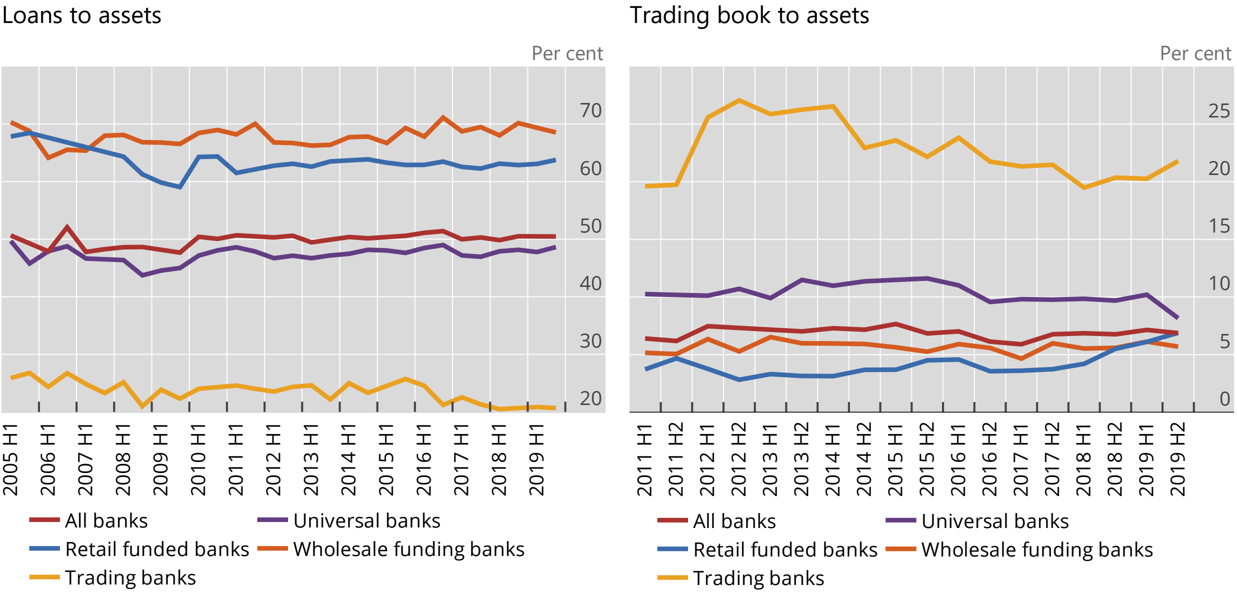
Evolution of selected balance sheet ratios Graph A20.1



Source: Basel Committee on Banking Supervision.

Evolution of selected balance sheet ratios

Graph A20.2



Source: Basel Committee on Banking Supervision.

A.21 Insights from academic literature and BCBS member survey responses on interactions within the Basel framework

A.21.1 Literature insights on interaction between capital and liquidity requirements

The literature has identified five channels through which capital and liquidity requirements can interact and thus affect the probability of crises: (i) excessive liquidity risk-taking, (ii) bank runs, (iii) contagion via interconnections, (iv) contagion via fire sales and (v) insolvency risk. These could be summarised as follows:

- **Banks' liquidity risk-taking incentives:** Acosta et al (2019), Gomez and Vo (2020) and DeYoung et al (2018) all find that, when banks' capital ratios increase, banks will adjust to reduce the degree of liquidity mismatch in their balance sheet. Therefore, higher capital requirements may also mitigate liquidity risk in that they may incentivise banks to refrain from excessive liquidity transformation.
- **Risk of bank runs:** Vives (2014) and Carletti et al (2020) broadly find that capital and liquidity requirements reduce the banks' exposure to the risk of bank runs since both offer bank creditors reassurance over the bank's ability to make good on their claims.
- **Contagion via interconnections:** Aldasoro et al (2017) find that an increase in either capital or liquidity requirements can reduce interbank loans, which help to lessen the scope of contagion via interconnectedness. They also find that liquidity requirements are more efficient than capital requirements in dealing with liquidity-driven runs. This in turn means that the interaction between two requirements with respect to this source of financial stability is imperfect since their efficiency is different.
- **Contagion via fire sales:** Aldasoro et al (2017) find that, while an increase in liquidity requirements will reduce the scope of contagion via fire sale, an increase in capital requirements will increase the likelihood of this type of contagion.
- **Insolvency risk:** Eisenbach et al (2014) and Koenig (2015) suggest that, since liquid assets have lower return than illiquid assets, higher liquidity requirements could undermine banks' solvency if their impact on banks' profitability is significant. This in turn indicates that two requirements may have conflicting interactions since they affect the insolvency risk in an opposite direction.

In relation to the impact of the interactions on banks' provisions of financial services, the literature to date has focused primarily on the individual impact of capital or liquidity requirements on the cost and the volume of lending. Using a calibrated model, some papers (DeNicolo et al (2014), Behn et al (2019), and Covas and Driscoll (2014)) find that adding liquidity requirements to capital requirements leads to a larger reduction in lending to non-financial sectors. These papers, however, do not assess the effect on lending of using both requirements as compared with the sum of the individual effects of each requirement. Kim and Sohn (2017) use a sample of US commercial banks to examine empirically how banks' liquidity levels affect the relationship between bank capital and lending. They find that for large banks, and in particular during the 2007–10 financial crisis period, the effect of an increase in capital ratio on credit growth becomes positive when banks retain sufficient liquid assets.

A number of more recent papers (eg Boissay and Collard (2016), Adrian and Boyarchenko (2018), Ikeda (2018) and Kara and Ozsoy (2020)) constructed a model to analyse the overall net benefits of the coexistence of capital and liquidity requirements. All conclude that, overall, both requirements allow regulators to attain a level of stability with the least long-term costs to the real economy.[23]

A.21.2 Literature insights on interaction between risk-based capital and leverage ratios

A first strand of the literature argues that the leverage ratio and the risk-based capital ratio are complementary since they behave differently over the cycle. Brei and Gambacorta (2014) find that the leverage ratio is significantly more countercyclical than the risk-based capital ratio. As a result, the leverage ratio would be a tighter constraint for banks in booms and a looser constraint in recessions.

A second strand of the literature argues that the leverage ratio and the risk-based capital ratio are complementary because they reinforce each other by covering risks that the other is less able to capture. The leverage ratio serves as a backstop measure by containing aggregate risk and protecting against rare (and highly correlated) losses in the financial system that are not fully covered under the risk-based capital framework (Grill et al (2017)).

A third strand of the literature explains that the combination of the leverage ratio and the risk-based capital ratio can provide additional benefits in terms of bank distress. For example, Fender and Lewrick (2015) show that the combination of the two ratios provides a signal of stronger quality with regard to future bank distress than would each ratio considered separately. Some authors suggest that a bank constrained only by the leverage ratio could be incentivised to shift its balance sheet towards riskier assets to earn more income. For example, Kiema and Jokivuolle (2014) note that the leverage ratio might induce banks with low-risk lending strategies to diversify their portfolios into high-risk loans until the leverage ratio is no longer the binding capital constraint. On the other hand, Acosta-Smith et al (2018) conclude that "the negative impact of increased risk-taking induced by a leverage ratio should be outweighed by the beneficial impact of increased loss-absorbing capacity" from having a leverage ratio. Their empirical model suggests that "a leverage ratio should be beneficial for financial stability by significantly reducing the distress probability of highly leveraged banks." The risk-based capital standards, if appropriately calibrated, should also limit such risk-taking.

A.21.3 Insights from the BCBS member survey

The majority of respondents indicated that they have not observed material evidence that the implementation of the LCR and NSFR in their respective jurisdictions had an impact on banks' compliance with risk-based capital and leverage ratio requirements (or vice versa). Some jurisdictions also cited a lack of evidence on this question to support any conclusion at this stage with some elements of the Basel standards yet to be implemented (eg the leverage ratio). Those respondents indicated there had been some observable interactions highlighted: (i) that the build-up of HQLA to meet the LCR may have helped banks to meet capital requirements; (ii) that banks' efforts to meet capital requirements may have also helped them to comply with the NSFR; and (iii) some banks may have optimised their approach to building HQLA in a manner that avoids increasing their leverage exposure.

[23] That is due to two key reasons: First, although for some risks, the two requirements can have similar impacts, their efficiency in dealing with those risks is different. Second, the two requirements together can achieve the same level of stability with less stringent calibrations for each than otherwise, which in turn will help to reduce the opportunity costs to the real economy in foregone or higher-cost provision of services.

A.22 Assessment of differences between the LCR and NSFR

To assess the relation between the LCR and the NSFR, as a first step, a decomposition of a bank's asset and liabilities can be performed in three parts, as follows:

(i) LCR HQLAs and inflows, and LCR outflows: composed of the short-term monetisable (liquid) assets and runnable liabilities of the balance sheet, with a maturity of less than one month, as required by the LCR;

(ii) "Additional Monetisable Assets" and "Additional Runnable Liabilities": composed of those additional assets and liabilities recognised in the NSFR, but not in the LCR, and captured by the calibration differences between both requirements; and

(iii) NSFR RSF and NSFR ASF: composed of assets that cannot be monetised (illiquid) and liabilities that are not expected to run (stable funding), as required by the NSFR.

While this decomposition is conceptually simple and clear, in practice, it is not as trivial to compare the LCR and NSFR, and a reconciliation is needed due to the slightly different logic around which each standard is structured. Once the balance has been decomposed, the requirements should be reconciled to make the comparison between the weighting factors of the requirements. As the requirements were designed using an inverse logic between them, the weighting factor comparisons could be done by inverting the LCR weights (1 – LCR weight) and evaluating the difference between the NSFR requirements and the inverted LCR requirements. For example, an 85% LCR inflow rate would be inverted to a 15% RSF comparable factor (RSF comparable factor = 1 – LCR inflow rate). This would allow for a simple but practical comparison of the weighting factors and, ultimately, between the weighted amounts of the requirements.

For example, regarding part (i) and (iii) of the decomposition described above, if a bank's balance sheet includes $100 million in "less stable" term deposits (uninsured) with a maturity of less than one month, this amount would be decomposed into $10 million in "*LCR outflows*", $90 million in "*NSFR ASF*", and 0 would be included in "A*dditional Runnable Liabilities*", as the inverted LCR requirement would be equivalent to the NSFR ASF weight.

ASF comparable factor = 1 – *LCR outflow factor* = 1 – 10% **=** 90% = ***NSFR ASF factor***

As a second example, regarding part (ii) of the decomposition, assuming a bank´s balance sheet includes $100 million in "stable" term deposits with a maturity of less than one month (eligible for a 3% run-off rate in the LCR) this amount would be decomposed into $3 million in "*LCR outflows*", $95 million in "*NSFR ASF*", and the remaining $2 million would be included in "*Additional Runnable Liabilities*", as the inverted LCR requirement (ASF comparable factor) would not be equivalent to the NSFR ASF weight, implying a calibration difference of 2 percentage points between requirements.

