



EUROPEAN CENTRAL BANK

EUROSYSTEM

Introduction to the FSC Working Group on Stress Testing



2022 Research Workshop of the FSC
Working Group on Stress Testing
29 September 2022

Katarzyna Budnik

FSC Working Group on Stress Testing



Mandate

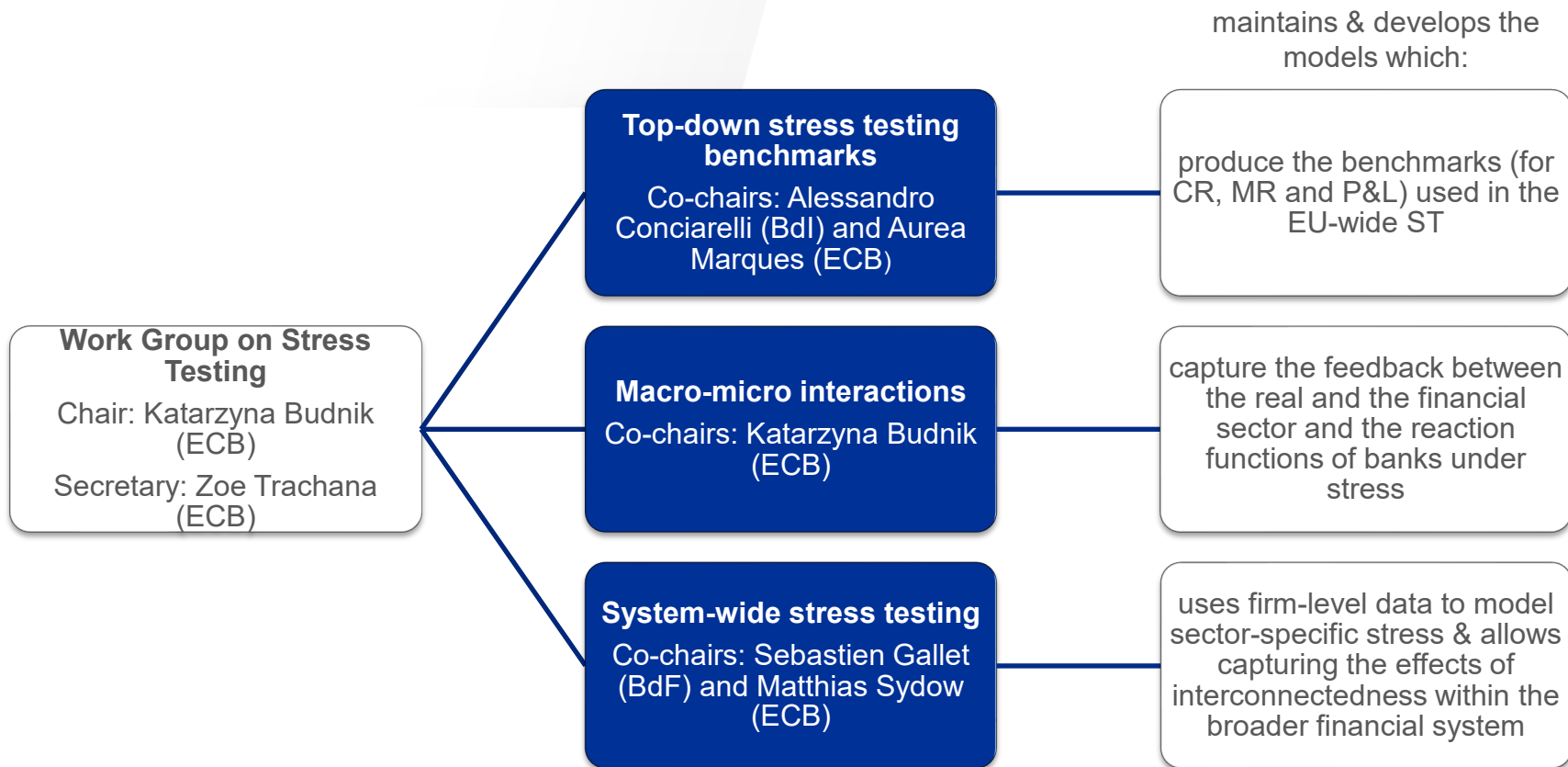
- Operationalize **state-of-the-art methodologies & academic research** on risk analysis, counterfactual risk & policy impact assessments.
- Propose **specific & readily implementable tools** to be shared among FSC members for consistent cross-country applications, under the condition that participating FSC members are willing to share the data needed for the development of such models.



Governance

- The WGST aims to **foster cooperation** between the FSC WGST members and promote ownership of the joint work
- The WGST **regularly updates the FSC** on its findings and work-plans.
- The WGST was launched at end-2018 with a mandate of 3 years then extended another year due to the pandemic. The membership of the group was also extended to EU non-EA countries & EBA.

WGST workstreams



FSC Working Group on Stress Testing 2018-2022

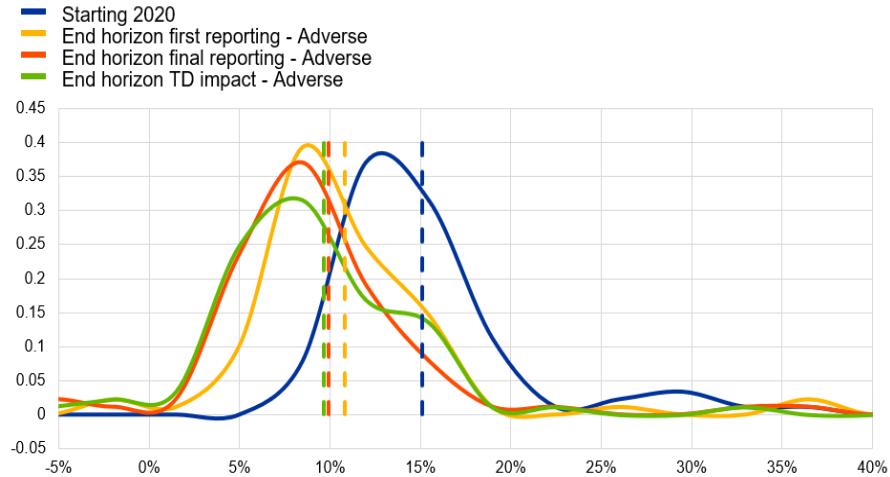
	Top-down benchmarks	Macro-micro interactions	System-wide stress test
Deliverables	<ul style="list-style-type: none"> • Improving & expanding benchmark models for credit, market risk & profitability employing new techniques, e.g. stochastic search variable selection, quantile regressions • Implementing a comprehensive validation framework • Fostering the exchange of data & absorbing new datasets e.g. EMIR, Anacredit • Delivering benchmark parameters for EU-wide stress tests 2018, 2021, forthcoming 2023 • Timely reacting to new challenges such as the need for sector-level analysis (climate risks, COVID-19) 	<ul style="list-style-type: none"> • Advancing a macro-financial semi-structural model for macroprudential stress testing • Introducing multiple-scenario analysis & growth-at-risk approaches within the model • Validating the estimates of main behavioural equations in macroprudential stress testing • Extending the use of dedicated datasets e.g. NPL coverage expectations 	<ul style="list-style-type: none"> • Developing a three sector model for banks, insurance companies and investment funds with the emphasis on direct and indirect contagion
Achievements	<ul style="list-style-type: none"> • Top down Vulnerability Analysis 2020 & later 2022 analyses incl. interest rate sensitivity, impact of Russian-Ukrainian war • Core position in the EBA centralised approach that aims to increase the top-down component of the EU-wide stress test 	<ul style="list-style-type: none"> • Regular macroprudential stress test 2018, 2020, 2021 • Assessment of Basel III finalisation • Tailored assessments of prudential (and other) policy measures • Macroprudential risk assessments incl. for climate risks, interest rate sensitivity 	<ul style="list-style-type: none"> • System-wide climate stress test 2022 • Implementation of the model in other institutions

