The Effect of Structural Risks on Financial Downturns

RPN 3/2021: Interaction of Cyclical and Structural Systemic Risks: Insights from Around and After the Global financial Crisis

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CNB Research Open Day, May 23, 2022

Motivation

- In the aftermath of the GFC, the **financial cycle** and **systematic risk** have (again) become much discussed and analysed topics
  - in response to the GFC, ***macroprudential policy*** was formed with its focus targeted at the systemic risk development in the financial sector
- We investigate **the extent to which various structural risks could exacerbate the materialization of cyclical risk** during a financial cycle downturn
  - **cyclical component of systemic risk** = dynamic evolution of the financial cycle
  - **structural component of systemic risk** = structural features of the financial sector and real economy
- We focus on the 2006q1-2019q4 period surrounding and following the GFC outbreak

Contribution to the Literature

- 1) We add to the literature on financial cycles:
  - we primarily show the extent to which **various structural risks could exacerbate the materialization of credit risk** (as seen through increase in nonperforming loans to total loans ratio, NPL) during a financial cycle downturn
- 2) We also contribute to the literature studying the financial system structure and its implications for lending and economic growth:
  - recent studies recognize that the course of financial crises is directly affected by certain structural characteristics of the financial sector (Rose and Spiegel 2012 JIE, Dawood et al. 2017 JFS; Langfield and Pagano, 2016 EP; Bats and Houben, 2020 JBF)
  - we consider a more comprehensive sample of structural risks than others (Stremmel and Zsámboki, 2015 ECB and Ari et al, 2020 ECB)
  - we show that also other structural characteristics of the financial system might be of importance -> such as **real estate exposure concentration, the level of indebtedness or the banking sector profitability and leverage ratio**

Data on Cyclical, Credit and Structural Risks

- Quarterly country-level data from **30 advanced countries in 2006Q1 – 2019Q4**
  - period is focused on **cyclical risk downturns during and after the GFC** – a textbook example of a crisis created by endogenously accumulating imbalances in the financial sector (similarly to the eurozone debt crisis that followed)
  - we do not assess Covid-19 crisis
- We rely on three types of data:
  - 1) a measure of cyclical (and credit) risk
  - 2) a dataset covering all sorts of structural risks.
  - 3) various macro-financial controls from numerous data sources
- We use two approaches:
  - Event study approach
  - Panel regression analysis

Table 1: Mnemonics and Description of Our Variables

Type of risk	Mnemonics (in regression)	Description	Source
Structural risks stemming from the characteristics of the banking sector	Assets/GDP	Total assets of the banking sector to GDP, per cent	FSI*
	FinOpen	The Chinn-Ito index (KAOPEN) measuring a country's degree of capital account openness	Chinn & Ito (2006)
	bank x market	Bank credit to private sector as ratio of GDP over sum of ratio of total non-financial sector debt market capitalization to GDP and ratio of stock market capitalization to GDP	WB(GFDD) and BIS
	REL/L	Residential real estate loans to total loans, per cent	FSI
	LR	Tier 1 leverage ratio defined as bank's core capital relative to its total assets, per cent.	FSI
	ROA	Return on assets, per cent	FSI
	Liq/Assets	Liquid assets to total assets (liquidity ratio), per cent	FSI
	DSTI	Debt service to total income, per cent	FSI
	C RWA	Regulatory capital to risk-weighted assets, per cent	FSI
	RW	Risk-weighted exposures to total exposures	FSI
	3M IR	3-month interbank interest rate	OECD database
Structural risks stemming from the characteristics of the real economy	Debt NFS	Debt of non-financial sector to GDP, per cent	BIS statistical warehouse
	Debt HH	Debt of households to GDP, per cent	BIS statistical warehouse
	Debt GOV	Debt of government to GDP, per cent	BIS statistical warehouse
	Debt PNS	Debt of private non-financial sector, per cent	BIS statistical warehouse
	Exp/GDP	Exports to GDP, per cent	WB database
	FCL/L	Foreign currency loans to total loans, per cent	FSI
	GDP growth	Real GDP growth, per cent	OECD database
Cyclical risks	NPL/L	Non-performing loans to total loans, per cent	FSI
	FCI	Financial cycle indicator	Aldasoro et al. (2020)
	d-SRI	Domestic systemic risk indicator	Lang et al. (2019)
	FinCyc	Financial cycle index	own calculation

