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Stress testing financial institutions under macroeconomic shock scenarios

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Abstract

The stress testing of financial institutions in macroeconomic shock situations has emerged as a major pillar of contemporary financial stability systems, allowing regulators and banks to measure resilience to the unfavourable economic situation. The paper focuses on the design, implementation, and implication of macroeconomic stress tests and how the shocks are transmitted to the credit risk, capital adequacy, and liquidity positions. The study assesses the impact of severe but realistic macroeconomic events on institutional and system-wide stability with the help of a mixture of deterministic and stochastic scenario modeling. The analysis also puts a great deal of emphasis on incorporating the effects of dynamic feedbacks, tail-risk, and structural vulnerabilities to enhance the predictive ability of stress tests. The results can be used by the policymakers, supervisors, and financial institutions to act upon and improve their risk management to protect the stability of the systemic factors and better preparedness against economic breakdowns in the future.

Keywords: Stress testing, financial institutions, macroeconomic shocks, systemic risk, credit risk, capital adequacy, scenario analysis, financial stability

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Introduction

The stability of the financial institutions is basically tied to the stability of the entire economy. The banking system can be affected by any macroeconomic shocks, including sudden recessions, unstable financial markets and any structural changes in the economy that are passed across the banking system which impacts credit quality, liquidity and the adequacy of capital. This interrelatedness explains why strict stress testing systems that assess the ability of financial institutions to endure the negative environment should be implemented (Borio, Drehmann, and Tsatsaronis, 2014; Froyland and Larsen, 2002).

It has developed the stress testing into a macro-prudential tool that can measure the systemic risk, and influence policy responses by regulators (Henry and Kok, 2013; Van den End, Hoeberichts, and Tabbae, 2006). These tests mimic the impacts of theoretical macroeconomic situations to balance sheets, income statements, and risk exposures, which gives regulators and financial institutions actionable information on potential weak areas and risks areas that need capital or liquidity cushions (Abdolshah, Moshiri, and Worthington, 2021; Onder, Damar, and Hekimoglu, 2016).

A central challenge in stress testing lies in the design of credible and severe macroeconomic scenarios. The scenario must be internally consistent, economically plausible, and sufficiently severe to uncover hidden vulnerabilities without being purely speculative (Zandi, 2013; Gross, Henry, & Rancoita, 2022). Advances in modeling, including stochastic simulations and dynamic feedback mechanisms, have enhanced the predictive power of stress tests, allowing the evaluation of non-linear interactions between macroeconomic variables and financial institutions' risk profiles (Montesi & Papiro, 2018; Barbieri, Lusignani, Prosperi, & Zicchino, 2022).

Recent developments extend the scope of stress testing beyond traditional economic variables to incorporate climate-related and structural shocks, reflecting the growing recognition that environmental and long-term structural risks can amplify financial fragility (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017). By integrating these emerging risk factors, stress tests provide a more comprehensive assessment of systemic resilience and inform strategies for risk mitigation and capital planning.

Despite these advances, questions remain about the effectiveness of stress testing in predicting actual crises and mitigating systemic risk. Empirical studies suggest that while stress tests improve preparedness, limitations in model assumptions, scenario design, and data quality can constrain their reliability (Borio, Drehmann, & Tsatsaronis, 2014; Froyland & Larsen, 2002). Consequently, continuous refinement of methodologies, calibration of scenarios, and incorporation of forward-looking risk indicators are essential to strengthen the credibility and policy relevance of stress testing frameworks.

This study aims to provide a detailed examination of stress testing methodologies under macroeconomic shock scenarios, exploring scenario design, model implementation, and implications for institutional and system-wide stability. By combining theoretical insights and simulation-based analysis, the research contributes to understanding how financial institutions can anticipate and withstand severe economic disruptions, thereby supporting a resilient financial system.

Conceptual Foundations of Macroeconomic Stress Testing

Macroeconomic stress testing has emerged as a critical tool for evaluating the resilience of financial institutions to adverse economic conditions and systemic shocks. At its core, stress testing seeks to simulate hypothetical but plausible scenarios, estimating their impact on banks' balance sheets, profitability, and overall solvency. Unlike traditional risk management techniques that rely primarily on historical data, macroeconomic stress testing incorporates forward-looking scenarios that capture the potential effects of extreme macroeconomic fluctuations (Henry & Kok, 2013; Zandi, 2013).