Quality assurance

Impact of the quality assurance between first and last submission in 2021 EU-wide stress test – adverse scenario

Kernel distribution

(%; vertical lines indicate the weighted average of banks)

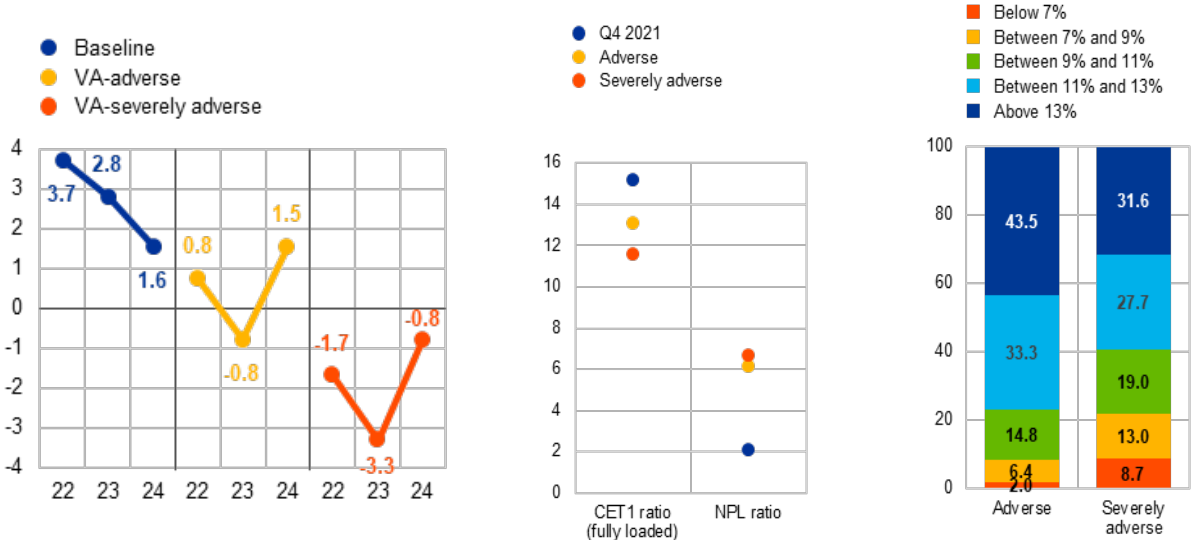


Source: Sources: participating banks, ECB and ECB calculations.

Vulnerability analysis 2022: the impact of the Russian-Ukrainian war

The impact of the Russia-Ukraine war: euro area real GDP growth, system-level CET1 and NPL ratios, share of banking sector assets below selected CET1 ratios

(percentage points)



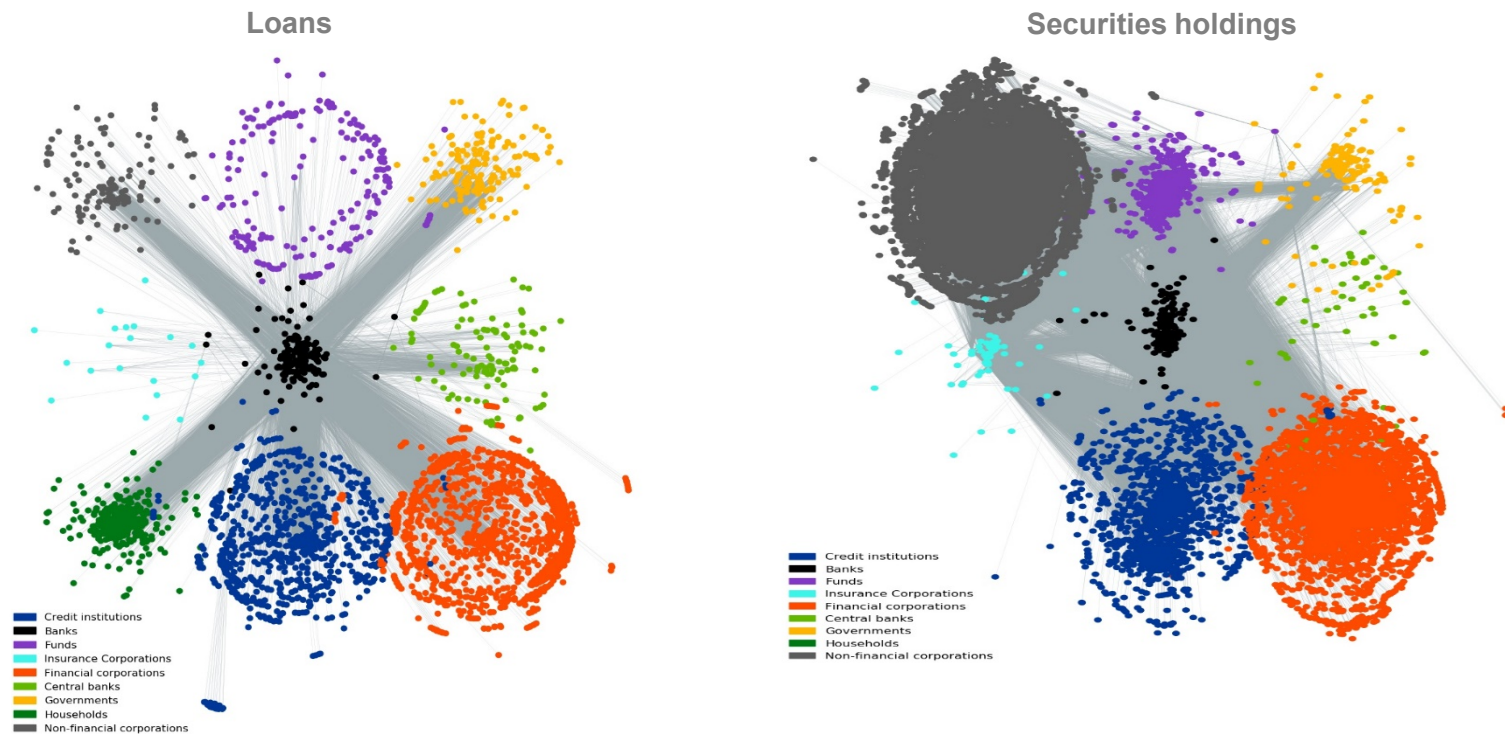
Source: [May 2022 FSR Box](#), Bloomberg Finance L.P., March 2022 ECB staff macroeconomic projections, Oxford Economics, OECD Input-Output tables, ECB (Supervisory Banking Statistics) and ECB calculations.

