Drivers of Systemic Risk: Do National and European Perspectives Differ?*

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Motivation

- Before the crisis, bank supervision and regulation was mainly a national issue and resulted in **supervisory fragmentation**.
- A national regulator might have incentives not to internalize all costs arising in other Euro area countries.
- The European Banking Union has **shifted** supervision for large banks to the Euro area level through the Single Supervisory Mechanism (SSM).
- This supervisor is mainly in charge of micro-prudential supervision but can also tighten macro-prudential measures implemented at the national level.

$\rightarrow$ It's important to know whether there are differences in the assessment of systemic risk.

Research questions

1. What is a bank's contribution to systemic risk at the Euro area in contrast to the national level?

2. Do the drivers of systemic risk differ at the Euro area level versus the national level?

Contribution

1. Distinction of regional levels
   - ▷ Limited evidence on banks' contribution to systemic risk at **different regional levels** (Benoit, 2014 or Weiß et al., 2014).
2. Drivers of systemic risk
   - ▷ No paper analyzes drivers of systemic risk at the **Euro area** versus the **national level** with special focus on the **Banking Union**.

   1st Look at **Bank characteristics** to find out whether they **[a]** can explain systemic risk and **[b]** they differ with respect to the regional level.

   2nd Are there heterogeneous effects conditional on **bank size**?

▸ Related Literature

1. What is a bank's contribution to systemic risk at the **Euro area** in contrast to the **national** level?

Measuring Systemic Risk: Intuition

- What is a bank's capital shortfall conditional on severe market decline?
- An **individual** bank's capital shortage might have minimal systemic consequences: asset liquidation, recapitalization or asset expansion.
- When there is an **aggregate** capital shortage, however, banks find it hard to **collectively** improve their balance sheets.

$\Rightarrow$ Banks with a capital shortfall when the market is in distress are contributing to systemic risk (Brownlees and Engle, 2015; Acharya et al. 2012).

$\Rightarrow$ Bank's failure to anticipate that other banks might have capital shortages too represents the externality that generates systemic risk.

Measuring Systemic Risk: SRISK[1]

- Capital shortfall is computed based on stock market data:

$$
\begin{aligned}
SRISK_{it} &= E_t(\text{Capital Shortfall}_{it+h} | \underbrace{R_{mt+1:t+h} < C}_{\text{Crisis}}), \\
&= E_t(k \underbrace{(\mathrm{D}_{it+h} + \mathrm{E}_{it+h})}_{\text{stressed Assets}_{it+h}} - \mathrm{E}_{it+h} | Crisis), \\
&= \underbrace{k(\mathrm{D}_{it} + (1 - \mathrm{LRMES}_{it})E_{it})}_{\text{Required Capital}} - \underbrace{(1 - \mathrm{LRMES}_{it})E_{it}}_{\text{Available Capital}}, \\
SRISK_{it} &= kD_{it} - (1-k)(1 - LRMES_{it})E_{it}, \quad \text{with}
\end{aligned}
$$

k = prudential capital ratio of equity to assets = 5.5 %.

D_{it} = book value of total liabilities.

$LRMES_{it}$ = sensitivity of banks' equity return to a 40% decline in some market index within six months.

E_{it} = current market capitalization of the bank or market value of equity.

[1] by Brownlees and Engle (2015); Go to Appendix A.

SRISK: National versus European Perspectives

- The LRMES part allows defining the regional level (Euro area vs. national) (Benoit, 2014):

$$SRISK_{it}^{EA} = kD_{it} - (1-k)(1 - LRMES_{it}^{EA})E_{it}$$
$$SRISK_{it}^{N} = kD_{it} - (1-k)(1 - LRMES_{it}^{N})E_{it}$$

- The difference between $SRISK_{it}^{EA} - SRISK_{it}^{N}$ indicates the ability to absorb losses of regional systemic risk:

$$\Delta SRISK_{it} = (1-k)(LRMES_{it}^{EA} - LRMES_{it}^{N})E_{it}$$

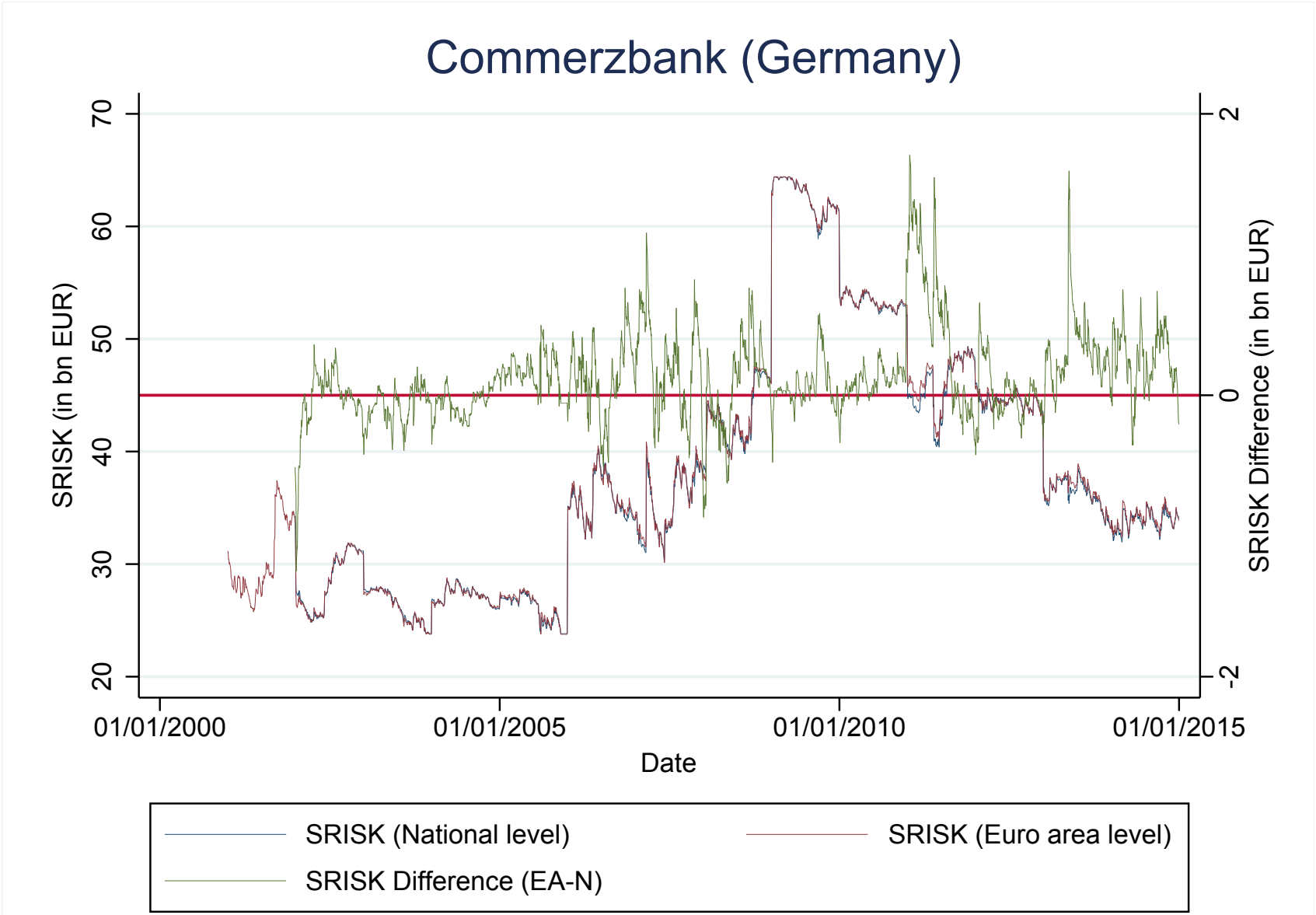
- **Euro area effect** if $\Delta SRISK_{it} > 0$. Bank has smaller ability to absorb losses at the Euro area.
- **National effect** if $\Delta SRISK_{it} < 0$. Bank has smaller ability to absorb losses at the national level.