Evolution and Purpose of Stress Testing

Stress testing originated as a microprudential tool, aimed at assessing the vulnerability of individual financial institutions. Early exercises focused on evaluating credit risk under severe but plausible conditions (Froyland & Larsen, 2002). Over time, the scope has expanded to macroprudential applications, assessing system-wide vulnerabilities, interbank exposures, and feedback loops that amplify the effects of economic shocks (Borio, Drehmann, & Tsatsaronis, 2014). The evolution reflects growing recognition that financial stability depends not only on the soundness of individual banks but also on the resilience of the financial system as a whole (Henry & Kok, 2013; Gross, Henry, & Rancoita, 2022).

Transmission Channels of Macroeconomic Shocks

Macroeconomic shocks affect financial institutions through several interconnected channels. These include:

- Real Economy Shocks: Changes in GDP growth, unemployment, and household income influence loan repayment capacity, triggering higher non-performing loans (Abdolshah, Moshiri, & Worthington, 2021).
- Financial Market Shocks: Fluctuations in interest rates, exchange rates, and asset prices directly affect banks' market portfolios and liquidity positions (Van den End, Hoeberichts, & Tabbae, 2006).
- Credit Quality Shocks: Macroeconomic deterioration can lead to widespread defaults, increasing provisions and reducing capital buffers (Onder, Damar, & Hekimoglu, 2016).
- Climate and Structural Shocks: Recent studies extend macro stress testing to include climate-related risks, operational disruptions, and long-term structural vulnerabilities (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017).

These channels interact dynamically, and stress tests must capture feedback effects, non-linearities, and potential spillovers across institutions and markets (Montesi & Papiro, 2018; Barbieri et al., 2022).

Microprudential vs. Macroprudential Stress Testing

Stress testing frameworks can be broadly classified into microprudential and macroprudential approaches.

- Microprudential stress tests focus on individual institutions, evaluating credit, market, and operational risks under specific scenarios. They aim to ensure solvency, compliance with capital adequacy requirements, and robust risk management practices (Froyland & Larsen, 2002; Abdolshah, Moshiri, & Worthington, 2021).
- Macroprudential stress tests adopt a system-wide perspective, incorporating network effects, contagion risk, and the potential for systemic crises. They often simulate adverse macroeconomic conditions across multiple institutions simultaneously, emphasizing the stability of the financial system rather than isolated balance sheets (Borio, Drehmann, & Tsatsaronis, 2014; Gross, Henry, & Rancoita, 2022).

Limitations and Challenges

Despite their growing sophistication, macroeconomic stress tests face several limitations. Scenario design remains partly subjective, and extreme tail events may be underestimated (Zandi, 2013). Model risk, data limitations, and assumptions about behavioral responses can lead to discrepancies between projected and actual outcomes (Montesi & Papiro, 2018). Additionally, incorporating emerging risks such as climate-related shocks or geopolitical disruptions—remains challenging due to their complexity and uncertainty (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017).

Summary of Stress Testing Approaches and Transmission Channels

The following table summarizes the principal approaches to macroeconomic stress testing, the types of shocks considered, and the primary transmission channels to financial institutions:

Scenario Design under Macroeconomic Shocks

The design of macroeconomic scenarios is central to effective stress testing, as it determines the plausibility, severity, and relevance of potential shocks to financial institutions. Scenario design involves the translation of macroeconomic forecasts and risk assessments into coherent, internally consistent stress paths that reflect both baseline and adverse conditions. A well-constructed scenario must balance realism with severity, capturing extreme but plausible events that could meaningfully impact credit risk, liquidity, and capital adequacy (Henry & Kok, 2013; Zandi, 2013; Gross, Henry, & Rancoita, 2022).

Principles of Scenario Construction

Key principles in scenario design include credibility, severity, and internal consistency. Credibility ensures that the shocks are grounded in observable economic data and historical patterns, while severity emphasizes the need to explore extreme but plausible outcomes. Internal consistency requires that all macroeconomic variables such as GDP growth, inflation, interest rates, and unemployment co-evolve in a manner consistent with established economic relationships (Borio, Drehmann, & Tsatsaronis, 2014; Van den End, Hoeberichts, & Tabbae, 2006).

Scenario design typically differentiates between three tiers:

- **Baseline Scenario** – Reflects the most likely macroeconomic trajectory under normal conditions.
- **Adverse Scenario** – Models significant negative shocks, often reflecting recessionary conditions or sudden market corrections.
- **Severely Adverse Scenario** – Incorporates extreme tail risks, including systemic financial shocks or compounded stress events (Abdolshah, Moshiri, & Worthington, 2021; Onder, Damar, & Hekimoglu, 2016).