FSC Working Group on Stress Testing 2018-2022

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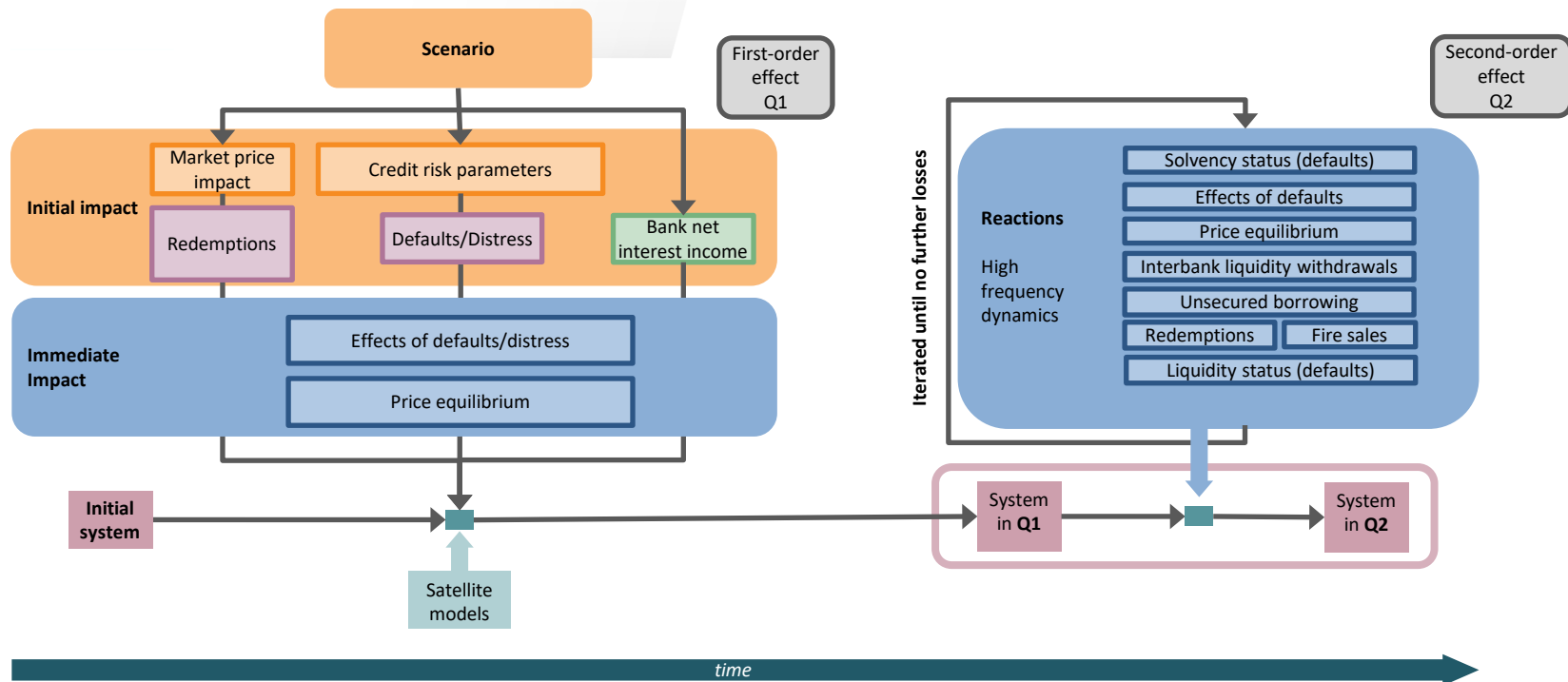
Exposure networks

Interconnectedness of 166 banks, 10555 investment funds, 18 aggregated insurance companies: loans and securities holdings



Notes: An edge represents a loan or security holding of a financial entity to another.

Amplification in the system-wide stress test

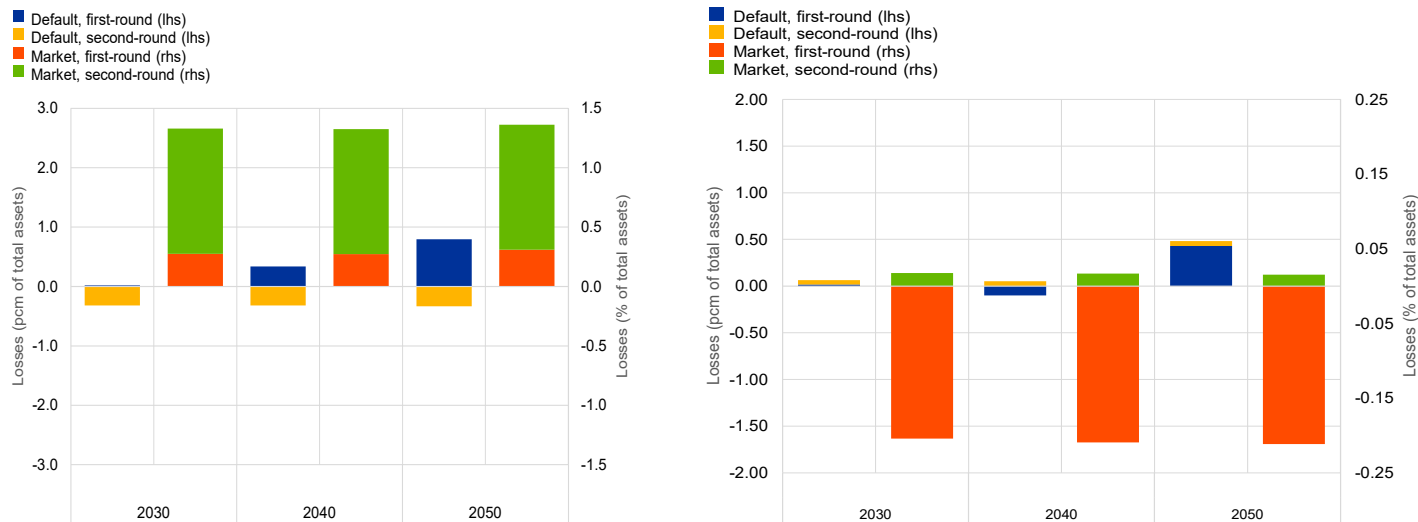


Notes: Sydow et al. (2021), [Shock amplification in an interconnected financial system of banks and investment funds](#), Working Paper Series, No 2581, European Central Bank, Frankfurt am Main, August.

System-wide losses in climate stress scenarios

System gains or losses in the Net Zero and delayed transition compared to the current policy scenarios

X-axis: years; Y-axis: gains and losses expressed in terms of total assets in the system; left axes are expressed in pcm (per cent mille), right axes in %.



Source: FSC/ESRB Project Team on Climate Risks (2022), [Macroprudential challenge of climate change](#). Own calculations.

Notes: Default, first-round" refers to NFC defaults. "Market, first-round" refers to exogenous market gains and losses both from the market scenario and from the price drop of exogenously defaulting NFCs issuing securities. "Second-round" gains and losses are model-driven.

