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BCC 14th Annual Conference
Resilience of the financial system:
Where do we stand?



Dynamic Responses of the Financial Stability Index to Macroeconomic Shocks: Evidence from the Tunisian Banking Sector

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Workshop 1: Shocks and financial stability

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How can financial stability in Tunisia be measured through a comprehensive Financial Stability Index, and how do macroeconomic shocks affect this index in terms of asymmetry and time-varying causality?

Evolution of the Concept of Financial Stability

Period	Evolution of the Concept	Description of the Evolution
Before 1980	Monetary stability and microprudential supervision	Before 1980, Financial stability was not yet treated as a distinct policy objective, the focus was mainly on price stability, monetary stability, and the soundness of individual banks . The failure of Bankhaus Herstatt in 1974 strengthened international supervisory cooperation and contributed to the creation of the Basel Committee on Banking Supervision (BCBS) in 1974 and the Basel Concordat .
1980–1996	Internationalization of prudential regulation	Banking supervision became more and more coordinated at the international level, while the regulatory approach remained mainly microprudential , focusing on the soundness of individual banks. A key milestone was Basel I (1988) , which introduced common minimum capital requirements and reinforced international prudential standards and supervisory cooperation.
1997–2006	Emergence of a systemic perspective on financial stability	The Asian financial crisis (1997–1998) highlighted the limits of focusing only on individual institutions and increased attention to systemic risk, contagion, and financial vulnerabilities . By the late 1990s, financial stability had become a major international policy concern.
2007–2009	Global financial crisis and challenge to the microprudential paradigm	The Global Financial Crisis exposed the limits of the microprudential approach and accelerated the shift toward system-wide risk and macroprudential policy .
2010–2019	Institutionalization of macroprudential policy and Basel III	Financial stability became an explicit policy objective. Basel III strengthened capital and liquidity requirements, while macroprudential frameworks were introduced to address systemic risk and improve financial-system resilience .
Since 2020	Broadening of financial stability to new systemic risks	Since 2020, financial stability has broadened to include new systemic risks , such as the COVID-19 shock, climate risks, cyber risks, digitalization, fintech, crypto-assets, and non-bank financial intermediation .

Evolution of the Concept of Financial Stability

Tunisian context

Period	Evolution of the Concept	Description of the Evolution
Before 1990	Monetary stability and banking control	The framework focused mainly on monetary stability and traditional banking supervision, with the BCT controlling individual banks and their activities.
1990–2010	Development and modernization of prudential regulation	Prudential regulation became more structured with BCT Circular No. 91-24 (1991) on risk division, risk coverage and monitoring of commitments. The banking framework was further modernized through Law No. 2001-65 , amended by Law No. 2006-19 , strengthening prudential requirements and banking supervision.
2011–2015	Strengthening microprudential resilience	Following the 2011 revolution, the BCT strengthened the resilience of individual banks through measures on governance, collective provisions, solvency and additional provisioning for old non-performing loans. Circular No. 2014-14 introduced a liquidity ratio aligned with the Basel III LCR.
2016–2019	Emergence of the macroprudential framework	A major institutional shift occurred with the new BCT statute and banking framework, which gave greater importance to financial stability, bank resolution and deposit protection. Prudential regulation increasingly converged toward Basel II/III, while the Loans-to-Deposits ratio (LTD) introduced by Circular No. 2018-10 added a system-wide liquidity and credit constraint.
2020–2021	Prudential and macroprudential crisis management	During the COVID-19 crisis , prudential and monetary measures were used to preserve bank liquidity, support credit and prevent the health shock from generating broader financial instability.
Since 2022	Institutionalization and deepening of macroprudential policy	The framework has progressively moved toward a broader financial-stability approach, combining microprudential supervision with system-wide risk monitoring, Basel III convergence, consolidated supervision and growing attention to emerging risks, including digital finance and Fintech.

Literature review

Study	Financial Stability Measure	Macroeconomic Variables	Method / Sample	Main Findings
Čihák & Schaeck (2007)	Financial Soundness Indicators: NPLs, capital adequacy, ROA	GDP, inflation, interest rates, real exchange rate	Panel of 96 countries	Financial soundness indicators respond strongly to the business cycle and inflation . Short-term interest rates and the real exchange rate also play an important role .
Illing & Liu (2006)	Financial Stress Index	Financial and macroeconomic variables	Canada	Develop a composite financial stress index capable of identifying episodes of financial stress. Their approach became an important reference for analyzing macro-financial interactions.
Li & St-Amant / Bank of Canada (2010)	Illing and Liu Financial Stress Index	Real GDP, inflation, real interest rate	VAR, Canada, quarterly data	Explicitly examine the interactions among financial stress, monetary policy, and real economic activity.
Hatzius et al. (2010)	Financial Conditions Index	GDP, inflation, interest rates, spreads, credit, asset prices	United States	Financial conditions contain significant information for forecasting future economic activity, even after controlling for past GDP and inflation.
Hubrich & Tetlow (2015)	Financial Stress Index	Real activity, inflation, monetary policy	Markov-Switching VAR, United States	The relationship between financial stress and the macroeconomy is nonlinear. The effects become substantially stronger during periods of high financial stress.
Martín Saldías (2017), (IMF working paper)	Financial Stress Index	Output growth, inflation, monetary policy	Bayesian Threshold VAR	The interaction between monetary policy and financial stability depends on the financial stress regime , suggesting that linear models may conceal important nonlinear effects.
Ullah, Ullah & Zaman (2024)	Composite Financial Stability Index (FSI)	GDP growth, inflation, interest rate, money supply, governance indicators	122 developed and emerging countries, 2013–2020; two-step system GMM	GDP growth and interest rates are positively associated with financial stability in the full sample, while inflation and money supply have adverse effects. Results differ between developed and emerging economies .