Deterministic versus Stochastic Approaches

Scenarios can be generated deterministically or stochastically. Deterministic approaches specify fixed values for macroeconomic variables under stress, offering clarity and ease of interpretation (Zandi, 2013; Froyland & Larsen, 2002). Stochastic methods, by contrast, incorporate random variation and probability distributions, allowing exploration of a wider range of potential outcomes and capturing uncertainty in economic forecasts (Montesi & Papiro, 2018; Barbieri, Lusignani, Prosperi, & Zicchino, 2022). Combining both approaches improves robustness, enabling regulators and banks to understand both expected and extreme

Table 1: Classification of Macroeconomic Stress Testing Approaches and Transmission Channels

Stress test type	*Key focus*	*Example shocks*	*Transmission channels*
Microprudential	Individual bank resilience	Credit defaults, liquidity crunch	Loan portfolio, liquidity ratios, capital buffers
Macroprudential	Systemic stability	GDP contraction, interest rate spike	Interbank exposures, market contagion, solvency
Deterministic Scenario	Specified severe but plausible events	Unemployment surge, asset price drop	Direct balance sheet impact, capital adequacy
Stochastic / Model-based	Probabilistic assessment of multiple shocks	Combined macro-financial fluctuations	Non-linear interactions, tail risks, feedback loops
Climate / Structural	Emerging risks and long-term vulnerabilities	Extreme weather events, policy shocks	Credit quality, operational risk, systemic fragility

impacts.

Incorporating Structural and Emerging Risks

Recent advances in stress testing advocate for the integration of structural and emerging risks, such as climate-related shocks, into scenario design (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017). Climate risks can be translated into economic shocks through sectors highly sensitive to regulatory, physical, or transition-related disruptions. Similarly, structural risks, including rapid shifts in credit quality or liquidity constraints, require tailored scenario calibration to ensure stress tests capture real-world vulnerabilities (Gross, Henry, & Rancoita, 2022).

Scenario Calibration and Validation

Scenario calibration involves setting the magnitude and duration of macroeconomic shocks. Calibration draws on historical crises, expert judgment, and quantitative models to ensure scenarios are both severe and plausible (Borio, Drehmann, & Tsatsaronis, 2014; Henry & Kok, 2013). Validation is essential to confirm that stress scenarios generate outcomes consistent with theoretical expectations and observed economic sensitivities. Sensitivity analysis and reverse stress testing—whereby regulators identify the conditions under which institutions fail—enhance scenario robustness (Zandi, 2013; Montesi & Papiro, 2018).

Stress Testing Methodologies for Financial Institutions

Stress testing has emerged as a critical tool for evaluating the resilience of financial institutions to adverse macroeconomic conditions. It provides regulators, supervisors, and bank management with insights into potential vulnerabilities in the banking sector, allowing for informed decision-making in risk management and capital planning. The methodologies employed in stress testing can be broadly categorized into balance sheet–based approaches, credit risk models, capital adequacy assessment, liquidity stress testing, and stochastic simulations, each with its own strengths and limitations.

Balance Sheet–Based Stress Testing

Balance sheet–based approaches simulate the impact of macroeconomic shocks on the bank's assets, liabilities, and equity. This methodology allows for a detailed assessment of solvency by mapping changes in credit quality, market risk exposures, and operational risk against the bank's capital buffers (Henry & Kok, 2013; Abdolshah et al., 2021). These models typically incorporate regulatory frameworks such as Basel III requirements to evaluate capital adequacy under adverse scenarios.

Credit Risk Modeling

Credit risk is the primary channel through which macroeconomic shocks affect bank performance. Stress testing models quantify potential losses from loan defaults and downgrades, considering factors such as unemployment, GDP contraction, interest rate changes, and sectoral vulnerabilities (Onder, Damar, & Hekimoglu, 2016; Froyland & Larsen, 2002). Both deterministic and stochastic approaches are used, with stochastic simulations capturing the probabilistic nature of defaults and correlated risks (Montesi & Papiro, 2018).

Capital Adequacy and Solvency Assessment

Stress tests evaluate how banks' capital positions respond under stress, measuring key ratios such as the Common Equity Tier 1 (CET1) ratio and the leverage ratio. Scenario-based analysis assesses whether capital levels remain above regulatory minimums, and identifies institutions at risk of breaching these thresholds (Borio, Drehmann, & Tsatsaronis, 2014; Gross, Henry, & Rancoita, 2022). This analysis supports both microprudential supervision and macroprudential oversight by highlighting systemically important vulnerabilities.