FSC Working Group on Stress Testing 2018-2022

Top-down benchmarks

Macro-micro interactions

System-wide stress test

Deliverables

- **Improving & expanding benchmark models for credit, market risk & profitability** employing new techniques, e.g. stochastic search variable selection, quantile regressions
 - Implementing a comprehensive validation framework
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 - Delivering benchmark parameters for EU-wide stress tests 2018, 2021, forthcoming 2023
 - Timely reacting to new challenges such as the need for sector-level analysis (climate risks, COVID-19)
- **Advancing a macro-financial semi-structural model** for macroprudential stress testing
 - Introducing multiple-scenario analysis & growth-at-risk approaches within the model
 - Validating the estimates of main behavioural equations in macroprudential stress testing
 - Extending the use of dedicated datasets e.g. NPL coverage expectations
- **Developing a three sector model** for banks, insurance companies and investment funds with the emphasis on direct and indirect contagion

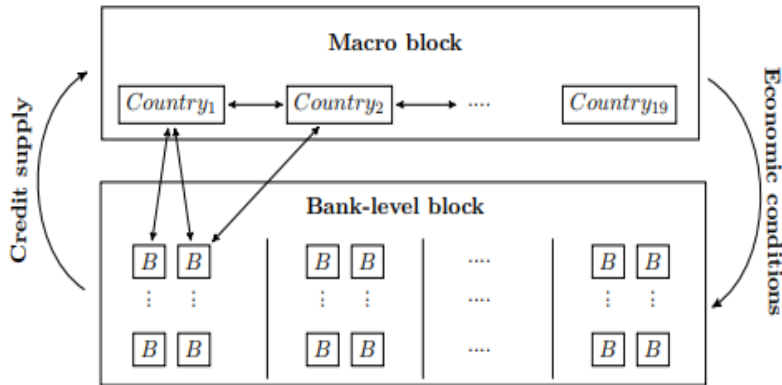


Achievements

- Top down Vulnerability Analysis 2020 & later 2022 analyses incl. interest rate sensitivity, impact of Russian-Ukrainian war
 - Core position in the EBA centralised approach that aims to increase the top-down component of the EU-wide stress test
- Regular macroprudential stress test 2018, 2020, 2021
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- System-wide climate stress test 2022
 - Implementation of the model in other institutions

High-level BEAST overview

A multi-country model with heterogeneous banks



Source: Budnik et al. (2020), [Banking euro area stress test model](#), ECB Working Paper Series, No 2469, September

Macro block:

- Representation of each euro area economy by 12 endogenous macro-financial variables e.g. GDP, HICP inflation
- Cross-border trade spillovers, common monetary policy

Banking block:

- Detailed representation of approx. 90 individual banks (70% of the euro area banking sector)

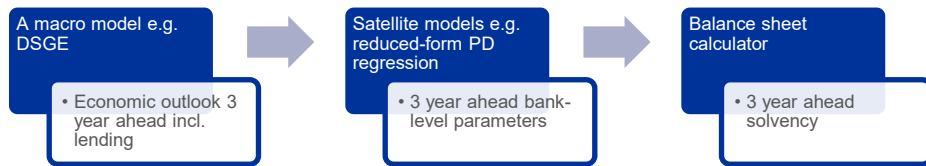
Portfolio	Modelling approach	Liability class	Modelling approach
Loans to NFC	geographical breakdown	Capital	geographical breakdown
Loans to HHHP		Sight deposits HH	
Loans to HHCC		Sight deposits NFC	
Loans to SOV	aggregated	Term deposits HH	
Loans to FIN		Term deposits NFC	
Other loans	exogenous	Wholesale funding	
Equity exposure			
Securitized portfolio			

- Full recognition of cross-border exposures
- Reduced-form 'sensitivity' equations for e.g. IRFS9 parameters
- Theory-informed estimated 'behavioural' equations e.g. lending volumes, with an overlay of ex ante mechanisms e.g. pecking order for liabilities
- Non-linearities and occasionally binding constraints

Changing macroprudential stress testing

Hybrid approach

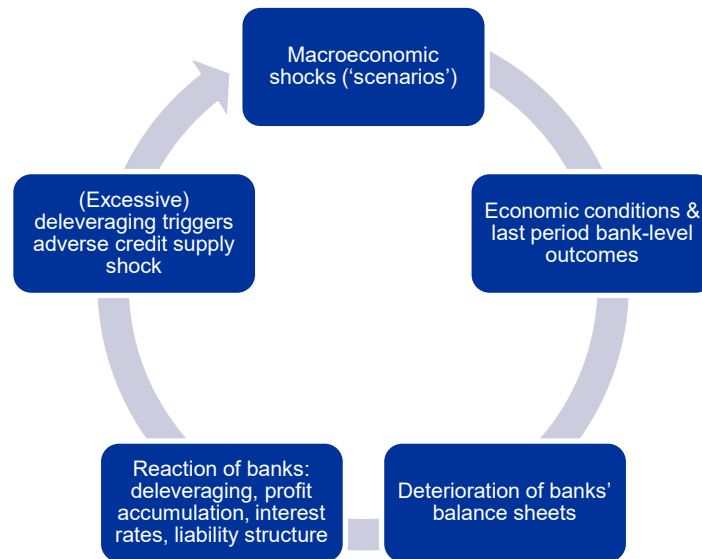
- Examples: ECB Stampe, Bank of England RAMSI
- Reliance on multiple models and their sequential use (for full horizon) e.g.:



- Possibility of iteration to better realign the outcomes across models

BEAST*

- One model and **a simultaneous solution** for all bank & economic variables

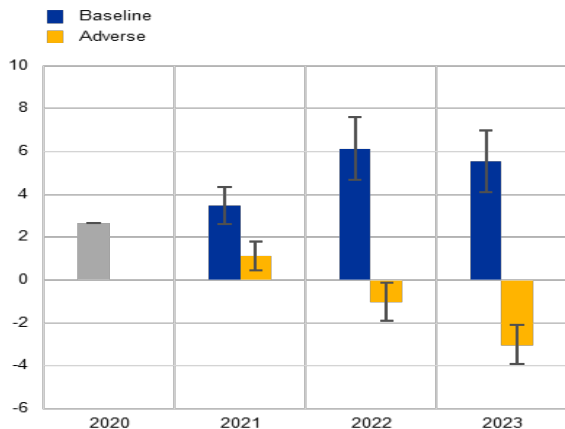


Semi-structural design

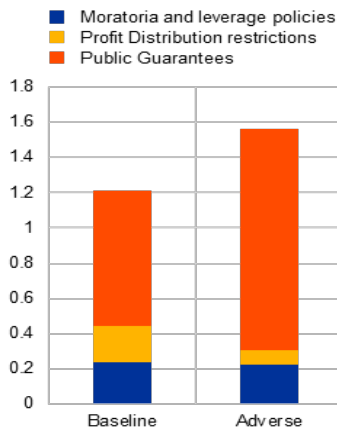
Equations	Example	Identification
Macroeconomic behavioural equations	E.g. country-level GDP depends on country-level loan volumes to the NFPS	Country-level structural panel VAR* with long-run priors
Macroeconomic identities	E.g. country imports depend on exports of its counterparties	Calibration on the basis of trade matrices
Aggregating equations	E.g. country-level loan volumes as a sum of bank level loan volumes	-
Bank-level behavioural equations	E.g. dividend distribution depends on profitability, economic situation, bank capitalisation, riskiness	Bank-level panel estimation: different methods incl. dynamic homogeneity where applicable
Bank-level regulatory limits	E.g. MDA	Calibration on the basis of existing regulation
Bank-level 'satellite' risk models	E.g. PDs	Bank-level panel estimation: different methods
Bank-level identities	E.g. calculation of loan-loss provisions	IRFS9 and other balance sheet identities