Sample and Data

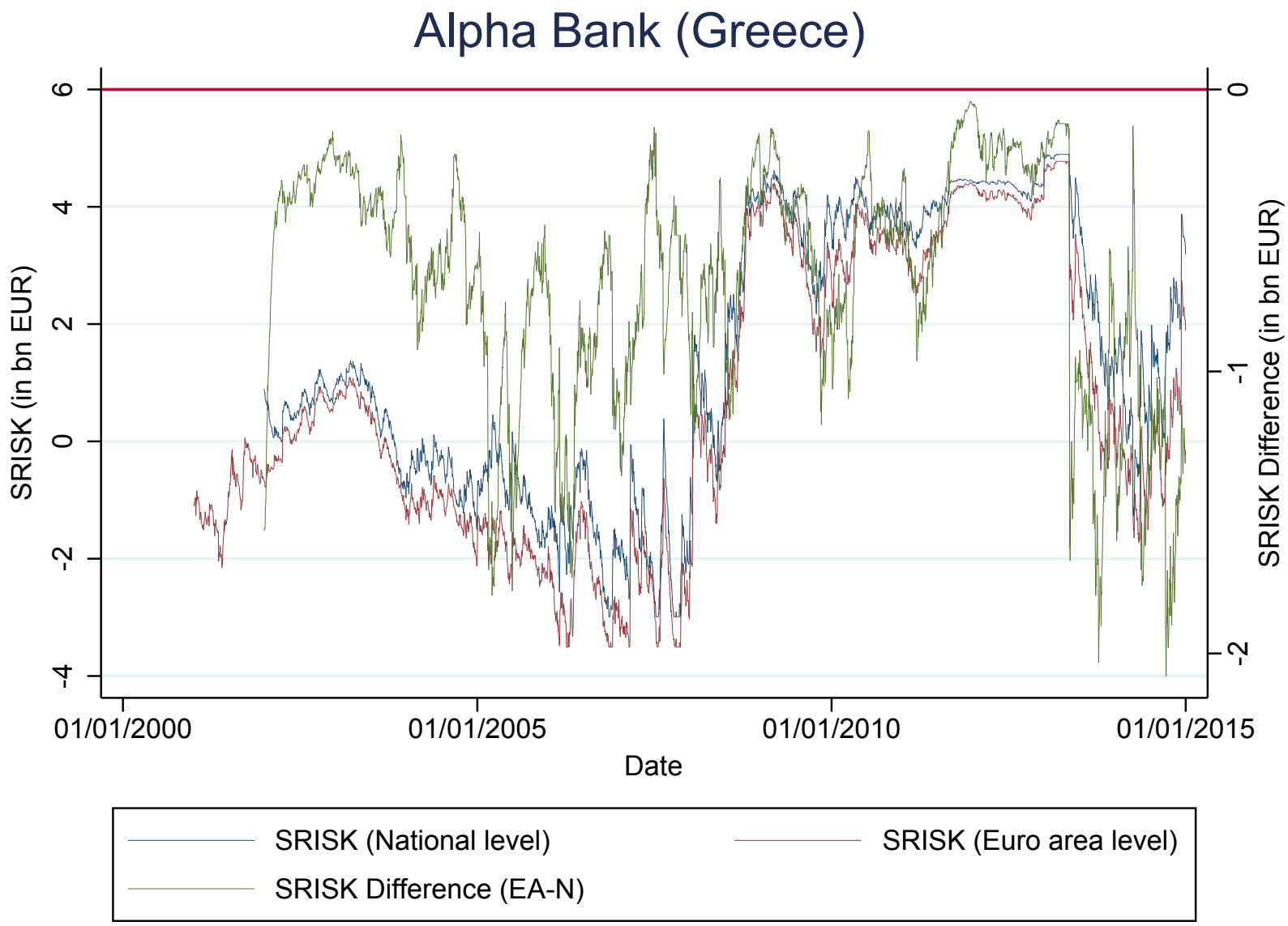
- Our sample is based on **80** (out of 111) **market listed banks** in 15 Euro area countries. The sample period spans the years 2005-2013.
- **Market data** from Datastream (stock prices and market values) and EuroStoxx (European index and national indices).
- **Balance sheet data** from Bankscope (e.g., loan share, assets, non interest income, npl).
- **Bank state aid** data from the state aid register of the EU commission (guarantees, direct grants, equity intervention, etc).
- **Internationalisation** (e.g., location and amount of subsidiaries) from Bankscope Ownership Module.
- **Macro controls** (e.g. inflation, GDP growth, government debt, domestic credit) from IMF and Worldbank.