How To Measure Cyclical and Credit Risk

- 1) A **composite financial cycle indicator** should be more successful than a single measure in reducing the uncertainty arising from the unclear definition of the financial cycle:
  - following Drehmann et al. (2012 BIS) and Borio (2014 JBF) in combining the information captured in the development of credit aggregates and property prices into a single financial cycle measure
  - we use the band-pass filter (Christiano & Fitzgerald,2003), to extract the cyclical component of the series under consideration and then we use PCA to get Financial Cycle Indicator (FinCyc)

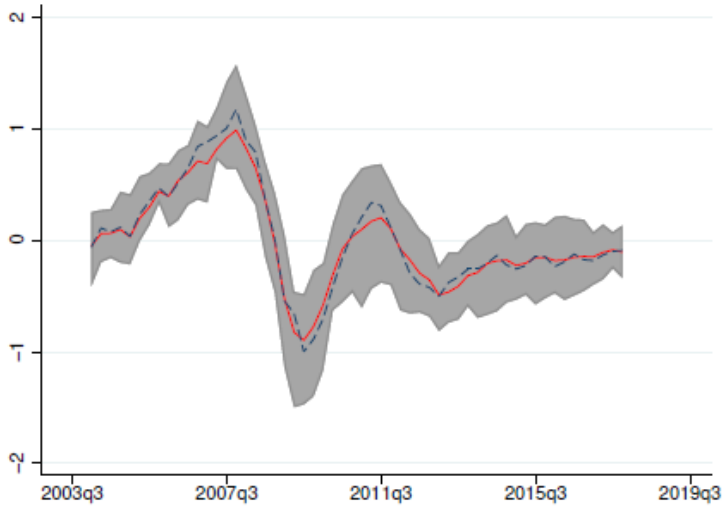
- 2) We also consider the **financial cycle index (FCI)** developed by Drehmann et al. (2012) and used in BIS studies and a **domestic cyclical systemic risk indicator (dSRI)** introduced in Lang et al. (2019) and used by the ECB

- 3) We also consider a subset of the cyclical risk – the **credit risk** which we proxy by the **NPL ratios:**
  - distinction between cyclical and structural risk factors seems clear in theory, some structural variables can also have a cyclical component
  - however there is no trivial two-way relationship between the level of structural risks and the level of credit risk materialisation

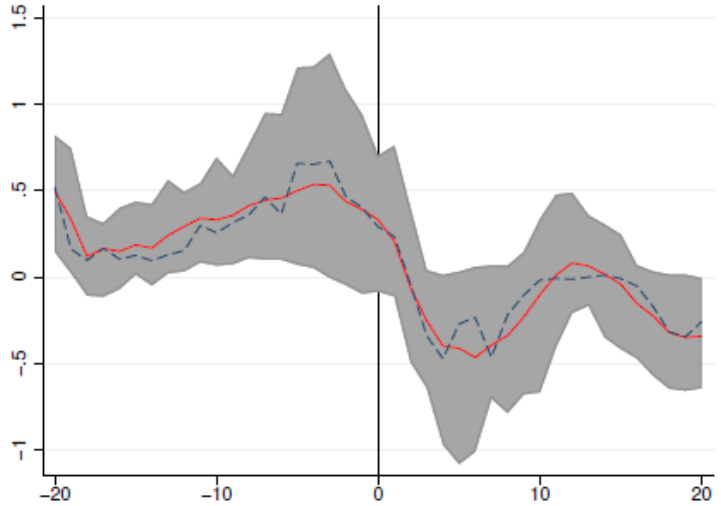
How To Measure Cyclical and Credit Risk

Figure 2: Cross-country Distribution of the Estimated Financial Cycle Index

(A) Composite Financial Cycle Indicator



(B) Evolution Around Systemic Financial Crises



Note: Panel A: The shaded region marks the area between the first and third quartile of the cross-country distribution. The solid red line denotes the mean and the dashed blue line the median. The sample size is 30 countries. Panel B: the x-axis depicts the number of quarters before/after systemic financial crises. $t = 0$ marks the beginning of a crisis any time during the 2004Q1–2019Q4 time span according to the ECB/ESRB crises database described in Lo Duca et al. (2017).

Source: Own computation based on various data sources.