Macroprudential stress test: additional information

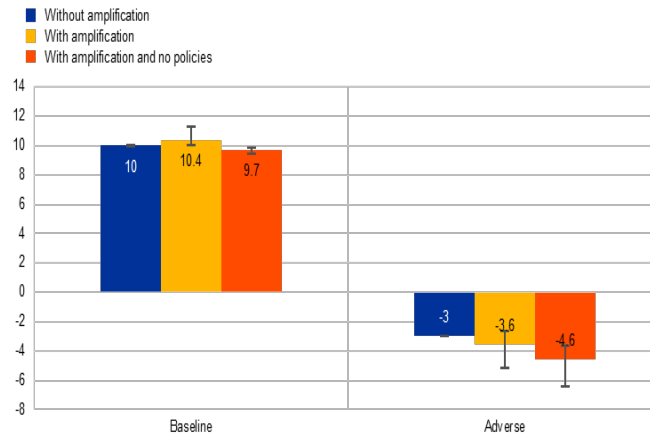
Annual loan growth to euro area non-financial private sector



Lending impact of COVID-19 mitigation policies 2021-2023



The cumulative growth of GDP in 2021-2023

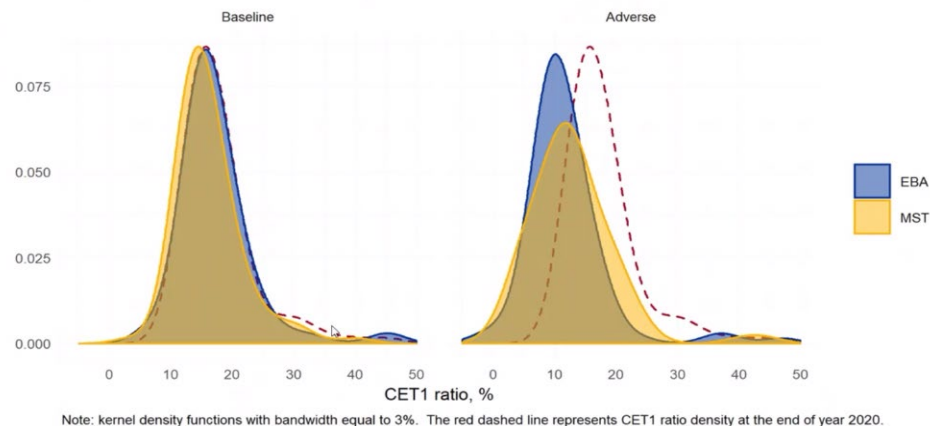


Source: [Macroprudential stress test of the euro area banking system amid the coronavirus \(COVID-19\) pandemics](#), ECB report, October 2021

- Robust, though also uncertain, lending outlook in the baseline scenario, & bank deleveraging in the adverse scenario (with different relative role of remaining Covid-19 mitigation policies in the two scenarios).
- In the absence of policies the feedback loop reduces euro area GDP by additional -1.6%
- ... which is mitigated by COVID-19 policies +1%
- ... resulting in the net effect on euro area GDP - 0.6%.

Macroprudential stress test: additional validation

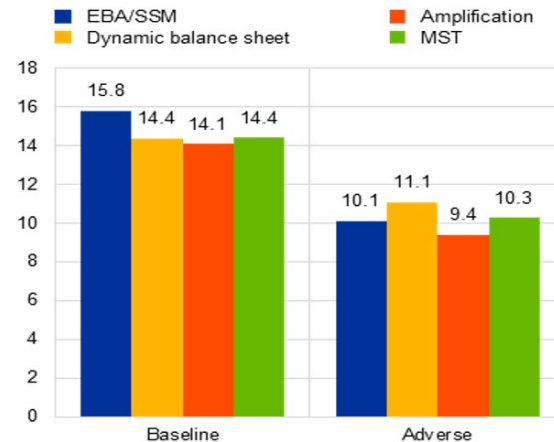
Bank solvency compared to EBA/SSM stress test: CET 1 ratio



Note: kernel density functions with bandwidth equal to 3%. The red dashed line represents CET1 ratio density at the end of year 2020.

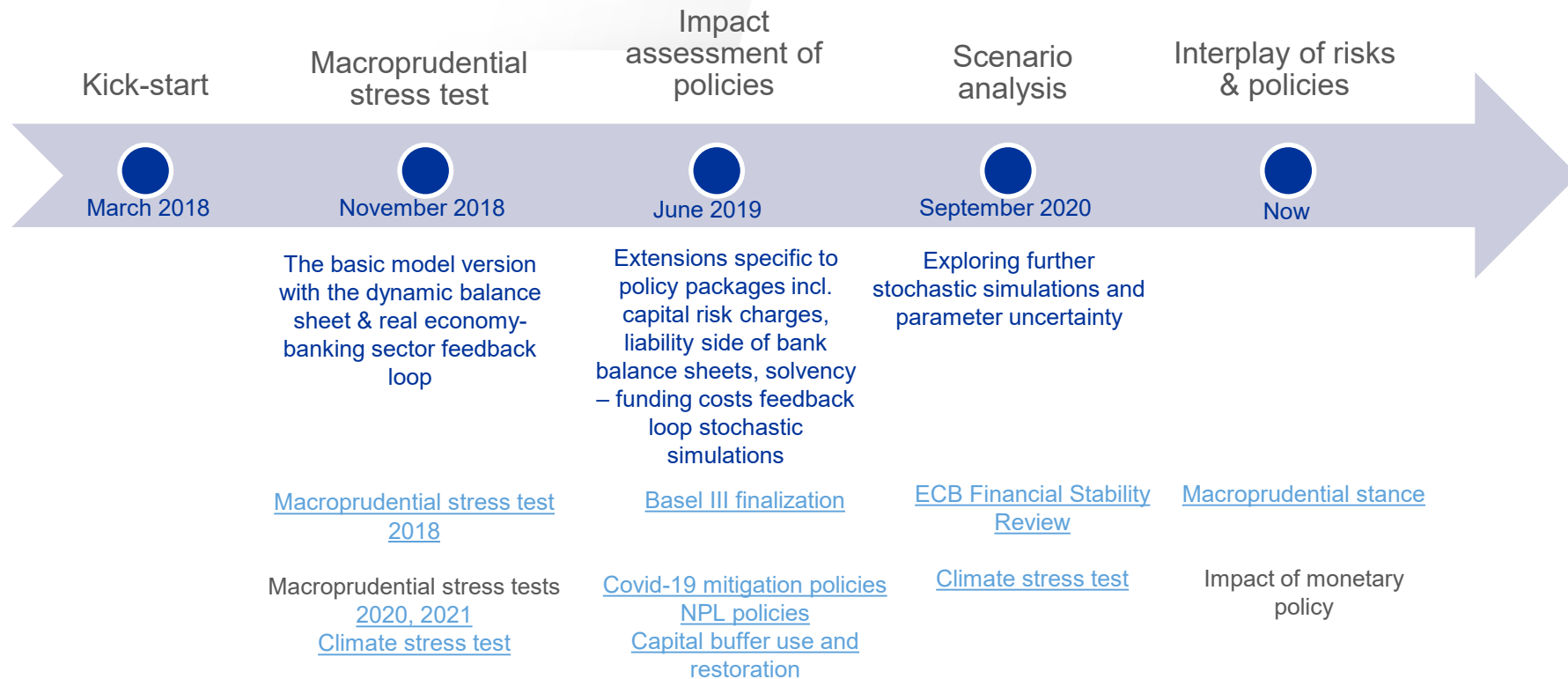
Legend: "Dynamic balance sheet" includes the dynamic response of banks in terms of asset, liability volumes and interest rates, and the top-down assessment of credit risk incl. the model-specific implementation of NPL coverage expectations. "Amplification" adds the solvency-funding costs and banking sector-real economy feedback loops to the dynamic balance sheet assessment. "MST" stands for the final outcomes of the 2021 macroprudential stress test, including the impact of COVID-19 mitigation policies.