Literature review

Study	Financial Stability Measure	Macroeconomic Variables	Method / Sample	Main Findings
Danisman & Tarazi (2024)	Bank stability measures	Economic Policy Uncertainty (EPU), with bank size, capital and liquidity as moderators	International bank sample in the post-GFC period; Panel analysis	Higher EPU is associated with lower bank stability. The adverse effect is stronger for larger banks and weaker for better-capitalized and more liquid banks.
Vuong et al (2024)	Bank stability measures, with alternative measures for robustness	EPU, geopolitical risk, climate-policy uncertainty, pandemic uncertainty, global supply-chain pressure, monetary-policy uncertainty	ASEAN-8 countries, 2010–2020; Panel fixed-effects, & quantile regression	Most forms of macroeconomic uncertainty weaken bank stability. EPU, climate-policy uncertainty, pandemic uncertainty, supply-chain pressure and monetary-policy uncertainty have negative effects; geopolitical risk is positively associated with stability.
Ali Awdeh et al (2024)	Bank financial stability and credit-risk indicators	Inflation; bank-specific and institutional-quality interactions	188 banks in 14 MENA economies, 1999–2021; dynamic GMM	Higher inflation weakens bank stability and worsens credit risk. Stronger capitalization, liquidity, bank size, market power, foreign ownership and political stability can mitigate the adverse effect.
Hakimi, Zaghdoudi, Zaghdoudi & Djebali (2017) – Tunisia	Z-score	GDP growth, inflation; bank-specific and industry-specific controls	10 Tunisian banks, 1990–2015; Bayesian Model Averaging and Panel Random effect	Capital adequacy improves bank stability, whereas liquidity risk reduces it. GDP growth and inflation are included as macroeconomic determinants, but the final empirical results do not find statistically significant effects for the macroeconomic variables.
Neifar & Gharbi (2022)- Tunisia	Z-score, capital adequacy, deposits/assets	GDP growth, inflation, interest rate, exchange rate, unemployment, FDI	Tunisian banks, 2005–2014	Banking stability in Tunisia is sensitive to macroeconomic conditions. Higher inflation, unemployment, and exchange-rate depreciation are associated with greater financial instability, while interest rates also have a significant effect.

1. Financial Stability Index (FSI)

- **Method:** Principal Component Analysis (PCA)
- **Objective:** Construct a quarterly Financial Stability Index.

How can a comprehensive Financial Stability Index be constructed for Tunisia?

2. Asymmetric SVAR

- **Objective:** Analyze the asymmetric responses of the FSI to macroeconomic shocks.

How does the FSI respond dynamically to macroeconomic shocks?

3. TVP-Granger Causality

- **Objective:** Identify when macroeconomic variables significantly influence financial stability.

During which periods are macroeconomic variables statistically causal for financial stability?

Construction of the Financial Stability Index (FSI)

Variables Selected for the Construction of the Financial Stability Index (FSI)

Index		Indicators		Role in the Index
Solvency	SOL	Capital Adequacy Ratio	CAR	Stabilizing (+)
Asset Quality	AQ	Non-Performing Loans Ratio	NPL	Destabilizing (–)
Profitability	PROF	Return on Equity	ROE	Stabilizing (+)
		Return on Assets	ROA	
Efficiency	EFF	Cost-to-Income Ratio	CIR	Destabilizing (–)
Macroeconomic Conditions	MAC	Domestic Debt/GDP	DD	Destabilizing (–)
		Import Coverage Days	IMPD	Stabilizing (+)

Construction of the Financial Stability Index (FSI)

Kaiser-Meyer-Olkin (KMO) and Bartlett's Tests

Test	Result	Interpretation
KMO global	0.63	Acceptable
Bartlett (p-value)	2.66×10^{-10}	Highly significant

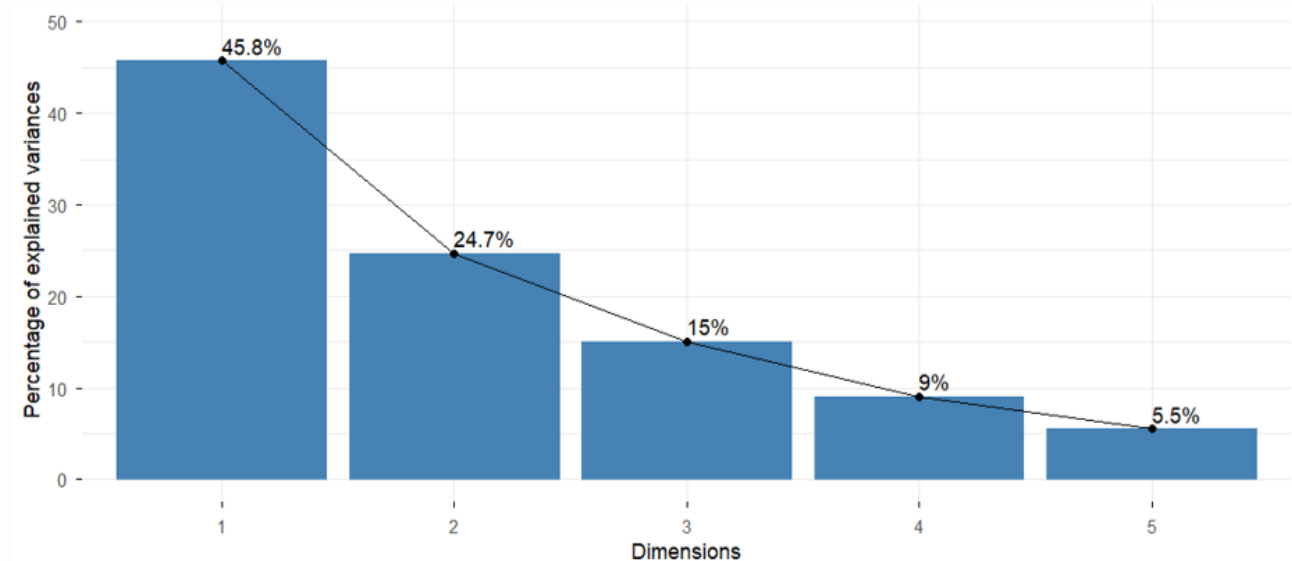
- The KMO statistic is **0.63**, indicating an acceptable level of sampling adequacy.
- Bartlett's test is **highly significant**, with a p-value well below 0.001, confirming that the variables are sufficiently correlated.