Results: SRISK

SRISK of Commerzbank is higher at Euro area level.



SRISK of Alpha bank is higher at national level.



$\Delta SRISK_{it} > 0$: cross-country and time series heterogeneity

	Number of banks per year with $\Delta SRISK_{it}>0$									Total number of banks at time *t*
	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Austria	1	0	0	0	0	0	2	2	1	5
Belgium	0	0	0	0	0	2	2	2	2	2
Cyprus	0	0	0	0	0	0	0	0	0	2
Finland	2	1	3	2	2	1	2	2	1	3
France	5	6	4	6	12	10	13	10	10	17
Germany	5	5	6	6	5	6	6	5	5	6
Greece	0	0	0	0	0	0	0	0	0	6
Ireland	2	0	0	0	0	0	2	2	1	2
Italy	3	1	1	0	0	2	2	0	1	18
Malta	0	0	0	0	0	0	0	0	0	3
Netherlands	2	2	1	1	1	2	2	1	1	2
Portugal	0	0	0	0	0	0	0	0	0	3
Slovakia	0	0	0	0	0	0	0	0	0	1
Slovenia	2	2	1	0	0	0	0	0	2	2
Spain	3	3	2	2	2	2	1	1	0	8
Total	25	20	18	17	22	25	32	25	24	80

2. Do the **drivers** of systemic risk **differ** at the Euro area level versus the national level?

1. Baseline panel regression[2]

$$SRISK^{R}_{ijt} = \alpha_i + \gamma_t + \beta_1 \text{Macro}_{jt} + \beta_2 X_{ijt-1} + \beta_3 \text{Foreign}_{ijt} + \beta_4 \text{Dummy}_{ijt} + \epsilon_{ijt}$$

DEPENDENT VARIABLE

- $SRISK^{R}_{ijt}$ = **SRISK** of bank i in country j at time t (R= Euro area or National level)

EXPLANATORY VARIABLES

- Macro_{jt} = **Country-level control**: GDP growth, Inflation rate.
- X_{ijt-1} = **Bank-specific characteristics**: bank size, business model, profitability and liquidity
- Foreign_{ijt} = **Internationalization**: geographical diversification measure, share of foreign subsidiaries to total subsidiaries
- Dummy_{ijt} = **Policy controls**: G-SIFI status by FSB, state-aid received by national public authority

[2] similiar to De Jonghe (2015) and Laeven et al. (2015).

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Crisis sample		
	SRISK EA	*SRISK NAT*	*t-test*	*SRISK EA*	*SRISK NAT*	*t-test*
GDP growth$_t$	-0.146	-0.158	1.186	-0.235	-0.246	1.217
	(0.218)	(0.224)		(0.169)	(0.175)	
Inflation rate$_t$	-0.860	-0.880	0.623	-0.367	-0.378	0.187
	(0.531)	(0.541)		(0.352)	(0.355)	
Log assets$_{t-1}$	**8.616****	**9.165****	**4.303****	**11.688*****	**12.406*****	**3.326***
	(3.414)	(3.478)		(4.164)	(4.327)	
Loan share$_{t-1}$	**-2.877***	**-2.983***	**3.331***	**-3.373****	**-3.451****	1.078
	(1.500)	(1.524)		(1.605)	(1.648)	
Non-interest income$_{t-1}$	-1.040	-1.032	0.159	-0.991*	-0.996*	0.043
	(0.736)	(0.740)		(0.587)	(0.591)	
RoA$_{t-1}$	**0.994***	**1.041***	1.772	**0.896****	**0.930****	1.478
	(0.570)	(0.601)		(0.414)	(0.438)	
NPL$_{t-1}$	0.876	0.785	5.076**	0.264	0.120	6.333**
	(0.644)	(0.668)		(0.810)	(0.850)	
Short-term debt$_{t-1}$	-0.493	-0.553	2.512	-0.939	-1.009	1.658
	(0.776)	(0.796)		(0.976)	(1.004)	
G-SIFI$_t$	5.624	5.598	0.018	7.898***	7.733**	0.502
	(3.955)	(3.984)		(2.965)	(3.033)	
State aid$_t$	4.776***	4.789***	0.022	5.002***	5.045**	0.193
	(1.675)	(1.751)		(1.863)	(1.944)	
Observations	430	430	-	328	328	-
R^2	0.336	0.330	-	0.414	0.406	-
Number of banks	75	75	-	66	66	-

This table reports fixed effects regressions for the full sample (2005-2013) and the crisis sample (2007-2012) that are based on yearly data of stock listed banks in Euro Area countries. The regressions take into account bank and year fixed effects. Standard errors are robust and clustered by individual bank and depicted in parentheses. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

2. Are big banks different?

- Do bank-specific characteristics affect the contribution to systemic risk heterogeneously conditional on bank size?
- Big banks rely more on short-term financing and find it easier to diversify. (Gennaioli et al., 2013)
- Regression with size interaction:

$$SRISK^R_{ijt} = \alpha_i + \gamma_t + \beta_1 X_{ijt-1} + \beta_2 Y_{ijt} + \beta_3 \text{Size}_{ijt-1} + \beta_4 \text{Size}_{ijt-1} * X_{ijt-1} + \epsilon_{ijt}$$

