

Stress Testing with Multi-faceted Liquidity

The Central Bank Collateral Framework as a Financial Stability Tool

Angelo Cuzzola

angelo.cuzzola@santannapisa.it

Joint with:

Claudio Barbieri (SSM, DG-HOL)

Ulrich Bindseil (ECB, DG-MIP)

Working Group on Stress Testing

2022 Research Workshop - Frankfurt - September 29, 2022

Motivation, background and contributions

Motivation and background

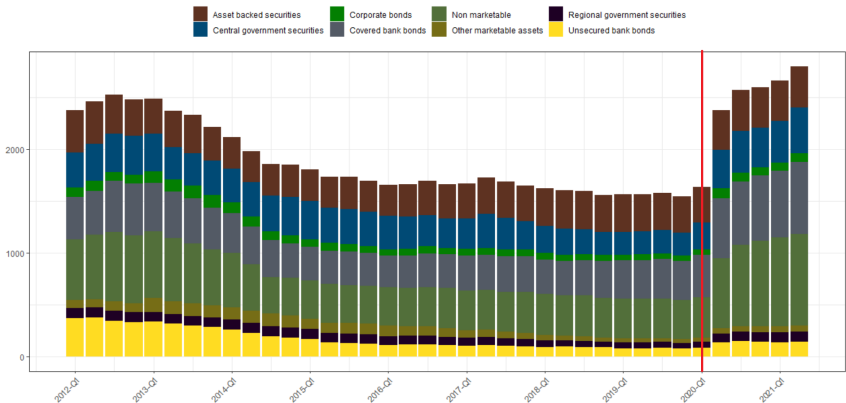
“The encumbrance ratio continued the upward trend initiated in 2020 and reached 29.1% in 2021.” (EBA Encumbrance Report 2022)



Motivation and background

“Central bank funding increased its relevance as the main source of encumbrance.” (EBA Encumbrance Report 2022)

From 13% in Dec. 2019 to 27.6% in Dec. 2021 as relative source of encumbrance.



Since the outbreak of the great financial crisis, stress tests have become fundamental tools for **banking supervision**.

More recently, the circumstances of the COVID19 crisis required the ECB to step in as an **essential liquidity provider**.

Banks interact strategically with ECB policies:

- Monetary policy affects quantity of high-liquid collateral
Grandia et al. (2019)
- Impact of LCR regulation on demand for CB reserves
Kedan and Veghazy (2021)

We aim to investigate the link between the effects of the ECB credit policies, with a focus on the design of the collateral framework, and banks' performances in a stress test.

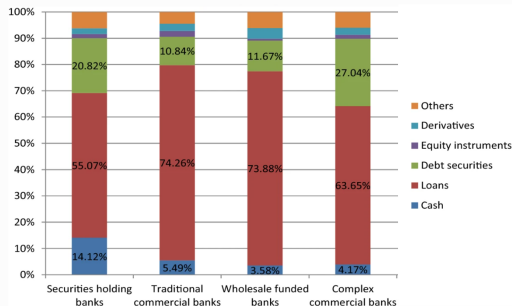
Motivation and background

The stress outcomes under multi-faceted liquidity

Banks with less liquid assets and lower liquidity buffers can naturally appear riskier in a stress test

During a crisis, however, banks can resort to the ECB credit upon collateralization.

A stress test model should



Source: Farnè & Vouldis (2021), p. 36

- represent the assets to account for the variety in the eligibility spectrum of the collateral framework (CBCF);
- explain changes in the risk profile of the banks induced by the CBCF;
- capture the multi-faceted nature of liquidity: the asset have different liquidity prospects on different channels.