Event-Study Approach

- We adopt a phase-centric approach, originally proposed for the analysis of a business cycle (Burns and Mitchell, 1946) – turning point analysis
  - a first look at the relationship between financial downturns, credit risk materialization and structural risks
  - we focus on the recessionary phase of a financial cycle (from peak to trough) = one unit of cyclical time
- Our specific methodology to **identify turning points** is based on Harding and Pagan (2002)
  - changes in log levels of the variables
  - local maxima and minima of our the *FinCyc* indicator*,* while imposing certain rules:
    - we require the duration of the materialization phase to be at least 4 quarters (d=4)
    - break between individual cycles is set to be at least 4 consecutive quarters of growth
- Having specified the turning points, we proceed by computing for each country in our sample the **amplitude of cyclical risk materialization** (A_m):

$$A_m = (f_{max} - f_{min}) \times d$$

Event-Study Approach

- We identify **69 phases of cyclical risk materialization** in our sample of countries over the period 2006Q1-2019Q4 (amplitudes of cyclical risk materialization)
- A majority of countries in the sample experienced at least two episodes of cyclical risk materialization, lasting from 6 to 9 quarters on average
  - The first identified amplitude was the most intense which is not surprising as it is linked for most countries to the period surrounding the GFC.
  - The second amplitude captures the period of Eurozone sovereign debt crisis
  - The third amplitude is mostly country specific, without a clear common denominator
- The most severe materialization phase was identified in case of Greece, the United States, Portugal and Italy

Amplitude (A_m)	Mean	Median	Min	Max	Standard deviation	No. of countries	Average duration
1	14.21	13.36	1.32	42.75	9.15	30	8
2	11.25	9.02	1.64	60.37	11.63	29	9
3	6.51	5.55	2.37	13.24	3.22	10	6

Event-Study Approach – Correlation Analysis

- We match the identified amplitudes of cyclical risk materialization with the levels of individual structural risks – then we run a correlation analysis

Q1: Did the initial level of structural risks determine the extent to which cyclical risk materialized?

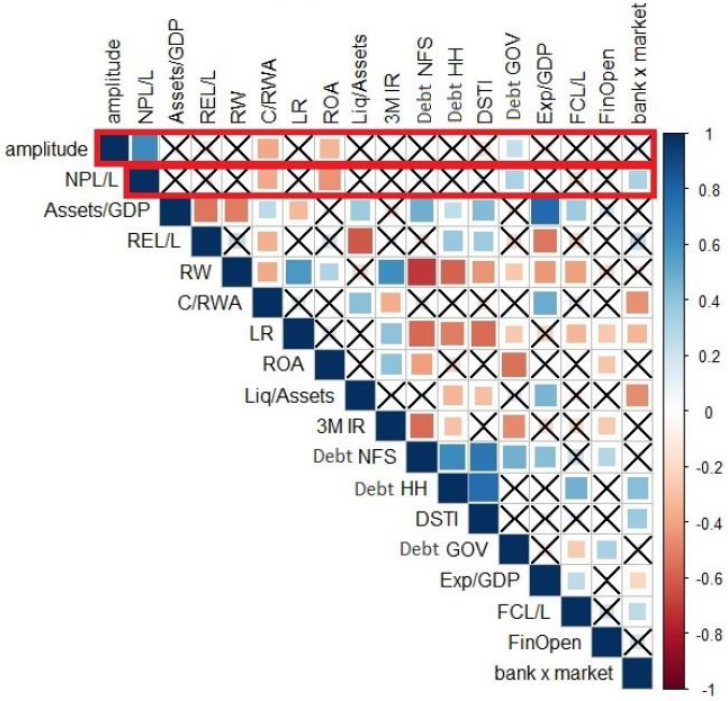
1. we consider **the level of the structural indicator at the start** of the materialization phase
2. if f_t marks the start of first financial cycle materialization phase at 2008Q3 and the end at 2010Q4, we pair the A_m value [(2008Q3 value - 2010Q4 value) times 10] with the level value of structural risk indicator at 2008Q3

Q2: How did structural risks evolve over the whole course of cyclical risk materialization?