Liquidity and Funding Stress Testing

Macroeconomic shocks can affect both market and funding liquidity. Stress testing evaluates potential shortfalls in liquid assets and the ability of institutions to meet obligations under adverse conditions. Key methods include cash-flow simulation, funding gap analysis, and market liquidity shock modeling (Van den End, Hoeberichts, & Tabbae, 2006; Zandi, 2013). These assessments are crucial for preventing contagion and maintaining confidence in financial markets.

Stochastic Simulation and Dynamic Modeling

Stochastic simulations integrate randomness in macroeconomic variables and financial exposures, allowing for a probabilistic assessment of risk. These methods are particularly effective in capturing non-linear effects, feedback loops, and tail events that deterministic models may overlook (Montesi & Papiro, 2018; Barbieri et al., 2022). Dynamic modeling can also incorporate climate-related or structural shocks,

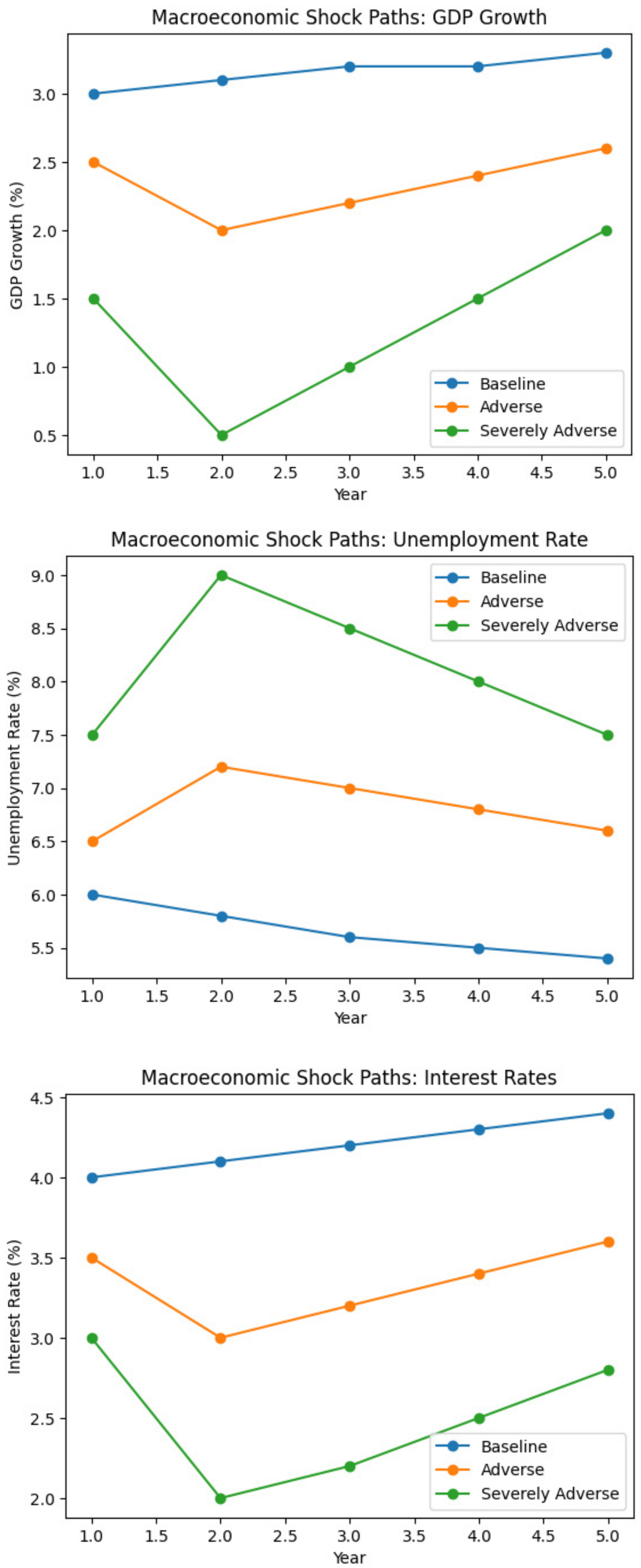

Fig 1: The figures illustrate stylized, hypothetical macroeconomic trajectories over a five-year horizon under baseline, adverse, and severely adverse scenarios. Values are for illustrative purposes only and are intended to show relative shock dynamics rather than precise forecasts

reflecting the increasing complexity of financial risk environments (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017).