Construction of the Financial Stability Index (FSI)

Scree Plot of Eigenvalues

	Eigen value	Variance %	Cumulative variance %
Dim.1	2.2366327	44.732655	44.73265
Dim.2	1.2911486	25.822972	70.55563
Dim.3	0.7935667	15.871334	86.42696
Dim.4	0.4063162	8.126324	94.55329
Dim.5	0.2723357	5.446715	100.00000

Figure 1: Scree Plot of Eigenvalues



- **Kaiser criterion:** Retain components with **eigenvalues > 1**.
- **Dim1:** Eigenvalue = **2.24**, explains **44.7%** of the total variance.
- **Dim2:** Eigenvalue = **1.29**, explains **25.8%** of the total variance.
- **Dim1 + Dim2 = 70.6%** of the total variance.
- **Only the first two components were retained for constructing the Financial Stability Index.**

Construction of the Financial Stability Index (FSI)

Figure 2: Quality of Variable Representation

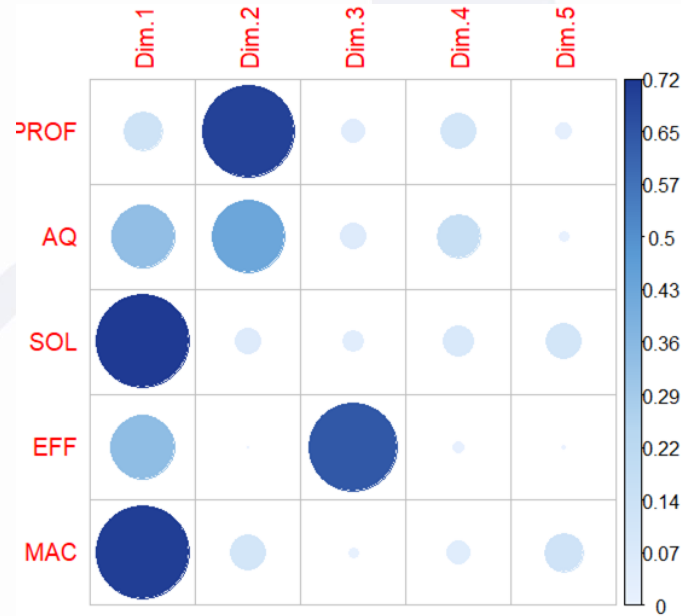
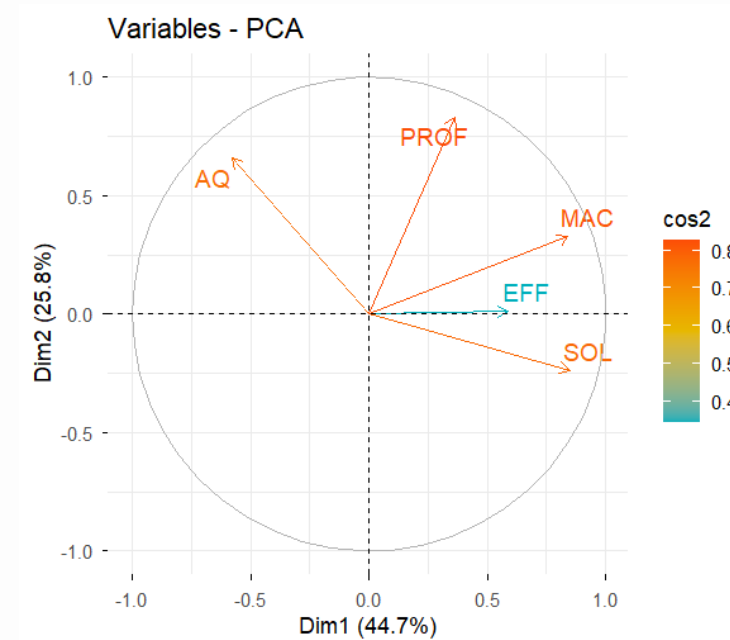