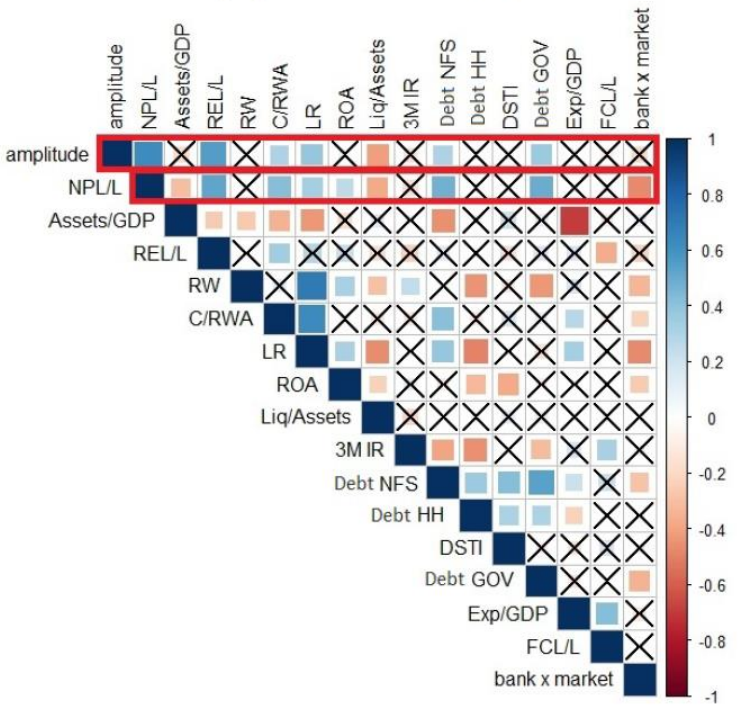
1. we calculate **the difference between the end and start values of structural indicators**, following the start and end dates of cyclical risk materialization
2. under this approach, we would pair the f_t value [(2008Q3 value -- 2010Q4 value) times 10] with the difference between the level value of structural risk indicator at the end and the start dates (i.e. 2010Q4 value -- 2008Q3 value)

Correlation of Cyclical and Structural Risks

(A) *START*



(B) *END–START*



- lower starting level of financial sector resilience means deeper and longer materialization of cyclical (and credit) risk
- the starting level of government debt is also positively correlated with *Am* and *NPL*

- *Am* and *NPL/L* are highly correlated
- more severe financial cycle downturn associated with an increase in the banking sector resilience but also more severe deterioration of the liquidity
- higher cyclical and credit risk materialization coincides with faster growth of private and public debt

Panel Regression Approach

- Unbalanced cross-country time series data set comprising 30 OECD countries over the period 2008Q3-2019Q4
- Panel regression (static), beta coefficients interpreted as elasticities:

$$Credit\_RISK_{it}^{mat} = \alpha + \beta \boldsymbol{Struct}_{it-4} + \gamma \boldsymbol{X}_{t-4} + \delta_t + \theta_i + \varepsilon_{it}$$

- We concentrate only on risk materialization phase, e.g. we only consider periods when $Credit\_RISK_{it}^{mat}$ increases on a quarter-to-quarter basis
- We use **(i) the NPL ratio as a credit risk approximation** (a subset of a cyclical systemic risk)
- We then use **(ii) various composite indicators of cyclical systemic risk** (and we are aware that structural risks may have a cyclical component similar to that of cyclical systemic risk indicators)
- We consider different model specifications based on the selection of structural risks in the vector $\boldsymbol{Struct}_{it-4}$ (bearing in mind the risk of multicollinearity)

Structural Risks and Credit Risk Materialization

Table 3: Structural Risks and Credit Risk Materialization

Dep. var.: NPL/L	(1)	(2)	(3)	(4)
Debt PNS	0.080***	0.081***		
	(0.018)	(0.020)		
Debt GOV	0.105***	0.153***	0.166***	0.153***
	(0.021)	(0.028)	(0.028)	(0.028)
Debt HH			0.172***	
			(0.041)	
Debt NFS				0.061**
				(0.027)
REL/L (real est. exp.)	0.145**	0.166**	0.119*	0.152**
	(0.058)	(0.068)	(0.067)	(0.069)
Liq/Assets (liq. ratio)	-0.084***	-0.082***	-0.082***	-0.091***
	(0.025)	(0.021)	(0.021)	(0.021)
bank x market	0.130**	0.116*	0.118*	0.184**
	(0.051)	(0.066)	(0.065)	(0.069)
C RWA (reg. cap. ratio)	-0.193**			
	(0.085)			
LR (leverage ratio)		-1.104***	-1.200***	-1.058***
		(0.266)	(0.271)	(0.264)
RW (risk weights)		0.190***	0.185***	0.189***
		(0.054)	(0.054)	(0.054)
3M IR (interest rate)	-0.362*	-0.229*	-0.345*	-0.117
	(0.214)	(0.150)	(0.154)	(0.151)
Exp/GDP (openess)	0.083***	0.075***	0.079***	0.068**
	(0.024)	(0.027)	(0.025)	(0.028)
Macro controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	800	622	622	622
adj. R^2	0.514	0.516	0.517	0.508
F-test	22.651	19.630	19.731	19.039
	0.000***	0.000***	0.000***	0.000***