ASF comparable factor = 1 – *LCR outflow factor* = 1 – 3% = 97% **≠** ***NSFR ASF factor*** = *95%*

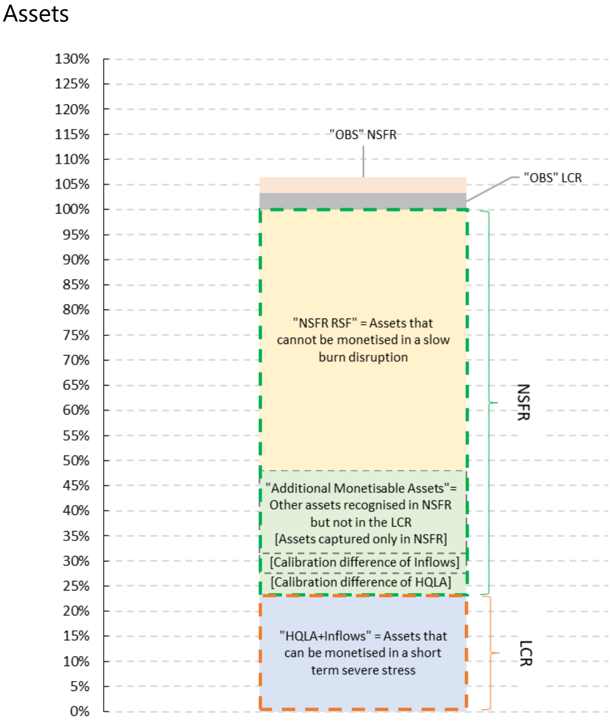
⇨ Calibration difference = 2%

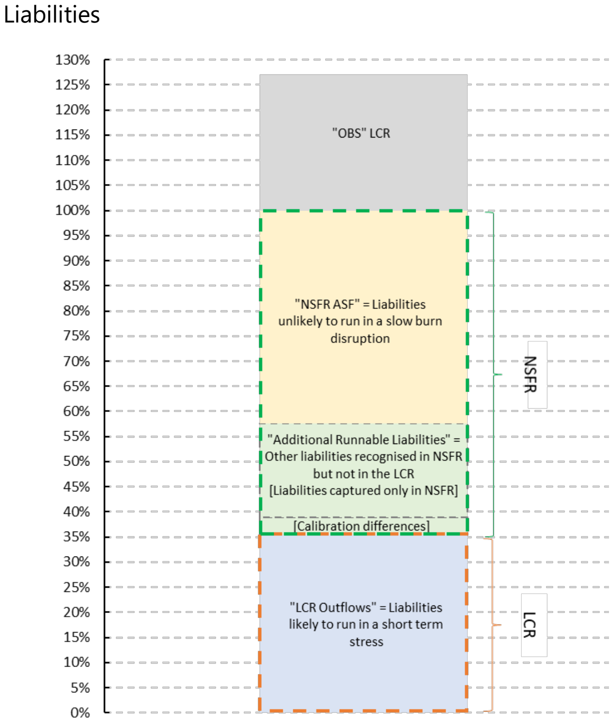
These examples illustrate in a simple manner how the balance sheet decomposition would be carried out, both for assets and liabilities, and give an idea about what elements make up each of the three parts of the balance sheet decomposition.

The main differences between the LCR and the NSFR are driven by the scope of additional assets and liabilities captured only by the NSFR (ie with a maturity of more than one month) and not by calibration differences for items with a maturity of less than one month (Graph A22.1). This suggests that the NSFR captures additional risks not covered by the LCR and so is not redundant. However, looking only in the maturity within 30 days (decomposition of the calibration differences can be observed in Graph A22.2), it can be observed that although on the liabilities side the ASF NSFR rates are smaller than those of the inverted LCR outflows rates (implying that the NSFR is stricter in the liabilities side), the RSF NSFR rates on the assets side are also smaller than the inverted LCR inflows and HQLA rates (implying that the NSFR is less strict in the assets side). Furthermore, comparing those differences (the size of the buckets), it can be observed that overall, for the short-term assets and liabilities, the NSFR is less restrictive than the LCR.

Conceptual comparability of requirements

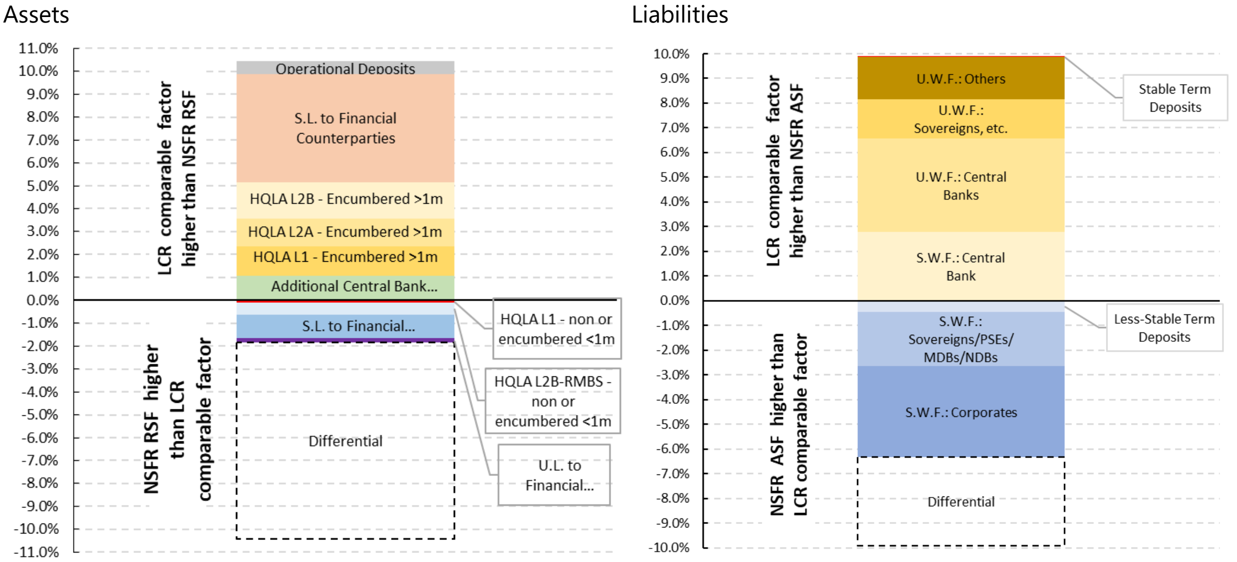
Graph A22.1





Note: The boxes depict the actual conceptual proportion that each element represents with respect to the total elements that compose each side of the balance sheet. "OBS" denote the off-balance sheet assets and liabilities, accordingly, recognised in either requirement. The regression methodology proposed in Kripfganz (2016) was used.

Decomposition of calibration differences between LCR and NSFR | Graph A22.2



Note: LCR comparable factors were calculated by inverting the LCR weights (1 – LCR weight). Subsequently, the difference was evaluated between the comparable (inverted) LCR factor and the NSFR requirements. Regarding the abbreviations: "S.L." stands for Secured Lending; "U.L." stands for Unsecured Lending; "S.W.F" stands for Secured Wholesale Funding; and "U.W.F" stands for Unsecured Wholesale Funding.

Source: Basel Committee on Banking Supervision.

Empirical analysis

To empirically assess the differences between the LCR and NSFR, the balance sheet decomposition was performed using data from the Committee for a balanced data set composed of 34 banks, from 12 jurisdictions, which reported information on each of the available biannual periods (Q2 and Q4) from Q2 2016 to Q2 2021 (11 periods in total).

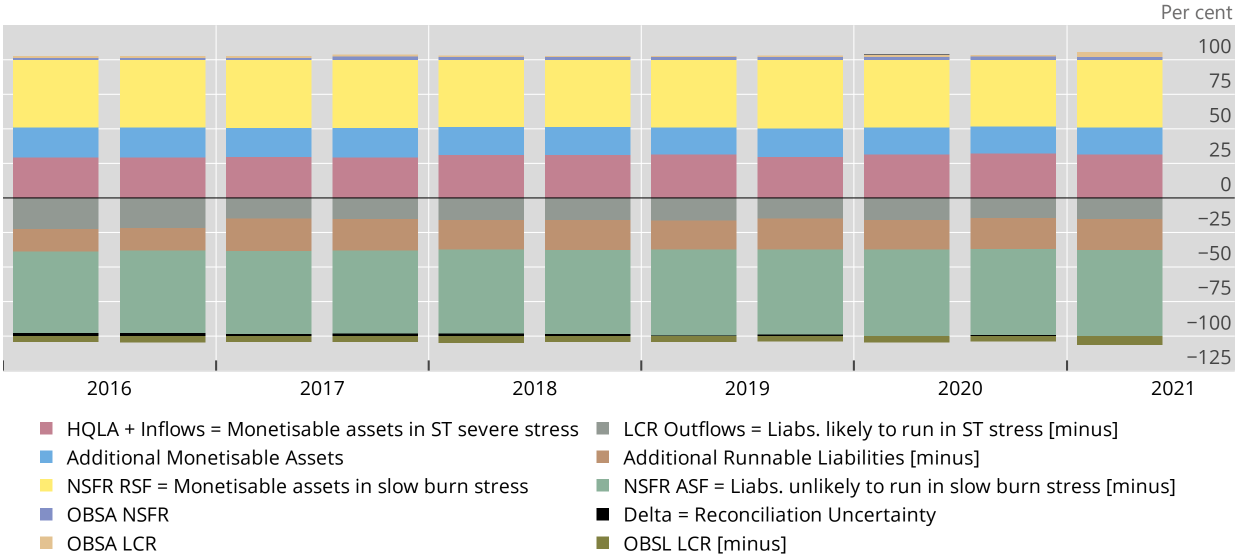
When leaving aside the OBS items, the differences between the LCR and NSFR lead us to conclude that (i) they are not redundant; (ii) the NSFR covers additional elements of the balance sheet in comparison with the LCR (LCR assets and liabilities represent a median of 23% and 11% of total assets, respectively); (iii) the NSFR can still be satisfied with elements in an horizon greater than 30 days only, without this implying that it is addressing short-term mismatches; and (iv) when looking at mismatches within the 30 days horizon, there is no consistency across banks to determine which requirement is more stringent.

The findings mentioned before hold for all types of bank business model considered in this sample (comprising 21 banks classified as "universal banking" and 13 banks classified as "retail/commercial banking"). However, the proportions show some differences between types of bank, where the additional monetisable assets represent a median of 22% and 16% of total assets for universal and retail/commercial banks, respectively; and the additional runnable liabilities represent a median of 20% and 23% of total assets for universal and retail/commercial banks, respectively (Graphs A22.4 to A22.7). These differences can be explained by those elements only captured by the NSFR, which are consistently larger on the assets side for universal banks as compared with retail/commercial ones (median of 20% and 15.8%, respectively); and the contrary is observed on the liabilities side (median of 16% and 23%, respectively) (Graphs A22.4 to A22.6). Regarding the calibration differences between requirements (elements within 30 days horizon), these are consistently larger on the liabilities side for universal banks as compared with retail/commercial ones (median of 2.9% and –0.3%, respectively), which is mainly explained by unsecured wholesale funding from sovereigns/PSEs/MDBs/NDBs and non-financial corporates.