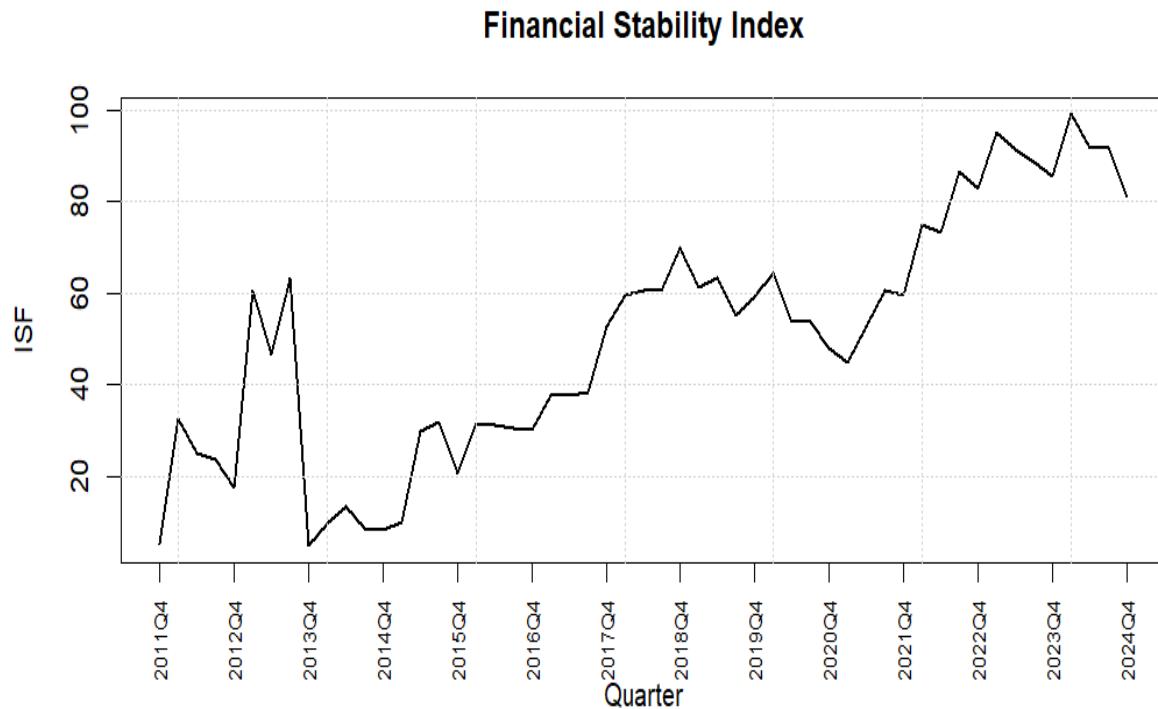
Figure 3: Correlation Circle



- Most variables are well represented on the first two dimensions.
- EFF is adequately represented but contributes less to the first two dimensions.

- **Component 1:** Structural financial stability (SOL, EFF, MAC).
- **Component 2:** Banking performance (PROF, AQ).

Construction of the Financial Stability Index (FSI)



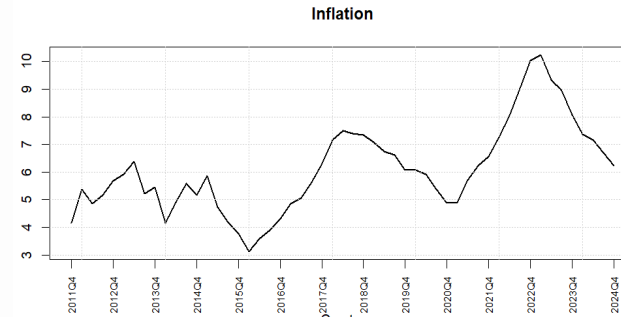
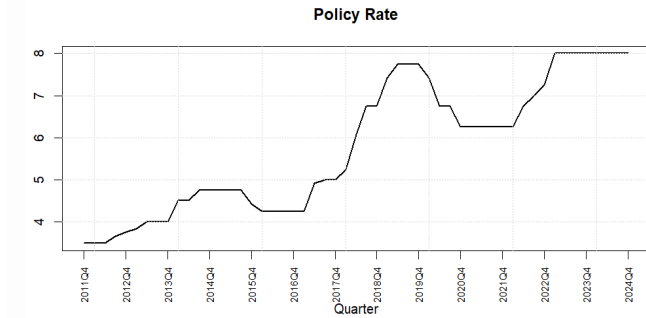
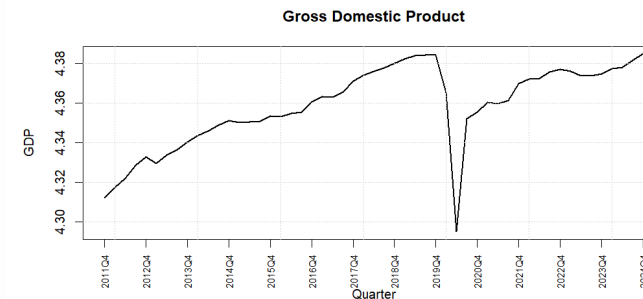
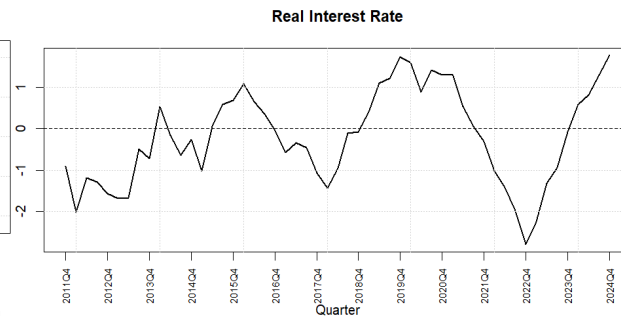
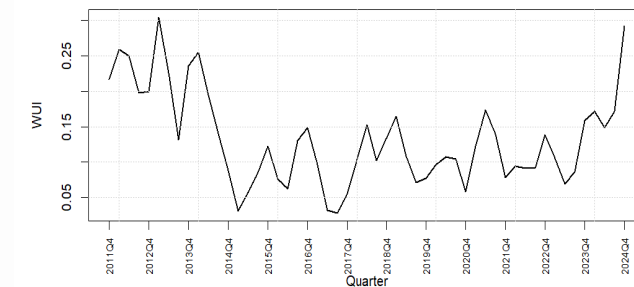
Overall, the index exhibits an upward trend, indicating a gradual strengthening of financial stability over the study period. However, this evolution can be divided into several distinct phases.

- **2011–2014:** Post-revolution instability → High volatility and weak financial stability.
- **2015–2019:** Prudential reforms and stronger banking supervision → Gradual improvement.
- **2020:** COVID-19 shock → Temporary decline in the FSI.
- **2021–2024:** Economic recovery and continued reforms → Stronger banking resilience and higher financial stability.