Source: [Macroprudential stress test of the euro area banking system amid the coronavirus \(COVID-19\) pandemics](#), ECB report, October 2021



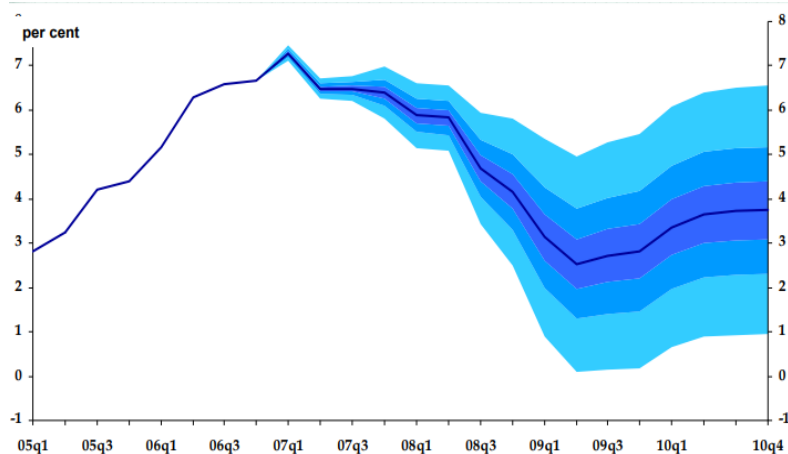
- Macro-financial mechanisms lead to higher dispersion of bank-level results in the adverse scenario compared to the constant balance sheet exercise (both for CET1 ratios and capital depletion).
- 2020 capital ratios can well predict the outcomes of the constant balance sheet and less so of the macroprudential stress test.
- Banks' adjustments in the adverse scenario help banks to preserve higher solvency ratios, but also trigger counterbalancing adverse amplification mechanisms.

BEAST's path toward the workhorse model



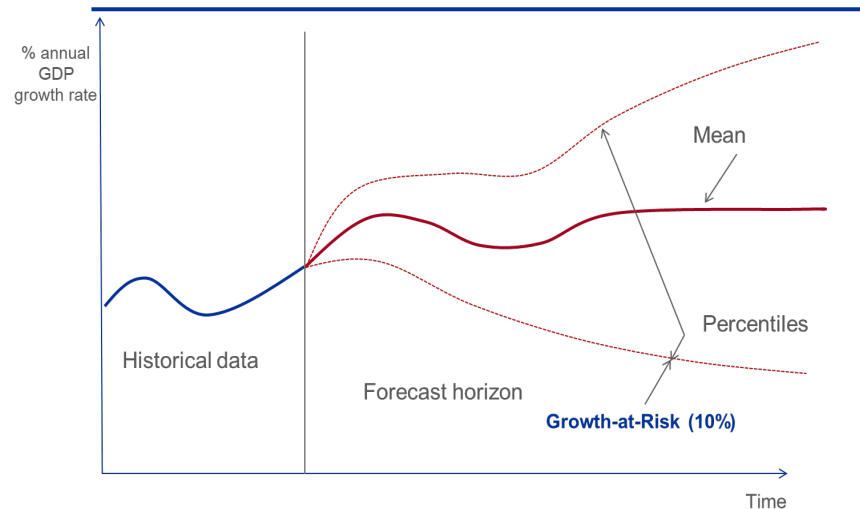
Semi-structural design versus G@R

Regular application of semi-structural models to generate GDP fancharts...



Source: National Bank of Poland (2008), [Fan charts of inflation and GDP](#), as based on Budnik et al (2009), [An update of the macroeconomic model of the Polish economy NECMOD](#), NBP Working Paper No. 64.

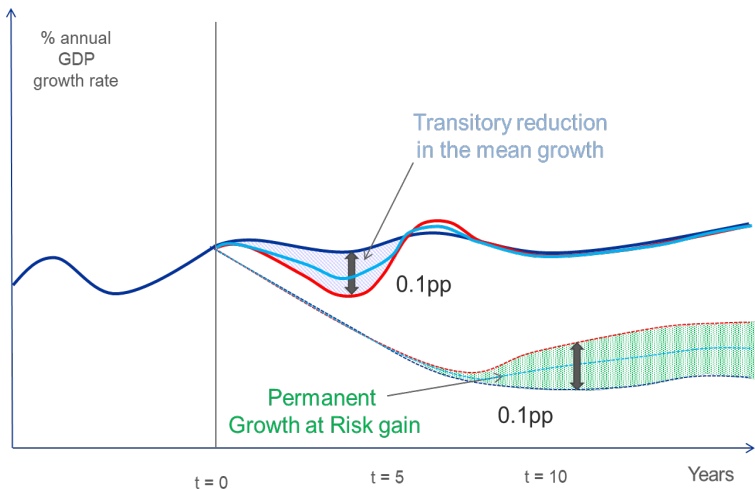
Reinterpreted from the Growth-at-Risk angle...



Note: Stylised representation.

Balancing costs and benefits of Basel III*

GaR based cost-benefit assessment of the plain vanilla and main EU approach to Basel III



Legend: Stylized representation. Solid dark blue line illustrates the mean GDP growth rate without Basel III implementation, solid red line stands for the mean GDP growth rate with the plain vanilla Basel III implementation, and solid light blue line for the mean GDP growth rate with the main EU specific Basel III implementation. Solid light blue field illustrates the reduction in the mean GDP growth following the plain vanilla Basel III implementation. Dotted dark blue line shows the Growth at Risk in the absence of Basel III implementation, dotted red line the Growth at Risk in the presence of the plain vanilla III implementation, while dotted light blue line shows the Growth at Risk for the main EU specific Basel III implementation. Green field illustrate the reduction in economic adversity in 10% tail events following the plain vanilla Basel III implementation.

Source: Budnik, Dimitrov, Gross, Lampe, Volk (2021), [Macroeconomic impact of Basel III finalisation on the euro area](#), Macprudential Bulletin No. 14

- The short-term costs of the phase-in of the plain vanilla Basel III implementation are low, amounting to a reduction in output growth by less than 0.1pp in the first years following the implementation.
- The Basel III implementation will permanently strengthen the resilience of the economy to adverse shocks, as reflected in the shift of the Growth-at-Risk measure by 0.1pp upwards.
- The main EU-specific design reduces both costs and benefits of the reform. Further output floor modifications are unlikely to lower the initial costs of reforms, while e.g. parallel stacks cuts down the long-term resilience gains by half compared to the main EU approach.