Note: The dependent variable is the ratio of non-performing loans to total loans expressed as the period-to-period increases over the period 2008Q3–2019Q4. Robust standard errors in parenthesis. The constant was estimated but is not reported. Macro controls include real GDP growth and the rate of inflation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

- The estimated parameters are robust to changes in the empirical specification and the use of composite cyclical risk indicators as the dependent variable (**Appendix**) instead of NPLs.

Considering the Thresholds of Structural Risks

Table 4: Empirical Link Between an Increasing NPL Ratio and the above and below threshold values of Structural Risks

Dependent variable: NPL ratio (upturns)	Above threshold structural risks				Below threshold structural risks			
Split by	REL/L	LR	Debt PNS	3M IR	REL/L	LR	Debt PNS	3M IR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Debt PNS	0.034***	0.112**	0.038	0.073***	0.061***	0.032***	0.053***	0.045***
	(0.008)	(0.053)	(0.028)	(0.025)	(0.016)	(0.008)	(0.009)	(0.007)
Debt GOV	0.123**	0.201***	0.132***	0.093**	0.065***	0.037***	-0.004	-0.015
	(0.050)	(0.046)	(0.043)	(0.047)	(0.024)	(0.014)	(0.012)	(0.010)
REL/L (real est. exp.)	0.343***	0.585***	0.491***	0.420***	0.005	0.010	-0.012	-0.005
	(0.102)	(0.222)	(0.132)	(0.085)	(0.044)	(0.025)	(0.020)	(0.031)
Liq/Assets (liq. ratio)	-0.103***	-0.089	-0.168***	-0.154***	-0.037	0.007	-0.001	0.024
	(0.033)	(0.241)	(0.045)	(0.032)	(0.042)	(0.013)	(0.011)	(0.026)
bank x market	0.346***	0.313***	0.305***	0.318***	-0.040	-0.052*	-0.082**	-0.023
	(0.070)	(0.094)	(0.101)	(0.084)	(0.043)	(0.030)	(0.033)	(0.024)
LR (leverage ratio)	-0.880	-0.777	0.019	-0.009	0.101	-0.513***	0.119	0.023
	(0.992)	(0.768)	(0.952)	(0.810)	(0.185)	(0.197)	(0.198)	(0.136)
RW (risk weights)	0.308**	0.317**	0.194**	0.138**	0.019	0.056*	0.032	0.069*
	(0.120)	(0.151)	(0.097)	(0.064)	(0.029)	(0.032)	(0.031)	(0.029)
3M IR (interest rate)	-0.415***	-0.384***	-0.398***	-0.590***	-0.053	-0.033	-0.083	0.045
	(0.112)	(0.109)	(0.157)	(0.064)	(0.104)	(0.098)	(0.120)	(0.077)
Exp/GDP (openess)	0.251***	0.245***	0.205***	0.223***	0.053	0.033	0.083	0.045
	(0.063)	(0.055)	(0.045)	(0.066)	(0.067)	(0.088)	(0.076)	(0.071)
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	413	295	378	463	436	440	435	418
adj. R^2	0.528	0.536	0.508	0.515	0.370	0.237	0.325	0.353
F-test	15.226	13.524	17.677	14.818	11.304	10.278	12.597	12.913
	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***

- threshold for the sample split: the average of the given indicator over the three-year window ahead of the start of our sample period in 2008Q3

Conclusion and Discussion

- We show that past accumulation of structural risks may influence the extent to which credit risk (and cyclical risk) materialize during financial cycle downturns:
  - among these risks**, private and public sector indebtedness, banking sector resilience and the concentration of real estate exposure stand out**
  - we show that above threshold levels of structural risks prior to financial cycle contractions substantially amplify the materialization of credit risks and the financial cycle contraction itself
- The elevated levels of some of the structural risks identified may be related to the long-standing accommodative economic policy:
  - low-for-long possibly leads to structural changes in the financial system and restricts the natural materialization of accumulated systemic risk during financial cycle contractions
    -> bigger role for macroprudential policy?
- **Countries with high levels of structural risks should be more proactive in increasing capital buffers during the expansionary phase of the financial cycle**