Descriptive Statistics and Evolution of Macroeconomic Variables

Descriptive Statistics

Variable	Mean	Median	Std_Dev	Minimum	Maximum
ISF	50,43	53,67	26,73	5,05	99,11
Inflation	6,10	5,90	1,61	3,13	10,25
Policy_Rate	5,77	6,08	1,57	3,50	8,00
lnGDP	4,36	4,36	0,02	4,29	4,39
WUI	0,13	0,12	0,07	0,03	0,30
Real_Rate	-0,20	-0,17	1,14	-2,79	1,77



- Stationarity was assessed using the Phillips–Perron (PP) unit root test.
- The Financial Stability Index (FSI) is stationary in levels ($I(0)$).
- All macroeconomic variables are non-stationary in levels but become stationary after first differencing ($I(1)$).
- Accordingly, the transformed stationary series were used in the subsequent econometric analyses.

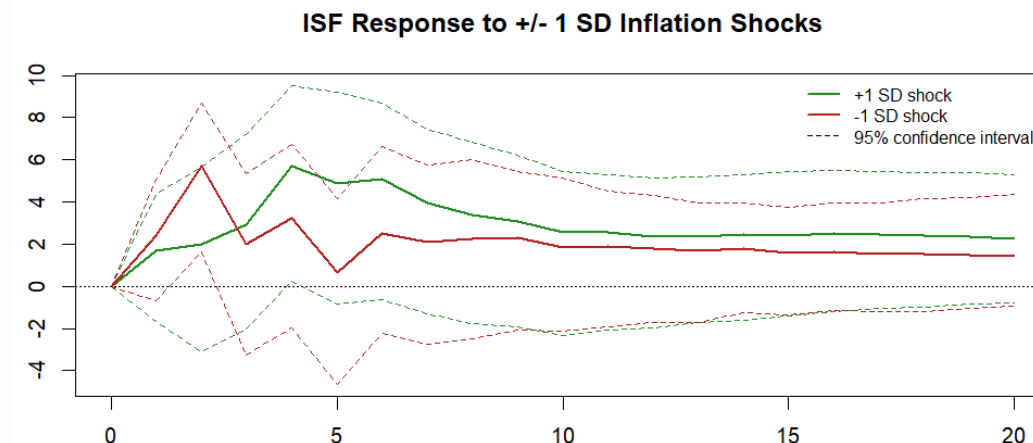
L'inflation :

- **Positive response of the FSI to both positive and negative inflation shocks.**
- **The response is stronger following a positive inflation shock, indicating sign asymmetry.**
- **Larger inflation shocks generate disproportionately larger responses (size asymmetry).**

(The response of the FSI to a 10σ inflation shock is not equal to ten times the response to a 1σ shock)

- **Suggests stronger monetary and prudential policy interventions during severe inflationary episodes.**
During episodes of high inflation, the Central Bank implements tighter monetary and prudential measures to contain inflationary pressures and safeguard financial stability

FSI Responses to Positive and Negative Shocks (*Sign Asymmetry*)



FSI Responses to Shocks of Different Magnitudes (*Size Asymmetry*)

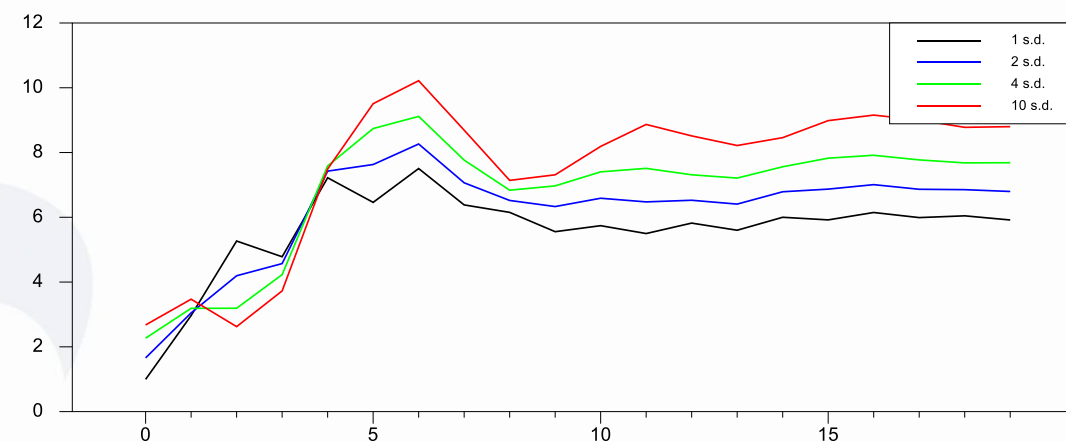


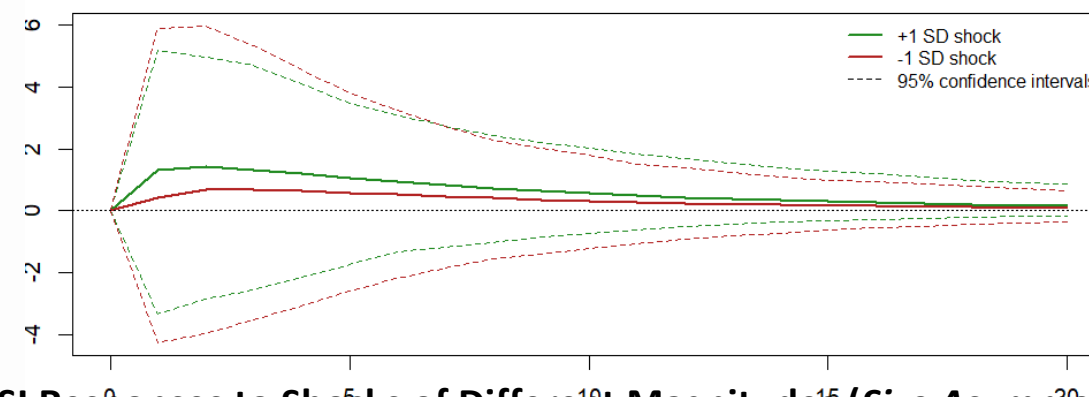
Figure : The Response of ISF to a Positive inflation Shock by Shock Size