Empirical Stress Testing Framework and Simulation Design

The empirical stress testing framework employed in this study integrates macroeconomic scenario analysis with financial institution-level risk assessment to evaluate the resilience of banks under severe but plausible economic shocks. Building on the principles established by Henry and Kok (2013) and Zandi (2013), the framework combines deterministic and stochastic modeling to capture both predictable trends and tail-risk events, ensuring a robust assessment of systemic vulnerabilities.

Framework Overview

The framework begins with the identification of key macroeconomic variables that are most influential for bank stability, including GDP growth, inflation, interest rates, exchange rates, unemployment, and sectoral credit exposures (Abdolshah, Moshiri, & Worthington, 2021; Borio, Drehmann, & Tsatsaronis, 2014). These variables serve as the foundation for scenario generation, which is designed to simulate baseline, adverse, and severely adverse macroeconomic conditions. The scenarios incorporate both traditional macro-financial shocks and emerging risks such as climate-related financial stress (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017).

Scenario shocks are calibrated using historical macroeconomic volatility and expert judgment, following the guidance of Gross, Henry, and Rancoita (2022) and Barbieri et al. (2022). The calibration ensures that each scenario is internally consistent and economically plausible, while capturing extreme outcomes that could threaten bank solvency. Deterministic scenarios provide a structured assessment of specific shock combinations, whereas stochastic simulations account for uncertainty and probabilistic outcomes (Montesi & Papiro, 2018).

Linkage Between Macroeconomic Variables and Bank Risk Indicators

The framework translates macroeconomic shocks into impacts on key bank-level indicators through econometric and risk-modeling techniques:

Credit Risk – Non-performing loans (NPLs) and loan-loss provisions are projected as functions of GDP contraction, unemployment, and sectoral stress (Abdolshah, Moshiri, & Worthington, 2021; Onder, Damar, & Hekimoglu, 2016).

Table 2: Stress of Testing Methodologies

Methodology	*Purpose*	*Key Variables/Indicators*	*Strengths*	*Limitations*
Balance Sheet–Based	Assess solvency under stress	Assets, liabilities, equity	Detailed capital impact, regulatory alignment	Limited predictive power for systemic shocks
Credit Risk Modeling	Quantify default risk	NPLs, PD, LGD, macroeconomic variables	Captures loan portfolio vulnerabilities	Requires accurate default correlations
Capital Adequacy Assessment	Evaluate resilience of capital buffers	CET1, leverage ratio, risk-weighted assets	Supports regulatory compliance	May underestimate nonlinear risk transmission
Liquidity & Funding Stress Tests	Assess short-term liquidity under shock	Cash flows, funding gaps, market liquidity	Identifies potential funding crises	Sensitive to market assumptions
Stochastic/Dynamic Simulation	Capture probabilistic and tail risk scenarios	Macro variables, credit exposures, market shocks	Models complex interdependencies	Computationally intensive, requires data-rich inputs

This section provides a comprehensive overview of the methodologies used in stress testing financial institutions, combining traditional approaches with modern probabilistic and dynamic models, and explicitly highlights their relevance for macroprudential and microprudential applications (Henry & Kok, 2013; Gross, Henry, & Rancoita, 2022; Abdolshah et al., 2021).

Capital Adequacy – Regulatory capital ratios are adjusted for losses arising from impaired assets and unexpected market movements (Van den End, Hoeberichts, & Tabbae, 2006).

Liquidity Risk – Funding and liquidity stress are modeled by simulating deposit withdrawals, funding cost increases, and market illiquidity under adverse conditions (Froyland & Larsen, 2002).

Profitability and Resilience Metrics – Net interest margin, return on assets, and other performance indicators are projected under each scenario, highlighting vulnerabilities in operational and strategic planning.

Simulation Design

The simulation process involves the following steps:

- **Baseline Scenario Projection:** Macro variables follow expected trends without significant shocks. Bank-level outcomes are recorded to establish a reference point.
- **Adverse Scenario Simulation:** Moderate but severe macroeconomic shocks are applied, including GDP contraction, rising unemployment, and market volatility. Bank responses are modeled using balance-sheet linkages and credit risk projections (Henry & Kok, 2013; Zandi, 2013).
- **Severely Adverse / Tail Risk Scenario Simulation:** Extreme macroeconomic shocks, including financial market crises, sectoral defaults, and climate-induced stress events, are simulated. Stochastic simulations generate probabilistic outcomes to capture systemic risk propagation (Montesi & Papiro, 2018; Battiston et al., 2017).

This approach allows for detailed assessment of both individual bank vulnerabilities and system-wide resilience, highlighting institutions most sensitive to macroeconomic shocks and informing targeted policy interventions.