A summary of the extant stress testing models analyzed along four fundamental modelling dimensions

	Active/Passive behavior of banks	Single/multi financing channel(s)	Contagion	Liquidity-solvency interaction
Greenwood et al., 2015	Active	Single-channel	✓	✗
Cont and Schaanning, 2017	Active	Single channel	✓	✗
Cont et al., 2020	Active	Multi-channel	✗	✓
BEAST (Budnik et al. 2020)	Active	Two channels	✓	✓
Sydow et al. 2021	Active	Multi-channel	✓	✓
SSM regulatory ST (bottom-up)	Passive	-	✗	-

- Design a stress test model with four key features: active behaviour of banks, multiple financing channel, implicit contagion effects and liquidity-solvency interactions.
- Liquidity is modelled as a multi-faceted property of assets providing a quantitative framework to study the implications of different collateral framework designs (beyond its risk-protection function).
- The model is used to analyze the effects of the CB collateral framework on banks' performances in a dynamic stress test.
- We apply the framework to a simulated financial system and to a dataset of European financial institutions, constructed integrating two different sources: FINREP and AnaCredit.
 - Properties in line with previous studies (e.g. threshold for systemic triggers, "robust-yet-fragile")
 - New insights on the liquidity/solvency interaction and on the post-shock adjustment process

The operational stress-test model

We extended existing stress models integrating and enriching their main characteristics in one operational framework.

- Cont and Schaanning (2017) and Coen et al. (2019): models with fire sales and indirect contagion through common exposures, based on theoretical (Shleifer and Vishny, 2011) and empirical studies on fire sales (Greenwood et al., 2015; Duarte and Eisenbach, 2021)
- Cont et al. (2020), a structural framework for the joint stress testing of solvency and liquidity
 - liquidity and solvency risk interact as the liquidity shortfalls are induced by the run-off of credit sensitive fundings -> **modelling liabilities run-off probabilities**
 - Banks respond to the liquidity shocks undertaking various mitigating action -> **modelling banks behaviour in a complex liquidity landscape**

An operational model featuring a population of financial institutions with a granular balance sheet representation

Assets side		Liabilities side	
$A_{\mu,i}^{M,enc}, A_{\mu,i}^{M,une}$	Marketable	e_i	Equity
$A_{\nu,i}^{N,enc}, A_{\nu,i}^{N,une}$	Non-marketable	l_i^u	Unsecured credit
c_i	Cash	l_i^{rp}	Repo credit
o_i	Other assets	l_i^{cb}	Central Bank credit
		l_i^{ot}	Other credit
		$\{l_{ik}^d\}_{k \in \mathcal{D}_i}$	Short-term deposits

Table: Balance sheet representation for bank i , with $\mathcal{D}_i$ defining the set of depositors of the bank.

With a given balance sheet representation the dynamics of the stress test is determined by this set of interactions

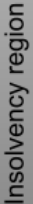
Asset value shocks. Exogenous when prompted as the starting point of the stress test or endogenously generated by mark-to-market price mediated contagion.

Liquidity shocks. Induced by the run-off of credit sensitive fundings due to the deterioration of banks fundamentals.

Banks' mitigating action. Banks compensate the liquidity shortfall accessing four different channels: i) unsecured credit (distance to default as in Cont et al. (2020)), ii.1) Repo credit, ii.2) Central Bank credit, ii.3) assets sales.

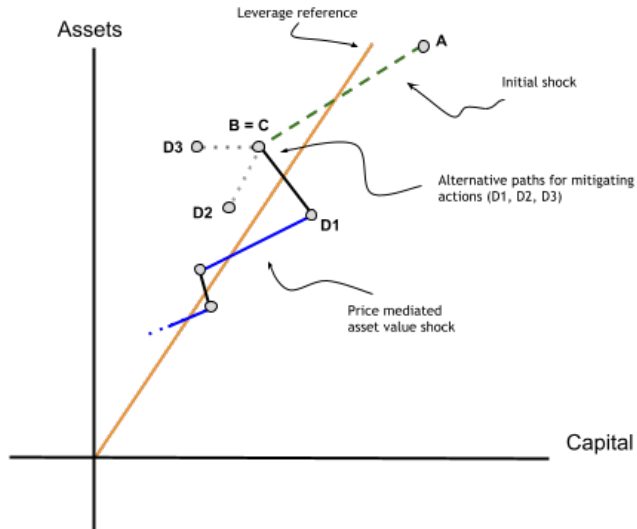
Price mediated contagion. Banks actions may affect assets' prices determining assets values shifts that are transferred to banks balance sheets as endogenous shocks.