Therefore, it can be concluded that, for universal banks, the NSFR captures additional risks not covered by the LCR in the assets side in a greater amount as compared with retail/commercial banks, and the opposite can be inferred from the liabilities side. Additionally, it is important to underscore that the negative calibration differences in liabilities between requirements observed for retail/commercial banks could be interpreted as the LCR being more stringent as compared with the NSFR for those liability components covered by both requirements, in contrast to what can be observed for the universal banks, for which the opposite can be inferred (Graphs A22.8 to A22.9).

Balance sheet decomposition for LCR and NSFR differences, weighted average bank

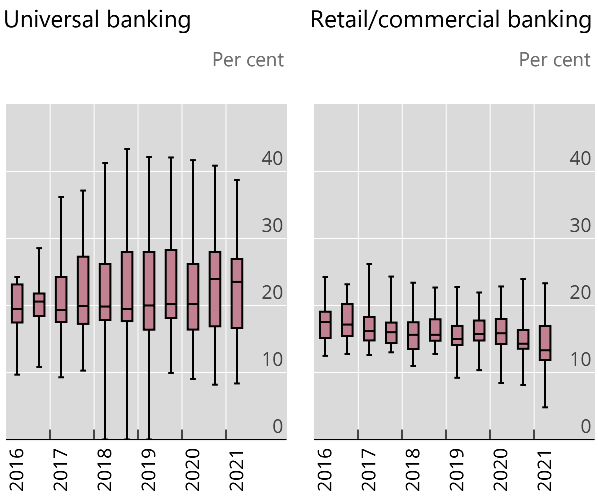
Graph A22.3



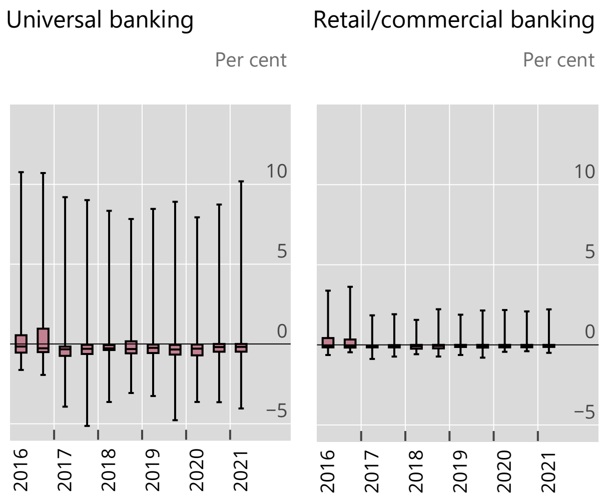
Note: Figures represent the weighted average by accounting total assets reported for each period.

Source: Basel Committee on Banking Supervision.

Distribution of additional monetisable assets: difference of scope (>1m), by type of business model — Graph A22.4

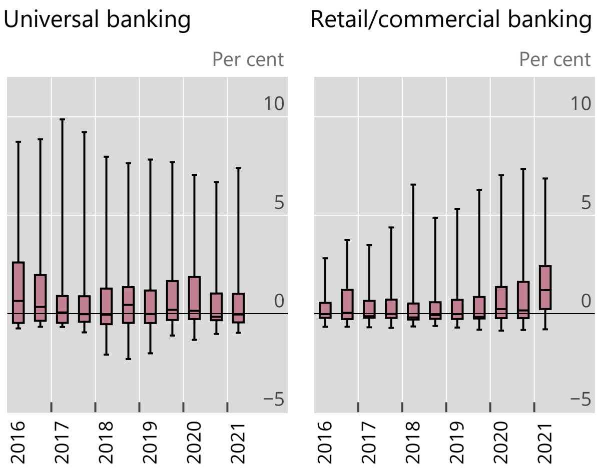


Distribution of additional monetisable assets: difference of calibration of inflows (<1m), by type of business model — Graph A22.5

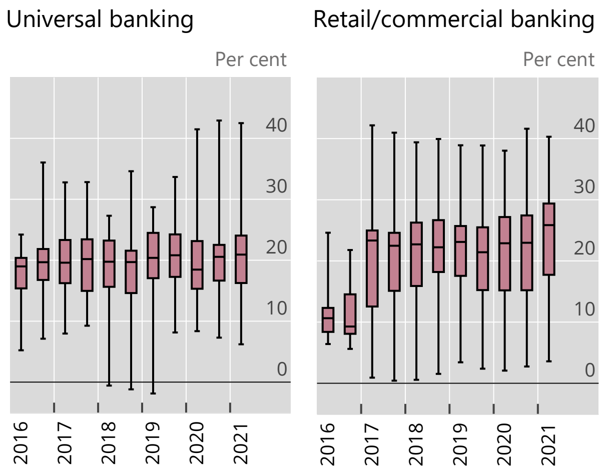


Source: Basel Committee on Banking Supervision.

Distribution of additional monetisable assets: difference of calibration for HQLAs, by type of business model — Graph A22.6



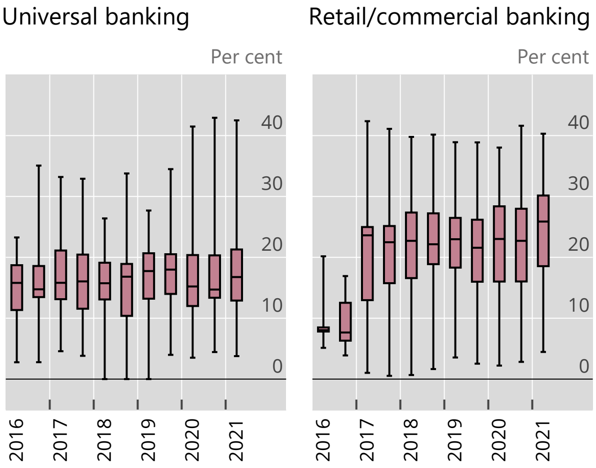
Distribution of additional runnable liabilities, by type of business model — Graph A22.7



Source: Basel Committee on Banking Supervision.

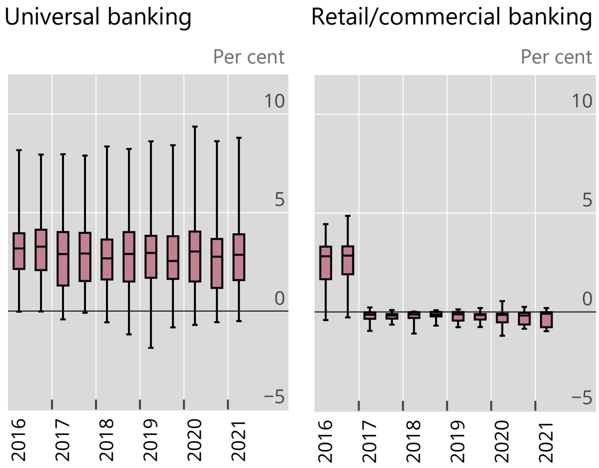
Distribution of additional runnable liabilities: difference of scope (>1m), by type of business model

Graph A22.8



Distribution of additional runnable liabilities: difference of calibration (<1m), by type of business model

Graph A22.9



Source: Basel Committee on Banking Supervision.

A.23 Description of a simplified balance sheet model

Cecchetti and Kashyap (2018) express the LCR and NSFR in terms of the balance sheet as follows:

Assets	**Liabilities**
- Reserves/HQLA (*R*) - On-balance sheet risky assets (*A*)	- Liabilities with residual maturity of less or equal to 30 days or subject to a run-off rate (*D*) - Liabilities with residual maturity greater than 30 days (*B*)
	Equity (*E*)
- Off-balance sheet assets (*OBSA*)	

Based on the definition of the LCR, Cecchetti and Kashyap (2018) use the following expression for the LCR:

$$R \geq \alpha D + \omega\theta A$$

where the parameter α is the weighted average of the LCR run-off rates applied to the runnable liabilities (*D*); ω is the weighted average of the run-off rate on off-balance sheet items (*OBSA*), and ϴ is the proportion of off-balance sheet assets (*OBSA*) to on-balance sheet risky assets (*A*).

On the other hand, the NSFR is expressed as:

$$\eta^B B + \eta^D D + E \geq \beta A$$

Where the parameters η^B and η^D are the weighted averages of the NSFR's available stable funding factors for the liabilities with residual maturity greater than 30 days (B) and the runnable liabilities (D), respectively, and β is the weighted average of the required stable funding factors applied to the risky assets (A).

These parameters correspond to the weighted average of the weighting factors established in the regulatory requirements by the relative importance of each one of the components for each bank and in each period. Specifically, these parameters are estimated by taking the sum of the different elements for each on- and off-balance sheet component (D, B, A and OBSAs) multiplied by either their run-off factor, inflow factor, ASF factor, or RSF factor, accordingly. This "weighted sum" is then divided by the unweighted sum of each component.

For example, α, ω, β, η^B and η^D are computed, for a given point in time, as follows:

$$\alpha = \frac{\sum_s f_s D_s}{\sum_s D_s}; \quad \omega = \frac{\sum_s f_s OBSA_s}{\sum_s OBSA_s}; \quad \beta = \frac{\sum_s f_s A_s}{\sum_s A_s}; \quad \eta^B = \frac{\sum_s f_s B_s}{\sum_s B_s}; \quad \eta^D = \frac{\sum_s f_s D_s}{\sum_s D_s}$$

where the numerator is the sum of every specific element of the balance sheet (D, B, A and OBSAs) multiplied by their specific run-off/inflow/ASF/RSF factor (f_s), and the denominator is the sum of each one of these elements of the balance sheet.

The restrictions assumed by Cecchetti and Kashyap (2018) for the LCR and NSFR do not reflect the real limits and potential interactions imposed by the requirements. In particular:

- The methodology assumes that HQLAs do not have a haircut; therefore, for our proposed model, *R* was set as the value of liquid assets after the haircut.
- The LCR restriction does not consider the cash inflows in the right side of the equation; therefore, in our model the cash inflows were subtracted from the cash outflows, expressing them as: $\eta^i(A + R)$, where the parameter η^i is the average of the LCR inflow rates on total on-balance sheet assets.
- The LCR restriction assumes that cash outflows either come from liabilities with residual maturity of less or equal to 30 days (*D*) or from off-balance sheet assets (*OBSA*). However, according to the Basel III LCR standard, there are other bank operations considered as outflows that are neither

on-balance sheet liabilities nor off-balance sheet assets. Some examples are: outflows from derivatives operations programmed to occur over the next 30 days, the look-back approach etc. Therefore, these operations were categorised as off-balance sheet assets and were included in *OBSA*.