Size_{ijt-1} = log of total assets

X_{ijt-1} = Bank-specific characteristics

Y_{ijt} = Macro controls, Internationalization, Policy controls

	(1)	(2)	(3)	(4)	(5)	(6)
	Interactions with log assets			Interactions with SSM status		
	SRISK EA	*SRISK NAT*	*t-test*	*SRISK EA*	*SRISK NAT*	*t-test*
GDP growth$_t$	-0.188	-0.196	0.353	-0.082	-0.095	1.559
	(0.209)	(0.216)		(0.202)	(0.208)	
Inflation rate$_t$	-1.097*	-1.115*	0.564	-0.872	-0.903	1.746
	(0.553)	(0.562)		(0.547)	(0.553)	
Log assets$_{t-1}$	**10.495*** **	**10.932*** **	**3.616***	**11.170*** **	**11.766*** **	**5.728****
	(3.661)	(3.747)		(3.500)	(3.533)	
Loan share$_{t-1}$	**-2.761****	**-2.914****	**9.709*** **	**-2.966****	**-2.947****	0.123
	(1.330)	(1.351)		(1.186)	(1.195)	
Non-interest income$_{t-1}$	**-1.866****	**-1.879****	0.206	0.653	0.651	0.004
	(0.897)	(0.904)		(0.492)	(0.498)	
RoA$_{t-1}$	**2.021****	**2.124****	**7.403*** **	-0.333	-0.346	2.250
	(0.960)	(0.987)		(0.216)	(0.215)	
NPL$_{t-1}$	**1.741****	**1.678****	**3.765***	-0.704	-0.766	3.212*
	(0.759)	(0.768)		(0.634)	(0.643)	
Short-term debt$_{t-1}$	0.731	0.698	0.443	0.328	0.287	2.579
	(0.989)	(1.012)		(0.663)	(0.667)	
G-SIFI$_t$	5.054	5.090	0.042	4.946	4.928	0.008
	(3.561)	(3.568)		(3.838)	(3.862)	
State aid$_t$	4.909***	4.982***	0.731	5.380***	5.431***	0.337
	(1.321)	(1.398)		(1.499)	(1.580)	
Interactions between the explanatory variables and log assets/SSM dummy						
Interaction with Loan share$_{t-1}$	-0.851	-0.960	8.290***	-0.152	-0.344	6.255**
	(1.461)	(1.460)		(1.701)	(1.702)	
Interaction with Non-interest income$_{t-1}$	**-2.693*** **	**-2.707*** **	0.601	**-3.237*** **	**-3.236*** **	0.001
	(0.715)	(0.714)		(1.150)	(1.152)	
Interaction with RoA$_{t-1}$	**1.340****	**1.393****	**6.242****	**2.778****	**2.908****	**6.806*** **
	(0.556)	(0.568)		(1.115)	(1.151)	
Interaction with NPL$_{t-1}$	**1.443****	**1.408****	1.371	**2.663*** **	**2.646*** **	0.155
	(0.602)	(0.618)		(0.902)	(0.906)	
Interaction with Short-term debt$_{t-1}$	-0.361	-0.363	0.001	-0.475	-0.477	0.000
	(0.983)	(1.010)		(1.319)	(1.348)	
Observations	430	430	-	430	430	-
R^2	0.407	0.401	-	0.360	0.354	-
Number of banks	75	75	-	75	75	-

▶ Marginal Effects Plot

Robustness

1. **Internationalization**: robust results, diversification vs. spill-over.
   Go to Appendix
2. **Correlated variables**: Results remain robust for including equity ratio or excluding return on assets. Go to Appendix
3. **SSM sample**: Robust except additional significance for NPL and RoA. Assets insignificant. Go to Appendix
4. **Additional bank level controls**: maturity mismatch as short-term debt to liquid assets enters significantly positive, no significant impact of market to book value. Go to Appendix
5. **SRISK**: average, median; Bank index vs. normal index; k=5.5%.
   Go to Appendix
6. **Country-level controls**: government debt, domestic credit, cross-border exposures and current account do not change results.
   Go to Appendix
7. **LRMES**: robust only for assets and state aid. Additional significance for short-term debt (+).

Conclusion

1st *What is a Bank's contribution to systemic risk at national/Euro level?*

- On average, banks' contribution to systemic risk is **higher at the national level** than at the Euro area level.
- But: **cross-section** and **time-series heterogeneity**.

2nd *Do drivers of systemic risk differ w.r.t. the regional level?*

- In general, **large banks** are more systemically important.
- More **profitable banks** and banks with a lower **share of loans to assets** tend to be more systemic.
- The **larger the bank**, effect of **non-interest income**, **profitability** and **non performing loans** on systemic risk is **heterogeneous**.
- **Qualitatively,** the determinants do not change with the regional level. But the **quantitative** importance of some factors differ.

Thank you for your attention!

Appendix A: related literature

- First strand: Measurement/determinants of systemic risk
  - *Adrian and Brunnermeier (2015)*
  - *Brownlees and Engle (2015)*
  - *Benoit (2014)*
  - *Weiß et al. (2014)*
- Second strand: Regulatory allocation in integrated markets
  - *Dell'Ariccia and Marquez (2006)*
  - *Agarwal et al. (2014)*
  - *Beck et al. (2013)*
- Third strand: Cross-border activities, complexity and financial stability
  - *Cetorelli and Goldberg (2011, 2014)*
  - *Buch and Goldberg (2014)*
  - *Carletti et al. (2015)*

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Appendix B

$$
\begin{aligned}
SRISK_{it} &= E_t(\text{Capital Shortfall}_{it+h}|\text{Crisis}), \\
&= E_t(\text{Capital Shortfall}_{it+h}|R_{mt+1:t+h} < C), \\
&= E_t(k(\text{Assets}_{it+h}) - Equity_{it+h}|R_{mt+1:t+h} < C), \\
&= E_t(k(\text{Debt}_{it+h} + \text{Equity}_{it+h}) - \text{Equity}_{it+h}|R_{mt+1:t+h} < C), \\
&= kE_t(\text{Debt}_{it+h}|R_{mt+1:t+h} < C) - (1-k)E_t(\text{Equity}_{it+h}|R_{mt+1:t+h} < C), \\
&= k\text{Debt}_{it} - (1-k)E_t(\text{Equity}_{it+h}|R_{mt+1:t+h} < C), \\
&= kD_{it} - (1-k)(1-MES_{it})E_{it}, \\
&= kD_{it} - (1-k)(1-LRMES_{it})E_{it}, \\
&= E_{it}\left[kL_{it} + (1-k)LRMES_{it} - 1\right].
\end{aligned}
$$

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Appendix C

Return decomposition

$$\begin{aligned} R_{mt} &= \sigma_{mt}\epsilon_{mt}, \\ R_{it} &= \sigma_{it}(\rho_{it}\epsilon_{mt} + (1-\rho_{it}^2)^{1/2}\xi_{it}), \\ (\epsilon_{mt}, \xi_{it} &\sim F). \end{aligned}$$

Marginal Expected Shortfall

$$\begin{aligned} MES_{it} &= E_{t-1}(-R_{it}|R_{mt} < C), \\ MES_{it} &= \sigma_{it}\rho_{it}E_{t-1}(\epsilon_{mt}|\epsilon_{mt} < C/\sigma_{mt}) + \sigma_{it}(1-\rho_{it}^2)^{1/2}E_{t-1}(\xi_{it}|\epsilon_{mt} < C/\sigma_{mt}), \\ LRMES_{it} &\cong 1 - exp(18 * MES_{it}) \end{aligned}$$