Scenario design vs. scenario selection

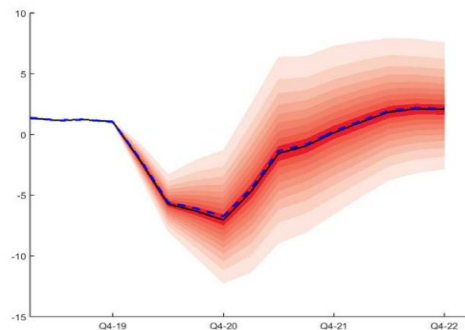
Hypothetical approach

- Reduced-form or structural shocks fed into a macro model to arrive at a scenario following a desired narrative

Full distribution of euro area GDP dynamics

(growth rate (year-on-year), percentages)

All scenario paths follow adverse shocks in 2020



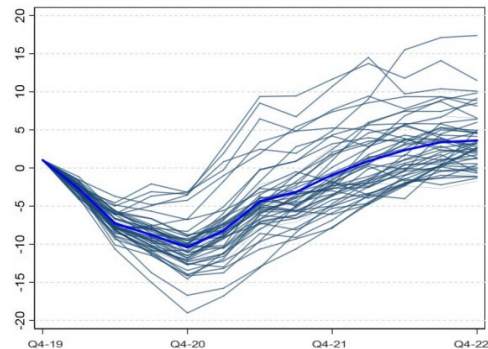
BEAST

- Selection of scenarios consistent with a desired narrative with the full distribution of plausible outcomes
- Weighting function on individual simulated scenarios operating on variables of interest (both exogenous incl. shocks, and endogenous)

Selected individual scenario paths within a U-shaped narrative

(GDP growth (year-on-year), percentages)

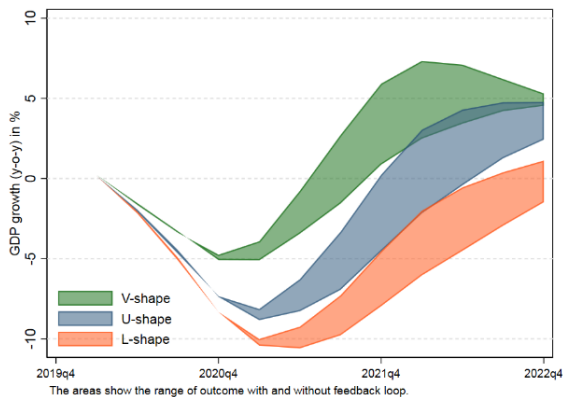
All scenario paths follow adverse shocks 2020



Source: Budnik, Dimitrov, Groß (2020), [Selecting adverse economic scenarios for the quantitative assessment of euro area banking system resilience](#), Financial Stability Review, ECB, November

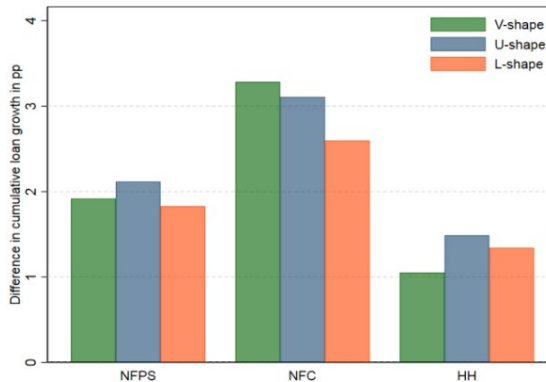
Lending impact of COVID-19 mitigation policies in times of high uncertainty

GDP growth with and without the feedback loop



Impact of the package on lending volumes to the non-financial private sector

Cumulative impact

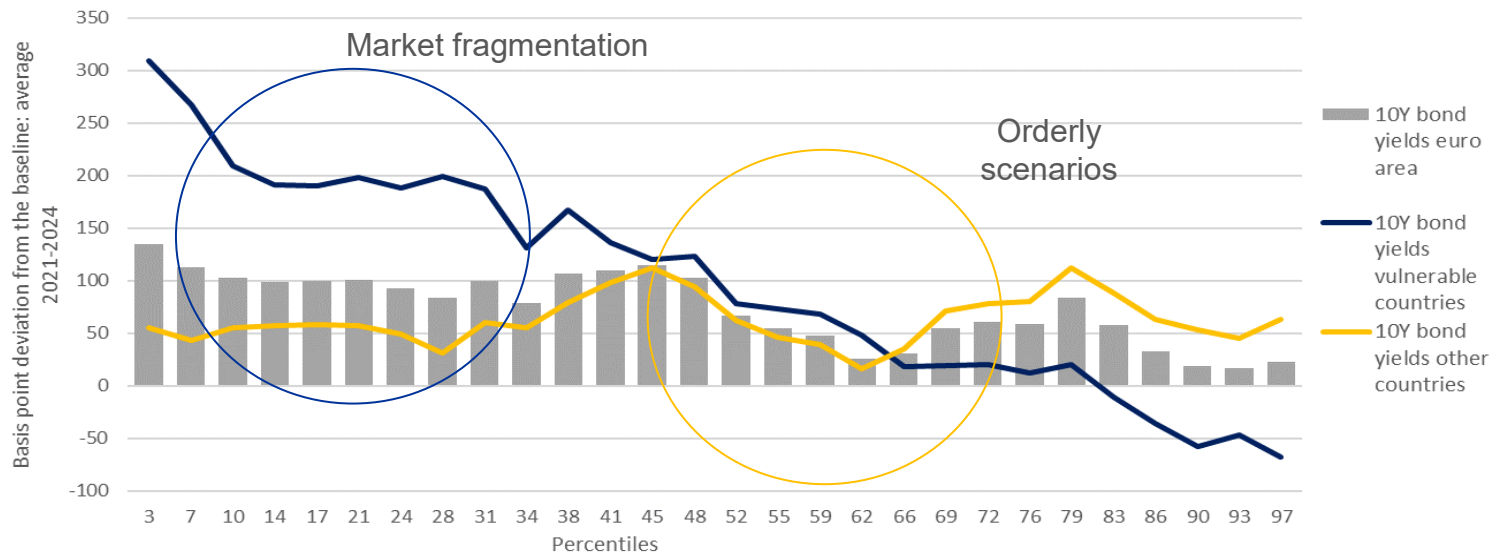


Source: Budnik, Dimitrov, Gross, Jancokova, Lampe, Sorvillo, Stular, Volk (2021) [Policies in support of lending following the COVID-19 pandemic](#), ECB Occasional Paper No. 257, May

- Three scenarios sharing the property on a deep contraction in GDP in 1-2Q 2020: **V-shape** - closest to 'medium' scenario, **U-shape** - extended repercussions of the first COVID-19 wave and a sluggish recovery, **L-shape** - the second wave of COVID-19 end 2020-beginning 2021
- An increase in the growth of loans to the non-financial private sector by around 2pp in cumulative terms by 2022 (around 230 bln EUR larger stock of outstanding loans)
- The strongest effect on the loan growth to the non-financial corporates (over 3pp) in V- and U-shape scenarios, while the package may not be sufficient to support lending in L-shape scenario

Market fragmentation risk

Pinning down the tail risk of market fragmentation following (tail) low asset purchases