Thank You for Your Attention

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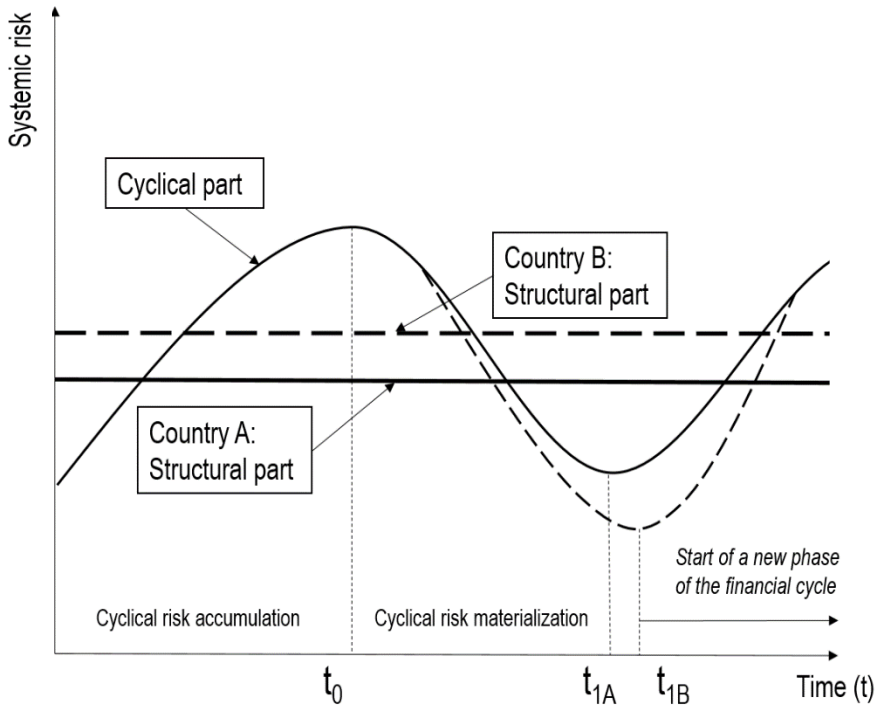
Back-up slides
Appendix