Policy Rate

- **Limited sign asymmetry:** both positive and negative 1σ shocks produce only a small positive response of the FSI.
- **The responses remain statistically insignificant.**
- **Strong size asymmetry:** large interest rate shocks have a disproportionately larger adverse effect on financial stability.
- **Moderate policy rate adjustments may support financial stability, whereas aggressive monetary tightening may weaken it**

FSI Responses to Positive and Negative Shocks (*Sign Asymmetry*)

ISF Response to +/- 1 SD Policy Rate Shocks



FSI Responses to Shocks of Different Magnitudes (*Size Asymmetry*)

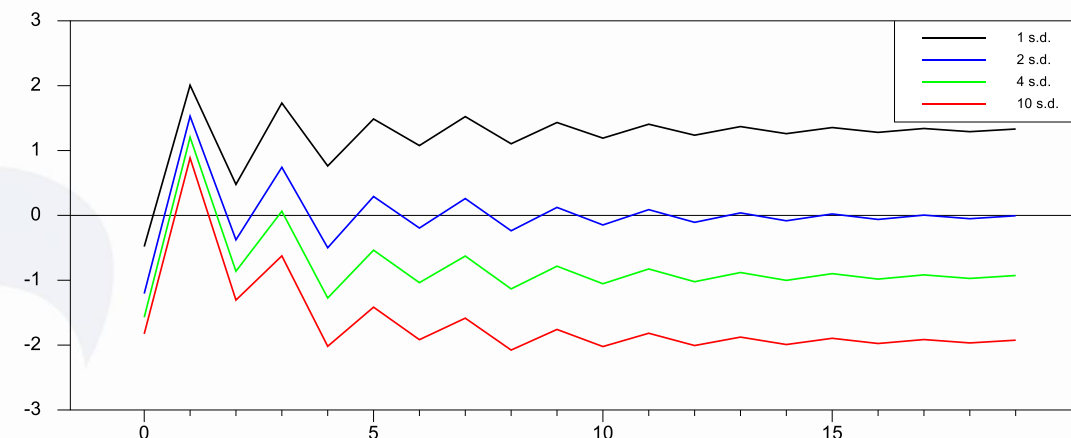


Figure : The Response of ISF to a Positive Policy Rate Shock by Shock Size

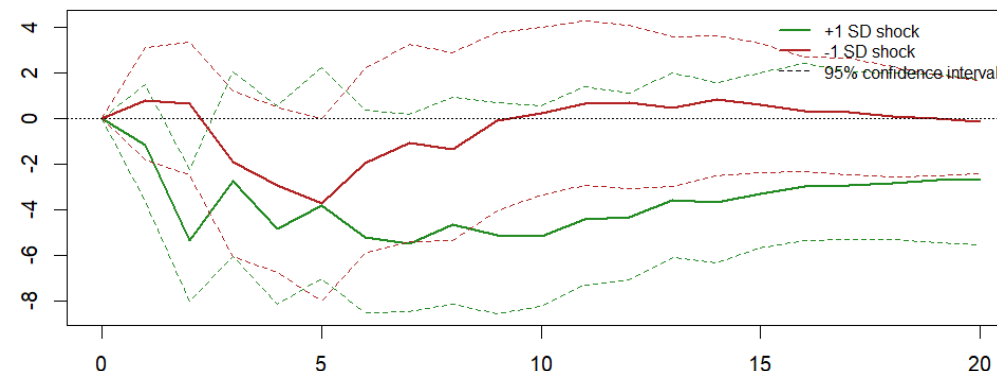
Real Interest Rate

- **Strong sign asymmetry.**
- **A decrease in the real interest rate slightly improves financial stability.**
- **An increase in the real interest rate leads to a much stronger deterioration of the FSI.**
- **Large real interest rate shocks amplify the deterioration of financial stability (size asymmetry).**
- **Inflation remains the dominant driver of monetary policy decisions.**

Increases in the policy rate are largely implemented to contain inflationary pressures and anchor inflation expectations. Consequently, the effect of higher real interest rates reflects the monetary tightening adopted in response to inflation.

FSI Responses to Positive and Negative Shocks (*Sign Asymmetry*)

ISF Response to +/- 1 SD Real Rate Shocks



FSI Responses to Shocks of Different Magnitudes (*Size Asymmetry*)