- The NSFR restriction in this model assumes that the RSF comes only from on-balance sheet risky assets. However, according to the Basel III NSFR standard, there are some HQLA that receive an RSF factor. Therefore, the parameter β is now being considered as the average required stable funding over the total on-balance sheet assets (*A* + *R*) and not only over on-balance sheet risky assets.

Therefore, with the aim for the model and the implied limits to correspond to 100% of the real value of the liquidity requirements, the sum of A and R (risky assets and HQLA) is added where applicable, and the cash inflows are also included, as a proportion of A and R. In this way, the objective of the model is establishing the LCR and NSFR in the same terms, allowing direct comparisons to be made between them. Thus, the expression of the LCR and NSFR requirements are modified as follows:

LCR: $$R \geq \alpha D + \omega\theta(A+R) - \eta^i(A+R)$$

NSFR: $$\eta^B B + \eta^D D + E \geq \beta(A+R)$$

After the above-mentioned adjustments to the model, classifying liabilities into runnable liabilities (*D*) and liabilities with residual maturity greater than 30 days (*B*), using the balance sheet identity (*A* + *R* = *D* + *B* + *E*) and normalising all balance sheet variables to equity (*E*=1). The LCR and NSFR restrictions are given by the following adjusted model, **Model 1:**

LCR:

$$\boldsymbol{D} \leq \frac{(1+\eta^i - \omega\theta)}{\alpha}\boldsymbol{R} - \frac{(\omega\theta - \eta^i)}{\alpha}\boldsymbol{A} \qquad (1)$$

NSFR:

$$\boldsymbol{D} \leq \frac{(\eta^B - \beta)}{(\eta^B - \eta^D)}(\boldsymbol{A}+\boldsymbol{R}) + \frac{(1-\eta^B)}{(\eta^B - \eta^D)} \qquad (2)$$

However, Model 1 also has an additional drawback, as there is independence between the liabilities subject to a run-off rate (D) and all other liabilities (B); that is, one can adjust one without necessarily adjusting the other one. Thus, in order to correct this drawback, and incorporate the observations above, an alternative model was proposed, based on expressing the LCR as follows:

$$R \geq \Omega P + \omega\theta(A+R) - \eta^i(A+R)$$

Where *P* are total on-balance sheet liabilities, the parameter Ω is the weighted average of the LCR run-off rates on total on-balance liabilities, and Θ is the proportion of off-balance sheet assets (*OBSA*) to total on-balance sheet assets (*A* + *R*), instead of just to risky assets (A). As mentioned before, $\eta^i(A+R)$ is the expression used to represent the LCR inflows.

Furthermore, the NSFR restriction is now being expressed as:

$$\eta^B P + E \geq \beta(A+R)$$

Where the parameter η^P is the weighted average of the NSFR available stable funding over the total on-balance sheet liabilities (*P*).

After defining the modified LCR and NSFR equations, following the methodology of Cecchetti and Kashyap (2016), the balance sheet identity was used (*A* + *R* = *P* + *E*) and the values were normalised to equity (*E*=1). This allowed us to rewrite LCR and NSFR restrictions as the following model, **Model 2**:

All bold characters (***P***, ***A*** and ***R***) represent quantities that are measured relative to equity.

LCR:

$$\boldsymbol{P} \leq \frac{(1+\eta^i - \omega\theta)}{\Omega}\boldsymbol{R} - \frac{(\omega\theta - \eta^i)}{\Omega}\boldsymbol{A} \tag{3}$$

NSFR:

$$\boldsymbol{P} \leq \frac{(1-\beta)}{(1-\eta^P)}(\boldsymbol{A}+\boldsymbol{R}) \tag{4}$$

In addition to the parameters described before, the parameters η^P and Ω are computed as follows

$$\eta^P = \frac{\sum_s f_s P_s}{\sum_s P_s}; \qquad \Omega = \frac{\sum_s l_s P_s}{\sum_s P_s},$$

where the numerator is the sum of every element of on-balance sheet liabilities (P_s) multiplied by their specific ASF factor (f_s) and LCR run-off rates (l_s), respectively, and the denominator is the sum of all on-balance sheet liabilities (P_s).

Empirical analysis and main findings

To evaluate the models empirically, Models 1 and 2 were calibrated using Committee's data with a balanced data set of 70 banks, from 17 jurisdictions, which reported information on each of the available biannual periods (Q2 and Q4) from 2017 Q2 to 2021 Q2 (nine periods in total). The results suggest that redundancy does not hold for banks in the data. For some banks the binding requirement is the LCR whereas for other banks it is the NSFR, but in most cases the binding requirement changes over time for the same bank. Although variations in the results can be observed depending on the model employed, for most banks both the LCR and the NSFR are the binding requirements along the periods analysed, regardless of the framework used. Nevertheless, regarding the differences between models, it can be observed that, over time, 97% of the banks are bound both by the LCR and NSFR in Model 1; while, in Model 2, over time 47% of banks are bound by both requirements and 31% of banks are bound only by the NSFR in all reporting periods.

This follows because the two models lead to different restrictions for the LCR and NSFR. While one model imposes the restrictions on total liabilities, the other model does it over short-term runnable liabilities, which is relevant because the LCR focuses on short-term liabilities and the NSFR considers all liabilities. This constitutes a type of robustness test in which, even when changing the model and, therefore, the restricted variable (total- or short-term liabilities), the conclusions remain consistent for most of the banks in the sample in which the binding requirement changes over time, constituting additional evidence that there is no redundancy between the LCR and the NSFR. Main findings can be observed in the Tables A23.1 to A23.4:

Sample statistics (**Overall**) — Table A23.1

	Model 1		Model 2	
Total number of banks in the sample	**70**	**100%**	**70**	**100%**
Number of banks for which binding requirement was the LCR for all reporting dates	1	1%	15	21%
Number of banks for which binding requirement was the NSFR for all reporting dates	1	1%	22	31%
Number of banks bound both by the LCR and the NSFR	68	97%	33	47%
Banks bound by the LCR most of periods (>60% periods)	3	4%	26	37%
Banks bound by the NSFR most of periods (>60% periods)	3	4%	34	49%
Banks bound by both requirements	64	91%	10	14%
Banks bound by the LCR most of periods (>70% periods)	3	4%	22	31%
Banks bound by the NSFR most of periods (>70% periods)	2	3%	31	44%
Banks bound by both requirements	65	93%	17	24%

Source: Basel Committee on Banking Supervision.

Sample statistics (**Jurisdictions**)				Table A23.2
	Model 1		Model 2	
Total jurisdictions in the sample	**17**		**17**	
Number of jurisdictions for which for all banks the binding requirement was the LCR for all reporting dates	0	0%	0	0%
Number of jurisdictions for which for all banks the binding requirement was the NSFR for all reporting dates	0	0%	3	18%
Jurisdictions with at least a bank bound by both requirements	17	100%	14	82%

Source: Basel Committee on Banking Supervision.

Sample statistics (**"Universal banking" banks**)				Table A23.3
	Model 1		Model 2	
Total "Universal banking"" banks in the sample	**43**		**43**	
"Universal banking" banks always bound by LCR	0	0%	12	28%
"Universal banking" banks always bound by NSFR	0	0%	13	30%
"Universal Banking" Banks bound by both requirements	43	100%	18	42%
"Universal banking" banks bound by the LCR most of periods (>60% periods)	2	5%	17	40%
"Universal banking" banks bound by the NSFR most of periods (>60% periods)	2	5%	19	44%
Banks bound by both requirements	39	91%	7	16%
"Universal banking" banks bound by the LCR most of periods (>70% periods)	2	5%	15	35%
"Universal banking" banks bound by the NSFR most of periods (>70% periods)	1	2%	17	40%
Banks bound by both requirements	40	93%	11	26%

Source: Basel Committee on Banking Supervision.

Sample statistics (**Retail/commercial banks**)				Table A23.4
	Model 1		Model 2	
Total "Retail/commercial" banks in the sample	**27**		**27**	
"Retail/commercial" banks always bound by LCR	1	4%	3	11%
"Retail/commercial" banks always bound by NSFR	1	4%	9	33%
"Retail/commercial" banks bound by both requirements	25	93%	15	56%
"Retail/commercial" banks bound by the LCR most of periods (>60% periods)	1	4%	9	33%
"Retail/commercial" banks bound by the NSFR most of periods (>60% periods)	1	4%	15	56%
Banks bound by both requirements	25	93%	3	11%
"Retail/commercial" banks bound by the LCR most of periods (>70% periods)	1	4%	7	26%
"Retail/commercial" banks bound by the NSFR most of periods (>70% periods)	1	4%	14	52%
Banks bound by both requirements	25	93%	6	22%

Source: Basel Committee on Banking Supervision.

A.24 Correlation between the LCR and the NSFR

Cross-sectional correlation at each half-year

Table A24:

Date	All reporting banks		Correlation of the LCR and the NSFR (balanced data set)
	Correlation of the LCR and the NSFR (1)	Number of banks (2)	(3)
H2 2012	37.3%	213	26.9%
H1 2013	35.9%	216	27.9%
H2 2013	40.5%	199	33.0%
H1 2014	40.8%	200	40.1%
H2 2014	25.8%	186	46.8%
H1 2015	56.7%	153	59.2%
H2 2015	52.8%	157	60.7%
H1 2016	37.4%	150	67.8%
H2 2016	33.0%	150	71.8%
H1 2017	45.6%	148	78.6%
H2 2017	54.1%	158	80.1%
H1 2018	48.3%	164	79.6%
H2 2018	39.8%	157	78.4%
H1 2019	42.7%	156	79.4%
H2 2019	34.7%	155	68.4%
H1 2020	42.1%	158	68.6%
H2 2020	40.0%	163	66.4%
H1 2021	27.5%	149	36.1%

Notes: The sample in column 1 includes all banks reporting their LCR and NSFR in a given Basel monitoring (the number of banks in the sample varies through time, see column 2). The sample in column 3 includes the same 64 banks in every time period.

Source: Basel Committee on Banking Supervision.

A.25 Relation over time between the LCR and the NSFR

To assess the relationship between the LCR and the NSFR, it was analysed whether current values of the LCR can be explained by lagged values of the NSFR, or vice-versa. The LCR and the NSFR lagged for six months (*t-1*) and 12 months (*t-2*) were considered, consistent with the semiannual nature of the data collected under the QIS.