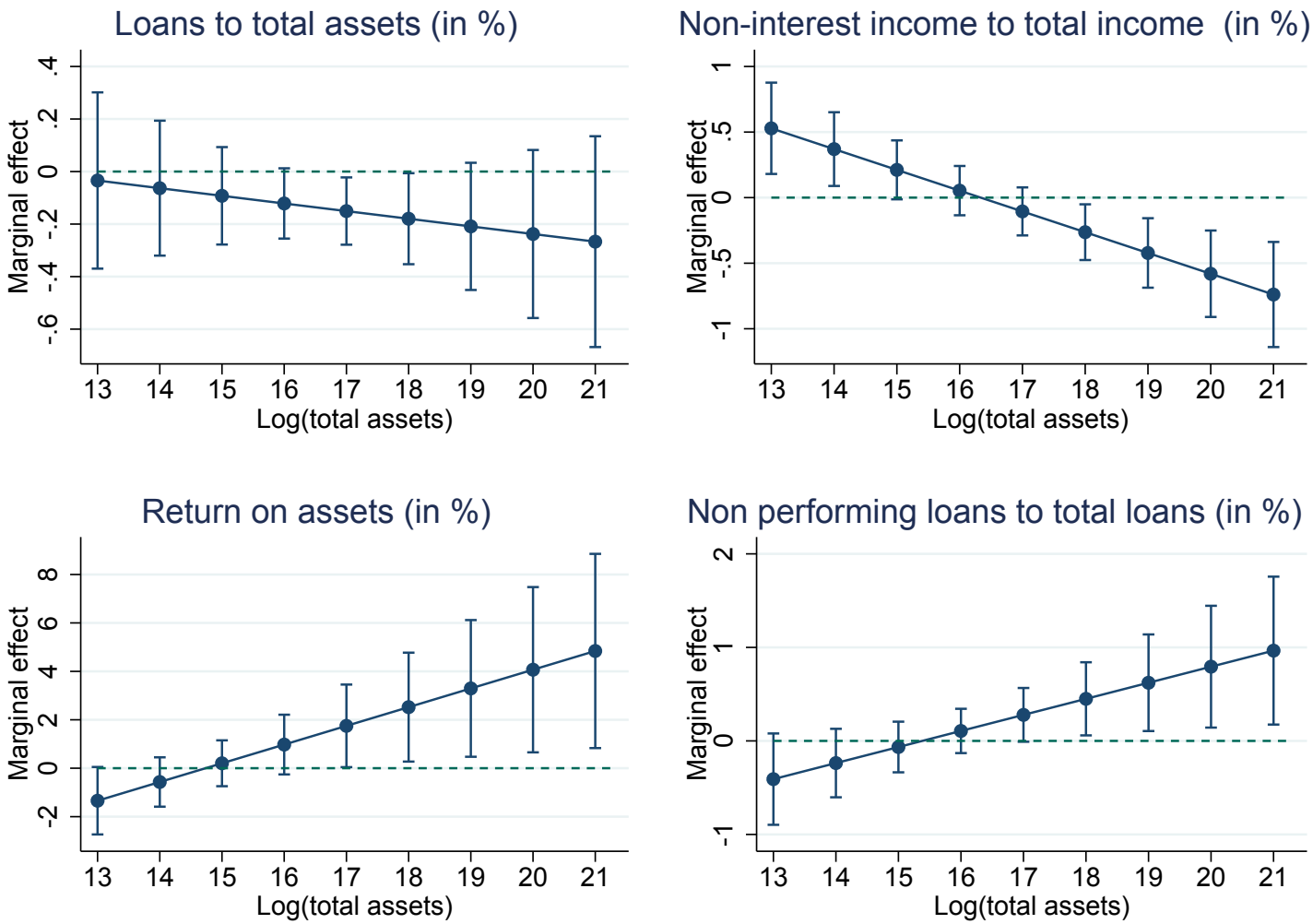
Summary statistics SRISK

	Obs.	Mean	Std. dev.	Skewness	Kurtosis	Min	Max
Total sample (80 banks)							
SRISK (Euro area)	177 563	10.75	25.55	3.26	14.23	-36.96	171.03
SRISK (National)	174 066	11.01	25.66	3.23	13.99	-39.93	170.48
SRISK (Difference)	174 066	-0.25	0.88	-10.02	490.67	-49.80	18.81
Not supervised by SSM (36 banks)							
SRISK (Euro area)	77 506	2.33	6.31	3.64	17.66	-31.29	42.26
SRISK (National)	75 984	2.37	6.32	3.67	17.51	-9.06	42.26
SRISK (Difference)	75 984	-0.04	0.63	-60.11	4 093.35	-49.80	2.52
Supervised by SSM (44 banks)							
SRISK (Euro area)	100 057	17.27	32.10	2.32	7.99	-36.96	171.03
SRISK (National)	98 082	17.70	32.18	2.29	7.87	-39.93	170.48
SRISK (Difference)	98 082	-0.42	1.00	-0.30	39.77	-15.74	18.81

Summary statistics bank characteristics

	Obs.	Mean	Std. dev.	Skewness	Kurtosis	Min	Max
Equity ratio (%)	430	6.55	3.11	2.17	12.70	1.45	24.60
Liquid assets (%)	430	17.11	10.23	1.31	5.25	2.51	61.56
Loan share (%)	430	62.21	17.13	-1.08	3.95	3.94	88.57
Market to book value (%)	415	1.19	0.78	0.99	3.51	0.06	3.84
Maturity mismatch (%)	430	0.01	0.05	8.14	68.62	0.00	0.48
Non-interest income (%)	430	21.14	8.87	2.06	13.45	3.73	78.44
Non-performing loans (NPL) (%)	430	5.24	4.26	1.56	5.96	0.41	25.45
RoA (%)	430	0.58	0.94	-2.63	17.12	-5.98	2.36
Short-term debt (%)	430	20.11	14.14	1.30	5.29	0.57	73.48
Total assets (log, k USD)	430	18.07	1.93	-0.09	2.38	13.39	21.66
Total assets to GDP (%)	430	34.28	45.95	2.02	7.28	0.03	231.58