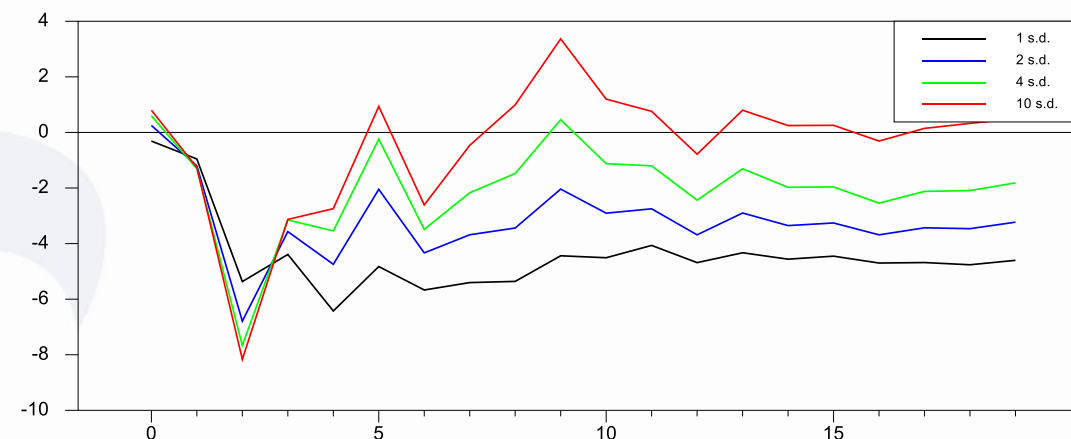
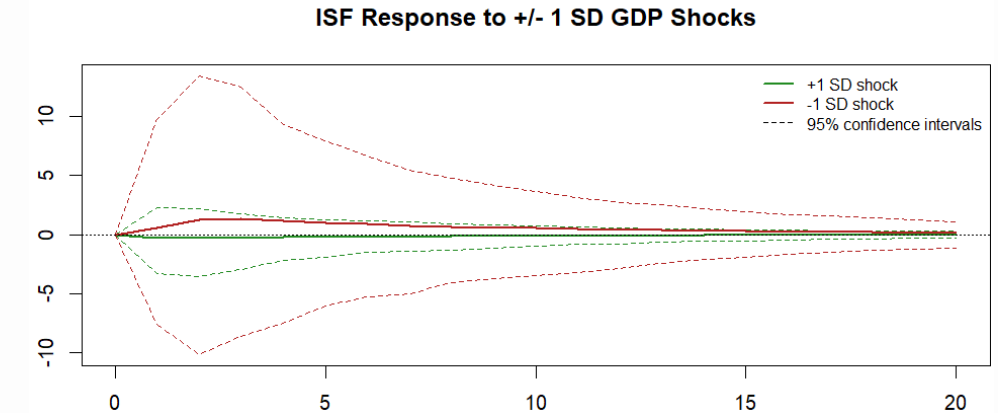


Figure : The Response of ISF to a Positive Real Interest Rate Shock by Shock Size

GDP Growth

- Sign asymmetry.
- Negative GDP shocks have a stronger impact than positive shocks.
- Larger GDP shocks generate stronger improvements in the FSI (size asymmetry).
- Economic growth does not always create financial stability.

FSI Responses to Positive and Negative Shocks (*Sign Asymmetry*)



FSI Responses to Shocks of Different Magnitudes (*Size Asymmetry*)

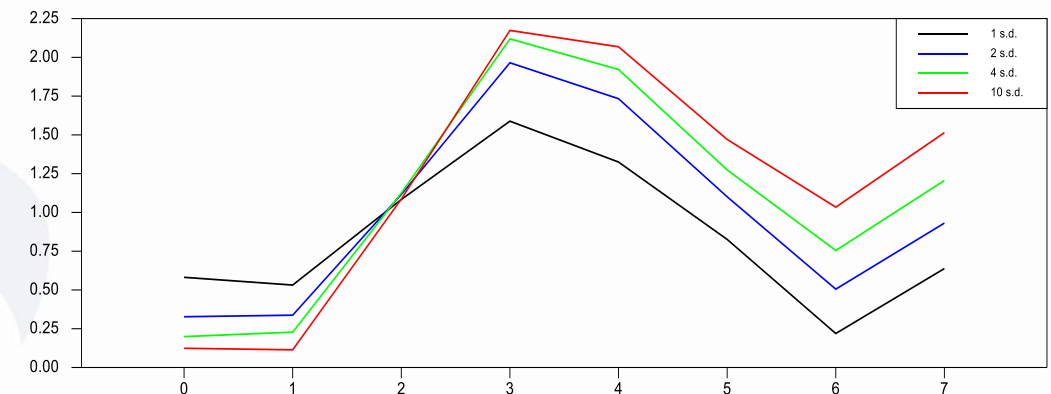


Figure : The Response of ISF to a Positive gdp growth Shock by Shock Size

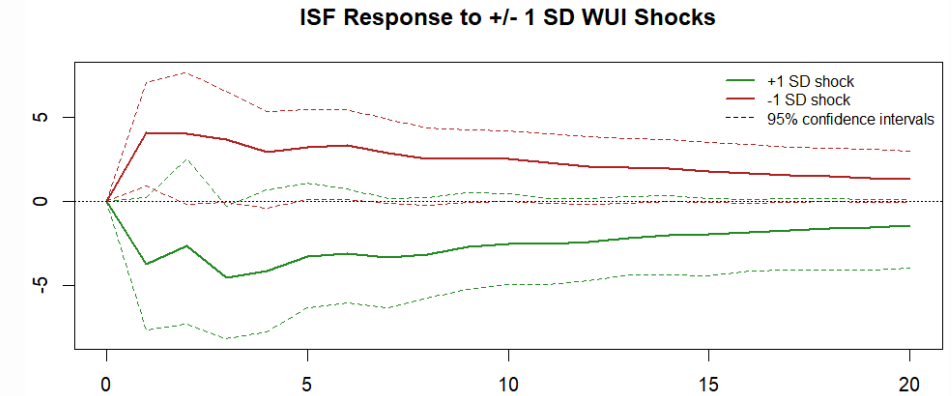
Asymmetric Responses of the Financial Stability Index

World Uncertainty Index (WUI)

- Symetric sign effect.
- Positive and negative uncertainty shocks have similar magnitude effects on the FSI.
- **Clear size asymmetry:** larger uncertainty shocks generate stronger deteriorations in financial stability.
- **This results can be explained as follow :** Large uncertainty episodes require stronger policy interventions.