To study this relation the following models were estimated:

$$LCR_{i,t} = \alpha_i + \tau_t + \rho_1 LCR_{i,t-1} + \rho_2 LCR_{i,t-2} + \beta_1 NSFR_{i,t-1} + \beta_2 NSFR_{i,t-2} + \varepsilon_{i,t}$$

And

$$NSFR_{i,t} = \alpha_i + \tau_t + \rho_1 NSFR_{i,t-1} + \rho_2 NSFR_{i,t-2} + \beta_1 LCR_{i,t-1} + \beta_2 LCR_{i,t-2} + \varepsilon_{i,t}$$

Results fixed effects panel model — Table A25

	Dependent Variable	
Explanatory Variables	$LCR_{i,t}$	$NSFR_{i,t}$
$LCR_{i,t-1}$	0.47** (0.19)	0.00 (0.00)
$LCR_{i,t-2}$	-0.01 (0.31)	-0.00 (0.00)
$NSFR_{i,t-1}$	0.22 (0.36)	0.90*** (0.08)
$NSFR_{i,t-2}$	0.58 (0.53)	0.19** (0.07)
N	1608	1625

Notes: Robust standard errors in parentheses. *** = significant at the 1%; ** = significant at 5%; and * = significant at 10%.

Source: Basel Committee on Banking Supervision.

A.26 Empirical design and additional results for quantitative assessment of interaction between Basel III regulatory ratios

This appendix provides further details on the methodology used in Chapter 9 of the report, the interpretation of the regression coefficients, as well as results on the effects of interactions between Basel III regulatory ratios on bank resilience and lending.

A.26.1 Empirical design and interpretation of regression coefficients

The regression specification for the interaction analysis takes the following form:

$$\Delta Y_{i,c,t/t-2} = \alpha + \beta_1 \cdot RegRatio1_{i,t-2} + \beta_2 \cdot RegRatio2_{i,t-2} + \beta_3 \cdot (RegRatio1_{i,t-2} * RegRatio2_{i,t-2}) + \theta X_{c,t} + \delta_i + \theta_t + \varepsilon_{i,c,t}$$

The main coefficient of interest of the regression is β_3 – the coefficient of the interaction term. The sign of this coefficient can help to shed light on the interactions between regulatory ratios, specifically on their dampening or amplifying effects. In the above specification, β_3 can be interpreted as the cross-derivative of $\Delta Y_{i,c,t/t-2}$ with respect to $RegRatio1$ and $RegRatio2$:

$$\beta_3 = \frac{\partial^2 \Delta Y_{i,c,t/t-2}}{\partial RegRatio1 \, \partial RegRatio2}$$

One could interpret the sign of β_3 as follows:

- if β_3 has the same sign as β_1 and β_2, the two regulatory ratios are complements, ie the absolute value of the total increase in banks' resilience generated by those regulatory ratios is bigger than the sum of the increase induced by each individual ratio. This means that the two regulatory ratios amplify each other's impact on banks' resilience.
- if β_3 has the opposite sign compared with β_1 and β_2, the two regulatory ratios are substitutes, ie the absolute value of the total increase of banks' resilience is smaller than the sum of the improvement induced by each individual reform. This means that the two regulatory ratios dampen the impact of each other on banks' resilience.
- If $\Delta Y_{i,c,t/t-2}$ is decreasing with respect to $RegRatio1$ and increasing with respect to $RegRatio2$ (ie, if β_1 is negative while β_2 is positive), then a negative sign of β_3 means that the reduction in bank's CDS spreads (ie improvement in resilience) from a higher regulatory ratio 1 would be amplified by higher regulatory ratio 2 (ie the reduction in CDS spreads would be even higher). A positive sign of β_3 means that the negative effects of regulatory ratio 1 would be dampened by higher regulatory ratio 2 (ie the reduction would be lower).

A.26.2 Results on interactions within the Basel III framework and bank lending

Table A26 reports the results of the regression analysis about the impact of interaction between Basel III ratios on the year-on-year lending growth. Only the interaction coefficient between the CET1 risk-based ratio and the leverage ratio is weakly significant. The individual coefficients are positive, indicating that banks with higher CET1 or leverage ratio exhibit a positive effect on lending growth. However, the negative interaction coefficient indicates that the CET1 risk-based ratio and the leverage ratio dampen each other's impact on lending growth. However, these results are only marginally statistically significant. Hence, we lack evidence of any material impact on lending growth stemming from the interaction of Basel III capital and/or liquidity standards.

Regression results on the impact of interactions between Basel III ratios on year-on-year lending growth (in log difference)

Table A26

Variables	(1)	(2)	(3)	(4)	(5)	(6)
CET1*Leverage	-0.00116*					
	(0.000670)					
CET1	0.00997**	0.00164	0.00335			
	(0.00401)	(0.00211)	(0.00935)			
Leverage	0.0228*			-0.0534**	-0.0210	
	(0.0123)			(0.0266)	(0.0198)	
CET1*LCR		3.57e-07				
		(1.89e-06)				
LCR		2.28e-06		9.79e-06		-9.43e-05
		(2.09e-05)		(2.55e-05)		(8.00e-05)
CET1*NSFR			-3.95e-06			
			(7.83e-05)			
NSFR			0.000463		-0.00400**	5.50e-05
			(0.00143)		(0.00191)	(0.000687)
Leverage*LCR				-8.31e-06		
				(2.22e-05)		
Leverage*NSFR					-2.34e-05	
					(5.70e-05)	
LCR*NSFR						7.57e-07
						(5.96e-07)
GDP growth	0.903	0.808	1.155	-0.224	2.046	0.825
	(0.744)	(1.222)	(1.220)	(4.749)	(5.187)	(1.280)
VIX	-0.332***	-0.291***	-0.251***	-0.222*	-0.143	-0.265***
	(0.0564)	(0.0568)	(0.0566)	(0.113)	(0.0924)	(0.0576)
Constant	-0.00380	-0.185***	-0.251	0.432**	0.674**	-0.165**
	(0.0636)	(0.0346)	(0.156)	(0.187)	(0.295)	(0.0694)
R^2	0.149	0.137	0.139	0.097	0.107	0.142
Observations	2,503	1,818	1,924	442	450	1,900
Number of banks	235	228	227	135	140	228
Bank fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Basel Committee on Banking Supervision.

A.27 Case studies on the interactions between the Basel and resolution frameworks

A.27.1 Case study 1: Washington Mutual assessed under new regulatory frameworks

Both the Basel III regulatory framework and the FSB's resolution framework were motivated by the Global Financial Crisis. The first is intended to improve the resiliency of banking institutions through enhanced capital and liquidity requirements. The second is meant to ensure sufficient "bail-in" capital to limit the public cost and the systemic disruption of large bank failures. To consider how these frameworks might have affected a failing bank, this case study briefly discusses the case of Washington Mutual, the largest bank failure in US history.

During the 2000s, Washington Mutual Bank (WaMu), a thrift institution and subsidiary of the financial holding company Washington Mutual Inc, pursued a high-risk residential lending strategy.[24] When the housing market slowed in the United States in 2007, WaMu began suffering losses. These losses worsened through 2007 and 2008. Due to its performance issues, deteriorating macroeconomic conditions, and the failure of other large financial institutions, WaMu experienced a run on its deposits in September 2008, which ultimately resulted in its failure.

This case study considers two questions: (i) would Basel III have required higher levels of capital and liquidity at WaMu?; and (ii) how does the resolution of WaMu compare with the guidance provided by the FSB's resolution framework?

To evaluate WaMu under the Basel III framework, this study calculates estimates of what WaMu's Basel III regulatory ratios would have been and compares them with Basel III's minimum requirements. First, Basel III focuses on improving capital quality by introducing CET1 capital requirements. The upper left-hand panel of Graph A27.1 shows an estimate of WaMu's CET1 and total capital ratios relative to minimum requirements. WaMu's ratios exceeded the minimum requirements for both measures. However, the growing gap between these ratios indicates a shift in the composition of WaMu's capital away from the stronger CET1 elements. This potentially limited the ability of its total capital to absorb losses.

Basel III also introduces additional capital buffers that banks should maintain. Along with minimum requirements, a large bank may have to satisfy a capital conservation buffer (CCoB) (2.5%), a buffer for global systemically important banks (G-SIBs) (varies by bank), and a countercyclical capital buffer (CCyB) (up to 2.5%). For the purposes of this study, we assume WaMu's G-SIB buffer would have been 2.5%, resulting in a required CET1 risk-based ratio of 12%.[25] The upper right-hand panel of Graph A27.1 shows WaMu's capital levels relative to these higher requirements. It would have been able to satisfy the general requirement (Min + CCoB) and an assumed maximum G-SIB buffer, but its CET1 risk-based ratio would have been below required levels under the most stringent scenario, which assumes a 2.5% CCyB. While this exercise compares WaMu's capital with potential requirements under Basel III, its actual requirement would have depended on its status as a G-SIB and the use of a CCyB.[26]

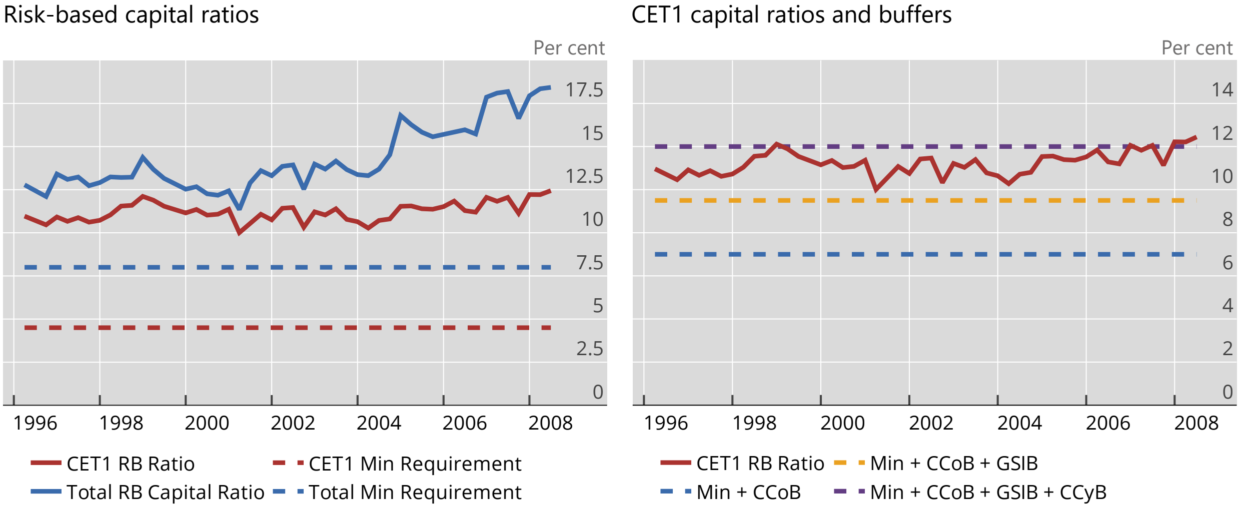
[24] Source: "Evaluation of Federal Regulatory Oversight of Washington Mutual Bank", Offices of the Inspector General, April 2010.