1. An exogenous shock hits the value of the assets. Banks' fundamentals change accordingly.
2. Credit sensitive fundings respond to the banks' balance sheets changes, possibly inducing bank-specific liquidity shortfalls.
3. All the banks in the financial system are called to action, initially they deal with liquidity shortfalls or use the available funding sources to restore the possibly deteriorated fundamentals. They access the various channels according to their objective and collateral availability.
4. Banks that are not able to cover the liquidity shortfall default for illiquidity, banks that, after repaying, cannot face the costs of the compensating financing operations default for insolvency.
5. The mark-to-market losses mediated by assets prices are transferred to banks' balance sheet items in the form of assets value shock as in step 1. The cycle restarts.



Model timeline

Leverage-ratio diagram



Model applications and results

Asset classes and liquidity categories

36 asset classes identified by a unique combination of CB haircuts, Repo haircuts, and market depths

Model initialization

50 banks

- Banks belong to one of the four business models defined in Farnè and Vouldis (2021)
- The size of banks is drawn from a lognormal distribution

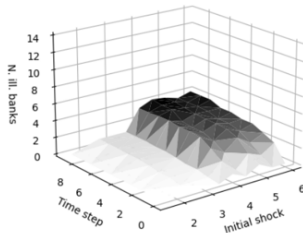
50'000 depositors

- Each agent has max 5 deposits
- The distribution of deposits is Pareto-like
- Depositors can be “stable” (70%) and “informed” (30%) and are uniformly distributed across banks

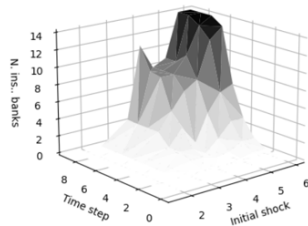
Model applications and results

A synthetic financial system: illiquidity triggers insolvency

- In our simulated baseline, insolvency is more common than illiquidity
- Illiquidity anticipates and fosters subsequent rounds of insolvency defaults: if the shock is strong enough to induce liquidity defaults in few banks, the recourse to fire sales triggers a price spiral
- “Robust-yet-fragile”: existence of a minimal threshold (here around 4%) for a shock to have systemic effects (e.g. Gai and Kapadia, 2008; Battiston et al., 2009)



(a) Illiquid banks.



(b) Insolvent banks.

Model applications and results

Synthetic financial system: effects of the CBCF

- Threshold of the collateral framework to affect financial stability (around 15% reduction of the CB haircuts)
- Larger effects on insolvency than on illiquidity

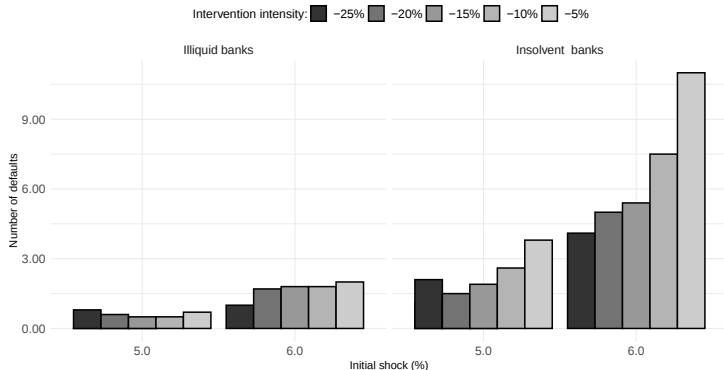


Figure: Illiquid banks and insolvent banks for 5% and 6% shocks to non-marketable assets for different values of collateral framework expansion.

Model applications and results

An application to the European Banking System (EBS)

Data Balance sheet decomposition using FINREP and AnaCredit:

- Country (Euro Area, main OECD economies, RoW)
- Type of counterpart: central banks, government, non-financial institutions, other financial institutions
- Type of securitisation (synthetic, traditional, unsecuritized)
- Industrial sector (NACE 2)
- Categorized by class of risk and class of maturity

Scenarios

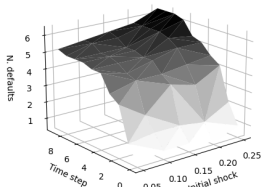
- EBA: calibrate shocks that replicate the loss in leverage of the 2021 EU-wide stress test
- Russia-Eastern shock: shock to sovereign, commercial and retail exposures to Russian and Eastern countries
- Southern European shock: shock to NFC and HH of southern European countries