Marginal effects - Interaction with bank size



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Robustness I - alternative bank controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	w/o RoA		Equity ratio		Maturity mismatch		Market to book value		Total assets to GDP		Liquid assets	
	SRISK EA	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*
GDP growth$_t$	-0.143	-0.156	-0.205	-0.216	-0.125	-0.136	-0.135	-0.155	-0.113	-0.126	-0.115	-0.126
	(0.221)	(0.227)	(0.220)	(0.227)	(0.209)	(0.215)	(0.268)	(0.280)	(0.201)	(0.205)	(0.219)	(0.225)
Inflation rate$_t$	-0.872	-0.892	-0.859	-0.879	-0.912	-0.938*	-0.929	-0.961	-0.811	-0.829	-0.875	-0.895
	(0.535)	(0.544)	(0.541)	(0.551)	(0.551)	(0.562)	(0.577)	(0.594)	(0.517)	(0.527)	(0.556)	(0.565)
Log assets$_{t-1}$	10.134**	10.755**	5.426	6.021*	8.408**	8.916**	8.531**	9.158**			12.730***	13.432***
	(3.952)	(4.077)	(3.572)	(3.601)	(3.457)	(3.517)	(3.762)	(3.832)			(3.459)	(3.563)
Loan share$_{t-1}$	-2.585*	-2.678*	-2.662*	-2.771*	-2.842*	-2.942**	-3.054*	-3.159*	-2.863**	-2.992**		
	(1.460)	(1.482)	(1.484)	(1.509)	(1.443)	(1.465)	(1.589)	(1.622)	(1.417)	(1.439)		
Non-interest income$_{t-1}$	-0.688	-0.663	-0.964	-0.957	-1.118	-1.118	-0.888	-0.894	-1.284*	-1.285*	-1.090	-1.085
	(0.751)	(0.760)	(0.756)	(0.760)	(0.720)	(0.724)	(0.694)	(0.697)	(0.734)	(0.737)	(0.725)	(0.728)
RoA$_{t-1}$			1.112*	1.158*	1.432*	1.513*	0.964*	1.017*	1.169*	1.226*	0.936*	0.982*
			(0.615)	(0.648)	(0.737)	(0.773)	(0.568)	(0.599)	(0.599)	(0.633)	(0.539)	(0.569)
NPL$_{t-1}$	0.159	0.034	0.874	0.784	1.090*	1.013*	0.823	0.743	1.095	1.010	1.027	0.942
	(0.926)	(0.977)	(0.594)	(0.618)	(0.560)	(0.572)	(0.673)	(0.702)	(0.662)	(0.689)	(0.694)	(0.720)
Short-term debt$_{t-1}$	-0.476	-0.535	-0.751	-0.808			-0.731	-0.806	-0.402	-0.454	-0.218	-0.267
	(0.760)	(0.778)	(0.840)	(0.861)			(0.850)	(0.875)	(0.751)	(0.770)	(0.679)	(0.695)
G-SIFI$_t$	5.811	5.794	6.044	6.012	5.520	5.488	5.586	5.560	5.155	5.109	5.729	5.706
	(4.002)	(4.033)	(3.920)	(3.952)	(3.950)	(3.987)	(3.915)	(3.943)	(3.733)	(3.738)	(4.119)	(4.150)
State aid$_t$	4.404**	4.399**	4.205**	4.226**	4.845***	4.856***	4.235**	4.281**	4.536**	4.525**	5.164***	5.191***
	(1.832)	(1.912)	(1.742)	(1.813)	(1.706)	(1.782)	(1.726)	(1.800)	(1.868)	(1.952)	(1.610)	(1.683)
Bank-level control$_{t-1}$			-1.726*	-1.701*	1.186*	1.278*	-1.130	-1.048	6.484*	6.708*	0.703	0.736
			(0.981)	(1.000)	(0.705)	(0.742)	(0.884)	(0.923)	(3.323)	(3.510)	(0.764)	(0.767)
Observations	430	430	430	430	430	430	415	415	430	430	430	430
R^2	0.328	0.321	0.342	0.336	0.339	0.333	0.347	0.341	0.350	0.344	0.329	0.322
Number of banks	75	75	75	75	75	75	72	72	75	75	75	75

This table reports fixed effects regressions for the full sample (2005-2013) that is based on yearly data of stock listed banks in Euro Area countries. The dependent variable is the SRISK (bn Euros) whereas the reference level is either the Euro Area or the national level as indicated at the top of each column. The explanatory variables include GDP growth and the inflation rate as well as bank-level variables: log of total assets, loans to total assets (in %), non-interest income to total income (in %), return on assets (in %), non-performing loans to total loans (in %), short-term debt to total liabilities (in %), equity to total assets (in %), maturity mismatch (in %), ratio of market to book value, total assets to GDP (in %), liquid asset to total assets (in %). These bank-level variables are lagged by one period and standardized. G-SIFI denotes a dummy which equals one if the bank was classified as a globally systemically important bank by the Financial Stability Board and zero otherwise. State aid denotes a dummy which equals one if the bank received state aid following the State Aid Register of the European Commission and zero otherwise. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

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Robustness II - SSM sample

	(1)	(2)	(3)	(4)	(5)	(6)
	SSM sample			SSM crisis sample		
	SRISK EA	*SRISK NAT*	*t-test*	*SRISK EA*	*SRISK NAT*	*t-test*
GDP growth$_t$	-0.116	-0.132	1.092	-0.259	-0.271	0.671
	(0.252)	(0.260)		(0.198)	(0.204)	
Inflation rate$_t$	-0.986	-1.028	1.935	-0.450	-0.484	1.129
	(0.669)	(0.676)		(0.460)	(0.460)	
Log assets$_{t-1}$	9.677	10.597*	8.505***	11.543	12.767*	3.774*
	(5.884)	(5.892)		(7.189)	(7.338)	
Loan share$_{t-1}$	**-4.698****	**-4.849****	**4.172****	**-4.948****	**-5.091****	2.273
	(2.215)	(2.249)		(2.247)	(2.302)	
Non-interest income$_{t-1}$	**-2.235***	**-2.256***	0.272	**-1.740***	**-1.787***	1.022
	(1.312)	(1.319)		(0.976)	(0.985)	
RoA$_{t-1}$	**2.711****	**2.830****	**7.942*****	**2.219*****	**2.323*****	**8.419*****
	(1.124)	(1.155)		(0.790)	(0.810)	
NPL$_{t-1}$	**2.105****	**2.006****	**5.965****	0.921	0.764	5.215**
	(0.890)	(0.900)		(1.042)	(1.071)	
Short-term debt$_{t-1}$	-0.252	-0.292	0.416	-0.712	-0.749	0.207
	(1.274)	(1.306)		(1.410)	(1.455)	
G-SIFI$_t$	4.814	4.778	0.036	6.851**	6.670**	0.587
	(3.783)	(3.817)		(2.891)	(2.965)	
State aid$_t$	5.059***	5.116***	0.421	4.743**	4.829**	0.591
	(1.664)	(1.739)		(1.840)	(1.924)	
Observations	292	292	-	226	226	-
R^2	0.398	0.392	-	0.468	0.461	-
Number of banks	44	44	-	41	41	-