[25] 4.5% minimum CET1 ratio + 2.5% CCoB + 2.5 G-SIB buffer + 2.5% CCyB = 12%.

[26] To date, the CCyB has never been activated in the United States.

Capital position of Washington Mutual Bank

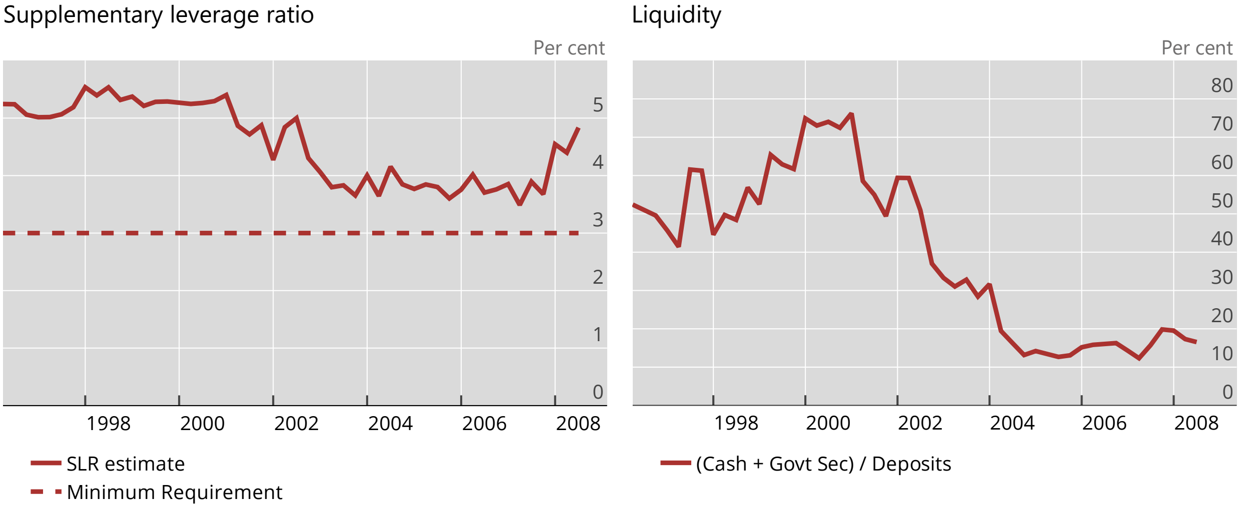
Graph A27.1



Source: FFIEC Call Reports.

Leverage and liquidity position of Washington Mutual Bank

Graph A27.2



Source: FFIEC Call Reports.

One important caveat of this evaluation of WaMu's capital position with respect to current requirements is that it relies on risk-weighted assets (RWA) measured at the time. However, Basel III includes adjustments to the calculation of RWA. While a recalculation of WaMu's RWA is beyond the scope of this study (and so the exact impact on WaMu's required capital is uncertain), the intention of these adjustments is to improve risk-sensitivity.

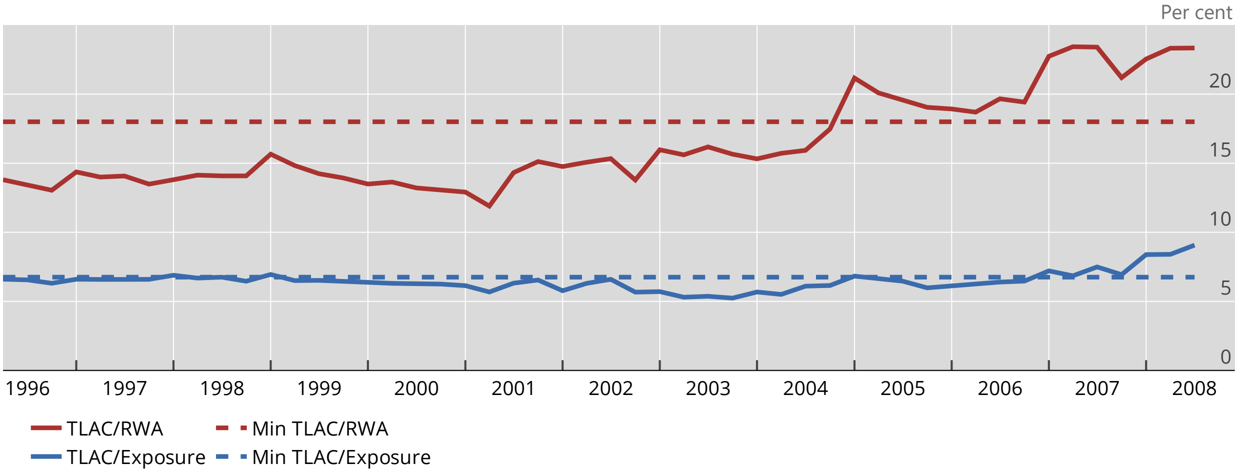
Basel III also introduced the leverage ratio as a complement and backstop to risk-based requirements, which is referred to as the supplementary leverage ratio (SLR) in the US implementation of Basel III. The United States has a longstanding Tier 1 leverage ratio requirement in addition to the SLR. The lower left-hand panel of Graph A27.1 shows an estimate of WaMu's SLR (the ratio of T1 capital to the sum of assets and undrawn commitments). While WaMu would have satisfied minimum requirements, increases in off-balance sheet commitments resulted in a decline in its SLR over time (until the crisis, when there was a drop in commitments), which would have highlighted WaMu's deteriorating leverage situation to managers internally, to supervisors, and to external stakeholders including market participants.

While new requirements may have put upward pressure on WaMu's capital, it was ultimately a liquidity crisis that caused its failure. The deteriorating macroeconomic environment, as well as its own performance issues and the failure of other financial institutions prompted a run on WaMu's deposits. The lower right-hand panel of Graph A27.1 shows a simple measure of WaMu's liquidity over this period: the ratio of cash balances and US government securities to deposits. This estimate suggests a liquidity position that was in decline well before the financial crisis. New requirements could have identified this trend sooner and prompted a corrective response, reducing the potential for the liquidity crisis that ultimately led to WaMu's resolution.

According to the resolution framework, an effective resolution should use sufficient levels of "bail-in" capital to limit the exposure of public funds to losses, as well as ensure the continued provision of critical financial services. WaMu went into receivership on 25 September 2008, and a sale of its assets and deposits to JPMorgan Chase ensued. The sale price ensured that losses were borne primarily by equity holders ("bail-in"), and the sale was facilitated without the use of public deposit insurance funds. Also, JPMorgan Chase took over the provision of financial services to WaMu customers. Based on this result, the resolution of WaMu seems to have satisfied the key features of the FSB's guidance.

Applying the fundamental principles behind the FSB resolution framework, WaMu may have been required to satisfy TLAC requirements. Graph A27.2 provides an estimate of WaMu's TLAC (estimated as the sum of total regulatory capital and subordinated debt) as a proportion of RWA and the SLR exposure measure. It also shows the minimum requirements for these ratios (18% for RWA, 6.75% for SLR exposure). Under this estimate, WaMu hovered around minimum requirements for most of this period and exceeded them just prior its failure. WaMu exceeding minimum requirements is consistent with the sufficient "bail-in" capacity that manifested during the actual resolution process. However, in prior years, WaMu's TLAC would likely have been insufficient to satisfy current standards.

Estimated TLAC for Washington Mutual Bank — Graph A27.2



Source: FFIEC Call Reports.

In conclusion, under the Basel III framework, higher capital requirements and an additional leverage requirement, the SLR, may have increased WaMu's capital position. Additionally, liquidity requirements could have required WaMu to improve its liquidity position, potentially pre-empting the liquidity crisis that ultimately caused its failure. Thus, the different Basel III requirements may have prompted the bank to address problems earlier, which would likely have reduced the probability that it would face problems in a crisis. By increasing resiliency, Basel III also reduces the probability that supervisors will need to apply resolution strategies. Still, while a resolution framework may have required higher TLAC, WaMu was resolved in a way that was largely consistent with this guidance: sufficient "bail-in", no use of public funds, and the continuation of financial service provision.

Appendix: Estimates of new capital and liquidity ratios:

$$CET1\ RB\ Ratio = \frac{T1\ capital - Perpetual\ preferred\ stock}{Risk - weighted\ assets}$$

$$Total\ RB\ Capital\ Ratio = \frac{T1\ capital + T2\ capital}{Risk - weighted\ assets}$$

$$SLR = \frac{T1\ capital - Perpetual\ preferred\ stock}{Assets + Unused\ commitments}$$

$$Liquidity\ Ratio = \frac{Cash\ and\ balances\ due\ from\ DIs + US\ gov'tsecurities}{Deposits}$$

$$\frac{TLAC}{RWA} = \frac{T1\ capital + \ T2\ capital + Subordinated\ Debt}{Risk - weighted\ assets}$$

$$\frac{TLAC}{Exposure} = \frac{T1\ capital + \ T2\ capital + Subordinated\ Debt}{Assets + Unused\ commitments}$$

A.27.2 Case study 2: Lessons from Banco Popular's resolution

This case study aims at shedding light on the interactions between the level of regulatory ratios and the entry into resolution of a bank, based on a case study: the resolution of the Spanish bank Banco Popular in June 2017.

On 7 June 2017, Banco Popular was resolved by a sale of business to Banco Santander. This was the result of a decision made by the Single Resolution Board (SRB), following an overnight coordinated exercise among the SRB and the national competent authorities, the European Central Bank and the European Commission. All of the bank's existing shares (included in CET1), and the Additional Tier 1 instruments (€1.2 billion in convertible bonds) of Banco Popular were written down, while the €700 million-worth Tier 2 instruments were converted into new shares, which were transferred to Santander for the price of €1.

Although Banco Popular's vulnerabilities had been known for some time, the timely resolution was precipitated by a bank run. The bank's vulnerabilities resulted from its large stock of legacy assets and the reliability of some of its prudential disclosures. Market pressures on Banco Popular (the sixth largest amongst Spanish banks as of end-May 2017) mounted following a series of bad news since the start of 2017 that led to the bank's illiquidity. Deposit outflows accelerated at the end of May. Emergency liquidity assistance was only partially possible due to lack of eligible collateral. It should be noted that the bank's LCR exceeded 100% before the deposit outflows, suggesting a very large and sudden move by depositors.

Markets reacted positively and contagion was limited. This resolution decision allowed the parties involved to swiftly solve the difficulties of the bank, without significant impact on financial stability or on depositors or ordinary creditors. Banco Santander's shares went up by 5% in the week following the announcement. The resolution of Banco Popular was viewed by market participants as safeguarding financial stability in Spain, without weakening the health of the acquiring bank according to the International Monetary Fund and market analysts. Taxpayers did not have to cover any losses. Contagion to other banks due to mistrust was limited to a couple of medium-sized banks identified as weaker by the markets.