Model applications and results

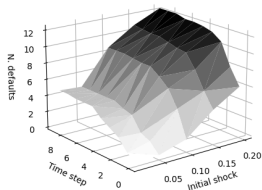
An application to the EBS - Defaults

- Even small shocks cause banks' distress (no evidence of a threshold in the empirical model)
- Bigger shocks proportionally trigger higher levels of defaults

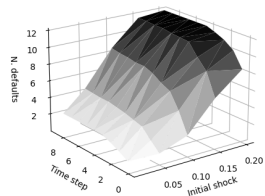
EBA scenario



Eastern Countries scenario



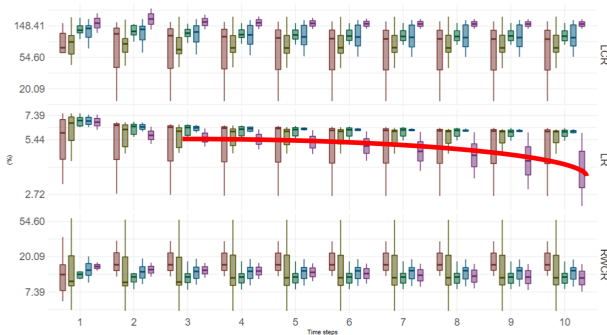
South. res. scenario



Model applications and results

Russia and eastern countries scenario

- Shocks affects the distributions of the regulatory ratios of banks by country
- Immediate and mild impact on liquidity coverage ratio and capital ratio
- Longer term impact on leverage ratio: long lasting liquidity adjustment process



(b) Eastern countries scenario (I5).

Next steps

- We are currently refining the comparison between with/without collateral framework scenarios.
- The assets classification can be further exploited for the definition of other scenarios (e.g. sectoral shock).
- Checking the robustness of the encumbered/unencumbered classification and extending to all asset types (at start) in the empirical application.

Thanks for your attention!

Questions and comments are welcome

- BUDNIK, K. B., M. BALATTI, I. DIMITROV, J. GROSS, M. KLEEMANN, T. REICHENBACHAS, F. SANNA, A. SARYCHEV, N. SINENKO, AND M. VOLK (2020): "Banking euro area stress test model," .
- COEN, J., C. LEPORE, AND E. SCHAANNING (2019): "Taking Regulation Seriously: Fire Sales Under Solvency and Liquidity Constraints," *Bank of England Working Paper*.
- CONT, R., A. KOTLICKI, AND L. VALDERRAMA (2020): "Liquidity at risk: Joint stress testing of solvency and liquidity," *Journal of Banking & Finance*, 118, 105871.
- CONT, R. AND E. SCHAANNING (2017): "Fire sales, indirect contagion and systemic stress testing," *Indirect Contagion and Systemic Stress Testing* (June 13, 2017).
- DUARTE, F. AND T. M. EISENBACH (2021): "Fire-Sale Spillovers and Systemic Risk," *The Journal of Finance*, 76, 1251–1294.
- FARNÈ, M. AND A. T. VOULDIS (2021): "Banks' business models in the euro area: a cluster analysis in high dimensions," *Annals of Operations Research*, 1–35.

- GRANDIA, R., P. HÄNLING, M. LO RUSSO, AND P. ÅBERG (2019):
“Availability of high-quality liquid assets and monetary policy operations:
an analysis for the euro area,” *ECB Occasional Paper*.
- GREENWOOD, R., A. LANDIER, AND D. THESMAR (2015): “Vulnerable
banks,” *Journal of Financial Economics*, 115, 471–485.
- KEDAN, D. AND A. V. VEGHAZY (2021): “The implications of liquidity
regulation for monetary policy implementation and the central bank
balance sheet size: an empirical analysis of the euro area,” *ECB working
paper series*.
- SHLEIFER, A. AND R. VISHNY (2011): “Fire Sales in Finance and
Macroeconomics,” *Journal of Economic Perspectives*, 25, 29–48.
- SYDOW, M., A. SCHILTE, G. COVI, M. DEIPENBROCK, L. DEL VECCHIO,
P. FIEDOR, G. FUKKER, M. GEHREND, R. GOURDEL, A. GRASSI, ET AL.
(2021): “Shock amplification in an interconnected financial system of
banks and investment funds,” .