Systemic Risk: an Overview

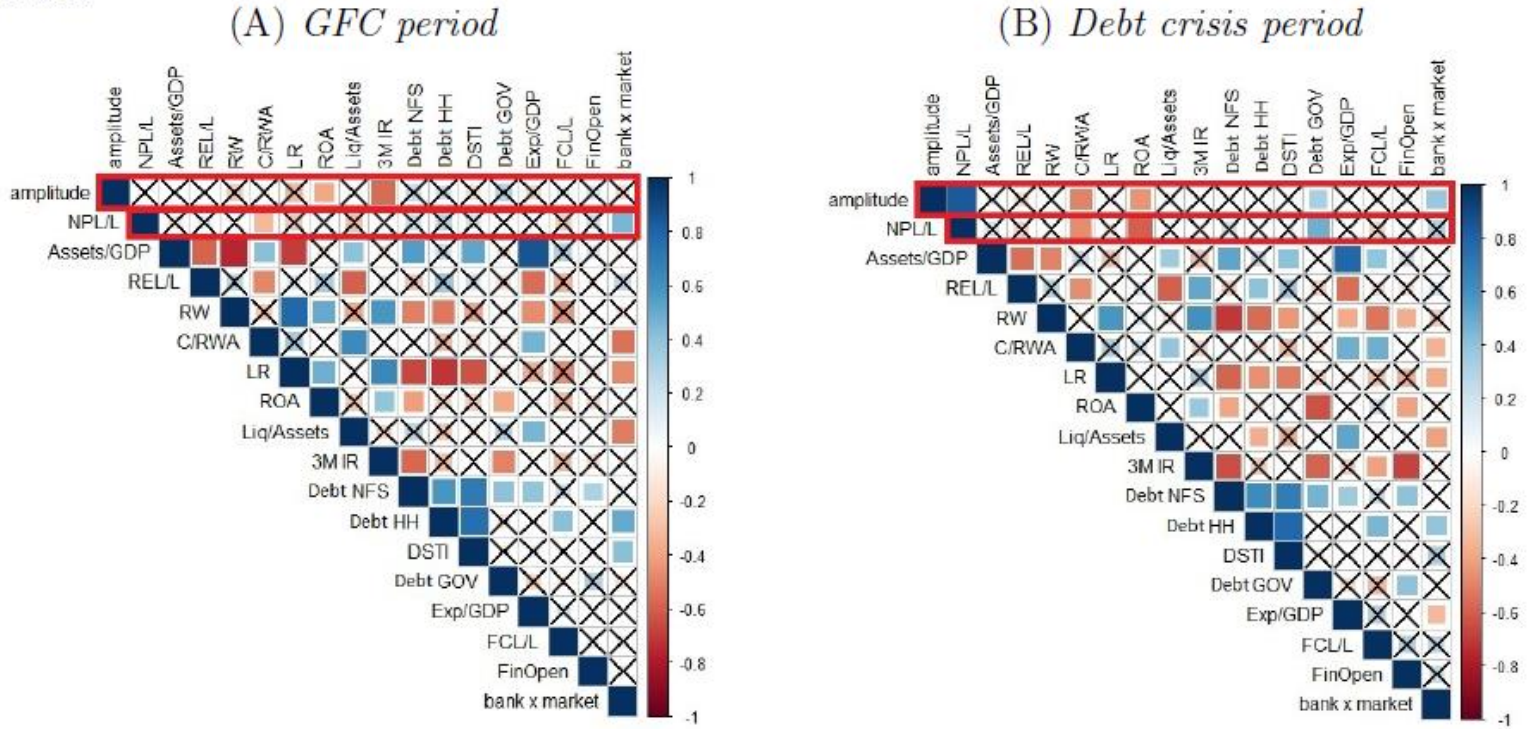
- The impact of systemic risk on real economy is directly observable only once it materializes:
  - **cyclical risk** illustrate the evolution of systemic risk during one phase of the financial cycle (i.e. its build-ups and materializations)
  - **structural risks** illustrate the level of systemic risk accumulated over time and has the potential to amplify the impact of adverse economic shocks
- The **cyclical risk** (and the related financial cycle) is well covered by the current literature
  - credit and house prices indicators (Borio & Zhu 2012, Aikman et al. 2015, BIS 2017).
- **Structural risks** are analyzed separately while the aim is often to identify threshold values (Pescatori et al., 2014 IMF; Lombardi et al., 2017 BIS).
  - but it abstracts from the relationship of structural risks and cyclical risks and from some amplification channels of structural risks (Table 1)
  - moreover, structural risks may develop in clusters

Figure 1: Stylized Interplay Between the Cyclical and the Structural Part of Systemic Risk



Further Insights From the Correlations

Figure A4: Correlation Matrices for Financial Cycle Amplitude and Individual Structural Risks