The regulatory ratios reported by the bank would not have allowed its near failure to be predicted. The case of Banco Popular provided a clear demonstration of the interactions between poor asset quality, lack of transparency about the genuine degree of asset quality and liquidity tensions: the emerging news about the bank's asset quality problems drove the enormous bank runs, which caused liquidity to evaporate very rapidly. In December 2016, six months before its swift resolution, Banco Popular displayed a total capital solvency ratio of 13.1%, and a (phase-in) leverage ratio of 5.3%. NSFR figures were not available at that time. In March 2017, two months before its resolution, the LCR of the bank reached 146%, with apparently comfortable liquidity buffers.

Conclusions taken from this case study on the interactions between the Basel III framework and the resolution framework:

- The main channel of interaction resulted from the benefits the LCR provided in terms of additional time for the regulators and the supervisors to resolve the bank, eg to find a buyer: Banco Popular's liquidity crisis started one month before the LCR breached the requirement, even though the trend had been declining earlier. In June, the deposit runs became so huge that the bank had to be resolved swiftly;
- The international TLAC framework was not in place at the time of Banco Popular's resolution, as the bank was not a G-SIB and was thus not subject to TLAC requirements. However, the bank had been subject to the European minimum requirement for own funds and eligible liabilities (MREL) since this requirement came into force in January 2016 and had to issue eligible instruments to comply with its first target set by the SRB in December 2016;
- The bank's fulfilment of the regulatory ratios seemed to have a greater impact on the cost of resolution than on the bank's probability of failure. On the one hand, the write-down of existing shares and additional Tier 1 instruments allowed the bank to absorb its losses and avoided any bailout costs for the government or the taxpayers. On the other hand, the predictive capability of the LCR has proven limited. Between April and May, Banco Popular's liquidity position deteriorated rapidly, leading to a breach of the regulatory LCR compliance level on 12 May (below 80%). The question whether the predictive capability of a regulatory ratio is an objective per se or not is debatable. Admittedly, the LCR started to exhibit a declining trend well before breaching the minimum requirement and the crisis resulted from a mix of asset quality problems and liquidity tensions. As regards capital ratios, it should be noted that the first downgrade by a rating agency took place in February 2017, following the disclosure of underprovisioning and the need for extraordinary provisions and significant year-end losses, thus not reflected in the end-2016 level of the solvency ratios. This raised concerns with the accuracy of the regulatory ratios reported by the bank in the year preceding its failure. The conclusion that the predictive capability of capital ratios was limited must thus be qualified with regard to the problems that were discovered with the reliability and accuracy of the bank's ratios and which undermined the predictive capacity of these regulatory ratios.

By contrast, liquidity indicators other than the LCR (eg survival time, survival time under stress conditions, counterbalancing capacity etc) were better in reflecting and predicting the deteriorating liquidity trends.

A.28 Analysis of interactions between Basel III and TLAC ratios

This appendix provides quantitative information on the interaction between banks' Basel III regulatory ratios and TLAC, including descriptive statistics for GSIBs, correlation between Basel III ratios and TLAC headroom, and regression analysis about interactions between Basel III capital/liquidity ratios and TLAC headroom on banks' resilience and lending.

A.28.1 Descriptive statistics for banks with TLAC

The analysis uses the Committee's data on G-SIBs, as TLAC requirements only apply to G-SIBs, which significantly reduces the number of banks. The TLAC ratio is defined as the sum of the amount of total capital and issued TLAC instruments (beyond those that count as total capital), divided by risk-weighted assets (RWAs). The TLAC headroom is defined as the TLAC ratio net of both the TLAC requirements and the CET1 headroom. The purpose is to reduce the effect of the definitional overlap between the CET1 headroom and the TLAC headroom. Summary statistics regarding the subsample of G-SIBs are reported in the table below.

The TLAC buffer is positive on average, but some banks still fail to build a headroom with regard to the negative minimum value.

Summary statistics of regulatory ratios (G-SIB subsample, in percent) Table A28.1

Variable	# of obs.	Mean	Std. Dev.	Min.	Max.
CET 1 ratio	506	12.2	2.2	6.9	21.8
CET 1 headroom	339	3.0	2.1	-1.9	8.7
Tier 1 ratio	506	13.9	2.5	8.7	23.7
Total capital ratio	506	16.5	3.0	9.2	30.5
Leverage ratio	505	5.0	1.2	2.1	8.3
LCR	497	132.7	23.8	69.5	268.4
NSFR	491	113.2	19.4	30.2	367.3
TLAC ratio (% of RWAs)	210	26.4	5.5	12.7	45.5
TLAC headroom (% of RWAs, net of CET1 headroom)	142	1.1	5.9	-15.0	24.2

Source: Basel Committee on Banking Supervision.

A.28.2 Correlation analysis between Basel III ratios and TLAC headroom for GSIBs

Table A28.2 shows the within-bank correlation figures between Basel III ratios and the TLAC headroom for banks with available TLAC figures. The TLAC headroom (ie amount of TLAC in excess of requirements) is positively correlated with every Basel III ratio. The only highly significant correlation coefficient involving the TLAC headroom is found with the leverage ratio, but the coefficient is moderate (34%), which does not provide sufficient ground to conclude that the two ratios exhibit strong co-movement or could be potentially redundant.

Within-bank correlation matrix of regulatory ratios and TLAC headroom (G-SIB subsample)

Table A28.2

	CET 1 ratio	Tier1 ratio	Total capital ratio	Leverage ratio	LCR	NSFR	TLAC headroom
CET 1 ratio	1.0000						
Tier1 ratio	0.9208***	1.0000					
	(0.0000)						
Total capital ratio	0.8764***	0.9466***	1.0000				
	(0.0000)	(0.0000)					
Leverage ratio	0.5242***	0.6077***	0.5836***	1.0000			
	(0.0000)	(0.0000)	(0.0000)				
LCR	0.2792***	0.3165***	0.3391***	0.3122***	1.0000		
	(0.0021)	(0.0000)	(0.0000)	(0.0000)			
NSFR	0.2336***	0.2938***	0.2870***	0.4578***	0.0890***	1.0000	
	(0.0000)	(0.0000)	0.0000	(0.0000)	(0.0000)		
TLAC headroom	0.0586	0.0910	0.0513	0.3363***	0.0945	0.1592*	1.0000
	(0.4883)	(0.2816)	(0.5440)	(0.0000)	(0.2665)	(0.0682)	

Note: p-value in parentheses

*** p-value<0.01, ** p-value<0.05, * p-value<0.1

Source: Basel Committee on Banking Supervision.

A.28.3 Regression analysis of Basel III ratios and TLAC headroom

The analysis attempted to estimate the year-on-year growth rate in banks' resilience measures and lending resulting from the impact of the interactions between the TLAC headroom and each of Basel III ratios. The analysis used the same panel data model performed for the regression analysis between Basel III ratios (See Section 9.4.2 of the report and Appendix A.29).

Given that the regression included only banks with TLAC figures, the sample size was very small and was restricted to G-SIBs (approximately 60 observations). Such a small sample could limit the reliability and robustness of our analysis in precisely identifying the interaction effects. It should be noted that one G-SIB was removed from the sample as this bank drove counterintuitive results in an initial regression regarding the effect of the TLAC headroom on the growth in CDS spreads. This confirms the high sensitivity of our results to effects driven by specific large banks.

The analysis did not produce any significant results either for the impact of the interaction between Basel III ratios and TLAC headroom on resilience or for the impact on lending. However, it is difficult to draw conclusions from these results since they could be driven by various factors. First, the small number of observations and the sensitivity to effects driven by specific large banks could severely limit the reliability and the robustness of those results. The results are not very robust to the definition of the resilience measure (ie results vary when we change the dependent variable to cost of debt/equity, PD, EDF, MES, SRISK), which again indicates that the small sample size may affect the robustness of the results. Another possible explanation is that there may be no significant interaction between Basel III ratios and TLAC headroom on banks' resilience and lending.

A.29 Methodological approaches for evaluating regulatory complexity

The analysis of regulatory complexity uses three approaches to assess different dimensions of complexity: (i) answers to the BCBS member survey; (ii) linguistic analysis to assess the comprehensibility of the standard texts for a reader; and (iii) the number of calculation steps, input variables and required data cells in QIS exercises to assess computational complexity. The following section shows the methodological approaches for linguistic complexity (Section A.29.1) and computational complexity (Sections A.29.2 to A.29.4), which are not explained in the main part of the report.

A.29.1 Linguistic analysis

The linguistic complexity measure uses the version of Basel II that was published in June 2006, see (BCBS 2006).[27] The Basel III text was derived from the consolidated Basel Framework as applicable on 1 January 2023, in the form of a full PDF document.[28] The PDF files were then transformed into .txt (plain text) files and the linguistic analysis was run on these .txt-files. Table A.29.1 lists the linguistic metrics used, including those presented in the more detailed analysis in Appendix A.30. These linguistic metrics were used because they are considered to be the most informative for analysing regulatory complexity. However, as Amadxarif et al (2019) and Brookes et al (2022) show, there are many other metrics in linguistic analysis.

Linguistic complexity metrics

Metrics used to evaluate the linguistic complexity of Basel standard texts

Table A.29.1

Linguistic metric	Definition
Flesch-Kincaid grade level readability metric by Kincaid et al (1975)	The number indicates how many years of schooling a reader needs to understand the text. A score of nine would indicate that a student in the 9th grade could understand the text. The number is generated by a formula, based on the number of words, the number of syllables and the number of sentences.
Number of words	Total number of words in the text.
References	Number of references to other paragraphs in the text.
Precision	The reported number is the number of precision indicators in the text divided by the total number of words in the text. Precision indicators are for example indicators of currency and percentages.
Conditionality	Total number of conditional clauses or expressions in a chapter divided by total number of sentences in a chapter. Words and phrases to indicate conditionality are if, when(ever), where(ver), unless, notwithstanding, except, but, provided (that).
Vagueness	Captures the extent to which the reader needs to use discretion and judgment in interpreting a given text. It is measured by: number of vague words in a chapter divided by total number of words in a chapter. The following vague terms are used: appropriate, adequate, available, effective, equitable, fair, good, likely, material, necessary, particular, possible, potential, practicable, prompt, reasonable, regular, several, significant, substantial, sufficient, timely.
Lexical diversity	Focuses on the use of concepts where a text that uses many concepts gets a higher score because it is more difficult to understand while a repetitive use of the same concepts makes it cognitively simpler. It is measured by: number of unique words in a chapter divided by total number of words in a chapter.

Source: Metrics according to Amadxarif et al (2019).

[27] See www.bis.org/publ/bcbs128.pdf.

[28] As available on the BCBS website at the end of November 2021. See www.bis.org/basel_framework/, use the time traveller to go to 1 January 2023, scroll all the way down and create a full version of the Basel Framework (PDF). To analyse the text of Basel II, we used the document "International Convergence of Capital Measurement and Capital Standards: A Revised Framework – Comprehensive Version, June 2006", www.bis.org/publ/bcbs128.pdf.