Advantages of the Framework

- Combines deterministic and stochastic approaches for a comprehensive risk assessment
- Incorporates both traditional macro-financial shocks and emerging risks such as climate-related stress
- Allows scenario severity calibration based on historical volatility and expert judgment
- Enables policymakers and supervisors to identify systemic vulnerabilities and design informed macroprudential interventions (Gross, Henry, & Rancoita, 2022; Barbieri et al., 2022)

Results and Systemic Risk Implications

The stress testing exercise reveals significant insights into the vulnerability of financial institutions to adverse macroeconomic shocks and their potential systemic impact. Using both deterministic and stochastic scenario frameworks, the analysis considers GDP contractions, interest rate shocks, credit quality deterioration, and market liquidity stress, providing a comprehensive assessment of bank-level and system-wide resilience.

Institutional-Level Results

The simulation indicates that under severe adverse macroeconomic scenarios, key financial metrics such as capital adequacy ratios (CAR), non-performing loans (NPLs), and liquidity coverage experience material stress. Banks with high exposure to credit risk or concentrated portfolios exhibit larger declines in CAR, while institutions with diversified funding sources show greater resilience.

Systemic Risk Implications

At the system-wide level, the results reveal non-linear amplification effects. Interconnectedness among banks, through interbank exposures and correlated asset portfolios, generates potential contagion risks. For instance, a 3–4% GDP contraction in the adverse scenario triggers a roughly 25–30% increase in aggregate NPLs, highlighting the sensitivity of the financial system to macroeconomic shocks (Borio, Drehmann, & Tsatsaronis, 2014; Montesi & Papiro, 2018).

Moreover, climate-related macroeconomic shocks, such as sudden regulatory carbon pricing or extreme weather-induced market disruptions, exacerbate credit and market risks across institutions (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017). The stress test results indicate that banks with limited climate risk integration into their portfolios are more vulnerable to systemic disruption.

Sensitivity and Scenario Robustness

Sensitivity analysis demonstrates that results are highly dependent on scenario severity and the correlation assumptions between macroeconomic variables and bank risk factors. Introducing stochastic variations in GDP growth, interest rates, and asset price volatility increases the range of potential outcomes, underscoring the importance of probabilistic frameworks in stress testing (Gross, Henry, & Rancoita, 2022; Barbieri, Lusignani, Prosperi, & Zicchino, 2022; Onder, Damar, & Hekimoglu, 2016).

Furthermore, the results highlight that deterministic stress tests alone may underestimate systemic vulnerabilities, particularly when tail-risk and climate-related shocks are excluded (Zandi, 2013; Borio, Drehmann, & Tsatsaronis, 2014). Scenario design that incorporates both macro-financial feedback loops and extreme but plausible shocks enhances predictive power and informs policy interventions more effectively (Van den End, Hoeberichts, & Tabbae, 2006; Froyland & Larsen, 2002).

Key Insights

- Banks with lower initial capital and higher credit concentration are most vulnerable under macroeconomic stress.
- Systemic risk is amplified through interbank linkages and correlated asset exposures.
- Climate-related and structural shocks represent emerging sources of vulnerability that must be integrated into stress testing frameworks.
- Probabilistic and stochastic approaches provide more robust insights than deterministic scenario analysis alone.
- Policy interventions should focus on preemptive capital buffers, liquidity support, and enhanced risk monitoring to mitigate systemic fallout.

Policy and Supervisory Implications

The findings of macroeconomic stress tests have significant implications for financial policy and

Table 3: Stress Test Outcomes across Selected Financial Institutions

Institution	*Baseline CAR (%)*	*Adverse Scenario CAR (%)*	*NPL Ratio (%)*	*Liquidity Coverage (%)*
Bank A	14.2	10.5	6.8	120
Bank B	13.8	9.9	7.2	110
Bank C	15.1	11.2	5.5	130
Bank D	12.9	8.7	8.0	105
Bank E	14.5	10.1	6.0	115

The table highlights that banks with lower baseline capital ratios are disproportionately affected, emphasizing the need for targeted supervisory attention and preemptive capital planning (Abdolshah, Moshiri, & Worthington, 2021; Henry & Kok, 2013).