This table reports fixed effects regressions for the sample of SSM banks and the period (2005-2013) as well as the crisis period (2007-2012) that are based on yearly data of stock listed banks in Euro Area countries. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

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Robustness III - Additional macro controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Government debt		Domestic credit		Cross-border exposures		Current account		Capitalization	
	SRISK EA	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*	*SRISK EA*	*SRISK NAT*
GDP growth$_t$	-0.240	-0.254	-0.052	-0.063	-0.204	-0.208	-0.086	-0.095	-0.303	-0.309
	(0.255)	(0.263)	(0.236)	(0.242)	(0.307)	(0.315)	(0.194)	(0.198)	(0.188)	(0.195)
Inflation rate$_t$	-0.462	-0.479	-0.793	-0.811	-1.058	-1.069	-0.735	-0.747	-1.044*	-1.054*
	(0.584)	(0.604)	(0.528)	(0.538)	(0.740)	(0.761)	(0.477)	(0.481)	(0.591)	(0.605)
Log assets$_{t-1}$	8.049*	8.458**	7.884**	8.425**	9.319*	9.601**	8.855**	9.419***	10.095***	10.581***
	(4.110)	(4.140)	(3.428)	(3.470)	(4.683)	(4.742)	(3.460)	(3.514)	(3.285)	(3.308)
Loan share$_{t-1}$	-2.616*	-2.764*	-3.168**	-3.277**	-2.650	-2.789	-2.662**	-2.755**	-1.929	-2.026
	(1.468)	(1.495)	(1.549)	(1.569)	(1.662)	(1.684)	(1.335)	(1.351)	(1.276)	(1.297)
Non-interest income$_{t-1}$	-1.212	-1.197	-1.026	-1.018	-1.074	-1.065	-1.072	-1.065	-0.768	-0.762
	(0.840)	(0.847)	(0.722)	(0.726)	(0.869)	(0.869)	(0.729)	(0.732)	(0.596)	(0.597)
RoA$_{t-1}$	1.180*	1.231*	0.910*	0.957*	0.946	0.991	1.064*	1.116*	0.910	0.961
	(0.591)	(0.623)	(0.512)	(0.542)	(0.582)	(0.609)	(0.609)	(0.642)	(0.569)	(0.600)
NPL$_{t-1}$	0.524	0.367	0.785	0.693	0.587	0.472	0.926	0.838	1.033	0.932
	(1.002)	(1.047)	(0.644)	(0.671)	(0.851)	(0.876)	(0.683)	(0.710)	(0.754)	(0.780)
Short-term debt$_{t-1}$	-0.998	-1.076	-0.614	-0.676	-0.572	-0.616	-0.477	-0.536	-0.856	-0.907
	(1.264)	(1.303)	(0.768)	(0.788)	(0.804)	(0.821)	(0.766)	(0.785)	(0.706)	(0.729)
G-SIFI$_t$	10.399***	10.279***	5.607	5.581	5.363	5.337	5.638	5.614	4.041	4.025
	(3.415)	(3.519)	(3.952)	(3.986)	(3.931)	(3.948)	(3.936)	(3.962)	(3.547)	(3.600)
State aid$_t$	6.387**	6.371**	4.855***	4.868***	4.527***	4.553**	4.800***	4.814***	4.949***	4.974***
	(2.709)	(2.801)	(1.658)	(1.733)	(1.659)	(1.740)	(1.673)	(1.749)	(1.772)	(1.849)
Country control$_t$	0.025*	0.026*	0.028*	0.028*	0.002	0.004	0.118	0.125	-0.568	-0.622
	(0.013)	(0.013)	(0.015)	(0.015)	(0.018)	(0.018)	(0.165)	(0.169)	(0.656)	(0.681)
Observations	357	357	430	430	378	378	430	430	413	413
R^2	0.443	0.433	0.340	0.334	0.355	0.350	0.338	0.332	0.329	0.324
Number of banks	64	64	75	75	67	67	75	75	75	75

This table reports fixed effects regressions for the full sample (2005-2013) that is based on yearly data of stock listed banks in Euro Area countries. Additional control variables at the country-level include government debt relative to GDP (in %), domestic credit to GDP (in %), cross-border exposures of the country's banking system to GDP (in %), current account to GDP (in %), the banking system's aggregate bank capital to assets ratio (in %). G-SIFI denotes a dummy which equals one if the bank was classified as a globally systemically important bank by the Financial Stability Board and zero otherwise. State aid denotes a dummy which equals one if the bank received state aid following the State Aid Register of the European Commission and zero otherwise. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

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Robustness IV - prudential capital ratio = 5.5%