The method for the analysis of linguistic complexity follows Amadxarif et al (2019) with the following specifications:[29]

- The definition of word-for-word counts is: a subset of a document's token strings, specifically any string separated by white space, excluding digits, symbols, punctuation marker, and strings with an indeterminate part of speech;
- Conditional expressions are: "if", "whenever", "when", "wherever", "where", "unless", "notwithstanding", "provided that";
- For number of sentences, the default Spacy model was used.

It should be noted that the results should be interpreted carefully. There are limits to linguistic complexity models. To take one example, such models will most likely interpret text strings without any punctuation mark as one single sentence. This can be problematic and introduce a form of measurement error. To exemplify, consider the following extract from the Basel III text from NSF99.2 which contains a table with text in different columns but without punctuation marks at the end of each cell.

RSF factor	Components of RSF category
0%	Coins and banknotes All central bank reserves All claims on central banks with residual maturities of less than six months "Trade date" receivables arising from sales of financial instruments, foreign currencies and commodities Assets with interdependent liabilities as in NSF30.35, subject to national discretion
5%	Unencumbered Level 1 assets, excluding coins, banknotes and central bank reserves

For the reader, the layout of the table is fairly clear. However, in the linguistic analysis program, this is read as one single long text string, ie as one long sentence, which is not easily understood. There are more of these types of table in Basel III than in Basel II. Also, some Basel III standards contain more of these tables than others.

A.29.2 Computational complexity – calculation steps

As part of the assessment of computational complexity, the number of formulas or calculation steps required to comply with the different standards is counted. These metrics are used as a proxy to measure the efforts a bank has to undertake to implement a certain standard and to calculate the regulatory requirement. While the calculation steps presented as formulas in the standard text are directly recognisable, in some cases it is ambiguous whether a description is to be considered as a calculation step.

There are three important caveats. First, certain standards contain options so that not all formulas may be necessary for all banks. However, as this optionality is also an indication of complexity, we report the gross numbers. Second, a bank's data collection burden depends on multiple factors besides the number of inputs (eg the data structures within the bank, the technical systems available in the bank and the approaches/options a bank applies). Third, there is a degree of subjectivity in measuring these metrics. Also, this analysis is performed manually. However, as the aim of this analysis is not to give an exact number of calculation steps for each standard, but rather to establish a tendency of which standards contain the most formulas, minor deviations or inconsistencies are less decisive for the conclusion. In this appendix, the following examples illustrate the procedure we have used for determining the number of formulas in the standards.

[29] The method uses natural language processing (NLP) and network analysis, based on code written using Python 3.9.7. The Flesch-Kincaid Grade level readability scores have been estimated using the Py-readability-metrics 1.4.5. For the rest of the linguistic complexity measures the "en_core_web_sm" has been used.

Standard CRE: Calculation of RWA for credit risk – Paragraph CRE20.4

First, the calculation of RWA for credit risk requires banks to multiply the value of their exposures with an assigned risk weight. The allocation of risk weights to different positions is considered as one formula for each exposure class, as for example, exposures to sovereigns, exposures to banks and exposures to covered bonds. For the sake of simplicity, the study does not count one separate formula for each external rating class. For example, paragraph CRE20.4 is counted as one formula and not as six formulas.

Exposures to sovereigns and their central banks will be risk-weighted as follows:

Risk weight table for sovereigns and central banks

External rating	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
Risk weight	0%	20%	50%	100%	150%	100%

[One formula for exposure value times risk weight]

Standard RBC: Risk-based capital requirements– Paragraph RBC20.4

Moreover, the study considers the comparison of two values as one formula. For example, according to paragraph RBC20.4, a bank has to determine the maximum of two values as one calculation step (first formula). The two values to be compared must be calculated beforehand. That is, a sum of three elements (second formula, see (1)) and a certain percentage of the sum of possibly other values (third formula, see (2)). Thus, for this study, paragraph RBC20.4 contains three formulas in total.

The RWA that banks must use to determine compliance with the requirements set out in RBC20.1 (and the buffers in RBC30 and RBC40) is the higher of: *[First formula: Maximum of (1) and (2)]*

(1) the sum of the following three elements, calculated using the bank's nominated approaches: *[Second formula: Sum of (a), (b) and (c)]*

(a) RWA for credit risk (as calculated in RBC20.6 to RBC20.8);
(b) RWA for market risk (as calculated in RBC20.9); and
(c) RWA for operational risk (as calculated in RBC20.10); and

(2) 72.5% of the sum of the elements listed in point (1) above, calculated using only the standardised approaches listed in RBC20.11. This element of this requirement is referred to as the output floor, and the RWA amount that is multiplied by 72.5% is referred to as the base of the output floor. This requirement is subject to transitional arrangements set out in RBC90. *[Third formula: 72.5% times sum of (1) under the standardised approach].*

Standard LCR: Liquidity Coverage Ratio – Paragraph LCR20.4

Other standards, for example the Liquidity Coverage Ratio (LCR), explicitly describe the calculation for each component in different paragraphs. The study assesses paragraph LCR20.4 as one single formula, since the computation of the two components are explained in the following paragraphs.

The LCR has two components:

(1) value of the stock of HQLA in stressed conditions; and

(2) total net cash outflows, calculated according to the scenario parameters outlined in LCR30 and LCR40.

$$\frac{\text{Stock of HQLA}}{\text{Total net cash outflows over the next 30 calendar days}} \geq 100\%$$

[One formula for calculating the LCR]

Standard LCR: Liquidity Coverage Ratio – Paragraph LCR30.38

Paragraph LCR30.38 defines the calculation of the stock of HQLA by adding five components, which are specified in the following paragraphs. The study considers that paragraph LCR30.38 contains one formula. The five components in turn also have to be calculated before they can be added up as described in paragraph LCR30.38. Paragraph LCR30.37 defines three components for calculating the stock of HQLA and thus the study considers that these contain three formulas. Moreover, LCR30.39 defines the two adjustments for calculating the stock of HQLA and thus two further formulas are counted.

> The formula for the calculation of the stock of HQLA is as follows:
>
> Stock of HQLA = Level 1 + Level 2A + Level 2B - adjustment for 15 % cap - adjustment for 40 % cap.
>
> *[One formula for stock of HQLA]*

Standard MAR: Calculation of RWA for market risk – Paragraph MAR32.5

Even though some passages do not include obvious formulas, they describe the calculation of a certain quantity. For example, paragraph MAR32.5 implicitly requires a bank to perform calculations to obtain a VaR measure. The study considers this calculation of the VaR measure as a separate formula. In general, more than one formula usually has to be performed to calculate the VaR measure. Since the number of these calculation steps varies among banks and, for the sake of simplicity, the study ignores that several calculation steps are necessary and counts only one formula.

> Backtesting of the bank-wide risk model must be based on a VaR measure calibrated at a 99th percentile confidence level. *[One formula for calculating the VaR measure]* (…)

A.29.3 Computational complexity – Number of input variables

For this analysis, the study defines an input as a certain type of data that is not contained in the standard itself and that banks need to gather or calculate to be able to apply the specific approaches outlined in the standard. There are bank-specific input parameters, as for example the exposure amount for a certain exposure class in the credit risk standard. There is also general (market) information, as for example external ratings of a certain type of lending necessary to determine the appropriate risk weight. However, the risk weight itself is given in the standard text (it simply has to be mapped with further information) and is therefore not counted as an input parameter.

A.29.4 Computational complexity – analysis of the Basel III monitoring workbook

Another way to estimate computational complexity is to assess the number of cells in the template used for the Committee's Basel III Monitoring workbook that banks have to report to the BCBS. These numbers represent the efforts by banks in terms of data collecting, data reconciliation and finally data reporting. The study's baseline is the template used for the data collection for December 2021.[30]

There are several reasons why the template's granularity varies across standards. For some standards, the desire to understand the underlying drivers was larger than for others. Not all standards are followed by the Committee's QIS data collections, and the numbers may also capture the number of variants of different standards (eg multiple approaches allowed by the framework to calculate credit risk-weighted assets), which again gets back to the issue of optionality. However, these numbers represent the efforts by banks in terms of data collecting, data reconciliation and finally data reporting. In that sense, they provide some indication of computational complexity.

30 As given by www.bis.org/bcbs/qis/.

A.30 Comparing the linguistic complexity of Basel II and Basel III

The analysis of the linguistic complexity of Basel II and Basel III in this paper was performed using a method outlined in Amadxarif et al (2019), by staff at the Bank of England. For details see Brookes et al (2022). Below we report a summary of the empirical results, some of which have already been presented in Section 10.2.2 of the report.

Table A30.1 lists the different linguistic measures when comparing the entire text of Basel II and Basel III.

Linguistic complexity: comparison of Basel II and Basel III — Table A30.1

	Basel II	Basel III
Readability (higher = more complex)	15.7	18.8
Length (higher = more complex)	156 296	338 320
References (higher = more complex)	1 855	5 772
Precision (lower = more complex)	0.099	0.201
Nodes (higher = more complex)	827	3 411
Conditionality (higher = more complex)	0.173	0.207
Vagueness (higher = more complex)	0.227	0.287
Lexical diversity (higher = more complex)	0.030	0.028

Source Brookes, Everitt and Vo (2022)

The number of individual subparts of a standard (nodes) in Basel III is more than four times as high as in Basel II. Moreover, Basel III has twice as many cross-references as Basel II, implying that the understanding of a given standard in Basel III may be more dependent on understanding of other standards within the framework than was the case in Basel II.[31] On the other hand, the chains of references are shorter under Basel III than under Basel II, indicating that any change to a specific rule would have fewer knock-on effects on other parts of the framework (Brookes et al (2022)). Basel III also includes more conditional elements (conditionality). A text with more conditional expressions is more difficult for a reader to process since hypothetical situations and specified exceptions have to be incorporated. Thus, Basel II with a lower number of conditional expressions might be easier for a reader to process. Furthermore, Basel III is slightly vaguer (vagueness). Vague words require more clarification to understand the context and thus make it more difficult for a reader to comprehend a text. Thus, Basel II may be easier to understand since it has fewer vague words. With regard to the choice of words, both frameworks have a similarly high rate of repetitive words (lexical diversity). Thus, both framework texts are based on a repetitive use of the same concepts which cognitively facilitates comprehension.

[31] Normalising by length, Basel III (5 772/338 320 = 0.017) is more complex than Basel II (1 855/156 296 = 0.012). Normalising by the number of paragraphs, Basel II (1 855/827 = 2.24) is more complex than Basel III (5 772/3 411 = 1.69). The number of paragraphs can also be found in Brookes et al (2022). In Basel II paragraphs are numbered consecutively from 1 to 827, whereas in Basel III paragraphs are numbered only within each chapter, eg the chapter *"MAR20 Standardised approach"* contains the paragraphs MAR20.1 to MAR20.85.