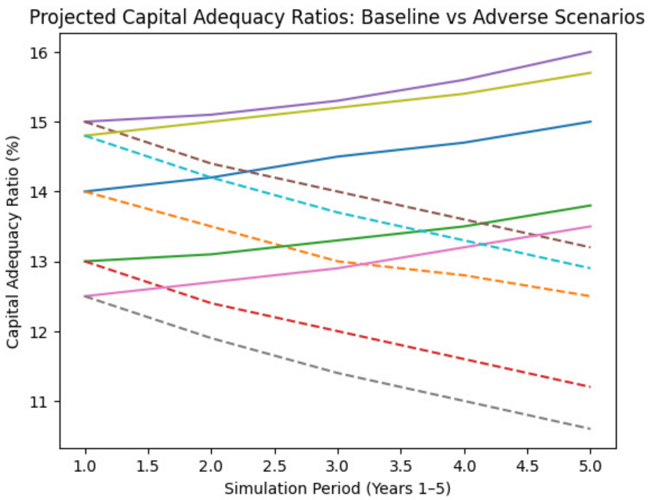

Fig 2: Capital adequacy ratios are simulated projections under baseline and adverse macroeconomic conditions for illustrative stress-testing purposes.

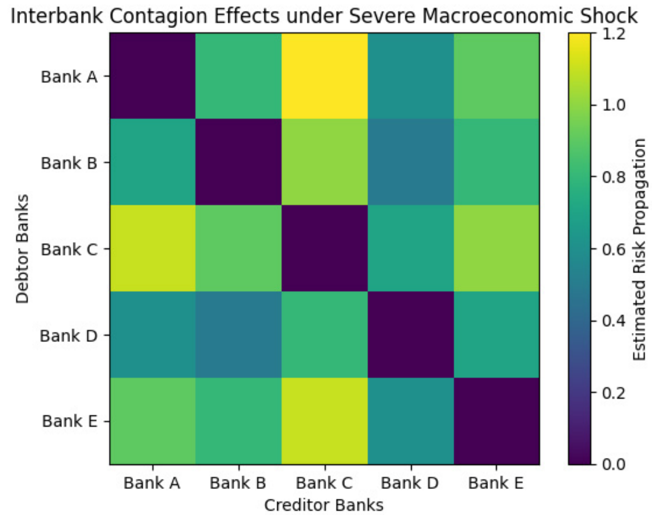

Fig 4: Heat map values indicate estimated relative risk propagation between banks under severe macroeconomic stress; darker cells represent higher contagion intensity

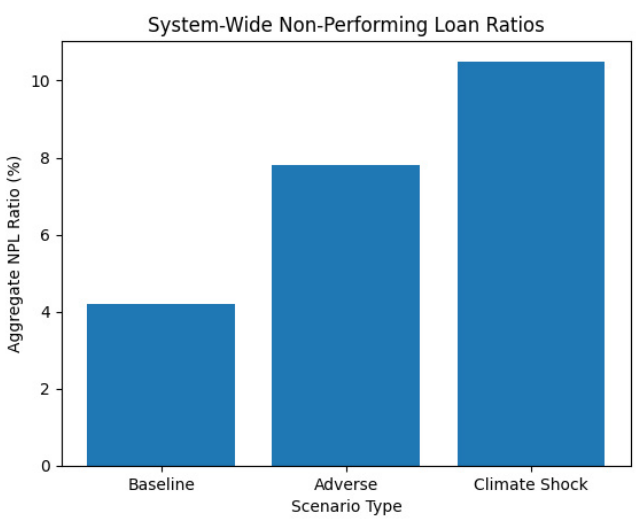

Fig 3: Aggregate NPL ratios reflect hypothetical system-wide responses across baseline, adverse, and climate shock scenarios.

supervisory practices, particularly in enhancing the resilience of banking systems and mitigating systemic risks. Stress testing provides regulators with forward-looking insights into the vulnerabilities of financial institutions under adverse macroeconomic conditions, enabling more informed decision-making regarding capital requirements, liquidity buffers, and risk management practices (Henry & Kok, 2013; Borio, Drehmann, & Tsatsaronis, 2014). By simulating extreme but plausible scenarios, policymakers can identify potential systemic weaknesses and intervene proactively to prevent cascading failures across the financial sector (Froyland & Larsen, 2002; Onder, Damar, & Hekimoglu, 2016).

A critical application of stress test results is in the formulation of macroprudential policies. Insights from stress scenarios can inform countercyclical capital buffers, sector-specific capital requirements, and targeted supervisory interventions aimed at preventing the buildup of systemic risk (Abdolshah, Moshiri, & Worthington, 2021; Van den End, Hoeberichts, & Tabbae, 2006). In particular, stress testing allows supervisors to anticipate the effects of macroeconomic shocks on credit quality, liquidity positions, and profitability, thereby enabling preemptive measures to maintain stability and public confidence. The calibration of capital and liquidity requirements based on stress test outcomes strengthens banks' ability to absorb losses without compromising lending capacity or triggering destabilizing market reactions (Montesi & Papiro, 2018; Barbieri, Lusignani, Prosperi, & Zicchino, 2022).