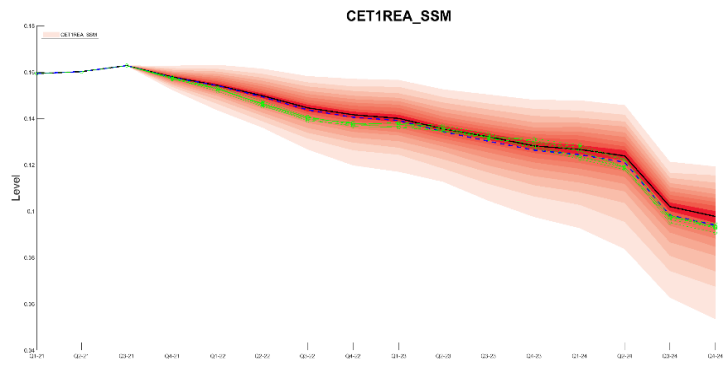
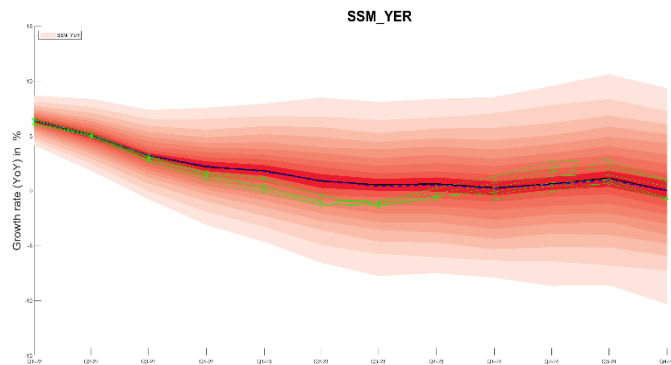
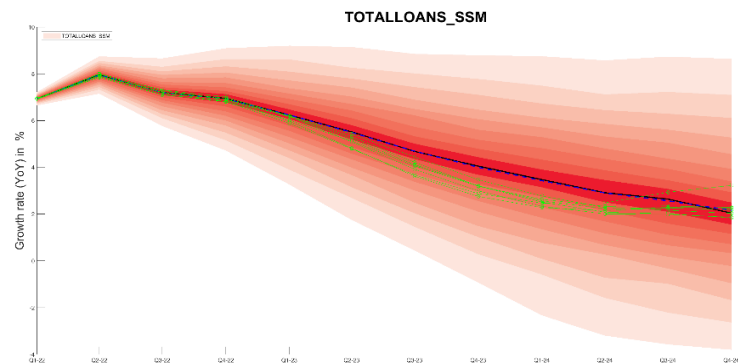
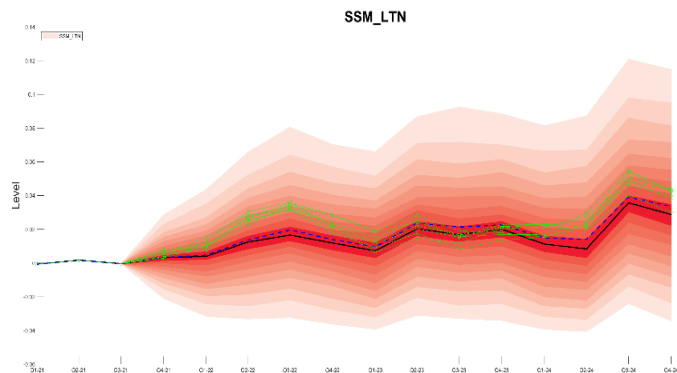


Legend: Based on December 2021 starting point.
Source: ECB calculations.

- Narrative scenario selection: **sorting** all scenarios along with the criteria related to (i) **an increase in the euro area 10Y bond yields**, (ii) **an increase in the spread** between 10Y bond yields for vulnerable and other countries

Market fragmentation scenarios

Selecting market fragmentation scenarios from the distributions conditional on lower asset purchases

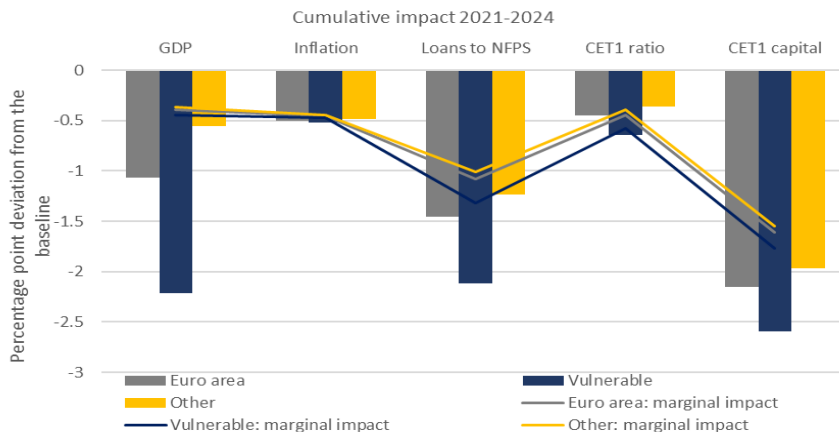


Source: Own calculations.

Legend: Green lines mark the selected market fragmentation scenarios.

Monetary policy tapering & risk of fragmentation

Macro-financial total and marginal impact of lower than expected asset purchases in a market fragmentation scenario (30th percentile)



Source: Own calculations.

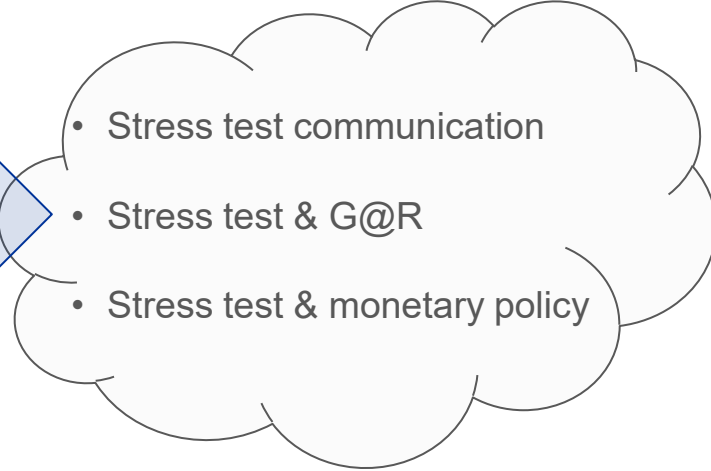
Notes: Based on the mean results for selected scenarios.

- Lower **output growth & lending** with differences between vulnerable & other countries
- Marked **bank capital losses**, though a similar impact on capital ratios, consistent with stronger deleveraging in the market fragmentation versus the benchmark scenario
- **Separating** between economic impact of the scenario (e.g. GDP impact of market fragmentation and lower asset purchases) and **the marginal impact of asset purchases** (e.g. GDP impact of lower asset purchases | market fragmentation)

Wrapping-up

- Pronounced progress in stress testing methods
- The need to “keep an eye” on the developments & react timely:
 - COVID-19 policies (guarantees)
 - Sectoral analysis
 - (Climate)
- [Applications](#) expand beyond stress testing*...
 - [Risk assessment](#)
 - [Policy assessment](#)
 - [Communication](#)
- ... and beyond financial stability
- Testing new grounds: a workhorse (BEAST) model for financial stability (stress testing, policy, forecasting)

Today's workshop

- 
- Stress test communication
 - Stress test & G@R
 - Stress test & monetary policy

* Macroprudential Bulletin No. 17, 2022

Thank you for your
attention!