Larger uncertainty shocks trigger a significantly stronger response from the FSI, meaning that extreme uncertainty episodes generate much greater deteriorations in financial stability

FSI Responses to Positive and Negative Shocks (*Sign Asymmetry*)



FSI Responses to Shocks of Different Magnitudes (*Size Asymmetry*)

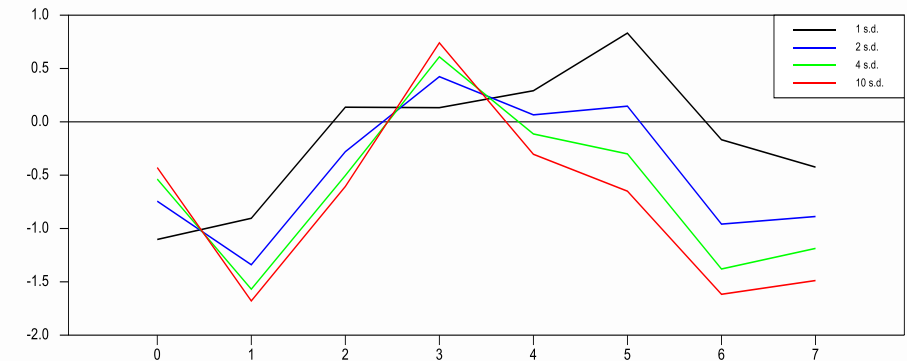


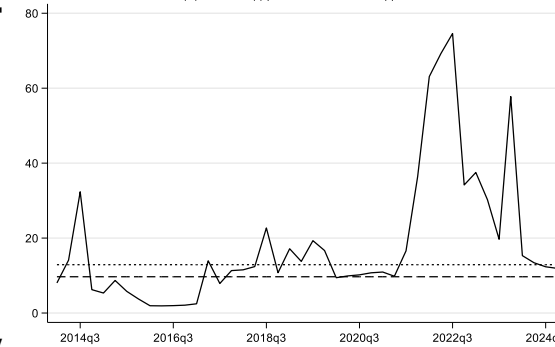
Figure : The Response of ISF to a Positive WUI Shock by Shock Size

- The TVP-Granger test identifies when Granger causality is statistically significant.
- Causal relationships are time-varying rather than constant.
- Inflation, GDP, the policy rate, and the World Uncertainty Index significantly affect the FSI mainly during periods of economic and political stress.
- The strongest causal effects are observed during the post-revolution period and the COVID-19 crisis.

TV Granger causality test results

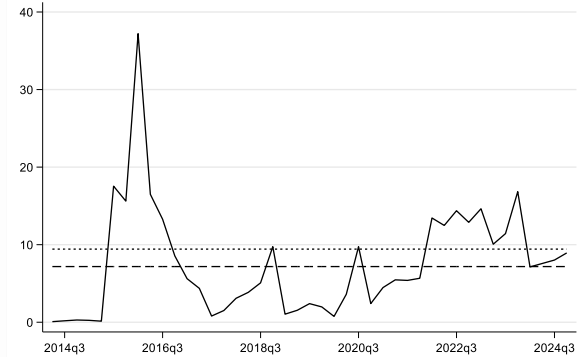
Inflation

Recursive expanding Wald test for Inisf G-caused by Inflation, 2011q4 - 2024q3
with 90th (---) and 95th (-) percentiles of bootstrapped test statistics



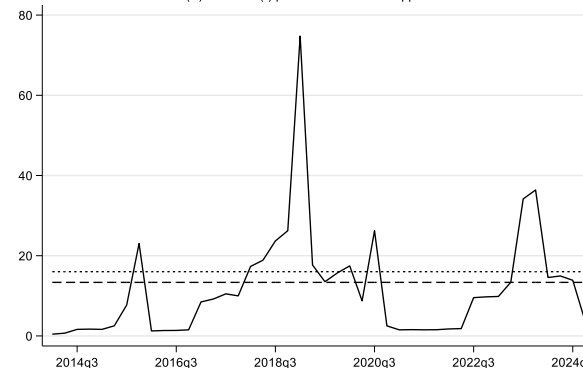
Policy rate

Recursive expanding Wald test for Inisf G-caused by dint, 2012q1 - 2024q4
with 90th (---) and 95th (-) percentiles of bootstrapped test statistics



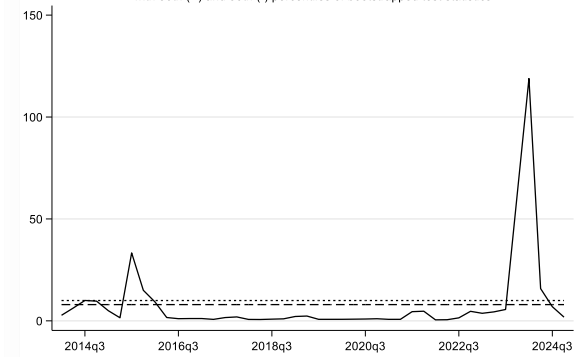
GDP

Recursive expanding Wald test for Inisf G-caused by lngdp, 2011q4 - 2024q3
with 90th (---) and 95th (-) percentiles of bootstrapped test statistics



WUI

Recursive expanding Wald test for Inisf G-caused by lnwui, 2011q4 - 2024q3
with 90th (---) and 95th (-) percentiles of bootstrapped test statistics



Main Findings

- A **Financial Stability Index (FSI)** for Tunisia was successfully constructed using **Principal Component Analysis (PCA)**, combining banking and macroeconomic indicators.
- The FSI captures the main episodes of financial stress and recovery, including the post-revolution period, the COVID-19 crisis, and the subsequent strengthening of financial stability.
- The asymmetric SVAR analysis reveals that financial stability responds **nonlinearly** to macroeconomic shocks:
 - Inflation exhibits both **sign** and **size asymmetries**.
 - The real interest rate generates the strongest asymmetric responses.
 - Large shocks have disproportionately larger effects on financial stability.
- The **Time-Varying Granger Causality** test shows that macroeconomic variables influence financial stability **mainly during periods of economic and political turbulence**, particularly after the Tunisian Revolution and during the COVID-19 pandemic.
- These findings highlight the importance of adopting **nonlinear and time-varying models** to better understand the dynamics of financial stability and support macroprudential surveillance.

Thank you



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