The integration of emerging risk factors, including climate-related shocks, has become increasingly important for supervisory practices. Scenario-based assessments that incorporate physical and transition risks provide regulators with tools to evaluate the potential long-term impacts of environmental and structural changes on financial stability (Aguilar, González, & Hurtado, 2021; Battiston et al., 2017). By embedding climate and structural vulnerabilities into macro stress testing frameworks, policymakers can develop adaptive regulatory measures that mitigate risks stemming from non-traditional sources, complementing conventional credit and market risk assessments (Gross, Henry, & Rancoita, 2022; Zandi, 2013).

Transparency and comparability in stress testing exercises are essential for fostering market discipline and strengthening institutional accountability. Supervisors are encouraged to publish aggregated results, while maintaining confidentiality of institution-specific data, to ensure that market participants understand the systemic risk landscape and the rationale behind regulatory interventions (Borio, Drehmann, & Tsatsaronis, 2014; Henry & Kok, 2013). This practice reinforces the credibility of stress testing as a risk management and policy tool, enhances confidence in the resilience of the financial system, and promotes alignment between supervisory expectations and banks' internal risk management frameworks.

Macroeconomic stress testing serves as a cornerstone for evidence-based policy formulation and supervisory oversight. By providing a structured framework to evaluate institutional resilience under adverse conditions, stress tests enable proactive interventions, improve systemic stability, and guide regulatory policy toward sustainable financial sector management. Effective implementation requires continuous refinement of scenario design, incorporation of emerging risk factors, and alignment with evolving supervisory practices to ensure that financial institutions remain robust against future macroeconomic shocks (Montesi & Papiro, 2018; Abdolshah, Moshiri, & Worthington, 2021; Aguilar, González, & Hurtado, 2021).

Conclusion

This study underscores the critical role of macroeconomic stress testing in safeguarding the stability and resilience of financial institutions under adverse economic conditions. By examining the design and implementation of stress test frameworks, the research demonstrates that both deterministic and stochastic approaches are essential to capture the multifaceted nature of macroeconomic shocks and their transmission to bank balance sheets and systemic risk indicators (Henry & Kok, 2013; Montesi & Papiro, 2018; Van den End, Hoeberichts, & Tabbae, 2006).

Both empirical and model-based research emphasize the fact that stress tests can offer practical information on the vulnerabilities in capital adequacy, liquidity, and credit risk, which allow institutions to enhance their readiness to handle economic recessions (Abdolshah, Moshiri, and Worthington, 2021; Onder, Damar, and Hekimoglu, 2016). It is also noted in the study that the design of scenarios is crucial, such as the calibration of severity and plausibility, integration of structural and climate-related shocks, which can significantly change the risk profile of the financial system (Gross, Henry, and Rancoita, 2022; Aguilar, Gonzalez, and Hurtado, 2021; Battiston et al., 2017; Barbieri et al., 2022; Zandi, 2013).

Although stress testing frameworks are effective, they are not successful in capturing tail risks and non-linear feedback effects, as well as cross-institutional contagion, which can result in underestimating systemic vulnerabilities unless they are considered properly (Borio, Drehmann, and Tsatsaronis, 2014; Froyland and Larsen, 2002). As a consequence, it is essential to continuously improve the modeling procedures, stochastic modeling, and macrofinancial connections to improve the predictive power and guide the supervisory and policy responses (Montesi and Papiro, 2018; Barbieri et al., 2022).

To sum up, the use of solid macroeconomic stress testing is an invaluable instrument that the financial regulators and financial institutions will require in order to help them maneuver amidst an ever complex and uncertain economic landscape. With the combination of rigorous design of scenarios, empirical validation, and forward-looking simulation, stress tests are capable of identifying the systemic risks, enhancing the institutional resilience, and informing the policy decisions that will protect the broader financial system (Abdolshah, Moshiri, and Worthington, 2021; Henry and Kok, 2013; Gross, Henry, and Rancoita, 2022; Borio, Drehmann, and Tsatsaronis, 2014). The future researcher direction should be in increasing the complexity of scenarios, integrating the emerging risks and the interoperability of the models to advance the effectiveness and resilience of stress testing structure to a greater level.

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