	(1)	(2)	(3)	(4)
	Full sample		Crisis sample	
	SRISK EA	*SRISK NAT*	*SRISK EA*	*SRISK NAT*
GDP growth$_t$	-0.120	-0.133	-0.187	-0.198
	(0.189)	(0.195)	(0.153)	(0.158)
Inflation rate$_t$	-0.661	-0.681	-0.263	-0.275
	(0.454)	(0.463)	(0.341)	(0.344)
Log assets$_{t-1}$	4.297	4.854	7.042*	7.770**
	(3.219)	(3.241)	(3.720)	(3.834)
Loan share$_{t-1}$	-2.342*	-2.453*	-2.789*	-2.873*
	(1.287)	(1.308)	(1.420)	(1.461)
Non-interest income$_{t-1}$	-1.052*	-1.044	-0.980*	-0.984*
	(0.630)	(0.635)	(0.539)	(0.544)
RoA$_{t-1}$	0.955*	1.004*	0.869**	0.905**
	(0.523)	(0.554)	(0.391)	(0.416)
NPL$_{t-1}$	0.747	0.654	0.161	0.013
	(0.617)	(0.643)	(0.812)	(0.854)
Short-term debt$_{t-1}$	-0.309	-0.370	-0.685	-0.756
	(0.678)	(0.696)	(0.858)	(0.883)
G-SIFI$_t$	5.863*	5.837*	7.655***	7.486***
	(3.087)	(3.103)	(2.353)	(2.397)
State aid$_t$	5.051***	5.062***	5.245**	5.287**
	(1.789)	(1.869)	(1.981)	(2.067)
Observations	430	430	328	328
R^2	0.375	0.368	0.445	0.436
Number of banks	75	75	66	66

This table reports fixed effects regressions for the full sample (2005-2013) and the crisis sample (2007-2012) that are based on yearly data of stock listed banks in Euro Area countries. The dependent variable is the SRISK (bn Euros) whereas the prudential capital ratio is set to 5.5. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

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Internationalization measures

- Geographical Diversification[3]:

$$HHI\_GEO_{it} = \frac{R}{R-1}\left(1 - \sum_{r=1}^{R}\left(\frac{count_{itr}}{totalcount_{it}}\right)^2\right)$$

R = # of regions: UK, Japan, South Korea, China, Canada, the USA, Taiwan, Middle East, other Americas, other Europe, Eastern Europe, other Asia, other

$count_{itr}$ = # number of subsidiaries of bank i at time t in region r

$totalcount_{it}$ = total # of subsidiaries of bank i at time t.

- Share of foreign subsidiaries (in %):

$$Share_{it} = \frac{foreigncount_{it}}{totalcount_{it}}$$

$foreigncount_{it}$ = # number of foreign subsidiaries of bank i at time t

$totalcount_{it}$ = total # of subsidiaries of bank i at time t.

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[3] following Cetorelli and Goldberg (2014).

Effects of internationalization?

- Unfortunately, no public data available that distinguishes between foreign vs. domestic assets in banks' balance sheets.
- Geographical Diversification and Share of foreign subsidiaries to total subsidiaries. Definition

\+ Diversification in the asset portfolio would act as a buffer for domestic shocks.

− Spill-over of shocks can be a source of systemic risk.

→ Testing whether determinants of systemic risk are heterogeneous conditioning on cross-border exposures:

$$SRISK^{R}_{ijt} = \alpha_i + \gamma_t + \beta_1 X_{ijt-1} + \beta_2 Y_{ijt} + \beta_3 \text{Int}_{ijt} + \beta_4 \text{Int}_{ijt} * X_{ijt-1} + \epsilon_{ijt}$$

Int_{ijt} = Internationalization measure

X_{ijt-1} = Bank-specific characteristics

Y_{ijt} = Macro controls, Policy controls

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	(1)	(2)	(3)	(4)	(5)	(6)
	Interaction with foreign ownership			Interactions with HHI geo		
	SRISK EA	*SRISK NAT*	*t-test*	*SRISK EA*	*SRISK NAT*	*t-test*
GDP growth$_t$	-0.077	-0.089	0.842	-0.182	-0.196	1.516
	(0.207)	(0.214)		(0.228)	(0.236)	
Inflation rate$_t$	-0.802	-0.825	0.767	-0.763	-0.788	0.830
	(0.557)	(0.566)		(0.578)	(0.584)	
Log assets$_{t-1}$	**6.778***	**7.326****	**4.711****	6.387	6.906	**3.434***
	(3.419)	(3.497)		(4.918)	(5.046)	
Loan share$_{t-1}$	**-2.890***	**-3.044***	**7.220*****	**-3.199****	**-3.294****	**2.719***
	(1.577)	(1.602)		(1.308)	(1.336)	
Non-interest income$_{t-1}$	**-1.994***	**-1.970***	0.560	0.669	0.681	0.298
	(1.113)	(1.123)		(0.517)	(0.525)	
RoA$_{t-1}$	-0.363	-0.331	1.739	0.610	0.646	1.165
	(0.612)	(0.620)		(0.487)	(0.516)	
NPL$_{t-1}$	0.977	0.888	7.485***	0.348	0.226	7.676***
	(0.639)	(0.643)		(0.683)	(0.711)	
Short-term debt$_{t-1}$	-0.379	-0.452	1.390	-0.509	-0.550	2.151
	(1.223)	(1.256)		(0.497)	(0.505)	
Internationalization$_t$	**2.148****	**2.136****	0.066	**-4.597****	**-4.710****	1.630
	(0.854)	(0.849)		(1.820)	(1.851)	
G-SIFI$_t$	5.493	5.466	0.020	4.598	4.554	0.062
	(3.858)	(3.884)		(3.465)	(3.475)	
State aid$_t$	4.178**	4.207**	0.104	4.544***	4.554**	0.011
	(1.824)	(1.902)		(1.691)	(1.752)	
Interactions between the explanatory variables and foreign ownership/HHI geo dummy						
Interaction with Log assets$_{t-1}$	0.558	0.545	0.046	1.075	1.208	0.684
	(0.941)	(0.933)		(3.464)	(3.440)	
Interaction with Loan share$_{t-1}$	-0.906	-0.796	11.04***	-1.854	-1.871	0.019
	(0.701)	(0.702)		(2.884)	(2.910)	
Interaction with Non-interest income$_{t-1}$	**1.905****	**1.877****	0.947	**-6.913*****	**-6.895*****	0.062
	(0.852)	(0.860)		(2.104)	(2.105)	
Interaction with RoA$_{t-1}$	**1.972****	**2.041***	1.435	2.221	2.291	0.583
	(0.988)	(1.027)		(2.014)	(2.035)	
Interaction with NPL$_{t-1}$	0.119	0.139	0.313	2.665	2.753	0.748
	(0.696)	(0.704)		(2.145)	(2.215)	
Interaction with Short-term debt$_{t-1}$	-0.016	0.036	1.026	1.602	1.541	0.241
	(1.087)	(1.102)		(1.984)	(2.069)	
Observations	420	420	-	420	420	-
R^2	0.372	0.366	-	0.413	0.406	-
Number of banks	74	74	-	74	74	-