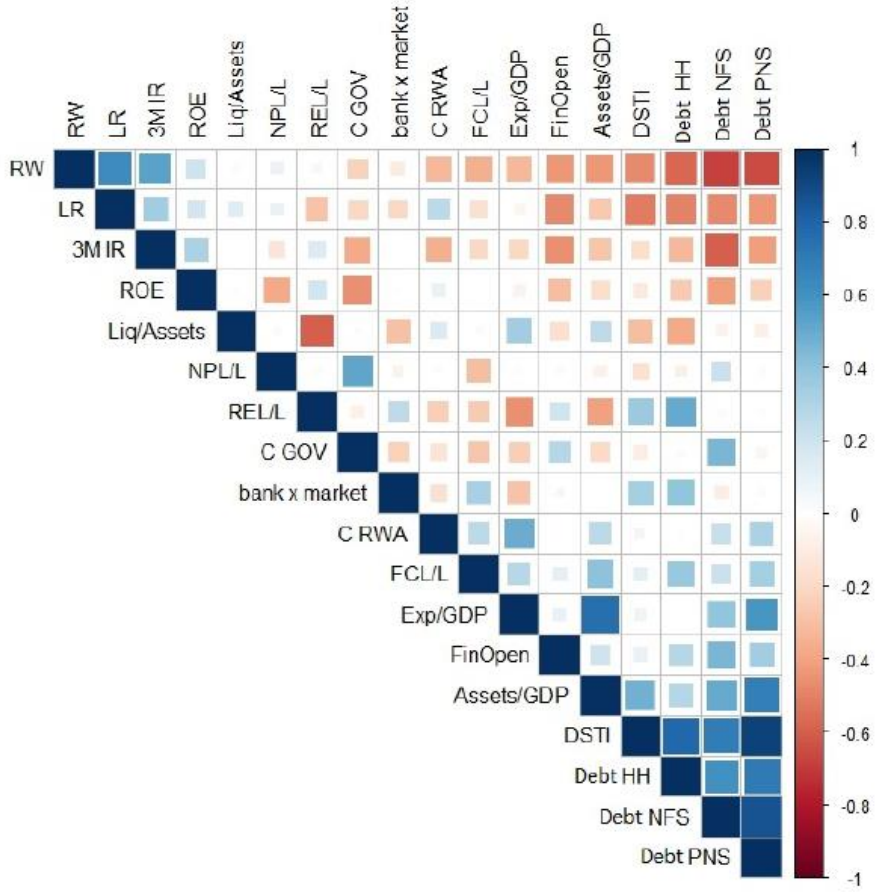


Note: Both correlations are based on the START approach, the same as the correlations in Panel A of Figure 4. Crossed fields denote a statistically insignificant correlation coefficient at the 5% level as evidenced by t-statistics.

Source: Own computation.

Structural Risks may Develop in Clusters

Figure A2: Correlation Matrix for Structural Risks



Note: We used the first principal component (FPC) order as the ordering method for the correlation matrix. The matrix should therefore show clusters of structural risks that are similar and emerge together.

Structural Risks and Credit Risk Materialization

Table C1: Structural Risks and Cyclical Risk Materialization

Dep. var.:	FCI(own)		FCI(BIS)		FCI(ECB)	
	(1)	(2)	(3)	(4)	(5)	(6)
Debt PNS	-0.031**	-0.036**	-0.025**	-0.008	-0.038**	-0.035***
	(0.012)	(0.018)	(0.012)	(0.037)	(0.016)	(0.010)
Debt GOV	-0.073*	-0.103**	-0.059**	-0.079**	-0.082**	-0.107**
	(0.040)	(0.052)	(0.025)	(0.031)	(0.032)	(0.041)
REL/L (real est. exp.)	-0.118*	-0.260**	-0.247**	-0.385***	-0.161*	-0.320***
	(0.062)	(0.128)	(0.109)	(0.126)	(0.087)	(0.101)
Liq/Assets (liq. ratio)	-0.010	0.003	-0.019	-0.012	-0.032	0.024
	(0.043)	(0.058)	(0.043)	(0.057)	(0.034)	(0.046)
bank x market	-0.517***	-0.569***	-0.316***	-0.445***	-0.271***	-0.322***
	(0.094)	(0.123)	(0.095)	(0.121)	(0.076)	(0.098)
C RWA (reg. cap. ratio)	0.359**		0.457**		0.281*	
	(0.180)		(0.182)		(0.145)	
LR (leverage ratio)		2.967***		2.988***		2.379***
		(0.501)		(0.493)		(0.397)
RW (risk weights)		-0.264***		-0.335***		-0.230***
		(0.101)		(0.099)		(0.080)
3M IR (interest rate)	0.556	1.160**	1.019**	1.531***	0.539*	0.774**
	(0.393)	(0.468)	(0.398)	(0.461)	(0.317)	(0.371)
Exp/GDP (openess)	-0.067*	-0.047	-0.019	0.004	-0.141***	-0.108***
	(0.041)	(0.050)	(0.041)	(0.049)	(0.033)	(0.040)
N	628	476	688	519	375	268
adj. R^2	0.239	0.267	0.285	0.342	0.203	0.244
F-test	7.534	7.434	9.286	10.215	6.312	6.702
	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note on Endogeneity

- A possible concern could be that during a financial cycle downturn, structural risks tend to increase as a result of, for example, government support of the economy, so that $cov(\boldsymbol{Struct}, \varepsilon) > 0$ (inflating betas)
- To cater for this, we lag the structural risk indicators and other control variables by one year (t-4)
- We formally examine the causal relationship between cyclical risk materialization and structural risks by employing panel Granger causality tests
  - Estimates suggest that within our data, the relationship is a one-way stream for most variable pairs
- Quarterly frequency should also be helpful in mitigating the endogeneity bias, when compared to annual data
- In our robustness checks, we split our sample into two groups based on the level of structural risks